The Effects of Endowment Size, Heterogeneity and History in a Binary-Choice Experiment with Positive Spillovers

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Abstract This study examines individual and group behavior in a finitely repeated binary-choice game setting with positive externalities, designed to mimic the flu vaccination decision environment. Subjects make decisions in two, theoretically identical sequences, differing in initial endowment levels only. Each decision involves a choice between an option with a certain payoff and an option with a payoff that is decreasing in the number of individuals that choose it. The results indicate that groups are able to reach both the Nash equilibrium outcome as well as the Social Optimum, however groups are not able to maintain socially optimal behavior for more than one round. Additionally, in early rounds, subjects choose the certain payoff option significantly less often in sequences with lower endowment levels than they do in sequences with higher endowment levels, but this difference disappears by the fourth round of each sequence.

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1. Introduction

The experiments in this study are based on the one-shot, binary-choice games in Lockhart (2013). Modeled to mimic individual vaccination decisions, subjects in these games face a decision between an option with a certain payoff (receiving a vaccine) and an option with a payoff that is decreasing in the number of individuals that choose it (not receiving a vaccine). The payoff structure is similar to those of market entry games, or models of traffic congestion (Anderson, Holt and Reiley (2008)). Similar to the market entry games literature[1], in Lockhart (2013), individual behavior is well predicted by the Nash equilibrium for symmetric environments. For asymmetric environments, individual behavior did vary slightly from the Nash predictions. In all environments, individuals chose the certain payoff option substantially less than socially optimal. These were all one-shot games however, and subjects received no feedback until all decisions were finalized. Thus, subjects did not have an opportunity to learn, cooperate or coordinate. The first goal of this study is to determine what effect repetition and feedback have on group and individual behavior in these environments.

In Lockhart (2013), subjects also provided forecasts of others' decisions. In general, the greater the number of others an individual forecasted to choose the certain payoff option, the *more* likely they were to choose this option themselves. This was true for all decision environments, and significantly so in half. Additionally, for the asymmetric/non-probabilistic decision environment (the environment we will consider in this study), only 15 out of 88 forecasts made were actually correct. Furthermore, out of the 73 individuals that provided incorrect forecasts, just one erred on the side of too few group members choosing the certain payoff option. This means that the majority of individuals believed that more of their fellow group members would choose the certain payoff option than actually did. Since beliefs were significantly correlated with decisions, we may expect that when the game is repeated and individuals receive feedback, behavior will change across rounds. Individuals may adjust their beliefs as they receive feedback, potentially leading to fewer individuals choosing the certain payoff option.

If individuals do behave in this manner, it may have important public health implications. Recall that the certain payoff option represents choosing to receive a vaccine. Although some vaccination decisions are one-shot by nature and a repeated game model is not applicable, other vaccination decisions, such as for the flu, are made somewhat regularly. Since flu viruses are constantly changing, each year's flu vaccine is different, and is chosen to protect individuals from the specific flu viruses predicted to be the most prevalent during the upcoming flu season.[2] Even though it would be unrealistic to apply a model with a very large number of repetitions of the one-shot game in Lockhart (2013), individuals do face a simlilar decision environment each year, and so behavioral dynamics over a moderate number of repetitions may be important.

The second objective of this study is to determine what effect potentially

[1] Kahneman (1988); Rapoport (1995); Sundali et al. (1995)
[2] http://www.cdc.gov/flu/protect/keyfacts.htm

negative payoffs has on individual and group behavior. We will consider an environment similar to Asym/np in Lockhart (2013), except with individual endowments sufficiently reduced so that players who choose the uncertain payoff option may actually receive a negative payoff (i.e. lose money). Theoretically, this decrease in endowment should not affect individuals' choices. As noted in Camerer (1989) however, when subjects are given a sufficienty high endowment, "losses from such windfall stakes obtained without any effort may be coded as gains", which could lead to differences in behavior.

We find that groups are able to reach both the Nash equilbrium outcome as well as the social optimum, however groups are not able to maintain socially optimal behavior for more than one round. Additionally, in early rounds, subjects choose the certain payoff option significantly less often in sequences with lower endowment levels than they do in sequences with higher endowment levels, but this difference disappears by the fourth round of each sequence.

The rest of the paper is organized as follows: Section 2 contains the basic game setting and theoretical predictions, Section 3 contains behavioral conjectures, Section 4 describes the experimental decision setting, and Section 5 contains a summary of the results.

2. Theoretical Model and Decision Setting

The basic game is identical to the asymmetric model in Lockhart (2013). We will briefly summarize the main points here, but refer to Lockhart (2013) for further detail.

2.1 Theoretical Model

A group of N agents, each with an initial endowment, $e > 0$, must choose exactly one of two options, V or NV. There are two types of agents, High-loss and Low-loss. If an agent of either type chooses V, then they pay some cost, c, where $0 < c \leq e$, and they keep $e - c$. If a High-loss agent chooses NV, then their payoff is either e or $e - l_H$. If a Low-loss agent chooses NV, then their payoff is either e or $e - l_L$, where $0 < l_L < l_H \leq e$. The probability that an agent of either type incurs this loss if they choose NV depends on the actions of the other $N - 1$ agents and is increasing in the number of agents choosing NV. The exact probabilities are calculated as follow:

- If an agent chooses NV, there is a $p \times 100\%$ chance of directly incurring a loss, where $p \in [0, 1]$.
- If an agent chooses NV and incurs a loss, there is a $q \times 100\%$ chance (with $q \in [0, 1]$) that they will transmit this loss to another given agent who also chose NV.

For the vaccine example, NV represents not getting the vaccine. Individuals who do not get vaccinted are at risk for catching the disease (i.e. incurring a loss). The more unvaccinated individuals there are, the more likely any one of these individuals is to catch the disease. The $p \times 100\%$ chance of "directly incurring a loss" represents the likelihood that an unvaccinated individual will catch a disease when it is first introduced into society from some ”outsider”. The $q \times 100\%$ chance of ”transmitting the loss” represents the likelihood that an individual who catches the disease will pass it on to another unvaccinated individual.

Let $d_i \in \{0, 1\}$ denote agent i's choice, where $d_i = 0$ denotes a choice of V and $d_i = 1$ denotes a choice of NV. Additionally, let $\phi_i(p, q, d_{\neg i})$ denote the probability that agent i will incur a loss if $d_i = 1$. Note that ϕ_i is a function of the initial infection probability, p, the transmission probability, q, and the decisions of the $N - 1$ other agents, $d_{\neg i}$. Assuming risk neutrality, if agents seek to maximize their own expected payoff, the agent's problem is to choose $d_i \in \{0, 1\}$ so as to maximize

$$\pi_i = (1 - d_i)(e - c) + d_i((1 - \phi_i)e + \phi_i(e - l_j)),\ j = L, H.$$

where π_i denotes agent i's expected payoff.

Parameterization:

The following parameters are used for all decision rounds: $N = 6$, $N_H = 2$, $N_L = 4$, $c = 7$, $p = 0.10$, $q = 0.80$, $l_H = 25$, and $l_L = 20$. For half of the decision rounds, $e = 25$, and for the other half, $e = 7$.

