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Choosing Between Lotteries: Remarkable Coordination Without Communication

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ABSTRACT

The current research examines tacit coordination behavior in a *lottery selection task*. Two hundred participants in each of three experiments and 100 in a fourth choose to participate in one of two lotteries, where one lottery has a larger prize than the other. Independent of variations in the complexity of the mechanism of prize allocation, the prize amounts, and whether the lottery is the participant's first or second choice, we typically find that the percentage of participants who choose the high versus low-prize lotteries does not significantly differ from the equilibrium predictions. This coordination is achieved without communication or experience. We additionally find that participants with an analytical thinking style and a risk-averse tendency are more likely to choose the low-prize lottery over the high-prize lottery. This tendency seems to be stable across choices. The pattern of our results suggests that to achieve tacit coordination, having a subset of individuals who attend to the choices of others is sufficient.

KEY WORDS coordination; lottery; choice; risk taking; uncertainty; thinking style

Many decisions in everyday life involve choosing between two mutually exclusive alternatives in which one alternative seems more attractive than the other, and in which individual outcomes depend on the number of decision makers who choose each alternative. For example, when driving from the city to the beach, should one take the route with 80 miles of highway or the alternative route with 90 miles of highway? When applying for student housing that is distributed by a lottery, should one apply for the most attractive dorm? When the jackpot of a lottery increases, should one invest more money than usual?

We investigate these choice problems of *tacit coordination* that arise when a decision maker can choose only one of two or more independent and mutually exclusive alternatives and when the outcome of that choice depends on the number of decision makers who choose the same alternative. Hence, the optimal behavior depends not only on the utility of each outcome but also on the estimated number of participants who choose each alternative.

Despite the prevalence and importance of coordination problems, empirical research on this topic is scarce. One reason could be the mistaken belief that communication makes this type of problem easy to solve, and thus research is less needed. As pointed out by Camerer (2003, p. 337), however, "communication is not really a solution because simple coordination games with few players who do not talk are really meant as microscale reduced-form models of large social processes in which players cannot all talk at the same time." Particularly, when large numbers of agents are operating simultaneously, communication can easily become impossible (e.g., regulatory constraints), improbable (e.g., lack of incentives), inefficient (e.g., lack of communication mechanisms), and/or unreliable (e.g., trust concerns).

The current research examines behavior in this type of tacit coordination task through the use of a *lottery selection task*. Specifically, many individual participants must choose between entering one of two lotteries whose jackpots vary.

The basic task is as follows: participants are told that N participants, including themselves, have the opportunity to choose to participate in one of two lotteries, either H (a high-prize lottery) or L (a low-prize lottery). The winner of each lottery is the participant who guesses correctly a number between 0 and 9. This lottery task can be modeled as a noncooperative game with N players. The Nash equilibrium solution is the distribution of participants between the two lotteries for which participants receive no advantage from changing their choices. The Nash equilibrium, therefore, is the distribution of participants for which the expected values of the two lotteries are equivalent.

The expected value of lottery (*Lot*) can be defined as follows:

$$E[Lot_i] = \left(1 - (1-p)^{N_i}\right) * \frac{Prize}{N_i} \tag{1}$$

where N_i is the number of participants who participated in lottery i, p is the probability of being one of the winners (i.e., guessing correctly the number between 0 and 9), and *Prize* is the amount of the prize (see Appendix A for the mathematical development of this equation).

A critical feature of each lottery is that the number of participants who choose each lottery impacts the size of the prize or the probability of winning it. Thus, insufficient consideration of the presence and the decisions of others when deciding how to act may lead to inferior outcomes.

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In the current research, we focus on a one-shot version of the lottery selection task, precluding any adaptation, learning, or feedback derived from multiple trials.

Previous studies found an ability to coordinate in repeated games that do allow for learning and feedback between trials. For example, Rapoport, Chung Lo, and Zwick (2002) asked groups of 18 participants to repeatedly choose to participate in one of three lotteries with a range of prizes (e.g., \$14; \$12; \$10). For each trial, one winner was randomly selected from each of the three lotteries. Hence, the probability of winning a prize in the lottery decreased as a function of the number of agents choosing it. Participants received feedback regarding the winner of each lottery after each trial. This study revealed a strong pattern of tacit coordination achieved through repeated trials, under the assumption of a risk-averse utility function. In a variation of this experiment, Zwick, Rapoport, and Chung Lo (2002) asked participants to repeatedly choose among three lotteries. The lotteries differed with regard to the *number* of prizes (i.e., winners), but prize value was constant across all. This experiment also found impressive coordination. The authors proposed a model with randomly perturbed probabilities, which accounts quite well for their data.

