Minimum Effort

Teaching Note | MobLab x Harvard Business Impact

Primary Topic:	Game Theory, Organizational Economics, Behavioral Economics
Typical Duration:	Set-up: 5 min | Game play: 10 min | Debrief: 10-15 min
Group Size:	Default: 6 players per group; scales to any class size
Difficulty Level:	Introductory / Intermediate
Prerequisites:	Basic familiarity with the concept of Nash equilibrium helpful but not required. Works well as a first exposure to coordination problems and multiple equilibria.

1. Simulation Overview

Based on the classic coordination game of Van Huyck, Battalio, and Beil (1990), this simulation places students in the role of airline ground crew employees working to reduce a plane's turnaround time. Each group member simultaneously chooses an effort level — how many minutes to cut from their usual work time — between 1 and 7. Every player pays a cost of $1 for each minute of effort they personally choose. But the actual time the team saves is determined not by individual effort, but by the minimum effort chosen by anyone in the group.

This creates a stark tension. The bonus for every group member is $2 per minute the team saves, but the team's savings are capped by whoever exerts the least effort. Choosing 7 minutes of effort maximizes the team's potential savings, but it exposes the chooser to the worst possible outcome: if anyone in the group chooses 1, the team only saves 1 minute, and the player who chose 7 earns a net payoff of -$5. Choosing 1 minute guarantees a $1 payoff regardless of what others do.

The game has seven Nash equilibria in pure strategies — one for each effort level — and they are Pareto-ranked: everyone choosing 7 is the best equilibrium for all, but it is also the riskiest. The payoff-dominant equilibrium (all choose 7) requires perfect trust that no one will defect to a lower effort. The maximin equilibrium (all choose 1) is perfectly safe but wastes all potential gains. Where groups end up between these poles — and how their behavior changes across rounds and treatment conditions — is the heart of the experiment.

Citation: Van Huyck, John B., Raymond C. Battalio, and Richard O. Beil (1990). 'Tacit Coordination Games, Strategic Uncertainty, and Coordination Failure.' The American Economic Review, 84(1): 234-248.

Learning Objectives

By the end of this simulation, students will be able to:

- Multiple Equilibria and Pareto Ranking: Identify when a game has multiple Nash equilibria and explain how to rank them by Pareto efficiency — recognizing that all players prefer some equilibria to others, but that the most efficient equilibrium is not necessarily the one that gets played.
- Strategic Uncertainty and Coordination Failure: Explain why players may fail to coordinate on the payoff-dominant equilibrium even when everyone agrees it is the best outcome. Connect this failure to the concept of strategic risk — the risk that arises not from randomness in outcomes but from uncertainty about what other rational players will do.
- Reducing Miscoordination: Evaluate mechanisms — repeated interaction, communication, and target-setting — that can shift groups toward higher-effort coordination and explain why each mechanism works by reducing strategic uncertainty.
- Real-World Applications: Identify coordination problems with minimum-effort structure in organizational settings — team projects, software compatibility, safety protocols, supply chain reliability — and analyze what conditions make efficient coordination more or less likely.

2. Game Mechanics

Payoff Formula

Each round, a player's payoff is:

Total Payoff = (Effort Bonus x Minimum Group Effort) - (Effort Cost x Your Effort) = ($2 x Min) - ($1 x Your Effort)

With default parameters (Effort Bonus = $2, Effort Cost = $1), the worked example from the existing note illustrates the tension clearly:

- Your effort: 4 minutes. Other group members choose: 3, 5, and 7 minutes.

- Minimum group effort = 3 (the lowest choice in the group).
- Your payoff = ($2 x 3) - ($1 x 4) = $6 - $4 = $2.
- The player who chose 7 earns: ($2 x 3) - ($1 x 7) = $6 - $7 = -$1.
- The player who chose 3 earns: ($2 x 3) - ($1 x 3) = $6 - $3 = $3 (the most of anyone).

Full Payoff Matrix (Default Parameters)

The table below shows every player's payoff for each combination of personal effort and group minimum. The diagonal (where Your Effort = Min) represents equilibrium outcomes. Notice that moving up the diagonal strictly improves everyone's payoff — but moving above your row's equilibrium exposes you to losses if the group minimum falls short.

