Do anchoring effects underlie event-splitting effects?  
An experimental test  

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Abstract

Starmer and Sugden (Journal of Risk and Uncertainty, 1993, 6, 235–254) and Humphrey (Journal of Risk and Uncertainty, 1995, 11, 263–274) report experiments investigating the event-splitting phenomenon in experimental tests of theories of decision making under risk and uncertainty. This paper reports a test of whether the anchoring and insufficient adjustment of probability assessments could underlie these findings and concludes that it does not.

Keywords: Event-splitting effects; Anchoring and adjustment heuristic; Ambiguity

JEL classification: C91

1. Introduction

Tversky and Kahneman (1974) claim that when faced with a decision under risk or uncertainty individuals might rely on a decision heuristic, termed anchoring and adjustment, to simplify the difficulties associated with assessing probabilities and predicting outcomes. They claim that in forming probability assessments individuals begin by forming an anchor assessment on the basis of, for example, the formulation of the problem and then adjust this anchor to reach a final probability assessment. Formal models of this process have also emerged in the literature. Einhorn and Hogarth (1986) specify an anchoring and adjustment process whereby adjustments are made from the anchor via a simulation process (which involves individuals imagining values above and below the anchor to converge on the most plausible probability assessment) to account for any ambiguity in the decision problem. This paper is concerned with the possibility that the anchoring hypothesis could underlie the event-splitting effects (ESEs) reported by Humphrey (1995) and Starmer and Sugden (1993).

1 Ambiguity is defined as a state between ignorance, where no probability distributions can be ruled out, and risk, where all but one probability distribution can be ruled out. Tversky and Kahneman (1974) claim that anchoring can occur even when the starting point is given (as is the case under risk).
2. The anchoring hypothesis and ESEs

Consider the decision problems illustrated in Figs. 1 and 2. It was in decision-problem pairs of exactly this kind that Humphrey (1995) and Starmer and Sugden (1993) discovered ESEs, manifested in the conjunction of preferences $P_2 > P_1$ and $P_3 > P_4$, despite $P_1$ and $P_2$ and $P_3$ and $P_4$ being respectively stochastically equivalent. An ESE is said to occur when the subjective decision weight attached to an outcome depends not only on the combined probability of the states of the world in which that outcome occurs, but also on the number of states of the world. Subjects seemingly display greater preference for an option if it lists a particular outcome in two cells of the payoff matrix than they do if it is listed only once – despite the likelihood of that outcome being identical in both cases. These conjunctions of preferences can be explained by Kahneman and Tversky's (1979) prospect theory if it is stripped of the editing stage. For the details of this explanation, see Starmer and Sugden (1993) who point out that a stripped-down prospect theory implies:

$$\pi(1/3) + \pi(1/3) > \pi(1/3 + 1/3),$$

where $\pi(\cdot)$ is the subadditive weighting function applied to objective probabilities, and thereby predicts ESEs. However, if, as Tversky and Kahneman (1974) and Einhorn and Hogarth (1986) postulate, the anchors are likely to be pitched at each state of the world being equally likely to occur and, as is claimed is typically the case, any subsequent adjustment is

<table>
<thead>
<tr>
<th>Acts</th>
<th>1/3</th>
<th>1/3</th>
<th>1/3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_1$</td>
<td>$x_1$</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$P_2$</td>
<td>0</td>
<td>$x_2$</td>
<td>$x_2$</td>
</tr>
</tbody>
</table>

where monetary consequence $x_1 > x_2 > 0$

Fig. 1. Three-state decision problem.

<table>
<thead>
<tr>
<th>Acts</th>
<th>1/3</th>
<th>2/3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_3$</td>
<td>$x_1$</td>
<td>0</td>
</tr>
<tr>
<td>$P_4$</td>
<td>0</td>
<td>$x_2$</td>
</tr>
</tbody>
</table>

where monetary consequence $x_1 > x_2 > 0$

Fig. 2. Two-state decision problem.

\(^2\) Where $>$ denotes strict preference.
not sufficient for anchors to coincide with objective probabilities, the anchoring hypothesis can also explain conjunctions of preferences consistent with an ESE.

Assume that, when confronted with the decision problems in Figs. 1 and 2, individuals form anchors at each state of the world being equally likely to occur. Therefore, on the basis of the anchors, the three-state problem would be initially interpreted as a decision between either P1 offering amount \( x_1 \) with probability 1/3 or P2 offering \( x_2 \) with probability 2/3. Similarly, the interpretation of the two-state problem would be either P3 offering \( x_1 \) with probability 1/2 or P4 offering \( x_2 \) with probability 1/2. As far as the three-state problem is concerned, the anchors coincide with the true probabilities, and the adjustment process is somewhat trivial. If, however, in the two-state problem the adjustment process is incomplete, the final probability assessment for the left-hand state of the world would lie between 1/3 and 1/2 and, for the right-hand state of the world, between 1/2 and 2/3. Now consider the extreme case where there is no adjustment from the anchor probabilities. In this instance, a risk-averse individual might prefer P2 in the three-state problem since it offers a higher chance of winning, but prefer P3 in the two-state problem because given the anchors and the fact that \( x_1 > x_2 \), it stochastically dominates P4. The result is a conjunction of preferences (P2 > P1 and P3 > P4) consistent with an ESE as explained by stripped-down prospect theory. Furthermore, it is not necessary to invoke the extreme example for this possibility to exist. All that is required is that the anchoring and adjustment process is such that the individual believes they are more likely to win \( x_1 \) in the two-state problem than in the three-state problem to such an extent that whereas they avoid the extra risk associated with a larger outcome in the latter problem, they accept it in the former.

