Journal of Behavioral and Experimental Economics 58 (2015) 40–45

Contents lists available at ScienceDirect

Journal of Behavioral and Experimental Economics

journal homepage: www.elsevier.com/locate/socec

A note on making humans randomize☆

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ARTICLE INFO

Article history:
Received 1 August 2014
Revised 2 June 2015
Accepted 23 June 2015
Available online 11 July 2015

JEL Classfication:
C71
C92
D83

Keywords:
Coordination game
Experiment
Mixed strategy

ABSTRACT

This note presents results from an experiment studying a two-person 4×4 pure coordination game. We explore different strategy labels in an attempt to implement the mixed-strategy equilibrium that selects all four strategies with equal probability. Such strategy labels must be free from salient properties that might be used by participants to coordinate. Testing 23 different sets of strategy labels, we identify two sets that produce a distribution of subjects' choices which approximate the uniform distribution quite well. Our results are relevant for studies intending to compare the behavior of subjects who play against a random mechanism with that of participants who play against human counterparts.

1. Introduction

Coordination problems abound in real life. Some examples include the width of train tracks, business locations, and gentrification (Camerer, 2003). When the coordination game is pure, it is only of importance whether players coordinate at all, but not which action they coordinate on. The emergence of a convention regarding which side of the road drivers use is an illustration of a pure coordination game, which has two pure-strategy equilibria and one payoff-dominated mixed-strategy equilibrium. The players in a coordination game have a common interest in coordinating on some equilibrium, but the structure of the game is of no help in this regard.

Taking the coordination game as a case-in-point, this note explores different strategy labels in an attempt to implement the mixed-strategy equilibrium that selects all strategies with equal probability. Mixed-strategy equilibria are very important in game theory.[1] Accordingly, much attention in the literature has been directed at establishing whether or not people play mixed strategies in the laboratory (e.g., Moreno and Wooders, 1998; Rapoport and Amaldoss, 2000; 2004) and in the field (e.g., Chiappori et al., 2002; Walker and Wooders, 2001). In the present paper, we aim at creating a game representation that *induces* subjects to play mixed strategies. To this end, we consider different abstract strategy labels and analyze which of the sets studied performs best in inducing mixed-strategy play.

The labels of actions in coordination games may introduce so-called focal points (Schelling, 1960), which can facilitate coordination among players.[2] The classical example in this regard refers to the task of choosing a place to meet someone in New York without being able to communicate, where the Grand Central Station turned out as the most prominent focal point (Schelling, 1960). Our object in the present study is indeed the reverse of allowing subjects to coordinate on one action, that is, we want them to implement the mixed-strategy equilibrium. To this end, we have to find a set of strategy labels out of which none label is more salient than the others while still being distinguishable.[3]

☆ We thank the editor-in-charge John Wooders, two anonymous reviewers, Roland Hübner, Sarah Martiny, and seminar participants at the TWI Kreuzlingen for very helpful suggestions.

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[1] One reason for this lies in the fact that every finite strategic-form game has a mixed-strategy equilibrium, but not necessarily a pure-strategy equilibrium (Nash, 1950).

[2] See, for example, Casajus (2000) and Sugden (1995) for formal theories of focal points.

[3] The effectiveness of focal points for coordination was underscored by experimental work studying games with salient labels and symmetric payoffs. Mehta et al. (1994) distinguish between Schelling salience (a label is salient when it suggests itself to people who are looking for ways of solving coordination problems) and both primary and secondary salience. A label is therein called primary salient when it is directly brought to the player's mind and a label is secondary salient when it is expected to be of primary salience for the other player. For example, the city of birth may have primary salience for a subject when the question is "Name a city", but it will only be chosen as a response in a coordination task when this information is also available to many other

http://dx.doi.org/10.1016/j.socec.2015.06.008
2214-8043/

With respect to predicting which labels are salient, Mehta et al. (1994) use questions related to figures that allowed to predict responses according to focal principles.[4] Along similar lines, Bacharach and Bernasconi (1997) test principles such as the rarity preference (subjects should choose objects that are rarer), the symmetry disqualification (subjects should choose the odd alternative that disqualifies symmetrical ones), and trade-off (subjects should take account of the probability that an odd alternative is not recognized as such against the availability of other alternatives). In coordination games with simpler labels, intuitive focal points emerge, such as “X” when choices are labeled “X” and “Y” (Crawford et al., 2008) or “Rose” when the task asks for the name of a flower (Mehta et al., 1994). The labels used in this study were selected in order to make the identification of an alternative *as being the only one which has some conspicuous attribute* (Lewis, 1969) as difficult as possible.

In our experiment, subjects played a sequence of pure 4×4 coordination games. There are several Nash equilibria of which the mixed strategy where every strategy is played with equal probability is of particular interest for us and implies that the probability of successful coordination is equal to 25% . From a material incentive perspective, this would thus be similar to playing against a random mechanism with a matching probability of 25%. We tested 23 different sets of strategy labels. Our results show that it is surprisingly difficult to find strategy labels that produce play such that all actions are chosen with the same probability when equilibrium calls for it. However, we identify two sets of strategy labels that produce a distribution of subjects’ choices which approximate the uniform distribution quite well. The same labels may be a good starting point for non-focal labels in general 4×4 games.

