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Waiting to Cooperate?
Cooperation in one-stage and two-stage games

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Abstract
Cooperation between two players often requires exactly one to take the available action, while the other acquiesces. If the decisions whether to pursue the action are made simultaneously, then neither or both may acquiesce leading to an inefficient outcome. However, inefficiency may be avoided if players move sequentially. We test experimentally whether two-stage versions of this entry-exit game enhance cooperation. In one version, players may wait in the first stage to see what their paired player did and then coordinate in the second stage. In another version, sequential decision-making is imposed by assigning one player to move in stage one and the other player in stage two. Although there are fewer cooperative decisions in the two-stage treatments, we show that subjects coordinate better on efficient cooperation and on avoiding both acquiescing. Consequently they achieve higher profits. Yet, the least cooperative pairs do worse in the two-stage games than their single-stage counterparts. They use the second stage not to facilitate coordination but to disguise their uncooperative play or to punish their opponents.

Keywords: experimental economics, cooperation, efficiency, two-stage games, turn-taking.

***JEL* classification nos.**: C90, Z13.

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1. Introduction

Consider the following two-player game played repeatedly: each player privately receives a randomly drawn integer between 1 and 5 inclusive, each with equal probability. Each player then decides between one of two actions: enter or exit. By exiting a player receives zero. By entering, he receives his number if his opponent exits and one-third of his number if his opponent also enters. Thus, entry is the dominant strategy. By contrast, the socially optimal outcome involves the player with the higher integer entering, while the low-integer player exits. All other outcomes involve some measure of inefficiency with both players exiting (double exit) being the most inefficient. Although both entering (double entry) is the most egregious form of inefficiency, inefficient cooperation whereby the low-integer player enters and the high-integer player exits yields lower payoffs for some pairs of integers.

In this paper, we ask whether converting this single-stage game to a two-stage game reduces inefficiency and thereby increases players' payoffs. There are at least two natural ways in which players may make their entry-exit decisions over time rather than at the same instant in time. First, instead of entering or exiting in the first stage, a player may choose to wait; namely, he postpones his decision until the second stage after observing his opponent's first-stage decision. Second, there may be an intrinsic ordering of moves. In particular, one player, the first mover, may be required to choose between entry and exit in stage 1, while the second mover observes the first mover's decision and decides in stage 2 whether to enter or exit. We explore experimentally whether these two-stage games permit more efficient cooperation than their one-stage counterpart in repeated games over 60 rounds with fixed pairings.

The one-stage game was first introduced in Kaplan and Ruffle (2012).[1] The authors noted the similarity between this game and numerous real-world cooperation dilemmas. For example, bidders in an auction can actively compete with one another. In so doing, each reduces the other's expected surplus. Or bidders with sufficiently a low value for the good being auctioned can elect not to participate. Alternatively, consider two fast-food

[1] In that paper, the authors explored several one-stage variations of the above game with the goal of determining whether cooperative behavior takes the form of cutoff strategies (enter on high integers, exit on low ones) or alternating (players take turns entering and exiting).

chains that each contemplates opening a franchise in a small town. They may possess different expected private values of being the local monopolist that stem from different expected costs or demand for its products. If these two chains wish to collude implicitly, then the chain with a low value would stay out, under the presumption that the favor will be returned in the future. Also, individuals may choose not to enter contests or competitions if their value for the prize or probability of winning is sufficiently low and they care about other more deserving or more capable participants. Junior employees backing down from an internal promotion contest is a common occurrence. Finally, cab drivers, bicycle messengers, golf caddies, waitstaff, sky caps and vendors in a marketplace often face the decision of whether to compete for a customer or acquiesce, with the consequences of their decisions similar to our game's payoff structure.

Notice that none of the above-mentioned dilemmas is inherently a simultaneous-move game. For example, a bidder in an English auction might hesitate before calling out a bid to gauge whether other auction participants intend to bid. A firm may postpone the decision whether to enter a market to determine whether a rival firm values the market more as indicated by its swift entry. A cab driver not in the immediate vicinity of the fare may choose to wait to see if other cabbies respond to the dispatcher's call. In other examples the order of moves may be exogenously given. One bidder may be larger than the others. A chain store may be the market leader. A job, promotion or dating opportunity may be offered first to one candidate who can accept, or decline because he recognizes that the next candidate in line is better suited or more eager.

As suggested by all of these examples, the possibility that players commit at different times to their entry-exit decisions can facilitate a more efficient outcome according to which the player with the higher value for the action pursues it, while the lower-value player acquiesces. To illustrate, if a firm always enters for a certain range of high values, then the possibility of waiting permits the firm to refine its strategy to enter on only a subset of this range and wait otherwise. By waiting and subsequently not entering whenever the other enters, double entry is avoided and a higher social surplus attained.[2]

[2] Consider for illustrative purposes the following simplified game parameterization: the set of values is 1, 2 and 3, each with an equal chance. If firms enter on a 2 or 3, then double entry occurs 4/9 of the time, no entry 1/9 of the time and single entry the remaining 4/9. By switching to entry on 3 and waiting on 2,

Similarly, if there exists a natural sequential ordering to the firms' moves, then the second mover can enter whenever the first mover stays out and exit whenever the first mover enters, thereby completely avoiding double entry and double exit.

We evaluate whether the addition of a second stage improves outcomes.[3] Similar to the above illustrations, we include one experimental treatment in which players may choose to wait until stage two before committing to entry or exit. We refer to this as the *Wait* treatment. In the other two-stage treatment, each player is randomly assigned for all rounds of play to the role of choosing between enter and exit in stage 1 (Player 1) or choosing between entry and exit in stage 2 (Player 2). We refer to this sequential-move treatment as *Seq*. Play in *Wait* and *Seq* is compared to that in our baseline treatment (referred to as *Now*) which consists of single-stage game wherein players decide simultaneously whether to enter or exit. The payoff structure is identical in all three treatments. Payoffs are determined solely on basis of players' ultimate decisions whether to enter or exit.

Contrary to our expectations, we observe more frequent entry in the two-stage games, *Wait* and *Seq*, than in *Now*. Notwithstanding, play in the two-stage games is characterized by more efficient pairwise cooperation and by fewer instances of double exit. As a result, average profits are higher in the two-stage games than in their one-stage counterpart. Yet, average profits mask considerable payoff variance in the two-stage games compared to the relatively narrow range of payoffs realized by subjects in *Now*. Cooperative pairs in the two-stage games earn more than is feasible in the single-stage game. At the same time, the lowest-earning pairs originate predominantly from the two-stage treatments in which waiting and the second stage are used primarily to enter regardless of subjects' values or their opponents' first-stage decision. Thus, while waiting and a second stage enhance outcomes in the hands of cooperative subjects, our

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double entry occurs only 2/9 of the time (1/9 in the first stage when both have 3s and another 1/9 in the second stage when both have 2s). Single entry increases to 2/3 of the time with no entry still at 1/9.

[3] A different approach to reducing entry and improving cooperation would be to impose a limit on the total number of entries permitted by each player in the repeated game. In a similar vein, Engelmann and Grimm (2012) examine a two-player voting game where optimal cooperation requires one to vote for their preferred option only when one's private value is high. Interestingly, only when an exogenous budget constraint (in terms of number of votes) is imposed do they observe "cooperation" rather than players pursuing the dominant strategy of exaggerating their values and always voting for their preferred option.

experiments also illustrate the potential for these features to backfire and lead to worse outcomes.

Our paper contributes to the literature on the endogenous timing of moves. The addition of the wait option renders endogenous the timing of players' decisions to enter or exit. In Cournot duopolies, when the timing of quantity decisions is endogenous, players may postpone their decisions in order to make strategic use of other players' actions (see, for example, Hamilton and Slutsky 1990). Likewise, when publicly observable decisions reveal agents' private information, the strategic delay of decisions may be an equilibrium (see Chamley and Gale 1994; Gul and Lundholm 1995). Attempts to observe strategic delay in the laboratory have met with mixed results (Huck, Muller, and Normann 2001, 2002; Potters, Sefton and Vesterlund 2004; Ziegelmeyer et al. 2005; Fonseca and Normann 2008). In our environment, we analyze whether the waiting option is indeed exploited and to what end.

In the next section, we lay out the experimental design and procedures. In section 3, we provide a theoretical framework for our experiments and some testable hypotheses. For each of the experimental treatments, section 4 presents the results, including the degree of cooperation, the pairwise coordination of outcomes, subjects' profits, and an individual strategy analysis. Section 4 wraps up with some implications of our findings for market design.

2. Experimental Design and Procedures

2.1 Treatments

The experiments were conducted in z-Tree (Fischbacher 2007) with fixed pairs for 60 rounds preceded by five practice rounds in different pairings. Each subject in the pair privately receives an independently and randomly drawn integer between 1 and 5 in each round. In a between-subjects design, we conducted three treatments that differ in the number of stages and the timing of players' moves. The control treatment *Now* consists of a single stage in which players simultaneously decide whether to enter or exit. The decision to exit yields 0, whereas entry yields the value of the number if the partner exits and 1/3 of the value of the number if the partner also enters. After each round, subjects observe their partner's decision and value. The other two treatments, *Wait* and *Seq*, each consist of two stages.

