

**tenth research conference
on subjective probability,
utility and decision making**

helsinki, finland

26 — 29 august



P R O G R A M

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utility and decision making**



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SPUDM is an international, interdisciplinary conference committed to improving the theory and practice of decision making. It is open to those who believe that schemes prescribing how people should make decisions need to incorporate knowledge about the way people actually do make decisions. Conversely, descriptive studies are believed relevant in so far they offer suggestions for making better decisions. The increased demand for practical methods to tackle complex decision problems requires careful examination of theoretical conceptions and hypotheses employed for justifying any method. The SPUDM conference attempts to do this in meetings held every second year in a different European city.

The conference is largely conducted in plenary sessions in order to discourage division of the field into narrow specialities, and to encourage participants to discover the relevance of others' work to their own activities. Apart from (invited) special lecture and major papers, the conference will consist of presentations of specific papers, seven different workshops, computer program demonstrations, and some social events.

Conference site and secretariat:
Swedish School of Economics and Business Administration
Arkadiagatan 22
00100 Helsinki
ph. (90) 44 02 91

Helsinki, June 11, 1985

TO ALL REGISTERED PARTICIPANTS

This book offers information about the IOSPUDM program. The fact that it is sent to you confirms your registration and receipt of payment for participation in the conference.

The information in this book is not complete. One major paper and some of the abstracts for the workshops are missing. You will receive the missing information when you register at the conference site.

Two workshops are added to the five earlier planned: "Theory for decision support" and (not surprisingly) "Subjective probability". The work in the workshops will be organized differently, depending of the intention of the workshop organizer. This shows up in the variability of the information given concerning these workshops. Some additional information concerning the workshops that will be needed for the conference will be delivered by Helmut Jungermann at a later time.

Please observe the instructions concerning manuscripts for the volume of selected proceedings that will be published during Spring 1986.

The Organizing Committee is grateful to all those who have made program suggestions, accepted invitations (and their consequences) and accepted to organize workshops. We are also grateful to all those who have offered proposals for the inclusion in the program.

We will meet in Helsinki to make the conference both interesting and joyful!

Berndt Brehmer
Helmut Jungermann
Oleg Larichev
Peter Lourens
Gordon Pitz
Guje Sevón

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7 P R O G R A M

SUNDAY, August 25

19.00 - 22.00 Informal get together party at the Conference site, the Swedish School of Economics, Arkadiagatan 22, Helsinki. Registration

MONDAY, August 26

08.00	Registration	
09.00	Opening: Minister of Education, Ms. Kaarina Suonio, Vice Dean, Professor H.C. Blomqvist, and Guje Sevón	
09.30	Jay Christensen-Szalanski: Towards an understanding of human judgment: Medical pills for psychological ills. Chair: Helmut Jungermann	13
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10.20	Coffee	
10.40	Workshops	
12.30	Lunch	

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20.00 - 21.30	Lawrence D. Phillips: Tutorial "The practice of decision analysis"	174

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09.50	Joshua Klayman: Testing and revising hypotheses: Strategy and structure	274
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12.30	Lunch	
14.00 - evening	Excursion to LIFIM, Sannäs, the Finnish Management Center, situated 65 km east of Helsinki. Lecture by James G. March: Alternative visions of how decisions happen. Chair: Guje Sevón	173
	Sauna (optional), (BRING your swim suit if you want to take a swim in the swimmingpool)	

THURSDAY, 29 August

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09.20	Maria Lewicka: Towards a motivational account of cognitive biases	276
09.50	Maya Bar-Hillel & Avishai Margalit: Intransitivity in choice behavior	279
10.20	Coffee	
10.40	O.I. Larichev, E.M. Moshkovich & E.M. Furems: Decision support system CLASS (CLASSification System)	281
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16.40	Willem K.B. Hofstee: A criterion for the substitutability of objective procedures for judgments of quality	291
17.10	Break	
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WORKSHOP PROGRAM

Seven different workshops are offered. The idea of a workshop meeting is that one or two leading papers are presented, whereupon the rest of the session is devoted to extensive discussion, exchange of findings, plans, criticisms, and the like. Topics, workshop organizers and contributors are mentioned below. If the abstract of the contributions is included in this volume, the title of the abstract is mentioned.

(a) STRUCTURING OF DECISION PROBLEMS IN APPLIED SETTINGS (Ward Edwards)

Contributions (abstracts, see p 175 - 180):

Farrokh Alemni: Illustrative analysis of one employer's decision to join a preferred provider arrangement

F. Hutton Barron: Sensitivity in value loss of linear multiattribute value models to attribute completeness

Sue Brownlow: Methods for structuring multi-attribute value hierarchies: a comparison

Also contributing: Helmut Jungermann, Donald Kleinmuntz, Lawrence D. Phillips, and Detlof von Winterfeldt

(b) COGNITIVE MODELS OF DECISION PROBLEMS (Henry Montgomery and Ola Svensson)

Contributions (abstracts, see p 181 - 197):

Anders Biel & Henry Montgomery: Images in energy planning

S.F. Biggs: A descriptive study of auditor's use of analytical review in audit program design

Heiner Gertzen & Franz Schmalhofer: Judgment as a component decision process for choosing between sequentially available alternatives

A.D. Nikiforov & S.B. Rebrik: The study of capability of decision maker to carry out some elementary operations

Pertti Saariluoma: Decisions in chess players' problem solving

Tadeusz Tyszkä: The role of familiarity in the choice of decision strategy

Elke Weber: Portfolio theory revisited: A quantitative comparison with subjective expected utility

Martin Weber & Detlof von Winterfeldt: Bias in assessing weights in multiattribute decision making

Also contributing: Ulrike Becker, Helmut Jungermann, and Manfred Thüring

(c) APPLICATION AND EVALUATION OF DECISION AIDS (Berndt Rohrmann)

Contributions (abstracts, see p 198 - 202):

P. Neijens: Design and evaluation of a decision aid in a nationwide discussion

Monica Shapira: Application of decision aid in human service organization

Other contributors: Jay Christensen-Szalanski, Mark Chaput de Saintonge, S. Nagel, and Stuart Wooler

(d) INDIVIDUAL AND ORGANIZATIONAL DECISION MAKING (Zur Shapira)

Contributions (abstracts, see p 203 - 215):

Monday, August 26:

Godfried van den Wittenboer: Dynamic decision making in dual control problems with conflicting goals

Jane Fraser: Decision analysis with competition

David Messick: Decision making in social dilemmas

Also contributing: Dave Anderson

Tuesday, August 27:

Eric Johnson & Richard Thaler: Hedonic framing and the break-even effect

Inga-Lill Johansson & Ewa Wennström: Who can make use of financial information?

Richard Thaler: Perception of fairness in economic transactions

Also contributing: Dan Galai

Wednesday, August 28:

Jitendra V. Singh & Robert House: Organizational decision making and organizational survival

Dan Zakay: Quality of information and organizational decision making

Dan Zakay: Behavioral intents as determinants of decision-making processes

(e) APPLICATION OF DECISION THEORY TO INDIVIDUAL BEHAVIOR IN RISKY SITUATIONS (Heikki Summala)

Contributions (abstracts, see p 216 - 220):

George Cvetkovich: Hazard information and the public: Would a marketing approach help?

Ray G.C. Fuller: Reflections on risk homeostasis theory

Also contributing: Leonard Evans

(f) THEORY FOR DECISION SUPPORT (Patrick Humphreys)

Major contributions (abstracts, see p 221 - 230):

Eric Nappenbaum: A cognitive design paradigm in the theory of choice

Cristina & Amílcar Sernadas: Structured clausal knowledge bases for DSS modular development

Also contributing: Gerard de Zeeuw

Brief contributions:

Fred Bronner & Robert de Hoog: Industrial decision making and the design of external decision support facilities

Ja. L. Geurtz: Decision techniques and social research: Toward an integrated framework for problem-solving

Geoffrey G. Roy: Decision support and decision making in regional planning

(g) SUBJECTIVE PROBABILITY (Pieter Terlouw, preliminary organizer)

Contributions (abstracts, see p 231 - 245):

Mohammad J. Abdolmohammadi: An empirical examination of the efficiency of the Bayesian statistics in auditing

Roger M. Cooke: The principles of expert resolution

Ruma Falk: The credibility of evidence obtained by probabilistic knights and knaves

Gideon Keren: On the calibration of experts and lay people

Pieter Koele: The use of subjective probabilities for discriminating levels of partial knowledge concerning a test item

Graham Loomes: Testing for regret and disappointment in choice under uncertainty

Gregg Oden: The role of fuzziness in a theory of decision process

Pieter Terlouw: Overconfidence reconsidered

COMPUTER DEMONSTRATIONS

Contributions (abstracts, which constitute the framework for the demonstrations, see p 246 - 252):

C.W. Hopkins: Decision support systems: tools or assistants?

Raimo Keloharju: On-line demonstration of DYSMOD-software

Jac. Vennix: Communicating insights from complex simulation models

Towards an Understanding of Human Judgment:
Medical pills for psychological ills

Jay J. J. Christensen-Szalanski

The past decade and a half has witnessed the maturation of a "scholarly movement" that has examined the limitations of human judgment and decision making abilities. Represented by the works included in the books by Kahneman, Slovic, and Tversky (1982), and Nisbet and Ross (1980), this compilation of research on "cognitive heuristics and biases" has convincingly demonstrated that human judgment and decision making processes are imperfect. This line of research has also had a considerable impact upon the judgment and decision making literature, particularly in the United States. For example, researchers tend to cite preferentially its studies (Christensen-Szalanski & Beach, 1984), and to anchor their discussion of research findings on the "heuristic" paradigm itself (Berkeley & Humphreys, 1982).

Given the impact of this research on the academic environment, this paper will examine its usefulness to the practitioner making judgments and decisions in nonlaboratory contexts. Unlike previous papers which have criticized the usefulness of this research by questioning the existence of the laboratory-observed biases outside of the laboratory (see for example, Ebbesen & Konecni, 1980; Fiedler, 1983; Groner, Groner & Bischoff, 1983; Hogarth, 1981; Phillips, 1983; Wallsten, 1983), this paper will examine the practical usefulness of the cognitive bias research while assuming that all the currently documented cognitive biases do exist outside of the laboratory. The first section describes how the standard commonly used by researchers to evaluate human judgment and decision making differs from that commonly used by practitioners. The second section uses the practitioner's standard to assess the practical usefulness of the findings generated by the "cognitive heuristics and bias" research: It concludes that even given the assumption that all the currently documented biases do exist in nonlaboratory contexts, the knowledge generated by this research movement is of little use to the practitioner. The third, and final, section examines several

areas of research which have been neglected during the growth of this movement, but which might provide useful information to the practitioner: It concludes that researchers are not helping practitioners improve judgment and decision making abilities by focusing on errors in judgment and decision making and that an expanded research agenda is warranted.

Standards of Quality: Process vs Outcome

The usual procedure for research on the psychology of judgment and decision making consists of presenting subjects with a task for which a theory prescribes a "correct" answer. As one might expect, there usually is a discrepancy between what the subject does and what the theory prescribes. The question then arises of how to interpret that discrepancy.

The approach that commonly is used by researchers in this field regards the discrepancy as a reflection of the inadequacy of the subject's thinking processes. It views the normative theory as the standard of correctness and does not question the validity of the model's assumptions (Jungermann, 1983). Thus, for example, a "good" (i.e. correct) decision for the decision theorist is one that maximizes the expected utility of the outcome. Such a standard, as Majone (1984), and Wright and Murphy (1984) point out, means that the quality of the decision is evaluated with respect to the inferred process by which the decision appears to have been made, and not with respect to the outcome of the decision.

In contrast, the practitioner primarily is concerned with the outcome of the decision (e.g. Cassell, 1982; Jonsen, 1978). "Did the patient get better?" "Did our profits increase?" "Do I feel happier?" The process by which the decision or judgment was made is of secondary importance except when the outcome itself is bad. In such circumstances, the practitioner is interested in knowing whether he or she "did what was the correct thing" even though it did not result in the "correct outcome." On the other hand, when the outcome is good, the practitioner is not so concerned about evaluating the quality of the judgment or decision process. For example, the dictum

"If it works then use it" is commonly expressed in medicine as justification for the use of such "unscientific" treatment processes as placebos and faith healers (Gross, 1984; Kapp, 1983).

In summary, researchers and practitioners differ in the standards that they commonly use to evaluate the quality of a judgment or decision. The former uses a standard that focuses on the inferred process by which the decision or judgment supposedly is made, while the latter uses a standard that focuses on the outcome resulting from the judge's or decision maker's effort.

These different evaluative standards can result in researchers and practitioners differing in their interpretation of the usefulness of research findings. For example, when successful mathematicians are found to answer mathematical questions in a manner different from the predictions of a normative theory, the researcher is apt to interpret the results as evidence that even expert "acquaintance with formal logic and with probability theory does not extinguish erroneous intuitions" (Tversky & Kahneman, 1971, p.109). In contrast, the practitioner may wonder whether the fact that people apparently can be successful mathematicians in the real world (i.e. a good outcome) without being able to solve the experimenter's mathematical task suggests that the task itself is an inappropriate measure of the mathematician's abilities.

The existence of these differences in evaluative standards and interpretations suggests that, rather than being heedlessly generalized, the research results on cognitive biases and heuristics need to be evaluated from the practitioner's perspective in order to determine their implications for "practical tasks." In short, knowledge of the existence of a bias is not sufficient to help practitioners improve their judgments and decisions. Practitioners also want to know the effect of that bias on the resulting outcomes. Specifically, practitioners need to know (1) the degree to which the outcome resulting from their judgments and decisions will improve once the cognitive bias is eliminated, and (2) whether this improvement

merits the expenditure of resources (e.g. mental effort, time, money) needed to accomplish it.

The Practical Importance of Cognitive Biases

Relative to the large number of research studies that document the existence of cognitive biases, little attention has been given to documenting the effect of these biases upon the quality of the resulting outcome, or to evaluating the costs and benefits associated with the biases' elimination. This lack of attention to the outcome is not surprising given the aforementioned "process-oriented" goals of many basic researchers. When surveyed about their beliefs regarding the quality of the outcome of human judgment and decision making (Christensen-Szalanski & Beach, 1984) researchers frequently offered editorial comments to the effect that questions on the outcome are meaningless and irrelevant to the study of human judgment. Additionally, there is the tendency among the applied "consumers" of basic research to accept the reported experimental findings as facts that can be generalized cavalierly to all situations (Berkeley & Humphreys, 1982). Rather than examine the seriousness of the reported bias, the applied researchers generally use the demonstration of the bias as a warrant for the development of decision aids and training programs (Berkeley & Humphreys, 1982; Funder, 1983).

This section reviews the relatively few studies that have directly evaluated the relationship between the presence of a bias in cognitive processing and its impact on the quality of the resulting outcome. In so doing, it recognizes that there are several different consequences of a judgment and decision making process that can be regarded as outcomes of that process. In addition to the judgment or decision itself, the results that ensue from implementing an action based upon the judgment or decision are also outcomes. For example, a cognitive bias that affects a physician's ability to process information may affect several outcomes including the physician's diagnosis, the physician's selection of a treatment for the patient, and the patient's health after being treated by the physician. The studies reviewed in this section evaluate

the impact of cognitive biases on several different "levels" of outcome. The conclusions of all these studies are quite consistent: The use of a biased cognitive process does not imply that the resulting outcome will be adversely affected [Footnote 1].

Theoretical Analyses and Computer Simulations

Existence of a Flat Maxima -- Edwards and his colleagues showed that errors in the assessed value of different attributes (Von Winterfeldt & Edwards, 1973) or of the importance of the different dimensions of a problem (Stillwell, Seaver, & Edwards, 1981) may have little meaningful effect on the decision maker's ability to select the normatively correct solution. They reasoned that under certain circumstances, a "flat maxima" may exist whereby several different procedures could yield virtually the same "best" solution for the problem. The existence of this flat maxima effect has been empirically supported by Beach's (1983) analysis of couples' values for child bearing and by Stillwell, Barron, & Edwards' (1983) study of people's evaluation of credit applications.

Robust Efficiency of Biased Heuristics -- Several other theoretical and computer simulation studies have compared the outcomes obtained from using differently "biased" variations of normative strategies with their normative counterpart. These analyses likewise showed that extremely biased processing strategies could be surprisingly robust in their ability to generate outcomes that were not meaningfully different from those generated by the "bias-free" normative strategy. For example, Radner (1975; Radner & Rothschild, 1975) showed that "satisficing" rules for decision making were quite efficient under fairly general circumstances. Thorngate (1980; see also Eeckhoudt & Hansen, 1983), using an elaborate Monte Carlo simulation, showed that even severely biased decision strategies (e.g., failure to use any probabilistic or utility information) often picked the normatively correct solution (although, analyses by Johnson and Payne (in press) suggest that this ability may vary with different tasks). In addition, Kleinmuntz and Kleinmuntz (1981) found little difference in the

solutions reached in a simulation of a medical diagnosis whether it be by a normative strategy of information search, a random trial and error strategy, or a strategy that ignored base rates.

Complexity of the Natural Environment -- The complexity of the natural environment may similarly prevent a biased cognitive process from having an adverse effect upon the resulting outcome. Einhorn, Kleinmuntz, and Kleinmuntz (1979) examined this complexity and concluded that substantial amounts of redundant information often exist in the natural environment. When they examined the impact of redundancy upon the quality of the outcome resulting from a flawed method of processing information they concluded that (1) the problems associated with people's inability to attend to large amounts of information are reduced because of the limited amount of unique information necessary to make a decision, (2) extremely limited information search strategies still may yield highly accurate predictions because of the redundancy of the environment, and (3) the adverse effects associated with unreliable information are lessened because of the presence of multiple measures of the same cue. Using a similar line of argumentation, Hoch and Tschirgi (1983), and Wright and Murphy (1984) suggest that the redundant complexity of the natural environment also may account for people's ability to perform better on "context rich" problems than on abstract problems that are formally equivalent to them (e.g., Johnson-Laird & Wason, 1977; Griggs & Cox, 1982).

Empirical Studies

Infrequent Opportunity for the Expression of a Bias -- The existence of a bias may not have a meaningful effect on the quality of an outcome if there is little opportunity for it to be expressed. Consider for example the results of a series of studies that my colleagues and I conducted on physicians' ability to diagnose pneumonia. Over a two year period we observed the manner in which physicians managed patients who were at risk for having pneumonia. We found that physicians' estimates of the patients' probability of having pneumonia were poorly calibrated (Christensen-

Szalanski & Bushyhead, 1981), that the physicians did not use symptoms whose presence was negatively correlated with the presence of pneumonia (Christensen-Szalanski & Bushyhead, 1983), and that they were susceptible to using incomplete (and inaccurate) feedback obtained from chest radiographs that were ordered to diagnose pneumonia (Bushyhead & Christensen-Szalanski, 1981).

Initially it seemed that the existence of such a large number of cognitive biases strongly argued for the replacement of the physicians' unaided judgment with various diagnostic decision aids (e.g. Wood, Tompkins, & Wolcott, 1980) despite the costs associated with implementing such aids (Christensen-Szalanski, Diehr, Wood, & Tompkins, 1982). However, when the effects of the biases on the physicians' diagnostic performance were evaluated, they were found to be embarrassingly small. The total elimination of all bias would have helped the "average" physician to diagnose correctly only about one additional patient a year (Christensen-Szalanski, 1983). The small impact of the biases on the physicians' overall diagnostic performance was largely a result of the rare occurrence of pneumonia in the patient population -- less than 3% of the patients at risk for pneumonia, and less than 0.5% of the entire patient population seen by the physicians. Since pneumonia rarely occurred in the population being served by the physician, the judgmental biases associated with its diagnosis also rarely occurred, and the seriousness of the biases' effect on the physicians' diagnostic performance consequently was reduced [Footnote 2]. A further study of the biases' effect on the resulting outcome revealed that the presence of the biases had virtually no impact on the quality of the treatment given the patients since most patients who are misdiagnosed are given the same treatment that they would receive had they been correctly diagnosed (Bushyhead, Wood, Tompkins, Diehr & Wolcott, 1983). This latter finding illustrates a medical variation of the flat maxima effect in that the treatment given often may be the same regardless of which of several different diagnoses is assigned to the patient (Reuben, 1984).

Bias Has Little Practical Value -- Since researchers have focused on studying cognitive processes regardless of the process' impact on the resulting outcome, it is not difficult to imagine that some cognitive biases may have little practical value for the practitioner. An example of such a bias might be an inability to assign correct numerical forecasts of an event's occurrence. When one examines how many of the events which were assigned a 70% probability of occurring actually occurred, one might expect that the number should be close to 70%. Instead, the actual number often is much less than 70%. This "over-estimation" or "miscalibration" bias has been documented in over forty studies (see reviews by Fischhoff, 1982; and Lichtenstein, Fischhoff, & Phillips, 1982), and is one of the cognitive biases that is most easily called to mind by researchers in the judgment and decision making field (Christensen-Szalanski & Beach, 1984).

Despite the large amount of attention that has been given to documenting the existence of the miscalibration bias, its practical significance to the practitioner has largely been ignored. However, upon completing a detailed mathematical analysis of different forecasting performance measures, Yates (1982) concluded that the value of being perfectly calibrated was "largely aesthetic." Citing the importance of the outcome to the practitioner, he argued that from a practical point of view a person is primarily interested in being able to discriminate when the event under consideration will and will not occur regardless of whether the "right" numerical label is attached to this discrimination. Sanders (1973) reached a similar conclusion in his review of the research on probabilistic weather forecasting.

This ability to discriminate when an event will and will not occur is measured by the "resolution" of the person's forecasting performance (Murphy, 1973), and has no relationship to the calibration measure that has so preoccupied decision researchers (Yates, 1982). Thus, it is not surprising that when Centor, Dalton, and Yates (1984) compared physicians' forecasting performance to that of a logistic regression model, they found that physicians were more poorly calibrated than the

Christensen-Szalanski

model in assessing the numerical probability that a patient had a particular disease, while simultaneously being much better than the model at predicting which patients actually did and did not have the disease.

The Elimination of the Bias May Be Worse Than the Bias -- The studies cited thus far have demonstrated that the mere existence of a bias does not guarantee that it will have a meaningfully adverse effect on the quality of the resulting outcome. Indeed, data from a recent study on parents' decision to circumcise their sons (Christensen-Szalanski, Boyce, Harrell, & Gardner, 1984) indicate that the elimination of a bias may have worse results than when the bias was present [Footnote 3]. This study showed that the policy used by a group of American physicians to inform parents about the medical complications associated with circumcising newborn sons was based on two biased judgments: a misjudgment of the frequency with which the complications occurred, and an underestimate of the parents' perception of the seriousness of the complications.

To examine the effect of eliminating the physician's biases upon the parents' decision making, physicians were instructed to (1) read to the parents a prepared list of the complications associated with circumcision, along with the actual frequency of occurrence, and (2) request that the parents evaluate for themselves the seriousness of each complication. This procedure prevented the physicians' biases from affecting the information given to the parents. However, the elimination of these biases had no effect on the parents' decision to circumcise their sons: parents largely ignored the information on the medical complications when deciding whether to circumcise their sons, and based their decisions almost entirely on social, traditional, or religious considerations.

Moreover, the elimination of the physicians' biases not only failed to change the parents' decisions, it also generated a number of undesirable outcomes: (1) it required physicians to spend more time presenting the medical information to the parents; (2) it made parents less confident in the appropriateness of their

circumcision decision (the first major decision in their son's life); (3) it generated resentment among the parents because they felt pressure to "doubt the importance of their own beliefs"; and (4) it generated antagonism in the nurses who felt that the medical complications were excessively described to mothers whom the nurses considered to be intellectually incapable of understanding the information. Not surprisingly, these adverse outcomes eventually forced the termination of the experimental procedure.

Summary

This section has reviewed the relatively few theoretical, computer simulation, and empirical studies that have evaluated the effect that a biased cognitive process can have on the quality of the resulting outcome. These studies showed that it is possible that the existence of a cognitive bias has no meaningful adverse impact on the quality of the resulting outcome, and that the elimination of a bias may generate undesirable side effects that did not exist when the bias was present.

The small number of "outcome" studies completed thus far necessarily limits the generalizations that can be made about the practical importance of all cognitive biases. However, the combination of studies documenting a trivial effect of the cognitive biases, and the absence of studies documenting a meaningfully adverse effect of the biases suggests (1) that the existence of many of the cognitive biases may not reflect inadequacies on the part of people, so much as they reflect inadequacies on the part of the normative theory being used to evaluate people, or (2) that human judgment and decision making may be in great need of improvement, but that the information to satisfy that need is not being generated by the current "cognitive bias" movement.

Since the first possibility has already been discussed in detail elsewhere (Beach & Mitchell, in press; Cohen, 1981; Hammond, Hamm, Grassia, Pearson, 1984; Heiner, 1983; Jungermann, 1983; March, 1978; Wilkening & Anderson, 1982) the remainder

of this paper will consider the second possibility -- that the information needed to help improve human judgment and decision making is not being generated by the cognitive bias movement.

Future Areas of Research

Despite the immensity of the "cognitive heuristics and bias" literature, the previous section showed that it has generated little that the practitioner can use to determine when the cognitive biases will have a meaningful impact on the quality of the outcome, or to evaluate the relative costs and benefits associated with the elimination of biases. This shortcoming does not necessarily imply that this literature is of little use to understanding judgment and decision making processes (see for example Mook's [1983] discussion of external "invalidity" as well as the discussion by Levin, Louviere, Schepanski, & Norman [1983]), but it does suggest that researchers may have to focus on more than the existence of reasoning errors in order to provide the information that practitioners need to improve their judgments and decisions. This section speculates about some possible areas of basic research which may help generate that needed information.

Evaluating the Meaningful Significance of a Bias

Since the outcome of using different judgment processes has generally been ignored in the judgment literature, the proposed emphasis on examining outcome measures necessitates a slight shift in the way in which a finding's significance is evaluated. The quality of human judgment can no longer be evaluated solely on the existence of statistically significant biases, since, as demonstrated above, the existence of such biases may have little effect on the quality of the resulting outcome. Instead of attending only to the alpha and beta of the statistical test, researchers also will need to pay attention to "delta," the amount of a difference that makes a meaningful difference (Feinstein, 1974).

The evaluation of delta depends on scientific rather than statistical logic since there are no standards for deciding what is "bad" and what or how much is

"better" (Feinstein, 1971). A difference of 4 units in the mean values of two groups may seem important if the respective means are 1 and 5 and trivial if the respective means are 1001 and 1005.

The subjective nature of delta may be discomfoting to some. Clearly, investigators can enlarge or de-emphasize the magnitude of the difference according to the way in which they choose to express it (see Feinstein [1973] for examples). Consequently, arguments about whether the "glass is half empty or half full" may still arise when examining the quality of human judgment and decision making (see for example Loftus & Beach, 1982). Nonetheless the subjectiveness of this evaluation should not prevent researchers in the field from making a decision about the meaningful importance of an observed bias or cognitive heuristic. Such an evaluation is necessary to assess the costs and benefits of developing aids to eliminate these cognitive limitations, and to assess the quality of human judgment itself. Researchers in medicine have been able to deal with this subjectiveness when evaluating such things as the efficacy of different treatment regimens by conducting extensive outcome studies comparing control and "treatment" groups (Diamond & Forrester, 1983; Feinstein, 1977; Freedman, Lowe, & Macaskill, 1982); psychologists should be able to do the same when studying human behavior (see for example Lewis, Shields & Young, 1983).

Evaluating the Representativeness of a Study And the Seriousness of a Cognitive Bias

The evaluation of delta will require greater attention to the representativeness of the laboratory task used to test human judgment, but in a slightly different manner than is currently done. Psychologists have generally evaluated a study's representativeness on the basis of the appropriateness of the specific task being performed by a specific type of subject (Brunswick, 1956; Edwards, 1981, 1984; Hammond, 1978). This interpretation of representativeness, however, is not adequate to evaluate the quality of the outcome that results from the subjects'

cognitive strategy. Researchers must also consider the representative frequency with which the specific task occurs in the natural environment.

The importance of ascertaining the frequency with which a task occurs in the natural setting also highlights the need to use "prevalence sensitive" measures when evaluating the seriousness of the bias on a person's performance. For example, suppose that a physician using a "biased strategy" misdiagnoses 20% of the people with a particular disease. Such a finding might appear to suggest that the use of the biased strategy has a large and meaningfully adverse effect on the quality of the physicians' diagnostic performance. However, the measure "20%" does not reflect the frequency with which the disease occurs in the natural environment. The seriousness of the error associated with the biased strategy would be meaningfully different if the natural prevalence of the disease were 1 in 10 rather than 1 in a million. The former would translate into a 2% increase in the physician's error rate while the later would result in a 0.00002% increase in the error rate. Thus, despite the apparently large relative effect of the biasing strategy, from the individual physician's standpoint, once the frequency of the disease's occurrence was considered, the incremental difference in quality resulting from the biased strategy may not be considered serious enough to merit the costs (mental effort, time, money) to correct the biased strategy.

Selecting a Time Frame for Evaluation

During the course of the cognitive bias movement, researchers have given little attention to determining the appropriate time frame within which to evaluate the outcome of a person's biased judgment (Einhorn & Hogarth, 1981). However to evaluate better the practical importance of different cognitive limitations this omission needs to be addressed and the duration of a bias's effect on human judgment needs to be explored.

Consider for example the tendency for people's judgment to be affected by their exposure to highly dramatic stimuli (Tversky & Kahneman, 1973). When the biasing effect of a stimulus lingers for several years (see for example Featherstone, Beitman

& Irby, 1984; Wong & Lincoln, 1984), corrective aids may well be useful. However, if the biasing effect lingers for only a few days, or a few minutes it may be unreasonable to regard it as a meaningfully serious effect. At what point does the longevity of an effect become serious enough to warrant the use of corrective procedures?

Research establishing the time frame for the evaluation of a cognitive strategy also can provide insights of theoretical importance. The acceptance of the need to select a suitable time frame for evaluating the quality of a behavior implicitly questions the appropriateness of such things as the long-term expected value as the only rational measure of an outcome's worth. Lopes (1981) for example has argued that since people do not have an infinite number of opportunities to make (and remake) decisions, then the long-term expectation should be replaced or modified by short-term considerations when deciding the rationality of a decision. Tversky and Bar-Hillel (1983) have argued against this modification on theoretical grounds. However, the results of two empirical studies suggests that regardless of what is "correct" theoretically, people may be acting on short term considerations. In one study, Wagenaar (1985) observed that people bet differently when they had a single opportunity to gamble than when they had repeated opportunities to make the same gamble. He concluded that depending upon the context of the decision, the long-term expectation may not be considered by the decision maker. In a second study, I (Christensen-Szalanski [1984]) observed pregnant women deciding whether or not to request anesthesia during the delivery of their children. I found that at one month prior to labor, during early labor, and at one month after their children's birth, most women had values indicating a strong opposition to the use of anesthesia. The duration with which these values were held and the retention of these values after the children's birth suggested that they corresponded to the women's "long term" values. These values differed from those which the same women expressed during the few hours of active hard labor. These latter, "short term" values indicated a strong desire to

receive anesthesia. As a result of these conflicting values, women in hard labor were faced with the choice of maximizing their "long term" values (i.e. to deliver the child without the use of anesthesia), or maximizing their "short term" values (i.e., to receive anesthesia). Although there was an apparent inertial tendency among the women to delay requesting anesthesia until some time after their values switched toward favoring anesthesia, the women eventually did act on their short term values and requested anesthesia.

Assessing the Utility of An Outcome

The study of people's values and how they make utility assessments has received relatively little attention in the judgment and decision making literature (Einhorn & Hogarth, 1981). This neglect is noteworthy from the practitioner's point of view because of the frequent need for "accurate" utility assessments. In medicine for example, the manner in which patients make utility assessments has become important with the advent of the social policy that physicians should adhere to the patient's values when making management decisions (Kassirer, 1983; Kaufmann, 1983; McNeil, Weichselbaum, & Pauker, 1978; Moles, 1982; Pellegrino, 1973). Such a policy assumes that the values expressed by the patient (1) capture the relevant dimensions of the medical decision, (2) are stable over time, and (3) are representative of the patient's "true" feelings. However, empirical evidence exists that questions the validity of each of these assumptions. Patients' utilities may not be relevant representations of the medical decision because patients may attach a large value to information that has no bearing on the medical decision at hand (Berwick, in press). A person's values may not be stable over time because of sunk costs associated with past events and discounting effects associated with future events (Ainslie, 1975; Arkes & Blumer, in press; Christensen-Szalanski, 1984; Christensen-Szalanski & Northcraft, in press; Northcraft & Wolf, 1984). Finally, a person's expressed utility may not be representative of his or her "true" values because the utility assessment can be altered by factors such as: (1) the manner of eliciting the utility measurements

(Fayers & Jones, 1983; Fischhoff, Slovic, & Lichtenstein, 1980; Llewellyn-Thomas, Sutherland, Tibshirani, 1984); (2) the person's emotional status (Sjoberg, 1980, 1983; Fisher, 1984; Isen & Patrick, 1983; Kuhl, 1983a, 1983b); (3) the person's interest in the problem (Kuyper & Vlek, 1984; Marks & von Winterfeldt, 1984); and (4) the person's current health status (Herman, 1984; Jank & Becker, 1984). Given the variability in utility assessments that can be generated by the above factors, and the absence of research on how utility assessments are made, the physician who wants to practice the policy of adhering to the patient's values faces the new dilemma of having to decide "Which values to use?"

Academic researchers also may want to pursue the question of how people arrive at their utility assessments because of the number of important roles that utility is currently believed to play in the judgment and decision making process. For example, in addition to its traditional role as part of the calculations being used by the person to solve the problem, the utility associated with the outcome is also considered to be a driving force in the person's selection of which cognitive strategy to use (Beach & Mitchell, 1978; Christensen-Szalanski, 1978; Klein, 1983; Russo & Doshier, 1983), and a motivational force on the performance of the resulting behavior (Kuhl & Beckmann, 1983; Kuhl & Blankenship, 1979).

Evaluating Subjective Equivalence and "Good Enough"

The finding that many of the cognitive biases and heuristics being used by people yield outcomes which are not very different from those obtained from their normative counterparts suggests that people may be using these processes because they require lower processing costs than the normative process and yield a solution having an acceptable amount of error, i.e. one that is "good enough." Such a finding supports the notion that people behave in terms of "bounded" or "quasi" rationality (Brunswick, 1956; Hammond, 1966; Simon, 1955, 1978), but it also implies that people make subjective judgments of acceptable error when deciding upon which strategy to use.

The presumed existence of the subjective standard "good enough" suggests the need to examine the process by which this standard is determined by the individual. Unfortunately, the current focus on statistically significant errors has detracted from the study of judgments of acceptable error. However, earlier work by Beach and his students (Beach, Beach, Carter, & Barclay, 1974; Beach & Solak, 1969; Laestadius, 1970) may provide a good starting point for future work in this area. In this collection of papers Beach used a measure called the "equivalence interval" to examine the degree to which people discriminate between two measurements. The equivalence interval was defined as the interval of acceptable error around the correct answer within which judgments can be regarded as essentially correct (Beach & Solak, 1969) -- a measure that is conceptually the same as the standard "good enough".

Among the findings Beach and his colleagues obtained using this measure were that the breadth of the equivalence interval changed as a function of task difficulty and task familiarity (Beach, et al., 1974; Beach & Solak, 1969; Laestadius, 1970), information variability (Laestadius, 1970), and the amount of available information (Beach, et al., 1974). Beach, et al., (1974) also speculated that the breadth of the equivalence interval may be related to various personality characteristics such as a person's need for achievement or the person's perceived degree of internal control (Rotter, 1966).

A renewal of interest in subjective equivalence has potential importance that extends beyond evaluating the validity of the theories of bounded/quasi rationality. For example, a common method of evaluating choice behavior requires subjects to rely on quantities in order to choose between one response or another. As Beach, et al., (1974) point out, if the magnitudes of the numbers involved are very large, subjects may not be very discriminating; two numbers can be objectively fairly different and yet be subjectively similar. Such subjective similarity can lead to intransitivity in a choice task (Tversky, 1969) and a distortion of the experimental results from a broad range of decision research (Beach, Heinrich & Barclay, 1971).

Conclusion

Researchers in the field of judgment and decision making have tended to focus their attention on identifying systematic errors and biases in reasoning. One justification given for this focus is that it exposes some of people's intellectual limitations and suggests ways of improving the quality of human thinking (Armstrong, 1983; Evans, 1984; Kahneman & Tversky, 1982; Tversky & Kahneman, 1983). Those who have criticized the usefulness of this approach have done so largely by questioning the existence of the laboratory-observed biases in the real world.

This paper examined the practical usefulness of focusing on cognitive biases while ignoring the arguments which question the existence of the biases in the real world. It assumed that all the currently documented cognitive biases do exist in the real world. It then concluded that even given this assumption about the validity of the studies that identify cognitive biases, the knowledge generated by these studies is of little use to the practitioner because it does not capture the information most needed by the practitioner to improve the quality of his or her thinking -- information that evaluates the effect of these cognitive biases on the quality of the resulting outcome.

This failure to evaluate the quality of the outcome that results from a cognitive bias reduces the practical value of the research in several ways. It prevents the practitioner from being able to determine the degree to which the outcome would improve once the cognitive bias was eliminated, and whether this improvement merits the expenditure of resources needed to accomplish it. Additionally, as shown in this paper, it increases the likelihood that cognitive biases will be identified which have little meaningful impact on the quality of the resulting outcome. Researchers who unknowingly identify such "trivial" biases and assume that the biases have a meaningfully adverse effect on the outcome also can do harm by unnecessarily encouraging practitioners to (1) heighten their concern about improving their thought processes, (2) lower their confidence in their own abilities, and (3) allocate large

amounts of resources to develop "de-biasing" techniques -- techniques which even if perfectly effective at eliminating the bias would have no discernible impact on the quality of the resulting outcome.

Another reason for concern about the excessive attention given to identifying reasoning errors and biases is its consumption of resources that could otherwise be devoted to different areas of research. As discussed in this paper, there are several neglected areas of basic research on reasoning processes that do not focus on reasoning errors and that might better generate useful information for both the theorist and practitioner.

Finally, these criticisms of the current focus on reasoning errors are not meant to imply that people are "intuitive statisticians" who engage in only uniformly "good" reasoning processes. The futility of the research that tries to determine whether people are uniformly good or uniformly bad reasoners has been well described by Jungermann (1983), and Kruglanski, Friedland, and Farkash (1984). Rather, these criticisms are meant to encourage a shift in researchers' attention toward evaluating the quality of the outcome resulting from human reasoning processes and determining how much that quality can be improved in specific contexts given appropriate training.

Footnotes

1. In reviewing these "outcome" studies, one needs to attend to the overall quality of the resulting outcomes because the occurrence of bad outcomes is inevitable, regardless of the quality of the judgment and decision processes being used. Since uncertainty is an inherent component of expected value calculations, people can make the normatively correct decision (i.e. select the alternative with the greatest expected value) but still get a bad outcome because of forces beyond their control (Schwartz, 1979). Similarly, signal detection theory shows that, except in high signal to noise ratio conditions, there are bound to be errors of judgment; one cannot eliminate false alarms, without eliminating correct "sightings", and thus, bad judgments are the price one pays for making good judgments (McClosky & Egeth, 1983).

