Waiting to Cooperate?

Kaplan, Todd and Ruffle, Bradley and Shtudiner, Zeev

Universities of Exeter and Haifa, Wilfrid-Laurier University and Ben-Gurion University, Ariel University

22 September 2013

Waiting to Cooperate?

Todd R. Kaplan
University of Exeter
University of Haifa

Bradley J. Ruffle
Wilfrid Laurier University
Ben-Gurion University

Ze'ev Shtudiner
Ariel University

September 2013

Abstract

Sometimes cooperation between two parties requires exactly one to cede to the other. If the decisions whether to cede are made simultaneously, then neither or both may acquiesce leading to an inefficient outcome. However, inefficiency may be avoided if a party can wait to see what the other does. We experimentally test whether adding a waiting option to such a two-player cooperation game enhances cooperation. Although subjects cede less overall with the waiting option, we show that they coordinate more and consequently achieve higher profits. Yet, a dark side overhangs waiting: the least cooperative pairs do worse with this option. They wait not to facilitate coordination but to disguise their entry.

1. Introduction

Cooperation often plays a central role in achieving social surplus. One type of cooperation requires that one person cedes to another with the thought that the other person will in turn cede in the future. Bidding behavior in procurement auctions, competition for market share and entry decisions between firms with multimarket contact all share this property. In these examples, if each group member has a private value that derives from the situation (such as the item's value in an auction or the profitability of a particular market) and the values of all players are observable, the maximum joint profit can be attained if the player with less to gain acquiesces to the player with more to gain.

When players' values are private information, coordinating on efficient cooperation is more difficult. For example, suppose two fast-food chains each contemplate 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.

With values to being a local monopolist private and direct communication between the chains illegal, this form of cooperation cannot be realized. Instead, both chains may decide to enter the market or both may stay out. The possibility of waiting enables the chains to coordinate more efficiently. 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 entering on only a subset of this range and waiting otherwise. By waiting and subsequently not entering whenever the other enters, double entry is avoided and higher social surplus attained.[1]

In this paper, we analyze experimentally how the inclusion of a waiting option affects cooperative play. The starting point is Kaplan and Ruffle (2012). In their two-player, repeated cooperation game, each player privately receives a randomly drawn integer between 1 and 5 with equal probability in each round. Upon receipt of the integer, each player must decide between one of two actions: enter or exit. By exiting a player receives zero. By entering, he receives his number if his partner exits and one-third of his number if his partner also enters.[2] In this game, entry (non-cooperation) is the unique dominant strategy, but the social optimum is obtained when *only* the player with the higher value enters (or just one enters in the case of a tie). We conduct this treatment for 60 rounds with fixed pairs.[3] Both players' values are made public after each round.

[1] For example, suppose the set of values is 1, 2 and 3 with an equal chance of each. 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, double entry occurs only 1/9 of the time initially (when both have 3s) and another 1/9 after waiting (when both have 2s). Single entry increases to 2/3 of the time with no entry still at 1/9.

[2] While we refer to the other pair member as the "partner" for brevity, the experimental instructions invoke the more neutral phrase "the person with whom you are paired".

[3] Kaplan and Ruffle (2012) conducted this same treatment for 80 rounds. Because play typically converged well within 60 rounds, we opt for 60 rounds here.

We conduct this game under two experimental treatments that differ in the number of stages available to players when deciding whether or not to enter. In the *Now* treatment, players must decide simultaneously in a single stage between enter and exit. Play in *Now* is compared to play in a second two-stage game where players are given the option of waiting. We refer to this treatment as "*Wait.*" In stage one of *Wait*, each player decides between one of three actions: enter, exit or wait. By waiting, the player avoids committing to entering or exiting in stage 1. Instead, he observes his partner's stage-one decision and then decides in stage two between one of two actions: enter or exit.

Based upon whether players ultimately enter or exit, the payoff structure in *Wait* is identical to that in *Now*: by exiting in either stage, the player receives zero. By entering in either stage, he receives his number if his partner exited in either stage 1 or stage 2 and one-third of his number if his partner also entered in either stage. In *Wait,* entry remains the unique dominant strategy, while the social optimum again consists of only the player with the higher value entering. Note that if players choose not to make use of the waiting option in the first stage, the game reduces to *Now*.

Overall, we find that although *Wait* leads to a higher percentage of entry (a sign of reduced cooperation), it also attains a higher degree of efficient cooperation (where the player with the higher number enters and the player with the lower number stays out) and higher average profits than *Now*. The cooperation and profit improvements occur since many subjects use the waiting option to coordinate more efficiently. For example, many subjects who see their partner enter in stage 1 opt to exit in stage 2 to prevent double entry.

