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RATIONAL CHOICE AND THE RELEVANCE OF IRRELEVANT ALTERNATIVES *

by

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Abstract

This experimental study investigates the influence of irrelevant or phantom alternatives on subjects' choices in sequential decision making. Using experimental data from 45 subjects, we found that irrelevant alternatives bear significant relevance for decision making. We observe that only 38% of our subjects make the same choice after two phantom alternatives, as compared with the same decision problem when analyzed from scratch. Even allowing for a natural error rate as high as 25%, we find that between 40% and 60% of our subjects are led astray by the presence of phantom alternatives.

Testing then basic postulates of rational choice, we find moderate violations of contraction monotonicity and static preference consistency, and substantial violations of dynamic preference consistency.

Finally we find that subjects exhibiting rational choice behaviour are far less susceptible to dependence on irrelevant alternatives than subjects which violate rational choice behaviour. Rational choice behaviour is thus a good proxy for the independence of a subject's choices of irrelevant alternatives.

Keywords: Independence of Irrelevant Alternatives, Phantom Alternatives, Sequential Decision Making, Rational Choice, Multiattribute Decision Making.

JEL classification: C91, D46, D80, A14.

1 Introduction

One of the central axioms of both individual and collective decision making is the axiom of *independence of irrelevant alternatives*. Psychologists have captured this phenomenon by the term *procedure invariance*, i.e., the course of a decision process should not influence its result. The present study was prompted by the finding that phantom alternatives may exert a decisive influence on the decisions made in processes of sequential decision making. A phantom alternative is some form of irrelevant alternative, viz. it “is an option that looks real but for some reason is unavailable at the time the decision is made¹”.

There are different ways in which irrelevant or phantom alternatives can influence the decision process. Farquhar and Pratkanis, for instance, report on some evidence in “poultry stock selection decisions where the best performers in USDA egg-laying tests can be experimental breeds or foreign imports that are not commercially available. Sometimes these phantom birds are not recognized until after dominance screening has reduced the hundreds of options to a few choices. When a phantom bird is belatedly discovered, poultry farmers usually select from the other breeds remaining after screening rather than consider options eliminated by the phantom ...²” A similar problem can arise in a beauty contest, say to elect Miss America. If one of the contestants of the 50 member states of the U.S.A. drops out, then the beauty contest may well confine itself to the remaining contestants rather than first screening for the second ranked beauty of the state whose contestant had dropped out. We cannot exclude that this beauty, although being second ranked in one particular state, outstrips all Misses of the other states.

When designing our experiment of sequential decision making to investigate this phenomenon, we became increasingly suspicious of the usefulness of distinguishing between static and dynamic decision models. For a long time, psychologists have stressed that a single decision is not a matter of a snapshot, but the result of perceptual, emotional and cognitive processes, which all contribute to a dynamic process in which the decision maker seeks and evaluates information sequentially³. Trying to minimize cognitive effort, a decision maker is unlikely to start a laborious multi-staged decision process again from scratch when he is told that his most favourite choice alternative is no longer available. Rather will he put up with an alternative from those which were eliminated at the latest. Such attitudes engender the paradoxical decisions associated with phantom alternatives.

In the course of a preliminary experiment we observed that subjects which exhibited rational choice behaviour were less susceptible to pitfalls of decision making due to phantom alternatives. This induced us to systematically investigate interrelationships between rational choice behaviour and the relevance of irrelevant alternatives.

Section 2 develops the theoretical underpinning of our paper. It starts by explaining the dynamics of decision making through decision makers’ effort to minimize cognitive effort. Then we proceed to review the most important varieties of irrelevant alternatives and propose basic postulates of rationality.

Section 3 gives a detailed description of our experiment, and Section 4 contains the results of our study. Section 5 concludes.

¹Farquhar and Pratkanis (1993), 1214.

²Farquhar and Pratkanis (1993), 1220.

³Cf., e.g., Montgomery and Svenson (1976), 283; Svenson (1979), 86.

2 How to Simplify Decision Problems

2.1 Minimizing Cognitive Effort

A decision maker's task of seeking, gathering and evaluating information involves a considerable *cognitive effort* or cost of thinking⁴. As different decision rules may require different amounts of cognitive effort, decision makers who try to minimize the amount of cognitive effort will, during the decision process, tend to apply simpler rules before they try rules which require more cognitive effort⁵.

Now, which decision rules can be assumed to be simpler rules in multiattribute decision making? Multiattribute decision rules⁶ can be divided into *noncompensatory* or noncommensurable and *compensatory* or commensurable decision rules. The distinction between these types of decision rules is straightforward. Under a noncompensatory rule, the abundance in some attribute cannot compensate for the deficiency in another. Under a compensatory rule, trade offs among all attributes must be defined.

Empirical research has shown that decision makers apply decision rules sequentially in order of increasing cognitive effort. This means that they use first noncompensatory rules to whittle down the number of choice alternatives by eliminating alternatives, thereby simplifying the decision task considerably. Compensatory decision rules are subsequently used to analyse the simplified decision problem. Indeed, noncompensatory rules are applied to decision problems with many alternatives whereas compensatory rules dominate in decision problems with only few choice alternatives⁷.

Suppose now that a decision maker, upon having toiled through a laborious multi-staged decision process, is told that his chosen alternative is no longer available. Given his attitude of minimizing cognitive effort, will he start the multi-staged decision process anew, or will he rather fall back on the alternative which was the last one that has been eliminated⁸? Empirical evidence suggests that there is a strong tendency for subjects to follow this precept⁹. It is precisely this circumstance which gives rise to the decision problems caused by phantom alternatives¹⁰.

2.2 Do Irrelevant Alternatives Matter?

Irrelevant alternatives may influence the decision process in many ways. The kind of influence depends, first and foremost, on the type of irrelevant alternatives. By and large

⁴For an interesting theory of the cost of thinking cf. Shugan (1980). The cost of optimization was analysed by Conlisk (1988). Von Winterfeldt and Edwards (1982) and Harrison (1994) have blamed experimental economists for insufficient rewards used in their experiments, which were not attractive enough to compensate subjects for their decision cost. They argue that insufficient rewards could have been the cause for much observed falsification of correct theories. For a fully-fledged model of decision costs and subjects' performance in experiments cf. Smith and Walker (1993).