2. Of course, an increase in the frequency of pneumonia would theoretically increase the occurrence of the related biases and thus their impact on the outcome. Such an event would reinforce the need to develop "prevalence sensitive" measures of a bias's seriousness as discussed later in this paper. On the other hand, as Lichtenstein, Slovic, Fischhoff, Layman, and Combs (1978), and Manu, Runge, Lee, and Openheim (1984) have shown, a bias associated with a low probability event is not always associated with a higher probability event. The extremely rare occurrence of pneumonia in the present study likely made it difficult for physicians to assess accurately the prevalence of pneumonia, let alone the symptoms that were predictive of it (see for example Sampson & Smith, 1982). Under such circumstances, physicians are forced to rely on written or verbal estimates of the frequency of pneumonia when developing their diagnostic policy. If the prevalence of pneumonia were greater in a given population, the physicians' diagnostic performance might easily be improved because they could subsequently rely more readily on their own direct experience with the prevalence of pneumonia (Christensen-Szalanski & Beach, 1982, 1983; Eckel, 1983).

3. In contrast to the relatively uncommon practice of circumcising males in most European countries, nearly 80% of new-born males in the United States receive elective circumcisions.

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A COGNITIVE THEORY OF JUDGMENT AND DECISION

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Choice of research direction is all-important. We all seek to make contributions of lasting value, but success is elusive. The history of psychology, short as it is, shows a long litter of dead and unproductive issues, our own blind alleys, one may say. The causes are several, and there is no algorithm for good choice. It seems apparent, however, that certain of these blind alleys could have been avoided with better forethought. This matter deserves consideration, for our own decision about research direction is important for our future well-being. Two main directions in judgment-decision research—cognitive and normative—are compared here with concern for their proper use and relative promise.

Judgment-decision theory has been dominated by one idea: human judgment and action should obey prescriptions of rationality and optimality. The bulk of the research, accordingly, has revolved around various normative models. Until about 1970, the hope was nourished that normative models would not only prescribe but also describe behavior. The demise of this hope did not, however, lead to abandonment of the normative models.

Quite the contrary. Deviations from the normative models were seized on as phenomena, reified as "biases" that needed explanation. One of the first such biases, of course, was the "conservatism" of Bayesian theory. Many others have followed.

Reification of biases is logically strange. If the normative model is cognitively invalid, deviations from that model cannot generally have cognitive significance. By focusing on biases, the normative conceptualization has retarded cognitive analysis, a point that has been made previously (Anderson, 1974c) and that will be amplified here.

This paper illustrates how one cognitive theory, namely, the theory of information integration (Anderson, 1981a, 1982), conceptualizes "biases" in cognitive terms. The first part outlines general characteristics of the theory, which embody a broad view of judgment-decision. The second part presents case examples to illustrate the marked differences that result from choice of the cognitive and normative approaches. The last part discusses directions for future research, with emphasis on motivations and judgments of everyday life.

INFORMATION INTEGRATION THEORY

INTEGRATION AND VALUATION

The primary focus of the theory is on processes of information integration, as befits a world of multiple causes and determinants. One of our major findings has been the operation of a general *cognitive algebra* of integration processes.

This parallels the normative view, for many normative models are prescriptive rules for integration. Integration theory takes a nonnormative approach, however, and it finds nonnormative rules. Cognitive algebra is not normative algebra.

A similar contrast appears in valuation processes, by virtue of which the informational stimuli attain their specific values relative to the operative goal. Some normative approaches, it is true, have tried to admit subjective values, but they have been hobbled without an effective theory of psychological measurement. The functional measurement methodology of integration theory has had good success, for it is based on cognitive algebra.

MOTIVATION

Motivation is central to information integration, because motivation constitutes the source and essence of goals, and hence of values. Behavior is typically purposive, directed toward some goal, and stimulus information is evaluated in relation to operative goals. The dimensional character of values derives from goal-directedness, that is, from approach and avoidance tendencies relative to the goal. The purposiveness of behavior thus leads to an important simplification of cognitive representation, in which complex information fields are reduced to one-dimensional values.

Focus on motivation brings out some properties of values that are often passed over. Foremost is that values, like motivations, are variable, a proposition nicely represented in the saying that a boy's eyes are bigger than his stomach. The term, *functional measurement*, recognizes this variability of values, for it is concerned with values functional in relation to the operative goal. Functional measurement thus provides a new approach to the analysis of motivation.

Motivation is the Cinderella of judgment-decision theory. Although it provides the basis for goals and values, it has been taken for granted and virtually ignored. More surprising has been the neglect of motivation in mainstream cognitive psychology, a neglect that is sometimes outright divorce. In the present view, motivation is an integral component of cognition, and is subject to exact analysis.

FUNCTIONAL VIEW

The goal-directed quality of thought and action is mirrored in a functional view, that processing of information is heavily determined by its function in goal attainment. It follows that cognition is *contextual* and *constructive*.

Thought and action are contextual, because the local situation is a determinant both of relevant stimulus information and of goals. And values, as already noted, vary with the goal.

Thought and action are constructive, because the same internal knowledge must subserve many goals. Values, in particular, must generally be constructed in relation to operative goals, because context and situation are too complex and too changeable to allow for memory storage (Anderson, 1974b, pp. 88-90, 1974c, pp. 289-290). This functional view is embedded in the concept of *functional measurement*, which has provided an effective methodology for measurement of values as they function within the operative context.

KNOWLEDGE SYSTEMS

The functional view leads to a focus on *knowledge systems* as the basis for thought and action. A knowledge system typically contains both declarative knowledge and procedural knowledge, that is, knowledge about things and procedures for utilizing such knowledge. In many important cases, if not typically, a knowledge system will also contain affect and motivation, which are here considered basic forms of knowledge.

A prototypical knowledge system may be found in the concept of *attitude*, much studied in social psychology, but here viewed as a cognitive system. This is qualitatively different from the popular view, originating with Thurstone, that attitudes are one-dimensional evaluative reactions. In the present view, attitudes unite, rather than separate, the classic three components of motivation-cognition-action.

In this conception, a knowledge system may be likened to schema concepts of cognitive psychology. Motivation and affect, however, which get short shrift in other cognitive theories, are here taken as fundamental. Their role is illustrated by the function of attitudes in valuation processes.

A related difference appears in the present concept of *functional memory*. Memory research, both traditional and contemporary, has been dominated by the concept of reproductive memory. Studies of reproductive memory are typically unconcerned with function and goal except the goal of reproduction. This appears in the reliance on accuracy, whether in reproduction by rote or for meaning. With a focus on goal-directed behavior, however, comes a concern with memory as its functions to subserve goals.

BIOSOCIAL HEURISTIC

The nature of human thought and action depends on both its biological foundation and its social construction. These two aspects may be treated as a biosocial heuristic, that is, as a basis for conjectures about cognitive processes (see Groner, Groner, & Bischof, 1983). This biosocial heuristic may seem too general to be useful, but it yields some important suggestions.

Motivation illustrates both the biological and the social aspects. Man's phylogenetic inheritance contains an array of motivational systems, ranging from biological and affectional to perceptual and intellectual, that is at once efficient and adaptable. This adaptability may be seen in the evolution of civilization and in its continuous reconstruction from new-born organisms. The diversity of goals among different individuals also testifies to the basic shaping role of social learning and development.

The biosocial perspective bears directly on various normative assumptions. Normative models typically rest on some stationarity assumption, for example, whereas the natural world is notably nonstationary. Recency effects thus make sense, biologically and socially, as a means of alerting the organism to changes in the environment. To term recency a "bias" may blind the investigator to a heuristic clue about its biosocial significance. In a similar way, the once-popular normative assumptions of cognitive consistency failed because nature and society both condition man to survive in a world marked with inconsistencies and conflicting information (Anderson, 1974b,c).

Biology and society are both concerned with survival in the real world. They have done remarkably well, on the whole, considering the unpromising origins and the small size of the human brain. One key to success lies in general-purpose processes, especially of valuation and integration, that can determine rough-and-ready actions in diverse situations. But flexibility is generally achieved at the expense of optimality. Especially in the artificial worlds of so many judgment-decision studies, defined in abstract terms and hedged by arbitrary, often implicit normative assumptions, suboptimal behavior is not unexpected.

Cognitive algebra, which our developmental studies suggest is substantially biological in origin, constitutes one such set of general-purpose processes. It is no surprise, therefore, that what seem irrational biases from a normative view may make good sense in cognitive algebra (Anderson, 1981a, pp. 27-29, 45-49, 83, 214, 293, 367).

EVERYDAY LIFE

Everyday life is a realm of person cognition, especially self cognition, of social attitudes, marriage and parenting, leavened with diverse social motivations from liking and obligation to blame and ego defense. This is a primary realm for human thought and action.

Everyday life has been the main field for development of the theory of information integration, which began as a theory of social cognition. This work, it may be emphasized, has been at the same cognitive level that has characterized most judgment-decision research. There are many common concepts, weight, value, and probability, for example, and typical response measures are at the same molar level. Everyday life is far richer, however, than the narrow world of urns and bets that is prototypical of the judgment-decision area. Everyday life provides new horizons for judgment-decision research.

Everyday life has a deeper significance for judgment-decision theory, for it is a source of many knowledge systems that are used in making judgments and decisions. Logic problems, for example, are easier when stated in terms of familiar content than when stated abstractly. This facilitation is considered to result from the assemblage of background knowledge pertinent to the operative goal. Personification, similarly, represents the utilization of social knowledge systems outside their ostensible range. This kind of thinking, heavily metaphorical, is what the biosocial heuristic would suggest for a small brain.

COGNITIVE ANALYSIS

Little of the foregoing discussion reflects novel ideas. Many workers in judgment-decision have been concerned with cognitive process rather than with normative studies, and many of those in the normative approach have also contributed to cognitive analysis (see, e.g., Kahneman, Slovic, & Tversky, 1982; Scholz, 1983; Wallsten, 1980). The purposiveness of behavior was a major theme of Tolman, Freud, and Lewin, to name but three, and a contextual view has been advocated not only in personality theory (e.g., Magnusson & Endler, 1977; Sarbin, 1977) but even in memory (e.g., Jenkins, 1974). Organization of knowledge has been a major concern of both associationist and gestalt schools, and schema concepts have been employed by figures as diverse as Kant (see Webster's unabridged dictionary), Bartlett (1932), and Piaget (1970). Some form of biosocial view has been adopted by workers in many areas, especially in developmental psychology (e.g., Bowlby, 1969; Harlow & Harlow, 1969; see also Haith & Campos, 1983), but also in animal learning and motivation (e.g., Deutsch, 1983; Rozin & Kalat, 1971). Everyday life has been a primary concern of much work in social and developmental psychology. These and related influences have been important in the present theoretical development.

Integration theory does, however, provide a unified treatment of all these ideas. These ideas have evolved naturally from the basic focus on processes of valuation and integration and out of the concern with everyday life. This is the origin of the concept of functional memory. This is the basis for the concern with motivation.

Furthermore, integration theory has succeeded. It is not a hopeful promissory note; it is not a manifesto; it is a working reality. The discovery and establishment of cognitive algebra have provided a base and frame for psychological measurement and a powerful tool for cognitive analysis.

COGNITIVE AND NORMATIVE APPROACHES

The cognitive and normative approaches lead to different conceptual frameworks, to different methodologies, and to different lines of investigation. Both approaches have appropriate areas of application, but they are often incompatible.

Indeed, our first applications of information integration theory to standard judgment-decision tasks found serious discrepancies from normative behavior. Intuitive number-averaging, for example, yielded strong recency effects (Anderson, 1964), a result generally verified in parallel studies of psychophysical averaging (e.g., Weiss & Anderson, 1969), not to mention the Bayesian two-urn task (Shanteau, 1970). Such order effects would cause inaccuracies, so normatively they would be considered "biases." Our concern, however, was nonnormative, for three different processes could explain recency (see Anderson, 1974b, pp. 68-81). There was, moreover, the basic question of determining the rule governing the serial integration process.

A second result was nonadditivity in tasks presumably obedient to multiattribute utility models, which prescribe adding rules for attribute integration. In this case (Anderson, 1965), nonadditivity was deliberately sought out as a critical test between adding and averaging rules. The general failure of the adding rule and the success of the averaging rule imply that cognitive algebra is different from normative algebra.

In both these areas, we found normative considerations generally a hindrance. They led to inappropriate conceptualizations, to unrevealing experimental studies, and to unrevealing data analysis. The following sections illustrate this theme with case examples.

UTILITY THEORY

Cognitive algebra differs from normative algebra in the core area of utility theory. For multiattribute utility, indeed, the difference is qualitative, involving averaging rather than adding.

Multiattribute Utility. One large class of decision tasks involves revealed attributes of some entity, such as a consumer good. A robust result of over two decades of work is the evidence for averaging: adding positive information may actually cause the judgment to become less positive. This averaging effect has been found across many areas, including attitudes (Anderson, 1981b), and consumer goods (Troutman & Shanteau, 1979), to name but two. Its biological nature is indicated by its appearance in young children (Anderson, 1980).

The standard normative assumption requires some kind of adding process. The averaging effect, however, rules out almost any form of adding, such as adding with diminishing returns. More important is that the averaging effect reflects an exact algebraic rule that has fundamental importance for cognitive analysis.

Subjective Expected Utility. The reference task in SEU theory is to judge worth of two discrete entities, both typically uncertain. Normative theory suggests the model

$$SEU = SP_1 \times SU_1 + SP_2 \times SU_2,$$

where SP_i and SU_i are the subjective probabilities and utilities of the two entities.

The key to testing this SEU hypothesis lies in finding a way to measure subjective probability and utility. Historically, therefore, joint measurement of subjective probability and utility became the cardinal problem of utility theory. Normative axioms, assumptions about rational behavior, were expected to provide a basis for measurement (see Luce & Suppes, 1965). This axiomatic approach was pursued strenuously, as Estes (1980) indicated, because of "the assumption that once the theoretical variables were adequately measured, the task of theory construction would be virtually completed [p. 265]." This axiomatic approach failed. Some workers even concluded that the SEU model was untestable.

This measurement problem was solved with functional measurement methodology. The success of the initial application (Anderson & Shanteau, 1970) has been supported by the later work of Shanteau (1974, 1975a). The basis for measurement was found in cognitive algebra, specifically, in the multiplication rule.

A curious result of this work was the appearance of a subadditivity effect. This subadditivity, like the averaging effect, meant that the normative axioms were doomed to fail. Unfortunately, this subadditive "bias" has gone largely unexplored. One natural hypothesis is that bundles of distinct commodities are subject to a generalized law of diminishing returns. This seems plausible on the grounds that diminishing returns, which makes sense for bundles of similar commodities, generalizes to bundles of dissimilar commodities by virtue of task similarity. An alternative hypothesis is that the pervasive averaging process is overlaid on a basic adding process.

Expectancy-Value Models. The SEU model is one of a class of *expectancy-value* models that have arisen in many different areas of psychology (see Feather, 1982). A recurrent theme of the contributors to Feather's book is measurement, for the use of such models depends heavily on capabilities for measuring expectancy and value. Fischhoff, Gotein, and Shapira (1982), for example, note that "It is extraordinarily difficult to study simultaneously the form of the decision models that people use and the substantive considerations [i.e., values] incorporated in them [p. 317]" As they recognize, however, this is just what functional measurement has accomplished.

Besides the studies of the previous subsection, applications have been made to hunger-thirst judgments (Klitzner & Anderson, 1977), to snake phobics (Klitzner, 1977; cited in Anderson, 1981a, Section 1.5.5), to helping behavior (Lynch & Cohen, 1978), to measurement of motivation (Anderson, 1978a), to poker (Lopes, 1976), and to dating judgment and choice (Shanteau & Nagy, 1979). Functional measurement can thus transform a hopeful verbalism into exact theory.

Decision Weights. The integration model is more general than the normative model. In particular, the subjective probabilities are replaced by more general weight parameters. As noted by Anderson and Shanteau (1970; see, similarly, Shanteau, 1975a, pp. 133-134)

A second, more specific difference arises in the interpretation of the weight parameters. Integration theory applies to value judgments generally, whether or not they involve chance elements. The weight of an informational stimulus represents its importance in the total evaluation, and this may be large or small for a variety of reasons. . . .

In decision making with uncertain information, the weight parameter would reflect the reliability or likelihood of the informational stimulus. But other factors would also affect weight. A potential loss, e.g., might have greater felt importance than a potential gain [pp. 449-450].

This replacement of subjective probability with the more general concept of weight has been questioned by some writers (e.g., Payne, 1973, p. 449; Rapoport & Wallsten, 1972, p. 147). However, a similar idea has been adopted by Karmarkar (1978) and by Kahneman and Tversky (1979), who have suggested the term, *decision weight*. Integration theory has the advantage of having solved the measurement problem.

Nonadditive Utility. Additive utility models can be useful in two ways: as approximation and as bases for optimal action. The subadditivity effect, for example, is not large, and it could be neglected in many practical applications. To a lesser degree, the same is true of the averaging effect.

But for cognitive analysis, clearly, additive utility models may be seriously misleading. Furthermore, calling the nonadditivity a bias does nothing to elucidate its nature. Its meaning is quite different depending on its locus in the flow of information processing. Nonadditivity could result from information interaction at the valuation stage or from a nonlinear integration rule, but these two are psychologically different. Cognitive analysis is required to determine this. This was a fundamental issue in the establishment of the averaging model discussed next.

AVERAGING

The averaging rule is a quantitative law of cognition, one of the few that have been set on solid ground. Establishing the averaging rule as an exact model was by no means easy, and several difficult theoretical problems had to be resolved (Anderson, 1981a, Chapter 2). The averaging rule has become one of the basic results of the theory of information integration, and it possesses some notable advantages for cognitive analysis.

Weight Identifiability. The averaging model possesses the remarkable property of allowing estimation of weights of qualitatively different attributes on a common ratio scale. Comparison of attribute importance, unconfounded with scale value, thus becomes possible. In this property, the averaging model seems unique.

Many decision models employ weights, it is true, but only the averaging rule seems to provide valid psychological measures of weight. Regression weights, for example, are confounded with scale unit and so are not properly comparable across different predictor variables. Standardization does not solve this problem, and may make it worse (Anderson, 1982, Section 6.1). In all these cases, the weights are arbitrary mathematical parameters, lacking in psychological meaning.

Self-estimation of weights, in which the judge is asked to rate importance of each attribute, may thus be put on a rigorous base with the averaging model. Self-estimation is fairly common, but its validity has been untestable because the true weights were unknown. The averaging model goes beyond providing a validity criterion, for this can be used as the basis for developing empirical procedures that may be expected to yield valid self-estimates under general conditions. This capability, as emphasized at an earlier conference (Anderson, 1982, Note 6.1a), illustrates how cognitive theory can contribute to practical analysis.

Water Down (Dilution) Effect. A "bias" produced by averaging is that information of zero or near-zero value may reduce the polarity of the response. This happens because neutral information may have non-zero weight, and so pull the response in toward the neutral center. This disagrees with virtually any form of adding model.

An illustration from attitude theory was given by Himmelfarb (1974). Previous work had shown that a polarized message produced less attitude change when it followed an initial near-neutral message. The interpretation was that the initial message produced some active discounting of the following message. This interpretation is unwarranted, as Himmelfarb argued, because the averaging model predicts the same effect without any active discounting process—and incorrect, because averaging theory had been successful in attitude research. The origin of the misinterpretation, it may be noted, lay in the implicit normative assumption of an adding model.

An analogous idea was used in a thought experiment about the form of similarity models by Anderson (1974a, p. 256; 1981a, Section 5.6.5). This thought experiment consisted of adding common elements to two stimuli, thereby increasing their similarity. This eliminates the model of additive dissimilarities that has been standard in multidimensional scaling. It agrees with an averaging process for similarity judgments.

A striking instance of this averaging effect was found by Shanteau (1975b; Troutman & Shanteau, 1977) for the Bayesian two-urn inference task. Samples of equally many red and white beads, although completely uninformative, nevertheless caused the response to shift toward the 50:50 point. Shanteau's *water down effect* was rediscovered by Nisbett (Nisbett & Ross, 1980) and Zukier (1982), who renamed it the *dilution effect* (see Anderson, 1981a, Section 2.3.6).

As Shanteau emphasized, a sharper contrast between the cognitive and normative approaches can hardly be imagined. Here again a result that seems mysterious bias from the normative standpoint becomes meaningful within cognitive theory.

SERIAL INTEGRATION: ANCHORING AND ADJUSTMENT

Integration of information is typically serial. Even though the information may be presented all at once, the judge ordinarily has to evaluate and integrate one piece at a time. An obvious problem is that order of processing may influence the final judgment. The later information, being fresher in memory, may have greater influence: a *recency effect*; or the initial information may crystallize the judgment, reducing the influence of the later information: a *primacy effect*. Serial integration was a basic concern in the initial development of information integration theory.

Process and Accuracy. The cognitive and normative approaches contrast nicely in studies of intuitive number averaging. Because of their concern with process and accuracy, respectively, they lead to different theoretical issues, to different kinds of experiments, to different methods of analysis, and of course to different kinds of substantive conclusions (see Busemeyer, 1985).

The first integration study (Anderson, 1964) obtained good evidence for a serial averaging model, in which the order effects (strong recency) were represented as weight parameters of the model. This analysis made it possible to test, in particular, that subjects did estimate an arithmetic mean rather than some other measure of central tendency. This had remained an arbitrary assumption in the normative approach.

A notable contribution of the serial averaging model was its capability for obtaining a complete serial curve that showed the weights of the stimulus at each serial position (see Anderson, 1981a, Figure 2.10). Previous work on primacy-recency had been limited to gross comparisons between the first and second halves of the sequence. Functional measurement not only yielded the detailed serial curve, but the success of the model provided a validation base for the

measurement. These possibilities lay entirely outside the normative capability. With integration theory, the inaccuracy "biases" began to make psychological sense in terms of attention, salience, and discounting processes. As concluded in a later application (Anderson, 1968)

The general approach taken here is of interest from a joint theoretical-methodological standpoint. [Previous approaches] have placed primary emphasis on response accuracy, evaluated against some numerically "correct" criterion such as mean or midpoint [and] considered high accuracy to be the most important result that had been obtained. Such results can be quite interesting, of course, but they can obscure the basic theoretical problem. . . . emphasis on a normative criterion may retard development of an adequate theory [p. 392].

Generality. Generality is a further advantage of the serial integration model. It has been applied extensively in social cognition, where normative theory is seldom relevant because no accuracy criterion is available. Moreover, it does not require a prior metric for the stimulus values, and it can allow for personal values.

One area of application has been to the personality adjective task, which, in contrast to number averaging, can yield a primacy effect, with the initial information having greater effect. Three main explanations for this primacy effect have been considered: *change-of-meaning*, according to which the initial adjectives interact with and change the meanings of the later adjectives; *discounting*, according to which the initial adjectives act to reduce the weight of the later adjectives; and *attention decrement*, according to which the weights show a steady decrease across serial position owing to attention decrement, independent of adjective interaction. The final array of evidence (see Anderson, 1974b, pp. 68-81) overwhelmingly favored the attentional explanation.

Anchoring and Adjustment. The anchoring and adjustment "heuristic" of Tversky and Kahneman (1974) is a special case of serial integration. According to this heuristic, subjects integrate by beginning with one piece of information and adjusting their response in the direction of a second piece of information which is just serial integration. The essential content of this heuristic is that adjustments are "typically insufficient [p. 1128]."

Anchoring and adjustment does not explain anything. The examples considered by Tversky and Kahneman are merely rephrasings of the statement that adjustments are insufficient. No explanation is given why adjustments are insufficient; this is taken as an empirical generalization.

This "heuristic" contrasts with the cognitive approach outlined in the previous subsection. Insufficient adjustment would, of course, produce primacy effects. The psychological problem is to determine what processes are responsible for these primacy effects. Earlier work had already advanced far beyond the position of Tversky and Kahneman.

Even as an empirical generalization, anchoring and adjustment is unsatisfactory because it is false. In judgment-decision research, many studies of serial integration show recency, as in the

cited study of number-averaging and in Shanteau's (1970, 1972) studies of Bayesian theory (see Busemeyer, 1985). To handle the facts would require two heuristics: anchoring and underadjustment; and anchoring and overadjustment. With this, anything can be explained.

Theoretical Derivation of Anchoring and Adjustment. Anchoring and adjustment is implicit in serial integration. Given a sequence of stimuli, the equation for the adjusted response at each step of the sequence is

$$R_{i+1} = w_0 R_i + w_{i+1} s_{i+1},$$

where R , w , and s denote response, weight, and value, respectively, and i is the serial position index.

In the special case of averaging, the weights sum to unity, so the model may be written in the proportional-change form as

$$R_{i+1} = R_i + w_{i+1}(s_{i+1} - R_i).$$

In this form, the prior response, R_i , may be called an "anchor," and $w_{i+1}(s_{i+1} - R_i)$ an "adjustment" in the direction of the present stimulus. The terms anchoring and adjustment add surplus meaning without theoretical substance.

This integration theory analysis has every advantage over the heuristic. It is rigorously testable, and it has succeeded in many applications. It allows construction of a complete serial curve of weight, thereby allowing both primacy and recency effects within the same sequence. It has been pursued to a deeper level of process, with some success, to understand primacy and recency. Most important is that it stands as part of a solid theory.

This point deserves emphasis. Primacy-recency effects have been studied intensively, but little of this work had an adequate theoretical base. The empirical studies led to a maze of conflicting results, sometimes recency, sometimes primacy, sometimes neither, without apparent order. Only with a deeper base in theory did these results begin to make sense, an interesting case history in scientific inquiry (Anderson, 1982, Section 7.14).

TWO-MEMORY HYPOTHESIS AND AVAILABILITY

An early, surprising finding in the integration studies was that judgment involved two memories: one for the literal information, another for the meaning of that information. This finding implies that reproductive memory is not sufficient for judgment-decision theory. A functional conception of memory is required.

Two-Memory Hypothesis. In the original experiment (Anderson & Hubert, 1963), subjects heard a list of trait adjectives that described a hypothetical person. They judged the person on likableness and recalled the adjectives themselves. The natural *verbal memory hypothesis* says that the judgment of likableness should be determined by the adjectives that are recalled.

This verbal memory hypothesis failed. Whereas the recall task yielded strong recency, the person judgment yielded weak recency or even primacy. Hence two distinct forms of memory seemed implicated; one for the relevant meanings of the trait words, the other for the words themselves.

This *two-memory hypothesis* disagreed with then-current views of memory. In the field of verbal learning, it was taken largely for granted that meaning was part of the word. In attitude research, which went beyond memory to judgment, it was explicitly assumed that attitudinal judgments were determined by the verbal retention.

The two-memory hypothesis has, however, been generally supported in subsequent work (see Anderson, 1981a, Section 4.2). It was one result that led to the present conception of functional memory. In this functional view, interest in memory shifts away from the normative concern with accuracy of reproduction to a cognitive concern with memory function in judgment and action. Functional measurement can measure functional memory, as illustrated by the capability of obtaining complete serial curves for judgment. This approach does not depend on any specific form of memory representation. Hence it also holds for multiform, distributed memory and for any mix of serial and parallel processing (Anderson, 1983a).

Availability. The two-memory hypothesis disagrees with the availability heuristic of Tversky and Kahneman (1973). This heuristic says that judgments of event frequency are determined by recallability of instances. It is thus a special case of the verbal memory hypothesis, and so is inconsistent with the results just noted.

A second problem is that availability ignores nonmemory factors, such as relevance or source reliability, which are important in judgment-decision theory. This limitation was recognized by Reyes, Thompson, and Bower (1980), who acknowledged the need for nonmemory weighting parameters in attitudinal judgments, but still maintained that only recallable arguments affect judgment: "Recallable arguments that are unimportant will have as little effect as important arguments that are unrecallable [p. 10]." This attempt to save availability is insufficient, for the two-memory research shows that unrecallable arguments can have strong influence.

It may be objected that the availability heuristic applies only to judgments of frequency based on instance information. This would be a narrow concept, for it would not allow for the obvious fact that many other kinds of information, summary statistics, for example, can also affect judgments of frequency. But even this narrow concept would seem incorrect, as shown by Fiedler's (1983) experiment with instance information. Fiedler pointed out that the availability heuristic

rested almost entirely on anecdotal evidence with virtually no attempt at experimental scrutiny. Fiedler's results disagreed with availability. Indeed, Fiedler arrived at a conclusion similar to the two-memory hypothesis.

Frequency Judgments. A specific example may help clarify some differences between the present functional conception of memory and the availability heuristic. Consider the question, "Are more deaths caused by rattlesnakes or by bees?" The answer, "rattlesnakes," is taken to reflect not only the operation of availability, but also a normative bias, for more deaths are caused by bees.

But such questions seem almost meaningless within the availability framework, which involves only memory for instances. It is a rare subject who will have known or even read about any specific person killed by either rattlesnake or bee. Indeed, most judgments of frequency probably depend on non-instance information.

An alternative interpretation is provided by information integration theory, in terms of functional memory and the constructivist principle. To sharpen the issue, suppose subjects have no instance information. Being required nevertheless to give a judgment, they cast around for some usable response dimension. One springs to mind: *dangerousness*. Subjects accordingly construct impressions of dangerousness of rattlesnakes and bees, applying the averaging rule to their background knowledge. Rattlesnakes thus seem more dangerous than bees, and this judgment of dangerousness mediates the judgment of frequency.

On this analysis, the judgment is a nice piece of problem solving. Far from being a curious defect, as the normative view implies, it illustrates the cognitive flexibility of general knowledge systems in making judgments and decisions on the basis of scattered bits of information.

It is true that such behavior will often be inaccurate. That is the price of a general-purpose system, and it certainly needs attention. Much the same point was made about social stereotypes long ago by Lippman (1922; see Anderson, 1983b).

REGRESSION MODEL

The ordinary regression model yields a normative standard for many tasks, for it defines optimal response by an adding rule. Partially related is its use for practical prediction, in which it has exceptional importance. For cognitive analysis, however, the regression model is a weak tool. A surprisingly large part of work with regression models is vitiated by failure to come to grips with this cognitive-normative distinction (Anderson & Shanteau, 1977).

Configurality. Clinicians and laypersons alike believe, often strongly, that they process information in a configural manner, taking account of patterns and interrelations among the informational cues. Such configural capability was expected to be important in clinical practice.

Regression models, however, were found to be better clinical predictors than the clinicians' and even to be good predictors of the clinicians' own predictions (see Dawes & Corrigan, 1974; Goldberg, 1968; Meehl, 1954). It was often concluded that the clinicians' claims for configural judgment were incorrect.

In fact, configural judgment has been found in many integration studies (see Anderson, 1969, 1972). Later studies have found definite evidence for the widely hypothesized discounting of common cues in comparative judgment (Farkas & Anderson, 1979) and for an accident-configural rule in moral judgment (Leon, 1980), to name but two.

Curiously, the most strongly believed configurality was found nonexistent: trait adjectives in a person description do not generally interact to change one another's meanings (see Anderson, 1981a, Chapter 3). This finding of meaning constancy was a key result in developing a theory of person cognition.

These results illustrate again the advantage of cognitive algebra over normative algebra for cognitive analysis. This work also led to a better definition of configurality (Anderson, 1982, Section 7.10). Much of the literature is difficult to interpret owing to failure to distinguish between interaction among the stimulus informers, which is true configurality, and nonlinearity in the integration rule or nonlinearity in the response measure. At the same time, this work has helped develop better methods for the difficult problems of studying configurality (Anderson, 1981a, Section 3.4, 1982, Sections 1.1.5, 3.2, 7.10, and 7.13, 1983a, Sections D and E).

Averaging of Regressed Values. A nice example of the conceptual clarification conferred by the averaging model of cognitive algebra is given by Birnbaum's (1976) analysis of a probability learning task studied by Lichtenstein, Earle, and Slovic (1975). Subjects were trained to predict a numerical criterion from each of two separate numerical cues, with respective validities of .4 and .8, and tested with two-cue combinations. The normative model, both in Bayesian decision theory and in Brunswik's lens model, is the ordinary regression model, with regression weights determined by cue validities.

These normative models could not account for the data. They require that a medium value cue make the response more extreme, whereas the opposite result was obtained. This obtained effect is just the standard test of averaging discussed previously. Lichtenstein, *et al.* shifted from the normative adding rule to an averaging rule. They remained within the normative framework, however, by assuming that subjects "regressed" the separate cues, a normative correction for unreliability, and averaged these regressed values. The cogent analysis by Birnbaum ruled out this averaging-of-regressed-values model and showed how the averaging model of integration theory gave a unified interpretation of a complex set of results (see also Anderson, 1981a, Section 4.4.3 and Notes 4.4.3a,f).

The cognitive-normative distinction appears at several points in the two foregoing studies. As Lichtenstein *et al.* (1975) note, the regression model seemed to do well when assessed in the traditional way but "the traditional measures . . . were not useful in uncovering these serious discrepancies from the model [p. 85]." This agrees with the following discussion of weak inference. The traditional measures originate from the normative orientation and are ill-suited to cognitive analysis. As illustrated empirically in a previous study of intuitive statistics, "Emphasis on a normative criterion may retard the development of an adequate theory [Anderson, 1968, p. 392]."

Weak Inference. The inadequacies of the standard regression analysis for cognitive analysis have been emphasized many times (e.g., Anderson, 1962, p. 817, 1968, p. 736, 1969, p. 64, 1971, p. 193, 1972, p. 96; see also Anderson, 1982, Section 4.1; Anderson & Shanteau, 1977; Slovic & Lichtenstein, 1971, p. 675). The fault may lie less in the model than in the way it is used (Anderson, 1982, Section 4.3), but these statistical issues are not of present concern. What is of present concern is the cognitive-normative distinction.

Weak inference originated because the concepts and methods that had served well in practical prediction were continued without realizing that they were seriously inadequate for cognitive analysis. The very properties that made the regression model so useful for practical analysis vitiated it for cognitive analysis. Thus, the common claim that the regression models were so "powerful" that they failed to detect any real configularity did not realize that this was a sign not of power, but of weakness.

This cognitive-normative distinction is sometimes submerged under surplus meaning. One frequent claim is that the regression models "capture the policy" of the judge. Even a wary reader might be misled into thinking that "policy" had cognitive implications and that the regression weights had psychological significance (see Anderson, 1982, Notes 4.3.1c and 6.1.4b). From a cognitive standpoint, the work on cognitive algebra shows that regression analysis, crippled with weak inference, has done very poorly at capturing policies. An understanding of the implications of this cognitive-normative distinction is important for productive research, as shown by the case examples of Anderson and Shanteau (1977).

MEASUREMENT

Cognitive and Normative Response Bias. The cognitive-normative distinction is nowhere clearer than in the concept of response bias. Normative bias refers to ordinary inaccuracy, the difference between the observable response and some objective criterion measure. Normative bias is thus itself observable, at least in principle.

Unfortunately, normative bias is often interpreted in cognitive terms. This is a conceptual error of double meaning, whose clarification requires a definition of cognitive response bias.

Cognitive bias refers to the difference between the observable response and some unobservable subjective measure, such as subjective probability. Cognitive bias is thus not itself observable, but is rather a theoretical construct.

This vital distinction may be illustrated with simple sensations such as loudness. Subjects may be asked to assign numerical values to sounds in two ways: with the ordinary rating method or with the method of magnitude estimation propounded by Stevens (1974). These two methods give sharply different results. Since they are not linearly related to each other, they cannot both be linearly related to loudness sensation. At least one must be biased.

The problem for cognitive theory is to determine which, if either, method gives the true measure of sensation. This is the problem raised by Fechner for psychophysical stimuli and made prominent in recent times by Stevens's controversial power law, based on the method of magnitude estimation. This measurement problem has been resolved by cognitive algebra, both in psychophysics and in judgment-decision theory.

Overconfidence as Double Meaning. Double meaning can arise when a normative bias is treated as though it was psychologically real. As one example, consider the common claim that subjects are overconfident under certain conditions. In one method of assessment, subjects choose between two answers to questions of fact and judge the probability that their choice is correct. By a normative rule, the proportion of answers actually correct among those judged to have probability p should equal p . In this case, the subject's probability response is objectively correct in the mean. In fact, however, subjects are generally reported to be overconfident for harder items, underconfident for easier items (see Wright, 1984).

This result, of itself, is largely meaningless. The interpretation depends entirely on a concealed assumption that the investigators measured the probability response on a true psychological scale. No study of this kind seems to have provided evidence for the validity of the response scale. Since response scales of this kind are subject to various known biases (see Anderson, 1982, Chapter 1), the assumption seems dubious and unwarranted. Perhaps the subjects were unbiased at the cognitive level and the bias was introduced by poor experimental procedure.

It may be objected that no cognitive implications were intended in these studies; that the only intended conclusion is that the proportion correct among those rated p is systematically different from p ; that this rating has an unknown relation to subjective confidence; about which, therefore, no conclusion can be drawn. But if the bias is indeed in the response scale, it would seem more fitting to conclude that what was miscalibrated was not the subjects but the experimental procedure.

This example is one of several in which measurement theory is critical to the interpretation. This may be called the *double meaning bias*, for it depends on eliciting cognitive implications that are unwarranted by the normative referent. Double meaning is easily cured by avoiding cognitive terms for normative referents.

RESEARCH DIRECTIONS

Choice of research direction is important in any field, but especially in a developing field like judgment-decision. The normative direction has undoubted practical value, and can ameliorate narrowing tendencies inherent in process studies (Anderson, 1981a, pp. 91-92). The normative approach has internal problems, however, one of which is that normative specification may be more or less arbitrary. This arbitrariness has been noted in relation to the biosocial heuristic, and similar comments are given by Winkler and Murphy (1973), Hogarth (1981), Christensen-Szalanski and Beach (1983), as well as the extensive discussion by Cohen (1981) and his commentators.

From a cognitive standpoint, the normative approach has two dangers. One is that it imposes a conceptual framework that is generally ill-suited to cognitive analysis. This danger has been illustrated with the case examples of the previous part.

The other danger is that the normative conception blinds investigators to important problems of judgment-decision that lie beyond the normative horizon. This danger is addressed in this part, again by case examples, with emphasis on everyday life.

Three directions seem attractive from the present standpoint. One of these is cognitive analysis, including more detailed study of schemas and knowledge systems, of constructive processes in valuation, of information interaction, and of general integration processes, especially feature integration and assemblage. A related direction concerns dynamic settings, in which judgment and decision evolve within a sequence of processing. This includes information search, goal setting, and assemblage, as well as various forms of interpersonal interaction.

The third direction focuses on everyday life, treating our everyday judgments and decisions as a fruitful field for investigation. One attraction is the richness of this field. A second is its practical importance. And a third stems from the belief, indicated in the introductory part, that the modes of thought and the background knowledge developed in everyday life are important in general cognition.

The study of everyday life has been urged by many, including those of phenomenological and ecological persuasions. Much judgment-decision research is at the same molar level, although with the narrowness typical of the world of urns and bets. Judgment-decision research also suffers from its past reliance on the normative approach, which causes it to ignore much of everyday life, for which normative constraints do not exist. The following topical overview indicates some ways

in which integration theory has progressed in the study of everyday life.

PSYCHODYNAMICS OF EVERYDAY LIFE

The psychodynamics of everyday life is neglected in normative theory. With liking or blaming, for example, there is no general standard of accuracy or correctness. Hence there is no base for normative theory. Other moral and social judgments suffer like neglect. Some nonnormative approach is needed.

Integration theory provides a straightforward approach to everyday life, in terms of cognitive processes. Three topics, liking, blame, and fairness, will illustrate some theoretical issues that arise in social cognition and in general judgment theory.

Liking and Disliking. Judgments of liking and disliking are basic in everyday life. In one standard experimental task, subjects make judgments about a person described by several personality trait adjectives. This task has a number of advantages for experimental analysis (Anderson, 1981a, Section 1.8.4), and it was a key task in the development of information integration theory.