While there are clear improvements for some subjects and the overall average profits, the cumulative distributions of the pair profits for the two treatments intersect near 50%. More specifically, the pair profits in the lower half of *Now* stochastically dominate those of *Wait*. A closer look at the data points to malevolent uses of the waiting option. Low-profit subjects who wait in the first stage often enter in the second stage regardless of their value and their partner's first-stage decision, thereby illustrating the potential for the cooperation-enhancing waiting option to backfire.

Our paper contributes to several strands of literature. The addition of the wait option makes the timing of the player's decision to enter or exit endogenous. Hence, our paper relates to the endogenous timing literature. 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, strategic delay of decisions may also be an equilibrium (see Chamley and Gale 1994; Gul and Lundholm 1995). Attempts to observe strategy 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 find that the waiting option is indeed exploited but not always to increase cooperation.

Our paper also contributes to the tragedy of the commons literature (see Dietz, Ostrom, and Stern 2003) and the ability of institutions to facilitate cooperation (see Scholz and Gray 1997; Ostrom 2009). First, our game is a stylized version of a discretized tragedy of the commons dilemma: one can either fish or not fish, for instance. The social optimum requires a reduction of fishing. While the cooperative solution to the tragedy of the commons requires that both parties curtail fishing to avoid depletion of the resource, the cooperative solution in our game entails exactly one party choosing not to fish. In repeated settings, the implicit use of budgets to manage one's actions can help achieve cooperation.[4] Staying out in some periods when one has low values allows one to build goodwill that can be beneficial in periods in which one has a high value and wishes to enter. This possibility relates to work experimental work on the tragedy of the commons where self-governance is possible (e.g., Ostrom, Walker and Gardner 1992).

The addition of the wait option to our game allows us to examine how an institutional change can affect cooperation among parties. Our *Wait* treatment parallels institutions in which others' actions are more transparent, while *Now* is more similar to institutions in which the moves of others are opaque.

The next section introduces the experimental design, treatments and possible strategies. In section 3, we detail the experimental procedure. We present the results in section 4. Section 5 concludes.

[4] Engelmann and Grimm (2012) examine a two-player voting game where optimal cooperation requires one to vote only when one's private value is high. Interestingly, they observe very little cooperation unless an exogenous budget constraint is imposed.

2. Experimental Design

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. We conducted two treatments that differ in the number of stages. 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 (see Table 1 for a summary of the payoffs). After each round, subjects observe their partner's decision and value. The second treatment, *Wait*, consists of two stages. In the first stage, each player decides simultaneously whether to enter, exit or wait. Waiting in stage 1 allows the subject to observe his partner's stage-one decision 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*.

Wait affords more favorable conditions for cooperation. If the partner enters or exits in stage 1, a cooperative subject who waits simply chooses the opposite action in stage 2. If both wait, the game reverts to a one-stage game, but with potentially different beliefs about each other's values. For example, if a subject consistently waits only with a 3 or 4, after seeing him wait, his partner would believe that the subject has an equal chance of either value rather than an equal chance of a 1, 2, 3, 4 and 5 as in *Now*.

2.2. Environment and hypothesis

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.[5] The pair's expected payoff from playing the alternating strategy is 3. Another cooperative solution is for both players to enter only with high numbers, such as 3, 4 and 5. This cutoff strategy yields a slightly lower expected payoff of 2.88. Notwithstanding, Kaplan and Ruffle (2012) find it to be the modal strategy.

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 between in stage 1 can never be part of the social optimal in *Wait* (see the last paragraph of Appendix A for the proof).

Table 2 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 example, a player who employs the strategy 12(34)5 exits when he receives a value of 1 or 2, waits when he receives a value of 3 or 4, and enters when he receives a value of 5. 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, it is assumed that they employ the alternating strategy to resolve which one enters in stage two.[6]

Table 2 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)

[5] Turn taking has been observed in Zillante (2011), Cason et al. (2012), and Kaplan and Ruffle (2012).

[6] 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.

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 2, the most profitable symmetric strategies are 1(234)5 and 1(23)45 with joint expected profits of 3.53 and 3.44, respectively.

3. 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, after which they were paid.

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. Seventy subjects (35 fixed pairs) participated in *Now* and 72 subjects (36 fixed pairs) participated in *Wait*. A *Now* session lasted about 90 minutes on average and a *Wait* session lasted about 120 minutes on average. 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).