Your Effort \ Min	1	2	3	4	5	6	7
1	$1	$1	$1	$1	$1	$1	$1
2	$0	$2	$2	$2	$2	$2	$2
3	-$1	$1	$3	$3	$3	$3	$3
4	-$2	$0	$2	$4	$4	$4	$4
5	-$3	-$1	$1	$3	$5	$5	$5
6	-$4	-$2	$0	$2	$4	$6	$6
7	-$5	-$3	-$1	$1	$3	$5	$7

Key Insight: Every cell on the diagonal is a Nash equilibrium: if everyone else chooses effort level X, your best response is also X (choosing more costs you without increasing the minimum; choosing less reduces the minimum and your bonus).

3. Classroom Setup

Configuration	Recommended Setting
Group Size	Default: 6. Smaller groups coordinate more easily (lower strategic uncertainty). Try groups of 3 vs. 6 across sessions to show the group size effect directly.
Effort Range	Minimum Effort Level: 1 (default). Maximum Effort Level: 7 (default). The range determines the number of equilibria and the gap between the worst and best outcomes.
Effort Bonus	Default: $2 per minute saved by the team. This must exceed the Effort Cost for the game to have a meaningful coordination problem.
Effort Cost	Default: $1 per minute of personal effort. Setting Cost = Bonus eliminates the incentive to exceed 1; setting Cost > Bonus means only effort level 1 is individually rational.

Configuration	Recommended Setting
Number of Rounds	Single round (Minimum Rounds = 1, Ending Probability = 100%): shows raw coordination failure. Multiple rounds with fixed groups: allows learning and convergence. Recommended: run 3-5 rounds to see the trajectory.
Chat	Disabled for baseline. Enable in a replay session to show how communication shifts coordination toward higher effort levels.
Target Effort	Set to 0 to disable (default). Set to any value 1-7 to announce a target effort level to all group members before each round. Even a non-binding target dramatically increases coordination on higher effort.
Robot Players	Robots choose randomly from the effort range. This introduces random variation and may push group minimums down — useful for demonstrating that a single low-effort player can unravel the group's coordination.
Technology Required	Laptop or tablet with an up-to-date web browser. Direct students to video instructions before class.

4. Pedagogical Instructions

Recommended Game Sequence

The Minimum Effort game is most powerful when run as a progression across two or three sessions that isolate different mechanisms:

- Session 1 — Single Round, No Chat: The baseline. Most groups will show dramatic miscoordination in round 1, with wide dispersion of choices within groups and group minimums near 1-3. This is your cleanest demonstration of coordination failure.
- Session 2 — Multiple Rounds, Fixed Groups, No Chat: Run 3-5 rounds. Groups typically converge, but toward lower effort levels — last round's minimum anchors this round's choices downward. This shows how repeated interaction reduces excess effort (less waste) but does not solve the underlying coordination problem.
- Session 3 — With Chat or Target Effort: Enable either chat or a target effort announcement. Coordination on higher effort levels increases substantially. This is the treatment comparison that connects the game to real organizational solutions.

> **Instructor Tip:** Do not tell students the Nash equilibria or explain the payoff-dominant vs. maximin distinction before the first session. Let them experience the coordination failure and the downward anchoring organically. The theory lands much harder when students have already felt the frustration of watching their high effort wasted by a low-effort group member.

Pre-Game Briefing

Before the first session, walk through the payoff formula:

- Each of you chooses a number between 1 and 7 — how many minutes you will cut from your usual work time.
- You pay $1 for each minute you choose to save. Your team bonus is $2 for each minute the team actually saves.
- But the team's actual savings equals the lowest choice among all group members.
- Walk through the worked example: if you choose 4 and the group minimum is 3, you earn $2 x 3 - $1 x 4 = $2. If someone in your group chose 7 and the group minimum is still 3, they earn -$1.
- Ask: what is the safest choice? (1 — guarantees $1 regardless.) What is the best choice if everyone cooperates? (7 — earns $7.) What is the best choice if you expect someone to choose 1? (Also 1 — to minimize losses.)

