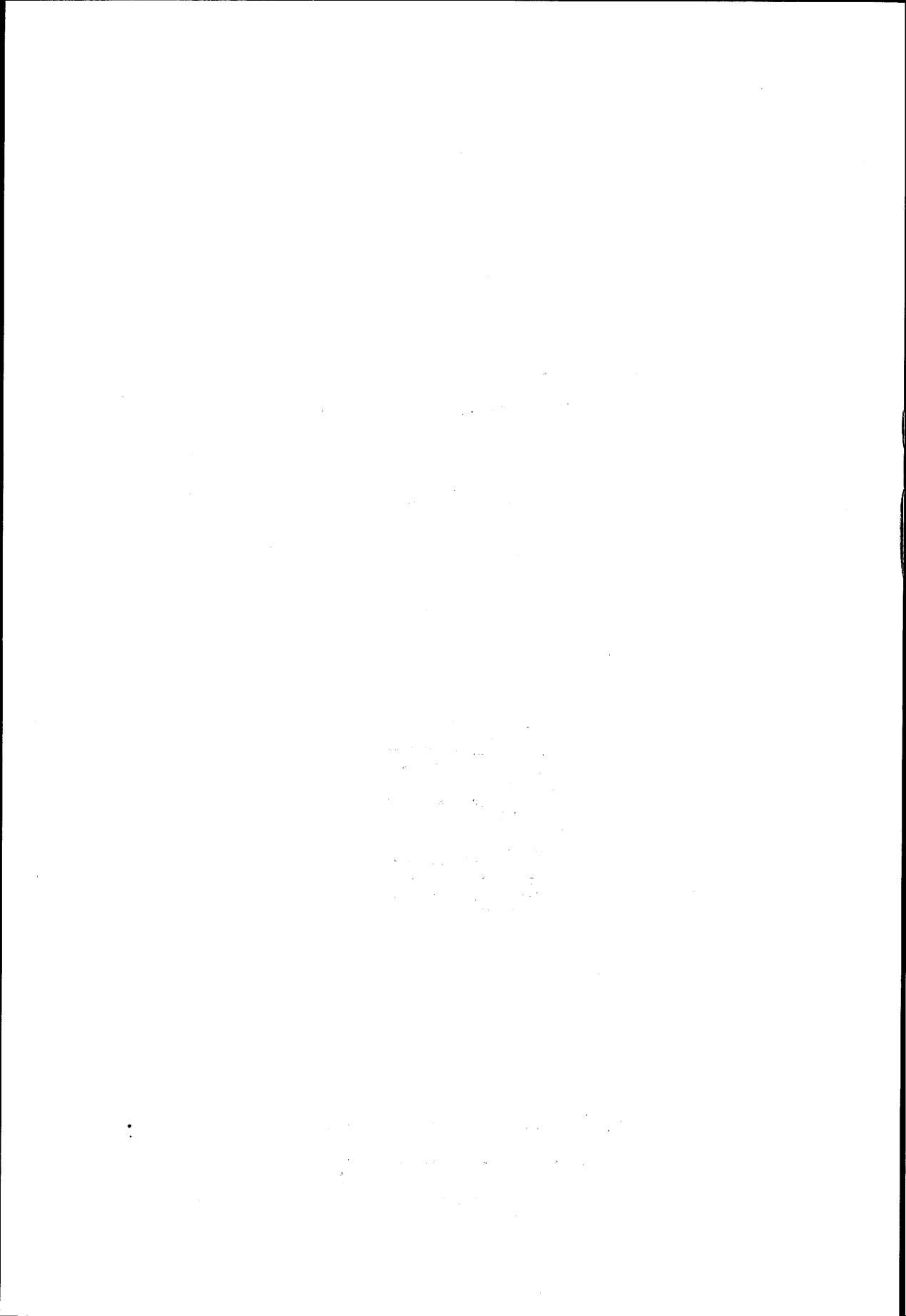


Preference Reversals in Judgment and Choice: The Prominence Effect

Marcus Selart



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Sweden



**Preference Reversals in Judgment and Choice:
The Prominence Effect**

Avhandling för filosofie doktorsexamen i psykologi, som med vederbörligt tillstånd av Samhällsvetenskapliga fakulteten vid Göteborgs universitet kommer att offentligens försvaras onsdagen den 23 november 1994, kl. 10.00 i sal L 5, Psykologiska institutionen, Skårs Led 3, Göteborg.

av

Marcus Selart

Doctoral dissertation at Göteborg University 1994

Abstract

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According to normative decision theory there exists a principle of procedure invariance which states that a decision maker's preference order should remain the same, independently of which response mode is used. For example, the decision maker should express the same preference independently of whether he or she has to judge or decide. Nevertheless, previous research in behavioral decision making has suggested that judgments and choices yield different preference orders in both the risky and the riskless domain. In the latter, the prominence effect has been demonstrated.

The main purpose of the present series of experiments was to test cognitive explanations which account for the prominence effect. One of the explanations provided a psychological account based primarily on decision-strategy compatibility. Two other explanations built on information structuring approaches. In the first one, the general idea was that decision makers differentiate between alternatives by value and belief restructuring. In the second approach, violations of invariance were assumed to be attributed to the information structure of the task which in many cases demand problem simplification.

A prominence effect was in most experiments found for both choices and preference ratings. This finding spoke against the strategy compatibility explanation. Instead, the different forms of cognitive restructuring provided a better account. However, none of these provided a single explanation. Yet, the structure compatibility explanation appeared to be the more viable one, in particular of the relation between experimental manipulations and response mode outcomes. The predictions of the value-belief restructuring explanation, on the other hand, seemed to be more valid for the prominence effect found in choice than for preference ratings.

Belief-value - Compatibility - Decision making - Information processing - Preference reversals - Prominence effect - Response mode - Restructuring

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To my family

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Preface

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List of publications

The present thesis is based on the following four research papers, which will be referred to in the text by their Roman numerals:

- I Montgomery, H., Gärling, T., Lindberg., & Selart, M. (1990). Preference judgments and choice: Is the prominence effect due to information integration or information evaluation ? In K. Borcharding, O. L. Larichev, and D. M. Messick (Eds), *Contemporary Issues in Decision Making*. Amsterdam: Elsevier Science Publishers B.V. (North-Holland).
- II Montgomery, H., Selart, M., Gärling, T., & Lindberg, E. (1994). The judgment-choice discrepancy: Noncompatibility or restructuring? *Journal of Behavioral Decision Making*, 7, 145-155.
- III Selart, M., Montgomery, H., Romanus, J., & Gärling, T. (1994). Violations of procedure invariance in preference measurement: Cognitive explanations. *European Journal of Cognitive Psychology*. In Press.
- IV Selart, M. (1994). Can accountability and value differences modify the prominence effect in judgment and choice? *Göteborg Psychological Reports*, 24, 1-19.

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1.0 Introduction

1.1 Perspectives on rationality

In the behavioral sciences and in other disciplines, the area of decision making research has been given considerable attention. The main reason for this is that how we decide is a crucial phenomenon for the functioning of social systems. In fact, it can be argued that to what degree we are able to understand and interpret a social system depends on our knowledge of how people make effective decisions. In the discipline of psychology research has also to a high extent been concentrated on fundamental characteristics of basic mental functions that humans share with animals. Such processes are the acquisition of information from the environment, emotional reactions, learning, and memory. It is important to emphasize that no conflicts exist between the basic assumptions of these two directions within psychology. Higher mental processes like decision making has the potential of being linked to physiology. The connections are simply somewhat looser than to the basic mental processes (Campbell, 1986; Rachlin, 1989).

At the same time the contribution of psychological research in decision making to other social sciences, especially economics, is essential. Many economists today realize that issues like cognitions, emotions, and behavior must be taken into account in their rational models (Lucas, 1986; Plott, 1986). Still, there exist some general differences between economics and psychology in the study of human decision making. First, whereas economists focus on outcomes, questions of process are central to psychologists. Thus, psychologists are both concerned with the manner in which decisions are made as well as with the characteristics of the participants and of their resource endowments. Second, the empirical evidence in psychology is experimental in nature. Much work in modern economics is theoretical, that is, many economists are more interested in deriving implications from theory than performing experiments and tests. Nevertheless, there is a growing interest for "experimental economics" among economists. This tendency is perhaps most apparent in areas such as marketing, accounting, and public policy.

Over the years most investigations in the field of behavioral decision making have more or less explicitly dealt with the notion of rationality. On the one hand researchers have argued that all sorts of biases, errors, and inaccuracies speak against that people are generally rational. On the other hand, when faced with the suggestion that a person is irrational, the same researchers might have argued

against this and in favor of the good reasons of that person. Of course, issues like what is valid in general and exceptions from what is thought of as common can explain such different approaches which scientists have, but the rationality debate indicates underlying opposing perspectives (Berkeley & Humphreys, 1982; Cohen, 1979; Edwards, 1983; Einhorn & Hogarth, 1981; Fischhoff, 1983; Kahneman & Tversky, 1982; Nisbett & Ross, 1980; Phillips, 1983).

The rationality concept has been developed in philosophy and economics, and therefore these disciplines have had a great impact on the definition of the concept in psychology. The common assumption in behavioral sciences that people are expected to act in line with their values and beliefs, can be seen as an expression of this. A rational choice can according to Dawes (1988) be defined as one that meets three criteria: (i) It is based on the current assets of the decision maker. Assets include not only money, but physiological state, psychological capacities, social relationships, and feelings, that is vital phenomena for our well-being from a psychosomatic point of view. (ii) It is based on the possible outcomes of the choice. (iii) When these outcomes are uncertain, their likelihood is evaluated without violating the basic rules of probability theory. Such definitions have as their aim to satisfy the claims from philosophy that a rational action is "logical" or "consistent" as stated in a set of axioms. Rationality is hence specified normatively, that is, the mission of behavioral research is often to study empirically whether actual human behavior is rational in the sense that it obeys the norm. According to Dawes (1988) there are common decision making procedures that have no relationship to the criteria of rationality. They involve habit, tradition, conformity, convictions, and imitation.