Another class of coordination games that involves entering into markets and competitions obtained similar results. In a typical market entry game, *N* players are in a market with capacity *C*. Entrants earn a return that declines as a function of the number of entrants and becomes negative if more than *C* participants enter. Kahneman (1988) found the number of players who chose to enter the market in the market entry game was close to the number predicted by theory (i.e., around *C* entrants), even though all players made their choices simultaneously and could not communicate or learn from feedback. Since then, researchers have conducted several controlled experiments on the market entry game. In most of them, participants were told how many others decided to enter after each decision. Findings show the entry rate was close to equilibrium, with over-entry when the market capacity was low and under-entry when the market capacity was high (e.g., Rapoport, 1995; Rapoport, Seale, Erev, & Sundali, 1998; Sundali, Rapoport, & Seale, 1995).

Huberman and Rubinstein (2000) found less impressive coordination. They asked subjects to self-select into one of two contests, "coin" or "die". The winner in each of the contests was the person with the most correct guesses of 20 coin flips or 20 rolls of a die, respectively. Most subjects reported they believed most people would go to the "coin" but nevertheless incorrectly chose the "coin" contest.

Ochs (1990) also reported failure to coordinate in a decentralized market game. This coordination game consisted of several locations and a set of agents. Trade could take place at any of the locations, and each agent was required to select a trading location in complete ignorance of the decisions of other agents. This game was repeatedly played with either the same or a different set of players. The degree of coordination achieved was much higher—yet not perfect—when the game was repeatedly played with the same players. Meyer, Van Huyck, Battalio, and Saving (1992) also reported difficulty in reaching perfect coordination in a decentralized market game. The authors found that entry decisions did not converge to equilibrium unless subjects were experienced in the game. Another example is the optic cable industry, which shows a failure in coordinating the production of high-capacity optic cable. Similarly, field studies of business entry and exit find most new businesses fail and usually fail rapidly (Camerer, 2003).

Given the evidence regarding tacit coordination on the one hand and the failure of coordinating on the other hand, some important questions need to be addressed to better understand the conditions under which coordination may be achieved. First and most importantly, does tacit coordination emerge spontaneously when no opportunity for learning, experience, or repeated play exists? To determine the immediacy of tacit coordination, we mostly use a one-shot, rather than repeated trial, task.

Second, is tacit coordination likely in large groups of people? To examine the independence of tacit coordination on small, easily visualized sample sizes, we recruit a large number of participants ($n = 200$). Third, given the complexity of real-life situations, we aim to test whether tacit coordination depends on the complexity of the mechanism by which others' choices affect one's outcome. To do so, we vary the complexity of the mechanism by which the prizes are allocated. Finally, we examine the extent to which participants' choices are stable and correlate with thinking style and risk-taking tendency.

In the series of experiments we report in the succeeding text, we asked participants to choose one of two lotteries in which they wanted to participate. In all experiments, one lottery had a bigger prize than the other. We varied the complexity of the mechanism by which the prizes were allocated. In experiment 1, we randomly selected *one of all the participants* in each lottery to receive the prize money. In experiment 2a and b, we first asked participants to guess a number between 0 and 9. The winners were those who predicted the "lucky number" correctly, and *the prize was equally divided among all winners*. Like experiment 2, experiment 3 also had a preselection stage, but we randomly selected only *one of the winners in each lottery* to receive the prize money. In experiment 4, we replicated experiment 3 while trying to better understand the mechanism by which participants achieved coordination.

The results of the current research are striking. We found no significant difference from the equilibrium for almost all treatments, despite variations in the sizes of the prizes, the prize-allocation mechanism, and the equilibrium. These exceptional findings, across multiple studies, took place among 200 (or 100 in experiment 4) decision makers, in the absence of any communication, and in both a single-shot game (experiments 1 through 3) and a repeated game (experiment 4).

EXPERIMENT 1

In this experiment, we employed the lottery mechanism used by Rapoport et al. (2002). In this mechanism, a lottery among all participants in the same lottery determines the winner. Because the contingency between the number of other participants in the lottery and the probability of winning is straightforward, and the effect of others' choices

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on individual outcome is transparent, we consider this mechanism simple and therefore expect participants to take into consideration the effect of others' choices.

Method

Participants

We recruited 200 Israeli students at the university and gave them the opportunity to participate in a lottery in which they could win money.

Procedure

We told the participants that 200 participants, including themselves, had the opportunity to participate in one of two lotteries. We asked them individually to choose between participating in a 400 NIS (the Israeli currency) or 500 NIS lottery (at that time 1 NIS = $.23). We explained that we would randomly select one participant in each lottery to receive the prize money.

Results

We begin by computing the Nash equilibrium of the game. Figure 1 shows the expected value of the two different lotteries (400 NIS and 500 NIS) as a function of the number of participants who choose the 500 NIS lotteries.

The expected value of the two lotteries is equalized when 111 participants choose the 500 NIS lottery and 89 choose the 400 NIS lottery. If fewer than 111 participants choose the 500 NIS lottery, choosing the 500 NIS over the 400 NIS one is more advantageous. However, when more than 111 participants choose the 500 NIS, choosing the 400 NIS lottery becomes more advantageous.