Instructor Tip: After explaining the payoff, give students 60 seconds to write down their strategy before round 1 begins. Collecting these (or just asking for a show of hands on who planned to choose 7 vs. 1-3) sets up a powerful debrief comparison: did students follow their planned strategy, or did they hedge downward?

The Gameplay Experience

During play, watch for:

- Round 1 — Wide Dispersion: In most groups, some students choose 7 (hoping for coordination), others choose 1-3 (hedging against the worst case). The group minimum is typically 1-2, meaning high-effort players earn negative payoffs. This visceral experience of being punished for trusting your group is the emotional core of the experiment.
- Rounds 2-3 — Downward Anchoring: Players who chose high effort in round 1 and earned negative payoffs typically reduce their effort in round 2. Even players who chose low effort may reduce further, anchoring on the previous round's minimum. Groups rarely converge upward without intervention.
- The Coordination Trap: By round 3-5, most groups are coordinating around effort levels 1-3 — far below the payoff-dominant equilibrium. This is a stable, low-efficiency equilibrium: no one wants to unilaterally raise their effort because it would only waste money. This trap is the key teaching point.

Facilitator Checklist

1. Set up sessions in a playlist before class — one for baseline, one for the coordination-improving treatment.
2. Direct students to video instructions before class via the Instructions link.
3. Before round 1, ask students to write down their planned effort level and their reasoning.
4. During play, monitor the Monitor tab to observe which groups are miscoordinating in real time.
5. Before the debrief, navigate to Results and prepare both the Multi-Round Summary and the Round 1 distribution chart.

5. Debriefing & Discussion

Plan for 10-15 minutes. Ask for written reflection first, then open the results graphs. The most powerful debrief sequence is: show Round 1 individual choices, then show the group minimums, then show the across-round trend. Let students identify the gap between intended behavior and actual outcomes before introducing theory.

Suggested Reflection Questions (before viewing results)

6. What effort level did you choose in Round 1, and why? What were you worried about?
7. In later rounds, did you increase or decrease your effort? What drove that change?
8. Did anyone in your group try to signal a high effort level — and did it work?

Discussion Questions (after viewing results)

- Look at the Round 1 distribution. Most groups had large spreads of individual choices but group minimums near 1-2. Why did effort cluster low even though everyone would have been better off if everyone had chosen 7?
- The payoff-dominant equilibrium is for everyone to choose 7. Is this outcome also a Nash equilibrium? If yes, why didn't groups find it?
- Across rounds, did coordination improve? In which direction — toward higher or lower effort? Why does repeated interaction tend to push effort down rather than up?
- In the chat-enabled or target-effort session, what changed? Why does communication make a difference when the problem is about coordination rather than conflict?
- Think of a real organizational situation with a minimum-effort structure — a team project where the grade equals the weakest submission, a software system where compatibility requires every component to meet a standard, a supply chain where delivery speed is limited by the slowest link. What would you recommend to a manager trying to avoid the coordination trap?

Theoretical Connections

- Multiple Equilibria and Pareto Ranking: Unlike the Prisoner's Dilemma, which has a unique Nash equilibrium, the Minimum Effort game has seven. They can be ranked: all-7 is Pareto superior to all-6, which is Pareto superior to all-5, and so on. The existence of Pareto-ranked equilibria raises the question of why markets and organizations sometimes get stuck in inferior ones.
- Strategic Uncertainty: The concept of strategic risk — introduced by Harsanyi and Selten (1988) — captures why players may prefer a safer equilibrium to a more profitable one. Choosing 7 in a group of 6 requires confidence that all 5 other players will also choose 7. Each additional player in the group multiplies this risk. The game makes strategic uncertainty tangible in a way that pure theory rarely does.
- Risk Dominance vs. Payoff Dominance: Game theorists distinguish between the payoff-dominant equilibrium (everyone prefers it) and the risk-dominant equilibrium (it is the safest choice under uncertainty). In the Minimum Effort game, the maximin equilibrium (all choose 1) is risk-dominant: it is the best response to any belief about others. The tension between these two selection criteria is one of the most discussed problems in equilibrium selection theory.
- Communication and Cheap Talk: The chat-enabled session demonstrates that even non-binding communication — players can promise to choose 7 and then defect — dramatically increases coordination. This is a puzzle for standard game theory: if

promises are cheap talk and cannot be enforced, why do they work? The answer connects to concepts of social norms, guilt, and the intrinsic value of honoring a commitment.

