

A new preference reversal in health utility measurement

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A NEW PREFERENCE REVERSAL IN HEALTH UTILITY MEASUREMENT

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RESUMEN

Un supuesto central en la medición de utilidades de estados de salud es que las preferencias no dependen del método de utilizado para medir. Este supuesto lo desafía el fenómeno de las preferencias contradictorias. Estudios anteriores han observado estas preferencias cuando se utilizan métodos distintos, tales como elecciones e indiferencias, o elecciones y ordenaciones. Presentamos un nuevo tipo de preferencias contradictorias basado únicamente en elecciones. Observamos este fenómeno en dos estudios sobre estados de salud que se producen después de una embolia. Los dos estudios se realizaron a partir de muestras relativamente grandes y representativas de la población española, realizadas a partir de entrevistas personales realizadas por profesionales. Algunas explicaciones posibles de este fenómeno son la anticipación de efectos de desilusión o júbilo y el impacto de consideraciones éticas sobre el valor de la vida.

Palabras clave: medida de la utilidad de estados de salud, preferencias contradictorias, elecciones.

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ABSTRACT

A central assumption in health utility measurement is that preferences are invariant to the elicitation method that is used. This assumption is challenged by preference reversals. Previous studies have observed preference reversals between choice and matching tasks and between choice and ranking tasks. We present a new preference reversal that is entirely choice-based. Because choice is the basic primitive of economics and utility theory, this preference reversal is more fundamental and troubling. The preference reversal was observed in two studies regarding health states after stroke. Both studies involved large representative samples from the Spanish population, interviewed professionally and face-to-face. Possible explanations for the preference reversal are the anticipation of disappointment and elation in risky choice and the impact of ethical considerations about the value of life.

Keywords: Health utility measurement, preference reversal, choice behavior.

1. Introduction

A standard assumption in health economics and medical decision making is that preferences between options do not depend on the method used to elicit them. This assumption was challenged by evidence of preference reversals. Stalmeier et al. (1997) observed a preference reversal in a comparison between a choice task and a matching task. Let $(10y.,5)$ denote living for 10 years with a migraine for 5 days per week (followed by death). Most of their subjects preferred $(10y.,5)$ to $(20y.,5)$. However, when asked to equate these two options with a shorter period in good health, they usually asked more healthy life-years for $(20y.,5)$ than for $(10y.,5)$. Stalmeier et al. attributed this preference reversal to a proportional heuristic according to which a subject takes the number of years in full health as a fixed proportion of the number of years with migraine. Hence, the preference reversal can be explained by a difference in information processing strategy between the two tasks.

A different kind of preference reversal was observed by Robinson et al. (1997). They observed health states that were valued as better than death by a majority of their subjects in a VAS task but when the same subjects were asked to choose between 10 years in these health states and death, many selected death. Robinson et al. (1997) suggest that these preferences can to a large extent be explained by a neglect of the duration of the health states in the VAS task and by a tendency to put death at the bottom of the VAS scale.

In the general economics literature preference reversals have been observed between two types of gambles with comparable expected values: a P-bet offering a high probability of winning a relatively small amount of money and a \$-bet offering a low probability of winning a moderate amount of money (Lichtenstein and Slovic 1971, Lindman 1971). People generally choose the P-bet over the \$-bet but place a higher

monetary value on the \$-bet than on the P-bet. The opposite reversal, choosing the \$-bet but placing a higher monetary value on the P-bet is relatively rarely observed. The most common explanation for this preference reversal is a choice-matching discrepancy, a change of information processing strategy between choice and matching (Tversky et al., 1988). In support of the choice-matching discrepancy explanation, Bostic et al. (1990) found that systematic preference reversals disappeared when monetary values were determined through a series of choices rather than through matching.

Bateman et al. (2006) showed that the above preference reversal could be considerably attenuated if the values of the P-bet and of the \$-bet were determined through a ranking procedure instead of a matching task. Oliver (2006) extended their findings. He found preference reversals between options involving different distributions of life-expectancy and showed that these could be made less substantial by using a ranking procedure.

This paper will present a new preference reversal that, in contrast with the previously observed preference reversals is entirely choice-based and, hence, cannot be explained by a choice-matching discrepancy. Because choice is the basic primitive of economics and decision theory, the reversal we observe is more fundamental and troubling. The study we performed was commissioned by a leading pharmaceutical company and aimed to assess the potential benefits of a new medicine for stroke. Hence, the reversal we observed is not just an intriguing curiosity with little practical relevance, but raises significant problems for health policy and economic decisions involving health. The preference reversal was observed in two experiments and in a retest of the first experiment. Both experiments used representative samples from the general Spanish population and the data from both experiments were collected by professional interviewers in personal interview sessions. In the first experiment we observed our

preference reversal between a choice and a ranking task. The second interview showed that it also emerged when both tasks were choice-based. The second experiment also intended to test the robustness of the preference reversal by controlling for potential distorting factors in the first experiment. In spite of all the care we took to obtain high-quality data, the preference reversal emerged in both experiments and appeared to be robust.

In what follows, Section 1 briefly reviews some earlier findings on preference reversals. Section 2 describes the first experiment and Section 3 its results. Section 4 describes the second experiment, and Section 5 its results. Section 6 discusses our findings and reflects on possible explanations.