Results revealed that 100 participants chose to participate in the 500 NIS lottery and 100 chose to participate in the 400 NIS lottery. The number of participants who chose the 500 NIS is not significantly different from the Nash equilibrium solution of 111 participants.

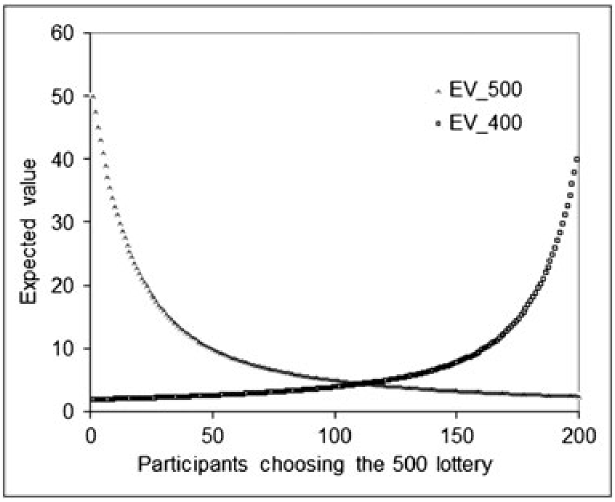

Figure 1. Expected value of the two different lotteries (400 NIS and 500 NIS) as a function of the number of participants who choose the 500 NIS lotteries

EXPERIMENT 2A

In experiment 2a, the Nash equilibrium was the same as in experiment 1, but the mechanism through which the outcome was determined, that is, how the prizes were allocated, was more complex. Adding a preselection procedure of correctly guessing a number between 0 and 9 required participants to infer that the greater the number of lottery participants, the greater the expected number of participants who are likely to guess the winning number, and consequently, the lower the expected value.

Method

Participants

We recruited 200 Israeli students at the university and gave them the opportunity to participate in a lottery in which they could win money.

Procedure

The procedure was the same as in experiment 1, except for the fact that we asked participants to guess a number between 0 and 9. We determined the winning number according to the last digit of the NIS to US Dollar exchange rate published on a certain day and time known to the participants. We also explained the prize would be equally divided among all winners.

Results

We observed that 119 of the participants chose to participate in the 500 NIS lottery and 81 chose to participate in the 400 NIS lottery. These numbers were not significantly different from the Nash equilibrium solution (111 in the 500 NIS). Participants in this experiment succeeded in coordinating their choices. This coordination is remarkable given that the mechanism is more complex, they participated in the lottery only once, and they were not allowed to communicate. To assess the generality of this finding, we ran an additional experiment (2b) that replicated experiment 2a with a different student population and a different Nash equilibrium solution.

EXPERIMENT 2B

Method

Participants

We recruited 200 Americans through web-based advertisements offering payment for participation in a decision-making study.

Procedure

The procedure was similar to that of experiment 2a, except for the fact that we asked participants to choose between participating in either a $250 or $500 lottery. We determined the winning number according to the last digit of the "Day's

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High" Euro to US Dollar exchange rate published in the investment section of the *Wall Street Journal* on a certain day known to the participants.

Results

The Nash equilibrium for this task is 133 participants choosing the \$500 lottery and 67 choosing the \$250 one. Analyzing participants' choices revealed that 132 participants chose to participate in the \$500 lottery and 68 chose to participate in the \$250 lottery. This result does not significantly diverge from the equilibrium and replicates the finding in experiment 2a.

EXPERIMENT 3

In experiment 3, we made the mechanism even more complex by allocating the prize to one of the winners in each lottery who would be randomly selected among the winners. Participants needed to understand that the greater the number of lottery participants, the higher the expected number of participants who were likely to guess the winning number, and consequently, the lower the probability to win the big prize.

In this experiment, compared with the former, the contingency between the number of other participants in the lottery and the probability of winning is less straightforward. Thus, the effect of others' choices on individual outcome is less transparent than in experiments 1 and 2, thereby making this mechanism more complex.

In addition, to deepen our knowledge regarding the process by which the equilibrium was achieved, we asked participants to estimate the number of participants that would choose each lottery. Specifically, we wanted to examine whether the choices participants made were accurate, given their expectations regarding the choices of other participants.

Method

Participants

We recruited 200 Israeli students at the university and gave them the opportunity to participate in a lottery in which they could win money.

Procedure

The procedure was the same as in experiment 2b with the following changes: because we ran this experiment in Israel, the prizes were in NIS instead of in dollars, and the winning number was determined as in experiment 2a. As in experiment 2b, we also explained that we would randomly select the winner of the lottery (i.e., the prize recipient) from all the participants who correctly guessed the number. Finally, we asked participants to explain their choices and to estimate the number of participants who would select each lottery.

Results

The Nash equilibrium for this task is 133 participants choosing the 500 NIS lottery and 67 choosing the 250 one. We found 136 participants chose to participate in the 500 NIS lottery and 64 chose to participate in the 250 lottery. This result does not significantly deviate from equilibrium and replicates the finding in our previous experiments.

