Does size matter? The Allais paradox and preference reversals with varying outcome magnitudes

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Abstract

The common consequence effect and preference reversals are two of the foundational violations of the standard model of rational choice (i.e. von Neumann – Morgenstern expected utility theory) and, as such, played an important role in the development of empirical behavioural economics. One can hypothesise, however, that due to varying degrees of risk aversion when faced with outcomes of different magnitude, the rate of both of these violations may vary with outcome size. Using various types of outcome, this article reports tests of these violations using different outcome magnitudes in within-respondent designs. The results observed are broadly consistent across outcome type: the common consequence effect, while rarely being substantially observed in any of the tests undertaken, was often found to be somewhat susceptible to outcome size while preference reversals, which were everywhere substantially observed, were not. In and of itself, the observation of systematic preference reversals implies that preferences are often constructed according to the way in which questions are asked, and is sufficient to question the usefulness of stated preference techniques for informing public policy.

Keywords: Allais paradox; common consequence effect; expected utility theory; outcome size; preference elicitation; preference reversals; rational choice

JEL classification: C91

Introduction

Background

Two of the most studied violations of expected utility theory (EU), both seminal in the development of empirical behavioural economics, are the common consequence effect and the original – or what we will refer to as classic – preference reversals. The common consequence effect is a violation of the EU cancellation or restricted branch independence axiom (herein referred to simply as independence), first demonstrated by Allais (1953). If accepted as a descriptive and not just a normative postulate, independence implies that the intrinsic value that an individual places on any particular outcome in a gamble will not be influenced by the other possible outcomes or by the size of the probability of the outcome occurring. It implies that, when comparing gambles, all common outcomes that have the same probability of occurring will be viewed by the individual as irrelevant, hereby demonstrated with reference to choices that resemble those designed by Allais, summarised in Table 1.

[Insert Table 1]

In the table, gambles A, B, A' and B' are presented in a split or collapsed form, so that it can readily be seen that, with a probability of occurrence of 0.89, A and B share a common outcome of $1million and A' and B' share a common outcome of $0. In all other respects A is identical to A' and B is identical to B'. When an individual is asked to choose between both A and B, and A' and B', independence requires that an individual who prefers A (B) in the choice between A and B should prefer A' (B') in the choice between A' and B', or express indifference between the options in both choices. Allais (1953) argued that under certain conditions individuals will systematically violate independence. Consider, for instance, the gambles in Table 1 presented in the following non-collapsed form:

A: $1m for certain
B: 10% chance of $5m, 89% chance of $1m, and 1% chance of nothing
A': 11% chance of $1m and 89% chance of nothing
B': 10% chance of $5m and 90% chance of nothing

Allais maintained that when individuals are faced with these options, many will express a preference for A and B', hence violating independence. This is the common consequence effect, and has been observed in many subsequent analyses (e.g. Conlisk, 1989; MacCrimmon and Larsson, 1979; Slovic and Tversky, 1974).

Classic preference reversals violate the assumption of procedural invariance, which specifies that an individual's preferences will be unaffected by the preference elicitation procedure – e.g. pairwise choice, monetary valuation, ranking – used. This type of preference reversal was uncovered by psychologists in the 1960s (e.g. Slovic and Lichtenstein, 1968) and involves two bets, commonly termed the *P-bet* and the *$-bet*. The *P-bet* offers a high probability of winning a modest amount, the *$-bet* offers a modest probability of winning a relatively large amount, both bets can entail the possibility of experiencing relatively small losses, and the two bets have similar expected values. A large number of studies have reported that a substantial percentage of people will choose the *P-bet* over the *$-bet* when faced with a direct pairwise choice, but will place a higher money value on the *$-bet* when valuing the two bets independently of each other. This systematic, predominantly unidirectional preference reversal cannot be attributed to random error.

To illustrate, consider the following bets, taken from Lichtenstein and Slovic (1971):

($4, 35/36; -$1, 1/36)	*P-bet*
($16, 11/36; -$1.50, 25/36)	*$-bet*

Here, the *P-bet* offers a 35/36 chance of winning $4 and a 1/36 chance of losing $1. The *$-bet* can be similarly read. Lichtenstein and Slovic (1971) in three tests reported that between 51-83% of their respondents chose the *P-bet* but placed a higher value on the *$-bet*.[1]

[1] Sceptical of the psychologists' findings, Grether and Plott (1979) undertook a carefully designed experiment that actually confirmed the observation of preference reversals and brought the phenomenon to the attention of a wider economics audience. As noted, there is now a large literature on preference reversals. For a review, see Seidl (2002), and for a recent discussion, see, for example, Loomes and Pogrebna (2016).

The common consequence effect was originally uncovered with the use of large, albeit hypothetical, money outcomes, and classic preference reversals traditionally used rather more modest money outcomes. Given that these two phenomena appear to reveal at face value differential risk attitudes across different choices, one may wonder whether, for a specific group of respondents, either or both of these observations are invariant to the size of the outcomes used (see Morgenstern, 1979). In tests of the common consequence effect, for instance, one might expect that more respondents would choose the risky option, B, over A if the consequences of not winning are not as catastrophic as losing out on $1million. Even before Allais published his seminal article, Markowitz (1952) had presented a formal challenge to whether the assumption, embedded within expected utility theory, of a constant risk attitude would hold up in descriptive choice. Markowitz presented to his acquaintances a series of questions that involved choices between a 10% chance of money gains or losses of $1 to $10,000,000 and the expected values of those lotteries, and discovered that they were typically risk averse when faced with a 10% chance of large gains and small losses, and risk seeking when faced with a 10% chance of small gains and large losses. In this article, we are interested only in the domain of gains; Markowitz thus predicted that people are more likely to be risk averse the larger the gain is (the Markowitz utility curve over gains is depicted in Figure 1), and thus, with small outcomes, we might hypothesise that the apparently heavy risk aversion observed in the choice between A and B in the common consequence effect will be lessened.[2] Following similar reasoning, greater risk seeking with the relatively small outcomes that tend to be used in classic preference reversals might provoke a relatively large number of respondents to choose the *$-bet* in the direct choice, which would imply that small outcome gambles are generating a minimal (although in observations still plentiful) number of systematic preference reversals.

[Insert Figure 1]

[2] Weber (2008) also contended that decision makers often tend to be more risk seeking for gambles with small outcomes than for gambles with large outcomes., which – to reiterate – might cause the common consequence effect to dissipate as the outcomes used diminish, since more people would choose the riskier option B over A (Conlisk, 1989).

Using abstract money gambles, the issue of whether the common consequence effect is susceptible to outcome size has occasionally been studied. Some researchers have observed substantial violations of independence irrespective of outcome size (Birnbaum, 2007; Camerer, 1989; Chew and Waller, 1986; Weber, 2008), whereas others have reported that the common consequence effect largely disappears when payoffs amount to just a few dollars (Fan, 2002). Direct tests on whether different magnitudes of outcome impact on the rate of classic preference reversals are lacking by comparison.

The evidence on whether outcome magnitude affects the common consequence effect and classic preference reversals is therefore a little mixed, where it does exist at all. Given the growing interest in the findings of behavioural economics in the policy discourse internationally over the past decade, it seems reasonable to investigate further the extent to which these two foundational behavioural economic findings are invariant to outcome size, an investigation that becomes ever more pertinent if attention is paid to outcome domains that are not confined to money. In health economics, for instance, the assumptions of economic rationality underpin many of the instruments that are used to value health states that are in turn used in many countries to determine whether health care interventions represent good value for money. Although there is some direct tests of the common consequence effect and classic preferences reversals using health-related outcomes (e.g. Oliver, 2003; 2006), the robustness of these phenomena in the face of varying health outcome magnitudes has not been studied at all.

This article aims to test with a within-respondent design the extent to which the common consequence effect and preference reversals are observed over different outcome magnitudes. Five separate studies are reported, which use a variety of outcome types to reflect to a degree the influence that behavioural economics is having on the broad policy discourse. Although the tests reported are laboratory-based and necessarily somewhat abstract, an attempt is made to broaden the framing of the questions beyond traditional decontextualized lotteries by using quasi-realistic decision contexts, with the objective of observing whether the general findings are independent of context type.

Financial investment scenarios

To test whether the common consequence effect and classic preference reversals appear to be susceptible to outcome size in an entirely within-respondent design over hypothetical financial investments, a convenience sample of 60 social science postgraduate students of various nationalities each attended an individual face-to-face interview.[3] In this and all of the other studies reported in this article, the decision tasks used were explained thoroughly to the respondents at the beginning of their interviews. At the same time, respondents engaged in warm up exercises that exposed them to questions similar in structure to those that they later answered and during which they could ask questions of the interviewer. This was done to attempt to ensure that the respondents fully understood what was being asked of them and it was felt by the authors that face-to-face interviews were the best way to achieve this objective. At the end of the warm up periods, all respondents appeared to understand the tasks. Forty-five of the respondents were female, 44 had studied economics, and 32 stated that they generally like taking risks.

Methods

Respondents were recruited via an email message that invited staff and students at a university to participate in the experiment. In relation to the tests reported here, the respondents answered 15 questions. The order of all of the questions to which the respondents were exposed was randomised (and differed across the respondents); 6 questions tested for the common consequence effect and 9 tested for classic preference reversals. Two of the former questions and three of the latter are replicated in Table 2.

[3] With a within-respondent design there is a danger that respondents will demonstrate artificially high consistencies across decision tasks. The counterargument is that any observed systematic inconsistency with the standard model of rational choice is likely to be particularly robust if a within-respondent design is used (Hershey and Schoemaker, 1980).