2. First Experiment

Health States and Subjects

The experiment was part of a study on quality of life after stroke. This study was commissioned by Pfizer Ltd. and aimed to examine the potential benefits of a new medicine for stroke. Six health states that are common after stroke were selected and were described by the Modified Rankin Scale, a psychometric scale frequently used to measure quality of life after stroke (Rankin, 1957; Bonita and Beaglehole, 1988). One of these health states was immediate death. The health states were printed on cards. The health states were identified by a letter, which was printed at the back of the card and which was not shown to the subjects. The health states other than immediate death are described in Table 1.

A random sample of 300 subjects aged over 18 was drawn from adults in the Spanish population. The sample was split into two groups of 150 subjects with equal divisions according to age, gender, and educational level.

Table 1: The Five Health States Used in the Experiments

Health state Q
The patient has symptoms as a result of a health problem; symptoms can include numbness, minor problems with movement, or some difficulty with reading or writing. The symptoms do not interfere with the patient's usual activities to any appreciable extent, but they may affect the patient's enjoyment of aspects of his daily life.
Health state R
As a consequence of the health problem the patient is restricted in participation in a major aspect of life that he engaged in previously. He may be unable to work or look after his children if these were major roles before; he may have restricted social and leisure activities; or he may have experienced significant disruption of close relationships. He can look after his own affairs (preparing meals, household chores, shopping in the neighbourhood, looking after his financial situation...) and can attend to his bodily needs (such as washing, going to the toilet, and eating) without problems.
Health state X
As a consequence of their health problem the patient is unable to live independently. He is unable to travel alone or shop without help if he did these things previously; and he is unable to look after himself at home for some reason (for example he may not be able to prepare a meal, do household chores, or look after money,.. ...). He can attend to his bodily needs (such as washing, going to the toilet, and eating) without problems.
Health state Y
As a consequence of his health problem the patient needs assistance with some basic activities of daily living or needs help from another person with walking. Basic activities of daily living include attending to bodily needs such as washing, going to the toilet, and eating.
Health state Z
As a consequence of the health problem the patient is bedridden, and unable to move from bed without assistance. He may be incontinent, and needs someone present all the time to look after him.

Procedure

The interviews were conducted by professional interviewers, who had received special training for this study. They visited subjects at their home, where a face-to-face interview was conducted. The interview was carried out in a single session averaging 50 minutes. Because we used health outcomes, no real incentives could be used. Subjects also received no payment for their participation. The issue of incentives is discussed in Section 6. The instructions of the first experiment, including the instructions for the interviewers, are in Appendix A.

The interview started with a motivation for the study. Subjects were told that the health states are common after stroke and that it is important for health policy to know

people's perception of these health states. Each subject had to conduct several tasks, two of which are relevant for this paper. First, subjects had to perform an "extended ranking" of the health states. They were asked to rank the cards describing the health states in descending order of preference. Equal ranks were allowed. To verify the ranking of the health states, subjects were then asked to rate the ranked health states on a scale that ranged from 0 to 100, where 0 corresponded to the worst imaginable health state and 100 to the best imaginable health state. Subjects were asked to rate the health states so that the distances between the health states reflected the differences in perceived level of severity. During the rating exercise, subjects were allowed to change the given ranking of the health states.

After the extended ranking, subjects were told that there exist two treatments after stroke, a high dose treatment and a low dose treatment, see Figure 1. Both treatments could either fail or succeed. For both treatments the success outcome was recovery to normal health. The failure outcome of the high dose treatment was death. The low dose treatment could not lead to death, but if treatment was ineffective the stroke would lead to permanent brain damage and, consequently, to one of the health states Q,R,X,Y, or Z. Subjects were then shown a card describing one of the health states Q,R,X,Y, or Z and were asked to choose between the high dose treatment offering a 75% probability of success (i.e. recovery to normal health) and a 25% probability of immediate death and the low dose treatment offering a 75% probability of success and a 25% probability of the displayed health state. It was explicitly stated that it was not clear which treatment dose was optimal.

Figure 1: Question Format of the Choices Between the Treatments

High dose treatment		Low dose treatment	
Success Probability	Probability of death	Success Probability	Probability of displayed state
75%	25%	75%	25%

Both groups of subjects were asked to make three choices between the high dose and the low dose treatment. The first group of subjects made one choice in which the failure outcome in the low dose treatment was R, one choice in which it was X, and one choice in which it was Z. The second group of subjects made one choice in which the failure outcome in the low dose treatment was Q, one choice in which it was Y, and a third choice, which is not relevant for the present paper.

Figure 1 shows the way the choices between the high dose and the low dose treatments were presented to subjects. The two treatments were printed next to each other so that subjects could easily compare them. The probabilities 75% and 25% are large enough not to be ignored. After the choice problem was explained, subjects were asked whether they preferred the high dose treatment, the low dose treatment, or whether they were indifferent between the two types of treatment.

As a robustness check of the elicited choices, the interviewer next determined, through a series of choices, probabilities p and q such that the subject was indifferent between the high dose treatment offering a $p\%$ probability of success and a $(1-p)\%$ probability of immediate death and the low dose treatment offering a $q\%$ probability of success and a $(1-q)\%$ probability of the displayed health state. Throughout this choice-based elicitation, subjects were allowed to revise earlier answers including the choices that are analysed in this paper and the ranking of the health states. Therefore, if a subject

thought at some later stage during the interview that he had made an error either in the ranking and rating of the health states or in the choice between the high dose and the low dose treatment, he could correct this error.