⁵Montgomery and Svenson (1976), 288f.; Svenson (1979), 107; Shugan (1980), 100; Russo and Doshier (1983).

⁶The experiment also enabled us to test various decision rules for multiattribute decision making. This is elaborated in a separate paper.

⁷Cf. Payne (1976), 382; Russo and Doshier (1983); Johnson and Meyer (1984).

⁸Payne (1982), 383.

⁹Wright and Barbour (1977), 102.

¹⁰Farquhar and Pratkanis (1993).

we may distinguish between *inferior*, *superior*, and *agenda-induced* irrelevant alternatives.

A decision process is influenced by an *inferior* irrelevant alternative, if an alternative is added to the choice set, where this alternative is, because of its obvious inferiority, never chosen, but nevertheless exerts influence on the actual choice, possibly by some anchoring phenomenon. A working example on inferior irrelevant alternative is the addition of asymmetrically dominated alternatives to the choice set, which may change preferences in favour of the (now) dominating alternatives. To be more precise, let us illustrate that with an example taken from Tyszka¹¹: Suppose we have two alternatives, a_1 and a_2 , and two attributes, d_1 and d_2 , as follows:

	d_1	d_2
a_1	5	3
a_2	3	5

We assume that higher attribute levels are always preferred. Now the preference of a decision maker depends on his evaluation of the attributes. Suppose that somebody tells the decision maker that there exists a third alternative a_3 which changes the choice problem as follows:

	d_1	d_2
a_1	5	3
a_2	3	5
a_3	4	2

Obviously a_3 is an asymmetrically dominated alternative, which should never be chosen; it is dominated by a_1 , but not by a_2 . By virtue of being dominated, a_3 should have been quickly eliminated in a so-called editing phase¹² if the decision maker in fact started his decision process with a screening phase. Empirical evidence has, however, amply shown¹³ that the addition of an asymmetrically dominated alternative changes subjects' preferences in favour of the now dominating alternative a_1 . This means that choice alternatives should be more attractive the more alternatives they dominate.

Agenda-induced irrelevant alternatives arise in the course of forcing an agenda on a decision maker in hierarchical decision making. This renders some alternatives irrelevant and can thus change the results of a decision process¹⁴. Such effects are well known from group decision making¹⁵, but may as well occur in hierarchical individual decision making. To illustrate¹⁶, assume that for a banquet there are two choices of food, French or Mexican, and two types of dress, formal and informal. If the agenda forces first the decision on the dress, and the decision maker (or the group of decision makers) opts for informal dress, then the alternative "banquet with French food and formal dress" is rendered irrelevant. If the decision maker had, under a different agenda, first opted for

¹¹Tyszka (1983), 244.

¹²Cf. Kahneman and Tversky (1979), 274ff.

¹³Cf., e.g., Huber, Payne, and Puto (1982); Huber and Puto (1983); Tyszka (1983); Ratneshwar, Shocker, and Steward (1987); Wedell (1991). For differentiated results cf. Simonson (1989).

¹⁴Tversky and Sattah (1979), 560ff.

¹⁵Cf. Plott and Levine (1978).

¹⁶Plott and Levine (1978), 147.

French food, the question of the dress being decided only later, then this alternative had remained among the relevant ones.

Superior irrelevant alternatives are choice alternatives which are considered to be best choices. However, in the course of the decision process it becomes apparent that they are not available; for some reason they drop out of the set of choice alternatives. Farquhar and Pratkanis (1993) have called them *phantom* alternatives, which seems to be a good term to describe their role. Phantom alternatives are the main concern of this paper. In case of phantom alternatives, too, preferences may depend on the structure of the option set and, thus, on irrelevant alternatives. Phantom alternatives also seem to trigger some anchoring mechanism. Farquhar and Pratkanis argue that the presence of a recognized phantom alternative which is preferred to other options on some attributes may yield a *contrast effect* that lowers the attractiveness of the other options on these attributes.¹⁷ Unrecognized irrelevant or phantom alternatives (i.e., options which are not known in advance to be unavailable) can produce striking changes in decision making. It is, in particular, “applications of dominance screening procedures [which] often fail to consider that dominance relations depend on the problem structure. As the problem structure changes, earlier dominance relations among the decision alternatives may no longer hold. ... Similarly, it is possible to eliminate the best option (of those that are truly available) in comparison with a dominating but unrecognized phantom.”¹⁸

In order to test the influences of irrelevant or phantom alternatives on the decision process, we designed our experiment as a sequential decision making process of recruiting a secretary, where a subject’s first and second best candidates drop out sequentially during the first part of the experiment. The third best candidate is then hired. The second part of the experiment replicates the candidates of the first part with the exception of the first best (in most cases also the second best) candidate(s), employing a somewhat camouflaged presentation. Then we check whether the best *relevant* alternative(s) of the first part of the experiment becomes also the best alternative(s) of the second part of the experiment. As there were some two weeks between the first and the second part of the experiment and some camouflage was applied, it was not easily obvious to subjects that they were confronted with virtually identical decision situations except for the one (or two) irrelevant or phantom alternatives in the first part of the experiment.

We have become aware of one precursor of our experiment, viz. the work of Wright and Barbour (1977). However, their experiment differs in many important respects from ours. The first phase of their experiment did not constitute a real decision problem for their subjects. Instead the subjects were just told of the choice alternatives not eliminated by some extraneous conjunctive rule with exogenously given cutoff scores¹⁹. In their experiment, however, either exactly one or no alternative passed all required attribute scores²⁰. In the first case subjects were told that even this one alternative was no longer available. As the extraneously enforced choice sets have thus become empty, the subjects

¹⁷Farquhar and Pratkanis (1993), 1219.

¹⁸Farquhar and Pratkanis (1993), 1220.

¹⁹Wright and Barbour (1977), 92. Subjects’ possible opposition against this tutelage might have induced them to discard conjunctive rules altogether in the second decision phase; cf. Wright and Barbour (1977), 105.