To gain initial insight into the process by which the equilibrium was achieved, we ran a logit analysis with the choice ($H = 1/L = 0$) as the dependent variable and the participants' expectations regarding the number of participants likely to choose the H lottery as the independent variable. The analysis revealed a significant effect for the expectations regarding others' choices. We summarize the results of the analysis in Table 1.

Although the logit analysis reveals participants consider their expectations regarding other participants when deciding, further examination of the accuracy of this consideration process is important. Table 2 presents the accuracy of participants' choices, given their expectations. We counted the number of participants who optimally acted on their beliefs about others' decisions. We then labeled choices as correct (i.e., the participant is optimally acting on his or her stated beliefs), incorrect/high (nonoptimal choice of high-prize lottery), or incorrect/low (nonoptimal choice of low-prize lottery). For example, if an individual predicted that 100 participants would select the high-prize lottery and 100 would select the low-prize lottery, the individual's actual selection would be coded as "correct" if she selected the high-prize lottery for herself. On the other hand, if she selected the low-prize lottery for herself, her selection would be coded as "incorrect/low."

As Table 2 shows, most of the participants who chose the high-prize lottery (76%, 104 out of 136) did so despite expecting more than 132 participants would choose the high lottery; that is, they nonoptimally chose the high-prize lottery ("incorrect/high"). In contrast, 24% of the participants who selected the high-prize lottery (32 out of 136) expected fewer than 133 participants to choose the high-prize lottery; that is, they correctly chose the high-prize lottery ("correct"). A different picture emerged for those who chose the low-prize lottery: most of the participants (70%, 45 out of 64) chose the low-prize lottery correctly—they expected more than

Table 1. Logit regression results: probability of choosing the high lottery as a function of expectations regarding the number of others choosing the high lottery

Explanatory variables	Coefficient (p-value)
Constant	1.179 (.06)
Expectations	.01 (.002)
Number of observations	200

χ^2 (1) = 10.13 ($p < .001$).

Table 2. Accuracy of choices in experiment 3 given expected choice distribution (n)

Choice	Correct	Nonoptimal/high	Nonoptimal/low
H: 500 NIS	24% (32)	76% (104)	0
L: 250 NIS	70% (45)	0	30% (19)

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132 participants to choose the high-prize lottery. Only 30% (19 out of 64) chose it incorrectly, expecting less than 133 to choose the high-prize lottery.

Although the low-prize choosers acted more correctly according to their expectations, the accuracy of the expectations of the low-prize and the high-prize choosers—that is, the extent to which their expectations matched the actual choices that were made—remains to be seen. We found that although the high-prize choosers expected, on average, that 83% of the participants would choose the high-prize lottery, the low-prize choosers expected that 73% of the participants would choose the high-prize lottery, which was closer to the 68% of the participants who actually chose the high-prize lottery.

Finally, we analyzed participants' explanations by categorizing them into explanations that took into account others' choices or explanations that focused on the prize size. A research assistant who was blind to the experimental conditions and hypotheses classified the explanations. The distribution of these classified explanations as a function of the lottery (high versus low) that was actually chosen appears in Table 3.

The fact that low-prize choosers behaved more optimally, given their beliefs about others' actions, is also supported in the reasons participants provided for their choices. As Table 3 shows, the majority of those who chose the high-prize lottery explained their choice by the attractiveness of the high prize and seemed to ignore the fact that this lottery was likely to be attractive to the other participants as well. Most of the participants who chose the low-prize lottery, on the other hand, justified their choices by anticipating that too many participants would go for the high-prize lottery.

To summarize, the low-prize choosers were more accurate in their expectations regarding others' choices, behaved more optimally given these expectations, and provided more accurate reasons for their choices. Table 4 summarizes experiments 1–3.

EXPERIMENT 4

This experiment aimed to deepen our understanding of the process by which the coordination observed in the previous experiments was achieved. In experiment 3, we found that participants who chose the low-prize lottery were more accurate in their expectations as well as in their behavior given these expectations. Consequently, in experiment 4, our primary goal was to examine whether the tendency to choose the low-prize lottery is a stable individual tendency, as well as the extent to which relevant individual differences predict individual choices, that is, the tendency to choose the low-prize versus the high-prize lotteries.

On the basis of our observation in experiment 3 that low-prize choosers were not only more accurate in their expectations regarding the choices of others but also behaved more rationally, we suggest that individual differences in cognitive thinking style—namely, rational versus intuitive (Pacini & Epstein, 1999)—may be a predictor of individuals' tendencies to choose the low-prize versus the high-prize lotteries. An additional relevant individual difference that we explore is risk preferences. Because choosing the low- (high-) prize lottery is likely to be perceived as the less (more) risky option, we expect it to be associated with risk preferences.