A primary theoretical issue concerned *meaning constancy*. Intuitively, adjectives in a person description clearly interact in their meanings. The quality of patience, for example, seems different in a *resourceful, patient* person than in a *submissive, patient* person. Subjects and experimenters alike testify to the reality of such change of meaning.

The success of the averaging model implied that the adjectives had constant meanings, contrary to intuitive belief. This conclusion seemed shaken, however, with the associated discovery of the *positive context effect*, in which the likableness rating of a single adjective, *patient*, in the above example, was strongly affected by the values of the other adjectives. At face value, this is change of meaning.

But the positive context effect has an alternative explanation, as a halo process. The first judgment, of the person, is the average of the unchanged values of the two adjectives. The second judgment, of the particular trait of that person, is the average of the unchanged value of that particular trait and the overall judgment of the person.

The difference between these two interpretations may seem subtle, but there is a clear difference in the processing flow of information (see Anderson, 1981a, Figure 3.2). Moreover, the two interpretations make different predictions. Under the meaning change hypothesis, for example, traits with a wider range of potential meaning will yield greater positive context effect, but not under the hypothesis of meaning constancy. These and other such tests gave almost uniformly favorable support to meaning constancy (Anderson, 1981a, Chapter 3).

Three implications of this work deserve mention. First is the evidence for the averaging model, which has proved generally useful in judgment-decision theory. Second is the evidence

against the validity of conscious report, in this case, about meaning change. Third is the demonstration of a way to get beneath conscious report with a rigorous analysis of the judgment process. This provides a valuable tool for cognitive analysis.

Blame. "*Who's to blame?*" is an almost reflex response when things go wrong. "*It's not my fault*" is almost as reflexive. Blaming and avoiding blame are two ubiquitous motivations of everyday life.

An organizer for blame research is provided by the blame schema (Anderson, 1983c):

$$\text{Blame} = \text{Motive} \otimes \text{Consequences.}$$

This schema reflects the common conception that judgment of blame for some action depends on the motivation behind the action and the harm caused by the action. The generalized integration operator, $\otimes$, has been found to be an averaging rule in a number of situations.

The reference study on the blame schema is that Leon (1980), who obtained many results, including the first demonstration of the averaging rule for moral judgment, disproof of Piaget's centration doctrine, assessment of integration rules for individual children, an accident-configural rule, and the first clear evidence for imputations about missing information. This sheaf of results from a single study illustrates the usefulness of functional measurement methodology, as well as the carefulness of Leon's work. Subsequent studies have applied the averaging model to measure true weights of Motives and Consequences (Surber, 1982), extended the averaging rule to include the moral variable of recompense (Hommers & Anderson, 1985), and have shown how integration rules can provide a new way to look at family influence (Leon, 1984).

Fairness and Unfairness. Equitable distribution of goods is a basic problem of society. A putative normative rule, that pay should be proportional to deserving, dates back to Aristotle and underlies the current women's cry of equal pay for equal work. Everyday life indicates, however, that both pay and deserving have multiple determinants, money, vacation, and status symbols being only three varieties of pay, and effort, need, and actual work accomplishment being only three determinants of deserving. A test of the proportionality rule thus depends on having some way to treat money and status symbols, for example, in the same subjective currency.

Although nearly all equity formulations have explicitly adopted some form of proportional rule (see Adams, 1965; Anderson, 1976; Walster, Walster, & Berscheid, 1978), the rule is untestable without a capability for measurement of subjective values. Functional measurement resolved this problem and established the operation of a cognitive algebra underlying judgments of fairness and unfairness. Two applications to cognitive analysis deserve mention.

Equity judgments are doubly comparative, involving comparison of pay to deserving and comparison between persons. These comparisons, however, may be made in three psychologically distinct ways. Letting P and D denote pay and deserving, and A and B two persons, the fairness

rule may be written in these three ways:

$$P_A/P_B = D_A/D_B$$

$$P_A/D_A = P_B/D_B$$

$$P_A/(P_A + P_B) = D_A/(D_A + D_B)$$

These three equations represent different orders of processing and different comparison operations. The first equation, which dates back to Aristotle, requires initial comparisons of persons A and B separately for pay and for deserving, followed by a comparison of these two comparisons. The second equation, popularized by Adams (1965), requires the opposite order of comparison. The third equation, from integration theory, has the same comparison structure as Aristotle's model, but a different algebraic form.

But these three equations are algebraically equivalent. Judgments of fairness cannot distinguish among them. Judgments of unfairness, however, defined as the difference between the two sides of each equation, can distinguish among the equations. These judgments eliminated the first two rules and gave good support to the third, derived from the averaging model of integration theory (Anderson, & Farkas, 1975; Farkas, 1982). The algebraic rule thus diagnoses the comparison structure of the information processing.

A second processing issue arises when deserving has multiple determinants. The natural, normative assumption had been that all determinants are first integrated to form a single overall deserving, which then determines the distribution. The integration studies, however, revealed a different rule, in which partial equity judgments are first made for each separate determinant, and these are then integrated to determine the distribution (Farkas, 1982; Farkas & Anderson, 1979). Here again, cognitive algebra provided a penetrating analysis hardly possible with other methods (see also Anderson, 1983a, Section C).

Social Motivation. The three foregoing topics, liking, blame, and fairness, are among the many social motivations of everyday life. Motivation has been neglected in normative theory, of course, owing to lack of accuracy standards. More surprising, most current cognitive theories also have difficulty in handling motivation (see, e.g., Clark & Fiske, 1982; Norman, 1980; Zajonc, 1980), an indication of an overly narrow conceptual framework. Integration theory, in contrast, provides a direct approach to motivation, which is considered an integral component of cognition.

MARRIAGE AND FAMILY

The family is a natural laboratory, not much exploited in psychology. It is a primary realm of everyday life, to which judgment-decision theory can bring perspective and methods lacking in other fields of family studies.

Influence. Family decisions are typically joint decisions. Even decisions that concern one family member alone are made relative to a background of constraints imposed by other members. The study of intra-family influence is thus important in both daily behavior and in long-term socialization processes.

A new method was developed to study influence between spouses. In one study, husband and wife each received the same information about a child's transgression and judged how much discipline should be applied. Husband and wife then received some added information, different for each, which they exchanged orally. They then revised their initial judgments, taking account of both their own and their partner's added information. The design was based on the foregoing blame schema, with factorial manipulation of motive and damage for the child's action (Armstrong & Anderson, 1984).

Results supported the averaging rule, not only for motive and damage, but also for spouse influence. This result made possible the tricky task of assessing the influence of each spouse on the other. This influence followed an egalitarian pattern for these child-rearing judgments. Of special interest was a substantial spouse similarity in moral values, measured in terms of the relative effects of motive and damage information. This result, like Leon's (1984) mother-son similarity, provides a novel way to assess long-term social influence. A more extensive investigation is given in Armstrong (1984).

Social averaging theory was applied by Graesser (1982) to study the related problem of negotiation to obtain a joint decision. Same-sex groups of unacquainted subjects were given individual payoff functions and bargained in sequential steps to a common point on the decision continuum. The social decision schemes studied by Davis and his students (e.g., Kerr, Stasser, & Davis 1979) could not account for the results. The social averaging theorem did quite well, illustrating the potential of integration theory in group decisions, including marriage.

Personal Design. The neglect of the family as a natural laboratory reflects the methodological difficulties that face the investigator. Experimental control is essential for serious causal analysis, and many questions require analysis at the level of the individual. In addition, it is often desirable to study each marriage within its own context.

The method of *personal design* developed in these integration studies provides some leverage on these methodological problems. Personal design consists of embedding the abstract task within the particulars of each marriage (e.g., Anderson, 1981a, Section 4.5.2, Note 4.5.2a). Experimental control can be obtained with factorial-type design, which allows diagnosis of the integration rule, together with functional measurement of individual values. Other experiments and discussion are given in Anderson (1983f). Of special interest are extensions to handle self-estimated parameters and other techniques that allow more flexible design, especially in natural situations (Anderson, 1982, Sections 4.3 and 6.2).

SOCIAL ATTRIBUTION

Causal attribution is central in everyday life, and the attribution of traits and motives to explain another's behavior seems almost as automatic as object perception. Such social attribution has a formal analog to Bayesian inference, although the social "causes" of behavior, such as motivation, are typically unobservable subjective constructs.

Attribution Schemas. Two schema formulations have been considered in social attribution: one based on integration theory (Anderson, 1974b, 1978b), the other due to Kelley (1972). Kelley's formulation is normative in that people are assumed rational, not subject to emotional bias, whereas integration theory is cognitive and includes motivation and emotion. Two points from the cited references will illustrate this difference.

First, causal schemas are cognitive procedures in integration theory, as exemplified by integration rules. In contrast, Kelley defines schema actuarially as a pattern of data, represented as frequencies of three types of events in a three-factor analysis of variance. The cognitive procedures, not being tied to actuarial rules, apply to many situations in which an actuarial knowledge base is absent. Indeed, some schemas have no actuarial representation even in principle, as with the foregoing blame schema.

Second, Kelley's concept of information is too narrow. Motivation and affect are not allowed in Kelley's conception of rational attribution. And even at the rational level, Kelley's schemas are limited to three specific kinds of event information (distinctiveness, consensus, and consistency), which correspond to his three analysis of variance factors. Without a place for the many other kinds of relevant information, this formulation cannot address much of the social attribution of everyday life.

Algebra of Attribution. Integration theory has established a number of exact rules of attribution. One result is cited here to point up the difference between cognitive algebra and normative algebra. In this study (Anderson, 1974b, Section III.B.2), subjects received information about two of three quantities, namely, Performance, Motivation, and Ability, of persons trying out for a running team, and judged the third quantity.

Judgments of Performance followed a multiplication rule (see also Anderson, 1983a, Note 3):

$$\text{Performance} = \text{Motivation} \times \text{Ability}.$$

Mathematically, therefore, judgments of Motivation and Ability should follow a dividing rule. In fact, they followed a subtracting rule.

$$\text{Motivation} = \text{Performance} - \text{Ability}$$

$$\text{Ability} = \text{Performance} - \text{Motivation}.$$

Subjects thus obeyed a cognitive algebra, but not a normative algebra.

INTUITIVE PHYSICS

As a normative domain, intuitive physics has certain advantages over the intuitive statistics of standard judgment-decision research. Judgments of area or speed, for example, have clear perceptual referents on each occasion, thereby avoiding the complications associated with inferences from samples and averages over multiple occasions. Nature, moreover, provides an exact standard of correctness on each occasion.

Two cases of intuitive physics are considered here. Both showed nonnormative behavior, but this made cognitive sense. In both cases, a normative focus on accuracy would have yielded little insight, whereas the pattern analysis of integration theory revealed a cognitive algebra. Both cases, moreover, involved developmental analysis, which increased our understanding of integration processes.

Height + Width Rule for Area of Rectangles. A serendipitous finding was that 5-year-olds judge area of rectangles by adding height and width. The natural reaction is that something must be wrong, for the child need only look to see how big the rectangle is. When the normative Height $\times$ Width rule is so perceptually direct, it hardly seems credible that young children should adopt a physically incorrect rule that seems cognitively more sophisticated. Many alternative explanations had to be explored, therefore, but a series of eight experiments placed the Height + Width rule on solid ground (Anderson & Cuneo, 1978).

Establishing the Height + Width rule leads on to the question of its interpretation. Anderson and Cuneo suggested that it was one manifestation of a general-purpose adding-type rule. Children are considered sensitive to one-dimensional cues to quantity, but have available only primitive integration operators, notably a general-purpose adding-type rule. Height and width, being the two salient one-dimensional cues, were accordingly added. The test of this interpretation was sought and found in other tasks of intuitive physics in which physics also prescribes a multiplication rule but children add (see Cuneo, 1982; Wilkening, 1980, 1982).

This general-purpose adding-type rule appears as early as 3 years of age, which suggests a biological base. Certainly there is little or no social training for such integration tasks. And although the rule is nonnormative, it provides a rough approximation and so makes biological sense for a small brain. These developmental studies can thus help us understand cognitive algebra (see also Anderson, 1983d,e; Wilkening & Anderson, 1982).

Distance, Velocity, and Time. Uniform motion exhibits the rule,

$$\text{Distance} = \text{Velocity} \times \text{Time},$$

which interlocks the three physical quantities algebraically. Psychologically, however, distance seems easier to apprehend than time. Nonnormative judgment might thus be expected.

Fundamental work by Wilkening (1981, 1982) has studied the developmental course of all three judgments. The experimental task asked for judgments about an animal fleeing from a barking dog. Three subtasks were used, in which information was given about one pair of quantities and judgments were obtained about the third.

All three judgments obeyed a cognitive algebra. Judgments of distance, given velocity and time, followed an adding rule in 5-year-olds, a multiplying rule in older subjects. Judgments of time, given distance and velocity, followed a subtracting rule in 5-year-olds, and a dividing rule in older subjects. Judgments of velocity, given distance and time, followed a distance-only rule for 5-year-olds, and a subtracting rule for older subjects.

Here again cognitive algebra is not normative algebra. Thus, the judgments of distance and time by 5-year-olds follow the foregoing general-purpose adding rule, not the normative multiplying and dividing rules. For each age group, moreover, the three judgments are normatively inconsistent, as in the foregoing study of social attribution.

HUMAN MOTIVATION

Motivation is central to judgment-decision theory. This reflects the purposiveness of behavior, for judgment and decision are typically directed toward some goal. Because of this concern with goal-directed thought and action, judgment-decision is more intimately concerned with motivation than almost any other area of psychology.

Motivation has, however, been taken for granted in judgment-decision research. Not that other areas of psychology give much help. Empirical work has concentrated on animal studies (e.g., Bolles, 1975), but even basic drives, like food and sex, are so heavily socialized in man that animal studies have limited relevance. Clinical psychology is constricted by the psychoanalytic conception of unconscious motivation, which has little bearing on the motivations of everyday life. Personality theory is more pertinent, but rarely goes beyond typology and test-correlation methodology, which is too gross to tell much about cognition or even about particular individuals in particular situations (e.g., Mischel, 1968). Nor does personality theory say much about motivations of everyday life.

One foothold for motivation research is provided by information integration theory, based on concepts of valuation and integration. Motivations rarely act singly; motivation integration is the norm (Anderson, 1978a, 1981a, p. 309). Integration processes for motivation can be studied in the same way as for other kinds of information.

Integration rules, moreover, can provide a base and frame for measurement of values. Values, because they derive from goal-directedness, are a basic concept in all approaches to judgment-decision.

This research direction is not just an aspiration, but a living reality. Liking, blame, and fairness, in particular, are with us every day. In a modest but effective way, they can be subjected to exact analysis, as already illustrated. These are the motivations of everyday life. This is motivation with a human face.

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ECONOMIC AND PSYCHOLOGICAL APPROACHES TO THE STUDY OF ECONOMIC BEHAVIOR:
SIMILARITIES AND DIFFERENCES

Psychology and the Complete Economist

"To be a complete economist, a man need only be a mathematician, a philosopher, a psychologist, an anthropologist, a historian, a geographer and student of politics; a master of prose exposition; and a man of the world with experience of practical business and finance, an understanding of the problems of administration, and a good knowledge of four or five foreign languages. All this in addition, of course, to familiarity with the economic literature itself. This list should, I think, dispose at once of the idea that there are, or even have been, any complete economists and we can proceed to the practical question of what arrangements are likely to provide us with men who will feel not wholly confounded when an important economic decision confronts them." (Shackle, 1955, p. 241)

Indeed the complete economist appears to be the complete social scientist and the typical economist should at least be open to scientific contributions from other social and behavioral sciences if not well versed in them. The purpose of this paper is to discuss some actual and potential relations between economics and psychology which can be seen as a perhaps basic step toward the complete economist. Incidentally, Shackle is one of the few economists who have done some work with psychological concepts in the company of psychologists.

Intuitively, economics and psychology seem to have much in common since both at least on the surface deal with human behavior, albeit they cut it into somewhat different slices. The psychologist's slices may just be very much thinner than those of the economist. A psychologist who looks at economic theoretical models to find a place where his knowledge of behavior can fit in and improve the theory, all the same faces

a difficult task. Somehow human actors and psychological concepts are rare in economic models. The behavior talked about turns out to be for example cost and revenue behavior, or behavior of supply and demand curves without any human agents. In econometric models, the psychologist usually looks in vain for variables corresponding to the concept of expectation which is frequently used both in psychology and economics.

It is no wonder then that the psychologist picks out and turns against the basic postulate of rationality in economic behavior. It should not be difficult for a determined psychologist to prove that there exists no such thing as an economic man. To the mainstream economist such attacks seem like shadowboxing. Attempts by a few economists to use psychology for replacing the rationality concept have on the whole not been very successful and they have been based on the idea that in some sense the rationality concept is not realistic (see eg. Scitovsky, 1976; Maital, 1982; Alhadeff, 1982 for examples of recent attempts and e.g. Weisskopf, 1955, for an early attempt). The promulgated new theory turns out to be difficult to apply to studies of reality although apparently more reality oriented in the sense that it is based on actual psychological theory.

In the remaining part of this paper I shall develop further the difficulties encountered and try to note some characteristics of the areas where some success has been achieved. I know little about the history of economics and only a little more about the history of psychology, but I think it is important to try to find out where the two sciences started diverging from their common footing in philosophy.

The Early History of Economics and Psychology

Both economics and psychology were closely related to philosophy in earlier centuries. Adam Smith who is often seen as the founder of economics through his "Inquiry into the Wealth of Nations" (1776) had seventeen years earlier published a study on "the Theory of Moral Sentiments" which had some basically psychological ideas. The French social psychologist Gabriel Tarde who coined the concept of economic psychology in the early 1880's and later published a two-volume work on economic psychology (Tarde, 1902), accused Adam Smith of having forgotten his knowledge of psychology when writing the economics book. Smith especially omitted the fact that the human being was a social being, interacting in many ways

with his fellow human beings. Interestingly enough, the same type of critique against Adam Smith is nowadays heard in debates about market systems and the pursuance of self-interest. Although Kant toward the end of the eighteenth century had declared that psychology could not be a science since it could not use mathematics and experiments, the idea of testing certain philosophical problems in the laboratory intrigued many would-be-psychologists (Boring, 1950; Luchins & Luchins, 1965). The fact that physiological studies were performed in the laboratory provided ideas that led to the opening of the first laboratory in experimental psychology in 1879. It should thus be noted that experimental psychology was not started because of problems in everyday life, but rather on account of interest in the philosophical mind-body problem.

The Austrian School in Economics and Utility Theory

When economics started developing into a science of its own, it relied on hedonistic philosophy and common sense rather than on the little there was of scientific psychology. The Austrian economist and social philosopher Carl Menger published his "Grundsätze der Volkswirtschaftslehre" in 1871. This was the beginning of the Austrian school in economics which for some time was highly influential. Similar ideas emanated from Bentham and Jevons who like Menger proposed utility theories. Jevons and Walras inspired the use of mathematics which was foreign to the Austrians. Jevons (1871) was apologetic about his use of mathematics, but justified his attempts to use differential calculus by pointing to the fact that political economy dealt with quantities.

The Austrian school which is often called psychological did not and still does not base its psychological concepts or reasoning on the science of psychology, but rather relies on selfdeveloped concepts (see e.g. chapters by Kirzner in Dolan, 1976). Without any support from scientific psychology Menger (1871) developed a need theory the essentials of which are shown in figure 1.

Figure 1 about here

The basic idea behind the table is that need groups can be ordered in terms of how demanding they are and that there are levels of satisfaction. The most demanding need group is I which according to Menger is the need for nourishment. When some satisfaction is given, the urgency of this need group diminishes and another need group is attended to. Menger suggests that need group V could be the need for tobacco which is then attended to when the four higher need groups have each got a certain degree of satisfaction. Embedded in this table is something very similar to the law of marginally diminishing utility which was formulated mathematically by Jevons (1871). The value of goods is according to both authors determined by their capacity to satisfy wants, i.e. the price the consumer is willing to pay can in principle be defined from Menger's table.

Jevons treated political economy as a "Calculus of Pleasure and Pain". "The Theory of Economy thus treated presents a close analogy to the science of Statical Mechanics, and the Laws of Equilibrium of a lever as determined by the principle of virtual velocities. The nature of Wealth and Value is explained by the consideration of indefinitely small amounts of pleasure and pain, just as the theory of statics is made to rest upon the equality of indefinitely small amounts of energy" (Jevons, 1871, preface). In developing the concept of utility, Jevons cited the work on emotions and will by the first British psychologist, Bain (see Boring, 1950).

A similar need theory to that of Menger was independently conceived much later by Maslow (1954). It has received a lot of attention, especially in social psychology, but it has not inspired the same type of quantitative precision as the theory of marginally diminishing utility.

Menger declared that those economists who were grappling with the causal contexts of goods and causal laws connected therewith, were mistaken about economics ("Wirtschaftstheorie"). Such tasks were to be solved by the natural sciences including psychology. "Wir dagegen haben die Güter als Mittel für menschliche zwecke zu erfassen, ihren zusammenhang im zweckbewusstsein der wirtschaftenden Menschen (ihren teleologischen zusammenhang) zu erforschen und die Gesetze desselben festzustellen." (Menger, 1871, p. 21 footnote). Similar views on the roles of economics and psychology still seem to characterize the Austrian, so-called psychological school in economics (see e.g. Dolan, 1976). It is a hedonism towards the future

whereas mainstream psychology became preoccupied with a hedonism of the past, i.e. reinforcement rather than teleology (Boring, 1950, p. 704).

Mainstream Economists and Psychology

Mainstream economists have adopted a paradigm - in the Kuhnian sense - in which mathematical reasoning plays a dominant role. Mathematics is used for deductive reasoning and by means of auxiliary, simplifying assumptions the models are empirically tested. Cyert & Simon (1983) have recently accused economic theory for being only a branch of applied mathematics and recommended that behavioralism should prevail rather than mathematics.

Mainstream economists firmly reject the idea that the study of the individual can be fruitful and rewarding. Becker (1976) calls his approach "the Economic Approach to Human Behavior" and obviously sees it as a complete model of human behavior, superior to any psychological or behavioral model. There are three components in this approach

1. utility maximizing behavior, i.e. rationality
2. stable preferences
3. market equilibria.

Deviations from rationality are assumed to cancel out in a population and are anyhow limited in range because there are limited opportunity sets in the market place (Becker, 1976). Stigler and Becker (1977) have shown that preferences are stable and that this also holds for the effects of advertising. Advertising is generally assumed to affect preferences, but in the framework of Stigler and Becker, it is reconcilable with the assumption of stable preferences. The concept of market equilibria is fundamental for economic analysis and essentially involves that market forces tend toward a balance - which may never be attained because new circumstances occur. Supply and demand, costs and revenues or benefits tend towards equilibria. This assumption is an important analytical tool. Psychological phenomena are at best epiphenomena, accompanying and being caused by more fundamental phenomena. A lot of interest is focussed on transmission of information and the role of expectations, only these concepts are devoid of psychological meaning and had better not be studied at the individual level.

Data collected from individuals are assumed to be laden with bias for at least three reasons.

1. people may lie about their behavior and expectations
2. people may ignore the facts asked for and still provide answers
3. people may be mistaken and give the wrong information

Despite ignorance and mistaken views, people may anyhow on average and over time display rational behavior. In addition to being error ridden, data on individuals tend to be expensive to collect. Consequently, mainstream economists have little interest in psychological theory and methods.

The Case of Rational Expectations Theory

Macroeconomic theory started with Keynes (1936). Like the so-called Stockholm School (Lindahl, Myrdal and Ohlin) Keynes paid a lot of attention to psychological concepts, but made no use of scientific psychology. Expectation became one of the mostly used concepts in macroeconomic theory and the question arose how expectations were formed. The prevailing notion was for many years that expectations were formed on the basis of previous experience and several models were developed on the basis of extrapolated experience or some adaptive mechanisms. In the latter models, the concept of learning was incorporated. The concept of expectation was considered to be psychological and unobservable and there was a quest for replacing it by measurements of objective data such as time-series of price level development. There was little discussion of the seemingly important question whether there could be expectations when there were hitherto unknown future phenomena to react to.

The theory of rational expectations turned the concept of expectation from psychology in the economist sense over to economics. Rational expectations is nothing more than the consistent application of neoclassical economic analysis to the decision making under uncertainty (Carter & Maddock, 1982; 1984). Facing uncertainty the rational individual is assumed to gather information up to the point where the marginal cost of additional information is equal to its marginal benefit (Stigler, 1961). The theory thus stresses the role of information or rather the use of the best available information. This means for example that decision makers tend to rely on the best available forecast of future price levels and even are willing to

pay for it. The original idea involved that decision makers formed their expectations in exactly the same way as qualified economists derived predictions (Sheffrin, 1983).

The most important characteristic of the theory from the vantage point of macroeconomics is that information about government economic policy measures is also included in the considerations of the decision makers. This is often interpreted in such a way that "aggregate demand management" practised by a government for example to lower unemployment will be ineffective (Carter & Maddock, 1984). This is known as the policy impotence result of rational expectations. The stagflation crises with both high inflation and high unemployment which have recently characterized many countries are seen as evidence of the impotence of governments and their economic advisers. The theory gives one way of explaining this impotence.

There is much more to say about the theory of rational expectations. It tries in Kuhn's sense to explain an anomaly within a paradigm and there is disagreement about how well it succeeds. With respect to psychology, the theory means that the concept of expectation has become more firmly rooted in pure economic theory and that rational expectations utilizing information can be deduced without recourse to psychology. There remain some problems with the empirical measurement since the objective macro-economic proxies replacing direct assessment of expectations do not seem to function too well (Carter & Maddock, 1984). The difficulties have as a matter of fact inspired some laboratory experiments run by economists to study how people combine information to form rational expectations. Even adherents admit that there are still many problems connected with rational expectations theory.

Some Economists' Expectations re Psychology

There appear to be three kinds of expectations on what psychology can contribute to economic theory among economists who entertain a hope of developing economics by means of psychology.

1. The concept of rationality can be challenged and replaced by ideas borrowed from psychological theory.

2. The concept of rationality is kept, but is extended, elaborated or complemented on the basis of psychological theory.
3. Psychological constructs on a low level of abstraction and the methods used to measure or assess such constructs are accepted for use in certain economic or econometric models.

Frontal Attacks on the Postulate of Rationality

Scitovsky (1976) attacked the rationality postulate in a book which tried to use psychological arousal theory as a basis for, if not really a new theory of consumer economics, at least a profound discussion of economic behavior. He distinguished between two major motivational forces in human behavior according to arousal theory: on one hand, to ward off disturbances or the search for comfort and the search for stimulation or pleasure, on the other. Giving a number of examples he elaborates on the importance of making this distinction for economic explanations and predictions. Just observing preferences as revealed through market behavior does not take care of this distinction. As a consequence the economist misses such things as the quest for variety which characterizes modern life in the welfare states and the stimulation or pleasure gotten out of work. To my mind there is no doubt that if the search for variety is a stable preference, forecasting of consumption will be very difficult.

There have been other frontal attacks on the postulate of rationality. Alhadeff (1982) starts his development of a new microeconomic theory by attacking the economic theoretical assumption that only rational behavior can be modeled. "The true barrier to modeling behavior is not irrationality but the absence of a lawful relation -." (Alhadeff, 1982, p. 3). He finds that Skinner's operant conditioning theory offers a fruitful way of modeling human behavior without recourse to such non-operational variables as utility and rationality. Behavior which goes against economic rationality can be lawful and modeled, as for example the fact that intermittent reinforcement raises the probability of responding above the value generated when all responses are reinforced. Alhadeff's model of consumer behavior is essentially a conflict model, based on operant conditioning theory and Neal Miller's conflict models.

It escapes the critique by economists that when psychologists study consumer behavior they have too much of a tendency to look at the attractiveness side and not the sacrifice side of the choice alternatives (Meyer, 1982; Maital, 1982).

Scitovsky, Alhadeff and another promotor of alternative behavioral economics, Maital (1982) stress the importance of empirical evidence on behavior and laud the use of laboratory experiments for studying economic behavior. This is also the tenet of the new branch which is called "Experimental Economics" (see Smith, 1982; Plott, 1982).

Reshaping the Postulate of Rationality

The concept of bounded rationality, which was proposed by Herbert Simon (1955) is by now a well-known concept although it is apparently not generally accepted among economists. It is widely used in behavioral theories of the firm and in consumer information processing. After Stigler's 1961 paper on the economics of information which incorporates a theory for information search there is a truly economic way of modeling some behaviors that only bounded rationality which was based on psychological concepts seemed capable of handling.

Other attempts that can be mentioned involve the development of prospect theory (Kahneman & Tversky, 1979) which I shall treat more fully a little later. It suggests on the basis of empirical evidence that expected utility theory leads to wrong predictions of risky choices. Maital (1982) has suggested that in the long run prospect theory may replace the present postulate of rationality.

An interesting attempt to turn psychology into economics by making a psychological theory commensurate with the rationality postulate has been made by Akerlof & Dickens (1982). They adopt the psychological theory of cognitive dissonance which as a matter of fact has a debated place in psychology, for use as an explanatory factor of seemingly irrational behavior. They rephrase cognitive dissonance theory so that it becomes compatible with the rationality postulate. Behavior influenced by cognitive dissonance is in other words seen as rational and predictable. A prerequisite is the assumption that people have preferences not only for different world states but also for their own beliefs about world-states and that they can choose their beliefs up to a point.

Using Psychological Knowledge Production

Sofar I have been dealing with the use of psychological theory at the micro level. Scitovsky and other economists who have borrowed psychological theory are not like most psychologists concerned about individual behavior, but rather about economic behavior in large aggregates like national economies or at any rate considerable portions thereof. An altered, at least from a psychological point of view improved microeconomic theory of consumer choice or entrepreneurial behavior, is put to crucial tests primarily on the aggregate level. The results of these tests decide whether the alterations are acceptable.

On the macroeconomic level, there has been an increasing use of psychological concepts and data collection methods. The concepts are few and usually restricted to expectations, certain attitudes and buying intentions or buying plans. The studies involve interview surveys and the results are reported as consumer or business confidence studies. The direct application of psychology at the macroeconomic level has to some extent been successful in the sense that the concepts and measurements have been adopted for use in many continued studies of national economies. The EEC countries for example conduct three annual surveys since the early seventies (see e.g. Oppenländer & Poser, 1984).

Economists are more interested in how things change than in how they are (Morgan, 1967, 1978). How is consumer buying behavior affected when incomes or relative prices change? How does inflation or a change in the rate of inflation influence saving behavior? Morgan asserts that many of the variables interesting to a clinical psychologist in interpreting behavior are of no interest to the economist for two reasons.

1. Some variables useful in explaining individual differences do not change over time, for example personality traits.
2. Some factors which affect behavior and also change over time, change in different directions for different people, in a kind of random fashion which cancels out in the aggregate.

The index of Consumer Sentiment

George Katona (1975) had already in the middle forties started developing what was later to be called the Index of Consumer Sentiment (ICS): The ICS involves the measurement of attitudes-expectations through five carefully selected interview questions posed to representative samples of the adult population. The questions are very simple and refer to judgments of past and future financial situations for the respondent's own household and the economy as a whole. The fifth question concerns whether it is a good time to buy durables or not. The answers to each question are, in the design always used by Katona himself, carefully followed up through probing techniques in which the interviewer asks broad, open-ended questions. The Index of Consumer Sentiment has shown a good capability of predicting on four to six months' notice upturns and downturns in the economy. It is in the mass media reported as an index of optimism-pessimism. Consumer optimism is up is then a good indicator of an upturn coming in the near future.

More or less against Katona's wishes, the ICS has been more and more used in econometric time-series studies of saving development and purchases of durables. There are many examples of significant contributions to the explained variance (e.g. Juster, 1981; Williams & Defris, 1981; Pickering, 1984), but there is also a debate about the use of ICS and of buying plans or intentions which often accompany the ICS questions (see e.g. Abeele, 1984).

Incidentally, the ICS questions and questions about buying plans were from the beginning included in the interview surveys to make them a little more interesting to the respondents (Morgan, 1967). It was felt by the psychologists that the economists wanted to ask too many boring questions about incomes, expenditures and wealth. Of course, nobody expected that these filling-out questions could ever be used in a meaningful way.

Some Psychologists' Expectations re Economics

What psychologists in the first place expect to get from economics is probably not related to economic theory. Many psychologists have been attracted to the study of economic behavior and in particular consumer behavior because this field has provided a testing ground for their ideas. The early

behaviorists for example were interested in the practical applications of their theory and some of them tried their skills on the advertising world. Good remuneration may have strengthened their interest. Watson himself became a director in an advertising agency.

Economic behavior involves interesting, both simple and complex problems and is displayed in many contexts. It is meaningful to subjects even in laboratory experiments and an experimenter can easily create testing situations with high ecological validity. This may have contributed to an increasing interest among (some) psychologists to study economic behavior, n.b. not in order to contribute to the development of economic behavior theory, but to develop further the usual, low abstraction level, psychological theory they are working with.

Contacts with economic theory have been rare and have mostly led to criticisms of the economic man concept. There is since long some ground of common interest in the field of utility and game theory. As far as I can tell the most promising development for interdisciplinary work of interest to both economists and psychologists has to do with the study of judgment and choice. Again, this research circles around the rationality or expected utility concept with little impact on empirical economics.

Marginally Diminishing Social Impact

Direct loans from economic theory outside of game theory occur occasionally. Let me give an example. Latané (1981) studies the influence of the real, implied or imagined presence of other individuals on people's physiological states, subjective feelings, cognitions, values and behavior, so-called social impact. A proposed theory of social impact is based on a principle called "The Psychosocial Law" which is modeled on the marginally decreasing utility of money.

The "Psychosocial Law" is defined as

$$I = sN^t ; t \leq 1 \text{ and for inhibiting social impact} \\ I = sN^{-t}$$

"When people are in a multiplicative force field, the amount of social impact, I , they experience, will equal some power, t , of the number of sources, N , times a scaling constant, g . Further, the value of the exponent t should be less than one. Impact will increase in proportion to some root of the number of people present." "Thus, I suggest, there is a marginally decreasing effect of increased supplies of people as well as of money." (Latané, 1981, p. 344). The inhibition or division of social impact occurs when the tendency to do something is inversely proportional to the number of people involved. An example is the disinclination of bystanders to help in an emergency which grows with an increasing number present. Latané (1981) reports on a study in which the amount of tipping per person in a restaurant was investigated and found to be an inverse power function with an exponent of about .2. Individuals dining alone tipped almost 19 %, while groups of five to six people tipped less than 13 %.

One of the areas of application suggested by Latané is the free-riding or social loafing problem where individuals restrict their inputs to a common task when the number of contributors increases (cf Stroebe & Frey, 1982).

A Bold Assertion

It is a bold assertion to state that economists are more imaginative in their use of theory than are psychologists. Yet there is apparently some truth in it. When psychology and economics parted from philosophy in a more definitive way in the nineteenth century, psychology took philosophical problems regarding the individual into the laboratory. Economists, on the other hand, were inclined to solve problems at the macro level in societies. Many of them were engaged in practical affairs. Böhm-Bawerk, a famous member of the early Austrian School, was for example for some time minister of Finance. Economics needed highly abstract theory to encompass a large variety of phenomena in a meaningfully aggregated way. Psychologists looked for general laws of simplified behavior and ended up with low-level, fragmentized theories.

The abstract microeconomic theory with rationality as a basic postulate presupposes layers of models, involving simplifying assumptions, for studies of reality to become possible. Failure of data to confirm hypotheses may in economics shake the models in one layer, but leaves the basic theory unmolested. In psychology, the low-level theory is directly tested and if not corroborated, has to be abandoned. It is often saved through new attempts with changed procedures, ad hoc assumptions, new hypotheses about interactions or contingencies, or a kind of domain assumptions (cf Musgrave, 1981). The upshot of this difference in model building is that economists produce more conclusions from their use of empirical data than do psychologists. Economic analysis of data yields more implications thanks to the more abstract level of the theory and can perhaps be said to be more parsimonious in its handling of data.

The Instrumentalist View in Economics

Another aspect is that economists seem to make a more liberal use of theory. With some exaggeration, it can be said that economists tend to take a more instrumentalist view of theory and stress predictive power whereas psychologists prefer a more realist view and emphasize description and explanation (cf Caldwell, 1980). In the philosophy of science, the logical empiricists favor the idea that there is perfect symmetry between explanation and prediction and that predictions can be made only if there are adequate explanations. The scientific ideal pursued by almost all experimental psychologists, is epitomized by the Hempel-Oppenheim Covering Law model (see Hempel & Oppenheim, 1953). This involves looking for good explanations in the first place.

In his famous statements about positive (i.e. descriptive) economics, the economist Milton Friedman has asserted that a theory may be completely wrong in its assumptions, but as long as it gives good predictions, it is a good theory. This has been called the as-if assumption or the F-twist and has been the subject of many discussions (see e.g. Cyert & Grunberg, 1963; Thaler, 1980; Musgrave, 1981). Similar instrumentalist views are apparently held by many macro-economists.

Psychological Theory and Reality

Social psychologists with an inclination towards strictly controlled laboratory experiments have been targets of many attacks. It has been suggested that subjects in psychological experiments should be treated more like human beings than objects to be manipulated (Harré & Secord, 1973). There is some relevance in this for the interrelations between psychology and economics as already Tarde (1902) pointed out. Social impact is no doubt essential for human economic decisions in many contexts, but studied very little in the areas of human information processing, judgments and choices. For my purpose, however, another type of criticism appears even more important. Ideas have arisen implying that psychology, especially social psychology, should be more concerned about reality. One way of thinking is represented by "Full-Cycle" social psychology (Cialdini, 1980) which essentially states that social psychology should work in the following way:

- make systematic observations of reality
- develop theory through laboratory experiments
- test the theories through surveys conducted in reality.

Applying the "full cycle" concept to the psychological study of economic problems would provide more interesting results than mere laboratory experiments studying invented problems. This certainly does not preclude that laboratory results can be valuable and interesting. It is rather similar to the criticism that social psychology does not create generative theory (Gergen, 1982). By generative theory is meant theory that can challenge what is taken for granted, serve as a basis for changes of (social) reality. Developers of generative theory are interested in the wide applications of their theory to problems of reality. Becker's consumer or home economics theory which treats households as both producers and consumers in analogy with the traditional theory of the firm is in principle a good example of generative theory. It has been applied to study problems in such diverse areas as consumption of goods, altruism, marriage and fertility. The application in the last two areas have met with scathing criticisms from behavioral scientists, but it may still have been fruitful (for critical views, see Bagozzi & van Loo, 1978; Berk & Berk, 1983).

The difference in imagination the existence of which I boldly asserted earlier, may in the first place be a difference in the views about theory construction and theory use. Although experimental psychologists tend to believe in the generality of their laboratory research results, they apparently do not consider the applicability of experimental results to non-laboratory situations as an important problem. They are still similar to the leading psychologist Kenneth Spence (1956) who stressed that psychology was a laboratory science and a young one at that. He held that too many people in psychology did not have the true scientific attitude: they were too eager to apply psychological research to practical problems or they gave in too easily to pressures from their environment to do so. Since Spence's days psychologists have become more interested in the applicability of experimental research to problems outside the laboratory, but they have with few exceptions shown little concern about the wider applicability. Gergen (1982) remarks that Skinner made the necessary steps towards making his theory generative when he applied his theory to society in his later writings (1971). Incidentally, in an article about his old age Skinner (1983) comments that twenty years earlier he felt that his productive life as an experimentalist was coming to an end. "What should I do with myself? 'Administration', Lehman (well-known researcher on scientific creativity and age) said. But I had been a department chairman, and that was not an attractive alternative. I turned instead to broader issues in the design of a culture, culminating in the publication of *Beyond Freedom and Dignity*." (Skinner, 1983, p. 243).