²⁰Wright and Barbour (1977), 101.

were asked to decide using some decision strategy they thought reasonable²¹. Wright and Barbour surmised that subjects would predominantly confine themselves to the small set of alternatives which survived the next-to-last cutoff²², and seem to have found some evidence for that. This means, however, that subjects should identify themselves with a decision process which has been carried out by some extraneous authority rather than by the subjects themselves. Therefore, we are somewhat sceptical of whether these authors have indeed applied an effective experimental design to test the influence of superior irrelevant alternatives.

2.3 Does Choice Satisfy Basic Postulates of Rationality?

Finally we investigate whether subjects' choices satisfy some rather elementary requirements of rationality, viz. contraction monotonicity, static preference consistency, and dynamic preference consistency. For the purpose of testing rationality we used the short lists of preferred choice alternatives as indicated by our subjects.

Contraction monotonicity is inspired by property α of social choice theory²³. Suppose that a choice alternative a is available in two choice situations $A_1 \subseteq A$ and $A_2 \subseteq A$, where $A_1 \supseteq A_2$. Then contraction monotonicity requires that a being in the short list of A_1 [which is denoted by $a \in \text{SL}(A_1)$] implies that a is also an element of the short list of A_2 . More formally, we have:

$$[A_1 \supseteq A_2, a \in A_2, a \in \text{SL}(A_1)] \Rightarrow a \in \text{SL}(A_2).$$

Preference consistency encompasses static and dynamic preference consistency. *Static preference consistency* simply requires that alternatives within the short list should be preferred to alternatives outside the short list. More formally, we have:

$$[a_i, a_j \in A, a_i \in \text{SL}(A), a_j \notin \text{SL}(A)] \Rightarrow a_i \succ a_j.$$

Dynamic preference consistency extends this requirement to two choice situations. In particular, this condition requires that even if new alternatives enter the short list in a contracted choice set, then the alternatives of the former short list should also be preferred to newcomers to the short list when they are still available. This should hold, of course, more so vis-à-vis alternatives remaining outside the short list. More formally, we have:

$$[A_1 \supseteq A_2; a_i, a_j \in A_2; a_i \in \text{SL}(A_1); a_j \notin \text{SL}(A_1)] \Rightarrow a_i \succ a_j.$$

These basic postulates of rational choice seem to be rather modest, and one might expect that anybody complies with them. Yet experience shows the contrary. As we shall see, more than half of our subjects did not comply with all three basic postulates of rational choice.

²¹Wright and Barbour (1977), 101.

²²Wright and Barbour (1977), 102.

²³Cf., e.g., Sen (1970), 17.

3 The Experiment

3.1 Stimulus Material

The stimulus was an evaluation sheet of the data of 25 applicants for the position of a chief secretary to be hired. The subjects were told that they should imagine themselves to be successful entrepreneurs and, since they were short of time, they entrusted the screening of the applicants for this position to a professional recruitment agency. The recruitment agency assigns a code number to each applicant and evaluates the applicants with respect to six attributes, viz.²⁴:

- (i) IQ ... quotient of intelligence defined with a mean value 100, a standard deviation of 15, and the assumption that intelligence is normally distributed;
- (ii) ST ... proficiency in shorthand and typewriting to be measured along a scale ranging from 1 to 100 points;
- (iii) L ... proficiency in foreign languages measured as a weighted index (the weights reflecting the needs of the firm) along a scale ranging from 1 to 100 points;
- (iv) AM ... appearance and good manners of an applicant measured along a scale ranging from 1 to 10 points;
- (v) EXP/PROF ... experience and proficiency in office work measured along a scale ranging from 1 to 10 points;
- (vi) COMP ... proficiency in working with personal computers, measured along a scale ranging from 1 to 10 points.

The *basic* evaluation sheet is depicted as Table 1. Choice alternatives are characterized by k -domination. A choice alternative a_i dominates the choice alternative a_j , if a_j has no better attribute level than a_i , but a_i outperforms a_j with respect to at least one attribute. Subjects were informed that higher attribute levels always indicate better qualification. Taking up a suggestion of Farquhar and Pratkanis, a k -dominated alternative means that exactly k options dominate the respective alternative²⁵. In this terminology, undominated alternatives are referred to as 0-dominated alternatives.

The basic evaluation sheet exhibits a simple structure. The applicants numbered 1 and 2 excel with respect to the first attribute, where alternative a_1 dominates alternative a_2 , although alternative a_2 is, in general, rather similar to alternative a_1 . Moreover, alternative a_1 is 0-dominated (undominated), whereas alternative a_2 is 1-dominated (by alternative a_1), so that, when alternative a_1 drops out, alternative a_2 becomes a 0-dominated alternative and can replace alternative a_1 as some kind of a similarly structured second best alternative. This pattern is repeated for the six pairs of alternatives a_1 to a_{12} .

²⁴There is evidence that there is some effect of attribute ranges on attributes' weights in multiattribute decision making; cf. von Nitzsch and Weber (1993). However, we see no possibility to control for these effects. We could hardly do more than keeping attribute ranges constant for the two parts of the experiment.

²⁵Farquhar and Pratkanis (1993), 1223.

Table 1: Basic Evaluation Sheet

Appl. No.	IQ	ST	L	AM	EXP/PROF	COMP
1	120	70	75	6	8	6
2	118	65	73	5	7	5
3	95	90	67	8	7	8
4	94	88	66	8	7	7
5	97	68	95	8	6	8
6	96	66	92	7	5	8
7	101	72	59	10	8	6
8	100	69	57	9	7	5
9	104	75	72	8	10	7
10	103	73	69	8	9	7
11	108	81	62	6	7	10
12	107	79	60	6	7	9
13	109	85	82	8	8	8
14	105	62	70	5	7	6
15	91	59	62	5	7	5
16	88	81	55	8	7	5
17	79	66	64	7	6	6
18	92	57	80	6	5	7
19	88	63	50	7	4	5
20	96	60	55	6	6	4
21	99	48	52	5	6	5
22	100	71	65	7	7	7
23	102	66	48	6	6	7
24	96	75	51	5	4	8
25	104	62	46	6	7	5

Alternative a_{13} , too, is 0-dominated. It is constructed such that the values of all its attributes are third best. For instance, only alternatives a_1 and a_2 have better values for the first attribute, only alternatives a_3 and a_4 have better values for the second attribute, and so on for all attributes.