We assessed thinking style with the REI-24 items (Pacini & Epstein, 1999). This scale differentiates between a rational style that emphasizes a conscious, analytical approach and an experiential style that emphasizes a preconscious, affective, holistic approach. We expect that the more experiential (or the less analytical) participants are in their thinking style, the higher their tendency to process information intuitively and affectively, and thus the more likely they are to be attracted to the lottery with the seemingly more attractive—that is, higher—prize.

We assessed risk tendency with a behavioral measure suggested by Holt and Laury (2002) that is based on choices

Table 3. Verbal explanations of choices in experiment 3

Choice	None	Because of the high prize	Most will choose the high lottery	Most will choose the low lottery	Most will choose high, but I want to win the big prize	Total
H: 500 NIS	26	104	0	2	4	136
L: 250 NIS	16	2	46	0	0	64

Table 4. Description and results of experiments 1–3

Exp.	High prize (*H*)	Low prize (*L*)	Participants	Winner determination	Prize allocation	Equilibrium (*H*;*L*)	Observed choices
1	500 NIS	400 NIS	Israeli undergraduate and graduate students	Randomly selected participant	Full prize to winner	(111;89)	(100;100)
2a	500 NIS	400 NIS	Israeli undergraduate and graduate students	Correctly guessing a number between 0 and 9	Equally divided among winners	(111;89)	(119;81)
2b	$500	$250	Harvard business school subject pool	Correctly guessing a number between 0 and 9	Equally divided among winners	(133;67)	(132;68)
3	500 NIS	250 NIS	Israeli undergraduate and graduate students	Correctly guessing a number between 0 and 9	One participant randomly selected among all winners	(133;67)	(136;64)

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between gambles. Researchers have used this measure in different contexts to examine risk attitudes (e.g., Harrison, John, & Towe, 2007, in the context of market behavior; Anderson & Mellor, 2008, in the context of health behavior). Because choosing the low-prize lottery is less risky, we expect that the more risk-averse participants are, the higher the probability that they will choose the low-prize lottery.

Moreover, the previous experiments involved a one-shot game, so detecting whether coordination was achieved by an individual tendency to choose the low-prize/high-prize lottery was not possible. In the current experiment, we asked participants to choose twice between two lotteries with a low and high prize. The equilibrium for each choice set of lotteries was similar, whereas the values of the prizes were different. If the equilibrium is driven by a relatively stable characteristic of the responder, then we should observe high levels of consistency in choosing either the low-prize or high-prize lottery across the two choices.

An additional goal of this experiment was to examine more directly the effect of expectations regarding others' choices on one's own choice of a lottery and specifically whether contextually making expectations regarding others salient is influential. Therefore, we asked half of the participants before they chose between the lotteries about their expectations, and we asked the other half after they chose.

Method

Participants

We recruited 206 Israeli students from a web experimental subject pool list at the university.

Procedure

The procedure was the same as in experiment 3 but conducted over the web. All participants in the subject pool received a link to the experiment, and when they agreed to participate, they were randomly allocated to the different conditions. Because the experiment was run over the web, we were concerned that some participants might not understand the task. Consequently, to increase the probability of remaining with close to100 valid participants in each of the two experimental conditions, we closed the website after reaching a total of 206 participants. The specific criterion we used to determine understanding appears in the results section.

We told the participants that 100 participants, including themselves, had the opportunity to participate in one of two lotteries. We asked them to choose between a high-prize and a low-prize lottery twice. In one pair of lotteries (denoted as H75), the high prize was 75 NIS and the low prize was 25 NIS. In the other pair of lotteries (denoted H30), the high prize was 30 NIS and the low prize was 10 NIS. We counterbalanced the order of the H75 and H30 lotteries. Half of the participants began with H75 and half with H30.

In the first pair of lotteries, we asked half of the participants, before they chose between the lotteries, about their expectations regarding others' choices, and we asked the other half after they chose.

After their first lottery choice, we also asked all participants to explain their choices. After making their second choice, they filled out two questionnaires:

(a) The REI (24 items) thinking-style questionnaire (Pacini & Epstein, 1999). The questionnaire consists of four subscales: Rational Ability, Rational Engagement, Experiential Ability, and Experiential Engagement. Rational Ability refers to the ability to think logically and analytically ($\alpha = .8$). Rational Engagement refers to the extent of reliance on and enjoyment of thinking in an analytical, logical manner ($\alpha = .77$). Experiential Ability refers to the ability to effectively use one's intuitive impressions and feelings ($\alpha = .84$). Experiential Engagement refers to reliance on and enjoyment of feelings and intuitions in making decisions ($\alpha = .75$).
(b) The Holt and Laury (2002) risk-aversion scale. We presented subjects with a list of 10 lottery-choice decisions in the positive version. Each decision represents a choice between a relatively "safe" lottery (with a small difference between the low-payoff and high-payoff outcome) and a more "risky" lottery (with a larger difference between the low-payoff and high-payoff outcome). Payoffs are identical in all 10 decisions; however, the probability of the high-payoff outcome increases in 10% increments from 10% in the first decision to 100% in the last decision. In each decision, we asked subjects to choose which lottery they preferred to play. As in Holt and Laury, on the basis of the total number of safe-lottery choices, we classified each participant into one of the following categories: risk loving, risk neutral, and risk averse.