In *Wait* each player decides simultaneously in stage 1 whether to enter, exit or wait. Waiting in stage 1 allows the subject to observe his partner's stage-one decision (but not value) before deciding in stage 2 whether to enter or exit. Waiting is costless; the payoffs depend only on the players' final decisions to enter or exit. Thus, the payoff structure is identical to that in *Now*.

In *Seq* the sequential ordering of moves is imposed. One player is randomly assigned to the role of choosing between enter and exit in stage 1 (Player 1). The other player (Player 2) observes Player 1's stage-one decision (but not value) and decides in stage 2 whether to enter or exit. Again, the payoff structure in *Seq* is identical to that of the other two treatments.

2.2 Experimental Procedures

All subjects were handed the instructions (see Appendix B). After reading them by themselves, the experimenter read them aloud. To ensure that the game was fully understood, subjects answered a series of test questions about the game. Participation in the experiment was contingent upon correctly answering all of the questions, which everyone did. Before the actual game began, five practice rounds were conducted with identical rules. To eliminate any strategic influence of the five practice rounds, subjects were rematched with a different partner for the paid 60-round experiment.

Before beginning the sessions, we drew two random sequences of 65 values (for the 60-round game and 5 practice rounds), one sequence for each pair member. We used these sequences for all pairs in all sessions and treatments. This eliminates the need to control for the random variation in values across pairs and treatments and allows us to compare more cleanly the subject pairs' decisions.

The subjects were students at Ben-Gurion University. Eighty-six subjects (43 fixed pairs) participated in *Now*, 88 subjects (44 fixed pairs) participated in *Wait* and 80 subjects (40 pairs) in *Seq*. A *Now* session lasted about 90 minutes on average, while the *Wait* and *Seq* sessions each lasted about 120 minutes. Subjects' profits were converted to shekels at a fixed experimental-currency-to-shekel ratio of 1:0.9. Subjects earned approximately 75 shekels on average (about $21 USD).

3. Theoretical Framework and Hypotheses

3.1 Theoretical Framework

The theoretical framework and properties of the one-stage game are presented in Kaplan and Ruffle (2012). There are non-cooperative and cooperative solutions to this game. The Bayes-Nash equilibrium is to follow the dominant strategy of always entering for values greater than zero (i.e., for all values in the present game). One cooperative solution is for one player to enter and the other to exit. In a repeated game, this cooperative solution can take the form of players taking turns entering and exiting.[4] The pair's expected payoff from playing the alternating strategy is 3. Another cooperative solution is to enter only with high numbers, such as 3, 4 and 5. This cutoff strategy yields a slightly lower joint expected payoff of 2.88. Notwithstanding, Kaplan and Ruffle (2012) find it to be the modal strategy in their *Now* treatment.

In *Wait*, a stage-one strategy maps values into the possible actions of enter, exit or wait. Full cooperation (maximizing a pair's joint profits) entails monotonic stage-one strategies. Namely, if the action for value x is enter, then the action for all values v>x is also enter. Also, if the action for value x is wait, then the action for all values v>x is either wait or enter (see Appendix A for the proof). It is worth noting that, in contrast to *Now* in which alternating is the joint-payoff-maximizing strategy, turn taking in stage 1 can never be part of the social optimal in *Wait* (see the last paragraph of Appendix A for the proof).

Table 1 displays the joint expected payoffs for all possible pairings of the 21 monotonic strategies and alternating. To describe the monotonic strategies, we use the following notation: the player exits with values to the left of the parentheses, waits with values between the parentheses, and enters with values to the right of the parentheses. For

[4] In addition to Kaplan and Ruffle (2012), turn taking has been observed in Kwasnica and Sherstyuk (2007) in the form of bid rotation in multi-object auctions with complementarities between the objects, as well as in Zillante (2011), Cason et al. (2012), Sibly et al. (2014) and Bjedov et al. (2015).

example, a player who follows the strategy 12(34)5 exits when he receives a value of 1 or 2, waits when he receives a 3 or 4, and enters on a 5. The expected payoff calculations assume that players play cooperatively in the second stage. Namely, if a player waits in the first stage, he enters in the second stage if the other player exited in the first stage and exits if the other player entered in the first stage. If both players chose to wait in the first stage, they employ the alternating strategy to resolve which one enters in stage two.[5]

Table 1 shows that several pairs of strategies achieve the highest joint expected profit of 3.60: 123()45-(12345), 12(3)45-(12345), 12()345-(12345), where the dash separates player 1's strategy from player 2's. This profit compares favorably with the full-information first-best expected surplus (i.e., only the player with the higher value enters) of 3.8. The first strategy pair above divides the expected profit evenly between pair members. Nonetheless, because all three of the above strategy pairs are asymmetric, we anticipate difficulty coordinating on them. Symmetric strategies are more likely to emerge. From the diagonal in Table 1, the most profitable symmetric strategies are 1(234)5 and 1(23)45 with joint expected profits of 3.53 and 3.44, respectively.

From the previous paragraph, we saw all three of the asymmetric joint-profit-maximizing strategies in *Wait* require one player to wait in stage one, regardless of the player's value, and select between enter and exit only in stage two. The *Seq* treatment precludes Player 1 from waiting while imposing it on Player 2. Thus, the two payoff-maximizing pairs of strategies in *Wait* that do not involve Player 1 waiting are also associated with the highest expected payoffs in *Seq*.

3.2 Hypotheses

As the previous subsection illustrates, both the *Wait* and *Seq* treatments offer the potential to better coordinate on efficient cooperation and to avoid double entry and double exit. In *Now*, the cooperative pair can obtain a maximum joint expected payoff of 3 by taking turns entering and exiting. However, Kaplan and Ruffle (2012) showed that few subjects

[5] Other payoff-inferior, second-stage strategies exist. For example, with the first-stage strategy 1(234)5, one second-stage strategy is as follows. If the other player waited in the first stage, exit with a value of 2, enter with 4 and flip a coin with a value of 3. The joint expected payoff given that both wait is 2.44, which is less than 3 obtained by alternating.

are able to coordinate on taking turns. Instead, cooperators play cutoff strategies. In this game, the socially optimal cutoff strategies of 12()345 yield a joint expected payoff of 2.88. If paired subjects play this strategy, double entry occurs with probability 9/25, double exit with probability 4/25 and efficient coordination the remaining 12/25.

By comparison, we anticipate cooperative subjects in *Wait* to adopt symmetric strategies that involve waiting. The socially optimal symmetric strategies of 1(234)5 and 1(23)45 yield joint expected profits of 3.53 and 3.44, respectively. Both reduce the probability of double exit to 1/25 and of double entry to 1/25 for the former strategy and to 4/25 for the latter one. The result is that these strategies achieve roughly 20% higher profits than the most profitable strategies in *Now* by committing to a first-stage entry or exit decision for fewer values than in the single-stage game. In this way, if only one player enters or exits in stage 1, his cooperative partner who waited simply chooses the opposite action in stage 2.

Cooperative subject pairs in *Seq* avoid double entry and double exit altogether. Whatever Player 1's choice of action in the first stage, a cooperative Player 2 chooses the opposite action to ensure precisely one pair member enters. Consequently, profits are expected to be highest in *Seq*. A cooperative pair earns 3.6 in expectation by playing either of the following strategy pairs: 123()45-(12345), 12()345-(12345). These strategies differ only in Player 1's choice of action when he draws a value of 3. Both strategy pairs lead to efficient cooperation with probability 22/25 and inefficient cooperation with the remaining 3/25 probability. Of the two strategy pairs, the first is the most likely since it divides the 3.6 units of surplus equally between the paired players.

In brief, the ability to postpone the entry decision in the *Wait* treatment ought to reduce double entry and double exit and facilitate efficient coordination. To the extent that subjects behave cooperatively, the staggered timing of decisions in *Seq* ought to eliminate entirely double entry and exit. Consequently, we expect profits to be highest in *Seq* followed by *Wait* and lowest in *Now*. In *Now*, the socially optimal cutoff strategy of 12()345 leads to an overall entry frequency of 60% and expected pair profits of 2.88 per round. In *Wait*, the first-stage strategies of 1(234)5 and 1(23)45 along with the stage-two actions taken to complement the paired partner's first-stage decision are expected to yield entry percentages of 50% and 56%, respectively with per round expected pair profits of

3.53 and 3.44. Finally, in *Seq* the equitable socially optimal strategy pair of 123()45-(12345) produces an expected pair profit of 3.6 per round and an overall entry percentage of 50%: in 40% of the rounds only Player 1 enters, while in the remaining 60% of the rounds only Player 2 enters.