The remaining alternatives a_{14} to a_{25} are at least 2-dominated. All are dominated by a_{13} and by at least one alternative of the first twelve alternatives. For example, a_{14} is dominated by a_{13} and a_1 ; a_{15} and a_{20} are dominated by 10 alternatives each; etc. The dominance structure is shown in Table 2.

This structure of choice alternatives as exhibited in the basic evaluation sheet is, of course, too revealing in this form to be presented to the subjects. Therefore, we employed a randomization of the lines of Table 1 and presented an evaluation sheet with randomly permuted lines to our subjects. (Notice that the chosen randomization was the same for all subjects.)

Let us, as a short digression, comment on our reasons for presenting the data in matrix form. Subjects may obviously proceed to gather and process information in two differ-

Table 2: The Dominance Structure of the Choice Alternatives

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Σ
1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	1	1	-	-	-	1	6
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	2
3	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	1	-	-	-	-	-	-	5
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	1	-	-	-	-	-	-	4
5	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1	-	-	-	-	-	5
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	1	1	-	-	-	-	-	2
7	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	1	1	1	-	-	-	-	4
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	-	-	-	-	3
9	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	1	-	1	1	1	1	1	-	1	9
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	1	1	1	1	1	-	-	7
11	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	1	1	-	1	1	1	7
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	1	1	1	5
13	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1	1	1	1	1	1	1	12
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	2
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	1	1	1	-	-	-	-	5
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Σ	0	1	0	1	0	1	0	1	0	1	0	1	0	2	10	3	7	3	11	10	11	3	5	3	5	-

1 means that alternative i (line) dominates alternative j (column). The line sums indicate the number of alternatives which are dominated by the alternative of the respective line. The column sums indicate the number of alternatives which dominate the alternative of the respective column (k -dominance).

ent ways: first they may screen alternatives²⁶ and, second, they may screen attributes²⁷. Tversky had maintained that intra-attribute (noncompensatory) comparisons are easier for the subjects than inter-attribute or intra-alternative (compensatory) comparisons. He conjectured, therefore, that intra-attribute comparisons will precede inter-attribute ones²⁸. However, empirical research by Bettman and Kakkar (1977) has demonstrated that the structure of information presentation greatly influences the information search and evaluation processes that will be used. Data presentation focussing on the choice alternatives favours intra-alternative search whereas data presentation given in attribute dimensions favours intra-attribute search. Their third experimental design was the matrix presentation of data which proved to be the most neutral one for the elicitation of search procedures²⁹. As we tried to eliminate biases from data presentation, we chose, therefore, the matrix form of data presentation.

For the second part of the experiment, we told subjects that, after several years, the chief secretary has been transferred to support the establishment of a new branch of the

²⁶This mode of search has also been called depth-first search [Montgomery and Svenson (1976), 287], brand processing [Bettman and Kakkar (1977), 234], intraalternative search [Svenson (1979), 99], alternative-based processing [Payne (1982), 391], holistic processing [Russo and Doshier (1983), 677], compensatory choice strategy [Johnson and Meyer (1984), 531 and 538].

²⁷This mode of search has also been called breath-first search [Montgomery and Svenson (1976), 287], attribute processing [Bettman and Kakkar (1977), 234], interattribute search [Svenson (1979), 99], within-attribute comparisons [Payne (1982), 391], dimensional processing [Russo and Doshier (1983), 677], noncompensatory choice strategy [Johnson and Meyer (1984), 534f. and 538].

²⁸Tversky (1969), 42f.

²⁹Empirical work by Russo (1977) has shown that the list presentation of unit prices for close substitutes of commodities is of the greatest benefit to consumers.

firm, and a new secretary was to be hired. As the recruitment agency had performed well, it is again entrusted with the evaluation of the applicants. For the second part, we used essentially the same set of alternatives. In order to camouflage this fact, we employed a different randomization of the lines, and re-ordered the columns, using AM as the first attribute, IQ as the second, EXP/PROF as the third, L as the fourth, COMP as the fifth, and ST as the sixth. We explained the re-structuring of columns by telling the subjects that the recruitment agency had changed its evaluation reports so as to enlist the features which concern an applicant's personality in the first places, and the more technical properties only thereafter. Moreover, one or two of the previous alternatives (to be explained in the next section) were deleted, so that a subject was presented an evaluation sheet containing 23 or 24 of the original 25 alternatives of the first part of the experiment, arranged, however, in a different order.

3.2 Response Method

Several days before the start of the first part of the experiment, the subjects were introduced to the problem (i.e., recruitment of a chief secretary) and received the agency's evaluation sheet (i.e., a randomized version of Table 1). They were told that they should carefully analyze it and think about a short list of candidates, about the candidate who should be chosen to be employed, and about the relative importance of the various attributes. Furthermore, subjects were asked to enter their names in a time-table and to show up at the agreed time for the first part of the experiment.

The experiment was administered on a computer. The subjects first entered their personal data to enable us to join the individual responses of the first and the second part of the experiment. Then the subjects were asked to order the six attributes according to their importance. They could state indifference as well as strict preference. We then asked the subjects for the short lists of their most preferred candidates. They could nominate up to ten candidates. Then we asked the subjects to state which candidate they wanted to hire. After the respective response, the subjects were told that the chosen candidate had just recently withdrawn her or his application. The subjects should kindly make another choice. After having done that, the subjects were informed that this very candidate had meanwhile accepted another offer and was, therefore, no longer available. They were told that the recruitment agency had assured that all of the remaining candidates were still available. The subjects should kindly accept the agency's apologies and make one more choice. This concluded the first part of the experiment.

This cancellation of chosen alternatives constitutes an important element of our experimental design. It was intended to surprise agents in order to confront them with a situation in which the decision process had to be resumed. The crucial problem we wanted to study is whether subjects would only fall back on those chosen alternatives which survived the next-to-last cutoff, or whether they would rather start the decision process again from scratch.

We then prepared a second evaluation sheet as described above. The first best alternative of the first choice was the one to be deleted. As we expected a distinct preference for alternative a_{13} , we deleted also this alternative, if a_{13} happened to be the first or second best alternative in the first part of the experiment. If the alternative a_{13} emerged as first best, then the second best alternative, too, was eliminated in order to correct

for a_{13} and make choices comparable with respect to deleted alternatives different from a_{13} . Then the subjects were invited to indicate the short lists of their most preferred candidates (up to ten) and the candidates to be hired with first and second priorities.