- Organizational Implications: Van Huyck et al. (1990) found that coordination failure was robust even in laboratory settings with full information. This result has been widely cited in organizational economics as evidence that firms need explicit coordination mechanisms — management, culture, target-setting, and monitoring — to overcome the strategic uncertainty problem that markets alone cannot solve.

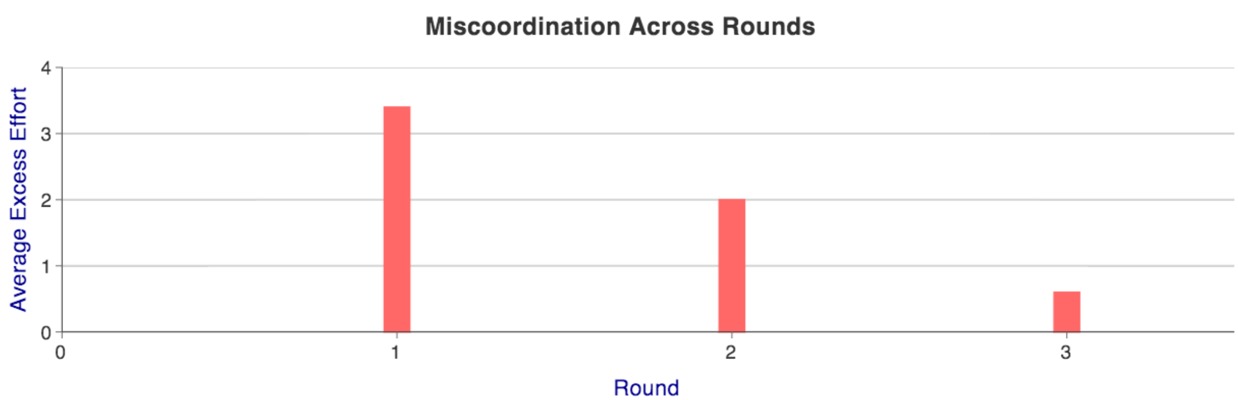
6. Results & Data Interpretation

Reading the Results Dashboard

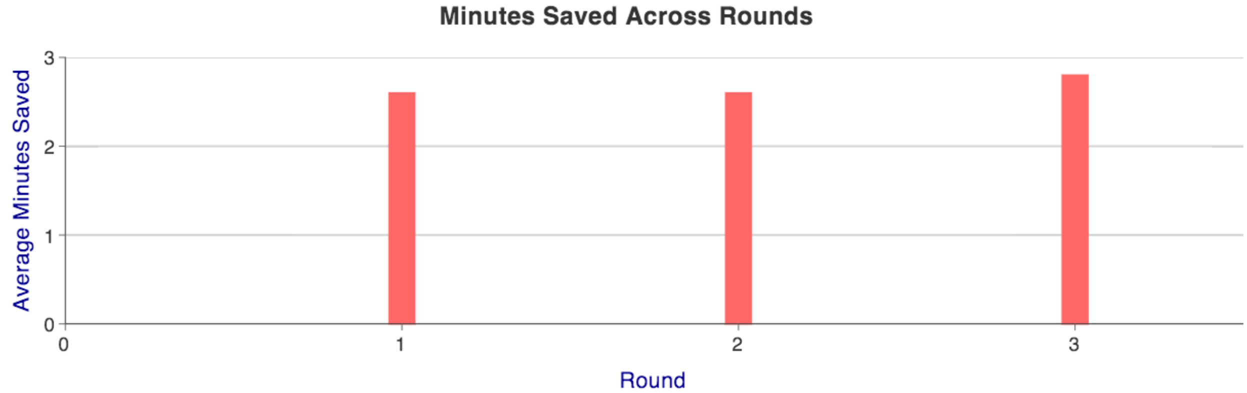
Use the dropdown at the top-left to switch between the Multi-Round Summary and individual round views:

Multi-Round Summary

- Miscoordination Across Rounds: Average excess effort per group per round. The average gap between individual effort choices and the group minimum. A decreasing trend means groups are wasting less effort as rounds progress (convergence toward some equilibrium). A flat or non-decreasing trend means groups remain stuck in miscoordination.