Retest

After the interview, subjects were asked whether they were willing to be interviewed again. The aim of this second interview was to test the reliability of the data. About 50% of the subjects agreed to be re-interviewed. Fifty of these (twenty-five from each group) were chosen at random and re-interviewed 2-3 weeks after the original interview. The people who were re-interviewed were offered €12 for their participation. Most subjects (thirty-four) declined to be paid for their participation. Experimental procedures of the second interview were identical to those of the first interview.

3. Results of the First Experiment

Methods of Analysis

The extended ranking yielded a preference ordering of the health states relative to death. The choice between the high dose and the low dose treatment also yielded a preference ordering of the health states relative to death. Because the common outcome (normal health) is obvious in the treatment questions, the display favours isolation (Kahneman and Tversky, 1979) and, hence, cancellation of the common outcome. Then a preference of the high dose treatment over the low dose treatment implies that the displayed health state was less preferred than death. Similarly, a preference of the low dose treatment over the high dose treatment implies that the displayed health state was preferred to death. For each health state we determined whether it was better than,

equivalent to, or worse than death both according to the extended ranking task and according to the choice between the high dose and the low dose treatment. This gave nine possible categories, six of which constituted a preference reversal, i.e. a difference in preference between the ranking task and the choice between the high dose and the low dose treatment.

Preference Reversal

Table 2 summarizes the results for health states R,X,Y, and Z. Because we observed no preference reversals for health state Q (all subjects indicated in both tasks that Q was better than death) we do not report the data for Q. The heading “treatment questions” refers to the choice between the high dose and the low dose treatment. Shaded cells indicate preference reversals. The proportion of preference reversals was 9.3%, 24%, 43%, and 18% for health states R,X,Y, and Z respectively. The reversals were highly asymmetric: they were virtually always such that a health state was ranked above death but was considered worse than death in the choice between the high dose and the low dose treatment. The asymmetry was strongly significant for all health states ($p < 0.001$ in all cases by a χ^2 -test that the preference reversals were equally distributed).

Table 2: Categorization of responses

2A. Health State R

		Treatment Questions		
		Better	Equal	Worse
Ranking	Better	136		12
	Equal			2
	Worse			

2B. Health State X

		Treatment Questions		
		Better	Equal	Worse
Ranking	Better	100		35
	Equal	1		
	Worse			14

2C. Health State Y

		Treatment Questions		
		Better	Equal	Worse
Ranking	Better	52	9	49
	Equal		1	6
	Worse	1		32

2D. Health State Z

		Treatment Questions		
		Better	Equal	Worse
Ranking	Better	20		21
	Equal	1		5
	Worse			103

For health states X, Y, and, Z the probability of displaying a preference reversal was not related to age, gender or employment status. For health states X, Y, Z there was neither an effect of level of education. For health state R, having at least elementary education significantly ($p=0.02$) reduced the possibility of displaying a preference reversal. There was no additional effect from having more than elementary education.

Results of the Retest

For all 50 subjects in the retest the ranking of the health states was identical to the ranking given in the first interview. The proportion of preference reversals was 0%,

16%, 28%, and 40% for health states R,X,Y, and Z, respectively. The reversals were, as before, highly asymmetric ($p < 0.001$) and such that the valuation of a health state relative to death was lower in the choice between the low dose and the high dose treatment. The pattern was therefore similar to that observed in the first experiment.

Table 3: Results of the Retest

Health State	R	X	Y	Z
Pattern				
C_1C_r	25	16	12	15
C_1PR_r	0	2	2	7
PR_1C_r	0	5	6	0
PR_1PR_r	0	2	5	3

Table 3 addresses the question whether subjects who exhibited a preference reversal in the first interview did so as well in the retest. C_1C_r denotes consistency in both the first experiment and the retest, C_1PR_r denotes consistency in the first interview, but a preference reversal in the retest, etc. Overall, about 50% of the subjects who exhibited a preference reversal in the first interview also exhibited a preference reversal in the retest. For health state R, there were no subjects in the retest who exhibited a preference reversal in the first interview. For health states X,Y, and Z, 28%, 45%, and 100%, respectively, of the subjects who exhibited a preference reversal in the first interview did so as well in the retest.

4. Second Experiment

4.1. Background

The principal aim of the second experiment was to examine whether the preference reversal could be replicated when both tasks were choice-based. Recall that the first task of the first experiment was to rank the health states, without ranking being related to choice, whereas the second task involved a choice between treatments. Hence, it may be that the preference reversal was due to a choice-ranking disparity. Even though Bateman et al. (2006) and Oliver (2006) observed less preference reversals in choice-ranking tasks, some preference reversals persisted. To rule out the possibility that the preference reversal was due to a choice-ranking disparity, in the second experiment ranking was derived from choice and, hence, both tasks involved only choices.

A second possibility that we wished to rule out was that the reversal was due to a framing effect. In the choice between the two treatments, we had labelled one treatment the high dose treatment and the other the low dose treatment. Even though the treatments only differed in the outcome that obtained when treatment failed, these labels may have led to a framing bias. For example, high dose may have a more positive connotation, even though the instructions clearly stated that there was no optimal dose, leading some subjects to simply choose based on the labels. In the second experiment we, therefore, used the neutral labels treatment 1 and treatment 2 and we varied which treatment was treatment 1 and which was treatment 2.