Similarly to experiment 3, we explained to participants that we would randomly select the winner of the lottery (who would receive the prize) from all the participants who correctly guessed the number.

Results

The Nash equilibrium for these two tasks (H30 and H75) is 78 choosing the high-prize lottery and 22 choosing the low-prize lottery. We begin by analyzing the first choice and then report the analysis of the second choice.

First choice

We excluded 20 participants from the analyses because their expectations regarding the number of participants who would choose the high-prize and the low-prize lottery did not sum to 100, indicating that they failed to understand the task.[1] Consequently, the final number of valid participants analyzed was 100 in the 30H condition and 86 in the 75H condition.

Table 5 presents participants' first choice as a function of the type of lottery (H75/H30) and of whether we asked

[1]We conducted analyses without excluding these participants and revealed the same pattern of results. Specifically, the marginal distributions of lottery choices were as follows: for H30, 14% chose the low-prize lottery ($n = 15$) and 86% chose the high-prize lottery ($n = 93$); for H75, 13% chose the low-prize lottery ($n = 13$) and 87% chose the high-prize lottery ($n = 85$).

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Table 5. Participants' first choice as a function of the type of lottery (H75/H30) and of whether they were asked about their expectations after or before choosing between the lotteries (n)

Type	Expectation assessment after/before choice	Low-prize lottery	High-prize lottery	Total *N*
H30	After	9% (5)	91% (50)	55
	Before	17.8% (8)	82.2% (37)	45
	Total	13% (13)	87% (87)	100
H75	After	17% (7)	83% (34)	41
	Before	11.1% (5)	88.9% (40)	45
	Total	14% (12)	86% (74)	86

about their expectations before or after they chose between the lotteries.

As Table 5 shows, 86% and 87% of the participants chose the high-prize lottery for the 75H and 30H lotteries, respectively. Consistent with our previous findings, the distribution for the H75 was not significantly different from the equilibrium. The distribution for the H30 lottery was, however, significantly different from the equilibrium ($p < .03$).

To better understand the individual choices, we ran a hierarchical logit regression analysis with the choice ($H = 1/L = 0$) as the dependent variable. In step 1, we entered expectations regarding the number of participants who would choose the high-prize lottery, as well as the following individual difference indices: the four scales of the REI questionnaire and the risk tendency classification. We coded risk tendency by two dummy variables (risk averse = 1, risk neutral = 1) with risk-loving tendency as the reference group. In step 2 of the regression, we entered the additional contextual variables: lottery type (H75 = 1/H30 = 0) and whether participants' expectations regarding others' choices were provided before (timing = 0) or after making their own choices (timing = 1). We also tested interactions between the lottery type and timing of expectations, between the four scales of the REI and expectations and between risk tendency and expectations, but we found that none were significant.

Table 6 presents results of the analysis. We report unstandardized beta weights and odds ratios.

The overall model at step 1 was significant ($\chi^2_{(7)} = 14.13, p < .05$) and correctly classified 87% of observations. As predicted, rational thinking style, and specifically the subscale of rational ability, had a negative linear effect, $b = -.85$, $p < .05$. The higher the rational ability of participants, the more likely they were to choose the low-prize lottery. We found a negative linear effect of risk tendency, and specifically of being risk averse compared with risk loving ($b = -2.17$, $p < .05$). Participants classified as risk averse were less likely to choose the high-prize lottery than were participants classified as risk loving. Adding the context-specific variables in step 2 did not significantly improve the predictive value of the model, $\chi^2_{(2)} = .12, p = .94$.

Table 7 presents the accuracy of participants' choices given their expectations. This table is parallel to Table 2 (experiment 3).

As Table 7 shows, the findings regarding the accuracy of participants' choices given their expectations are similar to those found in experiment 3. That is, participants who chose the high-prize lottery did so regardless of their expectation that a high number of other participants would choose the same option. Indeed, across both lotteries, less than 30% of the high-prize choosers acted accurately given their expectations. On the other hand, participants who chose the low prize lottery were much more accurate in their behavior. Across both tasks (H30 and H75), at least 50% of the low-prize choosers acted accurately given their expectations.

We next analyzed the explanations that participants provided, employing the same procedure and categories reported in experiment 3 and presented in Table 3. Similar to the results of experiment 3, most of the participants who chose the high-prize lottery explained their choice by the attractiveness of the high prize (91% in H30 and 94% in H75). However, most of the participants who chose the low-prize lottery justified their choice by anticipating that too many other participants would go for the high-prize lottery (92% in H30 and 91% in H75).

Second choice

Across the different lotteries, 82% of the participants chose the high-prize lottery and 18% chose the low-prize lottery. This distribution does not significantly differ from equilibrium, which is 78% choosing the high-prize lottery and 22% choosing the low-prize lottery.