However, in modern cognitive psychology the use of a normative yardstick is becoming more and more rare. Nevertheless, there are exceptions. For instance, the physical environment is often regarded as a standard in the study of perceptual illusions. But this physical standard is usually not treated as a yardstick. Instead physical stimuli are used to trigger responses which are not regarded as "deviant from" or "consistent with" the stimuli being used. Another exception is the assumption of an ideal speaker or listener which was formerly widely used in psycho-linguistic research. The growing use of semantic network theories has however turned the focus of interest towards the understanding of actual human use of language. Yet another exception is that in research on thinking and reasoning formal logic is still used as a norm, but as in the case of psycho-linguistics, the interest is slowly turning towards the content of thinking in place of its form.

In behavioral decision making research, normative models have, on the other hand, been heavily used since the early fifties. Research has had as its major objective to study, explain, and interpret discrepancies between predictions based on normative theories and actual decision/judgmental behavior. In the study of decisions the subjective expected utility (SEU) model represents the normative model which has been used whereas the most commonly used models of judgment are Bayes' theorem and multiattribute utility (MAUT) models. Much debate in the area still concerns these models, and the assumption agreed upon is the idea of rationality embodied in these models.

Briefly, the subjective expected utility (SEU) model demonstrates that if a decision maker's choices follow certain mathematical axioms, it is possible to derive utilities - or numerical values that represent the decision maker's values - such that one alternative, which is probabilistic in nature, is preferred to another if and only if its expected utility (probability of winning multiplied by the amount to be won) is greater than that of the other alternative. One of these axioms or principles, the so-called invariance principle, is of central importance for the present studies.

Bayesian inference can be regarded as an alternative to more classical approaches to statistical testing. The method is particularly useful for the updating of base-rate probabilities by specific data. For instance, this form of analysis deals more directly with the uncertainty of population characteristics, by making reference not to a population in itself but to our beliefs of the population. In Bayesian inference, these beliefs are characterized by probability distributions and density functions.

Multiattribute utility theory (MAUT) concerns how to evaluate rationally and choose accordingly among alternatives in a multicriteria decision task. As a tool, it is used to support the decision maker and to improve his or her decision making. Four steps are of vital importance for the analysis: structuring objectives, eliciting preferences, scoring alternatives, and finally aggregating preferences and scores (Keeney & Raiffa, 1976; von Winterfeldt & Edwards, 1986). After performing these four steps the focus of the decision maker can switch to the implementation of action.

1.2 General introduction to the present studies

According to normative decision theory there exists a principle of procedure invariance which states that the preference order of a decision maker should remain the same, independently of which response mode is used. For example, the decision

maker should reveal a preference indifference independently of whether he or she has to judge or decide. Nevertheless, previous research in behavioral decision making has suggested that judgments and choices yield different preference orders in both the risky and the riskless domain (Fischer & Hawkins, 1993; Goldstein, & Einhorn, 1987; Lichtenstein, & Slovic, 1971, 1973; Slovic, Griffin, & Tversky, 1990; Slovic, & Lichtenstein, 1983; Tversky, Sattath, & Slovic, 1988;) In the latter, the prominence effect has been demonstrated.

To account for violations of procedure invariance, several explanations which emphasize distortions in the weighting of attributes have been offered. In the risky context, both Expression Theory (Goldstein & Einhorn, 1987) and Change-of-Process Theory (Mellers, Chang, Birnbaum, & Ordonez, 1992) give psychological explanations of the so-called preference reversals phenomena. In the riskless context, Contingent Weighting Theory (Tversky et al. 1988) provide a psychological account based primarily on decision-strategy compatibility. This latter account will here be subject to investigation.

The possibility is also raised that violations of invariance in the riskless context can be explained by information restructuring approaches. Two such approaches have been launched. The first one builds on Dominance Structuring Theory (Montgomery, 1983) and Differentiation and Consolidation Theory (Svenson, 1992). The general idea is that decision makers differentiate between alternatives by value and belief restructuring, by up or downgrading of alternatives according to decision rules or strategies. In the second approach, violations of invariance are assumed to be attributed to the information structure of the task which in many cases demand problem simplification (Payne, Bettman, Coupey, and Johnson, 1990).

The following questions are emphasized: What are the characteristics of making decisions in comparison with other similar activities, such as making preference judgments? How do situational factors affect the way decisions are made? In what respect is decision making and judging governed by constructive processes that take place during the process? Several of these questions will be dealt with in the present dissertation.

2.0 Violations of Invariance

2.1 Assumptions of invariance

Expected utility theory was published by John von Neumann and Oskar Morgenstern (1947) as a theory of declining marginal utility. It was proposed as a normative theory of decision, that is, its intention was to describe how people behave if they follow certain requirements of rational decision making. According to the theory decision makers are supposed to maximize expected utility, or personal value, rather than monetary outcomes of decisions. In gamble situations, the expected value of each risky alternative is therefore equal to the probability of winning multiplied by the amount to be won.

A major objective of the theory was to provide an explicit set of assumptions, or axioms, as a basis for rational decision making. When these axioms were specified, decision researchers could use them to compare the mathematical predictions of expected utility theory with people's real behavior. A basic assumption was that people are able to express both consistent beliefs (predictive judgments) and consistent preferences (evaluative judgments). Another conjecture of the theory was that beliefs and preferences should be independent of each other, so that what you think is going to happen does not have an impact on what you would like to happen, or vice versa. Consequently, this theory of rational choice had as its main goal to describe the decisions of an idealized person. However, the theory says little about behavior per se; it is to a large extent a purely mathematical model that discusses utility theory's relevance to optimal economic decisions.

The dominance principle is one of the axioms of rational decision making. According to this principle, strategies which are "dominated" by other strategies should never be adopted by the decision maker. It is noteworthy that the principle only applies to situations where alternatives are represented by several attributes, which can be ranked in importance order. Given these prerequisites, pairwise dominance tests of alternatives can be used. The principle can in this way be used to reduce the choice-set of a decision situation, and it is therefore argued that it simplifies choice.

The so called invariance principle is another of the axioms. It stipulates that the way options are presented should not affect the decision maker. In other words the choices of the decision maker should be invariant with respect to either how he or she is required to make the choice or the manner in which the options have been

presented. For example, in terms of response modes, the preference of a decision maker between two jobs should not be affected of whether the preference is to be stated in terms of a choice based on comparison, or by a contingent value judgment, that is by a pricing procedure of how much each job is worth.

According to Tversky and Kahneman (1986) the four most basic rationality principles can be ordered by their normative appeal. The invariance principle together with the dominance principle seem to be the two most fundamental principles of decision theory and are commonly regarded as normatively essential. The status of the two other principles are more obscure: the transitivity principle could be questioned, and the cancellation principle has been rejected by many researchers. Thus, if the invariance and dominance principles are found to be invalid from a descriptive point of view, this would be most damaging to the normative theory.

2.2 Distortions in attribute weighting

One stream of research has dominated the debate on how humans make decisions. According to this stream, the nature of human judgment and decision making is emphasized as deficient. The general notion is that human capacity to make judgments and decisions is limited, leading to violations of the invariance principle (Jeans & Mann, 1977; Nisbett & Ross, 1980; Simon, 1955, 1979, 1986; Slovic, 1972; Tversky & Kahneman, 1974; see Jungermann, 1986, for a review).

Violations of invariance can be explained in terms of the effect of different frames for the decision problem on people's decision making behavior (Payne, 1982; Tversky & Kahneman, 1981). Often these instances are referred to as violations of descriptive invariance. According to Kahneman and Tversky (1979) coding outcomes in terms of gains and losses is one of several cognitive mechanisms which people use to edit, or represent, decision problems before the options will be evaluated. As in the case of judgmental biases these operations may as well lead to violations of rationality. The errors that occur are thought of as perceptual illusions (Tversky & Kahneman, 1981). In these situations, which are frame induced, subjects evaluate problems that differ in their surface structure but share the same basic deep structure. The explanation is that decision makers tend to operate on an edited version of the decision problem.

A well-known failure of descriptive invariance was reported by McNeil, Pauker, Sox, and Tversky (1982). They were investigating preferences between medical treatments for lung cancer, and subjects were provided with the statistical background for the outcomes of these treatments. Two experimental conditions

were established, one in which subjects were informed about the mortality rates of the treatments, another in which information was presented in terms of survival rates. The expected values of the treatments of both conditions were equivalent. After the presentation of the problem, subjects were instructed to elicit their preferences. The results revealed a clear framing effect. The overall percentage that favored one form of therapy rose from 18% in the survival frame to 44% in the mortality frame.

Recent research has also revealed violations of the invariance principle when risk is added to mortality and survival rates (Tversky & Kahneman, 1981). In the so-called Asian disease problem two medical programs were presented, one of which the outcome was certain, the other of which it was uncertain. Outcomes were framed differently in two conditions, that is, in terms of people saved or people lost as a result of each program. The expected values of the two programs of each condition were equivalent. Again, the results were found to violate the invariance principle. Evidently, individuals' decision frames differed in crucial ways from a formal representation of the problem.

Thus, variations in the framing of decision problems can produce systematic violations of the invariance principle, which are difficult to defend from a normative point of view. In trying to find a psychological explanation of why these violations occur, Kahneman and Tversky (1979) argued that the decision making process can be divided into two phases: an editing phase responsible for developing a decision frame and an evaluation phase during which the framed courses of actions are evaluated as a basis for choice. The operation of coding was suggested as a central process in the editing phase for the development of the decision frame.