When economists or more accurately expressed some economists use psychological theory, they are inclined to generalize freely and speculate about the use. Scitovsky's expounding of arousal theory is a good example. Similarly, Alhadeff (1982) who is rather formal in his discourse extends and generalizes Skinner's theory and Neal Miller's conflict models far beyond the situations in which and for which they were conceived. Personally, I think that this is a point where psychologists should learn from economists.

Generative Use of Psychological Theory

Let me take two examples of generative use of psychological theory. The first one is based on Tversky and Kahneman's "prospect theory" and an imaginative paper written by the economist Robert Thaler (1980). The second one concerns adaptation level theory and gives some ideas about how this theory can be used to derive hypotheses about behavior in relation to prices.

Prospect Theory

Criticizing the expected utility theory, Kahneman & Tversky (1979) suggest an alternative model, called prospect theory which need only be briefly summarized here. The major tenets of the theory are:

1. In choices among risky prospects, people underweight outcomes that are merely probable in comparison with outcomes that are obtained with certainty, the so-called certainty effect.

The certainty effect contributes to risk aversion when there is a sure gain in a risky choice.

The certainty effect contributes to risk seeking when there are sure losses.

2. Choice components which are shared by all prospects are discarded from attention, the so-called isolation effect.

The isolation effect appears as inconsistent preferences when the same choice is presented in different forms.

3. Prospect theory assigns values to gains and losses rather than to final assets and replaces probabilities by decision weights which except for low probabilities are lower than the corresponding probabilities.
4. The value function is generally concave for gains, convex for losses and steeper for losses than for gains (see Figure 2).

Figure 2 about here

The originators of prospect theory have tried out a number of implications in their own work. Thaler (1980) pushes the theory even further in a generative direction through discussing ten examples of economic problems where the solutions which seem to obtain in reality are strange to economic thinking but can be handled through prospect theory. He suggests that most people agree that the actual behavior which is shown in these examples deviates from economic rationality. Secondly, he shows that prospect theory can explain the deviating behaviors.

The Disregard of Opportunity Costs

Three of Thaler's examples refer to opportunity costs and what he calls the endowment effect. He notes on the basis of what psychologists would call anecdotal evidence that people do not generally consider opportunity costs i.e. the revenue you forego if you make a certain choice. Suppose you own a summer cottage which you could let for SEK 2 000 per month. You would never be willing to pay more than SEK 1 000 per month for a similar cottage. Few people would probably regard the revenue forgone as a cost if they occupy the house themselves for their summer vacation rather than letting it. This is obviously against economic theory which teaches that opportunity costs should be taken into account and is difficult to explain in economic terms. Thaler indicates that references are usually made to income effects or transaction costs, but that the explanations tend to be rather complex. He thinks that prospect theory offers a more parsimonious explanation. Since the loss function is steeper than the gain function and out-of-pocket costs can be viewed as losses and opportunity costs as foregone gains, the former will be more heavily weighted.

Thaler proceeds further and defines the endowment effect as the underweighting of opportunity costs. It is explained as follows. If something is removed from what you have, this is a loss with heavier weight than if the same amount is added, i.e. is a gain. Outlay costs will thus be more heavily weighted than opportunity costs.

In this context, two experimental studies of opportunity costs should be mentioned. There have been discussions about whether businessmen actually consider opportunity costs in making decisions. An important question is whether information about opportunity costs should be provided by the accounting process. An early experimental study found that

information on opportunity costs was disregarded (Becker et al, 1974). The subjects were given choices as exemplified in Figure 3. The authors attempt to explain "through pure conjecture" why opportunity costs are

Figure 3 about here

disregarded: "... people respond to the "language of economics" as well as to the ideas and concepts of economics." ... "People consider the cost of their children's clothes and education before buying a yacht or a Ferrari sports car. Why, then, did they ignore or treat as inferior opportunity costs in the decision situation we presented to them? The language of economics permitted and encouraged them to do so." (p. 327)

In a later experiment it was found that subjects used opportunity costs when presented with such information in formal financial reports, "realizing that the outlay costs normally presented are only part of the information set available concerning alternative investment opportunities." (Neumann & Friedman, 1978, p. 408). The authors suggest that subjects may impute opportunity costs when the latter are not explicitly stated which may explain the outcome of the 1974 experiment.

Thaler's idea about the existence of an endowment effect may have explained the differences in outcomes between the two experiments or it may not. It would have given the experimenters who belong to the discipline of accounting an interesting basis for experimental hypotheses. I have taken Thaler's paper as an example of a stimulating attempt to "fool around" a little with a psychological theory, something many psychologists should learn to do.

Adaptation Level Theory and Price

My next example refers to psychological theory applied to price. In an interesting contribution to a symposium on Pricing and Price Behavior, the social psychologist Fred Emery (1969) applied psychological judgment theory to the study of reactions to prices. He proposed four main hypotheses.

1. A price judgment is a judgment of value for money, where value refers to use-value of some commodity for some person or persons.
2. Price judgments are relative to what is known of other prices.
3. There is a normal or standard price for each discernible quality level in each commodity class, serving as an anchor for judgments of individual prices.
4. There is a range of tolerance about each standard price meaning that a certain amount of deviation has no effect up or down on sales.

On the basis of evidence from psychological judgment experiments, Emery elaborates these hypotheses. In the area of marketing there has been a long-time interest in the psychophysics of prices (Monroe, 1973). This can be seen as generative use of psychological theory. Emery's approach is, however, unique in the breadth of his approach and the way experimental evidence from non-price research is used. One of the theories Emery especially cites is Helson's adaptation level theory which I think could be a good object for some "fooling around" without necessarily producing directly testable hypotheses.

Adaptation Level

The concept of level of adaptation originated in psychophysics. When stimuli such as weights were judged, subjects seemed to use anchoring points against which comparisons were made to decide whether a particular weight was light or heavy. The measure of the adaptation level was defined as that stimulus weight that is judged on the average as being neither heavy nor light. Above the adaptation level weights tend to be judged heavy, below it they tend to be judged light. The adaptation level corresponds to a psychological zero point on a bipolar scale of quantitative meanings (Guilford, 1954). The adaptation level was shown to shift when special anchor stimuli of varying weights were introduced. Long experience with the type of stimuli decreased such shifts. The adaptation level is determined through three sets of stimuli

1. the set of stimuli judged (the focal stimuli)
2. background stimuli or anchor stimuli which are not judged (the contextual stimuli)
3. stimuli judged earlier: the residual effect of all pertinent, previous experiences (the residual stimuli)

The adaptation level is defined as the weighted geometric mean of all stimuli affecting the organism (Helson, 1964). The general equation for adaptation level is in psychophysics (Guilford, 1954, p. 330)

$$A_e = A_p^m A_c^n \bar{S}_i^e$$

where

A_e is the adaptation level resulting from all three sources of determination, including the stimuli being judged

A_p is the adaptation level at the time the experiment begins

A_c is the adaptation level which would be given by the contextual stimuli only

S_i is a stimulus being judged

$\bar{S}_i$ the geometric mean of S_i ; the adaptation level that would be determined by the experimental stimuli alone

m , n , and e are weights summing to unity.

In the more convenient logarithmic form the equation reads

$$\log A_e = m \log A_p + n \log A_c + e \log \bar{S}_i$$

From its origin in psychophysics adaptation-level theory has spread into many other areas (Insko, 1967; Emery, 1969; Appley, 1971; Stroebe & Frey, 1980). At first, there were great hopes that the theory would have wide applications to all sorts of judgments of social phenomena, but due to the complexity of the dimensions in such cases the studies have not added significantly to the knowledge about social phenomena (Insko, 1967). Some applications have been made in the area of prices and pricing.

Adaptation level theory has some interesting implications for consumer price sensitivity (see Emery, 1969). In the first place, products are hypothesized to be judged in relative terms - such as cheap or expensive - depending on an internal standard, in other terminology often called "fair price", and not judged in any absolute way (Kamen & Toman, 1970). Secondly, the internal standard tends to shift systematically on the basis of new experience. Kamen & Toman (1970, p. 35) note for example that motorists may try first to reduce their driving and other motoring costs when gasoline prices go up. "However, there appears to be an adaptation effect so that new and higher 'fair price' levels are gradually established, and the cost reduction methods lose their impact." If a consumer has negligible earlier experience of prices in a product class, the judgments will according to the theory be affected by contextual stimuli and by the prices of the considered products. Contextual stimuli are, for example, consumer price level data from commercial or non-commercial sources. If an extremely high price is presented as a contextual stimulus or part of the stimuli to be judged, and the consumer has little previous price experience the adaptation level, A_e , will be raised and other prices be judged as lower. Similarly if an extremely low price is shown, other prices will be judged to be higher and the products thus more expensive. This coincides with techniques used by skilled hagglers.

What can be derived from some generative use of the theory, in a sort of loose, deductive way, with an eye on reality, are hypotheses whose predictive power can in principle be tested. It is possible to construe laboratory experiments in which these hypotheses can be verified or rejected, naturally with some degree of artificiality. It may even be possible to get some evidence from making systematic observations of reality. The important thing is to generate new ideas by juggling with the theory, possibly combined with some sleight-of-hand. It seems likely that psychologists have a tendency to avoid instrumentalism and look for good explanations rather than interesting predictions. Although I have some skepticism about instrumentalism and on the whole prefer realism, I think the economists have an advantage there.

Some Concluding Ideas

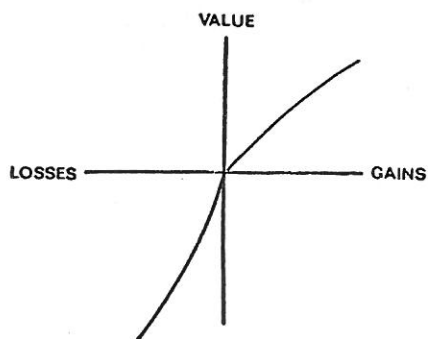
In this paper, I have run through a number of rather complex problem areas and I have dealt somewhat superficially with them. Despite the facileness of my discourse, the message is meant to be a bit alarming.

With respect to theory there is except in a few areas, best characterized by studies of decision making i.e. judgment and choice, little common ground between economics and psychology. Progress in the area of judgment and choice may serve to modify and elaborate the foundations of economic theory, i.e. the rationality postulate, in the long run, but will that affect the structure of economic theory and the many layers of strictly developed models involving auxiliary assumptions of negligibility of phenomena? There can be some doubt about the possibilities of really succeeding in replacing the simplifying assumptions, but I share the opinion of behavioral economists that it is not only worth trying, but a logical development (cf. Cyert & Simon, 1983). Personally I would be inclined to think that the measurement and analysis of otherwise unattainable magnitudes for some time will be the most important common interest for economists and psychologists. More elaborate measurements of expectations and the actual use of economic information should become a preoccupation both for economists and psychologists. It is hard for a psychologist to accept the abstract beauty of rational expectations theory and some time in the near future both experimental and survey oriented psychologists should become engaged in this new game in order to evince the power of full-cycle psychology.

When writing this paper, I have been forced by what Thaler (1980) calls "precommitment", a phenomenon which is also known to psychologists. The example Thaler gives is now corroborated through my experience (though some temporal and spatial characteristics should be exchanged). "Example 10. Professor X agreed to give a paper at the AEA meeting 'to assure that the paper would get written by the end of the year'. To be able to live up to my precommitment I had to rely on a generative theory, proposed by a well-known organizational psychologist, Karl Weick (1984), namely the "Psychology of Small Wins". The idea is that attempts to cope with large problems are self-defeating. So I have attempted to break down a large problem into a series of small problems with the chance of making small wins when grappling with them. Weick (p. 46) says: "A small win reduces importance ("this is no big deal"), reduces demands (that's all that needs to be done"), and raises perceived skill levels ("I can do at least that"). When reappraisals of problems take this form, arousal becomes less of a deterrent to solving them." It then strikes me that the impotence of policy which is a consequence of rational expectations, may perhaps be attacked through the "Psychology of Small Wins" rather than holistically. This would mean more place for psychology in macroeconomics.

I	II	III	IV	V	VI	VII	VIII	IX	X
10	9	8	7	6	5	4	3	2	1
9	8	7	6	5	4	3	2	1	0
8	7	6	5	4	3	2	1	0	
7	6	5	4	3	2	1	0		
6	5	4	3	2	1	0			
5	4	3	2	1	0				
4	3	2	1	0					
3	2	1	0						
2	1	0							
1	0								
0									

Figure 1 Needs Ordered after Urgency (Menger, 1871)



A hypothetical value function.

Figure 2 Prospect Theory (Kahneman & Tversky, 1979, p. 279)

<u>X</u>	\$	<u>X</u>	\$
Revenue	2,471,016	Revenue	2,471,016
Material	146,313	Material	1,231,759
Labor	153,035	Labor	831,612
Variable Overhead	2,045,219	Variable Overhead	161,648
		Foregone Profit	69,548

Note: For both the above projects, the materials cost represents the price paid for outside material purchases. The project on the right, however, uses materials from the stores, in addition to outside purchases, which are regarded as obsolete and treated as having a zero cost. They can be sold on the market, if not used in the project, for \$69,548.00.

Please do not forget to circle the "X" printed immediately above the project which you prefer.

Figure 3 Example of Choice Problem (Becker et al., 1974)

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DECISION MAKING AS A PROBLEM SOLVING PROCESS

Problem solving is one of the central areas of cognitive psychology. In my paper I discuss the interpretation of the process of decision making as a problem solving process. I think this approach is fruitful for decision theory , but I want to emphasize that I do not believe that the psychology of problem solving presents ready-made solutions to us.

1. Problem solving

A problem is characterized by (see for example Dörner, 1979², Newell & Simon, 1972, Simon, 1979) :

- (1) An (undesired) initial situation (initial state),
- (2) a desired goal situation (goal state),
- (3) the problem-solver does not know in advance how to transform the initial state into the goal state.

If my car does not move, this constitutes a problem for me. There is an undesired initial state and a desired goal state (the car running again), and I do not have a fixed routine to transform the initial state into the goal state. A standard example is a game of chess: initial state is the start position of the chessmen (chesspersons), the goal state is one of the numerous checkmate configurations.

An operator is an activity to alter states. In the car example among the operators to change the initial state are for instance : checking whether there is gas in the fuel tank, calling the repair shop. Usually the application of one operator does not suffice to transform the initial- into the goal-state. For example diagnosing an empty gas tank is an important operator, but it does not solve the problem by itself. Another operator (filling gas into the tank) has to be employed to reach the goal state. Therefore a sequence of several operators (not necessarily distinct ones) is applied. The realization of each opera-

tor generates an intermediate state (provided the new state is not the goal state). If the operators are already available the problem-solver's task is to construct a or the sequence of operators which leads to the goal state. In other problems the search for or the invention of operators may be a major part of the problem.

The problem solving states and the operators together define the problem-space, where the operators can be conceived as paths for moving from one state to another. In a specific state not all of the operators may be applicable, this knowledge about the constraints is incorporated in the problem space. In most cases the subjective problem-space is only a subset of the one objectively possible. Reasons for this are capacity limitations and restricted knowledge. One and the same problem may be represented by different problem-solvers in considerably different problem-spaces. One variable affecting the subjective representation is expertness, as has been shown in different areas (see for example Simon, 1979). Other relevant variables are for instance the problem formulation and characteristics of the task (for example time pressure).

As stated above problem solving may be viewed as a journey through the problem space. It is important to distinguish clearly between the simulation of an operator in the problem space and the actual execution of this operator. The cognitive representation enables us to test the consequences of an operator (for example of a specific move in a game of chess) without performing irreversible actions in the real world.

In most states in the problem space several operators could be applied. Therefore the problem-solver has to select one of them somehow. Among the strategies for operator selection are for example: General problem solving strategies like Means-End-Analysis and Progressive Deepening, or more task specific ones like the Recursive Subgoal Strategy and the Pattern-Following Strategy used in the Towers of Hanoi puzzle (Simon, 1975). Evaluation processes play an important role in these strategies (for example the evaluation of the similarity between the attempted state and the goal state). Thus one common theme for decision theory and problem-solving are the decisions among operators, but I do not pursue this specific topic further. Whereas such strategies seem to be sufficient to explain the behavior in simple well-defined

problems like the Towers of Hanoi , other control processes seem to be necessary in more complex problems (like for example writing a paper), where several different levels of action are involved. I discuss the question of control of the problem solving process in greater detail in section 5.

The problem-solver needs a knowledge base in order to deal with the problem.

Dörner (1979²) distinguishes two types of knowledge structures: The epistemic structure contains the problem-solver's knowledge about the topic of the problem. The heuristic structure contains the problem-solver's general and specific problem solving methods (operators). General techniques are for example: abstraction, induction, the use of analogies, etc.

There are different possibilities to define types of problems, see for example Dörner (1979²) and Greeno (1978). Relevant for decision making is the distinction between problems with a well-defined and an ill-defined goal state.

In a problem with a well-defined goal state there are clear rules which define for any state in the problem space whether it is a (or the) goal state or not. Examples of such problems are chess and the Towers of Hanoi puzzle. No such rules exist in a problem with an ill-defined goal state. For example when writing a book the author does not have a detailed concept of the goal state at the beginning. Another example - relevant for our discussion - is decision making. When I want to buy a house at the beginning of the decision process the goal state is very vague : of course I want to buy the best house possible, and I may even have some ideas about criteria the best house should fulfill, but I have no clear goal state. The goal state may become more specific in the course of the process or may undergo changes. The standards in the evaluation of the distance to the goal state may vary considerably in different stages of the decision process. I come back to the evaluation of the distance to the goal state in greater detail in section 2.1 .

2. Application of the operator approach to decision making

In this section I go into greater details concerning the application of the problem-solving approach to decision making. There are several aspects :

One concerns problem-solving tools. In decision counseling and other activities supporting a DM (decision-maker) general problem-solving tools are used, one example is brain-storming (group or individual) to increase the production of ideas. On the other hand some problem-solving programs incorporate also decision making tools, like Rubinstein's program (Rubinstein, 1981).

A further aspect in both, problem-solving and recent approaches to decision theory, is to understand decision making as a process. The process approach to decision making has been reviewed quite recently by Payne (1982) and Pitz & Sachs (1984).

In my contribution I concentrate on the operator approach. That means the explicit definition of problem-solving operators to alter states in the problem space and the modelling of the decision process as a sequence of such cognitive operators. The operator approach is reviewed by Posner & McLeod (1982). I want to discuss two examples of my own work, the first dealing with multidimensional choices, the second with a multistage decision task.

2.1 Multidimensional decisions

The following considerations are formulated for multidimensional decisions, but can be extended to simple decisions under uncertainty, where the consequences of all alternatives are analyzed according to the same set of events.

Some developments in research concerning this type of decisions may be interpreted in a way having similarity to the operator approach. Several authors divide the decision processes into phases which are interpretable as operators on a very broad level (Hollnagel, 1977; Kahnemann & Tversky, 1979; Montgomery, 1983).

A variety of heuristics for deciding (like Lexicographic Ordering-, Majority- and Weighted-Pros-Heuristics), have been formulated and investigated, for reviews see Aschenbrenner (1981), Huber (1982) and Svenson (1979). These heuristics can be viewed as operators, on a more fine-grained level than decision phases.

However, even these heuristics appear to be too coarse units of analysis. DMs use parts of such heuristics and combine them constructively in the decision process, the composition seems to be influenced by the DM as well as by the specific decision task (see also Bettman, 1979). Another problem with these simple heuristics seems to me the lack of a common theoretical base.

To overcome this disadvantages an operator model was developed, for details see Huber (1982). The model concentrates on the problem of choosing one alternative out of a given set of alternatives. Other partial problems of the decision process, like the search for alternatives, criteria and information are excluded (at the moment).

Let $A = \{x, y, z, \dots\}$ be a set of alternatives,

and $D = \{D_1, D_2, \dots, D_i, \dots\}$ a set of dimensions.

Each alternative x is a vector of aspects:

$x = \langle x_1, x_2, \dots, x_i, \dots \rangle$, with $x_i \in D_i$.

The set A/D_i contains the aspects of the alternatives on dimension D_i : $A/D_i = \langle x_i, y_i, z_i, \dots \rangle$.

Elementary operators

The repertoire of elementary operators is the vocabulary for the construction of complex heuristics, etc. The term "elementary" is used always relative to the present analysis, it does not exclude a further decomposition of these operators (see section 3). Two types of elementary operators are distinguished:

(1) Unspecific elementary operators.

These operators belong to the general operator repertoire of the DM, they are also applied in the solution of other problems, like concept-formation, solving of anagrams, etc., see for example Newell & Simon (1972).

For our purpose some examples of these operators are sufficient:

$X=Y$...This operator sets X equal to Y , where X and Y are sets or elements of sets.

$X \& Y$...Output of this operator is the pair $\langle X, Y \rangle$, X and Y being sets or elements of sets.

$M-X$... X is deleted from the set M , X is a set or an element.

$X \in M?$...This operator tests whether X is an element or a subset of M . Output is the corresponding element of $\langle \text{true}, \text{false} \rangle$.

$\text{SELECT}(M)$...Output is one element of the set M . The operator does not specify how this element is selected.

$\text{COUNT}(M)$...Output is the number of elements in the set M .

FOR ONE (m) FROM (M) AFTER THE OTHER $\rightarrow \alpha$...The sequence α of operators is performed in turn with all elements from M.

IF (condition) TRUE: α

FALSE: β ...If the tested condition (for example $(X \in M?)$) is true, the process goes to the sequence α , if false to sequence β .

(2) Specific elementary operators

These operators are specific for decision making (and presumably similar tasks).

EVAL, EVAL+, EVAL-

These three operators evaluate one element m of the set M on the subjective scale E_M , where $E_M = \langle e_1, e_2, \dots \rangle$ is a vector of different evaluation codes for the set M .

EVAL(m, E_M) attaches one element of the subjective evaluation scale E_M to m . For example if E_D is the scale for the weights of dimensions, and D_i is a specific dimension, EVAL(D_i, E_D) evaluates the weight of this dimension. The subjective evaluation scale may be fine-graded or very coarse in comparison with the information available. For example a DM may evaluate the possible wins in a gamble only as "high" or "low", even if the exact amount of money is presented. The scale may use a verbal, numerical, or analog code (for example lines of different lengths).

EVAL+ and EVAL- are like EVAL, but produce a positively or negatively biased evaluation.

MAX($M; \succ$), MIN($M; \succ$), EQUAL($M; \succ$)

M is a set, $\succ$ is an ordering relation defined over M (for example preference, subjective probability, subjective weight). The operator MAX selects that (those) element(s) which is (are) at the top of the ordering. For example the output of MAX($D; \succ$) consists of the most important dimension(s).

MIN($M; \succ$) is the counterpart to MAX, it selects that (those) element(s) which is (are) at the bottom of the ordering (for example the least probable event).

EQUAL($M; \succ$) produces as output one element of the vector $\langle \text{true}, \text{false} \rangle$. The output "true" results if the elements of the set M are "equal" in respect to the ordering relation $\succ$, for example if two (or more) events are equally probable, if two or more aspects are equally preferred, a.s.o. Formally this operator could be defined with the help of MAX or MIN, but I presume that a test of equality activates other cognitive processes than the selec-

tion of the maximal or the minimal element.

CONCATENATE, DIFF

CONCATENATE(M) concatenates the elements of the set M somehow. In fact this operator is a whole bundle of different concatenation operations. If for example the information is presented numerically in terms of cost, CONCATENATE may perform an arithmetical summation. If the information is available in analog form (for example the win in a gamble as a stack of coins) an analog concatenation operation may be performed (for example piling one stack of coins mentally upon the other). The set M may be a set of elements already evaluated by the operator EVAL.

DIFF(X,Y) is the pendant to CONCATENATE and produces as output the subjective difference between X and Y. $\text{DIFF}(x_i, y_i)$ for example generates the difference between the alternatives x and y on dimension D_i .

CRITERION, CRITERION $\uparrow$, CRITERION $\downarrow$

CRITERION defines for one or several dimensions a level of acceptance (for example a maximum price), also conditional levels of acceptance can be defined.

CRITERION $\uparrow$ and CRITERION $\downarrow$ rise and lower the level of acceptance respectively.

DISARMABLE(x_i)?

This operator tests whether the aspect x_i can be transformed into a more fitting aspect x_i' . This can be done by assuming a change of x_i in due time, or by disputing the credibility of the information.

Complex operators

A complex operator is an ordered sequence of elementary operators. There are three types of complex operators: sub-heuristics, structuring plans and decision-heuristics.

(1) Sub-heuristics

Sub-heuristics select from the set of alternatives A a subset of (one or more) alternatives $S(A)$. Both, $S(A)=A$ and $S(A)=\emptyset$ are possible extreme cases. Some of the sub-heuristics have resemblance to well-known heuristics, but here they do not lead to a decision. There is room to give only two examples of the many possible sub-heuristics:

Repeated applications of the sub-heuristic LEX are similar to the Lexicographic-ordering-heuristic. LEX allows the possibility that there is not one single most important dimension, but several. I

assume that in this case the DM tests whether one (or more) alternative dominates on the most important dimensions. The dominant alternative(s) - if there are any - are selected with the sub-heuristic DOMINANCE.

In the following sequence each operator is listed with its input and output, in the general form: OPERATOR(input) $\rightarrow$ output
LEX(A,D)

- 1 MAX(D;weight) $\rightarrow$ $D_{\max}$
COUNT($D_{\max}$) $\rightarrow$ $n(D_{\max})$
IF ($n(D_{\max}) > 1$) TRUE: 2
MAX(A/ $D_{\max}$;preference) $\rightarrow$ best alternative(s)
output =: best alternative(s)
- 2 DOMINANCE(A, $D_{\max}$) $\rightarrow$ dominant alternative(s)
output =: dominant alternative(s)

Another example for a sub-heuristic is the +BIASED TEST. There is not enough room to go beyond a verbal description, for a formalization see Huber (1982). This sub-heuristic includes some aspects of Montgomery's dominance-structuring (Montgomery, 1983).

+BIASED TEST tests whether a vector of aspects of one alternative - $x' = \langle x_1, \dots, x_m \rangle$ (with $x' \subseteq x$) - is acceptable or not. This test is biased because the DM wants a positive result and for this reason is willing to "cheat" a little. A situation where this sub-heuristic seems to be activated is the following: In a task with several alternatives and many dimensions the DM first concentrates on the important dimensions and (pre-)selects one alternative. Then he/she looks whether this alternative is acceptable also on the other dimensions. If this is the case the decision process is finished, therefore a little bias does not count so much. Only if significant negative aspects come to light this alternative is questioned again.

There are several ways to bias the test:

- 1) Using EVAL+ an aspect is evaluated as positively as possible.
- 2) A negative aspect can be compensated by a positive one. That means formally the evaluation of a pair (or triple, etc.) of aspects, instead of a single aspect. Again EVAL+ may be activated.
- 3) The DM may compute the subjective difference between an aspect and some standard on the same dimension (using DIFF). He/she may do this for a negative and a positive aspect. Then he/she compa-

res the differences for the positive and the negative aspects (with EQUAL and MAX). If the difference for the positive aspect is equal or greater than that for the negative one, the negative aspect is compensated.

4) The DM can reevaluate the dimension with a negative aspect, making the weight as small as possible with EVAL- .

5) The DM can try to eliminate the negative aspect with the help of DISARMABLE(x_1)? .

Another biasing technique - the introduction of fitting information (see Montgomery, 1983) - cannot be introduced in the formalism, because it contains no operators for information acquisition.

(2) Structuring plans

In many decision situations the DM is confronted with an overwhelming amount of information, for example with several alternatives described on several dimensions. In such situations DMs seem to employ plans to structure the task, see for example Payne (1982), Svenson (1979). In the present formalism a structuring plan is a complex operator where some details are left open. These details are filled in in the course of the process when it is necessary. I assume that the heuristic structure at least of adult DMs contains such structuring plans, and that the DM is able to develop new ones in new task situations.

The following example of a flexible adaptation of the number of dimensions was used by several subjects in Huber (1982), when there were several alternatives and more than ten dimensions. For the sake of shortness I describe the structuring plan only verbally:

1) The DM partitiones the set of dimensions into three groups: very important ones, important ones, less important ones (with EVAL and an evaluation scale E_D with three levels).

2) The DM then concentrates on the very important dimensions only and reduces the number of alternatives quickly using any sub-heuristic(s) he/she wants.

3) If the number of remaining alternatives is small enough (two or three) the DM expands the set of dimensions, and selects the best alternative by using information on the very important and important dimensions, and activating any sub-heuristic.

4) Finally the DM tests whether this selected alternative is okay on the less important dimensions also. Here +BIASED TEST may come into action.

(3) Decision-heuristics

As output a decision-heuristic produces one - the best - alternative. It contains the following components :

- 1) It contains at least one sub-heuristic, but may also contain other (simple or complex) operators.
- 2) It contains at least one evaluation of the difference between the present problem-solving state and the goal-state. I come back to this problem later.
- 3) It may contain one or more structuring plans.

A decision-heuristic is a complete way through the problem space. An infinite variation of decision-heuristics can be composed from the vocabulary of elementary and complex operators.

In very simple cases a decision-heuristic consists of only one sub-heuristic and the evaluation of the goal distance. If the first sub-heuristic does not lead to the goal state the DM applies another sub-heuristic and/or structuring plan. This may be repeated and results in a long and complicated path through the problem-space. Examples of simple and complex decision-heuristics in different decision tasks can be found in Huber (1982). For example one subject, who had to choose one out of six simple gambles, employed three sub-heuristics, until he was satisfied : one sub-heuristic computed the total sum of wins for each alternative using the CONCATENATE-operator (ignoring probabilities) and selected the alternative with the highest sum. The second sub-heuristic was similar to the Majority-rule, and finally he used a sub-heuristic corresponding to the Maximin-strategy. As it happened, the same (nondominant) gamble was selected with each sub-heuristic, thus in the end the DM chose it.

The way through the problem-space seems to depend on the individual as well as on characteristics of the task. For example in one of the experiments reported in Huber (1982) one independent variable was the presentation mode of the alternatives: alternatives were presented either one after the other to the DM, or all at the same time. In the sequential presentation mode the operators MAX, MIN and DIFF should be activated less often than in the simultaneous presentation mode, because in the sequential mode these operators need more space in the working memory. This hypothesis was confirmed. The task variables affecting the decision process which are reviewed in Payne (1982) and Pitz & Sachs (1984) can be incorporated in the operator model.

Distance to the goal-state

As far as I know decision theory did not investigate the question when the decision process is terminated. Exceptions are Ölander (1975), who goes into this problem in the context of the satisficing-principle, and Wendt (1977), who defines the goal-state as one where the DM selected one single alternative (in my formalism, when $S(A)$ contains exactly one alternative: $n(S(A))=1$).

Of course one characteristic of the goal state is $n(S(A))=1$, because it is the explicit task of the DM to select one alternative. However $n(S(A))=1$ is only a necessary but not a sufficient condition for a state to be the goal state. If $n(S(A))$ were the sole condition the DM could solve the decision problem very quickly: simply selecting one alternative (for example randomly) would be sufficient.

I assume that any state is characterized (at least) by the triplet:

$$\text{state}(i) = \langle n(S(A))=1, \langle \text{aspects} \rangle, \langle \text{op} \rangle \rangle.$$

$\langle \text{aspects} \rangle$ is the set of aspects the DM has used so far, it refers to the amount of information about the alternatives processed up to $\text{state}(i)$. I assume that the DM attempts to process all the relevant aspects of the alternatives, especially of the ones in the final choice. This assumption is based on the results of several experiments, see Payne (1982).

$\langle \text{op} \rangle$ is the sequence of operators the DM has employed up to now. Different operators (for example sub-heuristics) may have different value. That means the following: If the DM evaluates sub-heuristic H1 as better (more rational, etc.) than H2 a choice made with H1 would give the DM more confidence in the correctness of the decision than a choice made with H2 (other things equal). A remarkable common result of the experiments of Adelbratt & Montgomery (1980) and Huber (1983) is that subjects prefer more complex heuristics (processing more information, requiring more memory space) to simple ones.

Both $\langle \text{aspects} \rangle$ and $\langle \text{op} \rangle$ are stored in the DM's memory. Therefore these vectors do not constitute an objective bookkeeping of the decision process.

The initial state is the triple:

$$\text{initial state} = \langle n(S(A))=n(A), \langle \text{aspects} \rangle = \emptyset, \langle \text{op} \rangle = \emptyset \rangle.$$

The goal state is characterized by the vector:

$$\text{goal state} = \langle n(S(A))=1, \langle \text{aspects} \rangle^*, \langle \text{op} \rangle^* \rangle,$$

where $\langle \text{aspects} \rangle^*$ and $\langle \text{op} \rangle^*$ are an acceptable vector of aspects and operators respectively.

The DM terminates the decision process when the distance between the present state and the goal state is zero, in other words, when the characteristics of the present and the goal state are the same. Which vectors of aspects and of operators are acceptable is usually not clear from the beginning of the process (decision making as a problem with ill-defined goal state). The criteria for acceptance may change considerably in the course of the decision process. I assume that at least the following variables influence the acceptance of the vectors of aspects and of operators :

(1) The specific alternatives: Consider for example a DM who is confronted with two alternatives, none of them dominating. If this DM evaluates a sub-heuristic resembling the Dominance-heuristic as best, he/she nevertheless would have to readjust the level of acceptance nevertheless, because this sub-heuristic does not lead to a decision in the present situation.

(2) Some characteristics of the decision task which influence directly the amount and quality of available information or the processing of the information (For example time pressure).

(3) The amount of time and effort already invested in the decision task.

(4) The importance of the decision, for example the amount of utility involved, number of people affected, etc.

The number of alternatives, sequential or concurrent presentation mode, etc. should not affect the level of acceptance. This follows from the interpretation of the decision process as a constructive problem solving process. The DM is assumed to adapt the way through the problem space to the specific situation. In one of the experiments reported in Huber (1982) the subjects after each choice rated their confidence for having made the best decision. This was interpreted as indicator for the levels of acceptance for the vectors of aspects and of operators. None of the five independent variables and none of the interactions with these variables had an interpretable effect on the confidence rating (smallest $p=0.11$), but the number of dimensions and the familiarity of the decision task had (both affect the amount and quality of the information, see (2)).

Jones & Rapoport (1979). Such a task is an abstract model of very simple investment tasks, concerning the investment of money, time, effort, social relations, etc.

In the decision theoretical approach the main relevant behavioral variable is the stake s_i . Because - to my knowledge - no process analysis of the behavior in a MBG is available, a pilot study was conducted. The thinking-aloud protocols of this pilot study were the base for the development of an operator model and for the construction of hypotheses. The first experiments to test hypotheses about operators are already finished and in the phase of protocol coding.

In the pilot study the MBG was embedded in an ecological context. The task of the DM was to increase as much as possible the number of Golddotted Whiptail Lizards, a species on the verge of extinction. Only 20 of them are left, and they cannot reproduce in the laboratory. Because they are very prone to environmental factors they do not reproduce in their natural habitat either. Now a group of researchers has found one breeding place in an out-of-the-way valley. If the lizards reproduce successfully in this breeding place, each of them produces x ($x=1$ or 2) offsprings (the lizards are parthenogenetic, see Cole, 1984). However the breeding place is in an area with numerous small volcanoes which from time to time emit gas clouds deadly for the lizards. It is not possible to predict the gas clouds, only the probabilities are known ($2/3$, $1/2$ or $1/3$). Because the alternative is extinction, the breeding place has to be utilized in spite of the risk. The subject had to decide for each of a series of 20 breeding periods (trials) how many of the available lizards were to put into the breeding area.

Details from the pilot study and the operator model may be found in Huber (1985). All the following analyses of the process are based on the thinking-aloud protocols of the 22 subjects of the pilot study.

For the analysis it seems useful to interpret the situation as an interaction between a DM and an open system. A system consists of a set of variables and a set of relations among these variables, where some of the variables also have relations to other (external) systems. Among the variables in the present MBG there are: the probabilities of event L and W (gas clouds or not), the capital (lizards), the stake, etc. One of the relations

governing the transformation of variables is for example: If the variable "event" has the value "gas-cloud", the new value of the variable "capital" is defined by : capital - stake.

In general the decision behavior seems to depend on the DM's representation of the system, the goal(s) and considerations based upon the representation and goal(s). All three aspects may change during the process.

Process analysis

In a first analysis I divide the process of dealing with the MBG into six subprocesses, all of them may be relevant in each trial :

(1) Representation of the system

At the beginning of the task the DM constructs a representation of the system he/she has to work with. The representation includes the properties of the system, it may comprise accidental properties, and relevant details may be omitted. The system representation may change in each trial. The DM's knowledge about the system stems from several sources: External sources (most important one is the instruction), the DM's memory, the behavior of the system (therefore the DM stores some kind of history of the system), and inferences drawn from other information.

(2) Goals

A goal prescribes which value or set of values a specific variable should obtain. The first general goal (to breed as much lizards as possible) is established in the instruction. The DM usually formulates subgoals, intermediate goals, etc., and also goals concerning the problem solving process ("First I want to look what happens"). If the DM has a goal list with several goals priorities among goals have to be defined.

The general goal together with the representation of the system constitutes the task representation.

(3) Strategies

Strategies are subjective rules (conditional or not) for problem solving. Two types of strategies are distinguished: Strategies for choosing a stake ("After a series of three wins, put very few lizards into the breeding area"), and strategies for the problem solving process ("First gather information then develop a strategy"). The DM can maintain several strategies at the same time.

(4) Stake choice

This subprocess is relevant in each trial. The choice of the sta-

ke may be determined by a strategy in full or partially. Decision-heuristics as discussed in section 2.1 may describe the process of choosing a stake. The DM's expectation which event will occur next may influence the stake choice. When a stake has been selected the DM may test it by extrapolation into the future and planning. A DM may select several stakes in the first instance. In this case he/she has to decide which one to realize.

(5) Event generation and outcome determination

In each trial the random event has to be generated. When the DM knows the event he/she uses the system representation to determine the win or loss and the new capital.

(6) Situation evaluation

This subprocess is also activated in every trial. It evaluates the following components: Relevant variables in the system representation (for example: win, loss, remaining trials, history of the capital), goal distance, system behavior (whether it is in accordance with the system representation), and strategies.

Operators

As formulated above an operator is a cognitive activity to transform states in the problem space. A state in the present problem is a vector of variables and relations among them. Included can be for instance: the system representation, the momentaneous value of variables (for example: capital, probability of loosing, last stake), strategies for stake selection, a history of positive and negative events up to now.

The aim of presenting the operators is to describe their mode of operation and their function in the process, not to develop an elaborate formalism.

(1) General decision making operators

This group of operators contains (at least) the operators described in section 2.1.

(2) Operators concerning the system representation

SYSTEM ANALYSIS → system representation

Output of this operator is a representation of the system. Input is any of the sources mentioned above. This operator constructs a system representation or changes an old one.

UPDATING → system representation

This operator dates up the variables affected by the event and the outcome, for example current capital and history of events.

(3) Operators concerning goals

GOAL $\rightarrow$ goal(range,content)

This operator generates a goal concerning one or more system variables. A goal has a range (it holds for all or for some specific trials) and a content (what the DM wants to obtain, for example: "I want to reach 100"). Input of this operator are: system representation, information from the experimenter, and other goals of the DM.