4. Results

4.1 Entry

Surprisingly and counter to our conjecture, a comparison of treatments according to the overall percentage of entry (see the left panel of Table 2) reveals a higher percentage of entry decisions in *Wait* (77.2%) and *Seq* (76.6%) than in *Now* (71.9%). Higher entry on values 1 and 2 in the two-stage games accounts for the higher entry overall in these treatments. Specifically, subjects are 17 and 19 percentage points (hereafter "p.p.") more likely to enter on a 1 in *Wait* (38.0%) and in *Seq* (39.9%), respectively, than in *Now* (20.6%). This disparity in entry frequency between treatments is of a similar magnitude for the value 2. Are subjects beating up one another in the two-stage games or do these higher entry percentages attest to the successful avoidance of double exit? We will answer this question in the next subsection.

For the value 3, the disparity reverses: subjects in *Now* enter 10 p.p. and six p.p. more frequently than their counterparts in *Wait* and *Seq*, respectively. Because entry percentages approach 100% in all three treatments for values 4 and 5, differences between treatments become negligible. If we treat each pair of subjects' overall fraction of decisions corresponding to enter as the unit of observation, then the non-parametric Kruskal-Wallis test rejects the equality of the entry frequency distributions (χ^2=4.74, p=.094, n=126).

In Table 3, we report the estimates from two linear probability models on subject *i*'s decision to enter in period *t*.[6] Standard errors are clustered by subject, taking into account

[6] In this and the preceding analysis, we focus on *Wait* subjects' decision to enter or exit and disregard for the time being whether the ultimate decision to enter occurred in stage 1 or 2. Also, because all but one of the regressors are binary indicators, the significance and non-significance of all of our coefficients are all robust to whether we use the linear probability or Probit model (Angrist and Pischke 2010). We report the former for ease of interpretation.

possible correlation in the error terms across periods of play. Regression (1) includes only indicator variables for the *Wait* and *Seq* treatments. The highly significant coefficients of 0.053 and 0.047 (both p<.001) indicate that subjects are about five p.p. more likely to enter in *Wait* and *Seq* than in *Now* in which the constant term reveals an overall entry percentage of 71%. The inclusion of a series of controls for game variables and lagged play in regression (2) leaves the difference in entry frequency between the two-stage games and one-stage games essentially unchanged at around four-plus p.p. and highly significant (p<.001 for both).

The indicator variable *value>1* equals 1 if subject *i*'s period *t* value is 2, 3, 4 or 5 and 0 if it is 1. Similarly, *value>2* equals 1 if subject *i*'s period *t* value is 3, 4 or 5 and 0 if it is 1 or 2 and so forth for *value>3* and value>4. Thus, the estimated coefficients on *value>1*, *value>2*, *value>3* and *value>4* reflect the marginal propensity to enter on a 2, 3, 4 or 5, respectively. The highly significant positive coefficients reveal that subjects were more likely to enter on each additional value. The likelihood of entering on a 3 is a whopping 41 p.p. higher than it is on a 2. The regression also reveals that the subject's previous-period entry and that of his partner are associated with a higher likelihood of entry in the current period. Subjects also appear to take into account their partner's previous-period value in a conciliatory manner: for every additional point the partner received last period, the subject is four p.p. less likely to enter this period. Finally, the highly significant coefficient of 0.099 on the indicator variable for play in the final five rounds attests to a modest breakdown in cooperation as the known terminal period approaches. No significant difference in the propensity to enter is observed between the first five rounds (or similarly for the first 10 rounds) and the middle 50 (or middle 45) rounds.

4.2 Coordination of Outcomes

Despite higher levels of entry in the two-stage games, Table 4 shows that paired subjects in these treatments managed to avoid double exit and coordinate more frequently on the efficient-cooperation outcome whereby only the player with the higher value entered. More precisely, inefficient double exit drops from 8.7% in *Now* to 2.8% in *Wait* and to a negligible 0.6% in *Seq*. At the same time, efficient cooperation increases by 2 p.p. and 5 p.p. in *Wait* and *Seq* compared to the single-stage treatment. However, double entry – the most frequent outcome in all three treatments – displays a modest increase in the two-stage games, rising from 52.4% in *Now* to 57.1% in *Wait* and 53.8% in *Seq*. A chi-square test of proportions shows that the differences between treatments in the distributions of the pair-level outcomes are highly significant (χ^2=466, d.f.=6, p<.001).

Let us examine how subjects made use of the two stages to reduce double exit and coordinate on efficient cooperation. The center and right panels of Table 2 display the distributions of stage-one decisions in *Wait* and *Seq*, respectively, for each of the five values. In both treatments and in *Now* (left panel), exit is the modal decision for value 1. Exit remains the modal decision for value 2 in *Now* and *Seq* only. In *Wait*, the wait option becomes the modal choice for values 2 and 3. In fact, in large part due to the wait decision detracting from the decision to enter in the *Wait* treatment, stage-one entry percentages are lower in *Wait* than in *Seq* for all five values. Yet, the fact that overall entry percentages are marginally higher in *Wait* than in *Seq* suggests that many of these stage-one wait decisions convert into stage-two entry decisions.

When both players wait, the resulting subgame is strategically equivalent to *Now*. However, having seen the partner's decision to wait allows the player to update his beliefs about the partner's value. As we saw in the center panel of Table 2, subjects are four times more likely to wait on a 2 or 3 than on a 4 or 5. In fact, based upon the observed waiting frequencies, the chance that the partner has a value of 4 or 5 is reduced from 40% (*ex ante*) to 17.3% (observed). Updating their beliefs about their partners' values accordingly provides a possible rationale for entering on lower values in stage 2 and may partially account for the higher entry frequencies observed on values 1 and 2 in *Wait* than in *Now*.

Table 5 displays the stage-two entry percentages in each treatment conditional on the subject's value and the partner's stage-one decision. Subjects have no difficulty entering when their partner exited in stage 1: in both treatments, entry percentages are close to or at 100% for all values conditional on the partner exiting in stage 1. In *Wait*, exit remains the modal decision (44% entry) on a 3. However, the entry percentage jumps to 80% and 96% on values 4 and 5 after observing the partner's stage-one entry. If the partner also waited in stage 1, entry is the modal decision on all five values and reaches 100% for values 4 and 5. Thus, having received a 4 or a 5 and having chosen to wait in stage 1, the table shows that entry is almost certain in stage 2. This begs the question why subjects with values 4 and 5 bothered to wait in stage 1 if their intention was to enter in stage 2?

In *Seq*, after observing one's partner enter in stage 1, the subject also enters in the second stage 87%, 92% and 96% of the time with values 3, 4 and 5, respectively. Finally, the "total" column reveals entry percentages at 87% for value 3, increasing to 94% for value 4 and 97% for value 5. These stage-two percentages are similar to the entry percentages in stage 1 (right panel of Table 2). With such high entry frequencies, it is no wonder double entry accounts for over half of the outcomes in this treatment. The "total" column also displays stage-two entry percentages around 50% for both values 1 and 2, which are substantially higher than the corresponding stage-one entry percentages. This disparity can be partially attributed to Player 2's effort to avoid double exit.

4.3 Profits

On the one hand, overall higher entry in *Wait* and *Seq* would lead us to expect lower profits than in *Now*. On the other hand, we saw in the previous subsection that subjects in the two-stage games avoid double exit and succeed in attaining efficient cooperation more often. Table 6 displays summary statistics for paired players' profits. It turns out that pair profits are highest in *Seq* (170.2 on average), followed by *Wait* (167.9) and lowest in *Now* (163.2). A comparison of the distribution of pair profits for any two treatments at time using the Mann-Whitney rank-sum test reveals only one significant difference: profits in *Seq* are significantly higher than those in *Now* ($z=-2.04$, $p=0.04$).

If we express the mean pair profit by treatment as a percentage of the full-information efficient outcome by which only the high-value player enters (in the case of ties only one player enters) using the actual distribution of values drawn over the 60 rounds, *Seq* subjects earn on average 73.1% of this first-best social optimum compared to 72.0% for *Wait* subjects and 70.1% for *Now* subjects. All three percentages greatly exceed the 52.6% earned by Nash play, attesting to some measure of cooperation achieved in all treatments.

The more striking contrast concerns the differential degrees of dispersion of paired subjects' profits across treatments. To begin, note from column 3 of Table 6 that the standard deviation of pair profits of 13.1 in *Now* is about half that of the *Wait* and *Seq* treatments. The histograms of pair profits in Figure 1 offer some insight. In *Now*, fully 40 out of 43 subject pairs' profits fall between 140 and 180. Moreover, 32/40 pairs earn in the narrower range of 160 to 180. By contrast, the pair profit distributions for the *Wait* and *Seq* treatments resemble a uniform distribution over the entire range of 120 to 220. Only 18/44 and 18/40 pairs earn between 140 and 180 in *Wait* and *Seq*, respectively.

What is more, the highest pair profit in *Now* was 181, meaning that not a single pair appears in any of the three highest profit categories (190-220) in Figure 1. Contrast this with a highest pair profit of 215.7 in *Wait* and 211.3 in *Seq*, and 30% of the pairs in *Wait* and 23% of the pairs in *Seq* that placed in the three highest profit categories. At the other extreme, among the 18 paired subjects that earned less than 140 in the experiment, only two originate from *Now*, while nine played in *Wait* and seven in *Seq*.