4. Results

The ability to postpone the entry decision in the *Wait* treatment ought to facilitate efficient coordination. Consequently, we expect both less entry and higher profits in *Wait* than in *Now*. To the extent that players adopt the symmetric socially optimal cutoff strategies, these conjectures will find support in the data: for the strategies 1(234)5 and 1(23)45, the entry percentages are supposed to be 50% and 56%, respectively, with pair profits per round of 3.53 and 3.44, while 12()345 leads to entry of 60% and expected pair profits of 2.88 per round.

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 3) reveals a higher percentage of entry decisions in *Wait* (75.8%) than in *Now* (71.0%). Subjects are 14 percentage points (hereafter "p.p.") more likely to enter on a 1 in *Wait* (35.4%) than in *Now* (21.0%). This gap between treatments grows to 21 p.p. on the value of 2. In fact, higher entry in *Wait* holds for all values except 3. If we treat each subject's fraction of decisions corresponding to enter as the unit of observation, then the non-parametric Wilcoxon-Mann-Whitney test rejects the equality of the entry frequency distributions (z=-1.99, p=0.047, n=142).

In Table 4, we report the estimates from two linear probability models on subject *i*'s decision to enter in period *t*.[7] Standard errors are clustered by subject, taking into account possible correlation in the error terms across periods of play. Regression (1) includes only an indicator variable for the *Wait* treatment. The highly significant coefficient of 0.048 (p=0.026) confirms the significant difference between entry frequencies in *Wait* and *Now*. Despite a series of controls for game variables and lagged play in regression (2), the difference in entry frequency across treatments remains around 4 p.p. and highly significant (p=0.026).

The indicator variable Value1.5 equals 1 if subject *i*'s period *t* value is 2, 3, 4 or 5 and 0 if it is 1. Similarly, Value2.5 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 Value3.5 and Value4.5. The estimated coefficients on Value1.5, Value2.5, Value3.5 and Value4.5 reflect the marginal propensity to enter on a 2, 3, 4 or 5, respectively. The highly significant coefficients reveal that subjects were

[7] 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.

increasingly more likely to enter on each additional value. The likelihood of entering on a 3 is a whopping 43 p.p. higher than it is on a 2. The regression also reveals that the subject's previous period entry and especially 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 0.11 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 (not shown)) and the middle 50 (or middle 45) rounds.

4.2 Profits

Higher entry in *Wait* may lead us to expect lower profits than in *Now*. However, the mean pair profit of 170.4 in *Wait* actually exceeds that of 163.8 in *Now*. 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, *Wait* subjects reach 73.1% of this first-best social optimum on average, which is significantly and nearly three p.p. higher than the 70.3% obtained in *Now* (Wilcoxon-Mann-Whitney z=-1.81, p = 0.07). Both percentages greatly exceed the 52.6% earned by Nash play, attesting to the relatively high levels of cooperation achieved in both treatments.

4.3 Outcomes and the use of waiting to aid in coordination

How did subjects in *Wait* manage to earn higher profits despite such seemingly high levels of entry? Table 5 categorizes all game outcomes according to whether only the player with the higher value entered (efficient cooperation), only the low-value player entered (inefficient cooperation), both entered (double entry) or neither entered (double exit). The largest difference between the two treatments is that double exit (the lowest-payoff outcome) is six p.p. higher in *Now* (8.9%) than in *Wait* (2.9%). The missing six p.p. in *Wait* are picked up by double entry (3.6 p.p.) and single entry (an increase from

40.2% in *Now* to 42.5% in *Wait*). A chi-square test of proportions shows that the differences in percentages of the outcomes between the treatments are highly significant (χ^2=78.4, d.f.=3, p<0.01).

Increased efficient cooperation in *Wait* is the result of lower-value subjects waiting in stage 1 and, after observing their partner enter in stage 1, exiting in stage 2. The center panel of Table 3 shows that waiting was the modal stage-one decision for values 2 and 3, comprising about 60% of the decisions in both cases. Waiting constitutes another 40% of stage-one decisions when the subject received a 1; although, exit – the choice which guarantees against double entry – is the modal choice (45%). By contrast, exit occurs less than 1% of the time on the highest values of 4 and 5, with waiting accounting for between 12% and 15% of decisions and entering amounting to 85%-87%. In short, subjects tend to wait or exit on the lowest value of 1, wait on values 2 and 3, and enter with a 4 or 5.

The right panel of Table 3 shows that subjects follow through on their first-stage waiting decision to avoid double exit and, to a lesser extent, double entry in the second stage. After waiting in stage 1, subjects enter nearly 100% of the time if their partners exited in stage 1 (avoid double exit). Less emphatically, stage-two exit frequencies vary from a mere 7% with a value of 5 to 75% with a value of 1 after observing the partner entered in stage 1 (avoid double entry). 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 other's value. 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 14.5% (observed). Updating their beliefs about their partners' values accordingly provides a possible rationale for entering on lower values and may partially account for the higher entry frequencies observed on values 1 and 2 in *Wait* than in *Now*.