A third aim of the second experiment was to examine whether the preference reversal might have been caused by the inclusion of the rating task in the extended ranking. Robinson *et al.* (1997), who observed a reversal that bears some resemblance to the reversal we observed, found that in a rating task, where subjects were told

beforehand that all states lasted for 10 years and were followed by death, most subjects valued all health states as better than death, even very poor health states. When directly asked to choose between 10 years in such a poor health state (followed by death) and immediate death, many subjects preferred immediate death. Robinson et al. presented evidence that these preferences occurred because in the rating task people tended to put death at the bottom of scale and ignored the duration of the health states. The tendency to put death at the bottom of the scale was much weaker in our first experiment than in Robinson et al.¹, but it may nevertheless have reinforced the preference reversal. We, therefore, omitted the rating task in the second experiment. In addition, in case people also had a tendency to rank death as the worst state, we explicitly mentioned in the ranking task that it may well be that some health states are considered so bad that living in them for the rest of your life is worse than immediate death. It is unlikely that duration neglect can explain the reversal we observed, because the emphasis on the duration of the health states was similar in the extended ranking and in the choice between the treatments. Nevertheless, in the second experiment we emphasized at several places in the ranking task that all health states would last for the rest of subjects' lives.

4.2. Method

Subjects

Subjects in the second experiment were a random sample of 100 members aged over 18 from the general Spanish population. The sample characteristics were similar to

¹ Of the subjects who exhibited a preference reversal, 28% put death at the bottom of the scale for health state R, 25% for health state X, and 40% for health state Y. All subjects exhibiting a preference reversal for Z put death at the bottom of the scale, which is not surprising given that Z is a very poor health state. By comparison, in the Robinson et al. study, 66% of the subjects displaying a preference reversal put death at the bottom of the scale.

those of the first experiment except that the educational level of the second sample was higher.

Procedure

The procedure of the second experiment was the same as that of the first experiment except for the following. We did not split the sample and all subjects answered the same questions. Subjects had to perform fewer tasks in the second experiment and, hence, the duration of the interviews was less than in the first experiment, on average 30 minutes. The instructions of the second experiment, to the extent that they differ from those in the first experiment, are in Appendix B.

As mentioned above, in the first task ranking was derived from choice. Subjects were shown cards with 7 health states, which they were told are common after stroke. These health states were the five health states of the first experiment and normal health and death. Subjects were then told to imagine that they had had a stroke and we asked them in which of the 7 states they would prefer to be. After subjects had chosen this state we removed the card of this health state and asked them to choose between the remaining 6 health states. We continued this process until only one card remained. The first task, to which we will refer henceforth as *choice-based ranking*, was close to ranking, but involved choices and hence was entirely based on revealed preference. The reason we included normal health among the health states was to make the first choice easy and to test whether subjects understood the procedure. Indeed, all subjects chose normal health in the first choice. As mentioned above, we did not ask subjects to rate the health states on a 0-100 scale in the second experiment.

After the choice-based ranking task, subjects had to make five choices between risky treatments. The treatments were as in the first experiment: one offered a 75%

probability of normal health and a 25% probability of death, the other offered a 75% probability of normal health and a 25% probability of one of the health states Q,R,X,Y, or Z. Hence, in the second experiment subjects made the choices between the treatments for all five health states. As mentioned before, the treatments were anonymously labelled treatment 1 and treatment 2 and which treatment was 1 and which was 2 varied across subjects. Except for the labelling, the display of the choices was as in Figure 1. Contrary to the first experiment, we did not proceed to determine the probabilities for which subjects were indifferent between the two treatments after a choice was made. We also did not do a retest of the second experiment.

Standard Gamble Questions

We added a new risky choice in the second experiment in which only one of the treatments involved risk. Such *standard gamble* questions in which a riskless option is compared with a risky option are widely used in health utility measurement. As we will explain later, the standard gamble questions also led to a preference ordering of the health states relative to death. We included the standard gamble questions to further test the robustness of the preference reversal and to test whether theories of the gambling effect that have been proposed in decision under risk (Fishburn, 1980; Schmidt, 1998; Luce and Marley, 2000; Diecidue et al., 2004) could explain the preference reversal. As we show in Appendix C, these theories can explain the preference reversal we observed in the first experiment, but they cannot explain any reversals between the ranking task and the standard gamble questions.

For each of the health states Q,R,X,Y, and Z, subjects were asked to make a choice between that health state for sure and a treatment offering a 5% of normal health and a 95% probability of death. If a subject chose the treatment then we asked him to

choose between the health state for sure and a treatment offering a 0.1% of normal health and a 99.9% probability of death.

5. Results of the Second Experiment

Methods of Analysis

The choice-based ranking yielded a preference relative to death for each health state. As in the first experiment, we could also derive the preference of each health state relative to death from the choice between the two risky treatments. In the standard gamble questions, a preference for a health state relative to death was derived as follows. If a subject preferred the health state for sure in at least one of the two standard gamble questions then the health state was preferred to death. If the subject preferred the treatment in both questions then death was at least as preferred as the health state. Strictly speaking, it was possible that a subject would choose the health state for sure for a probability of success less than 0.1%. This preference would be very weak, however, and our inference about preference could be assumed to hold in close approximation.

Preference Reversal

Table 4 presents the results from the second experiment. We do not report the data for health state Q because in all three tasks all subjects preferred Q to death and, hence, we observed no preference reversals for Q. The first two rows of Table 4 give information on the preference reversal between choice-based ranking and the choice between the two risky treatments. The row Choice > Death > Treatments shows for each health state the proportion of subjects who preferred the health state to death in the choice-based ranking, but preferred death to the health state in the choice between the

two treatments. The row Treatments > Death > Choice shows for each health state the proportion of subjects who preferred the health state to death in the choice between the two risky treatments, but preferred death to the health state in the choice-based ranking.