The upshot of this analysis is that the two-stage games permit cooperative pairs to do better than is possible in the one-stage game, whereas uncooperative pairs tend to do worse with the addition of the second stage. Why would the better conditions for coordination in *Wait* and *Seq* affect pairs in different directions? To address this question, we analyze in the next two subsections how the behavior of the low-profit subjects in *Wait* and *Seq* differs from that of their high-profit counterparts.

4.4 Individual Strategy Inference

Recall from Section 3 that in the *Wait* treatment there are 21 possible monotonic cutoff strategies in stage 1 that condition on the subject's value. For each subject we compare the ability of each of the 21 monotonic cutoff strategies in Table 1 and the alternating strategy to classify correctly subjects' stage-one decisions. The strategy that minimizes the number of errors in classifying the subject's observed decisions is deemed the strategy the subject most likely employed. Table 7 presents the distribution of these best-fit strategies for stage 1 of *Wait*.[7] For each strategy we denote the number of subjects that employ the strategy (column 2),[8] the mean number of errors (deviations from the

[7] The inferred strategies are based on rounds 6-55 to exclude learning in the initial rounds and observed endgame effects. The distributions of best-fit strategies are highly similar to other ranges of included periods, such as all 60 rounds, the first 50 or 55 rounds and the last 50 rounds.

[8] For several subjects, two or more strategies tied for the fewest errors. In these cases, we assign a share of 1/*n* to each of the *n* tied strategies.

strategy) by those who employed it (column 3), the mean profit of those who employed the strategy and that of those subjects' partners as well as the mean entry percentage (after both stages of play) for the subject and his partner.

Seventy-five out of the 88 subjects (85%) employ strategies that involve waiting. The remaining subjects whose strategy doesn't include waiting either enter on all values (9%), exit on 1 and enter on values 2-5 (5.7%), or exit on 1 and 2 and enter on values 3-5 (1%). Capturing 24/88 subjects, the strategy 1(23)45 is the most widely employed. It is also the second most jointly profitable symmetric strategy, as evidenced by the high realized mean profit of 95.0 (column 4 of Table 7) earned by its adopters. The strategy of (123)45 is the second most widely used strategy with 12.75/88 subjects using it. These two strategies differ only in that 1(23)45 dictates exiting on the value of 1 while (123)45 calls for waiting. The latter choice to wait leads to lower mean profits of 82.3. One lone subject employed the joint profit-maximizing symmetric strategy of 1(234)5, while no pair was found to play any of the asymmetric strategy pairs that earn more than 1(234)5. Nor did any pairs in *Wait* adopt the payoff-inferior alternating strategy.

The subject's profit along with his partner's (column 5) attest to the pair's degree of cooperation. Paired partners in which at least one pair member followed the strategy 1(23)45 earned similarly high profits, implying a high level of reciprocal cooperation. Those who followed the strategy 1(23)45 also recorded the fewest deviations from their inferred strategy.[9] Tracking this strategy to stage 2, subjects on the whole appear to be playing the strategy 1(2/3)45 (wait with values 2 and 3 and, if the partner also waited, exit on a 2 and enter on a 3).

Another 5.5 subjects played the strategy (12345), namely, "always wait". Looking at the second-to-last column of Table 7, we see that these subjects entered an astonishing

[9] Overall, the error rates are low for most strategies, thereby attesting to the effectiveness of this simple technique in capturing subjects' behavior. Of the 4400 decisions made by the 88 subjects in *Wait* and the 4000 decisions made by the 80 subjects in *Seq* between rounds 6-55, 3740 (or 85%) and 3615 (or 90.4%) correspond to the best-fit strategy inferred for each subject compared to 4009 out of the 4300 (or 93.2%) decisions made by the 86 subjects in *Now*. The addition of the waiting option in *Wait* increases the number of monotonic pure-strategy cutoffs from six in *Now* to 21 in *Wait*, thus accounting for the highest error rate in *Wait* and lowest in the single-stage, binary-choice game, *Now*.

98% of the time in stage 2, eight p.p. higher than the "always enter" subjects in *Wait* and 11 p.p. higher than the "always enter" subjects in *Now*! That is, the always-wait subjects are wholly uncooperative – even more so than those who play always enter. The availability of the waiting option seems to attract the least cooperative types and, under the guise of waiting to decide, entices them to behave even more uncooperatively than they would in the absence of this option.

Now the natural question to ask is: were they successful in their attempt to deceive their partners? The last column of Table 7 reveals that their uncooperativeness was reciprocated with entry of 90% by their partners. This compares with entry of 86% by partners paired against "always enter" in *Wait* and 92% against "always enter" in *Now*. Hence, subjects' attempt to deceive was foiled, leading to low profits for themselves and the pair overall. The addition of the waiting option failed to conceal uncooperativeness whether in the form of always enter or always wait followed by entry.

In Table 8 we group together the best-fit strategies for subjects in *Now* (left panel) as well as for Player 1 subjects in *Seq* (right panel). The strategy 12()345 according to which subjects exit on values 1 and 2 and enter on values 3, 4 and 5 is the predominant best-fit strategy in *Now* (53/86 or 62% of subjects) and among Player 1 subjects in *Seq* (20/40 or 50%). In striking contrast, only a single subject utilized this strategy in *Wait* (1/88) in which the waiting option is also available. Only two pairs of subjects used the alternating strategy in *Now* despite it being the most profitable strategy in this treatment.

Subjects who played the dominant strategy of ()12345 (i.e., always enter) in *Now* earned a profit of 74 on average, 14% less than the mean profit earned by subjects who played the socially optimal cutoff strategy 12()345. In the two-stage treatments, by contrast, subjects who played always enter earned only 67.7 and 65.0 in *Wait* and *Seq*, respectively, which are more than between 40% and almost 50% below the mean profit of 95 for the socially optimally symmetric cutoff strategy of 1(23)45 in *Wait* and the mean profit of 96.4 from Player 1's socially optimally cutoff strategy of 123()45 in *Seq*. The message is that cooperative subjects earn substantially more than uncooperative subjects, especially in the *Wait* and *Seq* treatments in which cooperation helps to avoid double exit and coordinate on efficient cooperation.

4.5 Behavior of Low-Profit Subjects in *Wait* and *Seq*

Overall, the possible sources of low profits in *Wait* and *Seq* are inefficient cooperation, double exit and double entry outcomes. Yet, we saw that inefficient cooperation and double exiting are uncommon in *Wait* (accounting for 1.7% and 2.8% of the total outcomes respectively according to Table 4) and in *Seq* (3.8% and 0.6%, respectively). Double entry, on the contrary, accounts for 57% and 54% of the outcomes in each of the respective two-stage treatments. By the structure of the games, double entry must take place in stage 1 in *Now* and in staggered stages in *Seq*, whereas in *Wait* it can be the result of both subjects entering in stage 1, both waiting in stage 1 and entering in stage 2 or one entering in stage 1 and the other in stage 2. In fact, 57% of instances of double entry in *Wait* arise from both subjects entering in stage 1, 17% from both subjects entering in stage 2, and a troubling 26% from subjects entering in different stages. This breakdown of the percentages of double entry attests to uncooperative decisions.

We already observed from Table 5 subjects' tendency to largely disregard their partners' first-stage decision and enter on values 4 and 5, and also on value 3 if the partner also waited. Table 9 examines more closely waiting subjects' stage-2 choices conditional on their partner also having chosen to wait in stage 1 as a function of their values and their pairs' realized profits. For the nine lowest profit pairs that earned 120-139, we see, first of all, the large number of observations uniformly distributed across the five values, suggesting that many low-profit subjects chose to wait in stage 1 regardless of their value. Secondly, all of the entry percentages for these subjects are 83% and higher, rising to 100% for values 4 and 5 – to repeat for emphasis, this table concerns periods in which the partner also waited in stage 1. By contrast, the paucity of observations for values 1, 4 and 5 for the highest-profit pairs (earnings between 200 and 220) reflects a more selective use of the waiting option. The six highest earning pairs almost always exited on a 1 in stage 1 and entered on a 4 and 5. They primarily invoked the wait option when they received values 2 and 3. On the former value, they entered only 30% of the time, while on the latter value, they entered 77% of the time.

The differences in entry percentages across profit categories for a given value are even more stark conditional on the partner entering in stage 1 (Table 10). Despite the partner having already visibly entered in stage 1, subject pairs in the lowest profit category nonetheless enter with a frequency of 67.7% on a value of 1, increasing to 100% on values 4 and 5. Moving across the table, these entry frequencies drop dramatically for the second-highest and highest profit categories. In the highest profit category, no subject ever entered on a value of 1 or 2. In fact, among these highest profit pairs, the entry frequency increases to only 11.1% on a value of 4.

In summary, successful subject pairs condition their second-stage entry decision on their value and their partner's first-stage decision, whereas lower profit pairs tend to disregard both of these and enter in stage two.

The contrast in stage-two behavior between low- and high-profit subject pairs is equally as stark in the *Seq* treatment. Having observed their partners (Player 1) enter in stage 1, Table 11 reveals that Players 2 from the lowest profit pairs nonetheless enter 3/4 of the time even on a 1, quickly increasing to 100% entry on values 3, 4 and 5. By contrast, Player 2 subjects in the highest-profit pairs never enter on a 1 (0%), with their entry frequency rising gradually to 36% on a value of 4 and 64% on a value of 5.