An important issue to examine is which mechanisms could ensure the invariance of preferences (Tversky & Kahneman, 1986). It has thus been suggested that invariance would be maintained if the outcomes of the two decisions are aggregated in one kind of frame prior to evaluation, for instance in terms of lives saved. The violations of invariance that have been found can be viewed as indications of that people do not spontaneously aggregate coexisting courses of actions or use one frame for the outcomes. Still, the principle of invariance could hold even if multiple perspectives are maintained. This would require that the courses of actions were separately linear in probability and monetary outcome. However, the principle of invariance commonly fails due to the fact that the evaluation of outcomes and probabilities generally is non-linear, and because people do not use a common frame in their representations of the decisions. Failures of invariance can therefore be described in terms of framing effects that

control the representation of options, in combination with the nonlinearities of value and belief.

The emphasis on editing or representation of decision problems has added something new to the research. Previously, scientist's major objective was concentrated to describe final judgments and evaluations on behalf of the earlier stages of the decision making process.

Another important form of violation of the invariance principle is termed procedure variance. Situations belonging to this category are task induced, and the preference ordering is found to differ depending on the mode of response required by the task. A generally accepted explanation of violations of procedure invariance is that the response mode affects how the attributes are weighted. This issue is highlighted in the research on so-called preference reversals (e.g., Lichtenstein and Slovic, 1971, 1973; Slovic et al, 1990; Slovic & Lichtenstein, 1983, Tversky et al., 1988; see Payne, Bettman, & Johnson, 1992, for a review). In normative theories it is assumed that specific empirical procedures like choice or pricing should give the same results. A preference reversal occurs whenever an individual prefers one alternative in one procedure but shows the opposite preference order in another. There is much evidence showing that the price ordering of risky prospects is systematically different from the choice ordering. For example, when subjects have to indicate which bets they prefer and how much they would be willing to sell the bets for, they often choose the high-probability option but indicate the highest selling price for the high-payoff option. The explanation of the phenomenon attributable to Lichtenstein and Slovic (1971, 1973) is that subjects in judgments set minimum selling prices by a process of anchoring and adjustment. As an example, subjects who find a gamble attractive are believed to anchor on the amount they stand to win and then adjust downward for the amount and probability to lose. This is not the case in choice modes. Choice, it is argued, provides a freedom to use any decision strategy, whereas judgments often provide natural starting points, due to scale compatibility. In pricing, for instance, the natural starting point is provided in the gamble by the amount to win. Nevertheless, as many researchers know, probabilities are difficult for subjects to translate into monetary units. As a result, the adjustment downwards becomes insufficient, leading to a preference reversal. Because of this, an overpricing effect of gambles is established. However, it has been pointed out that this kind of adjustment is insufficient as an explanation (Tversky & Kahneman, 1974).

Other competing accounts of the preference reversals phenomena have been proposed by Goldstein and Einhorn, (1987) and Mellers et al. (1992). In Expression Theory, Goldstein and Einhorn (1987) state that previous research has

confounded judgment versus choice with the response scale used to express preference. For instance, prices have been expressed in dollars, ratings on rating scales. Instead, these factors are suggested to be crossed. They attribute the reversals found in the conditions to changes in the mapping from a gamble's components to the response. This transformation is assumed to differ predictably for each gamble and for each response mode.

In Change-of-Process theory (Mellers et al. 1992), it is assumed that the stimulus context also has the ability to influence preference orders. It is proposed that the inclusion of certain stimuli "steer" subjects away from one decision strategy and toward another. Different preference orders are assumed when subjects use different procedures to evaluate the quality of gambles. Hence, people are supposed to use different decision strategies in different tasks with the same scales. Such tasks can be the rating of attractiveness and risk, pricing, and the judging of strength-of-preferences.

In more recent research it has been established that the majority of reversals are violations of invariance, caused by over-pricing of the low-probability high-payoff bets (Tversky, Slovic, & Kahneman, 1990). Thus, intransitivity and failure of independence only account for a small proportion of the reversals (10%). The overpricing effect can be attributed to an effect of scale compatibility: When people are asked to set a price for how valuable the bet is, they look at how large the potential payoffs are. Payoffs are weighted more heavily in pricing than in choice because prices and payoffs are expressed in the same units. On the other hand, when people are asked to choose between two bets, they pay particular attention to the probability of winning. Thus, choosing between a pair of gambles seems to involve different psychological processes than bidding for each one separately.

Response-mode biases have also been found when subjects are asked to evaluate pairs of decision alternatives whose consequences are described by two attributes. Tversky et al. (1990) and Slovic et al. (1988) demonstrated a judgment-choice discrepancy, in the form of a riskless preference reversal, in such a case. One of the attributes was selected to be predominant or prominent. In choice tasks subjects placed more weight on this attribute than they did in matching tasks in which they were required to make the two options equally attractive.

The compatibility hypothesis was proposed to account for the prominence effect (Tversky et al., 1988; Slovic et al., 1990; Fisher & Hawkins, 1993; Hawkins, 1994). It is based on the pioneering work of Slovic (1975). In this hypothesis the effect reflects a general principle of compatibility according to which the processing of input (e.g., attributes describing options in a judgment or choice task) depends on how compatible it is with the output (i.e. subjects' responses).

Tversky et al. (1988) argued that both risky and riskless preference reversals are governed by stimulus-response compatibility. Identical components on both the stimulus and response side enhance compatibility. Such components are the use of the same scale units (e.g., grades, ranks), the direction of relations (e.g. whether the correlation between input and output variables is positive or negative), and the numerical correspondence (e.g., similarity between the input and output). The use of similar scale units have been referred to as scale compatibility by Fischer and Hawkins (1993) and Hawkins (1994). According to Slovic et al. (1990) the theoretical definition of scale compatibility is somewhat loose but its implications seem unambiguous. However, scale compatibility alone cannot account for the prominence effect (Hershey & Schoemaker, 1985; Schkade & Johnson, 1989; Slovic et al. 1990). It may account for variations in strength of preference found in different judgment modes, but in judgment-choice comparisons this type of compatibility can yield predictions directly opposed to the prominence effect (Fischer & Hawkins, 1993). For instance, if dollar is the prominent attribute, the scale-compatibility hypothesis implies that people will attach greater weight to money in dollar-matching tasks than in choice.

Another suggestion is that the prominence effect occurs because choice and matching tasks evoke different types of decision strategies giving different weight to the prominent attribute (Tversky et al. 1988). The qualitative response in choice is regarded as compatible with a qualitative lexicographic decision rule which renders quantitative weighting of attributes unnecessary. In contrast, quantitative judgments are compatible with a quantitative weighted additive rule. This form of compatibility is referred to as strategy compatibility (Fischer & Hawkins, 1993; Hawkins 1994). The cognitive basis of this suggestion is twofold. First, as in the former case of scale compatibility, noncompatibility is regarded as requiring additional mental operations which subjects avoid. Second, a response mode is seen as priming the focus of attention on those compatible features of the input that are compatible with the required output.

In conclusion, the theories provide cognitive explanations of violations of the invariance principle. For instance, observed response mood effects serve as a foundation for cognitive hypotheses, predicting which strategy is to be used in what response mode. A widely used perspective in this stream of research is that information processing capacity is limited, which leads to violations of rationality principles. The causes for this is often traced to the use of heuristics, to the representation of the problem, or to motivational factors. Normative models or the objective reality are not seldom used as rational yardsticks. A general growing consensus is that preferences and beliefs are constructive in nature. This means that

preferences for and beliefs about objects or events of any complexity are often constructed - not merely revealed- in the generation of a response to a judgment or choice task. This argument will also be highlighted in other directions of research to be reviewed.

2.3 Cost-benefit theories

A general idea put forward in cost-benefit theories is that decisions which violate the invariance principle nevertheless can be described as rational if the cognitive costs are taken into account. Hence, the decision costs must be weighted against the potential benefits resulting from the application of a decision strategy. This may lead to violations of invariance as it is stated in the subjective expected utility model (SEU). However, such violations are, according to the theories, perfectly rational (Beach, 1990; Beach & Mitchell, 1978, 1987; Einhorn & Hogarth, 1981). The selection of which decision rule or strategy is to be used (i.e., SEU, maximizing, satisficing, elimination-by-aspects, etc.) in a specific situation depends both of the decision maker's desire to make the best decision and his or her attitude towards investing time and effort in making a decision. Which strategy is perceived as superior in maximum net gain is the one being selected. Violations of invariance in the "classical sense" is thus something that the decision maker anticipates and tolerates. Which are then the benefits and costs for resolving the conflict inherent in choice, that is, which are the pros and cons of the engagement in the required mental effort? On the benefit side, one can put forward such gains as environmental control, clarifications of goals and preferences, creation of the habit of thinking, reformulation of problems which lead to discovering of new alternatives, and seeking ways of information that might resolve the conflict in choice. These five benefits are quite general in nature and apply across all kinds of consequential choice. It is interesting to note that the trade-offs of these benefits must be viewed from a temporal perspective. Short-term investments in terms of mental effort related to thinking and reasoning has long-term benefits in the sense of enhanced action control and improved capability of handling choice situations adequately. On the cost side, thinking and reasoning can be distressful in a state of preference uncertainty when you do not know what you want. A second cost of thinking is that the trade-offs in the decision situation are made visible. Third, since humans have a limited capacity to process information, there are costs due to acquiring, processing, and outputting information (Hogarth, 1987).