If an agent of either type chooses V, then they receive a payoff of $e - c$ with certainty. If a High-loss agent chooses NV, then their payoff is either e or $e - l_H$. If a Low-loss agent chooses NV, then their payoff is either e or $e - l_L$. The probabilities of incurring a loss for either type are as described above, and are as calculated in Lockhart (2013). Tables 1 and 2 outline these probabilites and expected payoffs for both agent types and each possible endowment level. As shown for $e = 25$ in Lockhart (2013), there is a unique pure-strategy Nash equilibrium in which both High-loss agents choose V and all four Low-loss agents choose NV. The social optimum however, is for four agents to choose V (the two High-loss agents plus two Low-loss agents), and for the other two Low-loss agents to choose NV. It is easy to show that decreasing the individual endowment to $e = 7$ does not change the Nash equilibrium or the social optimum.

2.2. The Decision Setting

Subects are randomly placed into an initial group of six. Each group contains two types of individuals, High-loss and Low-loss. There are two High-loss individuals and four Low-loss individuals in each group, with types randomly assigned within each group. Subjects know their own type and the distribution of types within their group. Subjects participate in two sequences of ten decision rounds each. For one of the two sequences, subjects begin each round with an endowment of 25 Experimental Currency Units (ECU), and for the other sequence, subjects begin each round with an endowment of 7 ECU. Subjects maintain their same group and type assignment within each sequence, but are randomly regrouped and types are randomly reassigned between sequences. In each round of each sequence, subjects must select one of two possible options, V or NV. Any individual that chooses V must give up 7 ECU. If an individual of either type chooses NV, then the number of ECU they get to keep (have to give up) depends on the actions of their group members. For each possible outcome, High-loss subjects receive a lower payoff from choosing NV than do Low-loss subjects. These payoffs are equal to the expected payoffs in the model discussed above, and are equal to the expected payoffs in Tables 1 and 2.

3. Behavioral conjectures

If individuals are rational, own-payoff maximizing agents, we would expect both group and individual behavior to be well predicted by the Nash equilibrium. In Lockhart (2013) however, subjects participated in a one-shot game identical to the E=25 decision environment in this paper, and the results were not quite Nash. Only 76.7% of High-loss subjects chose V (compared to the Nash prediction of 100%), and 11.7% of Low-loss subjects chose V (compared to the Nash prediction of 0%). These results could be due to subjects not fully understanding the game, in which case we might expect behavior to approach the Nash prediction over time, as subjects receive feedback from earlier rounds. This would be consistent with the market entry games literature (Sundali et al. (1995), Kahneman (1988)), in which group behavior approached the Nash equilibrium quite quickly. Duffy and Hopkins (2005) note however, that although group behavior in these early market entry games approached equilibrium predictions quickly, individual behavior across rounds was still widely varying. They find that individual behavior takes significantly longer to approach the pure-strategy Nash prediction, but that this convergence is faster when feedback is provided between rounds. Not only do we provide feedback between rounds in this study, but due to the heterogeneity of subject types, the pure-strategy Nash equilibrium is unique. For most of the market entry games, agents are symmetric and so there are multiple pure-strategy Nash equilibria, resulting in a coordination problem. We do not have that problem here, and so we might expect individuals to reach equilibrium much faster.

Conjecture 1: Individual and group behavior will approach the pure strategy Nash prediction.

Although we cannot directly compare this study to the public goods literature, we can still make some rough conjectures. In the public goods literature, subjects frequently exhibit non-equilibrium behavior, leading to more efficient outcomes (Isaac et al. 1994; Ledyard 1995). Even in these environments however, where the external benefits of contributions to the public good accrue to all individuals, contribution levels typically fall short of the social optimum and decay over time. In this study, the external benefits of choosing V are enjoyed only by individuals choosing NV. Because of this difference, we would not expect behavior in this study to be any more efficient than it is in the pure public goods environment.

Conjecture 2: In all decision rounds, individuals will choose V less than socially optimal.

Again, if individuals are indeed rational, own-payoff maximizing agents, then sequences with $e = 25$ and sequences with $e = 7$ are theoretically identical. As such, we should not expect to see any significant differences in behavior.

Conjecture 3: There will be no significant differences in behavior between sequences with $e = 25$ and $e = 7$.

If Conjecture 3 does not hold, then we may not be sucessfully creating a "domain of losses" when subjects are given an initial endowment high enough to ensure a postive payoff.

4. Experimental Decision Setting

The experiment consisted of four sessions conducted in the fall of 2013 with a total of 60 Indiana University students. Subjects were undergraduates from a variety of majors, recruited using ORSEE (Greiner 2004). In two of the four sessions, subjects participated in the sequence with $e = 25$ first, and in the other two sessions subjects participated in the sequence with $e = 7$ first. Each subject participated in only one session, lasting approximately one hour. The experiment was computerized using Z-tree (Fischbacher 2007).

At the start of each session, subjects read through general instructions on the computer monitors. After subjects finished reading, the experimenter presented the same instructions on a screen at the front of the room and read them out loud. These initial instructions included general policies and the general structure of the experiment. Subjects then proceeded to read the instructions for the first sequence of decision rounds. Again, the experimenter presented these instructions on a screen at the front of the room and read them out loud. Subjects were also provided with hard copies of all payoff tables contained in the instructions for the first sequence. After reading the instructions, subjects answered a short quiz to test their understanding of the decision enviornment. Subjects were required to answer each question correctly before the experiment could continue. Any questions were answered privately. Once all questions had been answers, subjects were informed of their type assignment for the first sequence and made their selection for the first round of Sequence 1. Once all subjects had made a selection, they were informed of their payoff for that round, their own decision for that round, the number of individuals in their group that chose V and the number of individuals in their group that chose NV. Subjects then proceeded to rounds 2-10. Between each round, subjects were given feedback on the most recent round only. Subjects were informed of this in the instructions for Sequence 1, and they were told that if they wished to keep a record of profits, choices, etc. from earlier rounds, they may do so on the paper provided. [3]

After the tenth round of the first sequence, subjects read an additional set of instructions for the second sequence of decision rounds. At this point, subjects were also given a hard copy of the payoff tables corresponding to the second sequence in their session. Again, these instructions were presented on a screen at

[3] Each subject was given a piece of blank paper and a pencil at the beginning of the experiment.

the front of the room and were read out loud by the experimenter. In particular, the experimenter emphasized that subjects would be randomly regrouped and types would be randomly reassigned. Subjects also answered a short quiz and were again required to respond correctly before the experiment could continue. Subjects were then informed of their type assignment for the second sequence and made their selection for the first round. Again, subjects received feedback between rounds for the most recent round only, but were provided with pencil and paper with which they could record the results of earlier rounds if they wished to.

All decision environments were described in Experimental Currency Units (ECU) and the exchange rate for all sessions was $0.08/ECU. Cash earnings depended on each subject's decisions and on the decisions of the other five members of their groups. Subjects received payment for all twenty decision rounds, as well as a $5 show-up payment. All decisions and earnings were private information. Subjects were not told the names, participant numbers, or earnings of their group members.

5. Results

5.1 Aggregate results

Table 3 contains the average fraction of individuals that chose V in each round for each sequence. These averagese are also depicted in Figures 1 through 4. Recall, Conjecture 1 proposes that individuals will behave according to Nash prediction, and Conjecture 2 proposes that individuals will choose V less than socially optimal. Looking at Figure 1, we see that the mean percentage of individuals choosing V is at or above the Nash prediction for all but one round, but is substantially below the social optimum for all rounds, giving some initial support for both Conjectures 1 and 2. Additionally, there appears to be a possible order effect for the first two rounds. For sessions where subjects participated in the "E=25" sequence first, the mean percentage choosing V is lower in the first round than it is for sessions where subjects participated in the "E=25" sequence second. This difference is reversed in round 2, and disappears by round 3. Even in the first two rounds however, these differences are not statistically significant (see Table 4).