The above stage-two entry percentages present a puzzle. They range from 25% to an alarming 93% after the partner entered in stage 1. Waiting can be beneficial when used to gather information to facilitate efficient coordination and a higher payoff for the pair. Yet entry after seeing the partner enter implies waiting was not adopted to avoid double entry. Alternatively, perhaps waiting was invoked to punish partners who entered while rewarding those who waited. But the fact that the entry percentage is higher after seeing a partner wait than after seeing him enter casts doubt on this punishment explanation.[8] Instead, a subject who enters after seeing a partner enter seems intent on entering regardless of any information received after stage 1. Given the intention to enter, why wait rather than enter in the first place? The likely answer is that waiting may be perceived as a less egregious action than directly entering. Thus, by first waiting, the subject wishes to appear cooperative to his partner. Later we will examine further this strategy and its success.

4.4 Distribution of Pair Profits

As a prelude to assessing the success of various strategies, let us take a closer look at the distribution of profits across treatments, currently masked by the simple comparison of mean profits discussed in Section 4.2. Figure 1 reveals a relatively diffuse distribution of pair profits in *Wait* compared to the highly concentrated distribution in *Now*. The distribution of pair profits in *Wait* resembles a uniform distribution, whereas 71.4% of the pairs in *Now* earned profits in the narrow range of 160 to 180. In fact, the highest pair profit was 181, meaning that not a single pair appears in any of the three highest profit categories. Contrast this with a highest pair profit of 215.7 in *Wait* and 31% of the pairs that placed in the three highest profit categories. At the other extreme, the four lowest earning pairs in the experiment with pair profits of 125, 131, 131, 132 all originate from *Wait*, below the lowest pair profit in *Now* of 135.

The upshot of these differences is that the distributions of pairs' profits intersect near 50%. That is, about half of the pairs in *Wait* earned lower profits than pairs in *Now*. To demonstrate the robustness of the intersection between the two profit distributions, avoiding it would require removing the nine pairs with the lowest profits from *Wait* (out of 36 pairs in total).

[8] If punishment motivated entry after waiting, we would expect the frequency of entry in different stages to rise over the course of the experiment. No such time trend is observed. In fact, the frequency of staggered entry is highest in the first 10 rounds (18.9% of outcomes), falling to between 9.7% (rounds 21-30) and 14.7% (rounds 31-40) for the remaining 10-round blocks.

Why do so many pairs in *Wait* earn low profits, despite the better conditions for coordination? To address this question, we analyze in the next two subsections how the behavior of the low-profit subjects in *Wait* differs from that of the high-profit subjects.

4.5 Individual Strategy Inference

Recall from Section 3 that 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 2 and the alternating strategy to classify correctly subjects' decisions in stage 1. 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 6 presents the distribution of these best-fit strategies for stage 1 of *Wait* (left panel) and for *Now* (right panel).[9] For each strategy we denote the number of subjects that employ the strategy (column 2)[10] and the mean number of errors (deviations from the strategy) by those who employed it (column 3).

In *Wait*, 86.5% of the subjects employ strategies that involve waiting. The remaining 13.5% of subjects simply enter on all values (7.6%) or enter on values 2-5 and exit on 1 (5.9%). Capturing 21/72 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 95.6 (column 4 of Table 6) earned by its adopters. The strategy of (123)45 is the second most widely used strategy with 12.5/72 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 82.9. 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 strategic pairs that jointly earn more than 1(234)5. Nor did any pairs adopt the payoff-inferior alternating strategy in *Wait*.

[9] The inferred strategies are based on rounds 6-55 and thus exclude decisions in the ten periods possibly influenced by learning in the initial rounds and the endgame effect. The distributions of best-fit strategies are highly robust to other ranges of included periods, such as all 60 rounds, the first 50 or 55 rounds and the last 50 rounds.

[10] For several subjects, two strategies tied for the fewest errors. In these cases, we assign each tied strategy a share of one-half.

The subject's profit along with that of his partner (column 5) attest to the pairs' 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 cooperation. Those who followed the strategy 1(23)45 recorded the fewest deviations from their inferred strategy.[11] Tracking this strategy to stage 2, subjects on the whole appear to be playing the strategy 1(2/3)45 (wait and exit with value 2, wait and enter with value 3 when the partner also waited).