To be able to get insight into the costs and benefits of thinking, and to identify the combinations of decision rules being used by decision makers, Payne (1976)

suggested that making inferences from behavior is not sufficient. Instead, he proposed that the study of acquisition and search of information should be emphasized as the prescribed research methods in the study of decision processes. In this respect, he was heavily influenced by models of human problem solving at that time (Newell & Simon, 1972). Another influence came from the development of the so-called information board technique. In a typical information-board experiment, matrices of alternatives by attributes are presented on a computer screen. Subjects are searching for information before stating their preference.

The studies of Ericsson and Simon (1980, 1984) dealing with verbal reports as data provided a source of inspiration for the development of another widely used technique, the protocol analysis. The major objective in studies involving both information board and protocol analysis techniques has been to identify whether decision processes follow compensatory or non-compensatory strategies¹ (see Ford et al. 1989, for a review). In fact the study of violations of the invariance principle, from the strategy identification point of view, has been one of the major issues. For instance, the effects of response mode on decision making strategies were investigated by Billings and Scherer (1988). They found that there were more information searched/ interdimensional processed in judgment response modes than in choice. They also found a more constant amount of information searched across alternatives in judgment than in choice.

In their attempt to identify the strategies used in different response modes in risky contexts, Schkade and Johnson (1989) studied cognitive processes in preference reversal gambles. In the first two experiments, they analyzed pricing-

¹Examples of compensatory decision rules or strategies are the additive utility and the additive difference rules. In these rules it is assumed that each dimension can be measured on an interval or ratio scale and be given a weight that corresponds to its importance. Each alternative is then evaluated by summing the weighted values on each dimension. In the additive difference rule the decision maker is assumed to evaluate the differences between the alternatives on a dimension by dimension basis, that is, the difference between the alternatives on each attribute is calculated and summed. The decision maker then chooses the alternative with the greatest aggregated difference. Among the non-compensatory strategies, four can be identified as the most frequently studied: the conjunctive, disjunctive, lexicographic, and elimination-by-aspects (EBA) strategies. In the conjunctive strategy the decision maker defines certain cut-off points or thresholds on the dimensions, and if an alternative on any dimension fails to reach any of these thresholds, it is rejected. A disjunctive model is on the other hand characterized by that a decision maker can accept a low score of an alternative on one dimension, provided that it has a high score on another dimension. In the lexicographic strategy, the decision maker makes an importance ordering of the dimensions, and then makes a choice on the basis of the most important dimension. The elimination-by-aspects (EBA) strategy is related to both the lexicographic and the conjunctive strategy. It is assumed in it that alternatives consist of a set of aspects, and that alternatives that do not exceed the required point is rejected, beginning with the most important dimension. All the "failing" aspects are eliminated dimension-wise, until there only is one surviving alternative.

choice and pricing-rating reversals. An important question was the role of anchoring and adjustment for the preference reversal effect. Attention to attributes and total time was used as dependent measures. The process analysis carried out in the first experiment (pricing-choice) revealed that pricing generally took longer time than choice. Another finding was that more attention was directed towards the pay-off information in pricing than in choice. Furthermore, less attention was directed towards the probability rates in pricing than in choice. The process analysis carried out in the second experiment (pricing-rating) showed that the starting points were affected by the compatible gamble elements in both pricing and ratings. As a rationale for this, the anchoring and adjustment principle was suggested.

Westenberg and Koele (1990, 1992) investigated the influence of response modes on decision strategies. Their general hypothesis was that the type of response required in a decision situation influences which decision strategy is selected. In both their studies subjects to a higher extent were found to use compensatory strategies as a function of the increasing number of categories (or scale-points) in the decision situation. In line with Billings and Scherer (1988) qualitative response modes tended to induce more non-compensatory strategies than judgments. Furthermore, an interesting difference was found between the two qualitative response modes of selecting and rejecting. Both response modes were found to induce non-compensatory strategies, but compensatory strategies were more frequent in the rejection than in selection mode.

This methodological approach was used in the present studies to validate one of the explanations of riskless preference reversals; the strategy compatibility hypothesis (Hypothesis H₁). Hence, the validity of the hypothesis will be tested with the use of both input and output data together with cognitive accounts in line with the information-search tradition (Russo, Johnson, & Stephens, 1989; Maule, 1992; Westenberg, 1992).

In conclusion, cost-benefit explanations of violations of invariance state that people have available or can generate different decision strategies for making choices or judgments. It is also assumed that the strategies differ in expected costs and benefits. To be able to select a strategy, the decision maker must take into consideration the anticipated costs and benefits of each strategy, given the specific task environment. In this stream of research, process tracing is typically carried out with information board techniques or protocol analysis (see also Johnson et al., 1988, for a review).

2.4 Restructuring theories

In Dominance Structure Theory (DST) (Montgomery, 1983) it is argued that the most cost-effective way for people to resolve the conflict inherent in choices is to find a cognitive structure which yields dominance for one alternative. Dominance structuring is seen as a principle for facilitating the information processing in the decision situation. The main idea is that people try to structure and restructure their representation of a decision problem so that one alternative always appears to be the best. The decision process is hence seen as a search for a dominance structure, that is, as a cognitive process where all possible disadvantages of a promising alternative are eliminated or neutralized. This alternative then appears as the best one, since it can be maintained that it dominates the other ones. It is important to mention that if the decision maker fails to find a dominance structure for a promising alternative, it is always possible to return to the previous phase and carry on the search for dominance (see also Dahlstrand & Montgomery, 1989, Montgomery & Hemlin, 1991, Montgomery & Svenson, 1989 for empirical tests of the theory).

A more recent contribution is Differentiation and Consolidation Theory (DCT) (Svenson, 1992). In this theory, decision making is conceived of as a process in which one alternative gradually is differentiated from another until the degree of differentiation is enough for a decision. Thus, it is not sufficient to choose an alternative that is better. Rather, the preferred alternative should be so much better than the nonpreferred alternative that it remains better even under unfavorable post-decision conditions² (see also Svenson & Benthorn, 1992, and Svenson & Malmsten, 1992, for empirical tests of the theory). However, the present studies are primarily based on the theoretical foundations of DST.

The primary aim of DST is to describe how choices or decisions actually are made. To be able to understand how the theory can explain violations of invariance, such as the prominence effect reported by Tversky et al. (1988), it is motivated to parallel the different steps of one of these models with the steps prescribed by a theory dealing with judgments in detail (see Tables 1 and 2). As mentioned earlier, multi-attribute utility theory (MAUT) provides such an account. The reason for this is to give insight into (i) why choices are more unpredictable from linear weighting models than judgments, and (ii) why the predominant

²Svenson (1992) actually postulates three types of structural differentiation modes or ways of changing the representation which all - at least in part - build on value and belief restructuring. The modes are labeled differentiation through attractiveness restructuring, differentiation through attribute importance restructuring, and differentiation through facts restructuring (see also Fishhoff, 1975, and Hogarth & Einhorn, 1985).

attribute looms larger in choice than in matching judgments. Among several attribute weighting models, the so-called direct weight elicitation method (DWT) (Edwards, 1977) was selected for this purpose, on the basis of its simplicity and theoretical soundness (see Borchering, Schmeer, & Weber, 1993, for a review).

Table 1. The phases of DST explaining choices.

Pre-editing phase. All unnecessary attributes and alternatives are deleted from further processing.

Finding a promising alternative phase. This phase implies that the decision maker detects an alternative with attractive attributes or at least an alternative with attributes that encourage great expectations of how such an alternative is supposed to be.

The dominance testing phase. This is a sort of everyday sensitivity analysis in which the decision maker tests if there are any disadvantages connected to the promising alternative. If no disadvantages are found, the promising alternative is chosen. The test can be carried out more or less systematic, depending on the felt pressure to choose the promising alternative.

The dominance structuring phase. This phase aims at "repairing" the deviations from dominance which have been localized in the previous phase. This aim can be completed by using different kinds of operations, such as bolstering of the advantages or de-emphasizing of the disadvantages of the promising alternative. But two other operations, cancellation or collapsing may also be used. Cancellation implies that the decision maker makes trade-offs between advantages and disadvantages of the alternative. This operation is often used when there exists a natural connection between an advantage and a disadvantage. Collapsing on the other hand implies that two or more attributes are collapsed into a superior attribute, which often is more comprehensive (see also Huber, 1989).

The search for a dominance structure is according to Montgomery (1983) supposed to go through four phases, that is pre-editing, finding a promising alternative, dominance testing, and dominance structuring. Edwards (1977) also presents four phases in his model, that is structuring the problem, determining the importance of dimensions, measuring alternatives on the dimensions, and choice.

Attempts have been made to test DST as a psychological account of violations of procedure invariance. Lindberg, Gärling, and Montgomery (1989), found it plausible that dominance structuring could be the answer to the worse fit of the predictions of multi-attribute utility theory (MAUT) to choices than to preference ratings.

Table 2. The Phases of DWT explaining judgments

Structuring the problem phase. This phase includes the following four steps: (1) The decision maker(s) is identified. (2) The decision is identified. (3) The alternatives to be evaluated are identified. (4) The dimensions on which the alternatives are to be evaluated are identified.

Determining the importance of dimensions phase. This phase includes the following three steps: (1) The dimensions are rank-ordered in terms of their importance. (2) The rankings are translated into ratings. (3) The ratings are converted to numbers that sum to 1.

Measuring alternatives on the dimensions phase. This phase includes the following two steps: (1) The alternatives are measured on each of the dimensions. (2) The overall worth of each alternative is calculated by summing each alternative's scores on the dimensions which were weighted earlier.

Choice phase. The previous phase yields a list of alternatives accompanied by their measures of relative worth. The normative rule is to choose the alternative with the largest assessment of worth.