PS-GOAL $\rightarrow$ PS-goal(range,content)

The goal generated by this operator is a problem solving goal ("I really should have a strategy").

Goal lists and -hierarchies : If there are several goals or PS-goals a goal list is formed. If a goal has been reached or is not attainable anymore it is removed from the list. A goal hierarchy is a goal list ordered by priority. Goal lists and -hierarchies can be constructed and changed with the help of the general decision making operators.

(4) Operators for strategy generation

PS-strategy generation $\rightarrow$ PS-strategy

This operator generates a strategy for the process of problem solving. For example, such a PS-strategy can constitute the plan first to gather information about the system and then to develop a strategy.

STRATEGY GENERATION $\rightarrow$ strategy

Here a strategy for the selection of a stake is selected. Strategies define conditional or unconditional stake limitations. The limitation may be very specific, for example a fixed percentage of the current capital. A strategy may also define a subset of all possible stakes. An example for a conditional strategy is the following, used by several DMs in the $p(\text{win})=2/3$ condition: If you have won two times, bet very cautiously until the gas cloud occurs, then go back to higher stakes.

(5) EXPECTATION GENERATION $\rightarrow$ expectation

Input of this operator is the system representation (at least the part concerning events and their probabilities) and the history of events. Output is that event which will most probably take place next, the output may also include an estimation of its probability. The function describing the behavior of this operator may be similar to that of the process which produces a momentary expectation in Jungermann's (1976) model of probability learning.

(6) Operators concerning stakes

STAKE SELECTION → stake

This operator selects a specific stake on trial *i* out of the set of possible stakes. This choice may be made in various ways, for example expectation(s) and/or strategies may play a role in the choice. In general I assume that the DM tries to optimize two variables at the same time: the possible win (which can be gathered with a high stake) and the capital saved (which is the higher the lower the stake is). Huber (1985) contains an attempt to model the dependency of this optimization from other variables (capital, number of offsprings, etc.).

The operator STAKE SELECTION is applied at least once in one trial but may be used several times, for example if the DM has more than one strategy. In this case a stake-list is formed.

STAKE TEST → result

The DM may test a selected stake by simulating what would happen if this stake is bet and lost, etc. I assume that the DM is planning ahead in this manner only very few trials (one or two). The reason is not only the DM's limited capacity, but also the fact that the present MBG does not necessitate planning ahead.

STAKE CHOICE → stake

This operator chooses the final stake from the stake list, if it contains more than one stake. There are many ways to choose. For example if there are stakes selected with different strategies in the stake list, one is to evaluate the respective qualities of these strategies. Another possibility is to treat the choice as an "ordinary" multidimensional choice.

(7) Event generation and outcome determination

EVENT GENERATION → event

This operator produces a random event, for example by throwing a die. It is not necessary if the event is generated by the system or by the experimenter independently from the DM.

OUTCOME DETERMINATION → outcome

This operator determines the win or loss and the new capital, after the event at trial *i* has occurred.

EVALUATION → result

This operator functions analogous to the operator EVAL, the difference is that EVALUATION performs more complex evaluations. This more complex evaluations can be constructed from the operators described in section 2.1. Some examples of EVALUATION are :

- 1) EVALUATION(present situation), where "present situation" is a list of values of variables which are relevant for the DM's stake decisions (present capital, history of wins and losses, etc.).
- 2) EVALUATION(goal distance). Goal distance is the difference between the present goal and the present capital.
- 3) EVALUATION(strategy). Here the DM evaluates whether a specific strategy is successful enough.
- 4) EVALUATION(system representation). The DM checks whether the system representation is sufficient or not.
- 5) EVALUATION(previous stake). After the outcome determination the DM may judge whether it was good to bet that specific stake.
- 6) EVALUATION(system behaviour). The DM analyzes whether the system behaves according to the present representation of the system. For example the DM may conclude that the history of positive and negative events suggests a different probability of win as stored in the system representation. This evaluation is especially sensible for deviations which are unfavorable for the DM.

Decision processes

Some of the operators are employed in each trial: STAKE SELECTION, EVENT GENERATION, OUTCOME DETERMINATION, UPDATING, and presumably EXPECTATION GENERATION, EVALUATION(present situation) and EVALUATION(goal distance). Other operators are activated according to the requirements of the momentary situation. For example the DM may apply STRATEGY GENERATION when there is a considerable change in the capital situation (to the better or to the worse), if a strategy has been evaluated as unsuccessful, or if a goal cannot be attained anymore. Examples for sequences of operators are presented in Huber (1985).

The present analysis concentrates on operators on the level where the DM controls the system (selects a stake, etc.). Operators on a metalevel are included if they influence directly the decision process. On the metalevel the DM chooses among operators, evaluates operators (for example strategies), works out plans for sequences of operators, and so on. One can interpret this meta-level also as a problem space with heuristics for choosing among operators as meta-operators. This meta-level again may have a meta-metalevel, the latter one a meta-meta-metalevel, and so on, in principle - but not in practice - infinitely. I discuss the problem of control of the decision process and levels of control in greater detail in section 5.

3. Advantages and problems of the operator approach

One advantage of the operator approach to decision making is that the construction of operators is closely linked with a task analysis. The task analysis begins with a clear definition of the problem to be modelled: which aspects of the solution behavior shall be captured, which not. For example an operator model for multidimensional decisions which attempts to include also the semantical organization of dimensions has to incorporate more operators than the one described in section 2.1. Task analysis is important also for the definition of the set of operators, because it helps to reveal the processing-steps which are necessary in the problem solving process.

An operator system is a very flexible and adaptable tool to model individual decision behavior, without abandoning the aim to develop generalized theories. Generalized hypotheses may involve elementary or complex operators, or clusters of these operators, specific realizations of an operator (for example analog concatenation), etc. Operator models are not necessarily in contradiction with algebraic models. An algebraic model may for example describe the input-output relation of a specific operator. Thus the optimal models of Funk, Rapoport & Jones (1979) could be incorporated into the operator STAKE SELECTION.

The specific properties of operators together with general cognitive theories enable the derivation of hypotheses about the dependence of operator applications from task variables. For example in task situations where stress is put on the working memory operators with greater memory requirements should be used less often, in tasks where the information on different dimensions is commensurable the operator CONCATENATION should be employed more often (see for example Huber, 1982).

The division of the process into simple operators (instead of heuristics, etc.) is advantageous in the analysis of thinking-aloud protocols. Simple operators can be detected more easily and are coded with higher reliability.

Elementary operators should of course be analyzed further whenever possible. They may link decision theory to general psychology. In some cases one can fall back upon already existing theories: For example the operators EVAL, EVAL+ and EVAL- belong to judgment processes. Psychology has gathered a body of know-

ledge about this topic (for example context effects, etc.). Theories about linear orderings (see for example Potts et al., 1978) may help us to understand the cognitive processes in connection with the operators MAX and MIN. For specific types of operators DIFF and CONCATENATE, namely addition and subtraction, theories of mental arithmetic are transferable directly. Posner & McLeod (1982) review the research on elementary operators in several areas of cognitive psychology.

Another advantage of the operator approach is that it raises new questions for decision theory. One question is the problem when the decision process is terminated, another is the control of the decision process. A third is the general question of problem isomorphs, that is the question which objectively identical problem formulations lead to different subjective representations (and why). I have some hope that the operator approach will help us to tackle the problem of characteristics of the DM more successfully. I assume that in this context it will be more fruitful not to work with global heuristics, but to break down the decision process into operators.

There are also problems in connection with the operator approach :

One problem concerns the empirical test. If an operator model contains no further (testable) assumptions beyond the definition of elementary and complex operators the empirical content of the model is rather low. In this case the sole testable condition is whether DMs do apply operators which are not in the vocabulary of the model or cannot be constructed from the vocabulary. Therefore it is necessary to formulate hypotheses about the use of elementary and complex operators, etc., for example depending on the number of alternatives involved. Such general hypotheses together with estimates of individual parameters (specific subjective weights of dimensions, specific individual preferences) enable a predictive simulation of individual ways through the problem space and thus a stronger test of the operator model. The problem is that at the moment not enough knowledge about the employment of operators is available to allow such a predictive simulation, especially in multistage decision making.

Another problem is the level of abstraction on which the operators are defined. There seems to be no general rule how fine- or coarse-grained the elementary operators in a model are

to be chosen. A too fine-grained operator definition seems to be the lesser evil, because it is always possible to pool elementary operators into clusters or to compose complex operators. However too much unnecessary details may hinder successful work with the model. For example if one is interested mainly in decision making the question how in detail the operators MAX and MIN select the elements (with the help of a spacial representation or a verbal one, etc.) is not so important.

Operators which are too coarse-grained comprise different actions. In the extreme case the definition results in rather meaningless global operators, if it is nothing more than naming a process which remains unanalyzed otherwise. For example it would be possible to define a global operator "decision" which performs the decision in a multidimensional choice task. Such an operator would be meaningless. However it is not always possible to avoid the introduction of rather coarse-grained operators if one does not have enough knowledge about a necessary (according to the task analysis) subprocess. One example is the operator SYSTEM ANALYSIS in the MBG. In my opinion such operators are acceptable only as a temporary ersatz for more detailed elementary operators.

4. Problem solving and emotional processes

The influence of emotions on the problem solving process and also decision making receives increasing attention in the last years, see for example Toda (1983).

It is very interesting that not only negative emotions (fear, anger) influence cognitive processes, but also positive ones. Isen et al. (1982) review some effects of positive emotions on decision making. Isen & Means (1983) induced positive emotions in one group of subjects. These subjects needed less decision time, used less dimensions and considered less often the same information again. It is not clear whether the subjects with positive emotions are more efficient DMs as Isen & Means conclude, because their paper does not contain systematic and controllable analyses of decision strategies. Dörner (1974) investigated the use of rules of deduction in propositional logic. He observed an

increase in errors caused by negligence when the subjects were convinced they would soon reach the goal state. This result may also be one explanation for the "cheating" behavior in connection with the provisionally selected promising alternative (see section 2.1; Huber, 1982; Montgomery, 1983).

Negative emotions can also be aroused by specific task conditions, for example time pressure. In investigations involving such task variables it seems desirable to separate the effect of the induced negative emotion from the effect of the information processing constraints caused by the specific task condition.

Dörner postulates an emergency reaction of the cognitive system (ERC) when the problem solver has maneuvered him/herself into a dangerous situation and therefore is in a condition of negative emotions. This reaction in the face of impending failure is only one aspect of Dörner's theory of complex problem solving (Dörner et al., 1983). In one of his experiments for example the subjects had to govern a simulated town over a period of several (simulated) years, which is a very complex task as compared with the ones usually used in problem solving research and in multi-stage decision making.

The ERC has two main consequences: One is an externalization of behavior control, the other a general activation.

Externalization of behavior control means a reduction of thinking. It results for example in rather limited goal analyses and decision processes, and in the abandonment of analyzing and integrating new information.

To which concrete type of actions the general activation leads depends on the specific emotional coloring: Anger leads to aggressive attacks on the problem, for example by the attempt to eliminate an obstacle with one radical cure. Fear results in avoidance behavior, for example instead of working on a difficult paper I feel the urgent craving to tidy up my study. Despair causes the problem solver to resign.

Dörner's theory seems to offer a variety of suggestions for research in decision theory. I think everybody dealing with decision making has observed examples of behavior interpretable in terms of ERC. DMs who have lost a lot of money (or lizards, by the way) in a gamble often try to get back their money all at once by betting a ruinous percentage of their remaining capital, - a clear instance of a radical attack. People facing a difficult

decision can be observed to gather still more and more information, thus avoiding the decision.

Systematic research in decision making concerning the ERC and other topics of emotional influence is called for and promises to be fruitful. In the MBG-experiment (breeding of lizards task) mentioned in section 2.2 I have put to test some hypotheses derived from the ERC.

5. Control of the decision process

Even if I interpret the global process of decision making as a problem solving process, I do not want to suggest that any part of the process is interpretable as a problem solving process too. One example for processes not being problem solving processes are automatic judgment processes (see Kahnemann, Slovic & Tversky, 1982; Pitz & Sachs, 1984). Because I am interested in problem solving aspects I restrict the following discussion to those parts of the decision process which are clearly problem solving processes in the sense of section 1.

Thus the general question is: How is a problem solving process controlled?

One theory of control favored by many authors rests on production systems (see Newell & Simon, 1972; Simon, 1979; Toda, 1983). A production system is a hierarchy of productions. A production is a rule that prescribes the execution of an appropriate operator (for example a specific sub-heuristic in a multi-dimensional choice) under specific conditions (for example when there are three or more alternatives). Conditions can be external as well as internal states. In the production system productions are ordered by priority: First the conditions of productions high in the hierarchy are tested, only if these are not satisfied the process goes to lower productions. Operator selection with a production system is on the whole automatic.

The problem with the assumption that production systems are the main instance of control is that it seems to be wrong. I do not deny that parts of the problem solving process may be governed by production systems, especially those where the prob-

lem solver has much experience. On the other hand there is strong empirical evidence from thinking-aloud protocols for planning, evaluating the own thinking process, reflections on goals, etc., see for example Dörner et al. (1983), Huber (1982, 1985). Dörner (1982) denotes such activities as "selfreflections".

Because at least a part of the control of a problem solving process takes place on a metalevel of cognition a theory about control cannot be restricted to production systems.

One line of research which might be fruitful for a control theory in problem solving and decision making is action theory.

I base the following discussion on Hacker (1973, 1980³), Oesterreich (1981) and Volpert (1982). Action theory investigates goal-directed actions, a basic assumption is the hierarchical-sequential organization of planning and control of actions.

I illustrate the principle of hierarchical-sequential organization of actions with an example by Volpert: A person X is in his/her home and plans to get a new shirt. We do not expect this person to plan a sequence of activities like the one in the following sketch : Go to the writing-table, open the drawer, take some money, close the drawer, put the money into the wallet, leave the room, go to the front-door, open the front-door, a.s.o. Person X will rather plan more complex actions like 'drive into the city', 'park in the central garage', and decompose these complex actions when it is necessary.

The basic unit for the theoretical analysis is the cyclic unit (Volpert, 1982), see Figure 1. A cyclic unit consists of a goal G and transformations (operators) $T_1, \dots, T_n$, which are actions to transform states. The model assumes a temporal organization: First the goal is defined, then one transformation after the other is executed, this is represented by the descending arrow and the horizontal ones in Figure 1. The ascending arrow (from T_n to G) symbolizes a feedback process, which evaluates whether the goal has been reached.

Components of one cyclic unit can be parts of cyclic units higher or lower in the hierarchy. The completion of a transformation T_i (for example 'drive into the city') may be the goal in a subordinate cyclic unit. The attainment of goal G (get a new shirt) may constitute one transformation in a superior cyclic unit (for example 'prepare your clothes for the journey').

Thus a complex hierachical and sequential organization of

actions emerges, a schematic example is depicted in Figure 2. Figure 2 entails also one example of a possible flow of control (and therefore of attention) in this hierarchy (arrows with broad lines) when the sequence of observable actions (bottom row of squares) is executed. It is important to note that in some cases control is not necessary when a cyclic unit is performed, for example when the problem solver is able to execute the cyclic unit automatically. Production systems can very well be incorporated in a hierarchical-sequential organization. Thus this organization of actions unburdens the problem solver and helps to save his/her information processing capacity. A further advantage is the possibility to deal with planning errors and unexpected obstacles: If in an action program a lower level cannot be performed as intended, it is not necessary in any case to change all superior levels too.

At present there is no general agreement how many levels of control there are altogether. Whereas Hacker (1973, 1980³) postulates three levels, Oesterreich (1981) assumes five. An advantage of Oesterreich's model is that his criteria for the distinction of levels are derived from the properties of the model.

One problem is that in action theory the actions on the lowest level are motoric activities. This makes good sense in the usual applications of action theory, and is connected with its roots in the psychology of working.

On the other hand in problem solving and decision making often not very much problem-relevant motoric actions are performed until the process is finished. An important decision may very well be made without any (problem-relevant) motor activities at all. In theories of decision making and problem solving cognitive operators constitute the actions on the lowest level. This change at the lowest level may necessitate the definition of other qualitative levels than the ones in general action theory.

In this section I was able to sketch some aspects of action-theory only. I think that an action-theoretical model is a more promising general base for modelling planning and control of the decision process than for example production systems alone. However, the situation here is similar to the one I mentioned in the introduction: We cannot expect to get ready-made solutions for decision making and for problem solving too.

Figure 1 : Scheme of a cyclic unit and two examples.

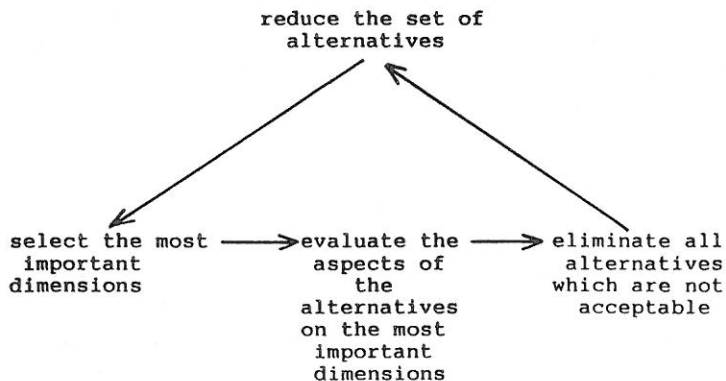
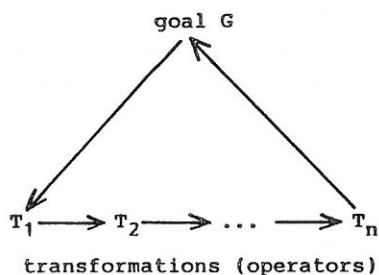
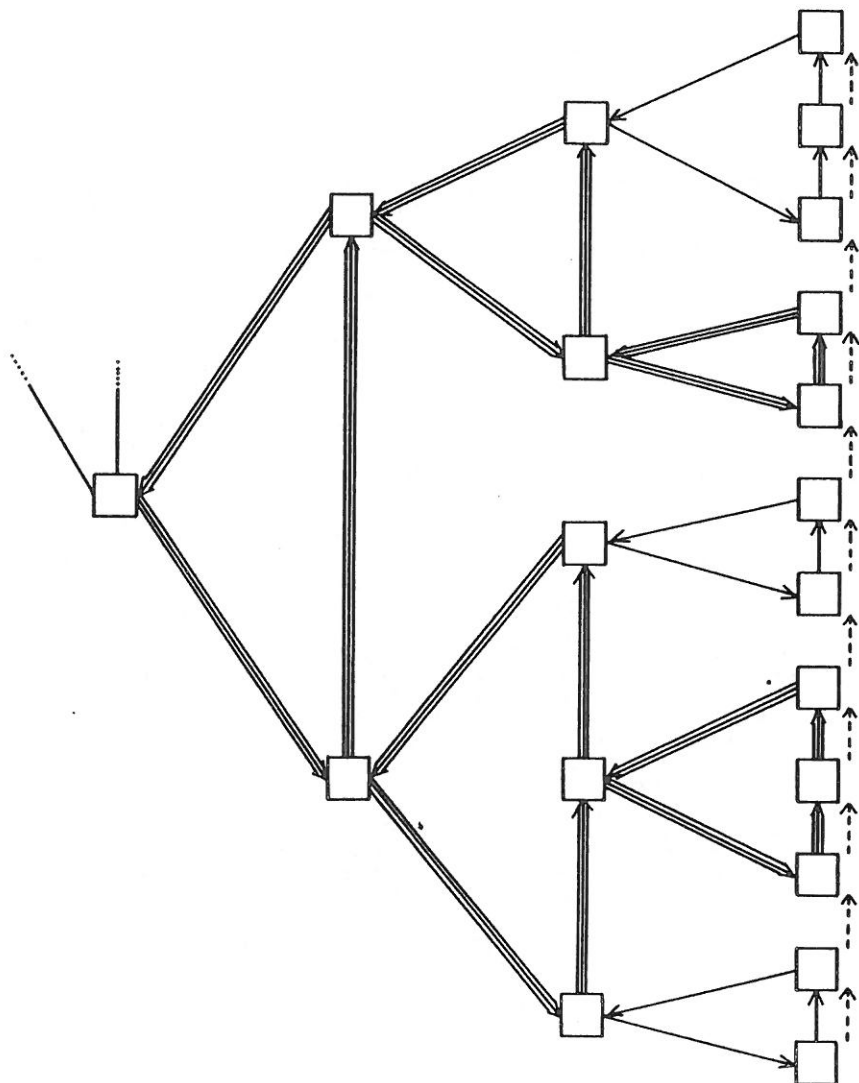


Figure 2 : Schematic representation of a hierarchic-sequential organization of actions. The squares and the solid arrows (broad and thin) depict cyclic units. The bottom row of squares connected by broken arrows represent the observable sequence of actions (level I). The arrows with the broad black lines picture a possible flow of control (and attention).



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Julius Kuhl:

Motivation and Decision Making:
 An Information-Processing Approach

Theories of human motivation are constructed to explain goal-directed behavior. They focus on the psychological mechanisms underlying (a) choice among action alternatives, (b) vigor in performing the selected alternative, and (c) persistence until the goal is reached. One of the most fundamental characteristics of motivational processes concerns the perseverance of motivational states over extended periods of time. While cognitive and emotional states are rather short-lived (Anderson, 1983; Izard, 1977), motivational states seem to have an intrinsic ability to persevere until the respective goal is reached (Lewin, 1935; Atkinson, 1964). Motivation research has investigated the dynamics of various persevering motivational states which affect goal-directed behavior: Successive arousals of a given motivational state can cause a cumulative increase in the related action tendency, arousal of one tendency can cause an indirect arousal of other (functionally related) tendencies (displacement), and performance of one tendency can reduce other (functionally related) action tendencies (substitution).

These dynamic processes may have behavioral effects that cannot be predicted on the basis of the action-related information available in the situation at hand. An individual may choose an action which has a lower expected utility than an alternative action tendency, simply because the motivational tendency supporting the former has received several instigations on previous occasions or because the latter has been reduced by a functionally related action. Nonetheless, cognitive processes underlying the appraisal of expected utilities affect goal-directed behavior, especially during the decision-making phase (Feather, 1982). Consequently, theories of motivation have incorporated and elaborated expectancy-value models of the decision process. For the past three decades this cognitive approach has dominated motivation research (see Kuhl, 1982, for a summary). In recent years, the limitations of cognitive models of motivation have become apparent. Three aspects of earlier theories of motivation are emphasized in recent research: (a) The dynamic properties of motivational processes have been analyzed with more powerful methods than earlier ones (Atkinson & Birch, 1978, Kuhl & Atkinson, 1985). (b) Lewin's (1935) admonition to take account of the motivational significance of the way action-related information is represented and processed in memory is being taken more seriously again in recent work (Hamilton, 1983; Kuhl, 1983). (c) Self-regulatory mechanisms supporting the maintenance and enactment of behavioral intentions have been incorporated into motivation theory (Kuhl, 1984).

In this chapter, I will summarize these three recent developments. I will discuss all three issues from an information-processing perspective. In doing so, I am adopting a somewhat broader definition of this term than the usual one. Cognitive psychologists use the term information-processing in an under-inclusive way, while they tend to use the term cognitive in an over-inclusive way. Frequently, the term cognitive is used as broadly as to comprise any mental process, including emotional and motivational processes. For example, emotions are considered "nodes" in a propositional network (Bower, 1981), one of "12 issues" for a cognitive science (Norman, 1980), or simply indistinguishable from cognitive processes (Mandler, 1983). I will use the terms cognitive to refer to processes mediating the acquisition and representation of knowledge, emotion to denote phylogenetically acquired evaluative responses (Plutchik, 1980), and motivation to refer to the dynamic properties of aroused action tendencies (Atkinson & Birch, 1978). This restricted use of terms may be useful in discovering potential differences among cognitive, emotional, and motivational processes. Not each and every experimental result regarding cognitive information processing is generalizable to the way information is processed within the emotional and motivational subsystems. Emotional processes, for instance, seem to be characterized by a holistic rather than the analytic-sequential (cognitive) mode of processing (Leventhal, 1980). Motivational processes differ from cognitive ones in their dynamic properties, e.g.,

perseverance, displacement, and substitution. With these conceptual distinctions in mind let us proceed to the first issue mentioned above.

Dynamic properties of motivational processes

Many cognitive theories of motivation and decision making are episodic; they analyze cognitive determinants of motivation within isolated temporal episodes. What aspects of a model are modified when the transition from an episodic to a dynamic model is made?

From episodic to dynamic models. First, a dynamic model focuses on changes in motivational tendencies over time. The mathematical description of a dynamic model requires differential equations rather than static algebraic equations. The dynamic theory of action (Atkinson & Birch, 1970) contains parameters which control the rate of increase and decrease of motivational tendencies over time.

The second change occurring as a result of the replacement of the episodic by the dynamic model concerns the degree of complexity of the motivational state considered. Many investigators have found it convenient to focus on the one particular category of behavior they happen to be interested in, for instance, achievement-related decisions or managerial decisions. This focus on just one behavioral category

suggests that individuals have only one motivational tendency at a time. Within the isolated temporal episode created in a laboratory experiment, one can arouse the action tendency of interest to such a degree that other incompatible tendencies become negligibly weak. However, when one broadens one's perspective and analyzes complex behavior in real life settings, one has to take account of the waxing and waning of the many simultaneously aroused action tendencies. An action tendency that is weak at a given point in time may become strong and expressed in behavior after a while. A dynamic model cannot confine itself to just one motivational tendency that happens to be dominant at a given point in time.

The third property distinguishing a dynamic from an episodic model may be called reflexivity. A dynamic model is reflexive when its output at a given time t_n affects one or more of its input parameters at a subsequent point in time (t_{n+1}). The dynamic theory of action has this property. Although it is hard to conceive of a living organism without postulating some form of reflexivity, reflexive models are extremely rare in psychology. The main reason for this is that the mathematical derivation of a model's implications become very difficult if it contains a reflexive relationship. However, this problem no longer prevents our formulating a reflexive model because today one can obtain the derivations by means of computer simulation.

Computer simulation: Overcoming theoretical misconceptions.

Although the Dynamics of Action (Atkinson & Birch, 1970; 1978) is based on only a few simple assumptions, it would become tedious, if not impossible, to derive predictions for complex situations from the differential equations describing the theory, especially because of the model's reflexive nature. The computer program that has been developed to allow simulation of the motivational and behavioral consequences of complex antecedent conditions enables investigators to derive testable predictions from the theory for a variety of experimental situations.

Even more important than this predictive use of computer simulation, may be the explicative use of computer simulation. Let me explain the explicative use of simulation with an example from physics. In addition to their formal theories, scientists often have a number of isolated beliefs which have a strong impact on the way they conduct their research. Physicists, for example, believed until recently that the erratic behavior of turbulences could be predicted - to the extent that it is predictable - only by very complex equations. Recent computer simulations have shown, however, that even a very simple (non-monotonic) equation can predict seemingly chaotic turbulences if reflexive changes in the relevant parameters are taken into account (Hofstadter, 1981). Without the use of computer simulations, one would not have known that even a simple model can predict extremely complex turbulences because mathematical derivations become

virtually impossible, even using simple equations, when one has to take account of reflexive changes in parameters. Although most psychologists would probably agree that mental processes are subject to similar reflexive changes, little use has been made of the computer to explore the implications of the various psychological models when temporal changes of parameters are taken into account. If psychologists continue to devote most of their effort to empirical research without taking time to examine the logical soundness of its premises, the empirical research may be misled by mistaken beliefs.

Basic Principles of the Dynamics of Action

Starting from the observable aspects of the stream of behavior, Atkinson and Birch's dynamic theory (1970) assumes that motivational tendencies underlie the corresponding activities which are initiated and terminated in behavior. The principle of behavior states that the dominant or strongest tendency is always expressed in behavior. Activities that are compatible with the activity that is sustained by the dominant tendency may also be expressed in behavior. Each motivating tendency ($\bar{T}$) is the resultant of an action tendency (T), representing positive motivation to do it, and a negaction tendency (N), representing a tendency not to do it. The resultant tendency is equal to the difference between the action and the negaction tendencies ($\bar{T} = T - N$). A basic assumption is that of inertial tendencies. A tendency,

once aroused, is assumed to persist until modified by some psychological force. Environmental influences that cause an increase in the strength of an action tendency are represented by the concept of instigating force (F). Similarly, environmental influences causing an increase in the strength of a negaction tendency are represented as inhibitory forces (I). Instigating and inhibitory forces cause a linear increase of action and negaction tendencies, respectively, as a function of duration of exposure (t) to the external or internal information producing them. The strength of a tendency being expressed in behavior is assumed to be reduced by the operation of a consummatory force (C), which is a multiplicative function of the momentary strength of the resultant tendency (T) motivating the activity and the consummatory value (c) of that particular activity ($C=cxT$). The change in strength of a tendency (dT) within a given period of time (dt) is equal to the difference between the instigating forces and the consummatory forces: $dT/dt=F-C$.

The average magnitude of instigating forces for subordinate tendencies is reduced by a parameter describing selective attention. This parameter is meant to account for less than continuous exposure to stimuli other than those involved in performing the ongoing activity that is motivated by the dominant tendency at that time.

The theory allows for displacement between tendencies (Atkinson & Birch, 1970, chap. 2). The parameter δ_{ij} describes the proportion of instigating force F_i that is added (displaced) to instigating force F_j depending on the degree

of functional equivalence of activities i and j . Each pair of activities can also be related by a parameter describing substitution (δ_{ij}). This parameter defines the proportion of consummatory force C_i that is added to C_j and represents the extent to which activity i substitutes for activity j . Hence, a tendency that is not expressed in behavior can be reduced by consummation involving another activity if the latter has some degree of substitute value for the former. Displacement and substitution may also operate between determinants of the strength of negation tendencies (I and R) where the parameter R describes the force of resistance analogous to consummatory force (C) but which reduces resistance to an activity.

Some Implications of the Dynamic Theory

Let me illustrate some implications of the dynamic theory by discussing a specific example. Consider the case of an executive who has to decide which of three new products (X, Y , and Z) should be developed to the extent that it meets the standards necessary to put it on the market. After a complex decision-making procedure involving many positive and negative attributes of each alternative he concludes that product B is the one having the highest expected utility. From a cognitive-episodic point of view the case seems to be closed: The decision has been made. The executive will support product Y . From a dynamic point of view, his behavior

may still vary across situations, even if his decision, and his evaluation of the expected utilities involved remains unchanged. How could this paradoxical situation arise? According to the dynamic theory, the motivational tendency to support products X or Z does not disappear after the decision has been made. This is illustrated in Figure 1.

Insert Figure 1 about here

The decision in favor of product Y occurs at time t_1 when the motivational tendency to support product Y is the strongest one. The fact that the evaluation of expected utilities associated with each alternative remains constant is reflected in constant "instigating forces" (which determine the slopes of the curves while they are "dormant", i.e., not dominant: $F_Y > F_Z > F_X$). Note one difference between traditional cognitive-episodic models and the dynamic theory: The outcome of a cognitive process determines the rate of increase of an action tendency rather than its absolute strength. As a result, even weakly instigated tendencies can become dominant: Successive arousals of a weakly instigated alternative may cumulate until it finally becomes dominant finally become dominant (cf. point t_3 in Figure 1).

A second mechanism promoting behavioral change despite the constant evaluation of alternatives is related to consummation. After tendency Y has been expressed in behavior for a while, it is reduced in strength as a result of

consummation (cf. point t_2 Figure 1). Our executive's motivation to support product Y might decrease a little bit after he has invested a considerable amount of energy in defending his decision at a meeting. Meanwhile he might have thought or talked about several positive aspects of alternatives X and Z, which resulted in an increase of the motivational tendencies supporting these alternatives. The vacillating behavior may appear irrational and dysfunctional in this case. However, the behavioral variability of the motivational system has its adaptive functions as well. It helps the organism divide its temporal and behavioral resources among the many conflicting goals that have to be attained to satisfy its needs.

Empirical evidence. Several experiments have confirmed various implications of the dynamic theory. In one experiment subjects were allowed to perform any of three activities for as long as they wished and switch forth and back among the activities during the experiment (Kuhl & Geiger, 1985). During the main phase of the experiment rated attractiveness of the three activities did not change. Nonetheless, subjects did not spend virtually all the time performing the most attractive activity as would be expected by a cognitive-episodic model. Instead, the proportion of time spent in each activity was proportional to its rated attractiveness as predicted by the dynamic model. Another experiment revealed direct evidence for the dynamic theory's implication regarding the performance of weakly instigated tendencies.

Although the cognitive evaluations involved in the decision (choice of difficulty level in an achievement task) had stabilized after an extensive practice period, subjects occasionally made choices that were inconsistent with the "preferred" (i.e., the most strongly instigated) alternative (Kuhl & Blankenship, 1979a; 1979b).

People not only occasionally switch to non-preferred activities; they sometimes fail to switch from a non-preferred to a preferred activity when the opportunity arises. In one experiment, subjects had to perform a rather boring sorting task for about 15 minutes (Kuhl & Eisenbeiser, 1985). Subsequently, they were given a choice between continuing on the sorting task or switching to an alternative activity (reading comics) that had been rated as much more attractive than the sorting task. Two thirds of the subjects continued the sorting activity. In a postexperimental interview most of these subjects considered their behavior inconsistent with their "true" preferences. The results are consistent with the dynamic theory if the assumption is made that, in subjects who failed to switch to reading, the motivational tendency supporting the reading activity could not increase rapidly enough within the decision period to outgrow the tendency supporting the sorting activity.

Action Control: Maintenance of Behavioral Intentions

The dynamic properties of the motivational system are not compatible with the idealized model of man as a "rational" decision maker. If people show variable behavior even if their latent hierarchy of preferences does not change; how can they ever enact any decision, let alone when evaluations underlying their decisions do change over time? The enactment of behavioral intentions requires their maintenance over an extended period of time. A decision can be enacted only if it is "frozen" and defended against competing motivational tendencies that may grow in strength as a result of cumulative instigations. I have argued recently that a comprehensive theory of human action has to take account of action-control mechanisms which support the maintenance of behavioral decisions (Kuhl, 1983; 1984; 1985). Let me briefly summarize the theoretical and empirical work conducted in our laboratory during the past 5 years.

An information-processing model of action control

The efficiency of action control may be considered a function of two factors. First, it depends on the self-regulatory abilities of the individual. Secondly, it depends on the difficulty of enactment, i.e., the amount of self-regulatory ability needed to enact the current intention.

Difficulty of enactment. Most models of self-regulation have little to say about the demands placed on the self-regulatory system in various situations. According to my model (cf. Kuhl, 1984), the difficulty of enactment is a function of three factors, (1) the number and strength of other self-generated action tendencies competing with the current intention, (2) the compatibility of socially demanded actions with the current intention, and (3) the mode of control that is currently activated. My own recent research efforts have focused on this third factor.

Two modes of control: Action and state orientations

I propose a distinction between metastatic and catastatic modes of control (Kuhl, 1984). Individuals do not always perform actions that they wish or intend to perform. According to the model, the catastatic mode renders the enactment of an intention very difficult whereas enactment is facilitated in the metastatic mode. When a computer is operating in the edit mode, instructions are not executed even if they are activated. Similarly, action-related memory structures can be activated in an individual on a fantasy-related level without being executed. In our research we have focused on one determinant of metastatic and catastatic modes of control. We call these action and state orientation, respectively. An organism is said to be action-oriented if attention is focused on a fully developed action structure.

If attention is focused on some internal or external state, the organism is said to be state-oriented. This state may be characterized by perseverating cognitions related to some present, past, or future state or even by the absence of any coherent conscious thought (e.g., an unconscious conflict or aim).

Antecedents of action and state orientations. I assume that the degree of action orientation aroused in a given situation depends on two factors, i.e. (1) the degree of perceived incongruence between any two pieces of information processed and (2) the extent to which an individual has developed degenerated intentions, i.e., cognitive representations of intentional states in which one or more elements are ill-defined, weakly activated, or not specified at all (Kuhl, 1984). Mild degrees of incongruence between an individual's expectations and new information, between various conflicting expectations or between conscious and unconscious representations may stimulate an action-oriented attentional focus and a strong involvement in the current activity (Berlyne, 1960; Cikszenmihalyi, 1975; Eckblad, 1981; Kuhl & Wassiljew, 1982). If incongruence exceeds a critical level, a state-oriented response is expected, i.e., attention focuses on the incongruence-producing information and the experienced cognitive-emotional state resulting from it.

The second assumed determinant of action and state orientations refers to the executability of the intentional

structure aroused. A cognitive structure representing an intention is said to be degenerated if one or more of its elements is not specified well enough for it to be executed. I have proposed a propositional-network representation of an intention specifying (1) the self as the agent of the intended action, (2) the quality of personal commitment to its enactment distinguishing an intention from "wishes" and other action-related knowledge structures, (3) the context in which the intended action is to be performed, and (4) the intended action itself (Kuhl, 1984). Depending on which part of a structure representing an intention is degenerated different types of state orientation may occur, i.e., failure-related state orientation, vacillating state orientation, and goal-centered state orientation (see Kuhl, 1985, for a fuller discussion). The central assumption of this model is that excessive attentional focus on incongruent material or on degenerated intentions claims part of the working-memory capacity needed for the control of the maintenance and enactment of any intention activated. As a result, the difficulty of enactment should increase substantially when an individual becomes state-oriented.

Empirical evidence. Many empirical studies have been conducted to test various aspects of this model (see Kuhl, 1983; 1984; 1985, for detailed summaries). According to the model, state-orientation should be associated with reduced efficiency of enactment of intentions that place heavy demands on self-regulatory functions. In the study by Kuhl &

Geiger (1984) three motives (achievement, curiosity, and altruism) were assessed prior to the experiment. Action-oriented children (identified by a questionnaire) showed a significantly smaller latency to initiate motive-congruent behavior in a free-play situation than state-oriented children did. In another study (Kuhl, 1982) it was found that correlations between children's intentions to perform several after-school activities and their actual behavior were considerably higher for children scoring high on a scale that was designed to assess a personal disposition toward action-orientation than for children classified as state-oriented.

Functional helplessness. While trying to enact their decisions, people may encounter obstacles. An individual's ability to enact her/his decision can be impaired as a result of her/his inability to cope with a series of failures to overcome those obstacles. This action-control deficit may be partly attributable to a motivational deficit ("giving up") and in part to a functional deficit. Our experimental results showed that action-control deficits following induced failure are, at least in part, attributable to a functional rather than to a motivational deficit alone (as assumed in the theory of learned helplessness: Abramson, Seligman & Teasdale, 1978). First, the performance deficits following a series of induced failures were observed only in subjects classified as state-oriented. Interestingly, this group showed no indication of an expectancy or motivational deficit. Secondly, performance deficits were found in the

entire sample of subjects in an experimental condition designed to induce state orientation (subjects were asked to write an essay about their "feelings"). Third, an experimental treatment that was to prevent state orientation (asking subjects to state their hypotheses explicitly), immunized state-oriented subjects against the detrimental effects of helplessness pretreatment. Finally, state-oriented subjects who suffered from generalized performance deficits following helplessness pretreatment reported to have been "obsessed" by task-irrelevant state-related thoughts while working on the test task despite trying hard to concentrate on the task. These results demonstrate that the ability to concentrate on the enactment of one's task-oriented decision can be severely impaired if one responds to past failures in a state-oriented way.