5 Conclusions

This paper illustrates how a modest institutional change can have important consequences for cooperation and efficiency. At first glance, converting a single-stage game, *Now*, into two-stage games, *Wait* and *Seq*, increases the frequency of individual uncooperative decisions. Yet the *timing* of these decisions enabled paired players to achieve a higher degree of pairwise cooperation and ultimately higher profits in these two-stage games.

However, a closer look at the distribution of profits reveals fully half of the subject pairs in *Wait* and 35% of the subject pairs in *Seq* earned less than in *Now*. The dark side of the waiting option is that this cooperation-enabling tool can be exploited by selfish individuals to disguise their uncooperative behavior. Rather than conspicuously entering right away, waiting veils their intent. Similarly, most first movers in *Seq* enter more than is socially optimal. Second movers retaliate by doing the same.

Our paper offers recommendations to economic parties designing mechanisms. Take for example a company or government involved in the procurement of a large contract: construction project, fighter jet, etc. (or selling off a large asset such as real estate or spectrum). It is typical to conduct one of two prevalent auction-type procedures. One procedure involves a single stage in which bidders enter and submit bids. A second procedure is to hold a two-stage process in which potential entrants are made known in the first stage and bidding occurs in the second stage. Intuitively, one would think that in order to prevent collusion a designer would want less information revealed between bidders and thus favor one stage over two stages or choose not to publicize the bidders participating. However, if a designer is primarily concerned with attracting a bidder, then the design should involve sequentially asking bidders if they wish to participate and announcing entry results since we found that double exit is lowest in *Seq*. If the designer is primarily concerned with instigating a competitive process, then two stages are best since we found *Wait* has the most double entry. Finally, if the designer is primarily concerned with inducing the low-cost supplier to enter, then either form of two-stage process will suffice since we found that *Seq* or *Wait* have similarly high levels of the combination of efficient cooperation and double entry.

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Table 1
The joint expected payoffs for any pair of strategies among 21 monotonic strategies and alternating (*Wait* treatment)

			Player 2																					
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
			12345()	1234(5)	1234()5	123(45)	123(4)5	123()45	12(345)	12(34)5	12(3)45	12()345	1(2345)	1(234)5	1(23)45	1(2)345	1()2345	[12345]	(1234)5	(123)45	(12)345	(1)2345	()12345	Alternate
	1	12345()	**0.00**	1.00	1.00	1.80	1.80	1.80	2.40	2.40	2.40	2.40	2.80	2.80	2.80	2.80	2.80	3.00	3.00	3.00	3.00	3.00	3.00	1.50
	2	1234(5)	1.00	**1.80**	1.80	2.42	2.42	2.40	2.86	2.86	2.84	2.80	3.12	2.92	3.10	3.06	3.00	3.20	3.20	3.18	3.28	3.14	3.00	2.00
	3	1234()5	1.00	1.80	**1.73**	2.44	2.37	2.29	2.92	2.85	2.77	2.68	3.24	3.17	3.09	3.00	2.89	3.40	3.33	3.25	3.16	3.05	2.93	1.97
	4	123(45)	1.80	2.42	2.44	**2.88**	2.9	2.88	3.18	3.20	3.18	3.12	3.32	3.34	3.32	3.26	3.16	3.30	3.32	3.30	3.24	3.14	3.00	2.40
	5	123(4)5	1.80	2.42	2.37	2.90	**2.85**	2.77	3.24	3.19	3.11	3.00	3.44	3.39	3.21	3.20	3.05	3.50	3.45	3.37	3.26	3.11	2.93	2.37
	6	123()45	1.80	2.40	2.29	2.88	2.77	**2.64**	3.24	3.13	3.00	2.84	3.48	3.37	3.24	3.08	2.89	3.60	3.49	3.36	3.20	3.01	2.80	2.30
	7	12(345)	2.40	2.86	2.92	3.18	3.24	3.24	**3.36**	3.42	3.42	3.36	3.40	3.46	3.46	3.40	3.28	3.30	3.36	3.36	3.30	3.18	3.00	2.70
	8	12(34)5	2.40	2.86	2.85	3.20	3.19	3.13	3.42	**3.41**	3.35	3.24	3.52	3.51	3.45	3.34	3.17	3.50	3.49	3.43	3.32	3.31	2.93	2.67
	9	12(3)45	2.40	2.84	2.77	3.18	3.11	3.00	3.42	3.35	**3.24**	3.08	3.56	3.49	3.38	3.22	3.01	3.60	3.53	3.42	3.26	3.05	2.80	2.60
	10	12()345	2.40	2.80	2.68	3.12	3.00	2.84	3.36	3.24	3.08	**2.88**	3.52	3.40	3.24	3.04	2.80	3.60	3.48	3.32	3.12	2.88	2.60	2.50
Player 1	11	1(2345)	2.80	3.12	3.24	3.32	3.44	3.48	3.40	3.52	3.56	3.52	**2.80**	3.48	3.56	3.48	3.36	3.20	3.32	3.36	3.32	3.20	3.00	2.90
	12	1(234)5	2.80	2.92	3.17	3.34	3.39	3.37	3.46	3.51	3.49	3.40	3.48	**3.53**	3.51	3.42	3.25	3.40	3.45	3.43	3.46	3.17	2.93	2.87
	13	1(23)45	2.80	3.10	3.09	3.32	3.21	3.24	3.46	3.45	3.38	3.24	3.56	3.51	**3.44**	3.30	3.09	3.50	3.49	3.42	3.28	3.07	2.80	2.80
	14	1(2)345	2.80	3.06	3.00	3.26	3.20	3.08	3.40	3.34	3.22	3.04	3.48	3.42	3.30	**3.12**	2.88	3.50	3.44	3.32	3.14	2.90	2.60	2.70
	15	1()2345	2.80	3.00	2.89	3.16	3.05	2.89	3.28	3.17	3.01	2.80	3.36	3.25	3.09	2.88	**2.61**	3.40	3.29	3.13	2.92	2.65	2.33	2.57
	16	(12345)	3.00	3.20	3.40	3.30	3.50	3.60	3.30	3.50	3.60	3.60	3.20	3.40	3.50	3.50	3.40	**3.00**	3.20	3.30	3.30	3.20	3.00	3.00
	17	(1234)5	3.00	3.20	3.33	3.32	3.45	3.49	3.36	3.49	3.53	3.48	3.32	3.45	3.49	3.44	3.29	3.20	**3.33**	3.37	3.32	3.17	2.93	2.97
	18	(123)45	3.00	3.18	3.25	3.30	3.37	3.36	3.36	3.43	3.42	3.32	3.36	3.43	3.42	3.32	3.13	3.30	3.37	**3.36**	3.34	3.07	2.80	2.90
	19	(12)345	3.00	3.28	3.16	3.24	3.26	3.20	3.30	3.32	3.26	3.12	3.32	3.46	3.28	3.14	2.92	3.30	3.32	3.34	**3.12**	2.90	2.60	2.80
	20	(1)2345	3.00	3.14	3.05	3.14	3.11	3.01	3.18	3.31	3.05	2.88	3.20	3.17	3.07	2.90	2.65	3.20	3.17	3.07	2.90	**2.65**	2.33	2.67
	21	()12345	3.00	3.00	2.93	3.00	2.93	2.80	3.00	2.93	2.80	2.60	3.00	2.93	2.80	2.60	2.33	3.00	2.93	2.80	2.60	2.33	**2.00**	2.50
	22	Alternate	1.50	2.00	1.97	2.40	2.37	2.30	2.70	2.67	2.60	2.50	2.90	2.87	2.80	2.70	2.57	3.00	2.97	2.90	2.80	2.67	2.50	**3.00**

Notation - The player exits on values to the left of the parentheses, waits on values in the parentheses, and enters on values to the right of the parentheses. For example, a player who employs the strategy 12(34)5, exits when he receives a value of 1 or 2, waits on values of 3 and 4 and enters when he receives a 5**.**

Table 2
Left Panel – frequency of entry for each value for *Now*, *Wait* and *Seq* treatments.
Center Panel – distribution of stage-1 entry, wait and exit decisions for each value in *Wait* treatment.
Right Panel – frequency of stage-1 entry for each value for *Seq* treatment.