Table 4: Proportion of Preference Reversals in the Second Experiment

	R	X	Y	Z
Choice > Death > Treatments	10	23	33	22
Treatments > Death > Choice	2	0	0	4
Choice > Death > SG	2	24	42	23
SG > Death > Choice	0	0	0	2
Treatments > Death > SG	2	7	13	3
SG > Death > Treatments	8	6	4	0

Table 3 clearly shows that in spite of the changes in the experimental design the preference reversal that we observed in the first experiment re-emerges. The proportion of reversals was comparable to that in the first experiment. Again, the reversals were highly asymmetric. The asymmetry was significant ($p = 0.039$ for health state R, $p < 0.001$ for all other health states). Of the subjects who exhibited a preference reversal, the proportion who put death at the bottom of the scale was lower than in the first experiment (20% for states R and Y and 22% for X).

Standard Gamble Questions

Table 3 also shows that a similar preference reversal was observed when we compared the choice-based ranking with the standard gamble questions. Except for health state R, we observed a considerable amount of preference reversals for all health

states and there was a pronounced asymmetry in the observed preference reversals: they were nearly always such that the health state was preferred to death in the choice-based ranking but death was preferred to the health state in the standard gamble questions. The asymmetry was significant for health states X, Y, and, Z ($p < 0.001$ in all cases).

The final two rows of Table 3 show that the choices between the risky treatments and the standard gamble questions were generally consistent. Preference reversals between the choices between the risky treatments and the standard gamble questions were much less common and, what is more, there appeared to be no clear asymmetry in the preference reversals. Only for health state Y was the asymmetry in the number of preference reversals significant ($p = 0.049$). For all health states and for all three comparisons, the probability of displaying a preference reversal was not related to age, gender, educational status, or employment status.

6. Discussion

Main findings

Several studies have observed that preferences can reverse across different tasks. The common explanation for these reversals is a choice-matching discrepancy: people's information processing strategy changes across tasks. In this study we observed a new type of preference reversal that cannot be explained by a choice-matching discrepancy. In the first experiment the reversal occurred between a ranking and a choice task, but the second experiment in which the ranking was made choice-based and, hence, only choices were used, showed that a difference in response modes cannot explain the findings. The reversal is more troubling for economics because, at least in the second experiment, it is completely within the revealed preference paradigm. The implications of the observed preference reversal for economic applications in the health domain are

clearly worrying: our findings suggest that the assumption that people have an invariant preference relation over health outcomes may be untenable.

Possible Objections

It seems unlikely that the reversal we observed was entirely due to response error. First, the preference reversal was highly asymmetric and this asymmetry was not a consequence of the fact that in one of the tasks either all subjects considered a health state as better than death or all subjects considered a health state as worse than death. Second, we used personal interviews to obtain high-quality data. Third, as noted in section 2, in the first experiment the ranking was followed by a rating task and the choices between the two treatments were followed by a series of choice questions to determine probabilities for which subjects considered the treatments equivalent. If subjects had made an error they were likely to discover this during these additional tasks and correct their earlier response. Fourth, for health state Q we observed no preference reversals. Finally, a sizeable proportion of the subjects who had displayed a reversal during the interview did so as well in the retest of the first experiment.

It might be argued that the preference reversal we observed is merely a violation of the independence axiom, which says that if prospect P is preferred to prospect Q then for any prospect R and $0 < \lambda < 1$, the mixed prospect $\lambda P + (1-\lambda)R$ is preferred to $\lambda Q + (1-\lambda)R$. It is well-established that people do not behave according to independence. See, for example Oliver (2003) for evidence in the health domain. We do not concur with the view that our preference reversal is caused by a violation of independence and believe that observed preference reversal is more fundamental. In the violations of the independence axiom that have been observed in the literature, the common outcome is typically a risky prospect and it is difficult to see that this prospect is common to both

choice options. In contrast, in our study, the common outcome was riskless and the display of the choices was such that it was clear that this outcome was common. Kahneman and Tversky's (1979) isolation effect then predicts that this common outcome is cancelled and that people's choices are determined by the outcome that is not common.

An interesting by-product of our study is that our findings suggest that the introduction of financial compensation might do more harm than good in health valuation experiments. In the retest of the first experiment we offered subjects financial compensation for their participation, but most of them declined. Apparently, people have an intrinsic motivation to participate in health valuation experiments because they feel that they are contributing to society. Offering financial compensation might negatively affect ("crowd out") this intrinsic motivation. Similar examples of crowding-out effects include Titmuss (1970) and Upton (1973), who found that people's willingness to donate blood decreased after they were offered financial compensation, Poterba *et al.* (1998), who found that government subsidies reduced private donations and charitable funds, and Gneezy and Rustichini (2000), who found that pupils collecting donation for charity performed worse when given moderate rather than no payment.

A difference between the tasks involved in our experiment was that the choice between the treatments (and also the standard gamble questions) involved only two health states and death, whereas in the ranking the initial choice set consisted of 5 health states and death in the first experiment and 6 health states and death in the second experiment. Empirical evidence suggests that the presence of other alternatives in the choice set may affect the evaluation of alternatives relative to each other (Tversky and Simonson, 1993; Wedell, 1991). Such context effects are unlikely to have caused the

preference reversal we observed. Recall that we observed the preference reversal for the three least attractive health states. If we make the plausible assumption that death is perceptually different from the other health states then the empirical evidence on context effects suggests that the presence of more attractive health states in the choice set would have the effect of making the less attractive health states less appealing compared to death. Hence, context effects predict that if preference reversals exist they are such that the health state is preferred to death in the choice between the treatments but less preferred to death in the ranking. This is the opposite of what we observed. Hence, if context effects were present they only attenuated the preference reversal we observed; without them the preference reversal would be even more pronounced.