As described earlier, the decision maker is according to the theory assumed to modify his or her beliefs/evaluations related to attributes and attribute levels in such a way that a favored alternative stands out as dominant. Lindberg et al. (1989) thus argued that such changes in belief-value structures in the choice process should make the outcome of the choice difficult to predict based on previously performed belief evaluations as input data for the multiattribute utility predictions. The results were in line with an interpretation which favored the idea of simplifying heuristics used in the dominance structuring of the choice task. These heuristics were not used in the judgment task which led to the better fit.

As noted above, Tversky et al. (1990) and Slovic et al. (1988) demonstrated a judgment-choice discrepancy in the form of a riskless preference reversal in the case where one of the attributes were selected to be predominant or prominent. In choice tasks subjects placed more weight on this attribute than they did in matching tasks in which they were required to make the two options equally attractive. The phenomenon was termed the prominence effect. The rationale provided was that the effect occurs because choice and matching tasks evoke different types of decision strategies giving different weight to the prominent attribute. The qualitative response in choice is regarded as compatible with a qualitative decision rule which renders quantitative weighting of attributes unnecessary. In contrast, quantitative judgments are compatible with a quantitative weighting rule.

If there are one prominent and one nonprominent attribute, as a result of the restructuring process the former will have more influence since the differences on that attribute are enlarged relative to the other. More precisely, subjects may modify their beliefs or values in such a way that there will be a larger discrepancy between the options on the more important attribute than on the less important attribute. Both the importance order of the attributes and the differences between the alternatives on the attributes will then speak in favour of a preference in line with the prominent attribute. The above mentioned modifications of beliefs or values are thought to take place primarily in choice which is characterized by an ability to resolve conflicts between alternatives. It is assumed that reasons or motives guide the modifications of values and beliefs. Therefore, Montgomery (1983, 1989) assumed that the importance of a decision is directly related to the degree of restructuring.

A hypothesis (H_2) which will be tested in the studies is that the prominence effect can be explained by Montgomery's (1983, 1989) theory of dominance structuring in decision making. It will be referred to as the value-belief restructuring hypothesis (or sometimes just the restructuring hypothesis).

Another perspective on restructuring is taken by Payne, Bettman, Coupey, and Johnson (1992). They suggest that one very important analytic tool for the understanding of the contingency of preferences on task demands is the restructuring of the input data. According to Payne et al. (1992) restructuring is thought to occur in the editing phase, which is earlier than what Montgomery (1983) suggested. Examples of restructuring operations are information transformations (e.g., rounding off, standardizing, or performing calculations), rearranging information (e.g., changing the order of the alternatives or attributes) or eliminating information (see also Russo, 1977, and Ranyard, 1989). The aim of

restructuring seems to be to make problems more manageable. With the help of transforming, rearranging, or eliminating information, the decision maker can use a processing strategy and obtain an acceptable amount of accuracy and cognitive effort in the task situation. That same strategy could have been too difficult to use before restructuring. A mode of differentiation proposed by Svenson (1992) in DCT encompasses this mechanism³.

The choice problems used by Payne et al. (1992) were either well-structured or poorly structured and information was presented either simultaneously or sequentially. The characteristics of a well-structured problem was that all information for an attribute was expressed in the same units, and information was presented in the same order within each alternative for any given attribute. Poorly structured problems were characterized by the fact that the information within the same attribute had different units, and that the information could appear in a different order within each alternative for any given attribute. Payne et al. (1992) let subjects take notes while processing, and those verbal protocols were then coded with respect to specific restructuring operations. These operations were used by the subjects to create different forms of helpful matrices in the poorly structured problems. To arrive at matrix representations, subjects used transformations, calculations, and rearranging operations. Subjects who made notes were then compared with others who did not. It was found that subjects who restructured (in the sense that they made notes) to a higher extent were using alternative-based strategies when processing the restructured material. The conclusion reached by Payne et al. (1992) was that subjects use restructuring as a means of mental effort investment to be able to later use a more accurate strategy with a reasonable amount of effort. They found that restructuring takes place in the early stages of the decision process, but this finding might be due to an artifact produced by the methodology of taking notes. Hence, restructuring is thought to

³ In Differentiation and Consolidation Theory (Svenson, 1992), the fourth mode of differentiation is based on heuristics taking place in the editing phase. Differentiation through decision problem restructuring implies that real life decisions can be more or less well-defined, as stated earlier. In the latter case people might want to create decision alternatives all by themselves, due to for instance perceived uncertainty, task complexity, or social conflict. Svenson (1992) illustrates this with a decision between manufacturers of prefabricated homes. A decision like this may involve much mental effort in composing alternatives from the different manufacturers, due to task complexity. Uncertainty may as well lead to decision problem restructuring. New and unfamiliar decision situations are therefore often difficult to differentiate on the alternative level. In situations like this, people often import a new reference alternative without seriously considering it in the decision situation. This might lead to an increased differentiation on the process level (see also Payne, 1982; Shafir, Simonson, & Tversky, 1993; Tyszka, 1983; and Wedell, 1991).

have the ability of occurring at any time in the decision process, although it mostly occurs in the early stages.

Instead of compatibility between qualitative/quantitative response mode and decision rule (Tversky et al. 1988), it may be assumed that the required output from subjects needs to be compatible with the structure of information in input. In a matching task there is an agreement between input and the required output. Subjects are required to match one value difference (required output) to another difference which is given in the task (input). Hence, there exists a dimensional compatibility between input and output. If the difference between attribute levels of the prominent attribute serves as input, then the difference between the levels on the nonprominent attribute serves as the required output, and vice versa. This form of compatibility involves transforming and rearranging of the information by subjects in the editing phase, since both differences always have to be taken into consideration.

In choices and preference ratings on the other hand, both differences serve as input. For example, in a two alternatives x two attributes choice task the input is built on four pieces of information (the attribute levels of each alternative), whereas the output corresponds to a preference order between alternatives. Here, there is no dimensional compatibility between input and output. Subjects therefore do not transform and rearrange the information to the same extent, simply because they are not forced to do it. The information structure of these tasks gives them the opportunity to select a lexicographic strategy.

Hence, whereas choice as a qualitative response mode is distinguished from judgments, the idea is offered that matching judgments can be seen as distinct from preference ratings and choices in that subjects have to evaluate one value difference relative to another to carry out the task. On the basis of this reasoning, a prominence effect is also expected for preference ratings, due to the assumption that information structure compatibility is salient for the selection of strategy. The crucial fact for the strategy being used is the dimensional compatibility between the input and output and not (primarily) the metric levels of the same.

The hypothesis (H₃) that restructuring in the editing phase can explain the prominence effect is investigated in the present studies. It is henceforth referred to as the structure compatibility hypothesis.

There are probably connections between restructuring in the editing phase and value-belief restructuring. Henceforth, it is generally assumed that the information structure in input of different response modes in terms of presentation mode of the alternatives (sequential, simultaneous) has an effect on the belief-value restructuring later to come. Therefore, it is assumed that if the information

structure is characterized by sequential presentation of alternatives, this will lead to a decrease in value-belief restructuring, and a reduction of the prominence effect. If, on the other hand, the information structure is characterized by simultaneous presentation of alternatives, then this will lead to an increase of the value-belief restructuring, and to an enhanced prominence effect (see also Birnbaum, 1992).

To conclude, in cognitive restructuring theories, violations of the procedure invariance principle is interpreted as resulting from constructive processing in choice. In the phase of restructuring a tentatively promising alternative is differentiated from another/others. Because of this the prominent attribute looms larger in choice than in other response modes, for instance in judgments. The prominence effect in choice is therefore assumed to be acquired by different forms of restructuring operations in which changes of the representations take place. Researchers which adopt this perspective challenge the view that human choice is cognitively deficient⁴. Different arguments can be used in support of this standpoint. First, it can be argued that an important parameter has been neglected which is the cost of a decision strategy. Second, decisions must be viewed as parts of a continuous constructive process. They are nevertheless often seen as discrete events. Third, it is argued that very little attention has been given to the internal structural representation of the problem. A central issue in all three arguments is what conditions humans reveal in which kind of behavior. The issue of human behavioral efficiency from a general point of view is thus of less interest.

⁴ Montgomery (1989) concludes that especially the operations of bolstering of advantages and de-emphasizing of disadvantages of a promising alternative are activities that may lead to what might be termed irrational decisions. Nevertheless, he makes clear that such outcomes are not to be regarded as biased decisions. When dominance structuring leads to violations of invariance it must be viewed as a rational output in the sense that the output is a result of minimization of cognitive costs. On the other hand it is also rational, and prescriptively better, to use the operations of cancellation and collapsing (Watson, 1992). This is due to that the latter operations are more in line with reality.

3.0 Summary of the Empirical Studies

3.1 Study I: *Preference judgments and choice: Is the prominence effect due to information integration or information evaluation?* (Montgomery, Gärling, Lindberg, and Selart, 1990).

In this study the question was addressed whether the prominence effect found by Tversky et al. (1988) would remain if the judgment procedure they used would be replaced by another. Tversky et al. (1988) operationalized preference judgments in terms of a matching procedure in which the decision maker adjusted one option to another.

The judgment mode selected was preference rating, which is a more direct way of eliciting preferences than matching, involving overall judgments of single options. As was the case in the Tversky et al. (1988) study subjects were presented with a set of choice problems with two alternatives described by two attributes which differed in importance. Based on the explanation of the judgment-choice discrepancy provided by Tversky et al. (1988), it was assumed that choices more often would follow the more important attribute than preference ratings. Provided this held true, two explanations were put forward as accounts for the differential predictability of choices and preference ratings, value-belief restructuring and strategy compatibility. The value-belief restructuring hypothesis implies that choice subjects are supposed to evaluate the information about the options differently than what subjects do in preference ratings. On a more concrete level, the assumption was made that subjects in choice modify their beliefs or values in such a way that a larger discrepancy will occur between the alternatives on the more important attribute. This notion was in line with the notion that making a choice requires more commitment and involves more conflict which may create a higher pressure to find consistent support for choices than for preference ratings (cf. Abelson & Levy, 1985).