Self-regulating abilities. The theory of state orientation is based on the assumption that state orientation is associated with a high degree of difficulty of enactment. Theoretically, state-oriented subjects might have as high self-regulatory abilities as action-oriented subjects have, but attain a lower self-regulatory efficiency than action-oriented subjects because difficulty of enactment is considerably greater for state-oriented subjects. Our empirical results revealed, however, that in addition to the factors increasing the difficulty of enactment (e.g., reducing working memory capacity when degenerated intentions are aroused), self-regulatory skills are underdeveloped in state-oriented

compared to action-oriented subjects.

The experimental data available suggest that, compared to action-oriented subjects, state-oriented subjects are: (1) less effective in actively controlling selective attention in favor of information supporting a decision (see Kuhl, 1984, 155f.); (2) less parsimonious in the amount of information processed before taking a decision thereby increasing the risk that a competing tendency takes over before the current intention is enacted (Kuhl & Beckmann, 1983), (3) less effective in enhancing the motivational basis of their current intention when necessary (motivation control), e.g., increasing the perceived attractiveness of an object tentatively chosen (Beckmann & Kuhl, 1984); (4) less inclined and/or less able to apply a parallel, "intuitive-holistic" mode of information processing that seems to facilitate complex problem solving (Kuhl & Wassiljew, 1984), and (5) more susceptible to the motivation-reducing effects of being rewarded for performing an intrinsically interesting activity (Kuhl & Melendez, 1984).

The empirical findings available suggest the following conclusions regarding the mechanisms which affect the degree to which an individual actually enacts her/his intentions.

(1) Active attentional selectivity facilitates the processing of information supporting the current intention and inhibits the processing of information supporting competing

tendencies. Mischel & Mischel (1983) report a series of experimental findings which show that children learn to maintain an experimentally induced intention against a seducing action alternative by avoiding visual contact with the source of distraction. Active selective attention to goal-related information can also mediate the following, more subtle, self-regulatory process.

(2) Encoding control presumably facilitates the protective function of volition by selectively encoding those features of a stimulus that are related to the current intention. It is interesting to note that this assumption is in line with recent experimental evidence of a biasing of pattern-matching resources in favor of memory structures involving the current goal (Anderson, 1983; La Berge, 1973; Posner & Snyder, 1975). There is a growing body of research demonstrating that perceptual tuning, i.e., the preconscious selection of input on the basis of higher-order conceptual structures (e.g., the current intention) occurs at very early stages of perceptual processing (Carr & Bacharach, 1976).

(3) Emotion control presumably facilitates the protective function of volition by inhibiting emotional states that might undermine the efficiency of the protective function of volition. It has been suggested and found that certain emotional states (e.g., sadness; depression) render the protection and maintenance of an intention to avoid a seducing action alternative difficult (Izard, 1977; Mischel,

Ebbesen & Zeiss, 1972). We are currently investigating in our laboratory when, and dependent on what developmental precursors, children learn to control their emotions in order to facilitate the enactment of current intentions against powerful alternative tendencies.

(4) Motivation control refers to a feedback relation from self-regulatory processes to their own motivational basis (Kuhl, 1984). This process is especially important when the current intention is supported by a weak action tendency. When a mismatch between the strength of the current intention and that of competing tendencies is detected (indicating that the current intention is insufficiently strong) a self-regulatory process is activated that increases the strength of the current intention by selectively processing information that supports it. If I form the intention of mowing my lawn while feeling afraid that my motivation is too low to pull myself together and actually do it, a motivation-control strategy is to think about what will happen should I fail to perform the intended action, i.e., my neighbors will be irritated, the grass will rapidly grow to a height that will make it much more difficult to cut later, etc.

(5) Environment control describes a strategy that may develop from the more basic strategies dealing with emotion control or motivation control. Emotional and motivational states may be controlled by manipulating the environment. Making social commitments is an example. People who intend to stop smoking

may inform a relevant other person about their intention because they know having informed another person will create some social pressure that may help maintain the intention. Clinically oriented theories of self-control (e.g., Thoresen & Mahoney, 1974) place particular emphasis on the process of environment control, probably because deficits in this process are more easily removed than deficits in the other, less easily observable, processes.

(6) Parsimony of information-processing is an aspect of volitional control that relates to the definition of stop rules for information-processing. Theoretically, an actor could go on forever processing new information about various consequences of potential action alternatives without ever performing any of them. Efficient action control requires optimizing the length of the decision-making process. Whenever the actor believes that further processing of information bearing on potential action alternatives may jeopardize the execution of the current intention, the process of appraising action alternatives should be brought to a halt, especially if further processing may reveal information that undermines the motivational power of the current intention.

Cognitive mechanisms affecting motivation

In light of the functional differences between motivational and cognitive processes one might overlook the interaction between these two types of processes. Five questions that we are focusing upon in our research may illustrate the type of cognitive mechanisms that may affect motivation: (1) How do the specific (propositional) memory structures representing beliefs, values, norms, and intentions affect motivation? (2) What is the functional significance of the phenomenal status (conscious vs. nonconscious) of action-related knowledge? (3) What role do active and passive attentional processes play in self-regulation (i.e., in maintaining the current intention and "protecting" it against competing tendencies)? (4) How does the representational format of action-related knowledge structures (e.g., pictorial, propositional, sequential) affect motivational processes? (5) How do different modes of information processing (e.g., intuitive-holistic vs. sequential-analytic) affect motivational processes?

In the remainder of this chapter I will discuss the first question (see Kuhl, in press, for a detailed discussion of this and the remaining four questions).

Memory representation of action related knowledge

When we tested the validity of Expectancy X Value Models in achievement-related settings on an individual basis, we found considerable individual differences regarding the type of information used in decisions and the way various pieces of information were combined. Some subjects based their decision (regarding the amount of effort invested in a task) entirely on value-related information, others focused exclusively on expectancy-related information. Some subjects combined expectancy and value by a conjunctive rule, others used a disjunctive decision rule (Kuhl, 1977; 1982). These findings and several theoretical and methodological problems prompted us to focus on individual memory representations affecting decisions among goals and action alternatives. Since we focused on propositional representations of action-related knowledge, the question regarding the particular characteristics of this type of knowledge arose. Propositional structures encode information about facts (F) and about the context (C) these facts are related to. As illustrated in Figure 2, the fact component is subdivided into a subject node (S) and a predicate node (P). The predicate is further subdivided into a relational node (R) and an object node (O). The context node may be subdivided into a temporal (T) and a locational (L) component. I have proposed (Kuhl, 1983a, p.107) that structures encoding motivationally significant knowledge differ from other propositional knowledge structures in four ways: First, in action-related

propositions the subject node refers to some aspect of the self as the agent of an action. Second, the context node describes the temporal and spatial conditions under which the intended action is to be performed. Third, the object node refers to an action plan or production system (Anderson, 1983). Finally, the relational component of action-related knowledge structures specifies the type of the motivational state it encodes. In accordance with earlier cognitive models of motivation (e.g., Ajzen & Fishbein, 1973), four types of motivational states are of particular interest, i.e., expectations, wishes (or "attitudes" toward an act), obligations, and intentions. Traditional expectancy-value models do not make any assumption as to how these motivational states are encoded in memory. I have assumed that the type of state, an action-related structure relates to is encoded by the relational component. Specifically, the verbs can, wish, must, and will presumably encode expectations, wishes, social norms, and intentions, respectively.

Insert Figure 2 about here

The latter state is of particular interest because in many expectancy-value models, intentions do not have a status separate from other motivational states. As a result, the functional significance of the personal commitment to an action which presumably distinguishes an intention from other

motivational states has been neglected in theories of motivation since Kurt Lewin's (1926) seminal paper in which he denied intentional states any special status (see Kuhl, 1984, for a fuller discussion of Lewin's paper). I have already discussed the assumption that the intentional format is particularly important because it controls access to an individual's repertoire of self-regulatory strategies.

The propositional model coincides with traditional decision models whenever the memory structure involved in a decision matches the decision rule described by a particular expectancy-value model. However, the propositional model has some advantages compared to a traditional model. First, the propositional model places more emphasis than traditional models upon the variability of decision-rules (both across and within individuals). Second, the propositional model facilitates cross-fertilization with information-processing approaches. Many issues that are currently debated in memory research have interesting motivational implications when applied to motivational phenomena. The five questions mentioned at the beginning of this section help generate numerous new hypotheses for future research.

Because of space limitation I will confine myself to one example which illustrates the heuristic utility of the information-processing approach applied to cognition-motivation interactions. In one study we investigated the motivational effects of the way subjects encoded an instruction. Specifically, we wanted to study the effects of

letting a behavioral intention degenerate, i.e., lose one of the components in the memory structure encoding it (Kuhl & Helle, 1984).

Hospitalized depressive patients and several control groups (hospitalized schizophrenics, drug addicts, and university students) were asked to clear up a desk on which many papers, computer card, pencils, etc. were scattered around. An attempt was made to induce a degenerated form of the intention to clear up the table by preventing the subjects from specifying the point in time when they were supposed to start clearing it up. The experimenter said they were not allowed to do it immediately because some tests had to be taken, but it would be up to them to decide when they would be able to do it. This manipulation was chosen to let the context component of the clear-up intention degenerate: Subjects were to be induced an intention to clear up the table without telling them when to do it. The experiment included control groups in which subjects saw the desk without being instructed to clear it up. It was expected that non-depressive subjects would modify the format of the cognitive representation of the instruction from an intentional format to a less self-committing format (e.g., a "wish") once they found out that execution had to be suspended. Depressive subjects were expected to maintain the intentional format of the instruction. According to our theory (Kuhl, 1985) this inflexibility should reduce working memory capacity needed for the enactment of other intentions.

This assumption was tested directly by administering several tests of working memory capacity after the experimental manipulation. As can be seen from Table 1, depressives did not differ from non-depressive subjects in short-term memory capacity in the control conditions while depressives suffered from a significant loss of memory capacity in the experimental condition that was to induce a degenerated intention. Interestingly enough, these results were

Insert Table 1 about here

replicated when subjects were subdivided according to the score on the scale assessing state and action orientations. While state-oriented subjects showed a significant decrement in working memory capacity in the condition in which an attempt was made to induce a degenerated intention, action-oriented subjects had identical memory capacity under experimental and control conditions.

Other experiments showed that this reduction of processing capacity can also be found in non-depressed individuals, especially when they have one or several perseverating degenerated intentions (see Kuhl, 1985). It can be concluded that we cannot derive any predictions as to whether a behavioral decision will be carried out unless we can specify the motivational state of the individual. Specifically, we need to have information regarding the way the current intention is represented in memory and regarding the

presence of other perseverating intentions (degenerated or not) which may impose considerable limits on the individual's capacity to enact the intention of interest.

Conclusion

In this chapter, I have discussed three information-processing mechanisms presumably affecting decision making and goal-directed behavior. First, motivational tendencies are subject to dynamic influences that may be confined to the motivational system, i.e., perseverance, cumulative arousal consummation in action, displacement, and substitution. Second, the maintenance and enactment of intentional states seems to be mediated by several mechanisms and strategies individuals use to shield their current intentions against competing action tendencies. Third, structural aspects of the memory representations of action-related knowledge affect decision making and goal-directed behavior. When some component of an action-related knowledge structure is ill-defined or degenerated, decision making and enactment of intentions can be severely impaired. We hope that a more comprehensive account of the processes mediating goal-directed behavior will generate new questions for future research and promote a fuller understanding of how decisions develop and how they are enacted.

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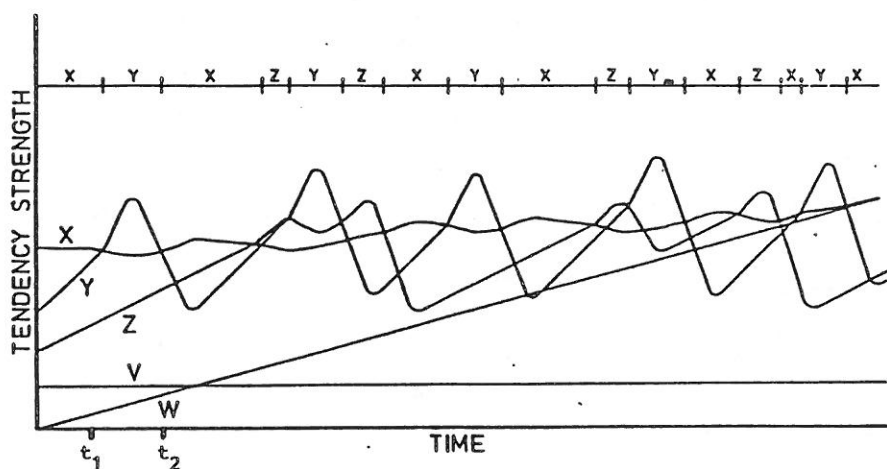


Figure 1: An example of a stream of activity (X,Y,Z) and the changing motivational state that accounts for it even when the personality and immediate environment are constant.

Table 1: Mean short-term memory span (as defined by Woodworth & Schlosberg, 1954) and reported frequency of thinking about the "messed-up table" as a function of the degree of depression (BDI-score) and experimental conditions.

Depression (BDI-Score)	low		high	
Experimental condition (clear-up-table instruction):	with	without	with	without
Memory span	4,84	4,83	4,42	4,83
Frequency of thoughts about messed-up table	2,3	2,2	3,0	1,3
n	13	14	14	13

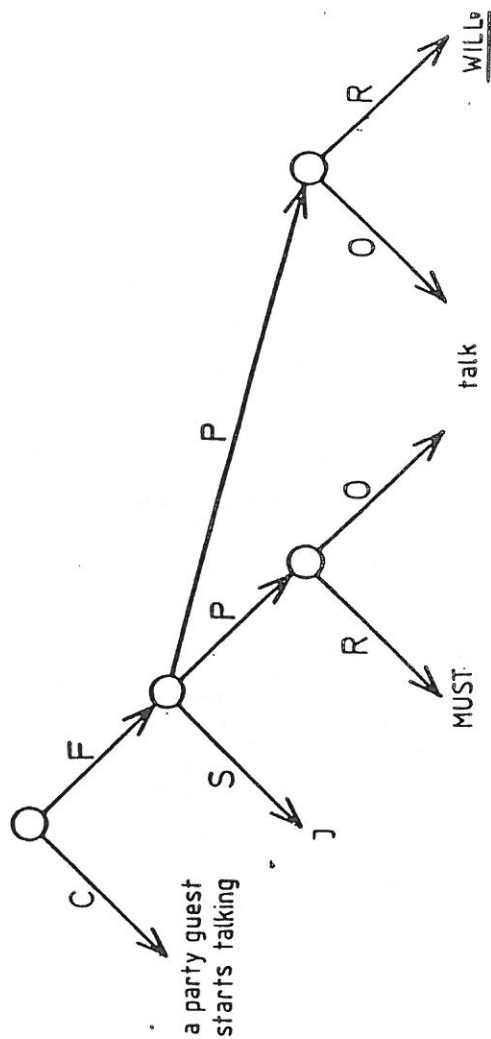


Figure 2 : Propositional representation of an intentional state

Patrick Humphreys, London School of Economics and Political Science, on:

INTELLIGENCE IN DECISION SUPPORT

Much has been claimed for expert systems based upon artificial intelligence techniques which aim to support decision making by capturing the knowledge of the decision maker in either declarative form (e.g., semantic networks, frames and logic), or procedural form (e.g., rule-space system). Yet their success in application has been limited to handling low-level, well-structured problems, in which the decision maker has little, if any, discretion in formulating a policy for action. Various AI-based systems which have encountered this application difficulty are reviewed and their limitations traced to (i) an over-restrictive definition of "knowledge" in terms of facts and rules, (ii) an inadequate conceptualisation of the way decision making is structured at different levels in both personal and organizational decision making, (iii) the belief that a person may be aided (rather than replaced) merely through capturing relevant knowledge, formalizing it in a "Decision Support System" (DSS), and then applying this knowledge in a similar way to how the unaided decision maker would.

All the above reflect failures of DSS design methodology, rather than of the resulting systems per se. The appropriate use of knowledge representation techniques is only one side of intelligence in decision support. The other side involves techniques for representing the DSS design problem and structuring the activities of the various participants involved at each stage in its life cycle. Key frameworks here analyse (i) levels of knowledge representation in handling decision problems, and (ii) the goals (roles and motivations) of participants in the process, the problem structuring languages they employ, and the types of expertise they possess.

The paper discusses how these frameworks may be used in practical applications, intersecting a "top down" (from high level to low level) requirements analysis with the traditional "bottom up" system development methodology to produce DSS which have the capability actually to aid high level decision making activities rather than just to frustrate or subvert them. Major issues here include:

- (i) The necessity of exploring and representing knowledge at five rather than two (declarative vs procedural) qualitatively different levels during DSS design, development and applications.
- (ii) Shaping the design and development process jointly from the top, through constraints predicated on goals and problem structuring language, and from the bottom, through constraints predicated on characteristics of available formalized methods, "knowledge representation shells" or generic software modules.
- (iii) Anti DSS-imperialism: Sharing the control of the problem structuring process, and its knowledge base between the decision maker and DSS.
- (iv) The importance of procedures for exchanging problem structuring knowledge between participants during DSS development.
- (v) Psychological validation throughout the system development life cycle, not just of the application.

SPECIAL LECTURE

The main concern of this lecture is with general aspects of the theory of human decision making.

James G. March, Stanford University, on:

ALTERNATIVE VISIONS OF HOW DECISIONS HAPPEN

Theories of individual and organizational choice normally begin with a simple structure that makes decisions a consequence of two guesses. The first guess is a guess about the uncertain future consequences of possible current actions. The second is a guess about the uncertain future preferences with respect to those consequences when they are realized. Choice is a matter of pursuing an alternative with expected consequences that we expect to like when they occur. The vision of decision making is a vision of intentionality and expectation.

There are other possible visions of how decision happen. In particular, we can consider:

1. Rule following. Decisions can be seen as happening through the application of standard rules to appropriate situations. The pool of these duties, roles, obligations, or standard operating procedures are assumed to evolve by some process of variation and selection.
2. Experimental learning. Decision can be seen as stemming from past experiences. We imagine a process of incremental trial-by-trial learning through which behavior successful in the past is less likely to be repeated than is behavior unsuccessful in the past.
3. Conflict and power. Decision can be seen as resulting from conflict, bargaining, and coalition formation among contending groups and individuals. The outcomes of conflict depend on the desires and powers of the various participants.
4. Contagion. Decisions can be seen as spreading through a population of decision makers. Variations in contact among decision makers, in their status, and in the attractiveness of behaviors affect the rate and pattern of the spread of decisions.

Most recently attempts to develop a behavioral decision theory have tried to relate psychological research on information processing, inference forming, and the allocation of attention to a rational choice vision of decision making. The research has been successful in showing important ways in which human decision do not conform to rational choice of the classical form.

The research, however, has implications not only for decisions that happen through choice, but also for decision that happen through rule following, learning, conflict, or contagion. At the same time, a focus on these alternative perspectives on decision making may suggest alternative directions for behavioral decision theory, directions that might tie it more generally with research on how decision actually happen in the real world of modern institutions.

TUTORIAL

Larry Phillips, London School of Economics and Political Science, will give a tutorial entitled "The practice of decision analysis". This tutorial is designed to give those who have no personal experience of doing decision analysis some idea of how it is actually done.

A

STRUCTURING OF DECISION PROBLEMS IN APPLIED SETTINGS (Ward Edwards, University of Southern California)

General structuring issues, decision trees, and examples of application will probably be put on Monday, and MAU on Tuesday. That implies that Alemni, Edwards, Jungermann, and Phillips will talk on Monday, and Barron, Kleinmuntz, Brownlow, and von Winterfeldt on Tuesday. Wednesday would be left for other volunteers, general discussion, and some attempt to pull it all together.

Farrokh Alemni:

Illustrative analysis of one employer's decision to join a preferred provider arrangement

SUMMARY

Employers often need to make a decision about whether to enter into a contractual agreement with a health care provider and, if so, under what terms. This is a complex decision with uncertain consequences and large stakes. It needs to be defended in front of organizational boards. Its cost and benefits need to be communicated effectively to skeptical employees. By reducing the complexity of the decision, analysis may help in the negotiations between the provider and the employer. This paper describes an example.

In a recent application, an employer was concerned that the combined effect of (1) new administrative costs, (2) different hospitalization costs, (3) changes in utilization patterns, and (4) different clinical costs would undermine any savings obtained through discounts offered. Analysis was able to show that a discount will lead to large changes in number of clinical visits as well as small changes in the frequency of hospitalization. Despite the changes in utilization patterns, however, it was still beneficial to join the preferred provider arrangement. The discounted hospitalization cost after adjustment for case mix differences was low enough to produce savings. Even with more than thirty percent increase in number of clinical visits some savings persisted.

The insights provided by this type of analysis helped the parties involved in their negotiations.

Sensitivity in Value Loss of Linear Multiattribute
Value Models to Attribute Completeness

F. Hutton Barron - University of Alabama
Don N. Kleinmuntz - University of Texas

The purpose of this paper is to examine a particular structuring issue - the impact of a set of missing attributes. The approach is both analytic and empirical.

Analytically, Kleinmuntz (1983) has examined conditions required for additive multiattribute value models to converge, when one model is based on the "entire" set of attributes, and the second model is based on the "considered" subset of attributes. The convergence relationship is:

$$\rho_{yy'} = (1 + \phi \rho_{YZ}) / \sqrt{1 + \phi^2 + 2\phi \rho_{YZ}} \quad (1)$$

where

Y is a linear composite of n-k "considered" attributes (k < n)

Z is a linear composite of k "missing" attributes

Y' is a linear composite of n (missing and considered) attributes

ϕ is the ratio σ_Z / σ_Y

The relationship (1) illustrates how ρ_{YZ} and ϕ influence convergence. Not surprisingly, $\rho_{yy'}$ is large when missing attributes are not important (ϕ is low) or the missing information is redundant (ρ_{YZ} is high). What is more surprising is the relatively large degree of convergence even when the missing information is relatively important and not redundant.

The empirical approach uses loss of value as a measure of the sensitivity of additive MAV models to alternative formulations -- specifically to the case of missing attributes. The distribution of loss of value, as a proportion of the maximum value based on the entire attribute set, is determined empirically for 18 sets of 15 alternatives each, specified (completely) by 9 attributes. Within each set of 15 alternatives and for equal attribute weights, the best alternative using 9 attributes, is compared to the MAV score (all 9 attributes) of the best alternative using reduced sets of 6 to 8 attributes. Results indicate both frequent non-optimality but with little loss of utility and occasional non-optimality with severe (40% to 60%) loss of utility. All of this occurs jointly with high analytic convergence. Two actual applications are also examined and some implications for practice are considered.

- 1: Kleinmuntz, D.N. The Sensitivity of Multiattribute Utility Models to Attribute Formulations, Department of Management Working Paper, 82/83 - 4-27. University of Texas at Austin, July 1983.

Methods for structuring multi-attribute value hierarchies:
a comparison.

Sue Brownlow,
Cambridge University.

Multi-attribute value analysis begins with the construction of a qualitative model of the attributes of the problem. The attributes are arranged into a hierarchy, in which each 'parent' attribute is defined in greater detail by the combination of its 'offspring'. Little is known about the structuring process, or about the effects of different methods on the form of the hierarchy which is developed.

Two different methods of structuring are commonly employed. In the first, top-down (TD) method, the overall objective is decomposed into a series of lower-level attributes, each of which may then be treated in the same manner. This successive decomposition continues until a level of sufficient detail has been reached. In the second approach, bottom-up (BU) structuring, attention is focussed on a detailed assessment of the lower level attributes, which are then clustered into groups under broader 'parent' attributes.

Any discussion of the effects of these methods may be expected to depend also on the type of problem to which they are applied. For the purposes of this work, problems were broken down into two types, according to the aims of analysis. In the first type of problem (C), the primary aim is the choice of one of a number of well-defined options. In the second type (E), the purpose is more generally to explore the nature of the problem.

This paper reports the results of an experimental investigation into the effects of these different structuring methods on different types of problem. Forty student volunteers were interviewed to develop hierarchies of their attributes for the problem of choosing a career, with the purpose either of choosing between a number of pre-specified alternatives, or of defining the attributes of their 'ideal' career.

The effects of the different methods were quantified according to three sets of measures for each group. The shape

of a hierarchy may be characterised by a series of measures including number of attributes, offspring width (ie. width of groups of siblings), depth of branches, and number of terminal nodes. Comparison with a master list of possible attributes gives a measure of the completeness of a hierarchy. The degree of certainty of the decision maker, both before and after the structuring process, may be assessed subjectively.

This paper concludes with a discussion of the implications of these results on the structuring process, and addresses the question of whether one of the methods is in any sense better than the other.

B

COGNITIVE MODELS OF DECISION PROBLEMS (Henry Montgomery,
University of Göteborg, and Ola Svensson, University of
Stockholm)

In cognitive psychology a number of ways have been suggested for how people represent information. These representations include attribute or dimensional descriptions, images or mental models, and association networks, cognitive maps or scenarios. In this working group we will discuss the limitations and merits of different types of representations as psychological models of how people view decision problems. We will discuss how different models relate to each other and how they may be combined. We will highlight a number of problems related to an attribute or dimensional representation. For example: To what extent and how do people classify different aspects as belonging to attributes? What are the effects of variations in expected range of aspects on attribute importance? How stable is a given attribute representation during a decision process? What types of relations do people see between attributes (e.g., hierarchical, cyclical or no relations)? To what extent are attributes related to higher order goals or life values?

IMAGES IN ENERGY PLANNING

Anders Biel

Henry Montgomery

Department of Psychology

University of Göteborg

The research to be presented aims at describing how political actors view different decision alternatives with an emphasis on alternatives in Swedish energy politics. Since energy planning in Sweden is a local responsibility within a frame of directions set up by the Government, both local and state level of planning and the correspondence between the two have been investigated.

An analysis was conducted of 34 speeches made by the Swedish Minister of Energy. The analysis was based on concepts related to behavioural decision theory. It was assumed that the speeches concerned a number of alternatives for supplying energy in Sweden. The views held about each alternative were described in terms of scenarios, where each scenario contains chains of consequences which are seen as resulting from the implementation of an alternative. Each consequence was assumed to have more or less favourable positions on an attribute. The attributes were divided into goal attributes (i.e. fulfilment of goals for the energy politics) and instrumental attributes (i.e. occurrence of means which affect possibilities of attaining different goals). Furthermore, the speeches referred to policy measures which could be used for changing the causal relationships in a scenario.

It was found that the views held by the minister to a large extent could be summarized in terms of a limited number of causal models regarding relationships between instrumental attributes and goal attributes. The most prominent causal model seemed to be that good technology promotes good economy. Another finding was that many alternatives were only related to a limited fraction of the goal attributes.

The concepts that turned out to be relevant in order to analyse the speeches were also applied to an investigation on the local level. Ten townships that were about to invest in new energy systems were studied. Interviews were conducted with politicians as well as with officials. Deliberately, people holding different opinions as to what system should be implemented in their town were selected. Each person was interviewed twice and the second interview concerned points on which the parties talked at cross-purposes on the first occasion. It was found that each party nearly always imagined positive consequences for the preferred alternative; whereas the alternative preferred by the opposite party was seen as mainly giving rise to negative consequences. In many cases, the disagreements could be reduced to a limited number of instrumental attributes. It is concluded that the model used in the present study seems to be a useful way of describing conflicts between different parties in a decision situation.

A Descriptive Study of Auditors' Use of
Analytical Review in Audit Program Design

by

S. F. Biggs, T. J. Mock and P. R. Watkins

Working Paper No. 71

This paper describes research of the auditor judgment process as it relates to analytical review. To date, a number of studies have been conducted concerning the properties of statistical and other formal modeling approaches to analytical review (e.g., Kinney, 1978; Stringer, 1975). However, little audit research has been conducted concerning the qualities of auditor judgment-based analytical review. Yet research in psychology, expert systems and decision science implies that human judgment may exhibit comparative advantages over models in areas such as pattern recognition and integration of diverse elements of information. The need and/or ability to recognize patterns and integrate diverse elements of information is characteristic of the information search and acquisition process used by auditors in analytical review.

To gain insights into the auditor judgment process when accomplishing analytical review, actual auditors were studied evaluating real working papers and an audit program of a client of a public accounting firm. The auditors verbalized their thought processes and these were then evaluated with respect to decision search patterns, information acquisition, and underlying decision processes.

The contribution of this paper is primarily descriptive. Evidence is gleaned from subjects' verbalizations concerning

information search and acquisition, analytical review procedures requested, and use of analytical review information in reviewing substantive audit procedures. This evidence forms the basis for identifying the "problem space" (Newell and Simon, 1973) of the auditors. Ultimately this type of evidence will be the basis for evaluating auditor expertise, problem representations, and for development of a framework to understand the organization of auditor knowledge and how that knowledge impacts audit judgments. This framework may ultimately provide the basis for expert systems development which would serve as audit decision aids to facilitate more consistent and better quality audits.

RESEARCH APPROACH

The approach to research for this study differs somewhat from other studies in accounting in that a "non-rational" (not to be confused with irrational) research methodology was employed. As shown in Table 1, the major, general, differences in this study may be characterized within the context of philosophy of science arguments. That is, in the current study the "traditional" rational science approach was not followed. Rather, a "humanist" approach advocated by Mitroff and Kilman (1978), Rosnow (1981), Reinharz (1979), Lachman, Lachman and Butterfield (1979) and Newell and Simon (1972) was utilized.

Judgment as a component decision process for choosing
between sequentially available alternatives

Heiner Gertzen and Franz Schmalhofer

Psychologisches Institut der Universität Heidelberg

Previous decision research has revealed several choice heuristics whose application depends upon situational factors as for example the mode of the alternatives' presentation (e.g. Aschenbrenner, 1984). Therefore the availability of the choice alternatives, i.e. both alternatives being available at once, or several alternatives being available only one after the other seems to be a situational factor of definite ecological importance which deserves some detailed investigation. For example, when buying a product the products offered by one store are simultaneously available, whereas the information about the products of different stores must be processed in sequence, possibly separated by some unrelated cognitive processing.

This differential availability of the information about the alternatives may favor the application of one or the other of two types of strategies. Contrary to the dimensional processing strategies which are applied when the information of both alternatives is presented at the same time, the limited capacity of working memory may favor the formation of an overall judgment of the alternatives. An alternative's overall judgment can be held in memory more easily than a list of the alternative's features. Thus alternative-based processing would be expected for sequentially available alternatives. In this case a choice may be derived by determining which of the overall judgments is better. Since such judgments knowingly differentiate less accurately between the attractivity of the two alternatives, more inconsistent choices may be expected for sequentially available choice pairs. Due to memory failure and the consequent application of some supplementary decision heuristic (possibly some satisficing principle), sequential availability could produce systematic biases for the firstly, or secondly presented alternative.

These assumptions were examined by an experimental investigation with a total of 90 subjects. Several pairs of multi-dimensionally described text-processing systems were presented to the subjects. For every description of an alternative a meaningless name was introduced and

presented in the choice task. Every subject first acquired knowledge about text-processing systems, making all subjects equally knowledgeable about this subject domain. In the three conditions of the experiment, which was run under the control of microcomputers, multi-dimensional descriptions of the alternatives were either presented simultaneously, sequentially, i.e. the description of one alternative after the other, or sequentially, with an interpolated task to be performed between the presentations of the two alternatives. Every alternative of a pair was presented in the first as well as in the second position, so that every choice pair had to be presented twice. Choices and choice latencies were collected.

In addition, subjects judged the attractiveness of the alternatives from memory as well as from multi-dimensional descriptions. Whereas in the memory judgment task, subjects were only presented with the name of the alternative, only multi-dimensional descriptions were shown to the subjects in the (regular) judgment task. The first judgment task, which was separated from the second by a distractor activity, thus indicates the judgments about the alternatives which are stored in the decision maker's memory after several choices. If persons based their decision upon the overall judgment of the alternatives rather than upon dimensional comparisons, the collected memory judgments should be suited for predicting the decision maker's choice.

For sequentially presented alternatives memory judgments were found to be a better predictor of the choices than for simultaneously presented alternatives. In that case, there was also a higher correlation between the two types of judgment, indicating that for sequentially presented alternatives, decision makers are more likely to base their choices upon overall judgments of the alternatives than for simultaneously presented alternatives.

The data also indicate that sequential presentation may yield fewer consistent choices. For the sequential presentation mode, the secondly displayed alternative was more likely to be chosen than the alternative being presented first. By including choice latencies it is analyzed whether and how various cognitive models (e.g. Aschenbrenner, Albert & Schmalhofer, 1984) can explain the reported results.

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THE STUDY OF CAPABILITY OF DECISION MAKER
TO CARRY OUT SOME ELEMENTARY OPERATIONS

NIKIFOROV A.D., REBRIK S.B.

The most advance methods of solving a multiple criterial mathematical programming problems, are man-machine procedures (MMP), in which the decision-maker actively finds the best solution.

The quality of solution, the attitude of decision maker to it are determined by the correlation between MMP's requirements to the DM, and his capability to perform correctly the necessary information processing.

The results numerous psychological studies conducted in recent years, evidence that human capabilities in processing complex multiple factors information are rather limited.

Implementing some operation DM makes errors, display contradiction, uses wrong heuristics.

The present work describe the result of investigation of capability of DM to implement some operation used in MMP. There was no results of psychological research concerning these operation. These operations are:

1. The criteria ranking operation on the basis of preferences of DM.
2. The operation of assignement of satisfactory value by one criterion.

We realized the conventional of a laboratory experiment. So we tried to approach it to the real conditions DM work. We take well familiar for subjects task: to chose the place for building

summer cottage. It was select special group of subjects, which was going to build summer cottage.

The various type of place for building summer cottage was described by means of 12 criteria having spread words definition and ordinal scales of estimation.

According to the results of experiments the next conclusions can be made:

1. The ranking of 12 criteria on the basis of preferences of DM is possible and can be carry out if the preliminary, special training of DM is fulfilled. It is necessary to make clear the preferences of DM and to form stable system relations between criteria.

2. The investigation proved that DM was consistent while assigning of satisfactory value by the one criterion if that criteria was important.

3. Assignment of satisfactory value by isolate criterion, leads in some case to contradiction with the value of this criteria in the group of chosen alternative.

4. When developing and evaluating MMP it is necessary to take into the consideration the fact that DM can pursue consistent policy towards criteria estimation of more important for him criteries and can be not consistent towards not important.

DECISIONS IN CHESS PLAYERS' PROBLEM-SOLVING

Decision-making and problem-solving are two thought processes which obviously are very close to each other. Most of human thinking presupposes both decision-making and problem-solving. At least it is very hard to imagine a genuine thought provoking life-situation which does not necessitate problem-solving as well as decision making. In order to increase our understanding of human thinking as a whole it is necessary to consider the interrelations of human problem solving and decision making.

Problem-solving is a complex and time-consuming process. The problem-solver must usually find his way among many alternatives to reach his goal. This naturally means that he must make a number of necessary decisions to be able to find the correct route from initial situation to his goal. One of the first tasks in studying the interrelations between problem-solving and decision making is to find out the types of decisions necessary for smooth problem solving.

In this work chess is a practical task environment. Some of the most fundamental findings in cognitive problem-solving research have been made by studying chess players' problem-solving (de Groot 1965, 1966, Newell and Simon 1972), which gives a promising opportunity to theoretical considerations of the interrelations of the two areas. On the other hand, searching for a move in chess is not only a problem-solving situation but the tree structure of the game obviously makes it also a decision situation, which should support the empirical work.

In this study the method of thinking aloud and protocol analysis has been used to classify a group of task necessary decisions and make a preliminary study of their function in chess players' problem-solving. By task-necessary decision I mean here a decision which is necessary for the smooth course of the process.

The decision processes in chess players' problem solving may be divided into two broad classes: metadecisions and decisions. Metadecisions are decisions concerning the problem solving process itself. They are important in controlling the course of the process. Decisions concern the selection of a move, i.e. the problem itself. To make a move a chess player must usually select between various reasonable moves, which necessitates an ordinary choice between a number of goals in the world outside the solver himself.

Three important metadecisions may be demonstrated in the protocols of chess players. They are the choice between relevant and irrelevant problem spaces, choices concerning allocation of resources, and the termination decision. A problematic chess position may be structured in the mind as a problem space in only one way at a time. The solver must decide what are the relevant ways of structuring the problem situation, i.e. which are the ideas he is going to consider, and he must also decide in which order he is going to consider them.

A solver must also decide how much effort he is going to invest in studying some alternative, since time is always limited. These are decisions about the allocation of resources. At the very end the solver must decide when to stop his search. The termination decision is reached when he is so satisfied with what he has achieved that he does not want to continue the search.

/ / /

At the present stage of research three types of decisions may also be demonstrated in chess players' protocols. They concern the value of the position, the value of the decisional evidence and the choice between reasonably good moves. These three types of decisions are, of course, related to each other as to the metadecisions.

To be able to select a move a chess player must evaluate the problem position as well as the goal positions he considers. He must decide whether the position is good or bad for him or it is equal. In a chess position there are always a number of chess-specific factors, such as open lines, weak pawns, active pieces etc., and the player, in evaluating a position, must be able to decide what the weight of individual factors is, i.e. which of them are important in this particular problem position and which are not. So decisions concerning the value of the position and value of the decisional evidence are strongly interrelated. The choice of a move is naturally based on evaluation. It may be a choice in circumstances of certainty or risk. The degree of certainty depends naturally on the nature of the position and the relevance of the decisional evidence collected.

There is some evidence that metadecisions are related to decisions. If a player finds a move which he evaluates very good he is very willing to make the termination decision. If he evaluates, even illusorily, his position as bad, he is apt to invest more resources to defensive moves than attacking moves and vice versa. This means that a problem-solver probably has a sophisticated cost/benefit analysis controlling his problem solving process similar to that which has been found in decision-making.

It is evident that decision-making and problem solving are closely interrelated processes. There are two important issues in their relations which may be preliminarily considered. Firstly, is it possible to explain errors in chess players' problem-solving by failures in task necessary decisions? Secondly, what is the role skill differences typical to chess in decision making during the problem-solving process?

The role of familiarity in the decision strategy selection.

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One of the most important controversies about the nature of the decision making deals with the problem whether it should be conceived as an optimizing or rather as a satisfying behavior; whether the chosen alternative is optimal in some sense or rather only satisfactory. The two approaches differ in how the information about alternatives is acquired, how through this information is and how descriptive and evaluative information is processed.

Generally, the model of satisfying behavior assumes less information acquisition and processing what fits better limited cognitive capacity. It also has stronger experimental support, especially as far as information seeking behavior is concerned. As regards evaluation processes, however, the advantage of the satisfying model is not so obvious. Both approaches assume clear, unambiguous human preferences, what in many decision situations need not be true. In such situations, evaluations of absolute type /X is good enough/ which are required by the satisfying model may be even more difficult for the human decision maker than evaluations of comparative type /X is better than Y/ - required by the optimizing models.

An experiment has been performed on the role of familiarity with the decision task and its impact on information and evaluation processes in decision making. A combination of two process tracing techniques that is information seeking and thinking aloud, has been used.

Obtained differences between groups dealing with more vs. less familiar decision tasks may be summarized as follows:

More familiar with decision task utilized, and processed, "richer" information. They acquired information "by alternatives" rather than "by aspects". Their descriptive as well as evaluative statements were predominantly of absolute type. Both last findings fit well satisfying behavior. Behavior of those less familiar with decision task fitted the satisfying model definitely badly; they used comparative statements in higher proportion than those more familiar with decision task, also their patterns of information seeking were less consistent. At the same time their behavior could indicate some difficulties with evaluation processes - probably related to lack of standards of evaluation.