As the second part of the experiment started only some two weeks later³⁰, and, as the second evaluation sheet was sufficiently camouflaged, we expected our subjects to start the second decision process from scratch in a similar way as they had proceeded in the first part of the experiment. However, in the second part of the experiment, the irrelevant alternatives were at the outset deleted from the choice set. If the choice process of the first part of the experiment had not been biased by the irrelevant alternatives, the second part should have produced the same first best choice as the third best choice of the first part. Of course, we could not expect to trap our subjects again with alternatives becoming irrelevant as a surprise. In order to avoid strategic behaviour on the part of subjects, we asked them at the outset for their first and second best choices adding that the recruitment agency had assured beforehand that all applicants are still available.

3.3 Procedure

The subjects were 45 students of the University of Kiel, mostly students of Economics, in their third or fourth year.

The subjects were introduced to the experiment on December 15 and 16, 1994, respectively, and received the first evaluation sheet. At the same time, they entered their names into a time-table, which allowed them 15 minutes at the computer. The first part of the experiment took place in the time period between December 19 and December 22, 1994, which left them more than a weekend to thoroughly analyze the choice problem before answering our questions. We then processed the second evaluation sheet, which started from a common re-arrangement of columns and another randomization of lines.

In order to keep framing effects at their minimum, we started with the same randomization of lines for all subjects. Whereas this different arrangement does not rule out framing effects completely, it warrants that all subjects are exposed to the same arrangement, thus correcting for different distortions among subjects. Possibly remaining framing effects should be modest and, therefore, tolerable.

Furthermore, the evaluation sheets were individualized by deleting the subject's first best alternatives of the first part of the experiment and also the alternative a_{13} if it had been chosen as the second best alternative. If the alternative a_{13} emerged as first best, then the second best alternative, too, was eliminated. Then these individualized evaluation sheets were re-numbered (carrying now 23 or 24 applicants) and were sent by mail to the subjects' private addresses on December 29, 1994. This left them ample time to analyze the second evaluation sheet. The second part of the experiment took place in the time period between January 4 and 6, 1995.

All subjects were promised at least 10 Deutsch Marks as an honorarium for their efforts of participation in the experiment, provided that they had not given obviously absurd answers, which would indicate their carelessness in treating this experiment. This proviso was made with the intention to induce the subjects to undergo a thorough and earnest analysis of the choice problem before making their choices. Indeed, it had not

³⁰We chose this short spell to exclude major changes of preferences, which would have invalidated the results gained from our experiment

proven to be necessary to deny a subject his or her honorarium. We finally paid the subjects 12 Deutsch Marks each for their participation.

There is a widespread conviction³¹ that experiments should conform with Smith's precepts, in particular with saliency and dominance³². *Saliency* requires that subjects are guaranteed the right to claim a reward which is increasing (decreasing) in good (bad) outcomes of an experiment. *Dominance* requires that the reward structure dominates any subjective cost associated with participation in the experiment. Whereas these precepts are largely undisputed for experiments with outcomes with a natural priority order (i.e., more money is better than less), it is dubious for experiments in which respecting undiluted individual preferences is vital. Otherwise, the reward scheme would distort subjects' behaviour in favour of the values imposed by the experimenter's reward scheme.

To illustrate, suppose one presents to a male subject photos of girls and ask him for the girl he would choose as his spouse. If he is certain to get the chosen girl as his spouse, he will truthfully reveal his preferences. However, if the choice is fictitious only and the choice alternatives are associated with different monetary rewards, then the subject is likely to express again his true preferences, but this time for money, not for spouses. (This resembles somewhat the distorting effect of a dowry in real life.)

Many experimenters have approached these difficulties by offering no rewards at all. Others have offered their subjects lump sum rewards or time-proportional rewards to reimburse them their opportunity cost (for local transport, for the time used for the experiment, etc.) of participating in the experiment. As we could not equip subjects with a firm along with the chosen secretary, we had to settle on some other reward. We discarded a time-proportional reward, as time spent at home could not be monitored and this kind of reward would set odd incentives. As we were fortunate enough to interest our subjects in the experiment, and, as we felt that we should offer our subjects some reward, we used the combination of subjects' interest and a moderate lump sum reward. In spite of the modesty of the financial reward, all subjects participated in both parts of the experiment, which demonstrates their vivid interest in our experiment. Our impression (coming also from discussions in the aftermath of the experiment) is that all subjects aspired after a good solution as if they really had to solve the recruitment problem described to them.

There is, finally, the problem of the reliability of our data. Subjects are notoriously susceptible to mistakes and errors in their responses. For instance, "they could misunderstand the nature of the experiment; they could press the wrong key by accident; they could be in a hurry to finish the experiment; they could be motivated by something other than maximizing the welfare from the experiment *per se*."³³ There have been several attempts to measure subjects' natural error rates³⁴. They suggest a natural error rate of 15 – 25%, Camerer's 31.6% and Battalio, Kagel and Jiranyakul's less than 5% being, as it seems, outliers. As to the error rate of our data we feel that Table 6 below would provide some good clues. If we take the failure to choose undominated alternatives in the ultimate decisions as our natural error rate, this gives us $\frac{12}{45} = 26,67\%$. If we take the

³¹Cf., e.g., Harrison's (1994) recent paper.

³²Cf. Smith (1982), 931 and 934.

³³Hey and di Cagno (1990), 292.

³⁴Cf., e.g., Camerer (1989), 81; Starmer and Sugden (1989), 170; Battalio, Kagel, and Jiranyakul (1990), 47, note 13; Harless and Camerer (1994), 1263; Hey and Orme (1994), 1296, 1318, and 1320f.

failure to choose alternatives which have been nominated as members of the short lists, we get a natural error rate of $\frac{7}{45} = 15,56\%$. These two figures delineate pretty well the interval of commonly recognized error rates.