The right panel of Table 6 displays the best-fit strategies for subjects in the *Now* treatment. Forty-four of 70 (62%) subjects employed the strategy 12()345, meaning they exited on values 1 and 2, and entered on values 3, 4 and 5. In striking contrast, not a single subject utilized this strategy in *Wait* in which the waiting option is available. Only two pairs of subjects used the alternating strategy despite it being the most profitable strategy in this treatment.

The dominant strategy of "always enter" was employed by twice as many subjects in *Now* as in *Wait* (15% and 7.6% respectively). In *Wait*, the mean subject profit for the strategy ()12345 (always enter) of only 65.0 is almost 50% below the mean subject profit for 1(23)45 of 95.6. In *Now*, the mean subject profit for the always enter strategy of 76.4 is 11% below the mean profit of 84.5 for socially optimal cutoff strategy of 12()345 and 12% below the mean profit of 85.3 from alternating. Cooperative subjects earn substantially more than uncooperative subjects, especially in the *Wait* treatment.

4.6 Behavior of Low-Profit Subjects in *Wait*

Overall, the possible sources of low profits in *Wait* are inefficient cooperation, double exit and double entry outcomes. Yet, we saw that inefficient cooperation and double

[11] Overall, the error rates are low for most strategies, thereby attesting to the effectiveness of this simple technique in capturing subjects' behavior. Of the 3600 decisions made by the 72 subjects in *Wait* between rounds 6-55, 3132 (or 87%) correspond to the best-fit strategy inferred for each subject compared to 3220 out of the 3500 (or 92%) decisions made by the 70 subjects in *Now*. With a binary decision in *Now*, the percentage of errors in *Now* is naturally lower than in *Wait*. The addition of the waiting option in *Wait* increases the number of monotonic pure-strategy cutoffs from six in *Now* to 21 in *Wait*.

exiting occur with strikingly low frequency in *Wait* (1.6% and 2.9% respectively according to Table 4). Double entry, on the contrary, accounts for 51% of the outcomes, 57.3% of which arise from both subjects entering in stage 1, 18.2% from both subjects entering in stage 2, and a troubling 24.5% from subjects entering in different stages. The percentages of double entry in stage 2 and especially entry in different stages are distressingly high and attest to uncooperative decisions.

An analysis of the second-stage decisions shows that subjects do not necessarily choose the action opposite to their partner's first-stage action. When paired subjects both wait in stage 1, Table 7 reveals that they tend to enter in stage 2 when their value is 5 or 4 (and in most cases when their value is 3). When their value is 1 or 2, the likelihood of entry differs dramatically between subjects and is highly negatively correlated with the degree of cooperation and profits achieved by the pair. For example, we see from Table 7 that for the three lowest pair profit categories (i.e., profits below 180), entry is the modal stage-two decision after the partner waited in stage 1 for all five values. By contrast, exit is the modal decision on a value of 1 for the second-highest profit category and on values 1 and 2 for the highest profit category.

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 8). Despite the partner having already visibly entered in stage 1, subject pairs in the lowest profit category nonetheless enter with a frequency of 66.7% 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 neither of these profit categories did anyone enter on a value of 1. No entry also holds for a value of 2 for the highest category. In fact, among the highest profit pairs, the entry frequency increases to only 11.1% on a value of 4.

Moreover, Tables 7 and 8 both attest to sharp increases in the entry percentage after waiting as the value increases for the two highest profit categories of 180-199 and 200-220. However, for the three lower profit categories, entry percentages begin much higher and rise more modestly as the value increases. In other words, successful subject pairs condition their second-stage entry decision on their value and their partners' first-stage decision, whereas lower profit pairs tend to disregard both of these and enter in stage two.

The individual strategy analysis allows us to examine this behavior in more detail. Although, as already noted, fewer subjects employed "always enter" in *Wait* (5.5 subjects versus 10.5 in *Now*), another 5.5 subjects played "always wait". We conjectured that its likely reason is to feign cooperative behavior. Indeed, looking at the second-to-last column of Table 6, those classified as “always wait” (12345) entered an astonishing 98% of the time compared to 89% entry by “always enter” subjects in *Wait* and 87% by “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 6 reveals that their uncooperativeness was reciprocated with entry of 90% by their partners. This compares with entry of 85% by partners paired against “always enter” in *Wait* and 82% 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.

5 Conclusions

This paper examines experimentally how the option of waiting affects cooperation. Although subjects entered more often in the *Wait* treatment for almost all entry values, the *timing* of the entry enabled paired players to achieve a higher degree of cooperation and ultimately higher profits in *Wait.* Thus, the ability to time decisions plays a crucial role in resolving in cooperative dilemmas.