[Insert Table 2]

Questions 1 and 2 in Table 2 essentially replicate respectively the choices between A and B and A' and B' in Table 1 (i.e. with outcomes and probabilities that mirror Allais' original exposition), but, as aforementioned, rather than presenting respondents with simple abstract lotteries, the options are described as hypothetical quasi-realistic investments.[4] Question 3 is a direct pairwise choice between an investment that offers a large chance of a relatively small amount – a *P-bet* – and one that offers a smaller chance of a larger amount – a *$-bet*. Questions 4 and 5 were designed to elicit the respondents' monetary values of the *P-bet* and the *$-bet*, respectively. In this and all other studies reported in this article, the outcomes in the tests of preferences reversals were chosen to be commensurate with the ones used in the tests of the common consequence effect. In an attempt to avoid respondent overvaluations of the investments, the Becker-DeGroot-Marschak (BDM) method was used (Becker *et al.*, 1964). For example, to approximate a certainty equivalent for the *P-bet* in question 4, the respondents were prompted to state the minimum amount for which they would sell the investment, say, £x. Once they had decided upon £x, a number between zero and the largest possible outcome of the investment – in this

[4] A difference between these investment questions and those typically asked in tests of the common consequence effect and preference reversals is that here the respondents were endowed with one of the options in each question. The reason for endowing one of the options was that inheriting an investment is realistically plausible, and, for the binary choice questions, the authors did not want to complicate or confound the questions by requiring the respondents to think explicitly about how much they would be willing to pay for the investments (which, to maintain an element of realism, would seem unavoidable, unless one simply asked the respondents which investments they would ideally prefer to own or inherit). According to independence and procedural invariance, violations of expected utility theory should still not occur when the questions are framed in this way, but it is possible that an endowment effect may have caused the respondents to favour the inherited options in the first three questions in Table 2 more than they otherwise would have done. The findings, however, revealed that very few respondents expressed a preference pattern that was consistent with a strong preference for the inherited options in the common consequence test, and although the inherited option was indeed the *P-bet* in the binary choice task in the test of preference reversals, the rate of predicted preference reversals was consistent with those reported in the literature in general, and with the other studies reported later in this article, none of which endowed any of the options.

case, £1 million – was obtained through a random number generator app. If the random number was equal to or greater than £x, the respondent would sell the investment for the price indicated by the random number. If the random number was less than £x, the respondent would be required to keep the investment. For most people, perhaps, the BDM method is not immediately obvious to understand, but the mechanism was carefully explained to the respondents during the interview, and all of them appeared to grasp that it was in their own best interests to state the minimum amounts at which they would indeed sell the investments.

The respondents were informed at the beginning of their interviews that the investments that they chose/were required to keep would be played out when they had answered all of the questions. However, the respondents' payments were not based on their answers to the 15 questions used in this study; rather, payments were based on their answers to 30 additional questions that they were required to answer during their interviews (for which they earned an average of approximately £7.50) that are not relevant to the tests reported here. Therefore, the tests reported here were not financially incentivised.

The questions in Table 2 facilitated tests over large outcomes in the millions of £ sterling. Similar tests were undertaken over moderate outcomes where all outcomes in Table 2 were divided by 100, such that, in relation to question 1, the choice presented to the respondents was between £10,000 for certain or a 10% chance of £50,000, an 89% chance of £10,000 and a 1% chance of nothing. Small outcome questions were obtained by scaling down the moderate outcomes by a further factor of 100. The 15 questions and the results associated with each of them are summarised in Table 3.[5]

[5] As earlier indicated, the 15 questions relevant to the tests of the common consequence effect and preference reversals reported here were embedded in a series of 45 questions in total. The other 30 questions were also presented as investment-related decisions that each involved a percentage chance of gaining or losing a particular money amount, the results of which test different phenomena and will be reported elsewhere. All 45 questions are reproduced in Appendix A. Since the experiment was conducted via face-to-face interview, the task and specific meaning of the questions were not described in a written script, but were delivered to each respondent verbally.

Results

[Insert Table 3]

The results of the common consequence effect tests are given in the top half of Table 3. The column headed AA' lists the percentage of respondents who chose A over B and A' over B' in tests using large, moderate and small outcomes, where each gamble is summarised in the first column of the table. BB', AB' and BA' can be read similarly. For large outcomes, 38% of the respondents violated independence (i.e. AB' + BA') in the common consequence test, and these violations were systemically and significantly in the direction of AB', consistent with Allais ($p < 0.001$ using the χ^2 statistic).[6] The rate at which overall violations of a postulate of economic theory is deemed problematic is a judgement call, but violations that are systematically unidirectional (e.g. AB' rather than BA') suggest that they cannot be attributed to random error. For moderate outcomes, 33% of the respondents violated independence, and these were again systematically and significantly in the direction predicted by Allais ($p < 0.05$), but only 15% of the respondents violated independence over small outcomes. Moreover, the difference between the AB' and BA' preference patterns was not statistically significant and may thus be attributed to random error. The difference in the rate of Allais-consistent patterns between the large and moderate outcome questions was not statistically significant, but it was between large and small outcomes ($p < 0.01$) and between moderate and small outcomes ($p < 0.005$).

The tests of classic preference reversals, presented in the bottom half of the table, tell a different story. The column headed PP lists the percentage of respondents who chose the *P-bet* in direct pairwise choice (question 3 in Table 2) and who also valued the *P-bet* higher than the *$-bet* in the valuation tasks. $$, P$ and $P can be read similarly. The rates of preference reversal were modally, systematically and

[6] Conlisk (1989) tests whether violations of independence in the common consequence test are random or are systematically in the direction predicted by Allais by developing a test statistic that has a standard normal distribution. The χ^2 statistic can also be used to test whether violations of rational choice theory are significantly systematically unidirectional. Both tests yield the same conclusions in this article where, throughout, the reported p-values relate to χ^2 tests.

significantly in the direction of respondents choosing the *P-bet* in pairwise choice but valuing the *$-bet* higher (i.e. P$) across all outcome magnitudes (P$ > $P at $p < 0.001$ across all three outcome magnitudes). The violation rate did not differ significantly across outcome magnitude.

In summary, then, the common consequence effect, compared to preference reversals, were relatively inconsequential and dissipated with outcome size. This prompts the question of whether similar observations are found in further money-related quasi-realistic contexts. Since rational choice theory is generally assumed to hold in the economic theory of suit and settlement (see, e.g., Guthrie, 2003), we therefore conducted a similar study using a litigation frame.

Litigation scenarios

The respondents were 60 postgraduate students, research and administrative staff of various nationalities, who each attended an individual face-to-face interview. Thirty-eight of the respondents were female, 29 had studied economics, 31 stated that they generally like taking risks, and 54 said that they were either somewhat or very good with numbers.

Methods

Respondents were again recruited for face-to-face interview via an email invitation sent to a university's staff and students. During the interview, they answered 15 questions to test for the common consequence effect and classic preference reversals over large, moderate and small outcomes. The question order was randomised across the respondents. The respondents were asked to assume the role of a plaintiff in a civil law suit, and were required to make decisions after considering the possible monetary consequences of different strategies that they might pursue in the cases they faced. The questions used to test these phenomena over the large outcomes are given in Table 4. The outcomes are defined in terms of money but the questions were not

financially incentivised. The respondents were merely incentivised to participate, by being paid a flat fee of £5.

[Insert Table 4]

Questions 1 and 2 in Table 4 test for the common consequence effect. Question 3 is a direct pairwise choice between a *P-bet* and a *$-bet*, and Questions 4 and 5, by eliciting the minimum amount of money that the respondents would prefer to settle on rather than face a decision from a jury were used to approximate their certainty equivalents of the *P-bet* and the *$-bet*, respectively. The large, moderate and small money outcomes used in the tests are summarised with the results in Table 5.[7]

Results

[Insert Table 5]

In the litigation tests, the large outcome questions gave a total independence violation rate of 32%, significantly in the direction of those predicted by Allais ($p < 0.05$). The total violation rate was 27% with moderate outcomes and 28% with small outcomes, but neither of these were significantly in the direction of Allais-type choices. Predicted preference reversals, on the others hand, were again the modal pattern, and systematically significant at $p < 0.001$ in all cases.

Overall, the results of the investment and litigation-related decisions suggest that classic preference reversals are a more robust phenomenon than the common consequence effect, and are not dependent on outcome magnitude. However, the questions in these studies were not financially incentivised, and a concern may be that the lack of incentives affected the results. Therefore, an incentivised study that tests the robustness of the common consequence effect and preference reversal over varying outcome magnitudes was designed and conducted.

[7] The full set of litigation questions are presented in Appendix B.

Loyalty points scenarios

A convenience sample of 80 postgraduate students, research and administrative staff of various nationalities – a different sample of respondents to those who participated in either of the studies reported above – each attended an individual face-to-face interview. Forty-seven of the respondents were female, 59 had studied economics, 35 stated that they generally like taking risks and 74 indicated that they are either somewhat or very good with numbers.

Methods

The respondents were recruited for face-to-face interview via an email invitation sent to a university's staff and students. At the beginning of each interview, the respondents were asked to imagine that they are collecting shopping-related loyalty points that could be exchanged directly for money. They faced a series of questions where they could earn additional loyalty points as a reward from the loyalty card company for their membership. The questions were designed so that the common consequence effect and classic preference reversals were tested over large, moderate and small loyalty point outcome magnitudes, and the question order was randomised differently for each respondent. Each question was financially incentivised.[8] The mean time taken to answer the 15 questions posed in this study was 7:58 minutes

[8] A disadvantage of financially incentivising every question is that it may cause a respondent's answer to any particular question to be dependent on their answers to other questions. During the warm up session, it was emphasised to the respondents that they should treat each question entirely independently from their answers to the other questions – i.e. as though each question was the only one they were answering. The respondents appeared to understand this instruction, although one still cannot rule out the possibility that for some respondents their answers were not independent across questions. An alternative way of conducting the experiment to avoid this possible problem would have been to inform the respondents that one of the questions would be randomly selected at the end of the experiment to be played out for real. The danger there though is that with fifteen questions in total, the respondents may have down-played the possibility of any one of them being selected and thus treated all of them as non-incentivised.

(median 7:42 minutes), and the mean total earnings were £7.16 (median £7.27).[9] The questions used to test the common consequence effect and preference reversals over large outcomes are replicated in Table 6.[10]

[Insert Table 6]

Questions 1 and 2 in Table 6 are the two choice contexts required to test the common consequence effect. Question 3 is a direct pairwise choice between a loyalty point-related *P-bet* and a *$-bet*. Questions 4 and 5 were used to approximate the respondents' loyalty point certainty equivalents of the *P-bet* and the *$-bet*, respectively; the BDM procedure was again used in these valuation tasks. Similar tests were undertaken over more moderate outcomes where loyalty points in the tens of thousands were available, and over small outcomes defined in the thousands of points.