- Minutes Saved Across Rounds: Average group minimum across all groups per round. It is common to see this stay flat or decline across rounds — groups converge, but at lower effort levels. A treatment that moves this line upward (chat, target effort, smaller groups) is directly visible here.



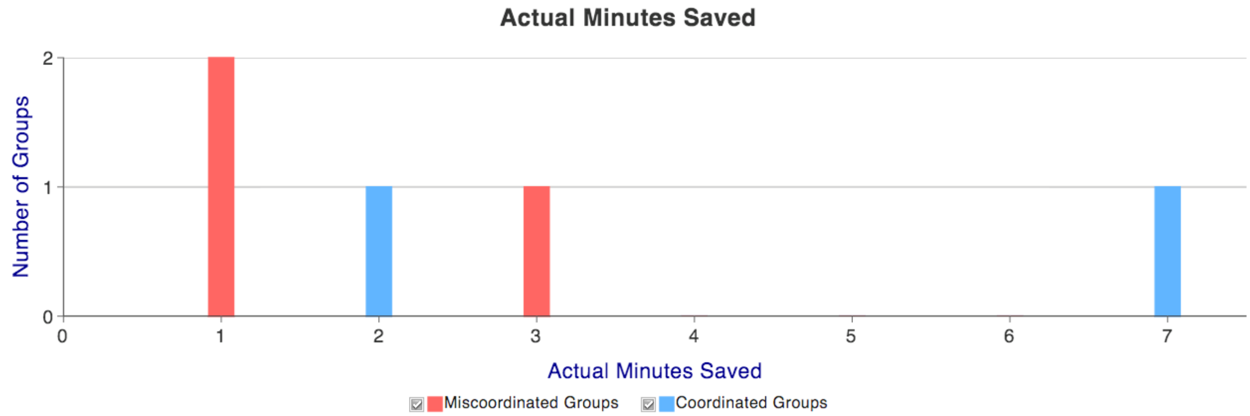
Individual Round Views

- Distribution Table: Shows the number of players choosing each effort level (1-7) within each group, plus Average Payoff for each group. Negative average payoffs in Round 1 are common and illustrate the cost of miscoordination vividly. Use this to find the group with the widest dispersion and the group with the best coordination for comparison.

Group #	# Played	# Saving 1 Min	# Saving 2 Min	# Saving 3 Min	# Saving 4 Min	# Saving 5 Min	# Saving 6 Min	# Saving 7 Min	Average Payoff
1	2	1	1	0	0	0	0	0	0.50
2	2	0	0	0	0	0	0	2	7.00
3	2	0	2	0	0	0	0	0	2.00
4	2	1	1	0	0	0	0	0	0.50
5	2	0	0	1	1	0	0	0	2.50

Group #	Min Minutes Saved	Mean Minutes Saved	Median Minutes Saved	Mode Minutes Saved	Max Minutes Saved	Wasted Effort
1	1	1.50	1.5	1	2	1
2	7	7.00	7	7	7	0
3	2	2.00	2	2	2	0
4	1	1.50	1.5	1	2	1
5	3	3.50	3.5	3	4	1

- Per-Group Summary Table: Shows min, max, mean, median, and mode choices for each group, plus total Wasted Effort (sum of individual efforts minus group minimum times group size). The Wasted Effort column is the most direct measure of coordination failure — use it to show how coordination efficiency changes across sessions.
- Actual Minutes Saved Distribution: A bar chart showing how many groups achieved each possible minutes-saved outcome (1-7). Blue bars are coordinated groups (all members chose the same level); red bars are miscoordinated groups. This is the single most effective visual for the debrief, show it round by round to watch how the distribution shifts.