Yet, a closer look at the distribution of subjects' profits reveals that while profits in *Wait* were higher on average, nearly half of the subjects in this treatment earned less than in *Now*. The dark side of the waiting option is that this tool designed to enhance cooperation helps only those with a desire to cooperate: selfish individuals exploit the waiting option in an attempt to disguise their uncooperative behavior.

References

Angrist, J. D., Pischke, J.-S. 2009. Mostly Harmless Econometrics: An Empiricist's Companion, Princeton University Press.

Cason, T. N., Lau, S.-H. P., Mui, V.-L. 2012. "Learning, teaching, and turn-taking in the repeated assignment game", Economic Theory.

Chamley, C., Gale, D. 1994. "Information revelation and strategic delay in a model of investment", Econometrica 62, 1065-1085.

Dietz, T., Ostrom, E., Stern, P.C. 2003. "The struggle to govern the commons", Science 302(5652), 1907-1912.

Engelmann, D., and Grimm, V. 2011. "Mechanisms for Efficient Voting with Private Information about Preferences", Economic Journal 122(563), 1010-1041.

Fonseca, M. A., Normann, H.-T. 2008. "Mergers, Asymmetries and Collusion: Experimental Evidence", Economic Journal 118(527), 387-400.

Gul, F., Lundholm, R. 1995. "Endogenous timing and the clustering of agents' decisions", Journal of Political Economy 103, 1039-1066.

Hamilton, J. H., Slutsky, S. M. 1990. "Endogenous timing in duopoly games: Stackelberg or Cournot equilibria", Games and Economic Behavior 2, 29–46.

Huck, S., Muller, W., Normann, H.-T. 2001. "Stackelberg beats Cournot – on collusion and efficiency in experimental markets", Economic Journal 111 749–766.

Huck, S., Muller, W., Normann, H.-T. 2002. "To commit or not to commit: endogenous timing in experimental duopoly", Games and Economic Behavior 38, 240–264.

Kaplan, T., Ruffle, B. J. 2012. "Which way to cooperate", Economic Journal 122(563), 1042-1068.

Ostrom, E. 2009. Understanding institutional diversity. Princeton University Press.

Ostrom, E., Walker, J., and Gardner, R. 1992. "Covenants with and without a sword: Self-governance is possible", American Political Science Review, 86(2), 404-417.

Potters, J., Sefton, M., Vesterlund, L. 2005. "After you - endogenous sequencing in voluntary contribution games", Journal of Public Economics 89(8) 1399-1419.

Scholz, J.T., Gray, W.B. 1997. "Can government facilitate cooperation? An informational model of OSHA enforcement", American Journal of Political Science 41(3), 693-717.

Ziegelmeyer, A., Boun My, K., Vergnaud, J., Willinger, M. 2005. "Strategic delay and rational imitation in the laboratory", working paper, Max Planck Institute of Economics.

Zillante, A. 2011. "Recognizing and Playing Turn Taking Strategies" working paper.

Table 1 – Payoff Matrix

			Player with value B			
stage	Stage 1		enter	exit	wait	
		Stage 2	-	-	enter	exit
Player with value A	enter	-	1/3A, 1/3B	A,0	1/3A, 1/3B	A,0
	exit	-	0,B	0,0	0,B	0,0
	wait	enter	1/3A, 1/3B	A,0	1/3A, 1/3B	A,0
		exit	0,B	0,0	0,B	0,0

Table 3

Left Panel – frequency of entry given the subject's own value for *Wait* and *Now* treatments.
Center Panel – distribution of stage 1 entry, wait and exit decisions in *Wait* treatment for each value.
Right Panel – conditional probability of entry in stage 2 in *Wait* treatment given subject's own value and partner's stage 1 decision.

	Overall Entry		Stage 1 Decision			Entry Frequency in Stage 2 given Partner's Stage 1 Decision		
Value	***Wait***	***Now***	**Entry**	**Wait**	**Exit**	**Entry**	**Wait**	**Exit**
1	35.4%	21.0%	15.5%	39.4%	45.1%	25.4%	59.1%	97.5%
2	53.6%	32.2%	23.8%	61.9%	14.3%	28.4%	58.2%	100.0%
3	81.1%	91.6%	39.5%	59.9%	0.5%	40.0%	91.7%	100.0%
4	98.1%	96.6%	84.8%	14.9%	0.3%	74.5%	100.0%	100.0%
5	98.9%	96.7%	86.8%	12.4%	0.8%	93.3%	100.0%	100.0%
Overall	75.8%	71.0%	36.6%	63.4%	10.8%	39.4%	80.0%	99.5%
Obs	4320	4200	1581	2274	465	734	664	183