Although it is quite difficult to tell what decision strategy they did follow, there are hints indicating evaluation operations referred to by Montgomery as dominance structuring. One of these hints is that they expressed significantly higher proportion of positive evaluative statements than those more familiar with decision tasks.

Portfolio Theory Revisited: A Quantitative Comparison
With Subjective Expected Utility

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Previous tests of portfolio theory (Coombs, 1969; 1976) have been restricted because the absence of an independent measure of subjective risk. Some indirect tests of the model, testing qualitative predictions of portfolio theory, (e.g., Coombs, 1980; Coombs & Huang, 1976) have been favorable, while others (e.g., Aschenbrenner, 1978; Lehner, 1978) failed to find the predicted phenomena.

The present study takes advantage of a measure of subjective risk recently developed and validated (Weber, 1983; 1984; Luce & Weber, 1984) to make a quantitative comparison of the adequacy of expected utility theory and portfolio theory for predicting preferences between alternatives in risky choice situations.

The design of this study is completely within-subject since the objective is the prediction of individual preference. All analyses are done on individual subject data. The sample size is ten, including college students and highschool teachers. The study has two stages, parameter estimation (stage I) and comparison of predictive power of expected utility vs. portfolio theory for preference judgments (stage II).

Stage I: Using graphic rating scales appropriately labeled, subjects provide judgments of subjective riskiness for a set of three-outcome lotteries (monetary outcomes), and of desirability for a set of one-outcome lotteries. The outcomes of both sets of

lotteries span the range of the lotteries used in stage II. Subjects' subjective risk function parameters are estimated from their risk judgments (Weber, 1985; Luce & Weber, 1984). Subjects' utility for outcomes and subjective probabilities are estimated simultaneously using standard functional measurement techniques. To assess possible inaccuracy in the perception of expected value (Van Santen, 1978), subjects are also asked to rate average payoff of the three-outcome lotteries used in stage II.

Stage II: Subjects provide ratings of desirability for a new set of three-outcome lotteries (dependent variable). Using the individuals' parameters estimated in stage I, subjective riskiness and subjective expected utility are computed for this set of lotteries. A regression of desirability ratings on subjective expected utility provides a measure of the latter's predictive power (multiple R-squared). This is compared with the fit of the regression of the desirability ratings on expected value (or subjective expected value, average payoff) and risk (as a quadratic term, because distance from ideal risk point as opposed to absolute level of risk is hypothesized to affect preference in portfolio theory). Problems of comparison between the two models on the basis of a goodness-of-fit measure are discussed.

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Bias in Assessing Weights in Multi-Attribute Decision Making

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2)
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1)
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Throughout the last years there has been a growing body of research on bias in assessing one-dimensional utility functions. It has been shown that depending on framing, elicitation methods etc. different utility functions might be determined. Within the following paper we take a first step towards investigating bias in a multi-attribute decision making situation, i.e. investigating bias in assessing attribute weights. The results of our study indicate that the solutions of descriptive and prescriptive decision problems might depend on the method chosen to elicit the weights as well as on the structure of the system of decision relevant attributes.

In our empirical study we tried to address four main questions: i) How is the division of one attribute into two disjunct subattributes reflected in the weights of attributes and subattributes? ii) Are different methods of assessing weights more or less sensitive to dividing attributes resp. do different methods give different weights for the same system of attributes? iii) Is dividing attributes resp. choosing a method critical for predicting a decision maker's behavior? iv) Is the perceived correlation between subattributes a possible explanation for the observed bias?

To answer these questions we surveyed 280 German Business students who were divided into 8 groups. Each group received two questionnaires on attribute weights in a job choice situation, with 3, 4, 5, or 6 attributes in the first questionnaire and 6 or 3 attributes in the second questionnaire. The attribute systems with more than 3 attributes were generated by dividing 1, 2, or 3 of the original three attributes into disjunctive subattributes. Within each questionnaire we used four different methods to assess the attribute weights, checked preferential independence of attributes, determined perceived correlation of attributes and asked the students to choose between a number of jobs.

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C

APPLICATION AND EVALUATION OF DECISION AIDS (Berndt Rohrmann, University of Mannheim)

In this workshop the following topics shall be discussed:

- What criteria should be fulfilled by decision aids?
- Which evaluation methods are appropriate?
- When are clients satisfied by decision-aiding techniques?
- What practical problems occur within applications?
- How can the usability of decision-analytic approaches be improved?

It is planned to have one theoretical/methodological contribution, probably three presentations of application/evaluation examples and an integrative discussion of conclusions.

There will also be time for (short) statements about ongoing research. The group should consider quantitative as well as qualitative decision aids, and should look at different fields of application (e.g., social, economical, medical, legal decisions, etc.)

DESIGN AND EVALUATION OF A DECISION AID IN A NATIONWIDE DISCUSSION

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Two years ago the Dutch government instigated the General Social Discussion (GSD) about the use of nuclear power in the Netherlands. This discussion was divided into two parts. In the first part, the information phase, an independent committee collected information about the consequences of nuclear power and the possible alternatives to it. This information has been summarized in an 'Interim report'. In the second part of the GSD the committee had to collect the opinions of the population which had to be based on the previously collected information. These opinions are presented in the 'Final report'.

Several procedures have been used to collect the opinions of the public. One of them, the Choice questionnaire, has been developed by the authors. In developing this procedure we based our approach on the theory of decision analysis. To make a good decision one must, according to this theory:

- make an overview of the possible alternatives
- make an overview of the consequences of these alternatives
- evaluate these consequences
- make a choice on the basis of these evaluations

In line with the design of the GSD it was decided that the first two steps should be the task of the researchers. In the Choice questionnaire information was provided about the different possible energy sources. This information was based on the Interim report of the committee.

The respondents' task was to evaluate the information in order to make a decision on this topic.

In developing this 'decision aid' we had to answer the following questions:

- what is the appropriate formulation of the choice problem?
- what information about possible consequences has to be given?
- what is the most efficient way to present the information?
- what is the appropriate way of eliciting the evaluations and the choice?

In the first part of the paper, we will describe how we answered these questions. That means: we will give our arguments for the specific design of this decision aid.

In the second part of the paper a thorough evaluation of the Choice questionnaire will be presented. First of all, we asked the respondents about their opinion of the bias in the presented information. We also asked them if the Choice questionnaire was an aid to them for making a choice. Far more important than this subjective evaluation, we think, is an objective evaluation of the decision aid. Two aspects of the quality of the decision aid have been analysed: the quality of the evaluations of the consequences of the choice options given by the respondents and the quality of the choices made by the respondents.

First we will analyse the evaluations of the consequences: do the respondents evaluate consequences which are clearly advantageous as advantages? Do they evaluate disadvantageous consequences as disadvantages? Do they evaluate the same consequences of different alternatives the same? And if not: to what extent can these mistakes be explained by an existing opinion of the respondent about the alternatives before he or she fills in the questionnaire?

Second we will investigate if the choices made by the respondents are in line with their evaluations of the consequences, that means: in line with the presented information. We also analysed the direction of the relationship between evaluations and choice: does the choice determine the evaluations or do the evaluations determine the choice? In other words: we investigated if an effect of the Choice questionnaire on the choiceprocess exists.

We also analysed the effects of different possible ways to present the information.

For this evaluation study, we did research on four random samples of the Dutch population. We presented three different forms of the Choice questionnaire. In one sample we asked the opinion of the respondents without presenting information.

APPLICATION OF DECISION AID IN HUMAN SERVICE ORGANIZATION
(Helping Probation Officers to Decide Disposition of Juvenile Delinquents)

by

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Despite the recent growth of a variety of decision aids designed to help the decision makers to augment their minds' capacity, to reduce the complexity of judgmental tasks and consequently, to improve their performance in those tasks, there has been as yet little application of those aids to the actual making of decisions in human service organizations. In most social and clinical settings experts' judgments and decisions involving assessment of people, prediction of uncertain events in peoples' lives from complex and ambiguous information, and subsequent choice of preferable action are still largely a matter of doing one's best, of ignoring uncertainties, trusting intuitive strategies and relying on implicit and mostly unvalidated beliefs. The two main obstacles in introducing decision aids into decision making in human service organization can be traced to:

1) the absence of a known, or even knowable and measurable, criterion. Moreover, in those situations the information on the "true" outcomes of decisions is either incomplete, noisy, or lacking altogether. Therefore the task structure cannot be precisely defined and the criteria of optimality and accuracy lack external validity; 2) the proverbial resistance of helping professions to substitute the intuitive and implicit reasoning, based on professed commitment to the idea of uniqueness of an individual and belief in individualization by a systematic application of an explicit general rule. The resistance of professional experts is reinforced by organizational inertia and unwillingness to change established routines.

Our presentation describes a successful application of a decision aid, designed, developed and implemented in Youth Probation Service in Jerusalem. Probation Officers' task in recommending disposition presents a paradigmatic case of the general class of clinical-diagnostic and predictive decision made by professional experts in most helping professions, where people are assigned to treatments on the basis of professional assessment of their personal characteristics, their needs and their social circumstances.

Our decision aid is based on provision of procedural support to decision makers in the form of heuristic rule for processing, weighting and combining diverse information into disposition decisions, and on division of labor between the expert decision maker and computer capitalizing on each party's relative advantage. The knowledge, clinical experience and coding ability of professional decision makers is amplified by the computer's superior capacity to process and integrate information in an effective, consistent and reliable way.

Our presentation reviews the successive stages in designing and development of this support system: from the elicitation of expert knowledge and experience in terms of rules and facts^{and} encoding it into computer program, through incremental improvement in the knowledge base by reiterative trial-use of the system in direct interaction with experts to a final implementation of the system as a part of organizational routine of the Probation Service.

We address our presentation specifically to the issue of improving decisions in situations in which criteria of optimality are lacking and suggest how some "local" or partial optimality criteria can be evolved from the understanding of the specific tasks and of the social consequences of the experts' judgment. The specific strategies which helped to gain acceptance of professional experts and organization management for the support system will be discussed in greater detail. The social benefits and usability of such decision aids in human service organizations both in terms of people served and organizational decision practice will be presented.

D

INDIVIDUAL AND ORGANIZATIONAL DECISION MAKING (Zur Shapira, The Hebrew University)

The theme of this working group is to exchange ideas about the relationship between individual and organizational decision making. Some questions about the relevance of these levels of analysis to each other were raised by March and Shapira (in Ungson and Braunstein, eds., Decision Making, Boston, Kent Publishing 1982). Examples of issues to be dealt with include: (1) effects of commitment on choice; (2) conflict (within and between individuals); and (3) the role of incentives in organizational decision making. There are three 2 hour sessions and the plan is to discuss one or two related subjects in each session. The papers will be presented first and will be followed by brief statements by other participants on their related research, then a general discussion on the subject will be held.

DYNAMIC DECISION MAKING IN DUAL CONTROL PROBLEMS WITH CONFLICTING GOALS.

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Jacques de Bruyn, Social Science Informatics, University of Amsterdam
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Many real world decision problems are dynamic in nature. They can be characterized by a series of interdependent decisions in which the decision on each step creates a new decision problem at the subsequent step. The situation becomes more complex when two decision makers with conflicting interests are involved. Although this kind of problems is extensively studied in the literature on control theory and differential games, the models proposed are in essence still normative and a sound psychological basis is lacking.

In the full paper we study the decision making behaviour in a situation in which two decision makers (called players) in turn make decisions in order to control a simple dynamic system. The system state evolves according to a linear difference equation and each player can control this state in his turn by the size of his move. Both players pursue a different value of the system state. These values are called their respective goals, and the further they are apart the more conflicting the situation is. Each move is assumed to cause costs for both the players. They depend on the distance from the obtained system state to their goal and the size of their moves, both weighted by non-negative parameters. Adding these costs over n subsequent steps, we get the so-called individual loss functions. The decision theoretic problem for each player is to choose his moves in such a way that the value of his own individual loss function will be minimized.

An interesting aspect of this problem lies in the fact that more than one strategy is defined in literature and that they all can be played optimal: the all moves concerning competitive strategy, the one move minimizing myopic strategy and the all moves concerning cooperative strategy. Noteworthy is that the cooperative strategy leads to the least total individual loss, then the myopic strategy and then the competitive strategy. The myopic strategy requires no information on the other player's costs on each move and his total loss until then, but both the other strategies do. One has overlooked, however, that this information creates the possibility that people can see whether they do better than the other player and that they, besides minimizing costs, also want to win. In doing so, they rather will use more

aggressive strategies, even if these will lead to higher losses for themselves than needed. We define two such strategies: a plain aggressive strategy in which one maximizes the difference between the individual costs on a move, and a repressive strategy in which one maximizes the differences between the individual costs on both the own and the opponent's move. The hypothesis is that people who are more completely informed about their opponent's costs show a stronger tendency towards the aggressive strategies than people who are not.

Of course we are also interested in the real strategies and in strategy switches. In the full paper some hypotheses will be discussed concerning these aspects. In fact they all refer to the stability problem, which is especially of interest when the structure of the decision problem is changing during the decision making process by altering the weighting parameters from above.

In order to test these hypotheses an experiment was set up in which 36 subjects were assigned to the cells of a two by three factorial design. One factor of this design contains the complete and the low information condition depending on the fact whether the players, besides information on each move, also were informed about the opponent's costs. The second factor consists of three different sequences of the weighting parameters. The game was implemented on a computer and played on two terminals. The players were asked to play one of two factories that shared the market of a certain product. Each player was told that his best market share was 70% and that he could control the market by appropriate moves which could minimize his total costs. The subjects did know the form of their loss functions, but not the parameter values.

Only a few results can be summarized here. Analysis of variance shows very convincing that people in the complete information condition indeed use more aggressive strategies and that their total costs are considerably higher than in the low information condition. Remarkable in this result is that people need more information to make better decisions but that they, instead, use this information to fight each other. Another intriguing result is that no effect of differences in the weighting parameters can be found, but that different sequences of these parameters lead to different strategies and total individual costs. Though as yet no definite results can be given on the stability hypotheses, a first look at the data shows a higher correlation between the corresponding moves of both players ($r = .93$) than between their outset market shares and their moves ($r = -.67$). This suggests that people react more upon each other than upon the more important system state. Complete results will be reported in the paper.

DECISION ANALYSIS WITH COMPETITION

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Abstract

Decision analysis is a useful aid for decision makers, but it fails to model the interactive nature of competitive decision making. Game theory does model the interactive nature of competitive decision making but many of its methods and assumptions are incompatible with decision analysis. In particular, game theory uses the normal rather than the extensive form of analysis, has the goal of predicting aggregate behavior rather than advising an individual decision maker, generally assumes complete rather than incomplete information, and assumes all players are rational in a particular meaning of rationality. Other parts of game theory may be applicable to decision analysis; the analysis of games with incomplete information, and the ideas of rationalizable strategies have useful implications for decision analysis. We conclude that models of competitive decision making must confront, not avoid, two issues: the infinite regress of expectations and psychological models of decision making. Language and methods are needed for taking into account as much of the regress of expectations as is needed. A useful theory must also give various possible psychological models for one's opponents and then help the decision maker to calculate what to do against each type.

Decision Making in Social Dilemmas

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Social dilemmas are multi-person decision making situations in which (1) each person has a choice, which by the criteria of individual rationality, is better than another choice, but in which (2) if everyone makes their "best" choice, everyone is made worse off than if everyone made the less good choice. Thus the result of a set of individually rational decisions is a set of outcomes that are not desired by any of the decision makers. Many real world problems including pollution, overuse of shared resources, overpopulation, arms races, and overtaxation may be viewed as having the characteristics of social dilemmas.

In our research program we have been studying two different classes of solutions to social dilemmas. The first class concerns factors that tend to promote or hinder more socially "enlightened" individual decisions within the context of social dilemmas. Such factors include the amount of information individuals have about the impact of their decisions on the environment, the degree of homogeneity or heterogeneity in the decisions of other group members, and the extent to which the decision makers perceive themselves as members of a common social category.

The second class of solutions concerns the decision makers' willingness or desire to change the actual decision structure from a social dilemma to some other form. Possible alternative decision structures include the appointment or election of a leader who will make decisions for the entire group, the division of resources or responsibilities into private, non-shared units, or imposing restrictions on the decision options that effectively eliminate the pernicious structure that leads to sub-optimal equilibria.

The paper that I propose to give will describe one or two of the numerous studies we have conducted as well as the theory that we are developing to explain the relationships between the two types of decisions people make in social dilemmas and to predict when people will want to alter the decision structure that defines their interdependence.

Hedonic Framing and The Break-Even Effect

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Richard Thaler

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Seldom are decisions made in temporal isolation. Our current choice are evaluated with knowledge of the decisions and outcomes that have preceded them. Despite normative advice to ignore these historical events, it is well established that real decision-makers are often influenced by both past losses (i. e. sunk costs) and past gains. Our paper attempts to extend that work by providing a series of empirical regularities and at least a partial explanation of these results in the spirit of the pioneering work of Kahneman and Tversky (1979, 1982). Here we extend their descriptive model of decision under uncertainty, prospect theory, to simple two stage situations, in which a previous outcome might influence a subsequent decision.

We identify several principles based upon a series of experiments. The first we term hedonic framing: If possible individuals prefer the representation of risky prospects which maximizes their value, as represented by the prospect theory value function. Experimental evidence indicates, for example, that subjects prefer two gains one of \$50 and another of \$25 to a single \$75 gain. As implied by the curvature of the value function, the reverse is true for losses.

We also note important exceptions to this principle: For example, under many circumstances subjects seem unwilling to combine two losses, preferring instead to separate them. Consider for example, a situation where two losses, say a \$20 traffic ticket and a \$25 fine from the college registrar, befall our subjects. Here we simply ask subjects whether they would prefer these two events, to occur together, on the same day, or separate, on two different days. The overwhelming majority (71%) of respondents prefer the two events to occur apart. Thus, while subjects prefer a larger integrated loss to its components they seem unwilling or unable to perform this integration themselves.

This observation suggests that initial losses cause subsequent losses to be relatively more painful, an effect we term the ratchet effect. We provide several empirical demonstrations that initial losses reduce risk-seeking. Conversely, risk seeking can increase under some conditions. For example, decision makers seem much more likely to choose a risky option when it will wipe out the initial loss, an phenomenon we term the break-even effect. Another circumstance which increases risk seeking we term the house money effect: Risk seeking increases following an initial gain, if the losses presented by the risky option will not exceed the initial gain.

We close by summarizing these results, and suggest several alternative explanations. These explanations, along with several real world behaviors consistent with these principles, suggest that this is a promising area for future research.

Proposal for a paper to be presented in one of the workshops at the Tenth conference on subjective probability, utility and decisionmaking

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Title: "Who can make use of financial information?"

Summary

Financial information is supposed to be a useful basis for decisions. However, there is a lack of empirical descriptions of how financial information is used in organizations. Such descriptions are necessary for the development of information systems which can contribute to better decisions in organizations.

The purpose of this paper is to throw some light on how financial information is used in two companies in Sweden, by placing to users in focus.

After a short introduction, the paper begins with a description of the development of the two companies and their situations, organizational structures and systems today. We then change perspective and give an indirect description of two orderreceivers, one in each company.

We put the pictures of the two companies and the two orderreceivers together and try to compare the situations, the structures, the systems, the users and the use of information. There are similarities and differences. What explain this?

An analysis in terms of characters (following Riesman 1952) make the problem of how financial information is used, appear. With character we mean "the mechanisms which contribute to preserve the user's identity and in the same time to conform to the company". The company's character is a shadow of the characters of the employees and is preserved by the employees who can preserve their identity by joining the company. The character of the company appears in it's relation to society.

Only users who can make use of an information system to preserve his/her identity are supposed to make use of the information in the system. In the same way; Only companies who can make use of an information system to preserve it's identity, can make use of it.

We end up the paper with a discussion of how we plan to investigate if "character" can explain how financial information is used in organizations.

Perceptions of Fairness in Economic Transactions

Richard Thaler (with Daniel Kahneman and Jack Knetch)

The economic analysis of competitive markets assumes that agents will take advantage of all legal opportunities to increase profits. Based on this assumption, prices are assumed to adjust to allow markets to clear (where supply equals demand). We have investigated the class of actions which are legal economic opportunities, but which are viewed by the community as unfair or even outrageous. The conditions that lead to a judgment of unfairness are analyzed. These conditions are found to be incoherent since they are subject to framing manipulations. That is, two economically equivalent actions can differ in their perceived fairness. That certain actions (such as sharply raising prices during a shortage) are judged to be unfair is shown to prevent some markets from clearing.

Jitendra V. Singh, Robert J. House & David J. Tucker:

ORGANIZATIONAL DECISION MAKING AND ORGANIZATIONAL SURVIVAL

INTRODUCTION

Historically, the dominant perspective in the study of organizational decision making has been an adaptation perspective. According to this perspective, organizations, or, more specifically, leaders and dominant coalitions attempt to adapt to changing organizational contexts in order to ensure the performance and survival of organizations (March and Simon, 1958; Cyert and March, 1963; March and Olsen, 1976; Lawrence and Lorsch, 1969; Child, 1972; Galbraith, 1977; Pfeffer, 1978). However, in recent years, this adaptation perspective has been challenged by another perspective, population ecology theory (Hannan and Freeman, 1977) which argues that due to a variety of inertial factors organizations have a minimal capacity to make any major adaptive decisions. Instead of adaptation, selection by the environment is a more satisfactory approach to explaining change in organizational populations. Organizations that 'fit' the environment survive while others are selected out.

Although the adaptation and selection perspective are often seen as conflicting (Astley and Van de Ven, 1983) and it is debated whether organizational change is primarily due to adaptation or selection, our approach is different. We argue that, in general, both selection and adaptation occur in organizational populations and that it is important to attempt to model them simultaneously. We do so by modeling the effects of organizational changes on an age dependent model of death rates, in which younger organizations are more subject to selection pressures than older organizations, and, consequently, have higher failure rates.

Quality of Information and Organizational Decision

Making

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Submitted for presentation in the workshop on "individual and organizational Decision Making" organized by Zur Shapira. SPUDM 1985.

Communication is the vehicle through which coordination in organizations is accomplished. Many researchers see communication as the most significant essence of any organization and the process of communication as the heart of effective organization. As such, the quality of organizational communication is a critical determinant of the quality of organizational Decision-Making.

The present paper deals with a specific type of ineffective communication termed "Defensive Reporting" which is defined as a situation in which subordinates report what they think their superior wants to hear rather than what he should hear. Defensive Reporting (DR) refers to maximizing even trivial success and minimizing failure.

A survey was conducted among managers representing various types of organizations. The managers were asked to evaluate the range of DR and to give examples of cases in which organizational decision were harmed because of DR. The following examples, obtained in the survey, will further illustrate the severity of DR:

- a) Because of DR about the forecast of workload, a decision to buy a new computer was delayed.
- b) Because of DR about marketing potential of a new product, production was too high.
- c) Because of DR about the completion of a phase in a building project, fewer resources than needed were allocated for its completion.

A specific and severe problem which was found to be caused by DR is the threat to the reliability of computerized data bases on which large organizations tend to rely more and more.

A content analysis was conducted on the case studies and a conceptual model for the explanation of the causes of DR was suggested. The model was supported by the statistical analysis of the subjective estimations given by managers while taking into account the characteristics of the various organizations.

It was concluded that DR is a widespread phenomenon and is a severe danger to the quality of organizational decision making. DR was found to be highly influenced by the communicational climate of an organization. Potential methods for reducing the level of DR and its impact on organizational decision making were suggested.

Behavioral Intents as Determinants of Decision-Making
Processes

Specific paper. Submitted for presentation in SPUDM, 1985
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It is well known today that man is capable of utilizing various decision-making strategies, while coping with different decision tasks. The specific strategy used is dependent on the task, the context, the personality of the decision maker and his/her momentary psychological state. For instance, states of boredom, fatigue or inattention might lead to the use of simple strategies like random choice while time stress might lead to the utilization of non-compensatory and non linear strategies.

It is assumed here that variability in utilization of decision-making strategies stems from two main factors: 1) A basic individual tendency which favors the use of one or more specific decision strategies over others. This tendency is based on personality traits, education, past experiences, etc. 2) A momentary choice of a strategy stemming from the idiosyncratic meaning assigned to the momentary event as perceived by the decision maker (DM). Accordingly, it is suggested here, that the decision strategies utilized might be predicted from the meaning of the situation as perceived by the DM and from his set of beliefs and behavioral intents (BI) regarding the utilization of specific decision strategies.

The present study deals with the relationship between BI and the utilization of a specific decision strategy. The two decision strategies which were chosen for testing were compensatory versus a noncompensatory strategy. A compensatory decision is defined here as one in which the alternative chosen is superior to the other alternatives only in terms of the sum of the weighted utilities of all the attributes. A non-compensatory decision, on the other hand, is defined here as one in which the alternative chosen is superior to other alternatives only by virtue of its score on the most important attribute and is inferior to others considering the weighted sum of the utilities of all the attributes.

It was hypothesized that subjects with BI favoring a compensatory approach will actually utilize it significantly more as compared to subjects with BI favoring a noncompensatory approach. In the first phase a specific questionnaire

aimed at measuring BI toward the use of a compensatory or a noncompensatory strategy was built and validated. In the 2nd phase, 20 subjects participated in a decision making experiment, which was composed of 2 stages. In the first stage each subject was presented with six decision problems and was asked to decide upon the values and weights which he/she felt appropriate for each attribute in each alternative, in each decision problem. Using the data derived from this first stage, 36 binary decision problems for each of the individual subjects were constructed so that in each of them it was possible to ascertain from the selection of one alternative rather than the other, whether the choice was based on a compensatory or a non-compensatory strategy. In addition, each subject completed the BI questionnaire on the basis of which a score which indicated the strength of his/her BI toward utilizing a compensatory strategy was given (BIC). The proportion of compensatory decisions which were actually made out of the 36 decisions was calculated as well for each subject (PCM). The statistical analysis supported the hypothesis. The Pearson correlation between BIC and PCM was 0.79 ($df=18$; $p < 0.01$). The average PCM of subjects with BIC scores above the median was 0.63, while for subjects with BIC scores below the median it was 0.37. It is of interest to note that subjects utilized both compensatory and non-compensatory strategies and variation between these two types of strategies were found between as well as within subjects. However, each subject showed a consistent preference which was highly related to his/her BI.

The implication of the findings for understanding the decision making process within the frame of reference of the total cognitive system (e.g. memory, beliefs) are discussed.

E

APPLICATION OF DECISION THEORY TO INDIVIDUAL BEHAVIOR IN RISKY SITUATIONS (Heikki Summala, University of Helsinki, Finland):

This workshop attacks the problem how people manage risks in hazardous activities such as driving. Do they perceive or estimate risks so as to optimize their output according to expected utility models; or what would be the heuristics they use in maintaining safety? What is the fate of the widely discussed risk homeostasis theory? And, last, what kind of countermeasures would be successful for higher safety?

Hazard Information and the Public:
Would a Marketing Approach Help?

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It is often concluded that controversies over the development and control of hazardous technologies result from the public's lack of information about, or inability to understand, complex issues. This leads to the technical solution of providing more information, which it is assumed will clear up the disagreements, rather than treating such controversies as social problems. One apparent, and for a U.S. regulatory agency nearly unprecedented step in a more social orientation was made by the United States Environmental Protection Agency when it asked for public input concerning new emission control standards for arsenic from the Asarco copper smelter in Tacoma, Washington. By many accounts the EPA's informational workshops and public hearings were successful in getting a large number of people personally involved in the issue, in reducing suspicions about government actions, and in developing a sense of open dialogue and the sharing of information. Survey results, however, suggest that the effort was not entirely successful in increasing information and reducing conflict. Thirty percent of those who had attended the workshops were not able later to correctly answer two basic questions concerning emission risks to mortality and the requirements of the proposed standards. While the format used improved the political climate within which information was used and risk decisions made, additional considerations relating to the presentation of information seem to be needed. One direction that could be taken is suggested by a marketing approach which considers the needs of the hazard information consumer and the manner in which hazard information is processed.

Practical application of a marketing approach requires the development of a model of risk decision making. The model proposed, which is based on recent research on information processing, behavioral decision theory and social judgment theory, assumes that decision making is a dynamic process. People

make a decision, acquire additional information, take actions to mitigate the judged risks, and adjust their decisions as seems appropriate to them. Among the most important factors influencing the occurrence, order and frequency of the steps in the process are the nature of the person's interaction with the environment, the cognitive processes operating on the information, and existing images of risk and hazard held by the individual. The model suggests that marketing of hazard information should consider (1) the individual's involvement with the hazard issue; (2) the comprehensibility of the hazard information; (3) the applicability of the information to the risk judgment problem; and (4) differences among individuals and groups in information needs and processing abilities. The risk decision model will be supported and illustrated using results from three studies on the Asarco smelter issue -- 2 public surveys and one decision making simulation study. One important implication of a marketing approach is that it requires policy makers to explicitly decide what information is to be disseminated, in what form it will be presented in, who it is intended for and why it is being disseminated. These and other policy implications will be discussed.

REFLECTIONS ON RISK HOMEOSTASIS THEORY

by

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Summary

Risk homeostasis theory (RHT), as an explanation for the occurrence of road traffic accidents, has been criticised on a number of grounds but most recently by Evans (1985) who through analysis of traffic fatality field data concluded that there is "no evidence supporting it (RHT) and much evidence refuting it".

However the field evidence used by Evans (and indeed several other commentators on RHT) does not satisfy one or more of the requirements of an unambiguous test of RHT, which for such data is argued to include:

- (1) a measure of driver target risk level which is independent of accident rate
- (2) a measure of accidents which takes account of both frequency and severity
- (3) determination of risk in all domains of behaviour and
- (4) a time frame which is adequate enough to take account of feedback lag.

Nevertheless, given the difficulty, if not impossibility of satisfying these requirements for a good test of RHT, the question arises as to whether or not the theory is indeed testable. Examination of the postulates of RHT also raises questions about the internal consistency of the theory and the extent to which certain predictions made from it are valid.

RHT highlights the importance of feedback to drivers regarding the accident riskiness of their behaviour. However as Evans (1985) has concluded, "there is no justification for focussing on it as the sole controlling mechanism in driving". A recent psychological formulation of driver behaviour by Fuller (1984) which develops an earlier concept by Naatanen and Summala (1976) attempts a more comprehensive explanation of such controlling variables.

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F

THEORY FOR DECISION SUPPORT (Patrick Humphreys, London School of Economics and Political Science):

"Decision support systems" has been described as a rallying cry, and most sources which have attempted to develop a theoretical basis for such entities have concentrated on revamped systems design methodology or formalisms for data representation and inference (rules, production systems, etc.). Little of this work has addressed the fundamental question which have to be faced in the early stages of the system design life cycle: what needs to be supported? Who needs to be supported; and how should this support be understood and utilized within the decision process. How should knowledge of how to as well as what be shared between the computer based system (DSS) and the human activity (DSS) in the organization, or society? What constitutes organizational relevant knowledge, how is it to be conceptualized and accessed? How can we trade off present problem solving ability against future flexibility, or support for present, well defined procedures, against facilitation of future as yet undefined procedures?

Theory which informs the answers to questions like these is likely to be of a rather different character from that which graces present texts on Decision Support Systems. This workshop will concentrate on exploring possibilities concerning the nature of this theory. Three major papers are planned for presentation at the workshop in support of this enterprise, these are:

A cognitive design paradigm in the theory of choice
by Eric Nappelbaum, Institute for Systems Studies, Moscow

Theory of languages of user systems
by Gerard de Zeeuw, Subfaculty for Andragology,
University of Amsterdam

Structured clausal knowledge bases for DSS modular development
by Christina and Amílcar Sernadas, Faculdade de Ciências de Lisboa

It will also be possible to explore further any relevant issues raised in the pre-circulated paper on Intelligence in Decision Support.

Participants in the workshop will be able to make short presentation concerning their own experiences or ideas in relation to answering the above and related questions, but it is hoped that the majority of the workshop will be taken up in real discussion of theoretical and practical issues as they emerge. (If, perchance, the discussion achieves sufficient coherence, we could try subsequently to bring the points made together in a paper along the lines of "New directions for the theory of decision support").

Patrick Humphreys
Workshop Convener

COGNITIVE - DESIGN PARADIGM IN THE
THEORY OF CHOICE
E. Nappelbaum

In most of the contemporary models of choice the predominant underlying paradigm is that of the psychological measurement theory. In other words D.M. is regarded in them as a kind of a complicated transducer which have to convert the physical properties of available alternatives into the attitudes towards them e.g. in the form of the preferences which actually predetermine the ultimate choice. In doing so human D.M. first maps each alternative into its psychological attribute space (measurements of attributes) and then to convolve the latter into preferences (measurement of preferences) with the differentiation between the two stages dictated by the complicated nature of the over-all measurement task. In this sense the aim of the decision-making theory is to help a D.M. to map alternatives into his psychological space more accurately and to properly convolve the results of these measurements on the basis of special tests designed to reveal his basic attitudes seen as a kind of calibration factors of an instrument.

At the same time there exists a class of decision problems for which the main problem concerns designing a proper representation for the available alternative or in other words designing the psychological space into which the alternatives will be eventually mapped. Moreover for the problems of this kind this stage of the cognitive design is of a crucial importance and actually predetermines the outcome of the choice exercise.

The paper considers a cognitive-design paradigm which can be used to derive decision-making models for the problems of this kind.

The core of this paradigm is a variety of the balance principle prominent in psychology from the times of Hall. The paradigm explicitly recognizes three main components in representation of the choice situation a declarative or attributional one, an intencional or instrumental one and an attitudinal or value-oriented one and seeks to balance them within a representation it stives to design. The desired balancing presupposes certain "intersufficiency" of each of these components with regard to two others as well as their "consistency" in the sense that the designed representation pinpoint the alternative to be chosen.

The capabilities of the suggested approach will be illustreted by the analysis of wellknown paradoxes of Allais and Elsberg, and of varions established approaches to modeling of choice, e.g. Tverky's elimination by aspects technigue.

STRUCTURED CLAUSAL KNOWLEDGEBASES
for DSS MODULAR DEVELOPMENT

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SUMMARY

There are three main DSS Knowledge representation paradigms: the logical paradigm, the structural paradigm and the procedural paradigm.

The logical paradigm borrows tools from Mathematical Logic and identifies a Knowledgebase with a theory (for instance in the first order logic). Thus, the Knowledgebase is a set of theorems which can be obtained from the axioms using a fixed set of inference rules.

The structural paradigm puts emphasis on the structure of the facts composing the Knowledgebase. A set of fixed semantic primitives (abstractions) are provided to build the Knowledgebase. Examples are the popular conceptual modeling approaches used in database design, as well as the frame-oriented and other common approaches in AI applications.

According to the procedural paradigm the Knowledgebase is composed of active agents (e.g. actors) with definable reaction patterns.

Each of the three paradigms has some advantages, as well as some clear drawbacks compared to the others. The main

contribution of the logical paradigm is the unifying view of the Knowledgebase as a theory. However, it lacks structuring tools and control of the inference rules. It has been argued that no one can understand a logical information base with, say, 20000 axioms.

The structural paradigm provides some of the required organizational principles by giving a fixed set of semantic primitives (e.g. the entity and the event). However, inference mechanisms are closely related to the semantic primitives themselves and no general inference techniques are provided.

The procedural paradigm has the advantage of allowing direct implementations for the Knowledgebase access mechanisms, but it easily leads to a very low degree of understandability.

An important step towards the unification of the logical and the procedural paradigms was given with the development of Prolog and the fifth generation efforts. However, no serious effort was made to bring together the logical and the structural paradigms. It is the objective of this specific paper to provide a framework for this unification: the institutional framework.

The Knowledgebase is identified with a structured theory within the clausal institution. This structured theory is built using theory mappings that correspond to the semantic abstractions of the adopted structural Knowledge representation scheme. On the other hand, the Knowledgebase can be accessed through the clausal logic general purpose inference mechanisms.

Within this context, each DSS Knowledge representation approach corresponds to a library of theory mappings. Transformation tools from one DSS Knowledge representation approach to another DSS Knowledge representation approach can also be easily supported. Furthermore, new user-defined abstractions can be introduced at will, allowing the modular construction of the DSS Knowledgebase.

Such DSS structured Knowledgebases can be efficiently implemented in a Prolog environment.

INDUSTRIAL DECISION MAKING AND THE DESIGN OF EXTERNAL DECISION SUPPORT FACILITIES

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Robert de Hoog, Social Science Informatics, University of Amsterdam.

Introduction

Since the end of the seventies, the Dutch government has seen the stimulation of technological development as one of the key factors for revitalizing the Dutch economy. The improvement of the innovative capabilities of small and medium-sized industrial firms is an important aspect of this policy. However, the decision of such a firm to innovate or to use innovative technologies, depends to a large extent on the *availability of information* on these new possibilities. From research subsidized by the government, it has become clear that the major hindrances to an effective flow of information to manufacturers are not located at either the supply or the demand side. The main problems are in the distributive sphere, that is, *an effective transfer process is lacking*. This conclusion is confirmed by Moriarty and Spekman (1984), in their study on the use of information sources during the industrial decision and buying process. In order to get more insight into the preferred organizational structure for this transfer of information, the Dutch government has subsidized our research project which is the main topic of this paper.

Moulded in terms of decision theory and decision technology, the problem can be restated as trying to acquire knowledge as to how the design of external decision support facilities depends on the nature of internal decision problems of the industrial firms under consideration. As has been shown by Zakay (1984), the information search component of the decision process is considered by managers as one of the most important criteria for judging the quality of a decision. That is why decision support and decision aiding cannot neglect the information search component (see also Bronner, de Hoog, 1984a). This implies that empirical research has to study categories of recurring decision problems, the organizational characteristics of the firms involved and the need for information, in relation to preferences of those firms for external decision support facilities in order to promote an effective information transfer. In summary: the basic philosophy of the policy behind this research is that better information leads to better (more innovative) decision which in turn result in new economic opportunities.

Design of the research project

Given the diversity of the small and medium-sized companies, the project was limited to a small sector of this field with a high innovative potential: factories that produce machines for the food and chemical industries. The project was divided into two subprojects. First a self-completion questionnaire was sent to a sample of industries (n=123). This questionnaire contained questions concerning information needs, the information search process, use of informational inputs, organizational characteristics like R & D commitment, rate of growth, number of employees, new product development, internal information facilities as well as an evaluation of the status quo of information transfer. For a second project, a subsample (n=35) was drawn from the original sample. These managers were personally visited by an interviewer

who by means of a micro-computer elicited the subjects cognitive and preference structure for six different organizational structures for information transfer (a MAUD-like program, see Bronner, de Hoog, 1984b). The protocols of the computer sessions were coded and combined with the data from the first subproject, yielding an integrated data set for analysis.

Results

First we found that the information search behavior of most firms exhibited a wide variety of information sources, while most of the time this behavior was of an ad hoc nature. As far as external search of information can be considered, the kind of information sought could be clearly linked to six different types of decision problems facing the firms: decisions concerning production, decisions about applied technology, export decisions, marketing decisions, decisions concerning costs, decisions involving juridicial aspects. From the computer interview it became clear that the managers preferred two of the six hypothetical organizational structures for information transfer: both line-oriented, one available at regional and the other at national level. This preference was in no way related to the organizational characteristics of the firms, that is the preference holds across a wide variety of firms. But when related to the six different decision problems important differences did crop up. For example when a firm has to make decisions concerning production it prefers a centralized line-oriented facility, but when a firm is involved in an export decision it prefers a kind of 'information broker' who has inside information about the country that is the export target. Other relations will be elaborated upon in the full paper. Based on these results we advised the government to build an organizational structure that is largely line-oriented with a strong regional flavor, an advice that is now in the process of being carried out.

