CLASSIC COORDINATION FAILURES REVISITED: THE EFFECTS OF DEVIATION COSTS AND LOSS AVOIDANCE

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Abstract

Are communication failures common? We revisit a classic example of experimental coordination failure and explore, in a 2x2 design, the effects of deviation costs and loss avoidance. Our results suggest how to engineer coordination successes in the laboratory, and possibly in the wild.

Abstrakt

Jsou selhání komunikace častá? Vycházíme z klasického příkladu selhání koordinace při ekonomickém experimentu a zkoumáme efekty nákladů z odchýlení a vyhýbání se ztrátě ve schématu 2x2. Naše výsledky naznačují možnosti, jak zajistit úspěch koordinace jak v laboratoři, tak snad i ve skutečnosti.

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1. Introduction

Coordination games with Pareto-ranked equilibria have attracted major theoretical attention over the past two decades, as path-breaking experimental studies (Van Huyck, Battalio and Beil, 1990, 1991; Cooper, DeJong, Forsythe and Ross, 1990, 1992) were widely interpreted as suggesting that coordination failure -- here interpreted as failure of coordination on the efficient equilibrium -- is a common phenomenon in the laboratory. In Devetag and Ortmann (forthcoming), we argue that coordination failures are less common than is widely perceived (e.g., Ochs 1995 and Camerer 2003). We argue that it is by now well understood how coordination successes can be engineered in the lab and formulate specific conjectures about the impact of deviation costs and loss avoidance (e.g., also, Cachon and Camerer 1996 and Rydval and Ortmann 2005).

To test these conjectures, we use variants of the median action game first studied by Van Huyck, Battalio and Beil, -VHBB henceforth – (1991). Early results on the median action game had shown both a high frequency of coordination failure and strong history-dependence, in that the last- round median always equaled the first-round median in all treatments. In our experiments we test the robustness of these results by manipulating two variables related to the payoff function: the presence of negative/positive payoffs in the earnings tables, and the presence of linear/nonlinear deviation costs. i.e., the opportunity costs of deviating from the best response to a given median.

2. Design

In order to test our conjectures, we chose the following 2x2 design, where Neg stands for earnings tables that contain negative payoffs and Non-lin stands for non-linear deviation costs:

Table 1 (Design)

	Neg	Pos
Non-lin	A	B
Lin	C	D

"A" is mnemonic for the Anchor of design Table 1 and is identical to the key earnings table in VHBB (1991) while B – D are treatments.

Specifically, the four earnings tables A – D looked like this:

Payoff table A		Median value of X chosen						
		7	6	5	4	3	2	1
Your choice of X	7	1.30	1.15	0.90	0.55	0.10	-0.45	-1.10
	6	1.25	1.20	1.05	0.8	0.45	0.00	-0.55
	5	1.10	1.15	1.10	0.95	0.70	0.35	-0.10
	4	0.85	1.00	1.05	1.00	0.85	0.60	0.25
	3	0.50	0.75	0.90	0.95	0.90	0.75	0.50
	2	0.05	0.40	0.65	0.80	0.85	0.80	0.65
	1	-0.5	-0.05	0.3	0.55	0.70	0.75	0.70

Clearly, table A features negative payoffs and non-linear deviation costs: for example, the opportunity cost of picking action 4 when the current median is 3 equals 5 cents, whereas the deviation cost rises non-linearly to 55 cents when action 6 is picked. In B, negative payoffs have been eliminated by adding 1.30 to all payoffs.[1]

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[1] In B, deviation costs are the same in absolute terms but not in relative terms. This seems unavoidable.

Payoff table B		Median value of X chosen						
		7	6	5	4	3	2	1
Your choice of X	7	2.60	2.45	2.20	1.85	1.40	0.85	0.20
	6	2.55	2.50	2.35	2.10	1.75	1.30	0.75
	5	2.40	2.45	2.40	2.25	2.00	1.65	1.20
	4	2.15	2.30	2.35	2.30	2.15	1.90	1.55
	3	1.80	2.05	2.20	2.25	2.20	2.05	1.80
	2	1.35	1.70	1.95	2.10	2.15	2.10	1.95
	1	0.80	1.25	1.60	1.85	2.00	2.05	2.00

Table C results from substituting the squared term in VHBB (1991):

$$\pi(e_i) = aM - b[M - e_i]^2 + c$$

where M = median, $i \in \{1, 2,....,7\}$, a=0.10, b=0.05, c=0.60, with the absolute value (linearizing deviation costs), and by setting parameter b equal to .30.[2]

Payoff table C		Median value of X chosen						
		7	6	5	4	3	2	1
Your choice of X	7	1.30	0.90	0.50	0.10	-0.30	-0.70	-1.10
	6	1.00	1.20	0.80	0.40	0.00	-0.40	-0.80
	5	0.70	0.90	1.10	0.70	0.30	-0.10	-0.50
	4	0.40	0.60	0.80	1.00	0.60	0.20	-0.20
	3	0.10	0.30	0.50	0.70	0.90	0.50	0.10
	2	-0.20	0.00	0.20	0.40	0.60	0.80	0.40
	1	-0.50	-0.30	-0.10	0.10	0.30	0.50	0.70

In D, we only changed the last term of the payoff function in VHBB (1991) by substituting the squared term with the absolute value:

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[2] This way we recapture negative payoffs. The implied change in the size of the (now linearized) deviation costs seems unavoidable although we would have liked to avoid it since it was likely to affect the probability of coordination failure.