Table 2

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**
Player 1	**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
	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 4
Linear Probability Model on overall decision to enter

Regressor	(1) M.E.	(2) M.E.
Wait	.048** (.010)	.040*** (.018)
Value1.5	–	.144*** (.022)
Value2.5	–	.434*** (.029)
Value3.5	–	.110*** (.016)
Value4.5	–	.022*** (.005)
$enter_{i,t-1}$	–	.033** (.015)
$enter_{-i,t-1}$	–	.181*** (.019)
$value_{-i,t-1}$	–	-.038*** (.004)
$value_{-i,t-1}$ * $enter_{-i,t-1}$	–	.031* (.018)
first5	–	-.011 (.166)
last5	–	.109*** (.014)
constant	0.710 (0.013)	.260 (.037)
Obs	8520	8378
Adj. R^2	.003	.443

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

Wait equals 1 if observation is from *Wait* and 0 if from *Now*

Value1.5 equals 1 if subject *i*'s period *t* value is 2, 3, 4 or 5 and equals 0 if value is 1. Similarly, ***Value2.5*** equals 1 for values 3, 4 or 5 and 0 otherwise, and so forth for **Value3.5** and **Value4.5**

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

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

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

first5 equals 1 if rounds 1-5, ***last5*** equals 1 if rounds 56-60, 0 otherwise

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

Table 5
Percentage of outcomes by treatment

Outcome	*Now*	*Wait*
efficient cooperation	37.3%	40.9%
inefficient cooperation	2.9%	1.6%
double entry	51.0%	54.6%
double exit	8.9%	2.9%
Total	100.0%	100.0%

Double entry - both subjects enter
Double exit - both subjects exit
Efficient cooperation – the subject with the higher value enters, while the other subject exits
Inefficient cooperation - the subject with the lower value enters, while the other subject exits

Table 6
Distribution of strategies, mean own and partner's mean profit and mean fraction of errors by strategy and treatment, rounds range 6-55

		Wait						***Now***					
	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)**	**Number who played strategy**	**Fraction of errors**	**Mean profit**	**Mean profit of partner**	**Entry percent**	**Partner entry percent**
involve waiting	12 (3) 45	7	.07	96	93.4	62.9%	66.0%	-	-	-	-		
	1 (2345)	0.5	.36	63.7	75.7	88.3%	98.3%	-	-	-	-		
	1 (234) 5	1	.08	92	123.7	45.0%	51.7%	-	-	-	-		
	1 (23) 45	**21**	**.08**	**95.6**	**92.6**	63.9%	65.4%	-	-	-	-		
	1 (2) 345	0.25	.20	81.3	82.3	73.3%	76.7%	-	-	-	-		
	(12345)	5.5	.26	69	64.5	97.8%	90.0%	-	-	-	-		
	(1234) 5	1	.42	82.7	60.7	96.7%	73.3%	-	-	-	-		
	(123) 45	12.5	.14	82.9	80.1	79.4%	74.4%	-	-	-	-		
	(12) 345	8.75	.15	82.2	79.4	82.0%	81.0%	-	-	-	-		
	(1) 2345	4.75	.10	74.2	75.5	86.4%	85.3%	-	-	-	-		
do not involve waiting	() 12345	5.5	.18	65	70.8	88.6%	85.5%	10.5	.13	76.4	70.8	87.3%	81.8%
	1 () 2345	4.25	.15	76.4	80.3	84.2%	89.6%	11	.10	75.5	77.3	80.0%	82.1%
	12 () 345	-	-	-	-			**44**	**.5**	**84.5**	**85.3**	**66.5%**	**67.6%**
	123 () 45	-	-	-	-			0.5	.16	77.7	87.3	56.7%	60.0%
	1234 () 5	-	-	-	-			-	-	-	-		
	12345 ()	-	-	-	-			-	-	-	-		
	alternating	-	-	-	-			4	.14	85.3	85.3	55.8%	55.8%
	Average	Total 72	.13	85.2	85.2	75.8%	75.8%	Total 70	.08	81.9	81.9	71.0%	71.0%