The process for determining payments was transparent to the respondents. They were informed at the beginning of their interviews that in order to determine their payments the options that they ended up with in each question would be played out for real after they had answered all of the questions, and it was explained to them how this would work. For example, if they chose option A in question 1 in Table 6, they would receive a sure 100,000 loyalty points (and hence £1.50, since each loyalty point was worth 0.0015 pence) from that question. If they chose option B, on the other hand, an app would be used to generate a random number between 1 and 100. If the number generated was between 1 and 10 (i.e. a 10% chance), the respondent would receive 300,000 points (i.e. £4.50), if it was between 11 and 99 (i.e. an 89% chance), the respondent would receive 100,000 points (i.e. £1.50) and if it came out at 100 (i.e. a 1% chance) the respondent would receive no points from that question.

[9] This was the only study reported in this article where the time taken for the respondents to complete the questions was recorded. However, the respondents did not take more than 15 minutes to answer all of the questions that tested for the common consequence effect and preference reversals in each of the studies.

[10] The full set of questions used in this study are given in Appendix C.

The process to determine the payments was similar but slightly different in the questions used to elicit certainty equivalents in the tests of preference reversal. For example, take question 4 in Table 6. Respondents were encouraged to state the lowest number of points received with certainty that they would require for them to prefer option B over option A. An app was then used to generate a random number between 1 and the highest number of points attainable from option A (i.e. 100,000 points in this question). If the generated number was less than that stated by the respondent, s/he would be required to play the lottery in option A, which was processed in a manner similar to that described in the previous paragraph. However, if the generated number was greater than that stated by the respondent, s/he would receive the generated number of loyalty points for sure. For instance, had the respondent stated that they would require a minimum of 80,000 loyalty points from B in order to prefer B over A and the random number generated was 70,000, the respondent would be required to play out the lottery in option A and would be paid accordingly. If the random number generated had been 90,000 points, on the other hand, then the respondent would receive those points – and hence £1.35 – from that question.

The specific number of loyalty points offered in all tests are summarised with the results in Table 7.

Results

[Insert Table 7]

In these tests, the total independence violation rate was 22%, 27% and 19% for the large, moderate and small outcomes, respectively. The patterns of violation were over all three magnitudes significantly in the direction predicted by Allais (at, respectively, $p < 0.01$, $p < 0.05$ and $p < 0.005$), but irrespective of outcome magnitude, the rates of AB' preference patterns were not substantial. It could be contended that the rate of Allais-predicted patterns was low across all loyalty point outcome magnitudes because the financial incentives on offer were small, but the impression given by all but a couple of the respondents when they were answering the questions was that they were processing them in relation to the number of loyalty points on offer, rather than

in relation to the exact financial implications of those points. Either way, the financial incentive for each point on offer necessarily had to be small given that the experiment design called for small, moderate and large outcome domains.[11] Moreover, in the large outcome domain, the possible financial rewards ran to several £ sterling per question, which, as noted earlier, is a money magnitude over which others have observed substantial violations of independence.

Systematic predicted preference reversals were again a much more robust behavioural phenomenon. Preference pattern P$ was observed at very similar rates to those in the investment-related tests. As before, this predicted pattern was modally, systematically and significantly observed over all outcome magnitudes ($p < 0.001$ in all cases), and did not vary significantly with outcome magnitude.

As earlier noted, the assumptions of economic rationality underpin many aspects of public policy analysis, including those used in health care evaluation. Therefore, tests similar to those reported above but using health-related outcomes were also undertaken.

Health care treatment scenarios

A convenience sample of 120 postgraduate students, research and administrative staff of various nationalities each attended an individual face-to-face interview. Seventy-six of the respondents were female, 57 had studied economics, and 60 stated that they generally like taking risks.

Methods

Respondents were recruited for face-to-face interview via an email invitation sent to a university's staff and students; the respondents were not those who participated in any

[11] In general, the financial incentives in these tests, working out at an average payment of approximately £1 for each minute of a respondent's time, were a good rate for a study of this kind.

of the studies reported above. Given the nature of the outcomes used in these tests, the questions were not incentivised and the respondents' answers were not played out at the end of their interviews. The respondents were paid a flat fee of £5 to answer 15 questions to test for the common consequence effect and classic preference reversals over large, moderate and small outcomes, and the question order was randomised differently for each respondent. The questions used to test these phenomena over large outcomes are replicated in Table 8.[12]

[Insert Table 8]

Questions 1 and 2 in Table 8 are the two choice contexts required to test the common consequence effect. Question 3 is a direct pairwise choice between a health care-related *P-bet* and a *$-bet* where all outcomes are defined in terms of longevity. Questions 4 and 5 were used to approximate the respondents' longevity-defined certainty equivalents of the *P-bet* and the *$-bet*, respectively. The respondents were informed that they should assume that in all questions the lengths of time offered by the treatment options would be experienced in full health, so as to simplify their tasks somewhat. As noted, Table 8 presents the questions over large outcomes; similar tests were undertaken over more moderate outcomes where a smaller number of years were offered from treatment, and over small outcomes defined as only a matter of months. The specific number of years and months offered in all tests are summarised with the results in Table 9.[13]

[12] The questions in these health care scenarios are not intended to be structurally identical to those reported earlier. In the investment questions, as noted earlier, the respondents, via inheritance, are essentially endowed with the first investment in each question, whereas in the health care-related questions the respondents are required to choose or value a treatment from the position of having no treatment at all (there were no endowments in the litigation or loyalty points studies either). Also, the investment and loyalty points questions used the BDM procedure; the health care and litigation questions did not. The important point to note is that the common consequence effect and classic preference reversals should not be observed in the investment, litigation, loyalty point or health care scenarios, if the assumptions of economic rationality hold. Similarly patterned violations across differently constructed methods, if anything, adds to the robustness of the results.

[13] The full set of health care questions are presented in Appendix D.

Results

[Insert Table 9]

In these health-related tests with outcomes defined by longevity, very similar to the loyalty point-related tests, the large outcome questions gave a total independence violation rate of 24%, which may be deemed as not particularly problematic, but they were significantly in the direction of those predicted by Allais ($p < 0.01$). The total violation rate was only 15% with moderate outcomes, which was marginally less than the 18% with small outcomes, but the former were significantly Allais-type choices ($p < 0.025$) while the latter were not. Given the relatively low number of AB' preference patterns in all tests, Allais-predicted choices did not vary significantly with outcome magnitude. Even though the violations were significantly in the direction of those predicted by Allais for the moderate and large outcomes, their general lack of prevalence makes it difficult to conclude that they are particularly meaningful over any of these outcome magnitudes.

For preference reversals it was again a different story compared to the tests of the common consequence effect. The predicted P$ preference pattern was modally, systematically and significantly observed over all outcome magnitudes ($p < 0.001$ in all cases), and did not vary significantly with outcome magnitude. Again, classic preference reversals were in these tests a more robust phenomenon than the common consequence effect.

Using another respondent group the authors undertook a final study where the questions where framed around risky military decision-making, with the outcomes defined in terms of captured enemy soldiers.

Military decision-making scenarios

The respondents were 60 postgraduate students, research and administrative staff of various nationalities, who each attended an individual face-to-face interview. Thirty-eight of the respondents were female, 29 had studied economics, 29 stated that they

generally like taking risks, and 58 said that they were either somewhat or very good with numbers.

Methods

Respondents were again recruited for face-to-face interview via an email invitation sent to a university's staff and students, and, as with the studies reported above, they answered 15 questions to test for the common consequence effect and classic preference reversals over large, moderate and small outcomes. The question order was randomised across the respondents. The questions used to test these phenomena over the large outcomes are presented in Table 10. The respondents were paid a flat fee of £5 for their participation.

[Insert Table 10]

Questions 1 and 2 in Table 10 test for the common consequence effect. Question 3 is a direct pairwise choice between a *P-bet* and a *$-bet*, and Questions 4 and 5, by eliciting the minimum number of enemy soldiers that the respondents would need to capture for certain instead of pursuing a riskier strategy, were used to approximate their certainty equivalents of the *P-bet* and the *$-bet*, respectively. The specific large moderate and small money outcomes in the tests are summarised with the results in Table 11.[14]

Results

[Insert Table 11]

As can be discerned from the table, the large, moderate and small outcome questions gave total independence violation rates of 19%, 22% and 16%, respectively, but none of these were significantly in the direction predicted by Allais. Therefore, the

[14] The full set of military questions are given in Appendix E.

violations, which were quite infrequent, can be attributed to random error around answers that were on the whole consistent with rational choice theory. It may have been the case that the heavy weight attached to certainty that drives the common consequence effect was weakened by respondents believing, erroneously or otherwise, that risk-taking is a necessary strategy in order to win battles and shorten conflicts. Before concluding that people tend towards rationality when adopting that mindset, however, it is evident that preference reversals were once again modal and systematically significant at $p < 0.001$.

Individual-level comparisons

When one examines the individual-level results, it is clear that many respondents demonstrated the common consequence effect and preference reversals across some, but not all, outcome magnitudes. For instance, consider Table 12. The first numerical column in the table gives the percentage of the respondents who exhibited each of the behavioural phenomena assessed in this article in each study. For example, in the study of financial investments, 42% and 77% of the respondents respectively answered according to the common consequence effect and predicted preference reversals for at least one outcome magnitude. The next three columns give the percentages of respondents who respectively violated rational choice theory at only one, at two and at all three outcome magnitudes in each study. For instance, of the 42% of respondents who demonstrated the common consequence effect in the financial investment questions, 48%, 40% and 12% answered in such a way over one, two and all three outcome magnitudes, respectively. The results highlight that for both behavioural phenomena – particularly for the common consequence effect – it tends to be relatively rare for a respondent who violates rational choice theory to consistently violate the theory at every opportunity.