	Overall Entry			***Wait* Stage-1 Decision**			***Seq* Stage-1**
Value	***Now***	***Wait***	***Seq***	**Entry**	**Wait**	**Exit**	**Entry**
1	20.6%	38.0%	39.9%	18.0%	39.5%	42.5%	30.7%
2	33.9%	55.2%	48.5%	26.5%	59.9%	13.6%	44.1%
3	93.2%	83.4%	87.3%	43.5%	55.9%	0.5%	87.9%
4	97.2%	98.5%	96.6%	84.7%	15.0%	0.3%	99.2%
5	97.3%	99.0%	98.2%	85.7%	13.6%	0.8%	99.6%
Overall	71.9%	77.2%	76.6%	54.2%	35.7%	10.2%	75.2%
Obs	5160	5280	4800	2859	1884	537	2400

Table 3
Linear Probability Model on overall decision to enter

Regressor	**(1)**	**(2)**
Wait	.053*** (.012)	.044*** (.010)
Seq	.047*** (.016)	.040*** (.013)
value>1	–	.138*** (.013)
value>2	–	.414*** (.021)
value>3	–	.105*** (.009)
value>4	–	.011** (.005)
$enter_{i,t-1}$	–	.125*** (.013)
$enter_{-i,t-1}$	–	.078*** (.017)
$value_{-i,t-1}$	–	-.041*** (.004)
$value_{-i,t-1}$ * $enter_{-i,t-1}$	–	.014*** (.005)
first5	–	-.008 (.015)
last5	–	.099*** (.010)
constant	0.710 (0.013)	.231 (.019)
Obs	15,240	14,986
Adj. R^2	.003	.419

Dependent variable - ***$enter_{it}$*** equals 1 if subject *i* entered in period *t* and equals 0 if subject exited in period *t*

***Wait*, *Seq* –** indicator variable for whether observation is from *Wait* or *Seq* treatment, respectively

value>1 equals 1 if subject *i*'s period *t* value is 2, 3, 4 or 5 and equals 0 if value is 1. Similarly, ***value>2*** equals 1 for values 3, 4 or 5 and 0 otherwise, and so forth for ***value>3*** and ***value>4***

$enter_{i,t-1}$*, *$enter_{-i,t-1}$ – subject's and his partner's previous-period entry decisions, respectively

$value_{-i,t-1}$ – partner's previous-period value (from 1 to 5)

$value_{-i,t-1}$*$enter_{-i,t-1}$ – interaction term between partner's previous-period value and entry decision

first5 – indicator variable for first 5 rounds

***last5* –** indicator variable for last 5 rounds (rounds 56-60)

*** p-value less than .01
** p-value less than .05
* p-value less than .10

Table 4 Distribution of outcomes by treatment			
Outcome	*Now*	*Wait*	*Seq*
efficient cooperation	36.4%	38.5%	41.8%
inefficient cooperation	2.5%	1.7%	3.8%
double entry	52.4%	57.1%	53.8%
double exit	8.7%	2.8%	0.6%
Total	100.0%	100.0%	100.0%

Efficient cooperation – only the subject with the (weakly) higher value enters
Inefficient cooperation – only the subject with the (strictly) lower value enters
Double entry - both subjects enter
Double exit - both subjects exit

Table 5 – Stage-two entry percentages conditional on partner's stage-one decision

Value	*Wait*				*Seq*		
	Exit	enter	wait	total	exit	enter	total
1	97.6%	26.8%	61.4%	50.7%	92.7%	28.2%	49.1%
2	100%	30.1%	64.0%	47.9%	95.2%	42.3%	52.9%
3	100%	44.1%	92.6%	71.3%	99.3%	81.9%	86.7%
4	100%	79.7%	100%	91.5%	100%	92.1%	94.0%
5	100%	95.9%	100%	98.1%	100%	96.0%	96.9%

Table 6 – **Summary statistics for pair profits by treatment and, for *Seq*, by player type**

Treatment	Obs.	Mean	Std. Dev.	Min	Max
Now	43	163.2	13.1	129.3	181
Wait	44	167.9	26.0	125.3	215.7
Seq	40	170.2	23.9	128.7	211.3
Seq – Player 1	40	86.9	13.8	60.7	118
Seq – Player 2	40	83.3	13.8	58.7	106

Table 7 – Best-Fit Strategies in *Wait*

Distribution of best-fit strategies with the mean fraction of errors by strategy, mean own and partner's profit and mean own and partner's entry frequency for *Wait*, based on rounds range 6-55

		Wait					
	Strategy	**Number who played strategy**	**Fraction of errors**	**Mean profit**	**Mean profit of partner**	**Entry percent (after both stages)**	**Partner entry percent (after both stages)**
involves waiting	12 (3) 45	7	.07	96.0	93.4	0.63	0.66
	1 (2345)	0.5	.36	63.7	75.7	0.88	0.98
	1 (234) 5	1	.08	92.0	123.7	0.45	0.52
	1 (23) 45	**24**	**.08**	**95.0**	**93.3**	0.64	0.65
	1 (2) 345	1.25	.26	82.7	75.4	0.81	0.79
	(12345)	5.5	.26	69.0	64.5	0.98	0.90
	(1234) 5	1.25	.43	80.6	62.1	0.97	0.77
	(123) 45	12.75	.15	82.3	79.9	0.80	0.75
	(12) 345	12.5	.15	83.6	80.0	0.82	0.80
	(1) 2345	8.5	.18	71.2	72.0	0.90	0.89
does not involve waiting	() 12345	8	.20	67.7	68.9	0.90	0.86
	1 () 2345	4.75	.15	74.8	80.4	0.84	0.90
	12 () 345	1	.26	67.0	88.3	0.77	0.90
	123 () 45	-	-	-	-		
	1234 () 5	-	-	-	-		
	12345 ()	-	-	-	-		
	alternating	-	-	-	-		
	Average	Total 88	.14	85.2	85.2	0.76	0.76

Table 8 – Best-Fit Strategies in *Now* and *Seq*

Distribution of best-fit strategies with the mean fraction of errors by strategy, mean own and partner's profit and mean own and partner's entry frequency for *Now* and Seq, based on rounds range 6-55

	Now						***Seq***					
Strategy	**Number who played strategy**	**Fraction of errors**	**Mean profit**	**Mean profit of partner**	**Entry percent**	**Partner entry percent**	**Number who played strategy**	**Fraction of errors**	**Mean profit**	**Mean profit of partner**	**Entry percent**	**Partner entry percent**
() 12345	13.5	0.11	74.0	70.3	0.89	0.85	9	0.04	65.0	60.3	0.96	0.92
1 () 2345	15	0.09	77.0	76.7	0.81	0.81	7	0.05	75.6	70.1	0.82	0.82
12 () 345	**53**	**0.42**	**84.6**	**85.6**	**0.66**	**0.68**	**19.5**	**0.06**	**81.0**	**80.5**	**0.70**	**0.74**
123 () 45	0.5	0.16	77.7	87.3	0.57	0.60	4.5	0.06	96.4	88.5	0.52	0.62
1234 () 5	-	-	-	-			-	-	-	-	-	-
12345 ()	-	-	-	-			-	-	-	-	-	-
alternating	4	0.14	85.3	85.3	0.56	0.56	-	-	-	-	-	-
Average	Total 86	0.30	81.6	81.6	0.72	0.72	Total 40	0.05	78.2	75.0	0.76	0.79

Table 9
Percentage of entry decisions in stage 2 (*Wait*), conditional on partner waiting in stage 1, by profit category and value

Value \ Pair Profits	120-139		140-159		160-179		180-199		200-220		Overall
	Perc.	**Obs.**	**Perc.**	**Obs.**	**Perc.**	**Obs.**	**Perc.**	**Obs.**	**Perc.**	**Obs.**	
1	**86.5%**	52	**61.05%**	41	**48.6%**	35	**41.2%**	24	**25.0%**	4	**61.4%**
2	**83.3%**	42	**88.0%**	25	**90.0%**	20	**51.5%**	55	**30.3%**	33	**64.0%**
3	**98.4%**	61	**100.0%**	32	**100.0%**	20	**93.4%**	83	**77.4%**	53	**92.6%**
4	**100.0%**	52	**100.0%**	15	**100.0%**	7	**100.0%**	8	**100.0%**	3	**100.0%**
5	**100.0%**	47	**100.0%**	11	**100.0%**	8	**100.0%**	5	**100.0%**	1	**100.0%**
Number of pairs	**9**		**11**		**7**		**11**		**6**		**44**

Notes: Percentage of stage-two decisions in the *Wait* treatment corresponding to enter, conditional on the partner waiting in stage one, by subject's own value and subject pair's profit category.