Payoff table D		Median value of X chosen						
		7	6	5	4	3	2	1
Your choice of X	7	1.30	1.15	1.00	0.85	0.70	0.55	0.35
	6	1.25	1.20	1.05	0.90	0.75	0.60	0.40
	5	1.20	1.15	1.10	0.95	0.80	0.65	0.45
	4	1.15	1.10	1.05	1.00	0.85	0.70	0.55
	3	1.10	1.05	1.00	0.95	0.90	0.75	0.60
	2	1.05	1.00	0.95	0.90	0.85	0.80	0.65
	1	1.00	0.95	0.90	0.85	0.80	0.75	0.70

The elimination of the squared term results in positive payoffs.[3]

Our main hypothesis is that the absence of negative payoffs and linear deviation costs are both efficiency-enhancing features: therefore, we expect to observe a higher incidence of coordination success in the experimental treatments compared to the anchor, *ceteris paribus*; however, since in treatment C deviation costs are higher than in the baseline for "small" deviations, observing less coordination in C than in the remaining treatments is a possibility.

3. Implementation

Experiments were conducted with 16 groups of players in 8 sessions using a between-subject design. We obtained 4 independent data points for each treatment:

Table 2 (Implementation)	Treatment			
	A	B	C	D
Groups	4	4	4	4
Rounds	10	10	10	10

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[3] Again unavoidably, this change relocated the secure equilibrium from Choice 1 to Choice 3.

For ease of comparability we implemented the same conditions as in VHBB (1991): groups of 9 subjects played the stage game for a total of 10 rounds. Each session included 18 subjects, who were seated randomly at computer terminals. The instructions specified that subjects would participate in a "market" that would last for ten rounds[4]. They would be divided into two groups randomly by the computer program at the beginning of the experiment, and the group composition would remain fixed for the whole duration of the market. Payoffs were expressed in experimental currency, to be converted into euros at the end of the experiment. In an effort to keep the maximum potential gain in euros constant across treatments, the conversion rate used in B was half that of the remaining treatments. At the end of each round group median, individual payoff and cumulated individual earnings were provided. Before starting the experiment, subjects had to answer some control questions to make sure that everybody had understood how to calculate the median of a series of numbers, and how payoffs were computed on the basis of the earnings table.

4. Results

Table 3 reports the median and mode of choices in the first round, pooled across groups and divided by treatment. Fig. 1 reports the entire distribution of first-round choices, divided by treatment (each treatment, in the first round, contains 36 independent observations), and Table 3 reports the observed medians in the first and last rounds of play, separately for each group and treatment, and hence adds a temporal dimension.

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[4] The term "market" was also used in VHBB (1991).

Turning to first-round results first, we have six observations: first, the median choice in treatment A reflects the typical case of coordination failure found in previous experiments (e.g., VHBB 1991, Cachon and Camerer 1996, Blume and Ortmann 2007). In contrast, in treatment D the median choice is the efficient one, confirming our key conjecture. That said, and second, contrary to all other experiments that we know (see Devetag and Ortmann, forthcoming), the modal choice in treatment A is the choice inducing the efficient equilibrium. The typical modal choice in previous experiments, 4 or 5, (e.g., VHBB 1991, Cachon and Camerer 1996, Blume and Ortmann 2007) is the second preferred action only in our case. Third, the efficient choice is also the modal choice for treatment D. In terms of the modal choice, the hypothesized joint effect of deviation costs and loss aversion can therefore not show up in our data, although we do see the distribution of choices shift in the hypothesized direction. The shift turns out to be statistically non-significant given our number of independent observations, but would become significant if we were to replicate our results. Essentially, the baseline results are "too good" to allow for the hypothesized effect to materialize in a statistically significant manner, given our original implementation plans. Fourth, the surprising results of treatment A also affect the hypothesized effects of treatments B and C. Specifically, using a Mann-Whitney U test, we do not get a significant difference going from A to B and only a weak significance ($p<.10$, one-tailed) going from A to C, and that effect goes in the wrong direction[5]. Fifth, we do find highly significant differences going both from treatment B to D ($p<.01$, one-tailed), and from treatment C to D ($p<.01$, one-tailed). Sixth, as hypothesized, in treatment D, in which there are only positive payoffs and deviation costs are linear (and, recall footnote 2, somewhat lower than in