The strategy compatibility hypothesis is based on the notion that subjects in choice and in preference ratings differ in how they integrate the information. In other words, differences may occur which can be attributed to the way subjects select and weight the information in the two response modes. This explanation would be in line with the contingent weighting approach of Tversky et al. (1988) which states that subjects in choice are supposed to follow a lexicographic decision

rule. If such is the case, value and belief modifications would be unnecessary, since the conflict would be reduced.

To test these explanations, before eliciting their preferences, subjects were asked to evaluate the attribute levels one by one on a rating scale. The implication was that if the prominence effect covaried with these evaluations, it would support the idea of value-belief restructuring. If, on the other hand, the prominence effect was not followed by any concomitant variation in the evaluations of attribute levels across the two response modes, the strategy compatibility explanation would gain support.

The selection of attribute levels for the main experiment was made in a pilot study. A matching procedure was used which was identical to the one applied by Tversky et al. (1988). Subjects' task was to find combinations of attribute levels which rendered the two alternatives in each problem equally attractive.

In the main experiment one choice condition and two preference rating conditions were employed. Three parallel versions of a booklet were distributed to the subjects. In all conditions subjects were instructed to rate each attribute level with respect to the extent it facilitated or counteracted their goal in the decision situation. Attribute level ratings were hence made on a scale with positive and negative end-points. In the choice condition, the two alternatives of each problem were presented simultaneously on the same page. Subjects' task was to rate the attribute levels and subsequently choose one of the two options of each situation. One of the preference rating conditions was designed to be similar in its structure to the choice task. The alternatives were for this condition presented on the same page. In the other preference rating condition, each alternative was presented sequentially on a separate page.

The response scores from the choices and preference ratings were made comparable by the use of similar scoring procedures. A prominence effect for choice was detected, indicating that the attributes which were selected to be prominent loomed larger in choice than in the two rating modes. It was further shown that a reliable judgment-choice discrepancy only existed between choice and sequentially presented preference ratings.

The differences between ratings on the prominent attribute were greater for the choice and the pairwise preference ratings than for separate preference ratings. On the nonprominent attribute they were greatest for same-page preference ratings and lowest for separate preference ratings. Finally, it was shown that the response scores were not reliably related to response condition independently of the attribute level ratings.

The results were interpreted in line with the value-belief restructuring hypothesis, since the prominence effect was produced because subjects interpreted and evaluated the given information differently when they were choosing between the alternatives than when they were rating them. The strategy compatibility hypothesis did not receive empirical support, since the prominence effect could not be explained in terms of simplifying heuristics used in choice. However, incongruent with both the value-belief restructuring and strategy compatibility, a significant difference between choices and preference ratings was not found when the latter were made of simultaneously presented options.

3.2 Study II: *The judgment-choice discrepancy: Noncompatibility or restructuring?* (Montgomery, Selart, Gärling, and Lindberg, 1994).

In Study II different groups of subjects performed (1) only preference ratings or choices, (2) preference ratings or choices preceded by attractiveness ratings of the aspects on a rating scale, and (3) preference ratings or choices accompanied by think-aloud reports. Both subjects who made choices and subjects who made preference ratings were presented with options simultaneously. The number of options was increased from two to four with the aim of discouraging subjects in the preference-judgments condition to make implicit choices. In constructing the choice options, attribute levels were selected in a pilot study. Only two options were however included. Pairs of options were made equally attractive and were considered to be the main candidates or target options for subjects' choices. On the basis of these options, two prescriptively less important filler options were constructed for each problem to be included in the main experiment. Study II differed from Study I in that think-aloud data were collected. Hence, inferences could be made about how subjects attended to and evaluated attributes and attribute levels (Montgomery & Svenson, 1989).

The response scores from the choices and preference ratings were in all conditions made comparable by the use of similar scoring procedures. A prominence effect was thus obtained. However, significant effects involving response mode were not found. This implied that the prominence effect was not different for preference judgments and choices. Furthermore, since no main effect or interaction effect involving method reached significance, this would implicate no important interfering effects of attractiveness judgments of attribute levels and think-aloud reports.

Previous studies of restructuring of choice problems (Dahlstrand & Montgomery, 1984; Montgomery & Svenson, 1989) have shown that amount of

attention to and positive evaluation of an option depends on whether it is finally chosen or not. A highly significant main effect of preferred/nonpreferred target option was obtained, reflecting subjects' tendency to judge as more attractive the attribute levels of the target options which were more often preferred. Thus, subjects' judgments of attractiveness of attribute levels were consistent with their preference judgments and choices. In addition, response mode was involved in a weak higher-order interaction with preferred/non-preferred target option, prominent/nonprominent target option, and attribute. However, this interaction effect did not suggest more restructuring for choices than for preference judgments.

The processing of the think-aloud reports followed a procedure which has been developed in previous research (e. g., Montgomery & Svenson, 1989; Svenson, 1989). On the basis of the coded results, two indices of information processing were computed reflecting the attention and evaluation of information. The attention index indicated that more attention was paid to the attributes in the preference-ratings condition than in the choice condition. On the evaluation index, the prominent attribute received a significant higher value than the nonprominent attribute. A significant main effect of response mode on the attention index was found. Target options received about half as much attention in choices as in preference ratings. Moreover, in choices the preferred target option drew more attention than the nonpreferred target option while the reverse was true in preference ratings. Evaluations were less positive in choices than in preference ratings. However, this difference was limited to nonpreferred target options. Thus, in support of the existence of restructuring of the choice options, the difference in degree of positive evaluation was larger between preferred and nonpreferred target options when subjects made choices than when they performed preference ratings.

The results thus replicated the prominence effect in showing that choices were more often made of the option with the highest value on the predominant or prominent attribute. However, a prominence effect was also demonstrated for preference ratings.

The prominence effect observed for preference ratings seems to rule out the strategy compatibility hypothesis as the sole explanation. It was undeniable that the response was more quantitative in preference judgments than in choices, but subjects nevertheless showed an equally strong tendency to attend to the prominent attribute. The same conclusion was reached by Westenberg and Koele (1992) on the basis of their finding that the prominence effect for different response modes was unaffected by the number of possible attribute levels.

However, the value-belief restructuring account did not fare better. The think-aloud protocols supported the assumption that subjects changed their values and beliefs when making choices. Such restructuring was also observed more frequently for choices than for preference ratings. Only in the case of choices was the observed value-belief restructuring accompanied by a prominence effect. Since a prominence effect was also obtained for the preference ratings, this form of restructuring could not be a sufficient explanation. When assessing the validity of the value-belief restructuring hypothesis, it should be noted that the judgments of attractiveness of the attribute levels did not clearly indicate that this form of restructuring was more frequent in the choice than in the preference-rating conditions. However, when performing the attractiveness judgments, subjects were perhaps influenced by the numerical attribute levels to the extent that they did not change their judgments much even though a change was experienced. In the think-aloud reports where subjects did not make any attractiveness judgments, such an influence was probably minimized.

The results of the study indicated that information was processed differently when subjects made preference ratings than when they made choices. Less attention was given to the target options in choices than in preference ratings which as an isolated finding indicate that subjects attended to fewer aspects (Lindberg et al., 1989). As suggested by the think-aloud protocols, in choices subjects furthermore differentiated the options more on the prominent attribute and less on the nonprominent attribute. No difference was found between choice and preference ratings with respect to how attractive the attributes were perceived.

A more general form of the compatibility hypothesis was therefore suggested in line with editing-phase restructuring. Whereas the choice task is different from both the matching and preference-rating tasks in being qualitative rather than quantitative, preference ratings are different from matching in calling for judgments of single options rather than matching one value difference to another. Thus, one may expect a prominence effect for preference ratings although it is not possible to predict how strong it will be relative to that for choice.

In summary, preference ratings appeared to be almost equally susceptible to the prominence effect as choices are. The structure compatibility hypothesis which was offered was therefore suggested to better explain the prominence effect than the value-belief restructuring explanation, even though, as the present results showed, value-belief restructuring was part of the process leading to a choice.

3.3 Study III: *Violations of procedure invariance in preference measurement: Cognitive explanations (Selart, Montgomery, Romanus, and Gärling, 1994).*

In the first experiment of Study III the value-belief restructuring hypothesis was tested as follows. It was argued that if value-belief restructuring explains the prominence effect, a factor which increases this restructuring should be expected to also increase the prominence effect. A decision may be more important if the consequences have personal relevance. Hence, two different sets of pairs of choice options were constructed. One set consisted of options which were framed as personally relevant, the other set consisted of options which were not directly personally relevant. The higher degree of personal relevance was expected to increase value-belief restructuring. In contrast, no difference was predicted from the strategy compatibility hypothesis. Different groups of subjects who either made choices or performed preference ratings were given the different sets of choice options. Think-aloud protocols were obtained as a means of assessing the degree of value-belief restructuring.

According to the strategy compatibility hypothesis more attention was supposed to be given to the prominent attribute in choice than in preference ratings. Furthermore, a prominence effect should only occur in choice.

In line with the editing-phase restructuring hypothesis, sequential presentation of alternatives was likely to reduce value and belief restructuring. The question was therefore raised whether a weaker prominence effect would be obtained also for choices if options were presented sequentially. Personal relevance was not supposed to make a difference.