4 Results

4.1 Testing the Relevance of Irrelevant or Phantom Alternatives

Recall the example of the American beauty contest addressed in the Introduction. If one of the contestants drops out, then the jury may confine itself to the remaining contestants rather than first screening for the second ranked beauty of the state whose contestant had dropped out.

In terms of our experiment, this would mean that the even-numbered alternatives from a_2 to a_{12} are no longer considered as eligible. Thus, if, for instance, alternative a_5 drops out, a_6 needs not necessarily be considered to replace it in the next best choice. Alas, the even-numbered alternatives from a_2 to a_{12} are only *similar* to their preceding odd-numbered alternatives. We cannot exclude that this similarity is not close enough to make this alternative really the next best candidate. Therefore, we relied on a comparison of the third best (or the second and third best) alternative of the first part of the experiment and the best alternatives of the second part of the experiment, as we have in both cases identical choice situations.

Thus, we check whether the third best solution (in those cases in which both the first best and the second best solutions were eliminated) of the first part of the experiment translates into the first best solution of the second part of the experiment. Otherwise, we trace its fate in the second part of the experiment. This is done in Table 3. In Table 5, we investigate those cases which retained both the second and the third best solution of the first part of the experiment in its second part.

Table 3: The Performance of the Third Best Solution of Part One in Part Two

Number of subjects for which the third best solution in part one becomes/is				sum
first best in part two	second best in part two	neither first, nor second best, but in SL	neither first, nor second best, nor in SL	
16	10	9	7	42

Table 3 establishes the relevance of irrelevant alternatives. Although faced with the same decision problems at the end of the first part of the experiment and at the beginning of the second part of the experiment, only 38% of the subjects made the same choice. The actual decision is, therefore, path dependent. Subjects tend to decide differently, if they reach some choice situation after two irrelevant or phantom alternatives, than in the case

where they are faced with this very same decision situation from scratch. Incidentally we observed that subjects increasingly chose dominated alternatives after a sequence of two phantoms, whereas they recovered their ability to discriminate and choose undominated alternatives after a two weeks' interruption³⁵. This improvement in decision-making is also reflected in Table 3. Subjects tend to correct choices which were inferior due to the influence of phantoms once they re-analyze the given choice problem. 38% of the subjects in Table 3 did not even repeat their third best choice of the first part in the second part of the experiment as their first or second best choice.

There is, of course, also the argument that, what we attribute to the influence of irrelevant or random alternatives, is truly caused by the influence of the natural error rate³⁶. However, assuming a natural error rate as high as 25% would explain some 10 deviations from the re-statement of the third best alternatives in part one as the first best alternatives in part two. If irrelevant or phantom alternatives had really no influence on the decision process, we would expect at least 32 translations from third best choices in part one into first best choices in part two. This is twice as much as was actually observed. We may, therefore, well conclude that irrelevant or phantom alternatives matter. Their presence leads between 40% and 60% of the decision makers astray, inducing them to settle on suboptimum choices. Wright and Barbour found even higher figures³⁷.

It is expedient to juxtapose these findings also in terms of conditional probabilities. This is done in Table 4.

Table 4 demonstrates from mere inspection that we hardly need statistical tests to show that the distribution in the last line is different from the distributions in the first and second line. This illustrates again the influence of irrelevant or phantom alternatives on decision makers' choice processes.

Table 5 shows the results for those three subjects who retained both their second and third best alternatives in the second part of the experiment.

Table 5 confirms the finding that irrelevant alternatives matter for the decision process, although the number of subjects in Table 5 is too small to command significance.

³⁵In the first part of the experiment, all 45 subjects chose undominated alternatives for their first best choice, 42 chose undominated alternatives for their second best choice, and only 38 chose undominated alternatives for their third best choice. In the second part of the experiment, 43 subjects out of 45 chose undominated alternatives for the first and for the second best choice.

³⁶We owe this point to Martin Weber.

³⁷Although Wright and Barbour (1977), 102, had explained to their subjects that the cutoffs in the first (exogenous) phase of their decision problem had been totally arbitrary, they observed that more than 70% of their subjects confined themselves to the small set of alternatives that survived the next-to-last cutoff. Subtracting a natural error rate of 25% from their results brings them slightly above our figure of 40% to 60% of all subjects whose decisions were influenced by the presence of irrelevant or phantom alternatives.

Table 4: Conditional Distributions of Part Two Choices for Part One Third Best Alternatives

	1st best	2nd best	in SL	not in SL
Theoret. distr. when irr. alt. had no influence	1.0	0	0	0
Distr. when no influence of irr. alt. with a 25% natural error rate	0.762	(·)	(·)	(·)
Actual distribution	0.381	0.238	0.214	0.167

Table 5: The Performance of the Second and Third best Solutions of Part One in Part Two

No. of subjects	2nd → 1st 3rd → 2nd	reverse order	only 2nd in choice set	only 3rd in choice set	both in SL	2nd in SL	3rd in SL	neither in SL
3	0	0	1	1	0	1	0	0

4.2 Testing Basic Postulates of Rational Choice

There was a total of 282 alternatives in the short lists of part one of the experiment. Of these, 85 dropped out for the second part of the experiment. This means that 197 of the alternatives of the short lists of the first part of the experiment were still available in the second part of the experiment. However, 41 of these (that is 20.8%) were not re-elected for the short lists in part two. Instead, 133 alternatives, which had not been in the short lists of part one, were additionally entered in the short lists of part two, thus yielding a total of 289 alternatives in the short lists of part two of the experiment.

Contraction monotonicity is obviously violated if we have

$$A_1 \supseteq A_2, a \in A_2, a \in \text{SL}(A_1), \text{ and } a \notin \text{SL}(A_2).$$

Table 6 refers to the distribution of violations of contraction monotonicity.

Table 6: Violations of Contraction Monotonicity

Number of subjects with n violations of contraction monotonicity					
$n = 0$	$n = 1$	$n = 2$	$n = 3$	$n = 4$	$n = 5$
22	10	10	1	1	1

Table 6 shows us that only 49% of our subjects did not violate contraction monotonicity. 22% had one violation (i.e., they discarded one alternative of the short list of part one which was still available in part two from the short list of the second part of the experiment), and 22% had two violations. The rest may well be considered to be outliers due to unattentiveness of a few subjects. If we consider the picture conveyed by Table 6 in terms of error, then this amounts to an error rate of roughly 15%, which is on the lower margin of the interval of the natural error rates³⁸.