Figure 2 depicts the same information but for sequences with E=7. Here the mean percentage of subjects choosing V is again substantially below the socially optimal level for all rounds, again giving support for Conjecture 2, but now it also falls below the Nash prediction for most of the first three rounds. Again, there appears to be a possible order effect for the first two rounds. For sessions where subjects patricipated in the "E=7" sequence first, the mean percentage choosing V is lower in the first round than it is for the sessions where subjects participated in the "E=7" sequence second. This difference is again reversed in round 2 and disappears by round 3. The difference in round 2 is statistically significant (p=0.029) (see Table 5).

Figures 3 and 4 compare behavior across the two different endowment levels by sequence ordering. Recall, Conjecture 3 proposes that there will be no significant difference between behavior in sequences with E=25 and sequences with E=7. Looking at Figure 3, we see that subjects appear to initially (i.e. in round 1) choose V more often when e=25 than when e=7, evidence against Conjecture 3. This difference however seems to disappear by round 4, and is only statistically significant (p=0.039) in round 1 (see Table 6). Figure 4 presents similar results. In Sequence 2, subjects choose V more often in the first three rounds when e=25 than they do when e=7, but this difference disappears by round 4 and is only statistically significant in round 1 (p=0.069) (see Table 7). Again, this gives some evidence against Conjecture 3 for the initial rounds, but evidence in support of Conjecture 3 for all subsequent rounds.

Figure 5 depicts the mean percent of subjects choosing V by round and endowment level, pooled across sequence order. Consistent with Conjecture 2 and the results described above, subjects choose V substantially less than socially optimal for all rounds and endowment levels. These results are significant for all rounds and endowment levels (see Tables 20 and 21). For E=25, subjects choose V somewhat more that the Nash prediction for all rounds, and significantly so in rounds 1, 5, and 9 (see Table 21), giving some evidence against Conjecture 1. For E=7, subjects choose V at or below the Nash prediction for the first three rounds, but then increase to slightly above the Nash prediction. Behavior was only significantly different than Nash in rounds 6 and 10 (see Table 22). Thus, subjects choose V less often in initial rounds when E=7 than they do when E=25. This difference however dissapears by round 4.

Tables 8-11 present the results of Fischer exact tests, comparing the frequency of choosing V across types for all endowment levels and sequence orderings. For the majority of rounds, High-loss individuals choose V significantly more often than Low-loss individuals. Figures 6 and 7 depict these results for each endowment level, pooled across sequence ordering. High-loss individuals very clearly select V more often than do Low-loss individuals, and the difference appears to be increasing across rounds. This supports Conjecture 1 which proposes that individual behavior will tend toward the Nash equilibrium. Figures 6 and 7 also allow us to compare type-specific behavior to their Nash predictions and the social optimum. Recall that for High-loss subjects, both the Nash prediction and the Social optimum require all High-loss individuals to choose V. That is we would expect the "High-loss" line to be horizontal at 1. Clearly this is not the case. Although the percentage of High-loss individuals choosing V does seem to increase across rounds, it is less than 1 for all rounds, giving some evidence against both Conjectures 1 and 2. On the other hand, the Nash prediction for Low-loss subjects is for none of them to choose V, i.e. a horizontal line at zero. Again, this is clearly not the case. Although the percent of Low-loss subjects choosing V appears to be slightly decreasing over time, it is still above zero for all rounds. The social optimum however, requires half of all Low-loss subjects to choose V, i.e. a horizontal line at 0.5. The mean percent of Low-loss individuals choosing V is below 0.5 for all rounds and endowment levels, giving some support against Conjecture 1 and for Conjecture 2.

5.2 Group level results

Although the aggregate results indicate fairly stable average behavior, especially over the last five rounds of each sequence, there is considerable heterogeneity across groups and variation within groups. Figures 8 through 26 depict group level outcomes by type for all endowment levels and sequence orders. Recall that there are two High-loss individuals and four Low-loss individuals in each group. The Nash prediction is for two High-loss individuals and zero Low-loss individuals in each group to choose V. The social optimum is for two High-loss individuals and two Low-loss individuals in each group to choose V. Looking at Figures 8 through 26, approximately half of all groups reached the Nash equilibrium at some point during the ten rounds, and about two thirds of all groups reached the social optimum at some point. Within each group however, behavior tends to vary from round to round. We are intersted not just in what outcomes groups are able to reach, but also what outcomes groups are able to maintain. If we consider "maintaining" and outcome to be achieving the same outcome for at least three rounds in a row, then slightly less than half of all groups were able to "maintain" some outcome. Of these, 37.5% "maintained" the Nash prediction, and 50% "maintained" an outcome slightly more efficient than Nash, but not quite the social optimum.

5.3 Individual level results

Due to the variation in behavior within groups, we already know that there must be variation in individual behavior across rounds. Table 22 contains the number of individuals by type, endowment, and sequence ordering that chose V a given number of times. If we consider a pure strategy to be an individual choosing V in every round (corresponding to $\#V = 10$ in Table 22) or never choosing V (corresponding to $\#V = 0$), then with a total of 60 individuals playing two sequences each, there are a total of 120 "opporunities" for pure strategies. Looking at the rows corresponding to $\#V = 0$ and $\#V = 10$ in Table 22, we see that most subjects did not play pure strategies. 23% of subjects played pure NV (i.e. $\#V = 0$), and 6.7% of subjects played pure V ($\#V = 10$). Of those that played pure NV, 93% were Low-loss subjects, and of those that played pure V, 63% were High-loss subjects.

The last row in Table 22 contains the mean number of times subjects of a given type, endowment and sequence ordering chose V. Looking at comparable High-loss and Low-loss columns, we see that High-loss subjects always chose V more often than Low-loss subjects did. Also, comparing Sequence 1 and Sequence 2 for each endowment level, High-loss subjects on average chose V more often in the second sequence and Low-loss subjects chose V less often, on average, in the second sequence, indicating that subjects move closer towards pure strategies across rounds.

To investigate why individuals that do not play pure strategies change their behavior, Figures 27 and 28 contain the mean frequencies of repeatedly selecting V, by type and outcome of the previous round. The results here are mixed. For E=25 (Figure 27), High-loss subjects repeatedly chose V more often when fewer individuals chose V in the previous period. This result is intutive and consistant with own-profit maximization. For Low-loss subjects, however, and for High-loss subjects with E=7, there does not seem to be any relationship between the number of individuals choosing V in one period, and their likelihood of choosing V in the next period. This is not necessarily evidence against Nash behavior, but could instead reflect unmeasured changes in beliefs over others' future actions.

Table 23 reports, by type, the fraction of individuals whose first switch was from V to NV and was following one or more rounds of missed profits, as well as the fraction of individuals whose first switch was from NV to V and was following one or more rounds of losses. The results here are again mixed. For High-loss subjects, the majority of subjects that switched from V to NV did so following just one round of missed profits. Additionally, all High-loss subjects that swtiched from NV to V did so following losses, but it took on average 1.78 rounds of losses before they made the switch. Low-loss subjects on the otherhand take slightly longer to switch from V to NV (1.28 rounds on average), and the majority of Low-loss subjects that switched from NV to V did so following profits. Again, this could be the result of changes in subject's beliefs over others' future actions, or it could represent other-interested behavior.