[Insert Table 12]

The fifth numerical column in Table 12 gives the percentage of those respondents who violated only once who violated over the lowest magnitude outcome in each study. For example, 8% of the respondents who demonstrated the common

consequence effect only once in the study of financial investments showed this effect over the lowest outcome magnitude. The final column gives the percentage of those respondents who violated twice who violated over the low and moderate outcome magnitudes. If the respondents randomly violated over outcome magnitude, the percentages in the final two columns of the table should be 33%. The only consistent patterns in this respect is that the percentages tended to be consistently less than 33% in the fifth numerical column for the common consequence effect, meaning that the frequency of this effect was less than randomness would predict over the lowest outcome magnitude (as implied from the results presented earlier), and that those who demonstrated preference reversals over two outcome magnitudes had a slight tendency to do this over the low and moderate outcome magnitudes.

The first column of Table 13 gives the percentage of respondents who violated rational choice theory (via the common consequence effect or predicted preference reversal) at least once in each study reported in this article; as can be seen, at most only 20% of respondents never exhibited these behavioural phenomena. The second and third numerical columns in the table show that – other than in the military decision contexts where the common consequence effect was very rare – those who did not demonstrate the common consequence effect were as likely to predictably preference reverse as those who did, suggesting that the observation of these effects are independent of each other.

[Insert Table 13]

Discussion

The results of the tests reported in this article, summarised in Table 14, are broadly consistent. Namely, they demonstrate that although a systematic common consequence effect was in most cases insubstantial, they were lowest with the smallest outcome magnitude (perhaps offering some support for Markowitz's (1952) prediction that people will be relatively more risk-seeking over small outcomes), whereas systematic predicted preference reversals were everywhere the modal pattern. Of course, this does not negate the possible importance of the common consequence

effect using large, moderate and even small outcomes in some circumstances, since others have observed evidence for it using money outcomes as outlined in the introduction.

[Insert Table 14]

Some may contend that when there is a low ratio between the middle and highest outcomes in A and B in the common consequence questions, violations of independence will be likely irrespective of outcome magnitude. For example, consider A and B in the small health outcome gambles in Table 9: respectively, (10mths, 1) and (30mths, 0.1; 10mths, 0.89; 0, 0.01). The ratio between the middling outcome in A and the highest outcome in B is 1:3, which may be wide enough to prompt relative risk seeking behaviour by many respondents. If the highest outcome was instead 20 months, giving a ratio of 1:2, more violations of independence may well have been observed. Indeed, Oliver (2003), using outcomes of 12 years and 18 years and thus a ratio of 1:1.5 observed a 52.6% independence violation rate, contrasting with the 15% observed using similarly moderate health outcomes in this article (see Table 9). However, manipulating the ratios in order to isolate the common consequence effect suggests that one has to search for this effect somewhat, particularly in small outcome questions, whereas preference reversals appear difficult to avoid.[15]

Where it is observed, several explanations have been offered for the common consequence effect. There are those who disagree that the effect is principally a violation of independence. For instance, Birnbaum (2004) attributes the common consequence effect to violations of coalescing; that is, when the options are presented in a non-collapsed form, people are unable to unpack them and thus fail to recognise that they contain common outcomes with an equal chance of occurring. However, although Keller (1985), using money outcomes, found that the common consequence effect was lessened – but not eliminated – when the options were presented in a split form similar to those presented in Table 1, Oliver (2003), using collapsed health outcomes, observed an effect size that was greater than those reported in this article.

[15] The results across all five of the studies referred to in this article were similar, yet used ratios that varied between 1:2.5 and 1:5.

Given this, it seems likely that at least some observations of the common consequence effect are attributable to violations of independence, and that the most widely accepted explanation for this violation of rational choice theory – namely, the certainty effect, where it is suggested that some people overweight outcomes that are considered certain relative to those that are merely probable (Kahneman and Tversky, 1979) – should not be dismissed.

The results reported in this article suggest that preference reversals are a more general and robust problem. Like the common consequence effect, several explanations have been proposed for this phenomenon. Mellers *et al*. (1992), for instance, attribute preference reversals to change-of-process theory; specifically, the proposition that people combine the probabilities and payoffs additively in the choice task but multiplicatively in the valuation task. Seidl (2002) summarises several alternative possible explanations. He notes that it is sometimes claimed that the endowment effect will often cause people to overstate their selling prices, and thus preference reversals may be a peculiar feature of selling price elicitation. However, Seidl cites a number of studies where significant predicted preference reversals occur when certainty equivalents are elicited via buying prices. A further explanation is that people possess an intransitive preference ordering, although studies demonstrate that this is a relatively minor cause of the phenomenon (Loomes and Pogrebna, 2016; Tversky *et al.*, 1990).

Possibly the most respected explanation for preference reversals currently is that which attributes most of the phenomenon to respondents using different heuristics, or rules of thumb, across preference elicitation modes. That is, choice tasks might focus attention on the probabilities, which favours the *P-bet*, while valuation tasks may tend to focus attention on the payoffs, which favours the *$-bet*. That people may focus on the payoffs in the valuation tasks is known as scale compatibility; for example, respondents are drawn to the money outcomes when asked for monetary valuations, a phenomenon that is of import elsewhere, such as in relation to the time trade-off method that is used in order to elicit numerical values for health states to be used as inputs into quality-adjusted life years, where the scale of preference – in that case, life years – may draw undue attention to the length of life rather than the quality of the health state. Relatedly, Bateman *et al.* (2007), among others, have argued that the *$-*

bet tends to be valued higher than the *P-bet* because, as a starting point when valuing the *$-bet*, people often anchor on its best outcome, but then fail to adjust the overall value of this bet downwards sufficiently to take account of its other attributes.[16]

If this explanation is valid in relation to the preference reversals reported here, then there is a case for arguing that direct valuation methods, such as willingness to pay, may produce upwardly biased valuations of policy interventions, particularly those that offer the chance, however meagre, of substantial benefit.[17] However, other elicitation procedures that rely on, for example, pairwise choice or ranking exercises may fair no better, because the value that people attach to any one of two or more options presented to them will often not be independent of each other. As indicated by the now longstanding range frequency effect (Parducci and Weddell, 1986), for example, people will invariably rate an option higher when it is compared to worse options than when it is compared to better options, which places a question mark against the validity of results obtained from visual analogue and other rating scales, and it is well known that introducing a supposedly irrelevant decoy option to an a priori binary choice set can influence people's preference between the two original goods in the set. If valuations and preferences can be manipulated so readily, then there is a concern that assessments of goods – particularly unfamiliar goods (including many public policy interventions) – may not be driven by intrinsic evaluations of the goods themselves, but rather by the framing of the preference/valuation elicitation question.

The tests reported in this article admittedly use relatively small sample sizes, and, at least in terms of the common consequence effect, the results contrast with some of those reported elsewhere in the literature. However, there are five studies reported in total, that used different respondents, structures, outcomes, probabilities, incentivisation procedures and domains of decision-making, and their testing of both

[16] Following Slovic *et al.* (1990), Loomes and Pogrebna (2016) report evidence that supports the conjecture that classic preference reversals are explained primarily by respondents overvaluing the *$-bet*s in valuation tasks. However, their evidence does not support a general simple anchoring and insufficient adjustment heuristic that applies both to the *$-bets* and to the *P-bets*.

[17] For similar reasons, Kahneman and Sugden (2005) also recommend against the use of willingness to pay in policy evaluation.

the common consequence effect and classic preference reversals in a within-respondent design is rare. That there are five broadly-defined repeat studies strengthens markedly the generally similar findings that the studies convey (Maniadis et al., 2014; Rubinstein, 2012); that preference reversals are a more robust finding than the common consequence effect over varying outcome magnitudes. The former finding alone, however, is enough to suggest that the results of stated preference techniques, irrespective of outcome size, should not be as readily accepted at face value as they often are at the practical policy making level.

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Figure 1
Markowitz utility curve over gains

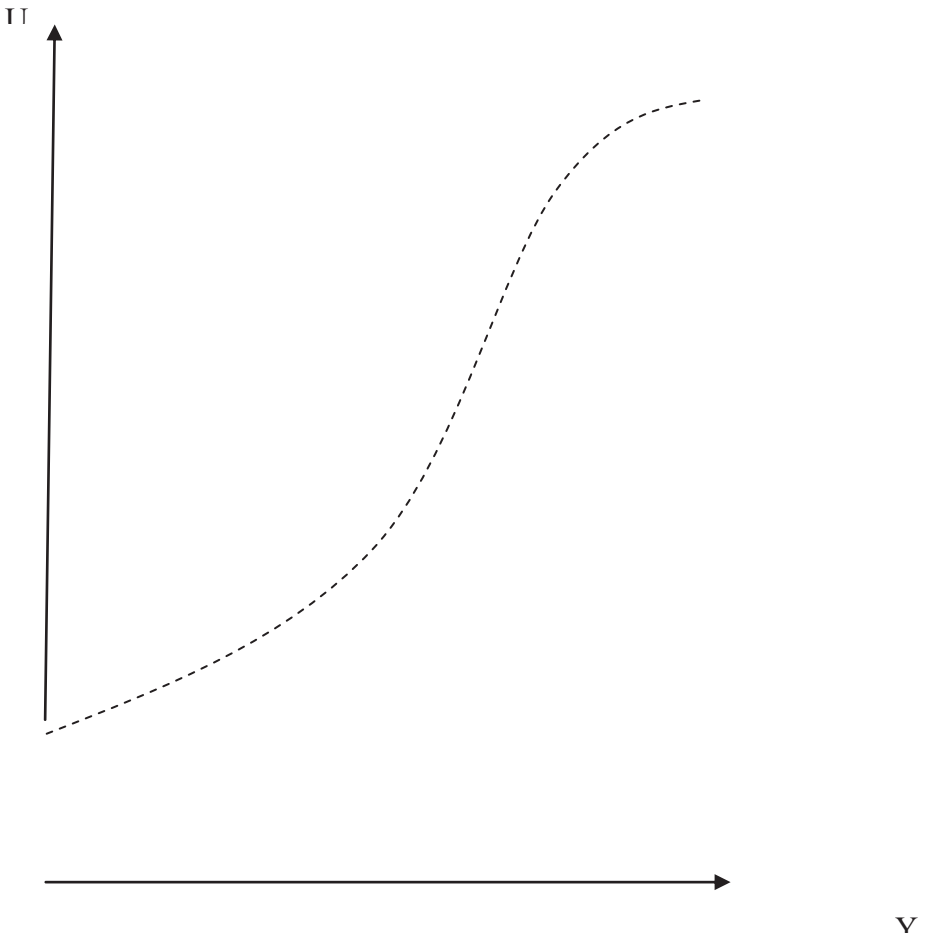

Table 1
Allais-type options

Probability:	0.89	0.10	0.01
Gamble A	$1m	$1m	$1m
Gamble B	$1m	$5m	$0
Gamble A'	$0	$1m	$1m
Gamble B'	$0	$5m	$0

Table 2
Financial investment questions

Common consequence effect

Question 1: You inherited an investment and you can, if you wish, cash it in for £1,000,000. Another investor has offered to swap your investment for one that offers a 10% chance of £5,000,000, an 89% of £1,000,000, and a 1% chance of nothing. Do you accept his offer?

