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The path to equilibrium in sequential and simultaneous games: A mousetracking study ☆

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Abstract

We study in the laboratory three-, four- and six-player, dominance solvable games of complete information. We consider sequential and simultaneous versions of games that have the same, unique Nash equilibrium, and we use mousetracking to understand the decision making process of subjects. We find more equilibrium choices in the sequential version than in the simultaneous version of the game and we highlight the importance of attentional measures. Indeed, depending on the treatment, equilibrium behavior is 30 to 80 percentage points higher for subjects who look at all the payoffs necessary to compute the Nash equilibrium and for those who look at payoffs in the order predicted by the sequential elimination of dominated strategies than for subjects who do not. Finally, the sequence of lookups reveals that subjects have an easier time finding the player with a dominant strategy in the sequential timing than in the simultaneous timing. However, once this player is found, the unraveling logic of iterated elimination of dominated strategies is performed (equally) fast and efficiently under both timings.

JEL classification: C72; C92

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1. Introduction

Our ability to strategize is contingent on the type of situations we face. Several studies (Camerer et al., 1993; Costa-Gomes et al., 2001) suggest that decisions in games follow simple algorithms that implement a limited number of steps of reasoning. These theories build on the hypothesis that cognitive abilities are limited. As the situation becomes more complex to evaluate, we typically observe larger departures from theoretical predictions. A striking but understudied example is *timing*. Individuals usually have a harder time making decisions when the order of play is simultaneous rather than sequential, even when the equilibrium action are the same.[1] This suggests that, ceteris paribus, a simultaneous timing is perceived to be more complex than a sequential timing. It also indicates that the way information is processed varies across timings.

The idea that sequencing affects decision-making has been the object of research in a wide range of fields. Among others, it has been studied in computer science to determine whether vast amounts of information should be presented sequentially or simultaneously (Jacko and Salvendy, 1996; Hochheiser and Shneiderman, 2000), in marketing to assess whether products of a new line should be introduced together or one at a time (Read et al., 2001; Mogilner et al., 2012) and in criminology to compare the efficiency of sequential and simultaneous police lineups (Steblay et al., 2001; McQuiston-Surrett et al., 2006). In economics, it is an open question for market design (school choice, auctions, etc.) whether the sequential or simultaneous elicitation of preferences matters in situations where truthful revelation is incentive compatible. Generally speaking, sequencing has this intuitive property of reducing the amount of information to consider in one batch and it is believed to ease the allocation of attentional resources (Just et al., 2001; Szameitat et al., 2002). Little is known however about the underlying processes at play.

The goal of this paper is to study the differences in both *attention* and *decisions* between simultaneous and sequential formulations in the context of stylized, abstract games. To this purpose, we conduct a controlled laboratory experiment where subjects play games that differ in the order of play but exhibit the same (unique) Nash equilibrium, and we track the information they attend to before making their decisions using the "mousetracking" method.

Isolating the effect of timing is key but non-trivial. To accomplish it, we construct the following special class of t-player dominance solvable games. In our design, the payoff of each player depends on her action and the action of exactly one other player. Also, one (and only one) player has a dominant strategy, so that the unique Nash equilibrium can be deduced through iterated elimination of strictly dominated strategies. Importantly, in the sequential version of the game the player with a dominant strategy always moves last, and the payoff of a player depends on her action and the action of the player who moves *next*. As a result, observing the choice(s) of previous mover(s) does not provide any direct guidance in finding the equilibrium. In other words, independently of the timing of the game, subjects need to identify the player with a dominant strategy and, from there, iteratively deduce the best response of the other players in order to find the Nash equilibrium.

[1] Even within a sequential timing, Brandts and Charness (2011) notice that choices in laboratory experiments may differ depending on whether we employ the direct-response or the strategy method.