Common Outcome Patterns

- Round 1 Miscoordination (universal): In virtually every run, Round 1 shows wide dispersion within groups and low group minimums. Average payoffs near zero or negative are typical. Some students will have chosen 7 and earned -$5, these students are your most vocal debrief participants.
- Downward Convergence (repeated play, no intervention): Across rounds with fixed groups, excess effort falls but group minimums also fall. Groups converge on effort levels 1-3, not 7. This is the coordination trap.
- Upward Shift with Chat (treatment): Groups with chat typically coordinate on higher effort levels by round 2-3, with some groups achieving the payoff-dominant equilibrium. Wasted Effort falls sharply. Use the Compare view to show baseline vs. chat sessions side by side.
- Upward Shift with Target Effort (treatment): Even a non-binding announced target dramatically increases coordination. Groups told the target is 7 typically achieve group minimums of 5-7 by round 2, compared to 1-2 in the baseline. This result is one of the most striking findings in the coordination game literature.

7. Extensions & Variations

Recommended Treatment Sequence

The game is most instructive when run as a controlled comparison. Recommended progressions:

- Baseline then Chat: Same groups, same parameters, round 1-3 with no chat, then replay with chat enabled. The visual comparison of group minimums before and after is immediate and striking.
- Baseline then Target Effort: Same groups, replay with Target Effort = 7 announced. The contrast between the no-target and target sessions isolates the effect of a non-binding coordinating device.
- Vary Group Size: Run one session with groups of 3 and one with groups of 6. Smaller groups coordinate at higher effort levels — with fewer players to trust, the strategic uncertainty is lower.

Cross-Disciplinary Connections

- Organizational Management — Team Projects and Weak Links: Any team output that is limited by the weakest contribution has minimum-effort structure. Academic group projects, surgical teams, construction crews, and manufacturing assembly lines all share this property. The game motivates why managers invest in screening, monitoring, culture-building, and incentive design to avoid the low-effort trap.
- Technology and Standards — Compatibility Problems: Network goods (software, communication protocols, power standards) require all participants to adopt a common standard. Coordinating on a superior standard is the payoff-dominant equilibrium, but strategic uncertainty about adoption can trap markets at inferior legacy standards. VHS vs. Betamax, QWERTY keyboards, and competing payment systems are all real-world minimum-effort problems.
- Public Health and Safety Protocols: Herd immunity requires a sufficient fraction of the population to vaccinate; workplace safety requires all employees to follow protocols. These are threshold coordination problems with minimum-effort structure. The game provides intuition for why top-down mandates or announcement campaigns can break the coordination trap even when individual incentives would not.
- Supply Chain Management: A supply chain's throughput is often limited by its slowest link. Coordinating investment in capacity or reliability across independent firms faces exactly the strategic uncertainty of the Minimum Effort game. Long-term contracts, reputation effects, and vertical integration are organizational solutions to this coordination problem.

8. References & Further Reading

The following resources pair well with this experiment:

- Van Huyck, J.B., Battalio, R.C., & Beil, R.O. (1990). Tacit Coordination Games, Strategic Uncertainty, and Coordination Failure. The American Economic Review, 84(1): 234-248. The original paper on which this game is directly based — required reading for instructors.
- Harsanyi, J.C. & Selten, R. (1988). A General Theory of Equilibrium Selection in Games. MIT Press. Introduces the concepts of payoff dominance and risk dominance that frame the equilibrium selection problem in this game.
- Cooper, R., DeJong, D., Forsythe, R., & Ross, T. (1992). Communication in Coordination Games. Quarterly Journal of Economics, 107(2): 739-771. Documents the effectiveness of pre-play communication in moving groups toward payoff-dominant equilibria.
- Bryant, J. (1983). A Simple Rational Expectations Keynes-Type Model. Quarterly Journal of Economics, 98(3): 525-528. The theoretical model that motivates the minimum-effort game as a model of macroeconomic coordination failure.
- Camerer, C.F. (2003). Behavioral Game Theory: Experiments in Strategic Interaction. Princeton University Press. Chapter on coordination games places the Minimum Effort game in the broader context of behavioral departures from standard equilibrium selection.