Question 2: You inherited an investment and there is an 11% chance that you could gain £1,000,000, with an 89% chance of gaining or losing nothing. Another investor has offered to swap your investment for one that offers a 10% chance of £5,000,000, with a 90% chance of gaining or losing nothing. Do you accept his offer?

Preference reversals

Question 3: You inherited an investment and there is an 80% chance that you could gain £1,000,000, with a 20% chance of gaining or losing nothing. Another investor has offered to swap your investment for one that offers a 20% chance of £4,000,000, with an 80% of nothing. Do you accept his offer?

Question 4: You inherited an investment and there is an 80% chance that you could gain £1,000,000, with a 20% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

Question 5: You inherited an investment and there is a 20% chance that you could gain £4,000,000, with an 80% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

Table 3
Financial investment results

Common consequence effect	N	AA'	BB'	AB'	BA'	Signif. predicted Allais paradoxes
Large outcomes: A: (£1m, 1) or B: (£5m, 0.1; £1m, 0.89; 0, 0.01) A': (£1m, 0.11; 0, 0.89) or B': (£5m, 0.1; 0, 0.9)	60	5%	57%	33%	5%	Yes, at $p < 0.001$
Moderate outcomes: A: (£10k, 1) or B: (£50k, 0.1; £10k, 0.89; 0, 0.01) A': (£10k, 0.11; 0, 0.89) or B': (£50k, 0.1; 0, 0.9)	60	3%	63%	25%	8%	Yes, at $p < 0.05$
Small outcomes: A: (£100, 1) or B: (£500, 0.1; £100, 0.89; 0, 0.01) A': (£100, 0.11; 0, 0.89) or B': (£500, 0.1; 0, 0.9)	60	2%	83%	10%	5%	No
Preference reversals	N	PP	$$	P$	$P	Signif. predicted preference reversals
Large outcomes: *P-bet*: (£1m, 0.8; 0, 0.2); *$-bet*: (£4m, 0.2; 0, 0.8)	51	37%	6%	55%	2%	Yes, at $p < 0.001$
Moderate outcomes: *P-bet*: (£10k, 0.8; 0, 0.2); *$-bet*: (£40k, 0.2; 0, 0.8)	50	24%	10%	64%	2%	Yes, at $p < 0.001$
Small outcomes: *P-bet*: (£100, 0.8; 0, 0.2); *$-bet*: (£400, 0.2; 0, 0.8)	51	24%	20%	51%	6%	Yes, at $p < 0.001$

Notes: In the tests of the common consequence effect, the column headed AA' lists the percentage of respondents who chose A over B and A' over B'. BB', AB' and BA' can be read similarly. In the tests of preference reversals, the column headed PP lists the percentage of respondents who chose the *P-bet* in direct pairwise choice and who also valued the *P-bet* higher than the *$-bet* in the valuation tasks. $$, P$ and $P can be read similarly. The frequency of preference patterns AA', BB', AB', BA', PP, $$, P$ and $P are rounded to the nearest whole percentage point. In testing preference reversals, only the respondents who

demonstrated a strict preference for the *P-bet* or the *$-bet* in both the direct choice and valuation tasks are included in the analysis.

Table 4
Litigation questions

Common consequence effect

Question 1: You are a plaintiff in a civil law suit. Your lawyer has offered you two strategies. In strategy A you are certain to be awarded £200,000. In strategy B, there is an 80% chance of being awarded £200,000, a 17% chance of being awarded £700,000, and a 3% chance that you won't be awarded anything at all. Which strategy would you prefer to pursue?

Question 2: You are a plaintiff in a civil law suit. Your lawyer has offered you two strategies. In strategy A there is a 20% chance of being awarded £200,000 and an 80% chance of being awarded nothing. In strategy B, there is a 17% chance of being awarded £700,000 and an 83% chance of being awarded nothing. Which strategy would you prefer to pursue?

Preference reversals

Question 3: You are a plaintiff in a civil law suit. Your lawyer has offered you two different strategies. In strategy A there is a 75% chance of being awarded £200,000 and a 25% chance of being awarded nothing. In strategy B, there is a 21% chance of being awarded £700,000 and a 79% chance of being awarded nothing. Which strategy would you prefer to pursue?

Question 4: You are a plaintiff in a civil law suit. Your lawyer has told you that if you rely on the jury's decision, you have a 75% chance of being awarded £200,000 and a 25% chance of being awarded nothing. Rather than relying on the jury, you have indicated to the defendant that you might be willing to accept a settlement. What is the minimum amount of money you would require the defendant to pay you in order to avoid the jury's decision?

Question 5: You are a plaintiff in a civil law suit. Your lawyer has told you that if you rely on the jury's decision, you have a 21% chance of being awarded £700,000 and a 79% chance of being awarded nothing. Rather than relying on the jury, you have indicated to the defendant that you might be willing to accept a settlement. What is the minimum amount of money you would require the defendant to pay you in order to avoid the jury's decision?

Table 5
Litigation results

Common consequence effect	N	AA'	BB'	AB'	BA'	Signif. predicted Allais paradoxes
Large outcomes: A: (£200k, 1) or B: (£700k, 0.17; £200k, 0.8; 0, 0.03) A': (£200k, 0.2; 0, 0.8) or B': (£700k, 0.17; 0, 0.83)	60	8%	60%	25%	7%	Yes, at $p < 0.05$
Moderate outcomes: A: (£20k, 1) or B: (£70k, 0.17; £20k, 0.8; 0, 0.03) A': (£20k, 0.2; 0, 0.8) or B': (£70k, 0.17; 0, 0.83)	60	5%	68%	17%	10%	No
Small outcomes: A: (£2k, 1) or B: (£7k, 0.17; £2k, 0.8; 0, 0.03) A': (£2k, 0.2; 0, 0.8) or B': (£7k, 0.17; 0, 0.83)	60	2%	70%	15%	13%	No
Preference reversals	N	PP	$$	P$	$P	Signif. predicted preference reversals
Large outcomes: *P-bet*: (£200k, 0.75; 0, 0.25); *$-bet*: (£700k, 0.21; 0, 0.79)	54	28%	6%	65%	2%	Yes, at $p < 0.001$
Moderate outcomes: *P-bet*: (£20k, 0.75; 0, 0.25); *$-bet*: (£70k, 0.21; 0, 0.79)	54	17%	4%	80%	0%	Yes, at $p < 0.001$
Small outcomes: *P-bet*: (£2k, 0.75; 0, 0.25); *$-bet*: (£7k, 0.21; 0, 0.79)	58	17%	14%	67%	2%	Yes, at $p < 0.001$

Notes: In the tests of the common consequence effect, the column headed AA' lists the percentage of respondents who chose A over B and A' over B'. BB', AB' and BA' can be read similarly. In the tests of preference reversals, the column headed PP lists the percentage of respondents who chose the *P-bet* in direct

pairwise choice and who also valued the *P-bet* higher than the *$-bet* in the valuation tasks. $$, P$ and $P can be read similarly. The frequency of preference patterns are rounded to the nearest whole percentage point, and only those respondents who demonstrated a strict preference for the *P-bet* or the *$-bet* in both the direct choice and valuation tasks are included.

Table 6
Loyalty point questions

Written premise: You are collecting loyalty points that you will later be able to exchange for money. Each loyalty point is worth 0.0015 of a penny. Thus, the more points that you have the more money you will be able to claim. The loyalty card company has decided to reward you for your membership by offering you a series of choices where you can earn additional points. Please answer each question, either by circling whether you choose A or B or by stating a number if a question asks for it.

Common consequence effect

Question 1:
A: 100,000 points for sure.
B: 10% chance of 300,000 points, 89% chance of 100,000 points, 1% chance of 0 points.

Question 2:
A: 11% chance of 100,000 points, 89% chance of 0 points
B: 10% chance of 300,000 points, 90% chance of 0 points

Preference reversals

Question 3:
A: 78% chance of 100,000 points, 22% chance of 0 points
B: 26% chance of 300,000 points, 74% chance of 0 points

Question 4:
A: 78% chance of 100,000 points, 22% chance of 0 points
B: What is the minimum number of points that would be better than A?

Question 5:
A: 26% chance of 300,000 points, 74% chance of 0 points
B: What is the minimum number of points that would be better than A?

Table 7
Loyalty point results

Common consequence effect	N	AA'	BB'	AB'	BA'	Signif. predicted Allais paradoxes
Large outcomes: A: (100,000, 1) or B: (300,000, 0.1; 100,000, 0.89; 0, 0.01) A': (100,000, 0.11; 0, 0.89) or B': (300,000, 0.1; 0, 0.9)	80	3%	76%	18%	4%	Yes, at $p < 0.01$
Moderate outcomes: A: (10,000, 1) or B: (30,000, 0.1; 10,000, 0.89; 0, 0.01) A': (10,000, 0.11; 0, 0.89) or B': (30,000, 0.1; 0, 0.9)	80	0%	73%	21%	6%	Yes, at $p < 0.05$
Small outcomes: A: (1,000, 1) or B: (3,000, 0.1; 1,000, 0.89; 0, 0.01) A': (1,000, 0.11; 0, 0.89) or B': (3,000, 0.1; 0, 0.9)	80	1%	80%	16%	3%	Yes, at $p < 0.005$
Preference reversals	N	PP	$$	P$	$P	Signif. predicted Allais paradoxes
Large outcomes: *P-bet*: (100,000, 0.78; 0, 0.22); *$-bet*: (300,000, 0.26; 0, 0.74)	69	30%	13%	55%	1%	Yes, at $p < 0.001$
Moderate outcomes: *P-bet*: (10,000, 0.78; 0, 0.22); *$-bet*: (30,000, 0.26; 0, 0.74)	68	16%	12%	69%	3%	Yes, at $p < 0.001$
Small outcomes: *P-bet*: (1,000, 0.78; 0, 0.22); *$-bet*: (3,000, 0.26; 0, 0.74)	71	17%	20%	59%	4%	Yes, at $p < 0.001$

Notes: The outcomes are the number of additional loyalty points that can be gained from each option. In the tests of the common consequence effect, the column headed AA' lists the percentage of respondents who chose A over B and A' over B'. BB', AB' and BA' can be read similarly. In the tests of preference reversals, the column headed PP lists the percentage of respondents who chose the *P-bet* in direct pairwise choice and who also valued the *P-bet* higher than the *$-bet* in the valuation tasks. $$, P$ and $P can be read similarly. The frequency of preference patterns are rounded to the nearest whole percentage point, and only those respondents who demonstrated a strict preference for the *P-bet* or the *$-bet* in both the direct choice and valuation tasks are included.