Table 10
Percentage of entry decisions in stage 2 (*Wait*), conditional on partner entering in stage 1, by profit category and value

Value \ Pair Profits	120-139		140-159		160-179		180-199		200-220		Overall
	Perc.	**Obs.**	**Perc.**	**Obs.**	**Perc.**	**Obs.**	**Perc.**	**Obs.**	**Perc.**	**Obs.**	
1	**67.7%**	31	**28.6%**	56	**10.0%**	40	**4.3%**	23	**0.0%**	7	**26.8%**
2	**92.5%**	40	**67.8%**	59	**19.5%**	77	**3.1%**	96	**0.0%**	44	**30.1%**
3	**95.1%**	41	**92.5%**	40	**61.4%**	44	**23.1%**	104	**4.5%**	66	**44.1%**
4	**100.0%**	26	**86.4%**	22	**100.0%**	7	**40.0%**	5	**11.1%**	9	**79.7%**
5	**100.0%**	45	**93.3%**	15	**100.0%**	7	**100.0%**	1	**60.0%**	5	**95.9%**
Number of pairs	**9**		**11**		**7**		**11**		**6**		**44**

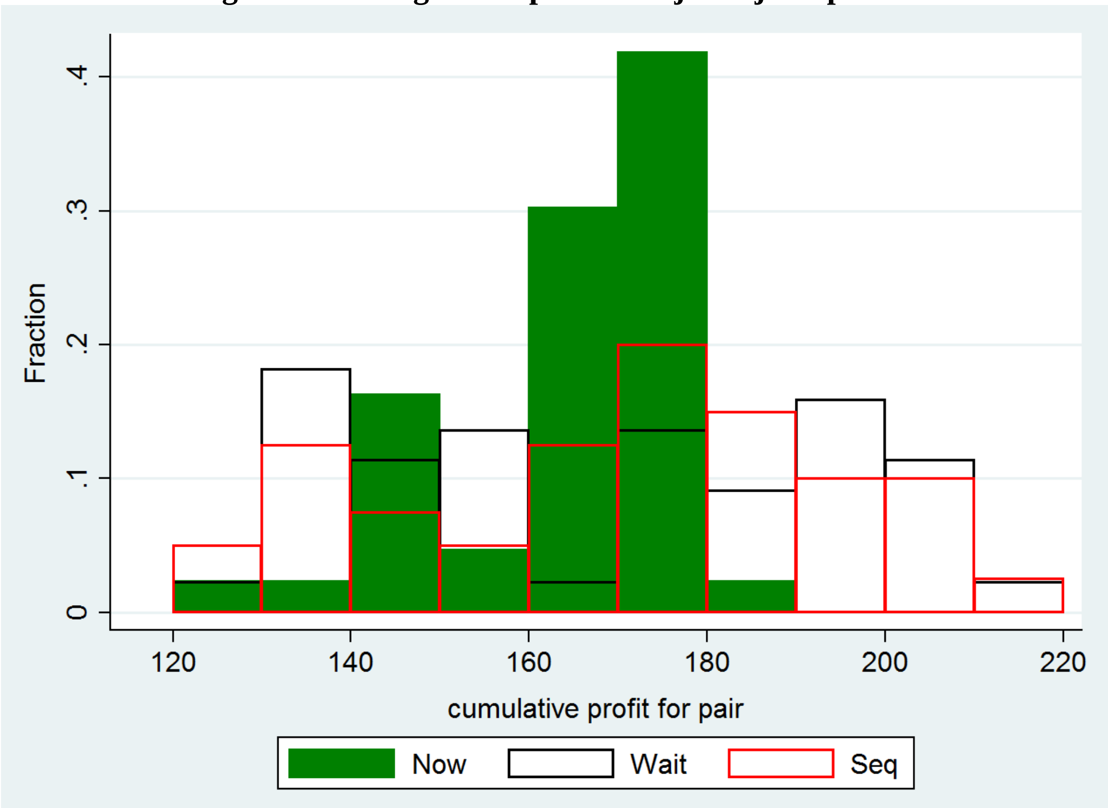
Notes: Percentage of stage-two decisions in the *Wait* treatment corresponding to enter, conditional on the partner entering in stage one, by subject's own value and subject pair's profit category.

Table 11
Percentage of entry decisions in stage 2 (*Seq*), conditional on partner entering in stage 1, by profit category and value

Value \ Pair Profits	120-139		140-159		160-179		180-199		200-220		Overall
	Perc.	**Obs.**	**Perc.**	**Obs.**	**Perc.**	**Obs.**	**Perc.**	**Obs.**	**Perc.**	**Obs.**	
1	**74.3%**	70	**36.8%**	38	**12.4%**	89	**4.4%**	68	**0.0%**	19	**26.8%**
2	**81.6%**	76	**78.4%**	51	**31.1%**	106	**5.4%**	74	**10.3%**	29	**30.1%**
3	**100.0%**	87	**96.7%**	61	**94.7%**	113	**57.5%**	80	**25.7%**	35	**44.1%**
4	**100.0%**	88	**100.0%**	56	**100.0%**	118	**91.6%**	83	**36.1%**	36	**79.7%**
5	**100.0%**	92	**100.0%**	59	**98.6%**	144	**97.9%**	97	**63.9%**	36	**95.9%**
Number of pairs	**7**		**10**		**13**		**10**		**5**		**40**

Notes: Percentage of stage-two decisions in the Sequential treatment corresponding to enter, conditional on the partner entering in stage one, by subject's own value and subject pair's profit category.

Figure 1 – Histogram of paired subjects' joint profits



Appendix A: Monotonic Strategies

Proposition: *The pair's joint expected profits are maximized by each pair member using a monotonic strategy in the first stage of the two-stage* game. *This will never entail the degenerate case of one player always entering and the other always exiting.*

Proof: More general than our simple game, suppose that each player receives a randomly drawn integer between *a* and *b* inclusive where the probability of receiving a number x is Π_x (where $\Pi_x > 0$ and $\sum_{x \epsilon \{a \ldots b\}} \Pi_x = 1$). By exiting a player receives zero and entering he receives his number if the other player exits, but receives some function f(x) increasing in his number, x, if both enter (in stage 1 or in stage 2). We assume that f(x) is strictly less than his number x (and f'(x)<1); hence entry imposes a negative externality on the other player. We also assume that if it is profitable for a player to enter alone (that is, his value is greater than zero), then it is also profitable for him to enter when his partner enters (f > 0 for values greater than zero).

The cooperative solution is given by the pair of strategies that maximizes the sum of the players' expected payoffs. If the player waited in stage 1, we assume he will enter and receive his number if his partner exited in stage 1, and he will exit and receive zero if his partner entered in stage 1.

Suppose the partner enters with probability p(y) and waits with probability t(y) when his number is y. The value of both waiting and optimally cooperating in the second stage is z(x,y), which is weakly increasing in x and weakly decreasing in y (from the cutoff strategies found in the one-stage game in Kaplan and Ruffle, 2012). The joint expected payoff to entering in stage 1 with number x is,

$$\sum_{y\in\{a,b\}}\prod_y \{x(1-p(y)-t(y))+p(y)(f(x)+f(y))+x\cdot t(y)\}$$

The joint expected payoff to exiting out in stage 1 with number x is

$$\sum_{y\in\{a,b\}}\prod_y \{yp(y)+y\cdot t(y)\}.$$

The joint expected payoff to waiting in stage 1 with number x is

$$\sum_{y\in\{a,b\}}\prod_y \{x(1-p(y)-t(y))+yp(y)+t(y)z(x,y)\}.$$

First, note that $\sum_{y\in\{a,b\}} t(y)(\mathrm{z(x+1,y)}-\mathrm{z(x,y)}) \le \sum_{y\in\{a,b\}} t(y)$. If $\sum_{y\in\{a,b\}} t(y)(\mathrm{z(x+1,y)}-\mathrm{z(x,y)}) > \sum_{y\in\{a,b\}} t(y)$, then we can use the same entry/exit decisions for the first player for x+1 with x and do better since any benefit due to player 1 receiving x or f(x) when the second player waits must be r*x+q*f(x) where r+q≤1, hence the derivative r+qf'(x)≤1. This would contradict the assumption that z(x,y) entails optimal cooperation.

We now see that the cooperative solution entails monotonic strategies. This is because if the joint expected payoff to entering is greater than the joint expected payoff to waiting for x, then it also holds for any value greater than x. And likewise if the joint expected payoff to waiting exceeds the joint expected payoff to exiting.

We still have to worry about the case of indifference between waiting and entering for several values of x. Indifference occurs only if the partner always stays out. The pair then earns the same whether the player enters or waits and then enters. In a repeated game, one player always exiting and the other always entering can take the form of alternating. As long as the upper bound of one player L's range of numbers strictly exceeds the lower bound of his partner H's range of numbers (and vice-versa), always exiting and alternating in the repeated game can never be socially optimal since the player always exiting (player L) can wait with his highest number and the player always entering (player H) can wait with any number strictly below that number. Whenever both players wait, player L enters and player H exits in stage 2 to obtain a higher joint payoff than from player L always exiting.

Appendix B: Instructions Sheets

Now Treatment – Instructions Sheet

Welcome

The experiment in which you will participate involves the study of decision-making. If you follow the instructions carefully and make wise decisions, you may earn a considerable amount of money. Your earnings depend on your decisions. All of your decisions will remain anonymous and will be collected through a computer network. Your choices are to be made at the computer at which you are seated. Your earnings will be revealed to you as they accumulate during the course of the experiment. Your total earnings from the experiment will be paid to you, in cash, at the end of the experiment.

You are requested not to talk to one another at any time during the experiment. If you have any questions, raise your hand and a monitor will assist you. It is important that you understand the instructions. Misunderstandings can result in lower earnings. Finally, we ask that even after the experiment is over you not discuss the details of this experiment with anyone.

There are several experiments of the same type taking place at the same time in this room.

This experiment consists of 60 rounds. You will be paired with another anonymous person. This person will remain the same for all 60 rounds.

Your information

At the beginning of each round, you and the person with whom you are paired each receives a randomly drawn number between 1 and 5 inclusive. You will see your number, and learn the other person's number only after the round ends.