3. Experimental design

The influence of anchoring and insufficient adjustment was tested as part of a larger experiment using decision problems illustrated in Figs. 3 and 4. The tests involved comparing responses for each problem type between conditions of risk and uncertainty. This was achieved by providing one group of subjects with complete numerical probability information.

\[
\begin{array}{c|c|c}
\text{Acts} & p & q \\
\hline
R & x_1 & 0 \\
S & x_2 & x_2 \\
\end{array}
\]

where monetary consequence \( x_1 > x_2 > 0 \) and \( p=0.3, \ q=0.7 \)

Fig. 3. Anchoring decision problem (type 1).

\(^3\) Notice that in this case the anchor probabilities are identical to the true probabilities.

\(^4\) Implicit in the exposition is the assumption that while adjustment occurs towards the objective probability it does not continue beyond it.
where monetary consequence $x_1 > x_2 > 0$ and $p=0.3$, $q=0.7$

Fig. 4. Anchoring decision problem (type 2).

The test, along the lines of Einhorn and Hogarth (1986), assumed that under risk probability assessments would coincide with the numerical probability explicitly stated. Thus, in problem type 1, if option R is chosen the subject knows the probability of winning $x_1$ is 0.3. Under uncertainty, however, this information is not provided and if the anchor probability for $p$ is pitched between equal odds and the true likelihood of 0.3 and then incompletely adjusted towards the true probability of 0.3, we would expect less risk aversion under uncertainty than under risk, since the belief under uncertainty is that the likelihood of winning $x_1$ is higher. A similar logic holds for type 2 problems except that since $x_1$ occurs in the more likely state of the world (with probability 0.7) we would expect subjects to be less risk-averse under risk than under uncertainty. Consequently, the null hypothesis is that there will be no difference in the proportions of riskier choices between risk and uncertainty. This will be tested against the alternative hypothesis that in type 1 problems there will be less risk aversion under uncertainty, and vice versa for type 2 problems.

The experiment employed a sample of 150 subjects with parameters given in Table 1. Standard experimental procedure was followed, controlling for possible problem order effects, location of outcome in display effects and potential biases introduced into the uncertainty environment by preferences over colours. The random lottery incentive system was employed with the overall expected payoff being around £7 sterling. Payments were made in cash immediately after the experiment.

4. Results

The results are presented in Table 2. Table 2 shows that in six of the 12 problem pairs considered the proportions of riskier options chosen across the different information conditions were split in a manner consistent with the anchoring and insufficient adjustment

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5 The experiment controlled for Holt’s (1986) objections to the random lottery incentive system in the manner outlined by Loomes et al. (1992).
hypothesis. In two of these cases (4 and 5) the effect is significant at the 5% level. In the remaining six cases preferences were not consistent with the anchoring and insufficient adjustment hypothesis. Considering the results as a whole we cannot confidently reject the

Table 2
Results

<table>
<thead>
<tr>
<th>Problem pair</th>
<th>Type</th>
<th>Risk</th>
<th>Uncertainty</th>
<th>Expected sign (of z)</th>
<th>z</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>28 (42%)</td>
<td>35 (42%)</td>
<td>-</td>
<td>-0.047*</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>15 (22%)</td>
<td>23 (28%)</td>
<td>-</td>
<td>-0.746*</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>40 (60%)</td>
<td>54 (65%)</td>
<td>+</td>
<td>-0.675</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>13 (19%)</td>
<td>31 (37%)</td>
<td>-</td>
<td>-2.401*</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>7 (10%)</td>
<td>22 (27%)</td>
<td>-</td>
<td>-2.478*</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>33 (49%)</td>
<td>47 (57%)</td>
<td>+</td>
<td>-0.899</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>29 (35%)</td>
<td>28 (42%)</td>
<td>-</td>
<td>-0.859*</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>13 (16%)</td>
<td>8 (12%)</td>
<td>-</td>
<td>0.653</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>49 (59%)</td>
<td>42 (63%)</td>
<td>+</td>
<td>-0.455</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>40 (48%)</td>
<td>33 (49%)</td>
<td>-</td>
<td>-0.129*</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>24 (29%)</td>
<td>14 (21%)</td>
<td>-</td>
<td>1.123</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>45 (54%)</td>
<td>41 (61%)</td>
<td>+</td>
<td>-0.859</td>
</tr>
</tbody>
</table>

Notes: z is the test statistic for a test (based on the normal distribution) of the null hypothesis that the population proportion of choices of the riskier option is the same under conditions of uncertainty as under risk. The test is a one-tail test with the alternative hypothesis given by the anchoring and adjustment hypothesis. The expected sign of the test statistic depends on whether the question pair compared is of type 1 or type 2. A solid circle denotes the question pairs for which proportions of riskier options chosen across the different information conditions are split in a manner consistent with the anchoring and insufficient adjustment hypothesis. An asterisk denotes question pairs for which the above is true, and where the effect is significant at the 5% level.
null hypothesis that there is no difference in responses across the two information conditions. This does not mean that anchoring effects do not exist, but in most cases (if they do exist) they appear to be weak and unpredictable. Furthermore, other possible explanations such as ambiguity avoidance do not organise the data.

5. Conclusions

Recall that the motivation for testing the anchoring and insufficient adjustment hypothesis was to ascertain whether it underpinned the ESEs observed in Humphrey (1995) and Starmer and Sugden (1993). The above data were generated as a part of the experiment reported in Humphrey (1995) in which ESEs emerged with high significance under both risk and uncertainty. Given that anchoring effects did not, we must be led to conclude that ESEs are not convincingly explained by the anchoring hypothesis. Consequently, it remains that the ESE data are best organised by a stripped-down version of prospect theory.

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References