Table 8
Health care treatment questions

Common consequence effect

Question 1: You have an illness which will kill you within the next few days unless you take a treatment. Two treatments are available to you. If you take treatment A, you will live for 10 more years for certain, and then you will die. Alternatively, treatment B offers a 10% chance of 30 more years, an 89% chance of 10 more years, but there is also a 1% chance that B will not work at all and that you will die within the next few days. Which treatment will you take?

Question 2: You have an illness which will kill you within the next few days unless you take a treatment. Two treatments are available to you. If you take treatment A, there is an 11% chance that you will live for 10 more years and then die, and an 89% chance that the treatment will not work and you will die within the next few days. Alternatively, treatment B offers a 10% chance of 30 more years with a 90% chance that it will not work at all and that you will die within the next few days. Which treatment will you take?

Preference reversals

Question 3: You have an illness which will kill you within the next few days unless you take a treatment. Two treatments are available to you. If you take treatment A, there is an 85% chance that you will live for 10 more years and then die, and a 15% chance that the treatment will not work and you will die within the next few days. Alternatively, treatment B offers a 28% chance of 30 more years with a 72% chance that it will not work at all and that you will die within the next few days. Which treatment will you take?

Question 4: You have an illness which will kill you within the next few days unless you take a treatment. Two treatments are available to you. If you take treatment A, there is an 85% chance that you will live for 10 more years and then die, and a 15% chance that the treatment will not work and you will die within the next few days. Alternatively, treatment B offers a number of years of life for certain, but we do not know exactly how many years that is. What is the minimum number of years you would require from treatment B in order for you to just prefer treatment B over treatment A?

Question 5: You have an illness which will kill you within the next few days unless you take a treatment. Two treatments are available to you. If you take treatment A, there is a 28% chance that you will live for 30 more years and then die, and a 72% chance that the treatment will not work and you will die within the next few days. Alternatively, treatment B offers a number of years of life for certain, but we do not know exactly how many years that is. What is the minimum number of years you would require from treatment B in order for you to just prefer treatment B over treatment A?

Table 9
Health care treatment results

Common consequence effect	N	AA'	BB'	AB'	BA'	Signif. predicted Allais paradoxes
Large outcomes: A: (10yrs, 1) or B: (30yrs, 0.1; 10yrs, 0.89; 0, 0.01) A': (10yrs, 0.11; 0, 0.89) or B': (30yrs, 0.1; 0, 0.90)	120	2%	75%	18%	6%	Yes, at $p < 0.01$
Moderate outcomes: A: (5yrs, 1) or B: (15yrs, 0.1; 5yrs, 0.89; 0, 0.01) A': (5yrs, 0.11; 0, 0.89) or B': (15yrs, 0.1; 0, 0.90)	120	3%	83%	12%	3%	Yes, at $p < 0.05$
Small outcomes: A: (10mths, 1) or B: (30mths, 0.1; 10mths, 0.89; 0, 0.01) A': (10mths, 0.11; 0, 0.89) or B': (30mths, 0.1; 0, 0.90)	120	1%	82%	11%	7%	No
Preference reversals	N	PP	$$	P$	$P	Signif. predicted preference reversal
Large outcomes: *P-bet*: (10yrs, 0.85; 0, 0.15); *$-bet*: (30yrs, 0.28; 0, 0.72)	105	19%	10%	69%	2%	Yes, at $p < 0.001$
Moderate outcomes: *P-bet*: (5yrs, 0.85; 0, 0.15); *$-bet*: (15yrs, 0.28; 0, 0.72)	104	13%	13%	73%	1%	Yes, at $p < 0.001$
Small outcomes: *P-bet*: (10mths, 0.85; 0, 0.15); *$-bet*: (30mths, 0.28; 0, 0.72)	110	9%	14%	78%	0%	Yes, at $p < 0.001$

Notes: In the tests of the common consequence effect, the column headed AA' lists the percentage of respondents who chose A over B and A' over B'. BB', AB' and BA' can be read similarly. In the tests of preference reversals, the column headed PP lists the percentage of respondents who chose the *P-bet* in direct

pairwise choice and who also valued the *P-bet* higher than the *$-bet* in the valuation tasks. $$, P$ and $P can be read similarly. The frequency of preference patterns are rounded to the nearest whole percentage point, and only those respondents who demonstrated a strict preference for the *P-bet* or the *$-bet* in both the direct choice and valuation tasks are included.

Table 10
Military questions

Common consequence effect

Question 1: You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, you are certain that you will capture 10,000 enemy soldiers. Following strategy B, there is a 25% that you will capture 25,000 soldiers, a 70% chance that you will capture 10,000 soldiers, and a 5% chance that you will not capture anyone. Which strategy would you prefer to pursue?

Question 2: You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, there is a 30% chance that you will capture 10,000 enemy soldiers and a 70% chance that you will not capture anyone. Following strategy B, there is a 25% that you will capture 25,000 soldiers, and a 75% chance that you will not capture anyone. Which strategy would you prefer to pursue?

Preference reversals

Question 3: You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, there is a 90% chance that you will capture 10,000 enemy soldiers and a 10% chance that you will not capture anyone. Following strategy B, there is a 36% that you will capture 25,000 soldiers, and a 64% chance that you will not capture anyone. Which strategy would you prefer to pursue?

Question 4: You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, there is a 90% chance of you capturing 10,000 enemy soldiers and a 10% chance that you will not capture anyone. Strategy B is less risky and will lead to you capturing a number of enemy soldiers for certain. What is the minimum number of soldiers you would need to capture following strategy B to tempt you to pursue B rather than A?

Question 5: You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, there is a 36% chance of you capturing 25,000 enemy soldiers and a 64% chance that you will not capture anyone. Strategy B is less risky and will lead to you capturing a number of enemy soldiers for certain. What is the minimum number of soldiers you would need to capture following strategy B to tempt you to pursue B rather than A?

Table 11
Military results

Common consequence effect	N	AA'	BB'	AB'	BA'	Signif. predicted Allais paradoxes
Large outcomes: A: (10,000, 1) or B: (25,000, 0.25; 10,000, 0.7; 0, 0.05) A': (10,000, 0.3; 0, 0.7) or B': (25,000, 0.25; 0, 0.75)	60	5%	77%	12%	7%	No
Moderate outcomes: A: (1,000, 1) or B: (2,500, 0.25; 1,000, 0.7; 0, 0.05) A': (1,000, 0.3; 0, 0.7) or B': (2,500, 0.25; 0, 0.75)	60	5%	73%	15%	7%	No
Small outcomes: A: (100, 1) or B: (250, 0.25; 100, 0.7; 0, 0.05) A': (100, 0.3; 0, 0.7) or B': (250, 0.25; 0, 0.75)	60	2%	82%	8%	8%	No
Preference reversals	N	PP	$$	P$	$P	Signif. predicted preference reversals
Large outcomes: *P-bet*: (10,000, 0.9; 0, 0.1); *$-bet*: (25,000, 0.36; 0, 0.64)	58	31%	9%	60%	0%	Yes, at $p < 0.001$
Moderate outcomes: *P-bet*: (1,000, 0.9; 0, 0.1); *$-bet*: (2,500, 0.36; 0, 0.64)	53	30%	9%	57%	4%	Yes, at $p < 0.001$
Small outcomes: *P-bet*: (100, 0.9; 0, 0.1); *$-bet*: (250, 0.36; 0, 0.64)	53	30%	11%	58%	0%	Yes, at $p < 0.001$

Notes: The outcomes are numbers of soldiers captured. In the tests of the common consequence effect, the column headed AA' lists the percentage of respondents who chose A over B and A' over B'. BB', AB' and BA' can be read similarly. In the tests of preference reversals, the column headed PP lists the

percentage of respondents who chose the *P-bet* in direct pairwise choice and who also valued the *P-bet* higher than the *$-bet* in the valuation tasks. $$, P$ and $P can be read similarly. The frequency of preference patterns are rounded to the nearest whole percentage point, and only those respondents who demonstrated a strict preference for the *P-bet* or the *$-bet* in both the direct choice and valuation tasks are included.

Table 12
Individual-level results: incidence of violations

	% of total who violated	1-time violators	2-time violators	3-time violators	1-timers who violate low magnitude	2-timers who violate low & moderate magnitudes
Common consequence effect						
Financial investments	42%	48%	40%	12%	8%	0%
Litigation	33%	50%	25%	25%	20%	40%
Loyalty points	28%	41%	18%	41%	22%	25%
Health care	30%	75%	17%	8%	30%	0%
Military	23%	64%	21%	14%	11%	66%
Preference reversals						
Financial investments	77%	47%	24%	30%	24%	45%
Litigation	85%	14%	45%	41%	43%	52%
Loyalty points	74%	29%	29%	42%	35%	47%
Health care	89%	27%	27%	46%	45%	45%
Military	80%	35%	29%	35%	29%	36%

Table 13
Individual-level results: incidence of dual violations

	% of respondents who violated at least once	Those with Allais patterns who preference reversed	Those without Allais patterns who preference reversed
Financial investments	88%	72%	80%
Litigation	88%	90%	83%
Loyalty points	80%	77%	72%
Health care	92%	94%	88%
Military	80%	100%	74%

Table 14
Rates of predicted violations of rational choice

	Common consequence effect			***Preference reversals***		
	Large	Moderate	Small	Large	Moderate	Small
Financial investments	33%	25%	10%	55%	64%	51%
Litigation	25%	17%	15%	65%	80%	67%
Loyalty points	18%	21%	16%	55%	69%	59%
Health care	18%	12%	11%	69%	73%	78%
Military	12%	15%	8%	60%	57%	58%

Appendix A
Full set of investment questions

The 15 questions used in this article

You inherited an investment and you can, if you wish, cash it in for £1,000,000. Another investor has offered to swap your investment for one that offers a 10% chance of £5,000,000, an 89% of £1,000,000, and a 1% chance of nothing. Do you accept his offer?