Our results may be relevant to experimental economists interested in distinguishing behavior when some outcome is either due to a random device or due to a decision from another subject. For instance, our interest in the topic was stimulated by a study in the law-compliance context (Bruttel and Friehe, 2013), in which we considered how variations of the law-enforcement process that did not affect material payoffs nevertheless impacted on compliance decisions. One treatment dimension was whether the detection probability was due to a move of nature or due to another participant in the role of the enforcer. In order to ensure that the material incentives were not changed by this variation, we had to design an interaction between potential violator and enforcer that led to the exact same detection probability that we used for the move of nature. This was achieved by implementing a “hide-and-seek game” using the set of labels that performed best in the study presented in the following. In Bruttel and Friehe (2013), there were no significant differences along this treatment dimension, which might be interpreted as saying that subjects correctly anticipated the similarity of payoff consequences. In sum, it may be argued that – by testing strategy labels to implement mixed-strategy equilibria – we make a methodological contribution (like, e.g., Gächter and Renner, 2010; Gürerk and Selten, 2012) by presenting a design that allows experimenters to compare decisions under risk with decisions under strategic uncertainty.[5]

In our study, we want to induce human subjects to play mixed strategies such that equilibrium play mirrors the probability distribution of a given random mechanism. Previous work in the context of social preferences has dealt with the problem of aligning human behavior with the probability distribution of a random mechanism in reverse order by adjusting the probability distribution of the random mechanism to the observed distribution of real subjects’ decisions. For example, when it comes to fairness preferences, early models (Bolton and Ockenfels, 2000; Fehr and Schmidt, 1999) have emphasized the importance of payoff differences, whereas Falk and Fischbacher (2006), for example, present a model in which both outcomes and intentions matter. In order to test whether intentions matter indeed, Falk et al. (2008) use a “moonlighting game” where the first move is either implemented by the first player or by a move of nature. In this context, it is important to keep the probability distribution of first-mover actions constant across the random device and the human choice conditions. This aspect of keeping the probability distribution constant is similarly important in scenarios in which decision-making under risk is studied and the cause of the risk may be due to either a move of nature or strategic risk.

The structure of the article is as follows. In Section 2, we present the experimental design and procedures. The experimental results are described in Section 3. Section 4 concludes the study.

2. Design and procedures

Our subjects played a sequence of pure 4×4 coordination games with random rematching of players after each round. The coordination game granted both players in a game the choice among four different actions, $S = \{a, b, c, d\}$, which were represented by four symbols or pictures arranged on the screen from left to right (see Fig. 1). Importantly, while the action set was identical for each pair of matched subjects, the representation of the alternatives on the computer screen was randomized. The four alternatives were randomly assigned to the four positions, and the assignment of labels to positions was independent across players.[6] The latter feature of the design was clearly communicated to participants and disabled straightforward attempts to coordinate, for instance, by selecting one of the actions depicted at the left- or right-hand side of the screen.

In any stage game, a successful coordination of both players on the exact same action implied a positive payoff x, whereas a mismatch implied a payoff of zero. The expected payoff in any stage game of a subject entitled row player R interacting with a column player C was thus

$$\pi^R = x(\alpha^R\alpha^C + \beta^R\beta^C + \gamma^R\gamma^C + \delta^R\delta^C),$$

where α^j denotes the probability that player j chooses action a (and so on for actions b, c, and d) and $\alpha^j + \beta^j + \gamma^j + \delta^j = 1,\ j = C, R$. There are four pure-strategy Nash equilibria such as that resulting from $(\alpha^j, \beta^j, \gamma^j, \delta^j) = (1, 0, 0, 0)$ for players R and C. Moreover, there are mixed-strategy Nash equilibria, where the equilibrium probabilities that are strictly between zero and one must all be symmetric. For example, players R and C may play both play $(\alpha^j, \beta^j, \gamma^j, \delta^j) = (1/2, 0, 1/2, 0)$ in equilibrium. This equilibrium would imply a probability of both players coordinating amounting to one half.

In the paper at hand, we are interested in implementing mixed-strategy equilibria by the use of adequate strategy labeling. Given that the actions themselves were abstract images arranged randomly on the screen for each player, the mixed-strategy equilibrium in which every action is played with probability 1/4 is of particular interest for us. Note that indeed only this mixed-strategy equilibrium is consistent with the criterion of Harsanyi and Selten (1988) that games with the same structure ought to have the same solution. Despite our focus on the outcome in which all strategies are used with equal probability, we will refer to the other mixed strategies in our results below since they indeed play some role in our data.

subjects. In our inquiry, we try to make coordination hard and thus make use of rather abstract illustrations which are not proper for differentiating along these lines.

[4] The task was assigning circles to one of two squares. Focal principles in this context include closeness (assign the circle to the square that is closer) and equality (assign an equal number of circles to each square).

[5] Whereas our interest resides in making decisions under risk and strategic uncertainty comparable with regard to the likelihood of events, Heinemann et al. (2009) are interested in bridging the individual perception of exogenous risk and strategic uncertainty by establishing a measure of strategic risk related to the well-known certainty equivalent.

[6] Blume et al. (1998) randomized the correspondence of the labels ∗ and # across players in a sender-receiver game. We found our design, in which actions have the same labels for both players, easier to explain to the subjects.