Explanations

The reversal we observed can be interpreted as a violation of elementary stochastic dominance, in the sense that if a health state is preferred to death then one of the treatments yields for each state of nature an outcome that is at least as good as the other treatment, but nevertheless it is less preferred than the dominated treatment. Such violations of elementary stochastic dominance have not been observed for monetary outcomes (Starmer, 2000). Our study is therefore the first to find systematic evidence of such choice-based violations of elementary stochastic dominance.

Several theories allow for violations of stochastic dominance, like subjectively weighted utility (Handa, 1977; Fishburn, 1978) and prospect theory (Kahneman and Tversky, 1979), but none of these theories can explain the violations of elementary stochastic dominance that we observed. Because we observed in the second experiment that a preference reversal also arose in the comparison between the choice-based

ranking and the standard gamble questions, the gambling effect models do not offer a satisfactory explanation for the preference reversal either (see Appendix C).

Our reversal somewhat resembles a preference reversal that was observed by Birnbaum *et al.* (1992) (see also Birnbaum and Sutton, 1992; Mellers *et al.*, 1992). They found that a majority of their subjects placed a larger monetary value on the gamble giving a 95% chance of \$96 and a 5% chance of \$0 than on the gamble giving a 95% chance of \$96 and a 5% chance of \$24. Dominance implies that people will choose the second gamble over the first gamble and a preference reversal results. A dual finding was reported by Goldstein and Einhorn (1987), who found that replacing zero by a negative outcome increased the valuation of a gamble. Birnbaum *et al.* (1992) showed that configural weight theory (Birnbaum, 1974; Birnbaum *et al.*, 1992) can explain their reversal. Configural weight theory can also explain our findings if we make the restrictive assumption that subjects give more weight to the outcome of successful treatment when death is the outcome of treatment failure. It is questionable whether this assumption holds. Death is not a neutral outcome, like receiving nothing in a monetary gamble, and several studies have found that the possibility of death makes people extremely risk averse (Lundberg *et al.*, 1999; Lenert *et al.*, 2001).

A possible explanation for our findings can be the anticipation of disappointment and elation in risky choice (Loomes and Sugden, 1986). In the comparison between the two risky treatments subjects may have anticipated feelings of disappointment when the treatment that offered normal health with 75% probability and a worse health state with probability 25% failed. In case the treatment involving a 25% risk of death failed such feelings of disappointment play no role because the subject would be dead anyway. The presence of disappointment in the evaluation of one treatment but not in the other may have caused the reversal of preference between the ranking and the risky treatments. In

the standard gamble questions subjects may have anticipated feelings of elation when the treatment, in spite of its poor prospects, would be successful. This anticipation of elation may have explained that some health states, which were considered better than death in the ranking, were nevertheless less attractive than a treatment offering only a 0.1% of success.

There is another, ethical, explanation for our findings. It may be that in the ranking task, the choice between a bad health state and death raised ethical problems that disappear when risk was introduced. In the ranking, the choice of death could be related to such issues as euthanasia or the value of life per se. When risk is introduced such ethical concerns are less prominent, because the choice of a treatment involving a risk of death cannot be so easily related to the same ethical considerations. Frey *et al.*, (1996) showed how moral considerations can counterbalance market forces. Our findings may be interpreted as providing additional evidence for the importance of moral considerations in decision making.

Implications

The reversal we observed is probably caused by the special role of death compared to other health states. That does not restrict the importance of our reversal, however. Many decisions involve a probability of death, e.g. life-cycle consumption choices and many insurance decisions. Our findings suggest that there exists no stable preference relation of health states relative to death and that the common assumption that a utility of health exists may be untenable. This is clearly worrying for economic evaluations of health care: the cost-effectiveness ratio of treatments and, hence, the decision which treatments to reimburse, can vary with the method used to elicit preferences. Also, decisions on whether or not to prolong treatment for severely ill

patients may depend on the method used to elicit preferences. As the costs of treating terminally ill patients take up the main part of the health budget in developed countries, such decisions clearly have important societal repercussions.

Unfortunately, it is not clear how to solve the problem indicated by our findings. In the second experiment, we based both tasks on revealed preference and tried to correct for several biases that we thought might have been responsible for the reversal in the first experiment. The reversal turned out to be robust, however. Hence, we see no reasons to believe that one of the tasks was superior to the other and in the absence of a gold standard for eliciting preferences, solving the dilemma is beyond the scope of the present paper. To solve the dilemma, future research may have to look deeper into the reasons behind people's choices. For example, if the ethical explanation we suggested above underlies the preference reversal then the answer which method to use to elicit preferences in economic evaluations of health care depends on whether or not these ethical considerations are to be included in health policy.

Appendix A: Instructions in the First Experiment. Interviewer Instructions are in Italics and Between [...].

This survey is part of a study conducted under the supervision of Pompeu Fabra University. The objective of the study is to know people's point of view about different health problems. We are going to ask you hypothetical situations, that is, that you do not face in practice but it would be of much help if you could tell us what you would do in these situations. Take into account that there are no right or wrong answers. We just want to know your opinion. Please, ask any question that you may have during the interview. Thanks.