You inherited an investment and there is an 11% chance that you could gain £1,000,000, with an 89% chance of gaining or losing nothing. Another investor has offered to swap your investment for one that offers a 10% chance of £5,000,000, with a 90% chance of gaining or losing nothing. Do you accept his offer?

You inherited an investment and you can, if you wish, cash it in for £10,000. Another investor has offered to swap your investment for one that offers a 10% chance of £50,000, an 89% of £10,000, and a 1% chance of nothing. Do you accept his offer?

You inherited an investment and there is an 11% chance that you could gain £10,000, with an 89% chance of gaining or losing nothing. Another investor has offered to swap your investment for one that offers a 10% chance of £50,000, with a 90% chance of gaining or losing nothing. Do you accept his offer?

You inherited an investment and you can, if you wish, cash it in for £100. Another investor has offered to swap your investment for one that offers a 10% chance of £500, an 89% of £100, and a 1% chance of nothing. Do you accept his offer?

You inherited an investment and there is an 11% chance that you could gain £100, with an 89% chance of gaining or losing nothing. Another investor has offered to swap your investment for one that offers a 10% chance of £500, with a 90% chance of gaining or losing nothing. Do you accept his offer?

You inherited an investment and there is an 80% chance that you could gain £1,000,000, with a 20% chance of gaining or losing nothing. Another investor has offered to swap your investment for one that offers a 20% chance of £4,000,000, with an 80% of nothing. Do you accept his offer?

You inherited an investment and there is an 80% chance that you could gain £1,000,000, with a 20% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 20% chance that you could gain £4,000,000, with an 80% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is an 80% chance that you could gain £10,000, with a 20% chance of gaining or losing nothing. Another investor has offered to swap

your investment for one that offers a 20% chance of £40,000, with an 80% of nothing. Do you accept his offer?

You inherited an investment and there is an 80% chance that you could gain £10,000, with a 20% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 20% chance that you could gain £40,000, with an 80% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is an 80% chance that you could gain £100, with a 20% chance of gaining or losing nothing. Another investor has offered to swap your investment for one that offers a 20% chance of £400, with an 80% of nothing. Do you accept his offer?

You inherited an investment and there is an 80% chance that you could gain £100, with a 20% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 20% chance that you could gain £400, with an 80% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

The 30 questions not used in this article

You inherited an investment and there is a 10% chance that you could lose £1,000,000, with a 90% chance of losing or gaining nothing. You can cancel this investment, but you will have to pay a penalty in order to do so. What is the maximum amount of money that you would be prepared to pay to cancel the investment?

You inherited an investment and there is a 10% chance that you could gain £1,000,000, with a 90% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 30% chance that you could lose £1,000,000, with a 70% chance of losing or gaining nothing. You can cancel this investment, but you will have to pay a penalty in order to do so. What is the maximum amount of money that you would be prepared to pay to cancel the investment?

You inherited an investment and there is a 30% chance that you could gain £1,000,000, with a 70% chance of gaining or losing nothing. You can, if you wish,

sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 50% chance that you could lose £1,000,000, with a 50% chance of losing or gaining nothing. You can cancel this investment, but you will have to pay a penalty in order to do so. What is the maximum amount of money that you would be prepared to pay to cancel the investment?

You inherited an investment and there is a 50% chance that you could gain £1,000,000, with a 50% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 70% chance that you could lose £1,000,000, with a 30% chance of losing or gaining nothing. You can cancel this investment, but you will have to pay a penalty in order to do so. What is the maximum amount of money that you would be prepared to pay to cancel the investment?

You inherited an investment and there is a 70% chance that you could gain £1,000,000, with a 30% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 90% chance that you could lose £1,000,000, with a 10% chance of losing or gaining nothing. You can cancel this investment, but you will have to pay a penalty in order to do so. What is the maximum amount of money that you would be prepared to pay to cancel the investment?

You inherited an investment and there is a 90% chance that you could gain £1,000,000, with a 10% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 10% chance that you could lose £10,000, with a 90% chance of losing or gaining nothing. You can cancel this investment, but you will have to pay a penalty in order to do so. What is the maximum amount of money that you would be prepared to pay to cancel the investment?

You inherited an investment and there is a 10% chance that you could gain £10,000, with a 90% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 30% chance that you could lose £10,000, with a 70% chance of losing or gaining nothing. You can cancel this investment, but you will have to pay a penalty in order to do so. What is the maximum amount of money that you would be prepared to pay to cancel the investment?

You inherited an investment and there is a 30% chance that you could gain £10,000, with a 70% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 50% chance that you could lose £10,000, with a 50% chance of losing or gaining nothing. You can cancel this investment, but you will have to pay a penalty in order to do so. What is the maximum amount of money that you would be prepared to pay to cancel the investment?

You inherited an investment and there is a 50% chance that you could gain £10,000, with a 50% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 70% chance that you could lose £10,000, with a 30% chance of losing or gaining nothing. You can cancel this investment, but you will have to pay a penalty in order to do so. What is the maximum amount of money that you would be prepared to pay to cancel the investment?

You inherited an investment and there is a 70% chance that you could gain £10,000, with a 30% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 90% chance that you could lose £10,000, with a 10% chance of losing or gaining nothing. You can cancel this investment, but you will have to pay a penalty in order to do so. What is the maximum amount of money that you would be prepared to pay to cancel the investment?

You inherited an investment and there is a 90% chance that you could gain £10,000, with a 10% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 10% chance that you could lose £100, with a 90% chance of losing or gaining nothing. You can cancel this investment, but you will have to pay a penalty in order to do so. What is the maximum amount of money that you would be prepared to pay to cancel the investment?

You inherited an investment and there is a 10% chance that you could gain £100, with a 90% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 30% chance that you could lose £100, with a 70% chance of losing or gaining nothing. You can cancel this investment, but you will have to pay a penalty in order to do so. What is the maximum amount of money that you would be prepared to pay to cancel the investment?

You inherited an investment and there is a 30% chance that you could gain £100, with a 70% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 50% chance that you could lose £100, with a 50% chance of losing or gaining nothing. You can cancel this investment, but you will have to pay a penalty in order to do so. What is the maximum amount of money that you would be prepared to pay to cancel the investment?

You inherited an investment and there is a 50% chance that you could gain £100, with a 50% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 70% chance that you could lose £100, with a 30% chance of losing or gaining nothing. You can cancel this investment, but you will have to pay a penalty in order to do so. What is the maximum amount of money that you would be prepared to pay to cancel the investment?

You inherited an investment and there is a 70% chance that you could gain £100, with a 30% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

You inherited an investment and there is a 90% chance that you could lose £100, with a 10% chance of losing or gaining nothing. You can cancel this investment, but you will have to pay a penalty in order to do so. What is the maximum amount of money that you would be prepared to pay to cancel the investment?

You inherited an investment and there is a 90% chance that you could gain £100, with a 10% chance of gaining or losing nothing. You can, if you wish, sell this investment. What is the minimum amount of money for which you would be prepared to sell the investment?

Appendix B
Full set of litigation questions

You are a plaintiff in a civil law suit. Your lawyer has offered you two strategies. In strategy A you are certain to be awarded £200,000. In strategy B, there is an 80% chance of being awarded £200,000, a 17% chance of being awarded £700,000, and a 3% chance that you won't be awarded anything at all. Which strategy would you prefer to pursue?

You are a plaintiff in a civil law suit. Your lawyer has offered you two strategies. In strategy A there is a 20% chance of being awarded £200,000 and an 80% chance of being awarded nothing. In strategy B, there is a 17% chance of being awarded £700,000 and an 83% chance of being awarded nothing. Which strategy would you prefer to pursue?

You are a plaintiff in a civil law suit. Your lawyer has offered you two strategies. In strategy A you are certain to be awarded £20,000. In strategy B, there is an 80% chance of being awarded £20,000, a 17% chance of being awarded £70,000, and a 3% chance that you won't be awarded anything at all. Which strategy would you prefer to pursue?

You are a plaintiff in a civil law suit. Your lawyer has offered you two strategies. In strategy A there is a 20% chance of being awarded £20,000 and an 80% chance of being awarded nothing. In strategy B, there is a 17% chance of being awarded £70,000 and an 83% chance of being awarded nothing. Which strategy would you prefer to pursue?

You are a plaintiff in a civil law suit. Your lawyer has offered you two strategies. In strategy A you are certain to be awarded £2,000. In strategy B, there is an 80% chance of being awarded £2,000, a 17% chance of being awarded £7,000, and a 3% chance that you won't be awarded anything at all. Which strategy would you prefer to pursue?

You are a plaintiff in a civil law suit. Your lawyer has offered you two strategies. In strategy A there is a 20% chance of being awarded £2,000 and an 80% chance of being awarded nothing. In strategy B, there is a 17% chance of being awarded £7,000 and an 83% chance of being awarded nothing. Which strategy would you prefer to pursue?

You are a plaintiff in a civil law suit. Your lawyer has offered you two different strategies. In strategy A there is a 75% chance of being awarded £200,000 and a 25% chance of being awarded nothing. In strategy B, there is a 21% chance of being awarded £700,000 and a 79% chance of being awarded nothing. Which strategy would you prefer to pursue?

You are a plaintiff in a civil law suit. Your lawyer has told you that if you rely on the jury's decision, you have a 75% chance of being awarded £200,000 and a 25% chance of being awarded nothing. Rather than relying on the jury, you have indicated to the defendant that you might be willing to accept a settlement. What is the minimum

amount of money you would require the defendant to pay you in order to avoid the jury's decision?