6. Conclusions

This study reports individual and group behavior in a binary-choice environment with positive externalities that accrue only to non-contributors. Subjects made decisions in two sequences of ten rounds each, differing in initial endowment level only. In each round of each sequence, subjects faced a choice between an option with a certain payoff and an option with a payoff that decreased with the number of individuals that chose it.

The results show that while average group behavior is well predicted by the (inefficcient) Nash equilibrium, behavior at the group and individual levels vary. These results are consistent with those of market entry games. Only about 18% of groups actually reached and maintained the equilibrium outcome. On the other hand, almost 25% of groups were able to maintain an outcome slightly more efficient than the Nash prediction, suggesting that some individuals may have other-interested preferences.

In addition, only 30% of subjects played pure strategies. Individual behavior did decrease in variation in the second sequence however, and tended toward the pure strategy Nash equilibrium.

Lastly, decreasing subjects' initial endowment low enough that they could actually lose money significantly altered behavior in the first round only. This is a promising result, and it suggests that as long as we use caution when interpreting early round results, we can successfully create a "domain of losses" in the laboratory by giving subjects an initial endowment, even if it is high enough that all subjects are guaranteed a positive payoff.

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Table 1: Endowment=25

	Number of *other* group members who choose *NV*					
	0	1	2	3	4	5
Payoff from choosing V	18	18	18	18	18	18
Probability of loss if choose NV	10%	17%	26%	34%	41%	47%
Expected payoff from NV for High-loss	22.5	20.7	18.5	16.45	14.75	13.3
Expected payoff from NV for Low-loss	23	21.6	19.8	18.2	16.8	15.6

Table 2: Endowment=7

	Number of *other* group members who choose *NV*					
	0	1	2	3	4	5
Payoff from choosing V	0	0	0	0	0	0
Probability of loss if choose NV	10%	17%	26%	34%	41%	47%
Expected payoff from NV for High-loss	4.5	2.7	0.5	-1.55	-3.25	-4.7
Expected payoff from NV for Low-loss	5	3.6	1.8	0.2	-1.2	-2.4

Table 3: Mean Percent "V" by Round

	E=25 (S1)	E=25 (S2)	E=7 (S1)	E=7 (S2)
Round 1	0.4 (0.08)	0.6 (0.082)	0.133 (0.125)	0.33 (0.183)
Round 2	0.5(0.079)	0.33 (0.183)	0.5 (0.148)	0.2 (0.067)
Round 3	0.4 (0.17)	0.4 (0.133)	0.233 (0.133)	0.27 (0.23)
Round 4	0.33 (0.079)	0.367 (0.163)	0.433 (0.072)	0.4 (0.17)
Round 5	0.43 (0.17)	0.467 (0.163)	0.367 (0.163)	0.47 (0.195)
Round 6	0.43 (0.17)	0.43 (0.082)	0.43 (0.082)	0.47 (0.125)
Round 7	0.43 (0.13)	0.43 (0.082)	0.367 (0.067)	0.37 (0.067)
Round 8	0.4 (0.08)	0.43 (0.17)	0.367 (0.125)	0.37 (0.067)
Round 9	0.43 (0.13)	0.47 (0.067)	0.4 (0.133)	0.47 (0.163)
Round 10	0.3 (0.125)	0.433 (0.133)	0.47 (0.125)	0.43 (0.08)
All rounds	0.41 (0.14)	0.44 (0.148)	0.37 (0.168)	0.38 (0.17)
1-5	0.41 (0.14)	0.43 (0.18)	0.33 (0.2)	0.33 (0.2)
6-10	0.4 (0.14)	0.44 (0.115)	0.41 (0.117)	0.42 (0.12)

(standard deviations in parentheses)

Figure 1:

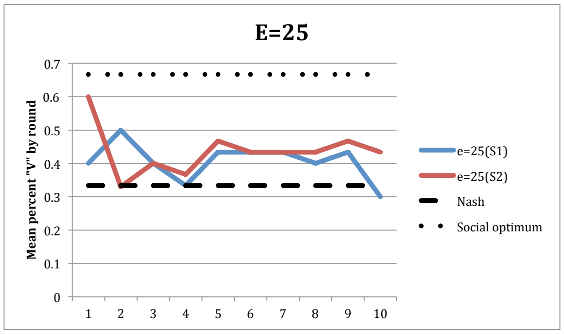


Figure 2:

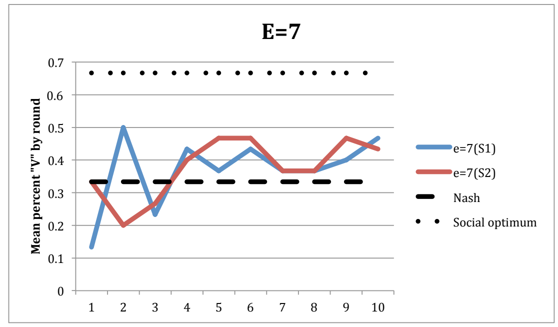


Figure 3:

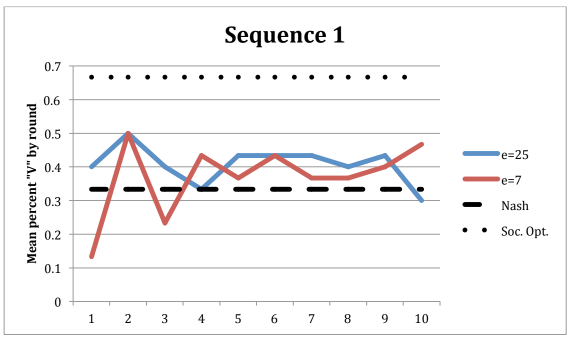


Figure 4:

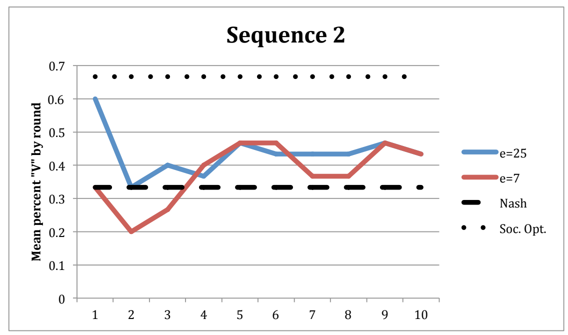


Figure 5:

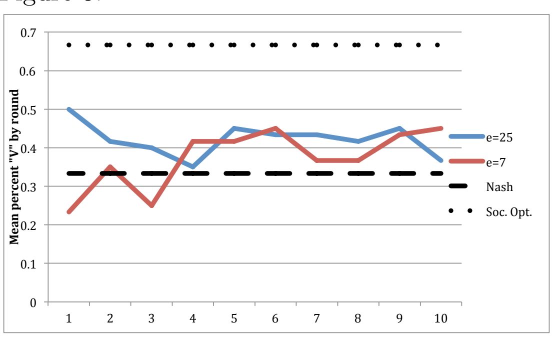


Table 4:

	E=25, (S1)	E=25, (S2)	Fischer's exact test
Round 1	12/30	18/30	p=0.196
Round 2	15/30	10/30	p=0.295
Round 3	12/30	12/30	p=1.00
Round 4	10/30	11/30	p=1.00
Round 5	13/30	14/30	p=1.00
Round 6	13/30	13/30	p=1.00
Round 7	13/30	13/30	p=1.00
Round 8	12/30	13/30	p=1.00
Round 9	13/30	14/30	p=1.00
Round 10	9/30	13/30	p=0.422

Table 5:

	E=7, (S1)	E=7, (S2)	Fischer's exact test
Round 1	4/30	10/30	p=0.125
Round 2	15/30	6/30	p=0.029**
Round 3	7/30	8/30	p=1.00
Round 4	12/30	12/30	p=1.00
Round 5	11/30	14/30	p=0.601
Round 6	13/30	14/30	p=1.00
Round 7	11/30	11/30	p=1.00
Round 8	11/30	11/30	p=1.00
Round 9	12/30	14/30	p=0.795
Round 10	14/30	13/30	p=1.00

** denotes significance at p=0.05

Table 6:

	E=25,(S1)	E=7,(S1)	Fischer's exact test
Round 1	12/30	4/30	p=0.039**
Round 2	15/30	15/30	p=1.00
Round 3	12/30	7/30	p=0.267
Round 4	10/30	12/30	p=0.789
Round 5	13/30	11/30	p=0.793
Round 6	13/30	12/30	p=1.00
Round 7	13/30	11/30	p=0.793
Round 8	12/30	11/30	p=1.00
Round 9	13/30	12/30	p=1.00
Round 10	9/30	14/30	p=0.288

Table 7:

	E=25,(S2)	E=7,(S2)	Fischer's exact test
Round 1	18/30	10/30	p=0.069*
Round 2	10/30	6/30	p=0.382
Round 3	12/30	8/30	p=0.412
Round 4	11/30	12/30	p=1.00
Round 5	14/30	14/30	p=1.00
Round 6	13/30	14/30	p=1.00
Round 7	13/30	11/30	p=0.793
Round 8	13/30	11/30	p=0.793
Round 9	14/30	14/30	p=1.00
Round 10	13/30	13/30	p=1.00

*denotes significance at p=0.10

Table 8:

	E=25, (S1) High-loss	E=25 (S1) Low-loss	Fischer's exact test
Round 1	4/10	8/20	p=1.00
Round 2	6/10	9/20	p=0.699
Round 3	4/10	8/20	p=1.00
Round 4	5/10	5/20	p=0.231
Round 5	7/10	6/20	p=0.056*
Round 6	5/10	8/20	p=0.706
Round 7	8/10	5/20	p=0.007***
Round 8	7/10	5/20	p=0.045**
Round 9	6/10	7/20	p=0.255
Round 10	7/10	2/20	p=0.002***

*denotes significance at p=0.10;
**denotes significance at p=0.05;
***denotes significance at p=0.001

Table 9:

	E=25, (S2) High-loss	E=25 (S2) Low-loss	Fischer's exact test
Round 1	9/10	9/20	p=0.024**
Round 2	4/10	6/20	p=0.690
Round 3	6/10	6/20	p=0.139
Round 4	6/10	5/20	p=0.108
Round 5	8/10	6/20	p=0.019**
Round 6	8/10	5/20	p=0.007***
Round 7	8/10	5/20	p=0.007***
Round 8	8/10	5/20	p=0.007***
Round 9	9/10	5/20	p=0.001***
Round 10	8/10	5/20	p=0.007***

** denotes significance at p=0.05;
*** denotes significance at p=0.001

Table 10:

	E=7,(S1) High-loss	E=7,(S1) Low-loss	Fischer's exact test
Round 1	2/10	2/20	p=0.584
Round 2	6/10	9/20	p=0.700
Round 3	3/10	4/20	p=0.657
Round 4	7/10	6/20	p=0.056*
Round 5	7/10	4/20	p=0.015**
Round 6	8/10	5/20	p=0.007***
Round 7	7/10	4/20	p=0.015**
Round 8	8/10	3/20	p=0.001***
Round 9	7/10	5/20	p=0.045**
Round 10	8/10	6/20	p=0.019**

*denotes significance at p=0.10;
**denotes significance at p=0.05;
***denotes significance at p=0.001

Table 11:

	E=7,(S2) High-loss	E=7, (S2) Low-loss	Fischer's exact test
Round 1	5/10	5/20	p=0.231
Round 2	5/10	1/20	p=0.009***
Round 3	4/10	4/20	p=0.384
Round 4	8/10	4/20	p=0.004***
Round 5	8/10	6/20	p=0.019**
Round 6	7/10	7/20	p=0.122
Round 7	9/10	2/20	p=0.000***
Round 8	8/10	3/20	p=0.001***
Round 9	9/10	5/20	p=0.001***
Round 10	8/10	5/20	p=0.007***

Table 12:

	E=25,(S1) High-loss	E=7,(S1) High-loss	Fischer's exact test
Round 1	4/10	2/10	p=0.629
Round 2	6/10	6/10	p=1.00
Round 3	4/10	3/10	p=1.00
Round 4	5/10	7/10	p=0.650
Round 5	7/10	7/10	p=1.00
Round 6	5/10	8/10	p=0.350
Round 7	8/10	7/10	p=1.00
Round 8	7/10	8/10	p=1.00
Round 9	6/10	7/10	p=1.00
Round 10	7/10	8/10	p=1.00

Table 13:

	E=25,(S2) High-loss	E=7,(S2) High-loss	Fischer's exact test
Round 1	9/10	5/10	p=0.141
Round 2	4/10	5/10	p=1.00
Round 3	6/10	4/10	p=0.656
Round 4	6/10	8/10	p=0.629
Round 5	8/10	8/10	p=1.00
Round 6	8/10	7/10	p=1.00
Round 7	8/10	9/10	p=1.00
Round 8	8/10	8/10	p=1.00
Round 9	9/10	9/10	p=1.00
Round 10	8/10	8/10	p=1.00

Table 14:

	E=25,(S1) High-loss	E=25,(S2) High-loss	Fischer's exact test
Round 1	4/10	9/10	p=0.058**
Round 2	6/10	4/10	p=0.656
Round 3	4/10	6/10	p=0.656
Round 4	5/10	6/10	p=1.00
Round 5	7/10	8/10	p=1.00
Round 6	5/10	8/10	p=0.350
Round 7	8/10	8/10	p=1.00
Round 8	7/10	8/10	p=1.00
Round 9	6/10	9/10	p=0.303
Round 10	7/10	8/10	p=1.00

Table 15:

	E=7,(S1) High-loss	E=7,(S2) High-loss	Fischer's exact test
Round 1	2/10	5/10	p=0.350
Round 2	6/10	5/10	p=1.00
Round 3	3/10	4/10	p=1.00
Round 4	7/10	8/10	p=1.00
Round 5	7/10	8/10	p=1.00
Round 6	8/10	7/10	p=1.00
Round 7	7/10	9/10	p=0.582
Round 8	8/10	8/10	p=1.00
Round 9	7/10	9/10	p=0.582
Round 10	8/10	8/10	p=1.00

Table 16:

	E=25,(S1) Low-loss	E=7,(S1) Low-loss	Fischer's exact test
Round 1	8/20	2/20	p=0.065*
Round 2	9/20	9/20	p=1.00
Round 3	8/20	4/20	p=0.301
Round 4	5/20	6/20	p=1.00
Round 5	6/20	4/20	p=0.716
Round 6	8/20	5/20	p=0.501
Round 7	5/20	4/20	p=1.00
Round 8	5/20	3/20	p=0.695
Round 9	7/20	5/20	p=0.731
Round 10	2/20	6/20	p=0.235

Table 17:

	E=25,(S2) Low-loss	E=7,(S2) Low-loss	Fischer's exact test
Round 1	9/20	5/20	p=0.320
Round 2	6/20	1/20	p=0.092*
Round 3	6/20	4/20	p=0.716
Round 4	5/20	4/20	p=1.00
Round 5	6/20	6/20	p=1.00
Round 6	5/20	7/20	p=0.731
Round 7	5/20	2/20	p=0.408
Round 8	5/20	3/20	p=0.695
Round 9	5/20	5/20	p=1.00
Round 10	5/20	5/20	p=1.00

Table 18:

	E=25,(S1) Low-loss	E=25,(S2) Low-loss	Fischer's exact test
Round 1	8/20	9/20	p=1.00
Round 2	9/20	6/20	p=0.515
Round 3	8/20	6/20	p=0.741
Round 4	5/20	5/20	p=1.00
Round 5	6/20	6/20	p=1.00
Round 6	8/20	5/20	p=0.501
Round 7	5/20	5/20	p=1.00
Round 8	5/20	5/20	p=1.00
Round 9	7/20	5/20	p=0.731
Round 10	2/20	5/20	p=0.127

Table 19:

	E=7,(S1) Low-loss	E=7,(S2) Low-loss	Fischer's exact test
Round 1	2/20	5/20	p=0.127
Round 2	9/20	1/20	p=0.008***
Round 3	4/20	4/20	p=1.00
Round 4	6/20	4/20	p=0.716
Round 5	4/20	6/20	p=0.716
Round 6	5/20	7/20	p=0.731
Round 7	4/20	2/20	p=0.661
Round 8	3/20	3/20	p=1.00
Round 9	5/20	5/20	p=1.00
Round 10	6/20	5/20	p=1.00

Table 20:

	E=25	Nash	Binomial test	Soc. Opt.	Binomial test
Round 1	30/60	20/60	p=0.011**	40/60	p=0.011**
Round 2	25/60	20/60	p=0.220	40/60	p=0.000***
Round 3	24/60	20/60	p=0.337	40/60	p=0.000***
Round 4	21/60	20/60	p=0.879	40/60	p=0.000***
Round 5	27/60	20/60	p=0.079*	40/60	p=0.001***
Round 6	26/60	20/60	p=0.136	40/60	p=0.000***
Round 7	26/60	20/60	p=0.136	40/60	p=0.000***
Round 8	25/60	20/60	p=0.220	40/60	p=0.000***
Round 9	27/60	20/60	p=0.079*	40/60	p=0.001***
Round 10	22/60	20/60	p=0.672	40/60	p=0.000***

Table 21:

	E=7	Nash	Binomial test	Soc. Opt.	Binomial test
Round 1	14/60	20/60	p=0.126	40/60	p=0.000***
Round 2	21/60	20/60	p=0.879	40/60	p=0.000***
Round 3	15/60	20/60	p=0.214	40/60	p=0.000***
Round 4	25/60	20/60	p=0.220	40/60	p=0.000***
Round 5	25/60	20/60	p=0.220	40/60	p=0.000***
Round 6	27/60	20/60	p=0.079*	40/60	p=0.001***
Round 7	22/60	20/60	p=0.672	40/60	p=0.000***
Round 8	22/60	20/60	p=0.672	40/60	p=0.000***
Round 9	26/60	20/60	p=0.136	40/60	p=0.000***
Round 10	27/60	20/60	p=0.079*	40/60	p=0.00***

Figure 6:

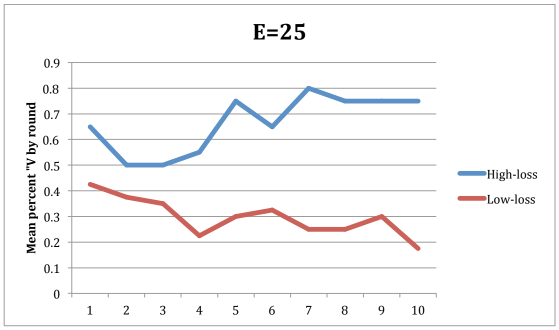


Figure 7:

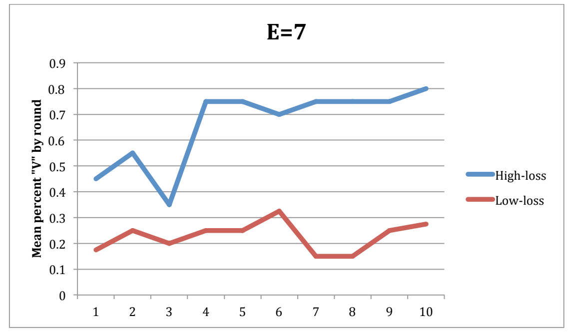


Figure 8:

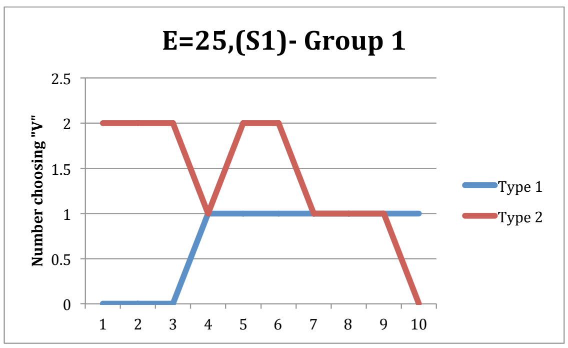


Figure 9:

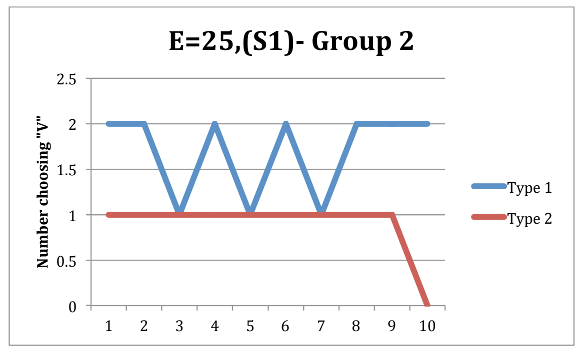


Figure 10:

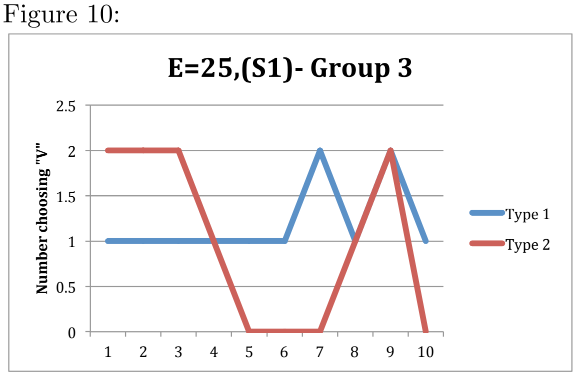


Figure 11:

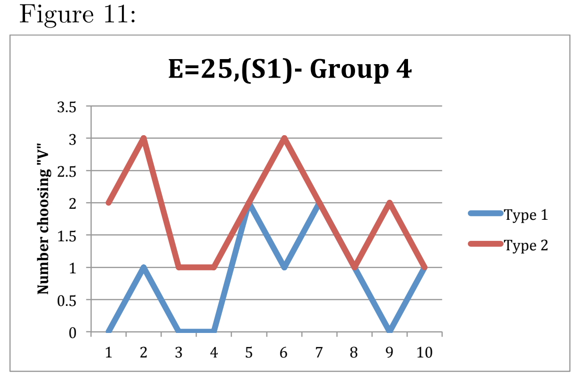


Figure 12:

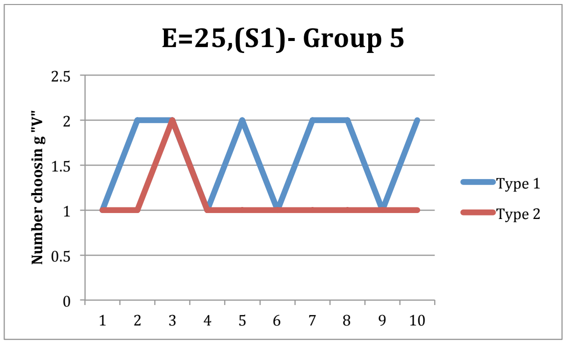


Figure 13:

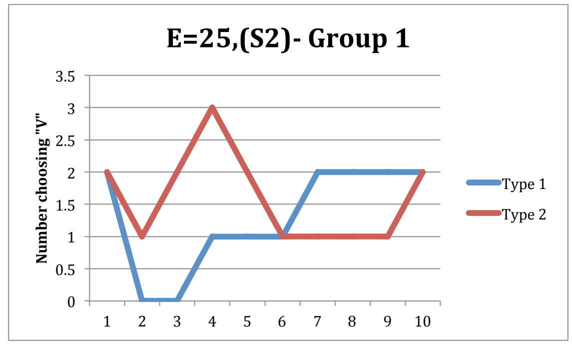


Figure 14:

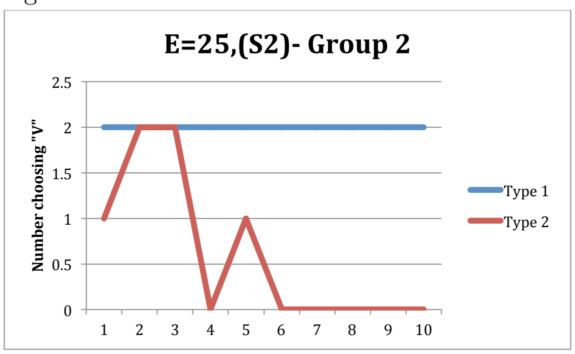


Figure 15:

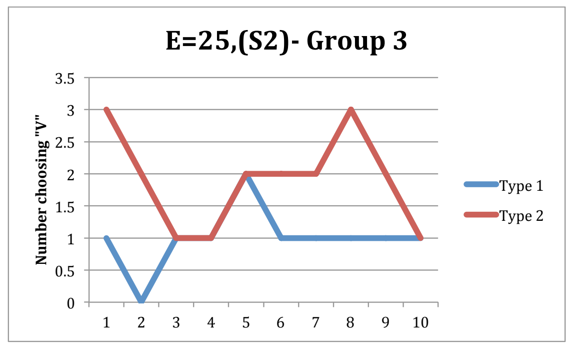


Figure 16:

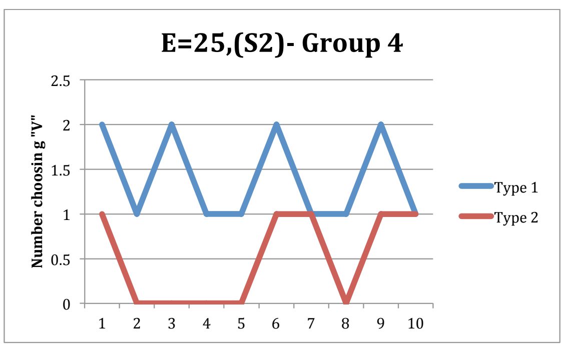
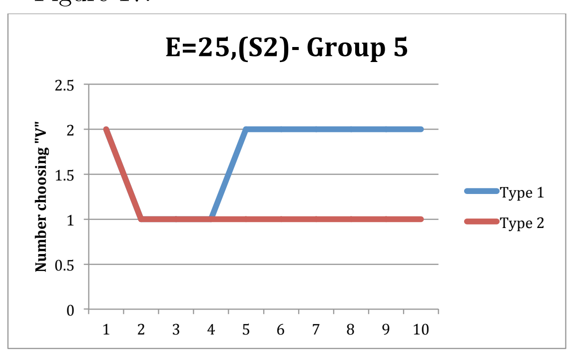


Figure 17:



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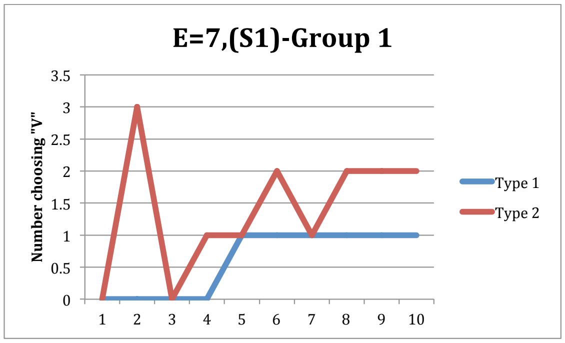
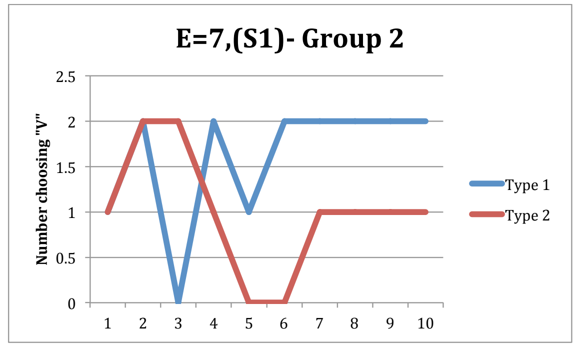


Figure 19:



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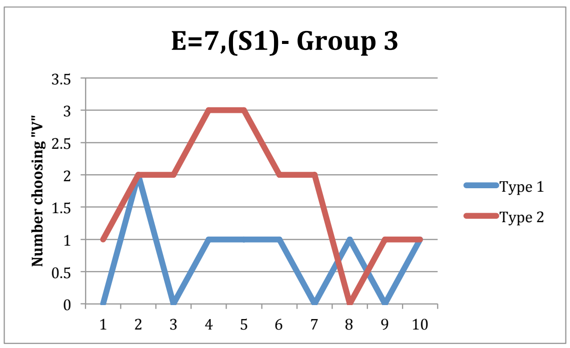

Figure 21:

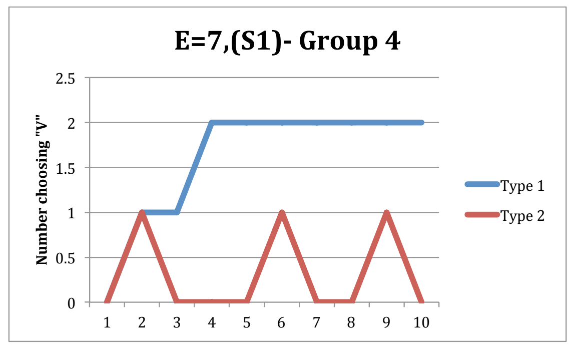

Figure 22:

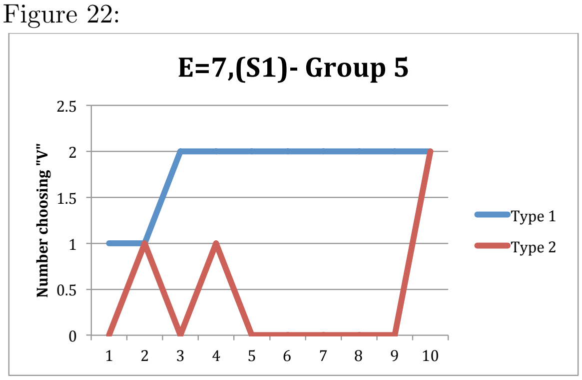

Figure 23:

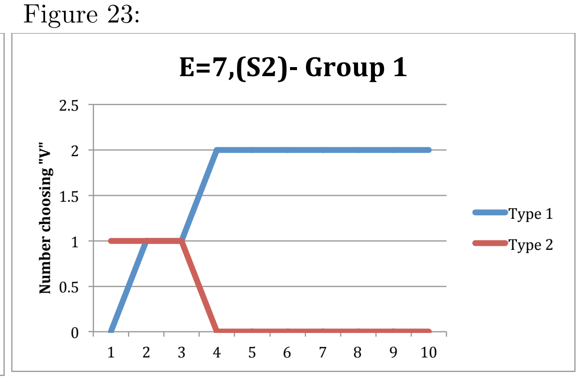

Figure 24:

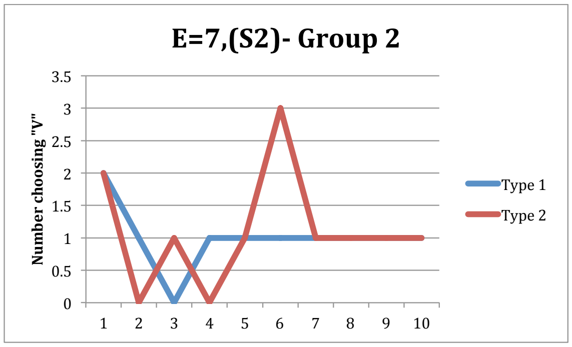

Figure 25:

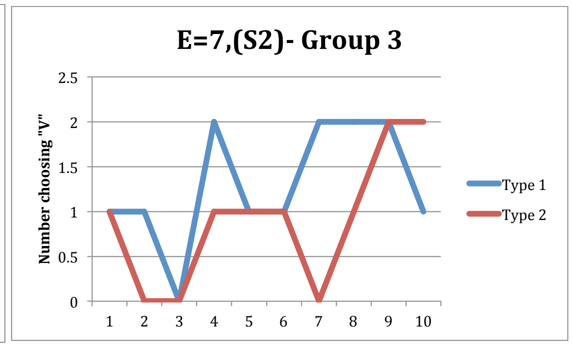

Figure 26:

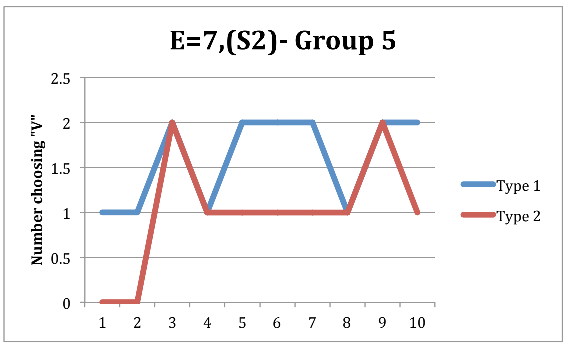

Table 22:

#V	E=25(S1) H-loss	E=25(S1) L-loss	E=7(S2) H-loss	E=7(S2) L-loss	E=25(S2) H-loss	E=25(S2) L-loss	E=7(S1) H-loss	E=7(S1) L-loss
0	1	6	0	7	0	8	1	5
1	0	3	1	3	0	2	1	4
2	0	1	0	1	1	1	0	3
3	2	2	0	4	0	1	0	2
4	0	3	0	3	1	2	0	1
5	1	1	1	1	1	2	0	3
6	0	0	0	0	0	2	2	1
7	2	0	2	0	1	0	1	1
8	2	2	3	1	2	0	3	0
9	2	1	3	0	0	0	1	0
10	0	1	0	0	4	2	1	0
Mean (s.d)	5.9 (3.04)	3.15 (3.31)	7.1 (2.47)	2.1 (2.20)	7.4 (2.88)	2.85 (3.30)	6.3 (3.30)	2.4 (2.23)

The first column represents the number of times (out of ten) that an individual chose "V". Entries denote the number of individuals of a given type, endowment level and sequence order that selected "V" a given number of times.

Figure 27:

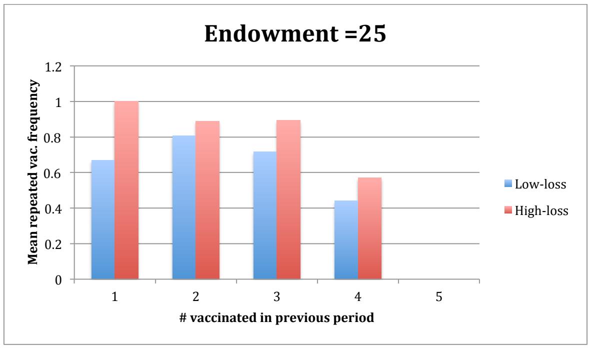

Figure 28:

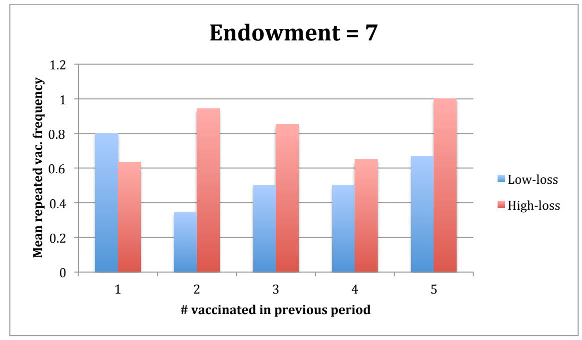

Table 23:

	V to NV	NV to V
High-loss	9/15 missed profits (mean=1.08 rounds)	18/18 losses (mean=1.78 rounds)
Low-loss	14/22 missed profits (mean=1.28 rounds)	11/29 losses (mean=1.27 rounds)

Entries in the first column represent the fraction of individuals of a given type who chose "V" in Round 1 and first switched to "NV" immediately following a round in which they would have received a higher payoff if they had chosen "NV". This is called "missed profits". Entries in the second column represent the fraction of individuals of a given type who chose "NV" in Round 1 and first switched to "V" immediately following a round in which they would have received a higher payoff if they had chosen "V". This is called "losses".