Stroke is a health problem caused by the placement of blood clots in the brain. Health after stroke can vary widely between patients. I am going to describe 6 possible health states after stroke. I am going to ask you to consider also death as a potential consequence of stroke. I would like to know how good or bad these health states are for you. Please rank the six cards from the most to the least preferred.

[Instruction for the interviewer: give the subject the six cards that describe the health states including the one with death. Cards are identified with a letter at the back. Let the subject read the cards. Wait until the subject ends with the ranking and then read the next sentence.]

In order to help you to express your opinion about how good or bad the 6 health states are we use a scale similar to a thermometer. In this thermometer 100 is the number associated to the best health state you can imagine. 0 is the worst health state you can imagine. We would like you to place on the scale each of the 6 health states taking into

account that when comparing two health states, the more preferred has to receive a higher number than the less preferred and the distance has to show how much better or worse it is.

Treatment questions

When somebody has a stroke it is very important to provide medication as soon as possible to remove the blood clot. Otherwise, there can be permanent injuries in the brain that may create important chronic health problems. However, the best treatment (or better said the best dose) is not clear. In general, there are two ways of dealing with this problem. The doctor can give to the patient two different doses, namely, high or low. The problem of the high dose is that in some patients it can lead to death. The low dose cannot cause death but in some patients it can be ineffective and then the stroke can cause brain damage and the patient will have health problems for the rest of his life.

We are now going to show you several hypothetical situations and we would like you to tell us which dose you prefer.

Appendix B: Instructions in the Second Experiment. Interviewer Instructions are in Italics and Between [...].

Stroke is a health problem that is produced by a blood clot in your brain. The consequences for your health can be quite different. I am going to describe to you several situations that you might have after a stroke.

Assume you may have a stroke. Assume that you can remain, for the rest of your life, as follows [*interviewer, show the cards*]

If you had had a stroke and you could be as one of those patients, which one would you choose to be?

P1. I would choose to be [*interviewer, if the subject does not say 'patient N' there is a mistake. Please, check that the subject has understood the question*]

This is right, the ideal thing would be to be patient N, that is, to be totally well after the stroke. However, in some occasions this does not happen. Patients will remain, for the rest of their life in a health state that is worse than the one they were enjoying before the stroke. Now, we ask you to make a choice between the other patients, according to your preferences. That is, if you could not be patient N, which patient would you choose to be? You will see that in one patient you read “dead”. Indeed, stroke can lead to death. Recall that your situation is chronic, that is, it is going to last for the rest of your life. It is possible that you think that the health state of some of the patients is so bad that it would had been better for you to die rather than living the rest of your life in the situation of one of those patients.

P2. If as a consequence of a stroke I could not be as patient N (normal health), I think I would choose to be patient.....

Please go on with the rest of the patients, by order of preference until the one that you think is the worst off.

Standard gamble questions

Finally, we are going to ask you to assume that you are as one of the above patients as a consequence of a stroke, but there is only one treatment available. You have to choose whether to accept the treatment or not. The problem is that this treatment is only

effective in very few occasions (5% of the cases, i.e. in 5 out of 100 people) and in the rest of cases it leads to death.

Assume that as a consequence of a stroke you are going to be as patient R the rest of your life and you are offered the treatment that with probability 5% allows you to return to your normal health, the situation you had before the stroke, and with probability 95% results in death.

Do you think that you would follow the treatment or you would accept to remain as patient R for the rest of your life? (we do not know what will happen in the future but assume that there is not going to be a better treatment available in the future).

- a. I would take the treatment *[interviewer go to next question]*
- b. I prefer to stay as R for the rest of my life.

Do you think that you would follow the treatment if you were informed that it only worked very rarely, say in 1 out of 1000 people?

- a. I would take the treatment *[interviewer go to next question]*
- b. I prefer to stay as R for the rest of my life.

Appendix C: Proof that gambling effect theories can account for the reversal between ranking and treatments but not between ranking and standard gamble questions

According to the theories of the gambling effect, people use different utility functions v and u to evaluate outcomes that are riskless and outcomes that are risky, respectively. To explain the common deviations from expected utility, these theories assume that for all outcomes x , $v(x) > u(x)$. In the extended ranking all outcomes are riskless and the function v is applied. In the choices between the treatments, all outcomes are risky and u is applied. If v and u do not order outcomes identically, i.e.

there exist health states h such that $v(h) > v(\text{death})$, but $u(\text{death}) > u(h)$ then the gambling effect theories can explain the preference reversal between the extended ranking and the choices between the risky treatments. A choice for the risky treatment in the standard gamble questions implies, however that $pu(\text{normal health}) + (1-p)u(\text{death}) > v(h)$ as $p \rightarrow 0$. This contradicts, however, that $v(h) > v(\text{death}) > u(\text{death})$.

References

- Bateman, I, Day, B., Loomes, G., and Sugden R. (2006). Can ranking techniques elicit robust values? Working paper UEA.
- Birnbaum, M. H. (1974). 'The nonadditivity of personality impressions', *Journal of Experimental Psychology*, vol. 102, pp. 543-561.
- Birnbaum, M. H., Coffey, G., Mellers, B. A., and Weiss, R. (1992). 'Utility measurement: Configural weight theory and the judge's point of view', *Journal of Experimental Psychology: Human Perception and Performance*, vol. 18, pp. 331-346.
- Birnbaum, M. H. and Sutton, S. E. (1992). 'Scale convergence and utility measurement', *Organizational Behavior and Human Decision Processes*, vol. 52, pp. 183-215.
- Bonita, R. and Beaglehole, R. (1988). 'Modification of Rankin scale: Recovery of motor function after stroke', *Stroke*, vol. 19, pp. 1497-1500.
- Bostic, R., Herrnstein, R. J., and Luce, R. D. (1990). 'The effect on the preference reversal of using choice indifference', *Journal of Economic Behavior and Organization*, vol. 13, pp. 193-212.
- Diecidue, E., Schmidt, U., and Wakker, P. P. (2004). 'The utility of gambling reconsidered', *Journal of Risk and Uncertainty*, vol. 29, pp. 241-259.

