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A test of mechanical ambiguity[☆]

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ABSTRACT

We implement an experiment to elicit subjects' ambiguity attitudes in the spirit of Ellsberg's three-color urn. The procedure includes three design elements that (together) have not been featured in similar experiments: strict ambiguity preferences, a single decision, and a mechanical randomization device with an unknown distribution (to both subjects and experimenters). We use this device in order to eliminate possible "strategic" ambiguity related to subjects' beliefs about the experimenters' motivations. In addition, we survey 40 experimental studies on Ellsberg's two- and three-color problems, and find that, on average, slightly more than half of subjects are classified as ambiguity averse. Our results, with our new design, fall on the low end of the range of results in the surveyed studies, and are comparable to a control test where "strategic" ambiguity was induced.

1. Introduction

There are many situations where decision makers must contend with natural phenomena which are not well understood. Take for example the first man to ever eat a mushroom. We might now know if the mushroom in question is toxic, and, if so, the probability of various reactions. This man, on the other hand, would have known nothing of the sort. Similarly, consider the first men to plant non-native crops in various parts of the world, chemists experimenting with new compounds, or early explorers on uncharted oceans. Each deals with what economists generally refer to as ambiguity. Further, the ambiguity in these instances stems primarily from acts of nature, which have no discernible strategic underpinnings.

In order to better understand the decision-making process in these situations we propose and conduct a lab experiment. While other experiments have looked at ambiguity, the source nearly always stems from some conscious decision maker. We instead take steps to ensure that the ambiguity stems from a mechanical process, which not even we as experimenters fully understand.[1] In order to maintain comparability to the existing literature in terms of results, we utilize a three-color Ellsberg urn with one risky and two ambiguous colors.

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[1] Natural processes have been used before to study ambiguity, but in ways that could be manipulated by the experimenter. We discuss these studies further in Section 3.1.

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In order to gain clean evidence on the effects of ambiguity from mechanical phenomena, we incorporate three design features that, in combination, have not before been implemented. The first feature is to differentiate between mechanical and strategic sources of ambiguity by constructing a mechanical randomization device with an unknown distribution (to both subjects and experimenters). The second is to eliminate the possibility of ambiguity "hedging" by sophisticated subjects. The last is to avoid mischaracterization due to indifference.

Upon implementing our design, we find that subjects are averse, in roughly equal proportions, to ambiguity from both sources. With our design this proportion seems to be around 40%. We also find that roughly 25% of subjects make ambiguity seeking choices, though further investigation of their reasoning allows for a different interpretation of this statistic. We additionally find high correlation between subjects' reasoning and their choices. In particular, subjects who emphasized the safety of the risky option (as compared to an ambiguous option) all chose the risky option. Meanwhile, subjects whose reasoning was congruent with the principle of insufficient reason were 40% more likely to choose the option suggested by that principle.

To put our results into perspective, in the next section we survey 40 experimental studies on the Ellsberg urn problem and find that on average slightly more than half of subjects were classified as ambiguity averse. With our new design features, we find that probably slightly less than half should be classified as ambiguity averse. Section 3 discusses in detail the choices we made with respect to the experimental design and procedures. Results are analyzed and discussed in Section 4. Finally, we close with a brief discussion of the implications of our findings in Section 5.

2. A survey of the experimental literature

Since Ellsberg's (1961) famous thought experiment there have been numerous laboratory experiments that implemented either the 2-color or the 3-color Ellsberg urn. Camerer and Weber (1992) provide a survey of the early literature. Since in recent years the experimental literature seems to have exploded, an updated survey may be valuable. Trautmann and van de Kuilen (2014) provide an excellent survey focussing on the premium that subjects are willing to pay in order to avoid ambiguity. In Table 1 we provide a survey of 39 experimental studies focussing on the percentage of subjects that can be classified as ambiguity averse.

We have collected all studies we could find that implemented a classical Ellsberg urn experiment and where we were able to infer the percentage of ambiguity averse subjects from data presented in the paper (column five in Table 1). Whenever possible, we chose the treatment that was closest to the classical Ellsberg experiment.

The second column of Table 1 notes whether it was the 2-color or the 3-color version. Column three indicates whether the experiment was designed to elicit a strict preference regarding ambiguity (e.g. by eliciting an ambiguity premium or by paying a higher prize for the ambiguous lottery). The fourth column indicates whether the experiment involved multiple decisions for the same subject (which often allows for some form of ambiguity hedging).

Table 1 shows that the range of the percentage of ambiguity averse subjects is large (from 8% to 93%). If we naively take a simple (unweighted) average of (the midpoints of the ranges) of all studies, we obtain a mean of 56.6 and a median of 58.5. If we discard the five most extreme studies on either side, the mean is almost unchanged at 57.1. If we only include studies that check for a strict preference toward ambiguity, we obtain an average of 51.2%. Thus, overall, a quite consistent picture emerges: Slightly more than half of subjects seem to be ambiguity averse.[2]

3. Experimental design

In the following three subsections we will discuss the three crucial features of our experimental design.

3.1. Strategic vs. mechanical ambiguity

Ambiguity can have two different types depending on its source. One type, which we shall call mechanical ambiguity, is the ambiguity about the distribution of a variable determined by some mechanical process. The second type, which we shall call strategic ambiguity, is the ambiguity about the distribution of a random variable determined by the conscious decision of some other agent.[3]

In a standard Ellsberg-urn experiment, subjects may perceive their decision problem as a game between whoever fills the urn and themselves. For example, subjects may believe that the experimenter is trying to trick them in order to protect his research budget.[4] Therefore, it can be said that these experiments are technically a case of strategic ambiguity. While strategic ambiguity is certainly important to study, as much ambiguity in life comes from conscious decision, it is not clear that results in these experiments can be applied to cases where ambiguity comes from unknown mechanical processes.

[2] The remaining subjects would be classified as either ambiguity loving or ambiguity neutral.

[3] Thus, the two types of ambiguity differ in a manner similar to the difference between nodes of game trees where players move, and nodes where nature moves.

[4] This concern has been raised in a number of experimental papers (e.g. Keren and Gerritsen, 1999; Charness et al., 2013; Dominiak and Duersch, 2012). See Trautmann et al. (2008) for an interesting approach countering this concern.