Decision stage

After you've seen your number and the other person has seen his number, each of you must decide separately between one of two actions: enter or exit.

Round Profit

At the end of each round, your number, your decision, and the other person’s decision determine your round profit in the following way.

- If you both chose to exit, then you both receive zero points.

- If you chose to exit and the other person chose to enter, then you receive zero points and the other person receives points equal to his number.

- If you chose to enter and the other person chose to exit, you receive points equal to your number and the other person receives zero points.

- If you both chose to enter, then you receive points equal to one-third of your number and the other person receives points equal to one-third of his number.

The table below summarizes the payoff structure. Suppose you receive a number, x, and the other person receives a number, y. The round profits for each of the given pair of decisions are indicated in the table below. The number preceding the comma refers to your round profit; the number after the comma is the other person's round profit.

		Other Person	
		Enter	Exit
You	Enter	x/3, y/3	x, 0
	Exit	0, y	0, 0

After you have both made your decisions for the round, you will see the amount of points you have earned for the round and the other person's decision and number. Please record these results from each round in your Personal Record Sheets. When you are ready to begin the next round, press Continue.

Total Payment

Each round follows this same sequence of events. At the end of the experiment, you will be paid your accumulated earnings from the experiment in cash. Each point earned in the experiment is equivalent to 0.9 shekels. While the earnings are being counted, you will be prompted to complete a questionnaire.

Prior to the beginning of the experiment, you will partake in five practice rounds. The profits earned in these practice rounds will not be included in your payment. The rules of the practice rounds are otherwise identical to those of the experiment in which you will participate. The purpose of the practice rounds is to familiarize you with the rules of the experiment and the computer interface. Note well that for the purpose of the practice rounds, you will be paired with a different person from the actual experiment.

Thank you for your participation

***Wait* Treatment - Instructions Sheet**

Welcome

The experiment in which you will participate involves the study of decision-making. If you follow the instructions carefully and make wise decisions, you may earn a considerable amount of money. Your earnings depend on your decisions. All of your decisions will remain anonymous and will be collected through a computer network. Your choices are to be made at the computer at which you are seated. Your earnings will be revealed to you as they accumulate during the course of the experiment. Your total earnings from the experiment will be paid to you, in cash, at the end of the experiment.

You are requested not to talk to one another at any time during the experiment. If you have any questions, raise your hand and a monitor will assist you. It is important that you understand the instructions. Misunderstandings can result in lower earnings. Finally, we ask that even after the experiment is over you not discuss the details of this experiment with anyone.

There are several experiments of the same type taking place at the same time in this room.

This experiment consists of 60 rounds. You will be paired with another anonymous person. This person will remain the same for all 60 rounds.

Your information

At the beginning of each round, you and the person with whom you are paired each receives a randomly drawn number between 1 and 5 inclusive. You will see your number, and learn the other person's number only after the round ends.

Decision Stage 1

After you've seen your number and the other person has seen his number, each of you must decide separately between one of three actions: enter, exit or wait.

Decision Stage 2

If you choose to wait in stage 1 and the other person chooses to enter or exit, you will see his decision after stage 1 ends. Then in stage 2 you must decide between one of two actions: enter or exit.

If you choose to enter or exit in stage 1 and the other person chooses to wait, he will see your decision after stage 1 ends. Then in stage 2 the other person must decide between one of two actions: enter or exit.

If you both choose to wait in stage 1, in stage 2 each of you must decide separately between one of two actions: enter or exit.

In other words, each person must ultimately decide whether to enter or exit. Each person may decide to enter or exit in stage 1 or wait until stage 2 to decide whether to enter or exit after observing the other person's decision in stage 1.

Round Profit

At the end of each round, your number, your decision, and the other person’s decision determine your round profit in the following way.

- If you both chose to exit (in either stage 1 or stage 2), then you both receive zero points.

- If you chose to exit (in either stage 1 or stage 2) and the other person chose to enter (in either stage 1 or stage 2), then you receive zero points and the other person receives points equal to his number.

- If you chose to enter (in either stage 1 or stage 2) and the other person chose to exit (in stage 1 or stage 2), you receive points equal to your number and the other person receives zero points.

- If you both chose to enter (in stage 1 or stage 2), then you receive points equal to one-third of your number and the other person receives points equal to one-third of his number.

The table below summarizes the payoff structure. Suppose you receive a number, x, and the other person receives a number, y. The round profits for each of the given pair of decisions are indicated in the table below. The number preceding the comma refers to your round profit; the number after the comma is the other person’s round profit.

After you have both made your decisions for the round, you will see the amount of points you have earned for the round, the other person's number and the other person’s decision. Please record these results from each round in your Personal Record Sheets. When you are ready to begin the next round, press Continue.

		Other Person	
		Enter (stage 1 or 2)	Exit (stage 1 or 2)
You	Enter (stage 1 or 2)	x/3, y/3	x, 0

	Exit (stage 1 or 2)	0, y	0, 0

Total Payment

Each round follows this same sequence of events. At the end of the experiment, you will be paid your accumulated earnings from the experiment in cash. Each point earned in the experiment is equivalent to 0.9 shekels. While the earnings are being counted, you will be prompted to complete a questionnaire.

Prior to the beginning of the experiment, you will partake in five practice rounds. The profits earned in these practice rounds will not be included in your payment. The rules of the practice rounds are otherwise identical to those of the experiment in which you will participate. The purpose of the practice rounds is to familiarize you with the rules of the experiment and the computer interface. Note well that for the purpose of the practice rounds, you will be paired with a different person from the actual experiment.

Thank you for your participation

Sequential **Treatment - Instructions Sheet**

Welcome

The experiment in which you will participate involves the study of decision-making. If you follow the instructions carefully and make wise decisions, you may earn a considerable amount of money. Your earnings depend on your decisions. All of your decisions will remain anonymous and will be collected through a computer network. Your choices are to be made at the computer at which you are seated. Your earnings will be revealed to you as they accumulate during the course of the experiment. Your total earnings from the experiment will be paid to you, in cash, at the end of the experiment.

You are requested not to talk to one another at any time during the experiment. If you have any questions, raise your hand and a monitor will assist you. It is important that you understand the instructions. Misunderstandings can result in lower earnings. Finally, we ask that even after the experiment is over you not discuss the details of this experiment with anyone.

There are several experiments of the same type taking place at the same time in this room.

This experiment consists of 60 rounds. You will be paired with another anonymous person. This person will remain the same for all 60 rounds. One of you in the pair will be designated Player 1 for the entire 60 rounds of the experiment. The other person will be designated Player 2 for all 60 rounds. You will learn whether you are Player 1 or Player 2 as soon as the experiment begins before the beginning of round 1.

Your information

At the beginning of each round, you and the person with whom you are paired each receives a randomly drawn number between 1 and 5 inclusive. You will see your number, and learn the other person's number only after the round ends.

Decision Stage 1

After you've seen your number and the other person has seen his number, the person who is Player 1 must decide between one of two actions: enter or exit.

Decision Stage 2

Player 2 will see Player 1's decision after stage 1 ends. Then in stage 2 Player 2 must decide between one of two actions: enter or exit.

Round Profit

At the end of each round, your number, your decision, and the other person's decision determine your round profit in the following way.

- If you both chose to exit (in your respective stages), then you both receive zero points.

- If you chose to exit and the other person chose to enter (in your respective stages), then you receive zero points and the other person receives points equal to his number.

- If you chose to enter and the other person chose to exit (in your respective stages), then you receive points equal to your number and the other person receives zero points.

- If you both chose to enter (in your respective stages), then you receive points equal to one-third of your number and the other person receives points equal to one-third of his number.

The table below summarizes the payoff structure. Suppose you receive a number, x, and the other person receives a number, y. The round profits for each of the given pair of decisions are indicated in the table below. The number preceding the comma refers to Player 1's round profit; the number after the comma is Player 2's round profit. Note that your payoff does not depend on whether you are Player 1 or 2. Only your decision, your number and the other person's decision determine your payoff.

After you have both made your decisions for the round, you will see the amount of points you have earned for the round, the other person's number and the other person's decision. Please record these results from each round in your Personal Record Sheets. When you are ready to begin the next round, press Continue.

		Player 2	
		Enter (stage 2)	Exit (stage 2)
Player 1	Enter (stage 1)	x/3, y/3	x, 0
	Exit (stage 1)	0, y	0, 0

Total Payment

Each round follows this same sequence of events. At the end of the experiment, you will be paid your accumulated earnings from the experiment in cash. Each point earned in the experiment is equivalent to 0.9 shekels. While the earnings are being counted, you will be prompted to complete a questionnaire.

Prior to the beginning of the experiment, you will partake in five practice rounds. The profits earned in these practice rounds will not be included in your payment. The rules of the practice rounds are otherwise identical to those of the experiment in which you will participate. The purpose of the practice rounds is to familiarize you with the rules of the experiment and the computer interface. Note well that for the purpose of the practice rounds, you will be paired with a different person from the actual experiment.

Thank you for your participation