- Fishburn, P. C. (1978). 'On Handa's "new theory of cardinal utility" and the maximisation of expected return', *Journal of Political Economy*, vol. 86, pp. 321-324.
- Fishburn, P. C. (1980). 'A simple model for the utility of gambling', *Psychometrika*, vol. 45, pp. 435-448.
- Frey, B. S., Oberholzer-Gee, F., and Eichenberger, R. (1996). 'The old lady visits your backyard: A tale of morals and markets', *Journal of Political Economy*, vol. 104, pp. 1297-1313.
- Gneezy, U. and Rustichini, A. (2000). 'Pay enough or don't pay at all', *Quarterly Journal of Economics*, vol. 115, pp. 791-810.
- Goldstein, W. M. and Einhorn, H. J. (1987). 'Expression theory and the preference reversal phenomena', *Psychological Review*, vol. 94, pp. 236-254.
- Handa, J. (1977). 'Risk, probabilities and a new theory of cardinal utility', *Journal of Political Economy*, vol. 85, pp. 97-122.
- Kahneman, D. and Tversky, A. (1979). 'Prospect theory: An analysis of decision under risk', *Econometrica*, vol. 47, pp. 263-291.
- Lenert, L. A., Sherbourne, C. D., and Reyna, V. (2001). 'Utility elicitation using single-item questions compared with a computerized interview', *Medical Decision Making*, vol. 21, pp. 97-104.
- Lichtenstein, S. and Slovic, P. (1971). 'Reversals of preference between bids and choices in gambling decisions', *Journal of Experimental Psychology*, vol. 89, pp. 46-55.
- Lindman, H. (1971). 'Inconsistent preferences among gambles', *Journal of Experimental Psychology*, vol. 89, pp. 390-397.

- Loomes, G. and Sugden, R. (1986). 'Disappointment and dynamic consistency in choice under uncertainty', *Review of Economic Studies*, vol. 53, pp. 271-282.
- Luce, R. D. and Marley, A. A. J. (2000). 'On elements of chance', *Theory and Decision*, vol. 49, pp. 97-126.
- Lundberg, L., Johannesson, M., Dag, G. L., and Borquist, L. (1999). 'The relationship between health state utilities and the SF-12 in a general population', *Medical Decision Making*, vol. 19, pp. 128-141.
- Mellers, B. A., Weiss, R., and Birnbaum, M. H. (1992). 'Violations of dominance in pricing judgments', *Journal of Risk and Uncertainty*, vol. 5, pp. 73-90.
- Oliver, Adam J. (2003). 'A quantitative and qualitative test of the Allais paradox using health outcomes', *Journal of Economic Psychology*, vol. 24 pp. 35-48.
- Oliver, Adam J. (2006). 'Further evidence of preference reversals: Choice, valuation and ranking over distributions of life expectancy', *Journal of Health Economics* vol. 25, pp. 803-820.
- Poterba, J. M., Venti, S. F., and Wise, D. A. (1998). '401(k) plans and future patterns of retirements saving', *American Economic Review*, vol. 88, pp. 179-184.
- Rankin, J. (1957). 'Cerebral vascular accidents in patients over the age of 60', *Scottish Medical Journal*, vol. 2, pp. 200-215.
- Robinson, A., Dolan, P., and Williams, A. (1997). 'Valuing health states using VAS and TTO: What lies behind the numbers?' *Social Science and Medicine*, vol. 45, pp. 1289-1297.
- Schmidt, U. (1998). 'A measurement of the certainty effect', *Journal of Mathematical Psychology*, vol. 42, pp. 32-47.
- Stalmeier, P.F.M., Wakker, P.P., and Bezembinder, T.G.G.. (1997). 'Preference reversals: Violations of unidimensional procedure invariance,' *Journal of*

Experimental Psychology, Human Perception and Performance, vol. 23, pp. 1196-1205.

Starmer, C. (2000). 'Developments in non-expected utility theory: The hunt for a descriptive theory of choice under risk', *Journal of Economic Literature*, vol. 28, pp. 332-382.

Titmuss, R. M. (1970). *The gift relationship*. London: Allen and Unwin.

Tversky, A., Sattath, S., and Slovic, P. (1988). 'Contingent weighting in judgment and choice', *Psychological Review*, vol. 95, pp. 371-384.

Tversky, A. and Simonson, I. (1993). 'Context-dependent preferences', *Management Science*, vol. 39, pp. 1179-1189.

Tversky, A., Slovic, P., and Kahneman, D. (1990). 'The causes of preference reversal', *American Economic Review*, vol. 80, pp. 204-217.

Upton, W. E. (1973). *Altruism, attribution, and intrinsic motivation in the recruitment of blood donors*. Doctoral Dissertation: Cornell University.

Wedell, D. H. (1991). 'Distinguishing among models of contextually induced preference reversals', *Journal of Experimental Psychology: Learning, Memory, and Cognition*, vol. 17, pp. 767-778.