Static preference consistency is violated if we have

$$a_i, a_j \in A; a_i \in \text{SL}(A), a_j \notin \text{SL}(A), \text{ and } a_j \succ a_i$$

Our data allow us to identify such violations of static preference consistency if alternatives are chosen which are not elements of the respective short lists. Table 7 lists the violations of static preference consistency.

Table 7: Violations of Static Preference Consistency

Number of subjects with n violations of static preference consistency					
$n = 0$	$n = 1$	$n = 2$	$n = 3$	$n = 4$	$n = 5$
38	7	0	0	0	0

Table 7 shows that 84% of all subjects did not violate static preference consistency, i.e., they made their actual choices only from the set of alternatives which were also listed in the short lists. However, 16% of our subjects exhibited preference inconsistency for one alternative, which is well covered by the natural error rate.

Dynamic preference consistency is violated if we have

$$A_1 \supseteq A_2, a_i, a_j \in A_2, a_i \in \text{SL}(A_1), a_j \notin \text{SL}(A_1), \text{ and } a_j \succ a_i .$$

Our data allow us only the following identification of violations of dynamic preference consistency. Suppose some a 's, although still available, vanish from the short list, but, at the same time, some alternatives, which had not been members of the short list of A_1 , now appear in the short list of A_2 . Assume, for example, that $a_1, a_2 \in \text{SL}(A_1)$; $a_3, a_4, a_5 \notin \text{SL}(A_1)$; $a_1, a_2 \notin \text{SL}(A_2)$; $a_3, a_4, a_5 \in \text{SL}(A_2)$. This pattern then indicates six preference inversions from $a_i \succ_1 a_j$ to $a_j \succ_2 a_i$, where $i \in \{1, 2\}$ and $j \in \{3, 4, 5\}$, and \succ_1 denote the preferences for the choice situation A_1 and \succ_2 for A_2 . This means six violations of dynamic preference consistency. We summarize the violations of dynamic preference consistency in our experiment in Table 8.

Table 8: Violations of Dynamic Preference Consistency

Number of subjects with n violations of dynamic preference consistency																
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
24	1	4	3	3	1	4	0	1	0	1	0	1	0	0	1	1

³⁸42 members of the short lists, which were not re-elected in the second part of the experiment, amount to 14.89% of the total of 282 alternatives originally in the short lists.

Table 8 shows us that only 53% of our subjects did not violate dynamic preference consistency. 47% of our subjects revealed some preference inversions with a maximum³⁹ of 16 and a modal value of 6 preference inversions. In view of our rather limited possibilities of detecting violations of dynamic preference consistency, we hold that the natural error rate cannot explain the amassment of violations of preference inversions as a familiar phenomenon. We suspect that the emergence of irrelevant alternatives is at least partly responsible for the amassed violations of dynamic preference consistency.

The next table shows the joint violations of preference consistency. Only 47% of our subjects committed neither a violation of static nor dynamic preference consistency.

Table 9: Violations of Preference Consistency

Number of subjects with n violations of preference consistency																
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
21	4	4	2	4	0	3	2	1	0	1	0	1	0	0	1	1

4.3 Rational Choice Behaviour Renders Irrelevant Alternatives Irrelevant

Out of 45 subjects, 20 subjects showed perfectly rational behaviour, i.e. they committed no offence against one of our basic postulates of rational choice. These are 44.4% of all subjects. Out of 45 subjects, 16 subjects, or 35.5%, exhibited independence of irrelevant alternatives in their choice behaviour.

If both events were stochastically independent, this should give us 15.76%, that is 7 subjects, who showed both perfect rationality and independence of irrelevant alternatives. However, we observed 12 subjects or 26.67% who showed both attitudes. This is even more revealing if we express it in terms of conditional frequencies. Three quarters of all subjects who exhibit independence of irrelevant alternatives show perfectly rational behaviour. This gives a conditional frequency of 75% as compared to the above unconditional frequency of 44.4%. Three fifths of all subjects who exhibit perfectly rational behaviour show independence of irrelevant alternatives. This gives a conditional frequency of 60% as compared to the above unconditional frequency of 35.5%. These preliminary considerations show that there exists a distinct relationship between rational choice behaviour on the one hand and independence of irrelevant alternatives on the other. Rational subjects are less susceptible to the relevance of irrelevant alternatives.

Next we investigate the interrelationship between compliance of the basic postulates of rational choice and independence of irrelevant alternatives. We abbreviate contraction monotonicity by C , static preference consistency by S , dynamic preference consistency by D , and independence of irrelevant alternatives by I . Furthermore, we code “the subject does not violate the respective attitude” by 0 and violation by 1, and compute the matrix of correlation coefficients. For the dichotomized variables, Pearson’s correlation, Kendall’s correlation and Spearman’s correlation coincide.

³⁹Notice that the theoretical maximum of preference inversions is 100 according to the design of our experiment.

Table 10: Rank Correlation of Attitudes

	<i>C</i>	<i>S</i>	<i>D</i>
<i>S</i>	0.1744 (0.247)		
<i>D</i>	0.9149 (0.000)	0.0901 (0.550)	
<i>I</i>	0.4809 (0.001)	0.0626 (0.678)	0.5087 (0.001)

Significance levels (according to Kendall) in brackets. (The significance levels of Pearson's and Spearman's correlations differ only slightly.)

Table 10 shows that three correlation coefficients are significant, viz. the nearly perfect correlation between contraction monotonicity and dynamic preference consistency, the correlation between contraction monotonicity and independence of irrelevant alternatives, and the correlation between dynamic preference consistency and independence of irrelevant alternatives.

Instead of dichotomizing the variables (assigning the value 0 to “no violation of attitude” and 1 to “violation of attitude”) we may also consider the number of violations (as taken from Tables 6 to 8) as ranks for the attitudes *C*, *S*, and *D*, and keep *I* as a binary variable. Then the correlation matrices using Pearson's, Kendall's and Spearman's rank correlation do no longer coincide. The respective correlation matrices are given in Tables 11–13.