You are a plaintiff in a civil law suit. Your lawyer has told you that if you rely on the jury's decision, you have a 21% chance of being awarded £700,000 and a 79% chance of being awarded nothing. Rather than relying on the jury, you have indicated to the defendant that you might be willing to accept a settlement. What is the minimum amount of money you would require the defendant to pay you in order to avoid the jury's decision?

You are a plaintiff in a civil law suit. Your lawyer has offered you two different strategies. In strategy A there is a 75% chance of being awarded £20,000 and a 25% chance of being awarded nothing. In strategy B, there is a 21% chance of being awarded £70,000 and a 79% chance of being awarded nothing. Which strategy would you prefer to pursue?

You are a plaintiff in a civil law suit. Your lawyer has told you that if you rely on the jury's decision, you have a 75% chance of being awarded £20,000 and a 25% chance of being awarded nothing. Rather than relying on the jury, you have indicated to the defendant that you might be willing to accept a settlement. What is the minimum amount of money you would require the defendant to pay you in order to avoid the jury's decision?

You are a plaintiff in a civil law suit. Your lawyer has told you that if you rely on the jury's decision, you have a 21% chance of being awarded £70,000 and a 79% chance of being awarded nothing. Rather than relying on the jury, you have indicated to the defendant that you might be willing to accept a settlement. What is the minimum amount of money you would require the defendant to pay you in order to avoid the jury's decision?

You are a plaintiff in a civil law suit. Your lawyer has offered you two different strategies. In strategy A there is a 75% chance of being awarded £2,000 and a 25% chance of being awarded nothing. In strategy B, there is a 21% chance of being awarded £7,000 and a 79% chance of being awarded nothing. Which strategy would you prefer to pursue?

You are a plaintiff in a civil law suit. Your lawyer has told you that if you rely on the jury's decision, you have a 75% chance of being awarded £2,000 and a 25% chance of being awarded nothing. Rather than relying on the jury, you have indicated to the defendant that you might be willing to accept a settlement. What is the minimum amount of money you would require the defendant to pay you in order to avoid the jury's decision?

You are a plaintiff in a civil law suit. Your lawyer has told you that if you rely on the jury's decision, you have a 21% chance of being awarded £7,000 and a 79% chance of being awarded nothing. Rather than relying on the jury, you have indicated to the defendant that you might be willing to accept a settlement. What is the minimum amount of money you would require the defendant to pay you in order to avoid the jury's decision?

Appendix C
Full set of loyalty point questions

Written premise: You are collecting loyalty points that you will later be able to exchange for money. Each loyalty point is worth 0.0015 of a penny. Thus, the more points that you have the more money you will be able to claim. The loyalty card company has decided to reward you for your membership by offering you a series of choices where you can earn additional points. Please answer each question, either by circling whether you choose A or B or by stating a number if a question asks for it.

A: 100,000 points for sure.
B: 10% chance of 300,000 points, 89% chance of 100,000 points, 1% chance of 0 points.

A: 11% chance of 100,000 points, 89% chance of 0 points
B: 10% chance of 300,000 points, 90% chance of 0 points

A: 10,000 points for sure.
B: 10% chance of 30,000 points, 89% chance of 10,000 points, 1% chance of 0 points.

A: 11% chance of 10,000 points, 89% chance of 0 points
B: 10% chance of 30,000 points, 90% chance of 0 points

A: 1,000 points for sure.
B: 10% chance of 3,000 points, 89% chance of 1,000 points, 1% chance of 0 points.

A: 11% chance of 1,000 points, 89% chance of 0 points
B: 10% chance of 3,000 points, 90% chance of 0 points

A: 78% chance of 100,000 points, 22% chance of 0 points
B: 26% chance of 300,000 points, 74% chance of 0 points

A: 78% chance of 100,000 points, 22% chance of 0 points
B: What is the minimum number of points that would be better than A?

A: 26% chance of 300,000 points, 74% chance of 0 points
B: What is the minimum number of points that would be better than A?

A: 78% chance of 10,000 points, 22% chance of 0 points
B: 26% chance of 30,000 points, 74% chance of 0 points

A: 78% chance of 10,000 points, 22% chance of 0 points
B: What is the minimum number of points that would be better than A?

A: 26% chance of 30,000 points, 74% chance of 0 points
B: What is the minimum number of points that would be better than A?

A: 78% chance of 1,000 points, 22% chance of 0 points
B: 26% chance of 3,000 points, 74% chance of 0 points

A: 78% chance of 1,000 points, 22% chance of 0 points
B: What is the minimum number of points that would be better than A?

A: 26% chance of 3,000 points, 74% chance of 0 points
B: What is the minimum number of points that would be better than A?

Appendix D
Full set of health care questions

You have an illness which will kill you within the next few days unless you take a treatment. Two treatments are available to you. If you take treatment A, you will live for 10 more years for certain, and then you will die. Alternatively, treatment B offers a 10% chance of 30 more years, an 89% chance of 10 more years, but there is also a 1% chance that B will not work at all and that you will die within the next few days. Which treatment will you take?

You have an illness which will kill you within the next few days unless you take a treatment. Two treatments are available to you. If you take treatment A, there is an 11% chance that you will live for 10 more years and then die, and an 89% chance that the treatment will not work and you will die within the next few days. Alternatively, treatment B offers a 10% chance of 30 more years with a 90% chance that it will not work at all and that you will die within the next few days. Which treatment will you take?

You have an illness which will kill you within the next few days unless you take a treatment. Two treatments are available to you. If you take treatment A, you will live for 5 more years for certain, and then you will die. Alternatively, treatment B offers a 10% chance of 15 more years, an 89% chance of 5 more years, but there is also a 1% chance that B will not work at all and that you will die within the next few days. Which treatment will you take?

You have an illness which will kill you within the next few days unless you take a treatment. Two treatments are available to you. If you take treatment A, there is an 11% chance that you will live for 5 more years and then die, and an 89% chance that the treatment will not work and you will die within the next few days. Alternatively, treatment B offers a 10% chance of 15 more years with a 90% chance that it will not work at all and that you will die within the next few days. Which treatment will you take?

You have an illness which will kill you within the next few days unless you take a treatment. Two treatments are available to you. If you take treatment A, you will live for 10 more months for certain, and then you will die. Alternatively, treatment B offers a 10% chance of 30 more months, an 89% chance of 10 more months, but there is also a 1% chance that B will not work at all and that you will die within the next few days. Which treatment will you take?

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You have an illness which will kill you within the next few days unless you take a treatment. Two treatments are available to you. If you take treatment A, there is an

85% chance that you will live for 10 more years and then die, and a 15% chance that the treatment will not work and you will die within the next few days. Alternatively, treatment B offers a 28% chance of 30 more years with a 72% chance that it will not work at all and that you will die within the next few days. Which treatment will you take?

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Appendix E
Full set of military questions

You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, you are certain that you will capture 10,000 enemy soldiers. Following strategy B, there is a 25% that you will capture 25,000 soldiers, a 70% chance that you will capture 10,000 soldiers, and a 5% chance that you will not capture anyone. Which strategy would you prefer to pursue?

You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, there is a 30% chance that you will capture 10,000 enemy soldiers and a 70% chance that you will not capture anyone. Following strategy B, there is a 25% that you will capture 25,000 soldiers, and a 75% chance that you will not capture anyone. Which strategy would you prefer to pursue?

You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, you are certain that you will capture 1,000 enemy soldiers. Following strategy B, there is a 25% that you will capture 2,500 soldiers, a 70% chance that you will capture 1,000 soldiers, and a 5% chance that you will not capture anyone. Which strategy would you prefer to pursue?

You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, there is a 30% chance that you will capture 1,000 enemy soldiers and a 70% chance that you will not capture anyone. Following strategy B, there is a 25% that you will capture 2,500 soldiers, and a 75% chance that you will not capture anyone. Which strategy would you prefer to pursue?

You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, you are certain that you will capture 100 enemy soldiers. Following strategy B, there is a 25% that you will capture 250 soldiers, a 70% chance that you will capture 100 soldiers, and a 5% chance that you will not capture anyone. Which strategy would you prefer to pursue?

You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, there is a 30% chance that you will capture 100 enemy soldiers and a 70% chance that you will not capture anyone. Following strategy B, there is a 25% that you will capture 250 soldiers, and a 75% chance that you will not capture anyone. Which strategy would you prefer to pursue?

You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, there is a 90% chance that you will capture 10,000 enemy soldiers and a 10% chance that you will not capture anyone.

Following strategy B, there is a 36% that you will capture 25,000 soldiers, and a 64% chance that you will not capture anyone. Which strategy would you prefer to pursue?

You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, there is a 90% chance of you capturing 10,000 enemy soldiers and a 10% chance that you will not capture anyone. Strategy B is less risky and will lead to you capturing a number of enemy soldiers for certain. What is the minimum number of soldiers you would need to capture following strategy B to tempt you to pursue B rather than A?

You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, there is a 36% chance of you capturing 25,000 enemy soldiers and a 64% chance that you will not capture anyone. Strategy B is less risky and will lead to you capturing a number of enemy soldiers for certain. What is the minimum number of soldiers you would need to capture following strategy B to tempt you to pursue B rather than A?

You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, there is a 90% chance that you will capture 1,000 enemy soldiers and a 10% chance that you will not capture anyone. Following strategy B, there is a 36% that you will capture 2,500 soldiers, and a 64% chance that you will not capture anyone. Which strategy would you prefer to pursue?

You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, there is a 90% chance of you capturing 1,000 enemy soldiers and a 10% chance that you will not capture anyone. Strategy B is less risky and will lead to you capturing a number of enemy soldiers for certain. What is the minimum number of soldiers you would need to capture following strategy B to tempt you to pursue B rather than A?

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You are the general of an advancing army of 100,000 soldiers, surveying a battlefield. The enemy army has a force that is equal to yours in size. You are considering two alternative strategies. Following strategy A, there is a 90% chance of you capturing 100 enemy soldiers and a 10% chance that you will not capture anyone. Strategy B is less risky and will lead to you capturing a number of enemy soldiers for certain. What is the minimum number of soldiers you would need to capture following strategy B to tempt you to pursue B rather than A?

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