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[5] As mentioned, in light of the fairly high deviation cost necessitated by the need to induce negative payoffs, that outcome was not surprising. Lower deviation costs are likely to reverse that result, as we can see from the zero deviation treatment in VHBB (1991). It is also likely that the lower deviation costs in treatment D contributed to the efficiency results we obtain for that treatment.

treatment C), the percentage of players picking the efficient action 7 is the highest (55%) relative to all other treatments.
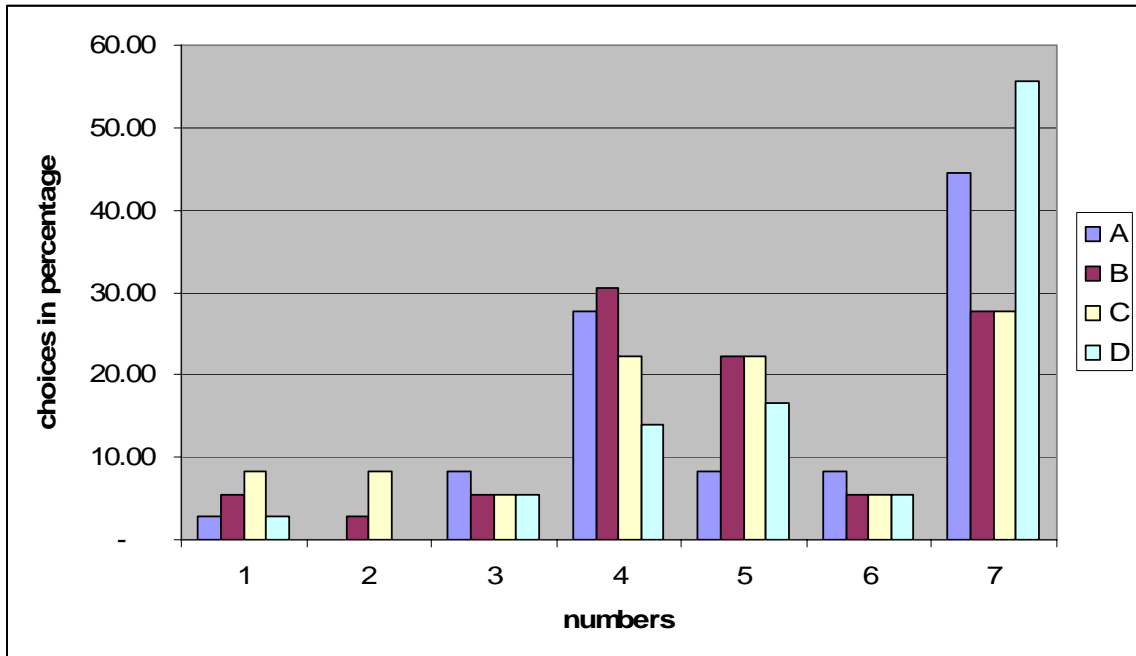
Fig. 1

Table 3

	A	B	C	D
N	36	36	36	36
median	6	5	5	7
mode	7	4	7	7

Table 4

Treatment	A	A	A	A	B	B	B	B	C	C	C	C	D	D	D	D
Group	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1st round median	5	6	6	7	5	6	5	4	5	5	5	5	5	7	6	7
10th round median	6	6	6	6	5	6	5	4	5	5	6	5	7	7	7	6

The data in Table 4 exhibit the inertia phenomenon that was documented in previous experiments. Specifically, the modal median is, in both rounds 1 and 10, 6 for treatment A, 5 for treatments B and C, and 7 in treatment D.

In summary, in the presence of only positive payoffs and linear deviation costs (our treatment D), the modal outcome is one of successful coordination on the efficient equilibrium, in line with our hypothesis. The data from treatment C suggest, quite in line with intuition, that the magnitude of deviation costs also plays a role in determining coordination success. The data from treatment B suggest, somewhat contradicting our priors, that positive payoffs alone are not sufficient to generate successful coordination.

5. Discussion

In Devetag and Ortmann (forthcoming), we argue that coordination failures are less common than is widely perceived (e.g., Ochs 1995 and Camerer 2003). We also formulate specific conjectures about the impact of deviation costs and loss avoidance. Using variants of the median action game first studied by Van Huyck, Battalio and Beil, 1991, we have reported experimental sessions designed to test our conjectures. By and far, our results suggest that some combination of loss avoidance and low, and linear, deviation costs is efficiency-enhancing. In effect, it seems that when going from treatment A to treatment D, simply changing the nonlinear term of the generating function used in VHBB (1991) made the difference between coordination failure and coordination success. Our results add to our understanding of what it takes to engineer coordination successes in the laboratory, and possibly in the wild.

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