Table 11: Pearson's Correlation of Attitudes

	<i>C</i>	<i>S</i>	<i>D</i>
<i>S</i>	0.0246 (0.872)		
<i>D</i>	0.8829 (0.000)	0.0203 (0.895)	
<i>I</i>	0.4766 (0.001)	0.0626 (0.683)	0.4226 (0.004)

Significance levels in brackets.

Table 12: Kendall's Correlation of Attitudes

	<i>C</i>	<i>S</i>	<i>D</i>
<i>S</i>	0.0926 (0.511)		
<i>D</i>	0.8119 (0.000)	0.0953 (0.485)	
<i>I</i>	0.4882 (0.001)	0.0626 (0.678)	0.4646 (0.001)

Significance levels in brackets.

Table 13: Spearman's Correlation of Attitudes

	C	S	D
S	0.0992 (0.517)		
D	0.8841 (0.000)	0.1052 (0.492)	
I	0.5237 (0.000)	0.626 (0.683)	0.5128 (0.000)

Significance levels in brackets.

Tables 11–13 show that taking the intensity of violations of C , S , and D into account does not much change the picture as conveyed by Table 10. Again the same three correlation coefficients are significant, viz. the correlations between C and D , between C and I , and between D and I . Again the correlation between C and D is rather high, although slightly lower than in Table 10.

Finally, we try logit estimates of the conditional probability of I given the attribute values of C , S , and D . We first use the dichotomic version of the attribute values (recall, “no violation” being encoded by 0, and “violation” by 1), and thereafter we explain the conditional probability of I by the number of violations of C , S , and D . Because of multicollinearity between C and D as evidenced in Tables 10–13, we enter only D into our logit estimates.

The parameters of the binary logit estimation are shown in Table 14. (The dichotomic values of S and D are denoted by a hat.)

Table 14: Binary Logit Estimation

Variable	Coefficient	Standard Error	Significance Level
Constant	-0.3546	0.4352	0.4152
\hat{S}	0.1436	1.0505	0.8913
\hat{D}	2.5798	0.8524	0.0025

Table 15 shows the parameters of the logit estimation for the conditional probability of I , taking the numbers of violations of the rational choice postulates as arguments. (The arguments are denoted by $S^\#$ and $D^\#$.)

Table 15: Logit Estimation based on the Number of Violations

Variable	Coefficient	Standard Error	Significance Level
Constant	-0.2673	0.4173	0.5218
$S^\#$	-0.0436	1.0917	0.9682
$D^\#$	0.6476	0.2742	0.0182

We see that the coefficients of neither \hat{S} nor of $S^\#$ are significant. Taking the constant (in spite of its insignificance) into consideration, we can compute the conditional probability of $\hat{I} = 1$ given the value of \hat{D} or $D^\#$ by

$$p(\hat{I} = 1 \mid \hat{D}) = \frac{1}{1 + \exp(-\hat{\alpha} - \hat{\beta}\hat{D})} \quad \text{and}$$

$$p(\hat{I} = 1 \mid D^\#) = \frac{1}{1 + \exp(-\alpha^\# - \beta^\#D^\#)} ,$$

where α denotes the constant and β denotes the coefficient. These formulae show that the conditional probability of $\hat{I} = 1$ is an increasing function of \hat{D} and $D^\#$, respectively. This was, of course, to be expected. In particular, we have:

$$p(\hat{I} = 1 \mid \hat{D} = 0) = 0.4123 ; p(\hat{I} = 1 \mid \hat{D} = 1) = 0.9025 ;$$

$$p(\hat{I} = 1 \mid D^\# = 0) = 0.4336 ; p(\hat{I} = 1 \mid D^\# = 1) = 0.5939 ; \dots$$

$$\dots p(\hat{I} = 1 \mid D^\# = 16) = 0.9999 .$$

We can use these estimates to juxtapose the predicted and the observed values for I and for its violation. This is comprised in Table 16, as these figures coincide for both kinds of estimates.

Table 16: Predicted and Observed Values for I and $\neg I$.

		Predicted Number of Cases		Correct Predictions
		I	$\neg I$	
Observed Number of Cases	I	14	2	87.50%
	$\neg I$	10	19	65.52%

We see that the probability of correct predictions is particularly high for the independence of irrelevant alternatives, but well above average also for the dependence of irrelevant alternatives. Indeed the overall probability of correct predictions is 73.33%. This result shows impressively that subjects which exhibit rational choice behaviour are considerably less susceptible to be influenced by phantom or irrelevant alternatives in their choice behaviour.

5 Conclusion

The main purpose of this paper is the analysis of the impact of phantom alternatives on the decision process. To investigate this issue we devised an experiment which embodies phantom alternatives in the context of recruiting a secretary. The applicants are coded by six attributes. The first part of the experiment asks subjects to make a choice which is,

however, distorted by the first and second best choices becoming phantom alternatives. Some two weeks later the subjects were confronted with the same choice problem as that preceding their third best choice in the first part of the experiment. We have found that repeated emergence of phantom alternatives tends to affect decisions as compared to an analysis of the very same decision problem from scratch.

We observed that, when faced with the same decision problem, first after two phantom alternatives and, second, presented as a fresh decision problem, only 38% of our subjects made the same choice. Even if we allow for a natural error rate as high as 25%, we can explain no more than half of this difference from the perfect repetition of subjects' choices. The presence of phantom alternatives leads between 40% and 60% of the decision makers astray, causing them to miss their optimum choices (as calibrated from the fresh presentation of the very same decision problem).

When testing basic postulates of rational choice, we found that violations of contraction monotonicity and of static preference consistency may well be explained by natural error rates around 15%. In contrast to that, only 53% of our subjects did not violate dynamic preference consistency. Considering that the possibilities for detecting preference inversions are rather limited, the accumulation of violations of dynamic preference consistency cannot be explained by subjects' natural error rates. We rather suspect that it is a consequence of the dependence of the decision process on irrelevant or phantom alternatives.

Finally we found that subjects with rational choice behaviour are far less susceptible to dependence on irrelevant alternatives than subjects which violate rational choice behaviour. This can be shown by using simple conditional frequencies, rank correlation matrices and logit estimations. Rational choice behaviour tends thus to render irrelevant alternatives irrelevant for subsequent choices.

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