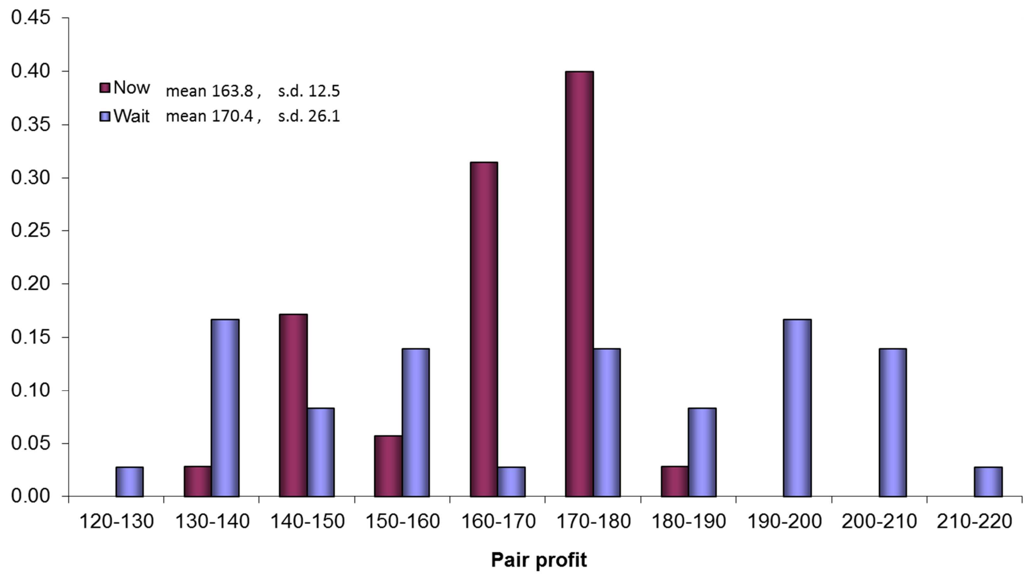
Table 7
Percentage of entry decisions in stage 2 (*Wait*), conditional on partner waiting in stage 1, by profit category and value

Value / Profit category	120-139		140-159		160-179		180-199		200-220		Overall
	Perc.	Obs.	Perc.	Obs.	Perc.	Obs.	Perc.	Obs.	Perc.	Obs.	
1	**86.7%**	45	**54.5%**	33	**54.8%**	31	**25.0%**	24	**25.0%**	4	**59.1%**
2	**87.5%**	40	**90.0%**	20	**88.2%**	17	**50.9%**	55	**30.3%**	33	**58.2%**
3	**98.2%**	55	**100.0%**	24	**100.0%**	14	**92.8%**	83	**77.4%**	53	**91.7%**
4	**100.0%**	46	**100.0%**	10	**100.0%**	4	**100.0%**	8	**100.0%**	3	**100.0%**
5	**100.0%**	42	**100.0%**	8	**100.0%**	6	**100.0%**	5	**100.0%**	1	**100.0%**
Number of pairs	7		8		6		9		6		36

Table 8
Percentage of entry decisions in stage 2 (*Wait*), conditional on partner entering in stage 1, by profit category and value

Value / Profit category	120-139		140-159		160-179		180-199		200-220		Overall
	Perc.	Obs.	Perc.	Obs.	Perc.	Obs.	Perc.	Obs.	Perc.	Obs.	
1	**66.7%**	21	**25.5%**	47	**12.9%**	31	**0.0%**	3	**0.0%**	7	**27.5%**
2	**93.9%**	33	**67.5%**	40	**15.7%**	51	**6.7%**	30	**0.0%**	44	**34.3%**
3	**93.1%**	29	**90.3%**	31	**64.5%**	31	**24.1%**	29	**4.5%**	66	**45.7%**
4	**100.0%**	19	**80.0%**	15	**100.0%**	6	**50.0%**	2	**11.1%**	9	**76.5%**
5	**100.0%**	27	**88.9%**	9	**100.0%**	3	**100.0%**	1	**60.0%**	5	**93.3%**
Number of pairs	7		8		6		9		6		36

Figure 1 - Distributions of Pair Profits by Treatment



Appendix A: Monotonic Strategies

Proposition: *The pair's joint profits are maximized by each pair member using a monotonic strategy in the first stage of the two-stage. 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 $\sum_{x \in \{a \ldots b\}} \Pi_x = 1$). 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,

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

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

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

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

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

First, note that $\sum_{y\in\{a,b\}} t(y)(\mathrm{z}(\mathrm{x}+1,\mathrm{y})-\mathrm{z}(\mathrm{x},\mathrm{y})) \leq \sum_{y\in\{a,b\}} t(y)$. If $\sum_{y\in\{a,b\}} t(y)(\mathrm{z}(\mathrm{x}+1,\mathrm{y})-\mathrm{z}(\mathrm{x},\mathrm{y})) > \sum_{y\in\{a,b\}} t(y)$, 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

***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

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