Next, we examined the consistency in participants' choices across their first and second choices. Table 8 presents the joint distribution of the two choices. We found a significant correlation between the first and the second choices, $\chi^2_{(1)} = 17.07, p = .001$.

Taken together, these results suggest that the tendency to choose the high- (rather than low-) prize lottery is a relatively stable individual tendency, which is negatively related to the extent to which an individual is risk averse and has a rational, rather than experiential, cognitive thinking style.

GENERAL DISCUSSION

The present findings provide further evidence for the ability of decision makers to reach coordination, demonstrating this phenomenon is even more robust than previously thought. It even exists in a one-shot interaction with a large number of participants with no opportunity for learning and with different mechanisms for allocating the prizes. Even with the most complex mechanism that we implemented in experiments 3 and 4, the behavior of the participants generally matched equilibrium. We found an exception for this pattern only for the H30 lottery in the first choice of experiment 4. This exception may be due to the small difference between the prizes in this condition compared with the other conditions. Future research should examine this possibility.

The analysis of the expectations that participants had regarding the choice of others revealed that only some of the participants correctly took this information into consideration. As Tables 2 and 7 show, the percentage of correct choosers among the high-prize selecting participants was low. On the other hand, participants who chose the low-prize lottery were more accurate in their expectations regarding

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Table 6. Logistic hierarchical results

	Step 1		Step 2	
Predictor	*b*	OR	*b*	OR
Rational ability	−.85*	.43	−.84*	.43
Rational engagement	.18	1.2	.18	1.2
Experiential ability	.53	1.68	.55	1.7
Experiential engagement	−.34	.71	−.36	.69
Risk averse	−2.17*	.11	−2.17*	.11
Risk neutral	−2.14	.12	−2.14	.12
Expectations	.02	1.02	.02	1.02
Lottery type (0 = H30, 1 = H75)			−.02	1.02
Timing of expectations assessment (0 = after, 1 = before)			−.16	.86
χ^2	$\chi^2_{(7)} = 14.13, p < .05$		$\chi^2_{(9)} = 14.25, p < .12$	

OR, odds ratio.
*$p < .05$.

Table 7. Accuracy of choices in experiment 4 given expected choice distribution (*n*)

	Choice	Correct	Nonoptimal/High	Nonoptimal/Low
(30;10)	*H*	25% (22)	75% (65)	0
	L	77% (10)	0	23% (3)
(75;25)	*H*	26% (19)	74% (55)	0
	L	50% (6)	0	50% (6)

Table 8. Joint distribution of first and second lottery choice (*n*)

	Second		
First	Low prize	High prize	Total *N*
Low prize	48% (12)	52% (13)	25
High prize	13.6% (22)	83.4% (139)	161
Total	34	152	186

others' choices and were also better choosers—that is, more optimal—given their expectations.

Kocher and Trautmann (2010) reported a somewhat similar pattern of results. In their study, participants needed to select themselves into markets with risky or ambiguous lotteries. People need to anticipate that other people may be ambiguity averse, and therefore infer that ambiguity offers a good chance to win. The authors found that many people believe in high competition in the risky market but still choose it. Another group correctly adjusts for their beliefs as in the current study.

In experiment 4, we examined whether choosing the low-prize lottery reflects an individual tendency or a random process. The results may support an explanation in terms of an individual tendency: across two choices, participants were relatively consistent in their choice of the high-prize lottery. Moreover, predicting this behavior, on the basis of individual differences in thinking style and risk tendency, seems possible. As expected, participants who were less analytical in their thinking style tended to choose the high-prize lottery more than participants with a more analytical thinking style. We also found risk tendency to have a unique contribution to the prediction of lottery choice. Participants' tendency to choose the high-prize lottery was higher among risk-seeking participants than among risk-averse participants.

Note that by an individual tendency, we do not mean a rigid choice of the high-prize lottery but rather individual characteristics that lead to choices based on the attractiveness of the prize and less on an analytical examination of the situation. We base this suggestion on the finding that participants who chose the high-prize lottery were also less accurate in their behavior given their expectations.

Moreover, both of these individual tendencies predicted the choice of lottery better than the expectations regarding others' choices. Furthermore, although the collective behavior in the H30 lottery was significantly different from the equilibrium, at the individual level of analysis, we did not find any effects of the type of lottery—that is, whether the high prize was 75 NIS or 30 NIS.