Attribute levels were selected on the basis of the results of a pilot study. Subjects' task was to make the alternatives of each pair equally attractive. One third of the subjects made choices of options presented pairwise on separate pages in a booklet. Another third accepted or rejected options which were presented singly. A final third of the subjects performed preference ratings of singly presented options.

Preference ratings, choices between options, and choices to accept were scored equivalently. A prominence effect was uniformly obtained. The prominence effect was reliably smaller for personally relevant problems and reliably larger for choices to accept. For the personally relevant problems, the prominence effect was furthermore reliably smaller for choices between options than for the other response modes. For the personally less relevant problems, the prominence effect was reliably larger for choices between options than for the other response modes.

Whether choices between options were construed as personally relevant or not did thus not seem to have an unequivocal effect. As predicted from the value-belief restructuring hypothesis, personally relevant problems affected the prominence effect for choices and choices to accept but did not affect the prominence effect for preference ratings. However, the effect was in the expected direction only for choices to accept. In addition, the think-aloud protocols did not indicate that personal relevance increased value-belief restructuring.

Evidence for value-belief restructuring preceding choices between options was obtained in that the difference between the evaluations of preferred and nonpreferred options were larger for choices between options than for preference ratings. However, choices to accept did not differ from preference ratings. A characteristic of the think-aloud data appeared to be that sequential presentation led to positive evaluations of both levels of the prominent attribute and negative evaluations of both levels of the nonprominent attribute. More comparisons were thus made when both options were available simultaneously.

Against the strategy compatibility hypothesis spoke that, in the think-aloud protocols, more attention was not given to the prominent attribute. The strategy compatibility hypothesis was also contradicted by the fact that an equally strong prominence effect was obtained for choices and preference ratings. This was in line with the results of Studies I and II.

A simultaneous presentation mode did not increase the prominence effect, which contradicted the editing-phase restructuring hypothesis.

In the second experiment of Study III the question was raised whether a prominence effect would also be obtained if the same subjects performed the matching task, either on the same or on a different occasion as they performed the choice or preference-rating task. If both tasks are performed on the same occasion, this may decrease the prominence effect for choices, according to the structure compatibility hypothesis. It may also decrease the prominence effect for preference ratings when alternatives are presented simultaneously, due to the similarity in information structure to the choice condition.

Furthermore, since performance of the matching task on the same or a different occasion does not affect strategy compatibility, no difference in prominence effect was expected on the basis of the strategy compatibility hypothesis.

The choices and preference ratings were scored as in the preceding experiment. A prominence effect was obtained in each condition. As expected from the structure compatibility hypothesis, the prominence effect was reduced when subjects performed the matching task in the same session. However, neither the main effect of session nor its interaction with response mode reached significance.

In both experiments the prominence effect was replicated. Although the options were matched to be equally attractive, the option with the highest value on the prominent attribute was more often chosen. This held true irrespectively of whether the same or different subjects performed the matching task, whether the same subjects performed the matching task in the same or in a different session, or whether the missing values were the same or varied. Consistent with previous findings (Fischer & Hawkins, 1993), a prominence effect was also observed for preference ratings. In the first experiment a prominence effect was similarly found for choices to accept an option. Thus, the results corroborated the generality of the prominence effect. At the same time they questioned the explanations of the effect which have been offered.

Unless there was some other explanation of the prominence effect for preference ratings, observing such an effect was not in agreement with the strategy compatibility hypothesis. This hypothesis only predicts a prominence effect for choices. In addition, the think-aloud protocols did not indicate that subjects attended more to the prominent attribute as the hypothesis implies they would. However, the value-belief restructuring hypothesis was also again contradicted. The think-aloud protocols in the first experiment supported the assumption that subjects' value-belief restructuring was more frequent in the choice problems in connection with choices between options than for preference ratings of sequentially presented options. In disagreement with the hypothesis, value-belief restructuring was however not more frequent for choices to accept than for preference ratings. Furthermore, only in the case of choices between options was the observed restructuring accompanied by a prominence effect. Since a prominence effect was obtained for the preference ratings and choices to accept, value-belief restructuring cannot be a sufficient explanation. The protocols further revealed that construing the problems in the first experiment as personally relevant did not lead to more value-belief restructuring.

Disregarding an effect in the unpredicted direction confined to choices between options, the results were consistent with the structure compatibility hypothesis. Yet, in disagreement with the hypothesis, a prominence effect was observed in the first experiment for choices to accept an option. Also in disagreement with the hypothesis, in the second experiment a prominence effect was found when subjects simultaneously performed the matching task. Still, the prominence effect tended to be weaker in this condition as compared to a condition when the matching task was performed in a different session.

3.4 Study IV: *Can accountability and value differences modify the prominence effect in judgment and choice?* (Selart, 1994).

In the first experiment of Study IV a matching procedure was used to provide the stimulus material for the following two experiments. Subjects task was to make the pairs of alternatives equally attractive. In the second and third experiments, preferences for the alternatives were elicited with choices and preference ratings. Two partly different manipulations of accountability were used in these experiments (Tetlock, 1983; Simonson & Nye, 1992). The value difference within attributes was also varied.

The analyses of the results of the matching experiment rested on the assumption that the attractiveness of the levels of the prominent and nonprominent attributes for the prominent option (with the highest value on the prominent attribute) were equal to the corresponding attractiveness of the levels of the prominent and nonprominent attributes for the nonprominent option. The mean weight ratios of the attributes indicated that effectiveness was a more important attribute than pain-relief. No reliable interaction between matching condition and value difference was found. On average no change with value difference was observed. The construction of the stimuli for the following experiments was accordingly based on the overall mean weight ratio.

In the second experiment pairs of descriptions of medical treatments were constructed as follows. In one set of pairs the numerical value differences on the prominent attribute were small, in another set they were large. A numerical value difference on the nonprominent attribute was for each treatment pair obtained by first multiplying the value difference on the prominent attribute with the mean weight ratio obtained from the matching task in the first experiment. The resulting numerical value difference was then slightly increased to make the nonprominent option appear more attractive than the prominent option, in line with the procedure in Tversky et al. (1988).

Preferences were elicited with choices and preference ratings. The descriptions were presented pairwise in the preference-rating condition like they were in the choice condition.

The degree of accountability was manipulated through task instructions in a way similar to that in previous studies. In the low accountability condition, subjects were told that all of their responses would remain totally confidential. In contrast, subjects were told in the high-accountability condition that the material they provided by their responses would be included in a booklet and subject to future class discussions. They were therefore told to explain and justify their judgments or

choices. After having completed all choices/ratings, subjects were allowed to review their responses and then write down their explanations and justifications. Without having been told in advance, subjects in the low-accountability condition were asked to do the same.

To further test the value-belief restructuring hypothesis it was proposed that accountability would increase this form of restructuring in choice. This was because justifying reasons for a choice should influence modifications of values and beliefs. Hence, a larger prominence effect was predicted for choices of high accountability than for those of low accountability. This manipulation was however supposed neither to increase nor decrease the prominence effect according to the competing hypotheses based on strategy compatibility and structure compatibility, respectively.

In addition, the value-belief restructuring hypothesis was tested by varying the numerical value differences between the options. Small numerical value differences were assumed to result in an increase of the effect in choices, based on enhancement of value-belief restructuring. The rationale behind this suggestion was that value-belief restructuring could be regarded as a "mental tie-breaking procedure" which was more likely to be set in action if options are closer in attribute values.

According to the structure compatibility hypothesis small numerical value differences were like in the matching situation supposed to decrease the effect in both choice and preference rating, whereas large differences should increase it.

In line with the strategy compatibility explanation it was implied that the response mode should prime the strategy selection independently of the magnitudes on the quantitative input side. Therefore, such a manipulation was not supposed to influence the prominence effect in any direction.

Choices and preference ratings were scored equivalently. A prominence effect was uniformly obtained. Some differences in the strength of the prominence effect were however evident. The prominence effect was reliably weaker when the numerical value difference was small than when it was large. In addition, the interaction with response mode was significant. Numerical value difference had little impact on the prominence effect in choice but affected the strength of the effect in preference ratings. There was no main effect of accountability. Furthermore, the interaction between response mode and accountability did not reach significance.

The written justifications and explanations were coded similarly as think-aloud data in the previous studies. Only value-belief restructuring through attribute

importance could be analysed. However, there were no effects of response mode in these analyses.

In summary, there was no clear evidence for an effect of accountability on the prominence effect. It may be the case that the accountability manipulation was too weak. Therefore another kind of accountability manipulation was used in a third experiment in which the stimuli consisted of a subset of those used in the second experiment. The procedure was identical to that in the second experiment except that accountability was manipulated in a slightly different way. In contrast to the second experiment subjects in the high accountability condition were asked to explain and justify in a written statement each choice or pair of preference ratings immediately after every elicitation. No explanations/justifications were required from subjects in the low-accountability condition. The predictions of the three hypothesis as well as the scoring procedures were essentially the same as in the second experiment.

A prominence effect was again uniformly obtained. Like in the second experiment it was reliably smaller when the numerical value difference was small than when it was large. However, neither the main nor the interaction effect of accountability reached significance. The justifications and explanation were coded and analyzed in the same manner as in the second experiment. There were no effects of response mode in this experiment.

The results of the experiments provided further evidence for the prominence effect. The strength of the effect was revealed in that the attempts to decrease preferences in line with the effect proved to be unsuccessful. Subjects still preferred the option with the highest value on the prominent attribute. As revealed by previous research, a prominence effect was found also for preference ratings. This finding supported the notion of the generality of the effect, and suggested that compatibility between input and output information could not alone account for the effect.