One possible approach for modeling this coordination process may be found in Zwick et al. (2002), who have shown a random model with noise that can model coordination in a repeated lottery selection task. Specifically, they propose that the individuals' propensities to choose a lottery emerge from a single set of *J* probabilities determined by an intuitive rule, but individuals differ because of random perturbation. We suggest that by replacing the random perturbations with systematic individual differences, capturing the regularities observed in the current data is possible. In accordance with their model, participants in our study may have intuitively defined the probabilities of entering the different lotteries by the ratio of the different prizes. They then updated these values according to their risk tendencies and thinking styles. For instance, in experiment 3, the payoff rate (*H*/*L*) is 3:1, and the entry rate is 82/18. Thus, participants may have intuitively defined the probabilities of entering the different lotteries as 3:1 and updated this value according to their risk and thinking-style tendencies. Such an intuitive rule for choosing between lotteries—that is, a rule based on matching—may also account for the failure to coordinate in Huberman and Rubinstein's (2000) study. In their setting, matching the probability of choosing the dice or the coin to the probability of guessing correctly (1/6; 1/2) is expected to lead to an over choice of the coin game and consequently to a failure to coordinate (as they observed) compared with the success in coordinating that we observe in our experiments.

Future research may explore additional boundary conditions under which coordination may break down. Examples include populations with an extreme low or high risk-taking tendency or a particular thinking style. In such population,

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coordination may break down because too many (few) people choose the low-prize lottery. A specific example would be a group of entrepreneurs, who tend to be relatively high-risk takers and thus are predicted to choose the high-prize lottery excessively. This prediction is in line with the over entry into markets that is often observed in real-life situations (Camerer, 2003), yet still needs to be tested empirically.

Our consistent demonstration of coordination is interesting in light of extensive reports in the behavioral literature regarding how others' decisions are excluded from one's own decision making. In these accounts, a failure to think about the actions of competitive others (Babcock & Loewenstein, 1997; Carroll, Bazerman, & Maury, 1988; Zajac & Bazerman, 1991), a failure to take the perspective of others in social dilemmas (Wade-Benzoni, Tenbrunsel, & Bazerman, 1996), and a failure to adjust for egocentric or focusing biases (Epley & Gilovich, 2004; Gilbert, 2002; Moore & Kim, 2003) are implicated in the tendency of individuals to over focus on their own past and future decisions. Our findings do not contradict this extensive body of research but rather point to the variance in those findings. Despite the fact that most participants do not act accurately given their expectations, some individuals do, and these seem to be sufficient for coordination to be achieved.

As Zwick et al. (2002) pointed out, following Schelling (1978), "what makes the analysis of coordination games interesting and difficult is that the entire aggregate outcome has to be evaluated, not merely how each member of the aggregate does within the constraints of his or her environment" (p. 137).

Daniel, Gisches, and Rapoport (2009) observed the discrepancy between the aggregate group behavior and the individual behavior in the context of departure-time behavior of commuters in a Y-shaped network. The authors showed that although the individual behavior is not consistent with a mixed strategy equilibrium, the aggregate group behavior is. This finding suggests that although predicting a particular player's behavior is difficult using the Nash equilibrium, it may still be useful for forecasting the aggregated population choices.

Results of the current research coincide with the idea that the Nash equilibrium can predict aggregated behavior but further suggest that predicting an individual player's behavior by individual tendencies in thinking style and risk taking is possible.

In conclusion, our work highlights the immediacy with which tacit coordination emerges in groups of individual decision makers. Our hope is that future work will deepen our understanding of the mechanism behind this phenomenon as well as its boundary conditions.

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APPENDIX

The expected value of each lottery can be computed by the following equation, which is equivalent to equation (1):

$$E[Lot] = \left[p \sum_{i=1}^{N-1} \frac{\binom{N-1}{N-i}(1-p)^{N-i} p^{i-1}}{i} + \frac{p^N}{N} \right] \times prize$$

It is the sum of the chances of the player winning across all possible combinations (nobody else wins, one other person wins, two other persons win.... etc., with each combination divided by the corresponding number of possible total winners), and this overall sum (i.e., the total probability of winning) is multiplied by the prize.

Next, we show how this equation and equation (1) are equivalent:

$$
\begin{aligned}
& p \sum_{i=1}^{N-1} \frac{\binom{N-1}{i-1}(1-p)^{N-i} p^{i-1}}{i} + \frac{p^N}{N} \\
&= \sum_{i=1}^{N-1} \frac{(N-1)!}{(N-i)!(i-1)!} \frac{1}{i} (1-p)^{N-1} p^i + \frac{p^N}{N} \\
&= \frac{1}{N} \left(\sum_{i=1}^{N-1} \frac{N!}{(N-1)!i!} (1-p)^{N-i} p^i + p^N \right) \\
&= \frac{1}{N} \left(\sum_{i=1}^{N-1} \binom{N}{i} (1-p)^{N-i} p^i + p^N \right) \\
&= \frac{1}{N} \left(\sum_{i=1}^{N-1} \binom{N}{i} (1-p)^{N-i} p^i + (1-p)^N - (1-p)^N \right) \\
&= \frac{1}{N} \left(\sum_{i=0}^{N} \binom{N}{i} (1-p)^{N-i} p^i - \left(1-p^N\right) \right) \\
&= \frac{1}{N} \left(1 - (1-p)^N\right)
\end{aligned}
$$

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