The value-belief restructuring hypothesis led to three predictions. First, it predicted a larger prominence effect for choices of high accountability than for those of low accountability. However, the accountability manipulation did not reach significance in any of the experiments. Second, it predicted that small numerical value differences should result in an increase of the prominence effect. The results suggested the reverse in both the second and the third experiment. Thus, the prediction that a small numerical value difference would produce value-belief restructuring and create a "mental tie-breaking procedure" lacked empirical support.

Third, it was predicted that this form of restructuring in justification and explanations should be more enhanced in choice than in preference ratings. However, no reliable effects due to response mode was found in any of these analyses.

The structure compatibility hypothesis made two predictions. First, it predicted that accountability was supposed neither to increase nor decrease the effect in choice. In line with the prediction, no reliable main effects of accountability was detected in the experiments. Second, it predicted that small numerical value differences should decrease the effect in both choice and preference ratings whereas large such differences should increase it in both response modes. As suggested by the hypothesis, reliable main effects of numerical value difference in the predicted direction were generally obtained. Therefore, it seemed plausible to assume that the obtained results due to numerical value difference could be attributed to the same kind of information organization principle in choice as in preference ratings.

Apart from the general claim that the responses in choices should differ from those in preference ratings, the strategy compatibility hypothesis made two predictions. First, accountability was supposed neither to increase nor decrease the prominence effect. The prediction was confirmed. Second, numerical value difference was not supposed to influence the prominence effect in any direction. This prediction turned out to be false. The results instead pointed towards that both response mode and variations in the stimulus material primed the strategy being used.

The generality of the prominence effect was once again demonstrated. In addition to a number of other factors it was shown that numerical value difference modified the effect. When considering the different explanations of the prominence effect, the structure compatibility explanation appeared to be the most capable in accounting for these. The explanation pointed to the possibility that variations in the stimulus material has the ability to prime the strategy being used.

4.0 General Discussion and Conclusions

Three cognitive accounts of why the invariance principle of decision theory was violated by the prominence effect were tested in a series of studies. These explanations were the strategy compatibility hypothesis, the value-belief restructuring hypothesis, and the editing-phase restructuring hypothesis.

The strategy compatibility hypothesis claimed that the prominent or predominant attribute looms larger in choice than in judgment because choice and matching tasks evokes different types of decision strategies giving different weight to the prominent attribute (Tversky et al. 1988; Fischer & Hawkins, 1993; Hawkins 1994). The qualitative response in choice is viewed as compatible with a qualitative decision rule which renders quantitative weighting of attributes unnecessary. In contrast, quantitative judgments are compatible with a quantitative weighting rule. The cognitive basis of this suggestion is twofold. First, noncompatibility is regarded as requiring additional mental operations which subjects avoid. Second, a response mode is seen as priming the focus of attention on the compatible features of the input.

The value-belief restructuring hypothesis stated that if there are one prominent and one nonprominent attribute, as a result of a restructuring process the former will have more influence since the differences on that attribute are enlarged relative to the other. More precisely, subjects may modify their values or beliefs in such a way that there will be a larger discrepancy between the options on the more important attribute than on the less important attribute. Both the importance order of the attributes and the differences between the alternatives on the attributes will then speak in favour of a preference in line with the prominent attribute. The above mentioned modifications of beliefs or values were thought to take place in choice which is characterized by a conflict between alternatives. It was assumed that reasons or motives guide the modifications of values and beliefs.

According to the structure compatibility hypothesis, it was assumed that the required output from subjects needs to be compatible with the structure of information in input. Whereas choice as a qualitative response mode is distinguished from judgments, matching judgments can be seen as distinct from preference ratings and choices in that subjects have to evaluate one value difference relative to another to carry out the task. On the basis of this reasoning, a prominence effect is also expected for preference ratings, due to the assumption that information structure compatibility is salient for the selection of strategy.

Furthermore, the hypothesis assumed that the presentation mode of the alternatives (sequential, simultaneous) in choice and preference rating tasks has an effect on the value-belief restructuring later to come. Therefore, it was assumed that if the information structure is characterized by sequential presentation of alternatives, this will lead to a decrease in value-belief restructuring, and a reduction of the prominence effect. If, on the other hand, the information structure is characterized by simultaneous presentation of alternatives, then this will lead to an increase of the value-belief restructuring, and to an emphasize of the prominence effect (see also Birnbaum, 1992).

In Study I the results were interpreted in line with the value-belief restructuring hypothesis, since the prominence effect was produced because subjects interpreted and evaluated the given information differently when they were choosing between the alternatives than when they were rating them. The strategy compatibility hypothesis did not receive empirical support, since the prominence effect could not be explained in terms of simplifying heuristics used in choice. However, incongruent with both the value-belief restructuring and strategy compatibility, a difference between choices and judgments were not found when both were made of simultaneously presented options.

The picture was not as clearcut in Study II. The results replicated the prominence effect in showing that choices were more often made of the option with the highest value on the predominant or prominent attribute. However, a prominence effect was also demonstrated for preference ratings.

A prominence effect observed for preference ratings seemed to rule out the strategy compatibility hypothesis as the sole explanation. It is undeniable that the response was more quantitative in preference judgments than in choices, but subjects nevertheless showed an equally strong tendency to attend to the prominent attribute.

However, the value-belief restructuring account was not supported either. The think-aloud protocols supported the assumption that subjects changed their values and beliefs when making choices. Such restructuring was also observed more frequently for choices than for preference ratings. Only in the case of choices was the observed value-belief restructuring accompanied by a prominence effect. Since a prominence effect was also obtained for the preference ratings, this form of restructuring could not be a sufficient explanation.

A more general form of the compatibility hypothesis was therefore suggested based on editing-phase restructuring. Whereas the choice task is different from both the matching and preference-rating tasks in being qualitative rather than quantitative, preference ratings are different from matching in calling for judgments

of single options rather than matching one difference to another. Thus it was concluded that one may expect a prominence effect for preference ratings although it is not possible to predict the strength of it relative to choice.

In both experiments of Study III, the prominence effect was replicated. Although the options were matched to be equally attractive, the option with the highest value on the prominent attribute was more often chosen. This held true irrespectively of whether the same or different subjects performed the matching task, whether the same subjects performed the matching task in the same or in a different session, or whether the missing values were the same or varied. Consistent with previous findings (Fischer & Hawkins, 1993), a prominence effect was presently also observed for preference ratings. In the first experiment a prominence effect was similarly found for choices to accept an option. This finding falsified the strategy compatibility hypothesis.

In line with the value-belief restructuring hypothesis the think-aloud protocols in the first experiment supported the assumption that subjects restructured values and beliefs in the choice problems more frequently in connection with choices between options than in connection with preference ratings of sequentially presented options. In disagreement with the hypothesis, value-belief restructuring was however not more frequent for choices to accept than for preference ratings. Furthermore, only in the case of choices between options was the observed restructuring in this form accompanied by a prominence effect. Since a prominence effect was obtained for the preference ratings and choices to accept, value-belief restructuring could not be a sufficient explanation. The protocols further revealed that construing the problems in the first experiment as personally relevant did not lead to more value-belief restructuring.

Disregarding an effect in the opposite direction confined to choices between options, the results were consistent with the structure compatibility hypothesis. Yet, in disagreement with the hypothesis, a prominence effect was observed in the first experiment for choices to accept an option. Also in disagreement with the hypothesis, in the second experiment a prominence effect was found when subjects simultaneously performed the matching task. Still, the prominence effect tended to be weaker in this condition as compared to a condition when the matching task was performed in a different session.

The results of the experiments in Study IV provided further evidence for the prominence effect. As in previous research, a prominence effect was found also for preference ratings. However, the value-belief restructuring hypothesis was not supported in that the accountability manipulation did not reach significance in any of the experiments. Furthermore, the results suggested that the prominence effect

was decreased rather than increased by the use of small numerical value differences. Third, no reliable effects due to response mode was found in any of the analyses of the explanations and justifications..

The structure compatibility hypothesis was on the other hand supported by the fact that no reliable main effects of accountability was detected in the experiments. As suggested by the hypothesis, reliable main effects of numerical value difference in the predicted direction were generally obtained. Therefore, it seemed plausible to assume that the obtained results due to numerical value difference could be attributed to the same kind of information organization principle in choice as in preference ratings.

The strategy compatibility hypothesis lacked support in that a prominence effect was found in choice as well as in preference ratings. The fact that numerical value differences had an effect on the prominence effect also spoke against the hypothesis. The present results instead pointed towards that both response mode and variations in the stimulus material affected the strategy being used. However, in accordance with the strategy compatibility explanation, the manipulation of accountability did neither increase nor decrease the prominence effect.

In conclusion, a prominence effect was in most experiments found for both choices and preference ratings. This finding speaks against the strategy compatibility hypothesis suggested by Tversky et al. (1988). Instead, different forms of cognitive restructuring may provide a better account. Two such approaches have been proposed, based on value-belief restructuring and restructuring occurring in the so-called editing phase, respectively. As was revealed in the present studies, none of these approaches provided a single explanation. However, the structure compatibility hypothesis appeared to be the more viable explanation, in particular of the relation between experimental manipulations and response mode outcomes. These predictions were also found to be more important for the modification of the effect. The assumption is hence made that the predictions of the structure compatibility hypothesis are more vital for the structural modelling accounts of the phenomenon, that is, for the relation between input and output data. The predictions of the value-belief restructuring hypothesis, on the other hand, seemed to be more valid for the prominence effect found in choice than for those detected in preference ratings. Therefore, it cannot be excluded that qualitative and quantitative response modes may result in different value-belief restructuring operations, likewise leading to a prominence effect for both response modes. This would depend on whether there is a difference in the editing of information in judgment and choice.

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Appendix