Conclusion

The topic of the paper is: how to design an organizational structure that acts as a decision support facility, making it as easy as possible for the decision maker to get the relevant information at the right time without too much inconvenience. In answering this question a relation has been discovered between the kind of decision problem at hand and the required information transfer structure. Notions from decision theory and decision technology proved to be helpful in eliciting the preferences of the decision makers involved.

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Decision techniques and social research: toward an integrated framework for problem-solving.

by:

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Abstract

Over the past century, two parallel streams of applied and scholarly activities have proceeded in almost complete ignorance of each other. The first, referred to here as the development and use of decision techniques*, has occurred largely in the interdisciplinary areas of planning, management and organizational studies. Scores of these standardized and repeatable procedures have emerged in recent years ranging from the highly quantitative techniques of operations research and formal analysis to the highly judgmental aids of futures research and group processes.

The second stream consists of several bodies of empirical, social and behavioral research conducted largely, but not exclusively within the realm of traditional disciplines. Examples include research traditions in the fields of behavioral decision theory cognitive psychology group dynamics, organizational change, innovation, and, the utilization of knowledge.

Both of these streams of activity seem to suffer from a common deficiency: they lack an organizing framework or set of contingency principles for ordering relevant techniques and empirical research findings along dimensions which are salient to both researchers and potential users. Indeed, throughout the research literature, the problem-solving or decision making process (the context for both streams of activities) is often treated as if it were a uniform and steady-state condition. The result with regard to decision techniques has been the over-use or misapplication of various aids with little or no regard for underlying assumptions and limitations. Persons with skill in the use of specific decision techniques -- much like the child when given a hammer discovers that everything needs hammering -- too often apply that technique indiscriminately as if it were equally suitable under all conditions. With regard to findings from the empirically based

research traditions, the result of this lack of an organizing framework is instability or extreme variance among findings within research traditions and scattering and fragmentation of related findings across traditions. Just as we oversimplify the nature of problems with regard to the application of techniques, so, it seems we also oversimplify our conception of problem solvers: people are not neutral information processors or cognitive machines but rather are influenced by the situation which they find themselves in. Complexity time pressure, stress, health, etc. all affect the outcomes of problem-solving deliberations.

This paper responds to the above deficiencies by developing a template or organizing framework which attempts to reconcile the two streams of activity with the realities of problem solving and decision making in real organizations. The framework explicitly recognizes that, while decision making in organizations is inherently a collective and often muddled phenomenon, there are, nonetheless, many distinctively different kinds of problem situations (ranging from problem formulation under conditions of relative ignorance to option selection under conditions of certainty) and that these situations have unique characteristics which make certain decision techniques or research findings less or more applicable.

The paper has three central topics:

- 1) it identifies and articulates central dimensions of a framework for organizing different problem types and decision situations;
- 2) it shows how the prescriptions and caveats which flow from the empirically-based research traditions can be organized and integrated using the above framework; and
- 3) it classifies, in a preliminary way, existing decision techniques using the same framework, on the basis of their nature and underlying assumptions.

It is discussed that such an integrated framework should be useful not only to the manager and decision maker (for technique selection and anticipating potential behavioral and organizational difficulties) but also to the research and scientific community (by identifying gaps both with regard to techniques and empirical research). The purpose of this framework is to promote the maximum utilization of the decision-relevant research and aids already present and to point out areas where such knowledge is lacking.

* The terms aids and techniques will be treated as synonyms.

DECISION SUPPORT AND DECISION MAKING IN REGIONAL PLANNING

by

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ABSTRACT

Regional planning is characterized by three principal concerns:

- The magnitude and complexity of the problem.
- The varying quality of data and analytical tools available to planners.
- The existence of conflicting multiple objectives.

In addition, it is normal to expect to have to operate within changing social, economic and political frameworks which have direct impacts on the processes by which alternative planning strategies are evaluated.

This Paper will present some of the results of a research programme which has resulted in the development and implementation of a computer aided regional planning system. This System (called the ISP System, for Interactive Spatial/Sectoral Planning) has been developed in an attempt to provide decision support for planners in their role of developing policy, predicting consequences and the analysis of results. The ISP System is currently installed in planning offices in Stockholm, Sweden, and in Perth, Australia.

The ISP System offers a user friendly interface with substantial use of graphics to assist the user in the operation of the programs. The user interface has been specifically designed to suit the needs of planners with flexibility to allow personalization of the operation procedures.

The ISP System represents one of the first attempts at implementing a decision support system in regional planning in a way that allows the inclusion of complex and comprehensive models to simulate various elements of regional systems.



SUBJECTIVE PROBABILITY (Pieter Terlouw, preliminary organizer)

This workshop deals with different aspects of probability judgments. The participants of this group will set up the conference program at the first workshop meeting of the conference

AN EMPIRICAL EXAMINATION OF THE EFFICIENCY
OF THE BAYESIAN STATISTICS IN AUDITING

by

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ABSTRACT

Competitive pressure is on in the accounting profession to improve both the efficiency and the quality of audit services. Among methodologies suggested in the literature for achieving these objectives is the Bayesian statistical approach to sample size decisions and error likelihood revisions. This paper reports on the results of two interrelated case-studies with 138 practicing auditors to investigate the efficiency implications of the Bayesian approach over the classical statistical approach in compliance testing tasks in auditing.

The results provide evidence in support of the efficiency of the Bayesian approach. (1) Using the Bayesian approach, experienced auditors decided on smaller sample sizes than those using the classical approach for the same level of confidence (95%). (2) Once the samples were taken, the study shows that the auditor's reliance on the Bayesian revision model resulted in higher efficiency than reliance on judgmental revision in two sample cases where auditors' behavior was conservative. While auditors were Bayesian in another two sample cases, they showed excessiveness in revisions beyond Bayes' model in a fifth sample situation. Implications for future research are discussed.

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THE PRINCIPLES OF EXPERT RESOLUTION

Introduction

Interest in expert resolution is chiefly motivated by the increasing use of subjective probabilities in scientific studies, particularly in quantitative risk assessment. However, the principles of expert resolution are also applicable in situations where probabilistic diagnostic systems must be evaluated.

The theory of expert resolution is concerned with the development of criteria for evaluating expert probability assessments. If experts are asked to make only non-probabilistic predictions, then it is quite easy to specify an appropriate criterion for evaluation: One expert is better than another if his predictions are more often correct. When experts are required to make probabilistic predictions, this simple criterion is no longer applicable. This paper is concerned with establishing the basic principles for a theory of expert resolution for probabilistic predictions.

Section 1 of this paper will present principles for evaluating subjective probability distributions. It turns out that whole distributions are easier to evaluate than single probabilities. Section 2 discusses an experiment recently carried out in the Netherlands which may be seen as validating the theory presented in Section 1. A final section discusses some problems associated with single probability predictions, and with the calibration scores which have been used in this case.

Theoretical considerations

Information

The information associated with a probability density P over the integers is defined as

$$I(P) = \sum_{i \in N} P(i) \log P(i)$$

where $P(i)$ is the probability assigned to the integer i . $I(P)$ attains its maximum value (zero) if $P(i) = 1$ for some i . Roughly speaking, smaller values of $I(P)$ correspond to a "flatter" density function. For densities having one central peak (as is usually the case for this type of subjective probability densities) $I(P)$ is a good measure of the degree to which the density is "spread out". Obviously, high information is a desideratum in expert probabilistic assessments. Other things being equal, we should prefer the advice of the expert whose probability densities tended to have the highest information.

Calibration

If an expert consistently provided highly informative density functions, while the true values always fell in the "tails" of his density functions, then we would say that his assessments did not have a high degree of correspondence with reality. Roughly speaking, calibration is intended to measure the extent to which a set of probability density functions "correspond to reality".

To get an idea how a calibration score could be defined, suppose an expert gives the same probability density function for a large number n of uncertain quantities. Call this density function P . By observing the true values for all these quantities we generate a sample distribution S' with $S'(i)$ equal to the number of times the value i is observed, divided by n . If in the long run $P = S'$, then we say that the expert is perfectly calibrated. The "distance" between S' and P can be measured by the relative information of S' with respect to P , $I(S', P)$:

$$I(S', P) = \sum_{i \in N} S'(i) \log[S'(i)/P(i)].$$

Larger values of $I(S', P)$ correspond to greater "distance" between S' and P . $I(S', P)$, however, is not itself a very good measure of calibration. Even if the expert is perfectly calibrated, it will seldom happen that P and S' are identical, as statistical fluctuations alone will produce a discrepancy between P and S' and hence will produce a non-zero value for $I(S', P)$. What we should like is an objective probability measure for observing a relative information score at least as high as $I(S', P)$, under the assumption that the expert is perfectly calibrated. In other words, we should like to know the objective conditional probability:

$$\text{Prob}\{I(S, P) \geq I(S', P) \mid \text{expert is perfectly calibrated}\}.$$

If the expert is perfectly calibrated, if P is concentrated on a finite number M of integers which include all observed values, and if we regard the uncertain quantities in question as independent, then as the number n of observations gets large, $nI(S', P)$ becomes chi-square distributed. The number of degrees of freedom is $M - 1$. Hence, we can calculate the above objective conditional probability by consulting a chi square table.

The above objective conditional probability is called the expert's objective likelihood function for the n observations, and we propose to use this quantity to measure calibration in expert probability assessments. Good calibration corresponds to high likelihood and is also a desideratum in expert resolution.

In the experiment described below $I(P)$ and $I(S', P)$ are used to define an information score and a calibration score.

The basic principle of expert resolution can now be stated as follows. With respect to the observations of n uncertain quantities, expert E_1 is to be preferred to expert E_2 if E_1 dominates E_2 with respect to scores for calibration and for information. If E_1 does not dominate E_2 with respect to both scores, then we can only define a preference between them by

deciding on some trade-off between information and calibration. We note that there is a sort of "natural antagonism" between good calibration and high information. Choosing the fractiles close together yields a high information score, but makes it "likely" that the true value will fall in one of the tails, producing a low calibration score. Under a superficial analysis, this natural antagonism would mask the fact, evident from the experiment discussed below, that "good experts" are better than "inferior experts" with respect to both calibration and information.

The experiment

An experiment was recently conducted at a large Dutch training facility for operators of technical systems in order to test the theory of expert resolution presented above. The experimental subjects fell into two groups. One group, the inexperienced operators, were in the last year of a five-year training program. All these subjects were between 20 and 23 years of age. The second group, the experienced operators, had all completed the training program. Their average was 36 years and they had on the average 15 years of practical experience.

The subjects were each given two tests, modelled on the tests of Raiffa (1982). A general knowledge test solicited fractiles for uncertain quantities in the general knowledge area, and a technical test solicited fractiles for uncertain quantities in the area of their expertise. The 1%, 25%, 50%, 75% and 99% fractiles were solicited. The experienced operators were thought to be the "better experts" for the items on the technical test, and we were interested whether they would score higher on information and calibration on the technical and general knowledge tests. The experiment is described fully in Cooke, Mendel and Thys (1984); a short summary is presented here.

On the general knowledge test, the experienced operators were not ranked significantly higher either with respect to calibration or with respect to information. On the technical test, however, the experienced operators were ranked significantly higher both with respect to calibration and information. This suggests that "being a good expert" is significantly correlated with better calibration and greater information. Being a good expert in the area of one's expertise, however, does not seem to make one a better forecaster in other areas.

The natural antagonism between information and calibration noted in the previous section was also observed in this experiment. Within the group as a whole there was a significant negative correlation between good calibration and high information on both tests. The same negative correlation was observed within the experienced and the inexperienced groups. (For the experienced group the correlation was not quite significant for the technical test. This might be attributable to the small sample size for this test; only 12 experienced operators took this test.) In other words, within each group, the subjects with the highest information scores tended to be ranked lower in calibration.

THE CREDIBILITY OF EVIDENCE OBTAINED BY PROBABILISTIC KNIGHTS AND KNAVES

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Most evidence concerning uncertain claims is mediated by human agents who are, as a rule, nonperfect transmitters. Unlike the task posed by some popular logical puzzles concerning "knights and knaves" (Smullyan, 1978), where a conclusive deduction is possible, with real-life witnesses the best we can achieve is a probabilistic evaluation of the uncertain hypothesis. In classical knights and knaves' problems deterministic solutions specifying both the truth value of the given evidence and the identity of the witnesses (whether knights or knaves) are based on the verbatim statements given in the problem. The complexities involved in considering probabilistic knights and knaves are two-fold: Not only are we obliged to formulate our conclusions probabilistically, but we have also to consider the prior probabilities of the different kinds of witnesses. We shall therefore consider only situations in which the identity of the witnesses is given. Such a problem was presented, for example, exactly half a century ago by Eddington (1935):

If A, B, C and D each speak the truth once in three times (independently) and A affirms that B denies that C declares that D is a liar, what is the probability that D was speaking the truth?

For simplicity's sake, all witnesses will be assumed to behave consistently with respect to the honesty trait. A constant parameter, $p \neq 1/2$, will denote a witness's probability of telling the truth across all situations. Let us distinguish between two types of witnesses: A witness inclined to tell the truth, i.e., whose $p > 1/2$, will be considered a probabilistic-knight, or "pight". A witness disposed to lie, i.e., whose $p < 1/2$, will be considered a probabilistic-knave, or "pave". We shall consider two simple models for the evolution of one's faith in the truth of an uncertain claim that is subject to multiple probabilistic testimonies. In both, the uncertain contention, such as the guilt of a defendant, will be denoted G.

In one, the Cumulative Model, n independent witnesses all testify that G is true.

In the other, the Chain Model, only the nth witness testifies. She claims that the (n-1)th witness said that the (n-2)th said that...the second witness said that the first said that G is true.

It will be shown that for the cumulative model, when all the witnesses are pights their evidence increases the credibility of G above the prior, and as n grows indefinitely, the probability of G tends to one. For the paves,

G's posterior probability approaches zero when n grows.

For the chain model, although the testimony of the n th of n pights also increases G's credibility, the longer the chain, however, the smaller that increment. When the chain's length grows indefinitely the posterior probability of G tends to the prior. The same limit is approached by a long chain of paves, though finite chains decrease G's posterior probability below its prior when n is odd, and increase it when n is even. Thus, when the chain is very long it makes little difference whether the witnesses were pights or paves and it does not even matter what the testimony was, as if the whole chain of witnesses did not exist (Falk, in press).

Several enrichments of the two models that would render them more realistic will be discussed and the relevance of these two models to various real-life situations will be considered.

Although the two models approach diametrically different conclusions, some anecdotal indications suggest the possibility that people occasionally credit the chain situation with a degree of belief that the cumulative model would have deserved.

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ON THE CALIBRATION OF EXPERTS AND LAY PEOPLE

Gideon Keren

Institute for Perception TNO

What type of skill is calibration: Can it be generalized or is it task specific? And how can it be improved? The present article reports two experiments addressing these questions. In Experiment 1 it is shown that meteorologists, known to be extremely well calibrated with weather forecasting, were not better calibrated than university students on a task of responding to general knowledge items. In Experiment 2, using university students as subjects, an attempt was made to improve calibration by specific instructions (warning subjects beforehand not to use absolute confidence ratings too frequently). Although the manipulation resulted in some improvement in calibration as suggested by formal measures of calibration, it is argued that this change is technical in nature and should not be interpreted as a real improvement in calibration. It is proposed that good calibration is task specific, and that real improvement in calibration can be achieved only by better knowledge of the underlying variables that affect the particular task (phenomenon). A preliminary model for calibration will be briefly presented.

The use of subjective probabilities for discriminating levels of partial knowledge concerning a test item.

Pieter Koele and Rob de Boo, University of Amsterdam

Abstract

The commonly used response method for answering multiple choice tests is of the forced choice type. The examinee has to select exactly one of the k possible answers, and he or she receives an item score of one if the selected answer is the correct one, and an item score of zero if the selected answer is a wrong one. Test score is then the sum of the item scores.

This response method has at least two disadvantages. First, many examinees do not like to gamble when uncertain, and they consider it to be unfair that they can give no indication of "partial knowledge". In the second place, the forced gambling introduces error variance into the distribution of the test scores, thus lowering the reliability and the validity of the test.

Response methods that try to overcome these problems have never obtained wide spread application, despite a not inconsiderable amount of encouraging empirical research (see Echternacht, 1972, for an overview). Finetti (1965) has contributed a theoretical study, in which he examines a variety of response methods for discriminating levels of partial knowledge concerning a test item, together with corresponding scoring rules. What he calls the most powerful response method is the method in which the examinee attaches a personal probability to each of the k answers of the test item, reflecting his or her belief in the correctness of the respective answers. The present study was undertaken to answer three main questions regarding the use of this so called probability testing:

- 1) Are examinees (university students) able and willing to handle the probability testing response method?
- 2) Which scoring rule is to be applied?
- 3) How are classical item and test indices affected?

A group of 119 students was asked to answer the same multiple choice test twice; one time in the usual forced choice way, one time using personal

probabilities. After completion of the tests they had to fill out a short questionnaire inquiring after their opinions about probability testing as compared to standard multiple choice testing.

The results indicate that psychology students have no problems in handling personal probabilities in this situation, and that they have no serious objections against this method. However, as far as the scoring rule is concerned two problems still have to be solved. First, the choice between the two most appropriate scoring rules, the quadratic one and the logarithmic one (see Van Naerssen, 1961), is not easy to make. Second, whatever scoring rule is selected, the determination of the cutting score of the test is (as yet) not completely satisfactory. In this paper some suggestions for solving these problems are proposed.

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Graham Loomes & Robert Sugden:

TESTING FOR REGRET AND DISAPPOINTMENT IN CHOICE UNDER UNCERTAINTY

Certain psychologically based alternative theories of choice under uncertainty, such as regret theory - see Bell (1982) and Loomes and Sugden (1982), (1983) - and disappointment theory - see Bell (1983) and Loomes and Sugden (1984) - can between them, explain a number of observed violations of standard expected utility theory, including the common consequence effect, the common ratio effect, and preference reversal - see Machina (1983, Sections 3 & 4).

However, much of the evidence concerning those violations was collected with the intention of testing conventional theory, and does not provide direct tests of the alternative models, nor give an indication of the relative importance of regret and disappointment.

This paper reports on recent evidence produced by experiments designed specifically to test and to distinguish between regret and disappointment. That evidence was obtained from a sample of 120 respondents who were paid for their participation according to the choices they made and the outcome of a random device. The results are largely consistent with predictions of both regret and disappointment models, but they also point to a number of other issues and questions that may reward further experimental work, some of which is currently in progress

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The Role of Fuzziness in a Theory of Decision Processes

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Of what value are fuzzy sets and fuzzy logic to the behavioral decision theorist? This paper will take a position between the unbridled enthusiasm of some proponents and the complete skepticism of many detractors. It will be shown that fuzziness is not a replacement for but rather a necessary adjunct to other forms of continuousness in an account of decisional mechanisms. In particular, fuzziness will be shown to be neither simply subjective probability in disguise nor just a consequence of a belief that everything is continuous.

In support of this position, the argument will be developed that the real value of the fuzzy approach is that it provides the means for discrete, propositional models of decision processes to deal with the continuous world in a way that preserves the meaningfulness and informativeness of gradations in subjective quantities while not being excessively susceptible to variability and perturbation. Such robustness under adversity is characteristic of human cognitive functioning. To achieve this end, it is necessary to distinguish, as fuzzy theories do, between physical continua, subjective continua, variability, and fuzziness.

In illustration of these points, a multi-level account of the psychological factors involved with a simple conjunctive decision problem will be presented. In addition, the place of this view of decision theory within the framework of a general fuzzy propositional approach to modeling cognitive processes will be examined. Fuzzy propositional models are the result of wedding the structural richness and expressive power of traditional semantic networks with the capability of fuzzy logic to tolerate and exploit continuousness. Models of this sort have proven to be successful in accounting for decisional subprocesses in other domains, such as pattern identification (e.g., Oden & Massaro, 1978; Oden, 1984), and conceptual categorization (e.g., Oden & Lopes, 1982).

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OVERCONFIDENCE RECONSIDERED

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One of the quality aspects of subjective probability distributions (SPD's) is accuracy: the degree of agreement between the subject's assessment distribution and the actual outcome. The concept of overconfidence (defined as, for instance, the number of times that the actual outcome lies outside the extreme bounds of an SPD) is directly related to the concept of accuracy. There is a large amount of research that reports people to be overconfident: the actual outcomes lie far more often than expected outside the extreme bounds of the assessed SPD's. To improve the quality of SPD's in this respect several suggestions have been made (Huber, 1974; Hogarth, 1980; Lourens, 1984). This paper will report on the implementation of some of these suggestions in experiments involving the specification of SPD's for proportions.

A first suggestion for improvement is to use more than one method for the assessment of SPD's and have the assessor reconcile the results (Huber, 1974; Hogarth, 1980). This suggestion is implemented in the interactive computerprogram SPAT (Subjective Probability Assessment Technique; Lourens, 1984; Terlouw, 1984; Terlouw, forthcoming). Experiments with SPAT showed no substantial improvement with respect to the overconfidence bias. In a repeated measurement subjects specified even tighter distributions and became more overconfident.

A second suggestion for improvement is to use extended questioning by letting the assessor make assessments also for the negation or the opposite of the problem at hand and by letting the assessor split up the problem into a number of meaningful categories or subproblems (Lourens, 1984). This suggestion was implemented as a preliminary interactive computerprogram before using SPAT, but an experiment showed subjects to become even more overconfident than in the experiment performed with SPAT only.

A third suggestion for improvement is to train the assessors through making them aware of their potential biases (Huber, 1974; Hogarth, 1980). A combination of this suggestion and a part of the second suggestion (the split-up into categories) was implemented in a paper-and-pencil experiment using a simple assessment method (specifying a best guess, a lower bound - specify the largest number of which you are almost absolutely sure that the right answer is above that number - and an upper bound - defined analogous to the lower bound -). The results with respect to the overconfidence bias were approximately the same as the results reported from the experiment with SPAT. A repeated measurement, however now, showed only a slight increase of overconfidence.

A fourth suggestion for improvement is to apply a so-called 'insurance policy', after the assesment the decision aider replaces a small fraction of the total probability density by a component almost uniformly distributed over the range of all possible outcomes (Molenaar, 1980). Calculations, using the SPD's from the first and third experiment mentioned above, point to promising results with respect to diminishing the overconfidence bias.

In conclusion, several suggestions made for the improvement of the quality of SPD's did not prove to be effective with respect to diminishing overconfidence. The reason seems to be that increased occupation with the task tends to elicit more overconfidence instead of realism. The use of insurance policies, by an assessment/decision aider, however, seems promising.

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COMPUTER DEMONSTRATIONS

We will have two sessions (which will be in parallel with specific paper sessions on Tuesday, August 27). The demonstrations will be devoted to presentations and discussions of computer software for decision analysis, decision aiding, or for research on decision making. (Organizer: Peter Lourens)

Colin Hopkins:

Decision Support Systems :
Tools or Assistants ?

(Abstract)

1. Introduction

This paper has arisen from research into the nature of adaptive dialogues expressed as a function of the interaction between the computer model of the user and the specific tasks the user is trying to achieve using the computer.

This paper outlines a perspective of human-computer interaction based on a representation of the goals and intentions that the user brings to a consultative session. This paper suggests that the responses of an automated decision support system will only be fully acceptable when researchers acknowledge the need for decision support systems to contain both knowledge of the domain and also wider knowledge of users as intentional agents within the context of a consultative session.

2. The Current State of Affairs

Existing decision support systems (e.g. expert systems) can solve problems to varying degrees of ability. What they lack, however, is the ability to provide acceptable justifications for their reasoning, and the ability to enter into a truly interactive dialogue with the user about the user's problem. This inability stems largely from the unequal nature of the interactive session between two different 'agents', the human and the computer. Each agent approaches the session with different, and sometimes opposing, goals and intentions. The user typically has varying domain knowledge, rich knowledge of the interactive session, and high expectations of what the outcome of the interaction should be. The computer, on the other hand, possesses varying domain knowledge and practically no representation of the goals and intentions that humans bring to interactive sessions.

March 27, 1985

One can view decision support systems as 'tools' or as 'assistants'; the former take no part in the decision making process other than to perform mundane calculations, while the latter enter into a dialogue with the user assisting her to solve her particular problem. Decision support systems are often programmed as a decision support tool whereas the questions typically asked of the system require it to possess the type of knowledge, and enter into a type of dialogue, we would normally require of a decision support 'assistant'. The resulting output from the computer may be highly unsatisfactory, from the user's point of view, because it has not been framed with reference to, or within, the context of these wider goals and intentions the user typically brings to an interactive session. Given that the goal of a decision support system is to aid the human user in solving his particular goal, research in planning and linguistic pragmatics suggests that computer dialogue should be framed not only in terms of the immediate problem, but with reference to the wider context of the decision support consultation, and the effects the computer's output will have on the user's representation of the problem.

3. Conclusion

This paper concludes that in order for a decision support system to be viewed as an assistant rather than as a decision support tool, it has to be given its own goals and intentions outside specific domain knowledge, and has to have some representation of the goals and intentions human users bring to the consultative session. The decision support system can only achieve this if it has some representation of the user, in terms of goals and intentions, and can frame its output with reference to this knowledge. Current work in the field of planning and pragmatics suggests possible formalisms that could be used to represent this type of knowledge. An example computer program, based on these formalisms, will be discussed.

On-line demonstration of DYSMOD-software

by

Dr Raino Keloharju

Helsinki School of Economics

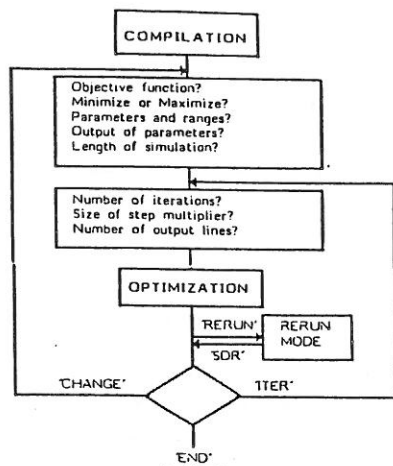
Relativity Dynamics (RD) is an extension of System Dynamics (SD), allowing the modellers in SD to optimize their models heuristically from a terminal in parameter space. The optimization procedure makes use of a specific software package, consisting of the DYSMAP programming language in SD and of the DYSMOD-software (DYnamic Systems MODeller and Developer).

In SD, the chosen systems are simulated on the computer. In RL, the use of DYSMOD gives two additional possibilities:

(A) Representative systems are chosen from the investigated class. This means that the computer acts as a model generator when the modeller(s) has(have) specified a set of potential models. Therefore the modelling procedure becomes a learning process where the modeller(s) analyse(s) and the computer synthesizes. The new methodology allows for the presentation of a cyclic problem in linear terms that corresponds to the way of human thinking.

(B) Obtained experimental data are processed by the computer. The data serve as the raw material for some decision rules which the computer uses in its role as model generator. Those decision rules could be replaceable algorithms (library programs, to be called on when needed). The stage of problem formulation can thus be separated from the stage of problem solution. A division of labour between substance modellers and algorithm developers is now possible.

- DYSMOD was developed in such a way that SD is a special case of RD
- Optimization in parameter space means that some model parameters are also variables for the heuristic optimization algorithm (Search Decision Rules) that is being used
- the systems that are generated are genetic as the occurrence of A is not necessary but is sufficient to explain the occurrence of B
- the optimization framework of DYSMOD in its basic form is shown below:



DYSMOD will be demonstrated with two small examples:

- (1) Without any use of the feedback theory, a model which generates a given S-formed growth curve is searched. This example relates to point (A) above
- (2) An algorithm partitions the optimization procedure for another simple model. The algorithm is a heuristic analogy for the Simplex rule in linear programming. This example relates to point (b) above.

Communicating insights from complex simulation models

Drs. Jac A M. Vennix, dr. Jac L.A. Geurts, Jan W. Gubbels: Catholic University of Nijmegen, p.o.box 9108, 6500 HK Nijmegen, the Netherlands

Formal economic models have become important aids in national economic decision-making. Even within the circles of the politically active, an elite seems to establish itself: those who understand and are able to use results from complex formal models have in many instances a certain advantage above those who do not (see a.o. Feldt, 1975). This is not a phenomenon only observable in economic decisionmaking. Formal models are used in several areas of policy-making (Watt, 1977, Greenberger a.o., 1976).

There are many reasons for the lack of effective and widespread use of the results of formal models. One has to do with a communication barrier that obviously exists at the science/public policy interface (Caplan, 1979; Duke, 1982). Simulations of large models are usually described in highly technical reports, which only a very few non-academic people can or will read and understand. One research-tradition tries to solve this problem by an integration of computersimulation with elements of gaming/simulation. The result is a technique called interactive simulation in which persons-in-roles in a question-and-answer-relationship with a formal dynamic model programmed on a computer, form the simulation of the system (Klabbers a.o., 1978, 1980; Van der Hijden, 1978; Geurts, 1981). The work reported here is part of that tradition. The project, of which the first phase will be described in this article, is aimed at the optimization (in terms of time, costs and results) of the procedure of man-machine simulation. It uses a formal economic model of the Dutch social security system as a case. The aim is to design a generic instrument based on experiential learning that will enable non-specialists to understand the dynamic behavior of a complex formal policy model. We will also test empirically whether the instrument achieves this goal. The instrument will have an interactive simulation as its base. Additional tools (such as diagram analysis and procedures for simplifying the model) will be included to facilitate the process of understanding the model used in the simulation. The project has the following phases:

1. development of the interactive simulation and exploratory research on its functioning;
2. design and construction of the additional tools for model understanding;
3. evaluation of the total instrument in a controlled experiment in which a non-simulation form of communication (the study of reports accompanied by verbal presentations by specialists) will be the control condition.

The project is currently in phase 2. Phase 1 was held necessary as a beginning because from the literature on educational impacts of gaming it was not completely clear whether a (man-machine) interactive simulation could

form a solid base upon which an instrument as intended could be built. Man-machine simulations of the type described below present a very special and difficult task to the participant a person or a small team is faced with the problem of increasing his or its understanding of the dynamic characteristics of a formal model by inputting decisions and collecting and assessing information about their effects. Most research on the educational impact of gaming does not deal with this type of games.

Phase 2 will be finished by the end of May 1985. Phase 3, the experimental evaluation, will be held between September 1985 and July 1986. The presentation by the authors will consist of a short explanation of the Dutch Social Security System and the economic model used in the simulation. Next the simulation/game constructed around this model will be presented in some detail. After that, as an illustration of the game's functioning, we present briefly some data we collected during the runs we have organized with this prototype in phase 1. Finally the design and construction of the additional tools for the understanding of the dynamic characteristics of complex formal policy models (the work of phase 2) will be described.

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SPECIFIC PAPERS FOR PLENARY SESSIONS

(in order of appearance in the program)

REASONING AND RISK AVERSION

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Although psychologists have studied human behavior under risk for more than thirty years, no clear consensus has been reached concerning such behavior. What is risk, and how do people respond to it? The answers to such questions should be at the heart of the psychology of risk, but they are largely not to be found in the extensive body of literature that exists on the topic. Instead, one finds primarily expositions of why and how people violate normative theories. In other words, psychologists have tended to prejudge the goals and, sometimes, the forms of decision under risk and to interpret people's behavior only in this light. I will present an alternative approach to risky decision making that is aimed at capturing the salient psychological aspects of risk both as people perceive it and as people respond to it in choosing among alternative risks.

The position taken is that an individual's responses to risk should be viewed as the acts of a goal-directed planner who is oriented toward improving his lot in some, usually local, time frame. These acts are viewed as reflecting at least the following three characteristics of the decision maker: (1) risks are represented psychologically in terms of the relative cumulative probabilities of the outcomes; (2) preferences among risks reflect primarily the relative likelihood that goals or aspirations will be satisfied; and (3) goals are often not set before the choice set is known but rather are created on the basis of an assessment of what is available.

Experimental evidence will be offered to support these claims drawn from studies of choice using both standard (but multioutcome) laboratory gambles and classic problems in the literature of risky decision making.

A PSYCHOLOGICAL STUDY ON THE COGNITIVE STRUCTURE OF RISK

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SSRI
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Problem

Within the last decade the evaluation of risk and risk management became an important topic of public discussion and also of social scientific research. This is true for the impacts of private activities like smoking or car driving and even more for large-scale technology developments like nuclear power plants. In this context, the determinants of risk judgment and the acceptance of risk are to be studied on an individual and a societal basis.

In an empirical study to be reported here, the cognitive structure of risk and risk related judgments was analysed. More specifically the following questions were investigated

- How do characteristics of the risk source influence the evaluation of risk and risk relevant aspects.
- What are the psychological determinants of these judgments.
- Do groups differ in what they mean by risk and how they evaluate risks.

Method

In a psychometric approach several groups of respondents gave judgments about risk sources with respect to different risk-relevant aspects. 24 risk sources were considered according to four characteristics: whether the risk source is an activity (private versus professional) or a housing situation (with technically versus environmentally induced risks), and whether risk primarily concerns accident potential or chronic health impacts. These characteristics led to eight classes each of which contained three risk sources. Four groups of subjects evaluated the risk sources with respect to eleven aspects, especially overall risk, individual and societal benefit and risk acceptance. In addition information about several covariates and about subject's attitudes towards environmental problems, technological development and postmaterial values was collected. The four groups (each

N = 20) were environmentalists, engineers, students of psychology and of technology. In addition ten risk researcher were included as 'experts'.

Results

The data analysis yielded the following main results:

- classification of risk sources according to the four characteristics mentioned above was meaningful: Risk sources from same classes were evaluated similar on risk relevant aspects and - by ANOVA - classes explained more variance than risk sources within classes.
- Groups show systematic differences in their evaluations of risk sources on risk relevant aspects.
- The judged level of risk and risk acceptance are quite well predictable by the considered risk-related aspects and attitudes.
- There are considerable differences in the relative importance of risk aspects when assessing the overall risk of a source between groups.
- The hypothesized cognitive structure of the psychological variables was mainly confirmed by means of causal analysis.

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Mon 16.10

A Comparative Analysis of Risk Perception in Hungary and the United States

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Decision Research, Eugene, Oregon

Risk is a fact of life. Yet, the facts of life vary from country to country, depending upon economic conditions, technological infrastructure, public health priorities, and natural hazards, among other things. Perceptions of risk may also vary from one country to another, depending upon what the news media choose to report, what people choose to discuss, what cultural norms are viewed as important, and what technical and political opportunities for control exist. Given these influences, one would expect the substance of risk perceptions to vary considerably, depending upon the information that people could and do have. It is less clear whether the structure of those perceptions will differ between countries. Will "risk" mean something different? Will the importance of different features of risk vary? Will the complexity of people's subjective risk space differ? These questions are explored by a replication in Hungary of research conducted in the United States. Results of these studies will be reported in this paper. Some highlights are as follows:

1. In many ways the risk perceptions of parallel Hungarian and U.S. groups was very similar. The "perceived risk factor space" that has been observed with diverse groups in the U.S. was also observed in Hungary, suggesting that it reflects fundamental aspects of the way that people respond to the hazards in their environment.

2. There were, however, substantial differences in the way that the U.S. and Hungarian samples judged the magnitude of various risks. The U.S. respondents showed a much higher level of perceived risk for almost every hazard.

3. Within each group, there were also some systematic differences in the ordering of perceived risks. The U.S. respondents were most concerned about the risks from newer, higher technology hazards such as chemicals

(food preservatives, pesticides, herbicides, medications), DNA research, nuclear power, and aviation. Hungarians were most concerned about the familiar, everyday hazards of electricity, home gas furnaces, motor vehicles, railroads, childbirth, boating, and mushroom hunting.

4. Differences in perceptions of benefit associated with these hazardous activities and technologies were less evident. The U.S. subjects judged police work and commercial aviation to be relatively more beneficial; the Hungarians saw X-rays, home appliances, and pesticides as relatively higher in benefit, compared to the U.S. respondents. Most other items were judged similarly beneficial by both groups.

The paper will conclude with a discussion of these results and some hypotheses will be put forth to explain why Hungarians see so much less risk in their world than Americans.

Mon 16.40

A DECISION-THEORETIC STUDY OF HANDLING LARGE-SCALE RISKS ^{x)}

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Over the past 5 years we have collaborated in a multidisciplinary project team to investigate methods, judgments and preferences revolving around "The assessment and evaluation of risks associated to the use of hazardous materials", especially LPG or liquefied petroleum gas, and SO_2 or sulfur dioxide as used in the production of beet sugar. The six-volume Final Report deals with technological, psychological and decision-theoretic aspects of this problem. The 80-page Summary Report (Vlek & Stemerding, with others, 1984), now being translated into English, gives a concise overview of the whole project.

The present paper summarises results and conclusions from the decision-theoretic subproject (see Kuyper & Vlek, 1984, and Vlek, Kuyper & Boer, 1985, for data and conclusions from the technological and psychological subprojects).

Company managers, civil safety inspectors and people living in the vicinity ("neighbours") of industrial sites harbouring LPG or SO_2 were asked to participate in individual as well as group sessions in which Gardiner & Edwards' (1975; Edwards, 1977) Simple Multi-Attribute Rating Technique (SMART) was tested for its usefulness and acceptability. In the first study SMART was fully applied to the evaluation of six schematically presented LPG gas stations by individual participants. We observed significant between-group differences in mean attribute importance weights and option-attribute scores. Little discrepancy, however, was revealed between intuitive and final 'calculated' preference orders.

In triadic sessions a manager, safety inspector and neighbour went through SMART together step-by-step. At critical steps, consensus was forced upon the triad by an averaging procedure applied to e.g. attribute importance weights and option-attribute scores. Again, between-group differences in weights and option scores were apparent, but little discrepancy was revealed between intuitive and 'calculated' preference orders.

Given these results we decided to apply SMART in a degenerated form in a parallel study conducted with groups of managers, safety inspectors and neighbours concerned with using SO_2 . This resulted in clear group differences in attribute importance rank orderings and in preference orders of sugar production options (e.g. with and without the use of SO_2).

Further exploring the road towards a social decision methodology we had the same respondents rank order a set of ten different societal groups potentially involved in social decision making regarding the use of hazardous materials.

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Our respondents appeared to come up with rather different sets of 'decisional influence weights' for the ten groups (e.g. managers assigning low weights to negative-interest groups, but neighbours attributing fair weights to the groups most directly involved). This could be related to systematically different assessments of the ten groups on a number of attributes entitling them to play a more or less important role in the social decision process.

Finally, we confronted our managers, safety inspectors and neighbours with six different methods or principles for making social decisions on the use of hazardous materials. Each briefly described on a card, these had to be rank ordered according to their believed suitability. This time, the three respondent groups revealed a fair amount of consensus about the two most preferred methods/principles, viz. 'professional (expert) judgement' and 'decision analysis'. One may wonder to what extent this result is replicated when the groups have had actual experience with the methods/principles judged.

The observed consensus about the most preferred decision methods did, however, not go without differences of opinion about the relative importance of certain parts or aspects of decision procedures. For example, all three groups endorsed the usefulness of technical risk analyses, but they differed in their belief as to the testability of estimated risks against a priori set standards. They also disagreed about the role lay-people's risk estimates should play in policy formation concerning hazardous materials' uses.

In an "Epilogue: social decision making about technological risk" to this empirical study, we conclude that:

- a. simple multi-attribute rating techniques can be helpful for people who don't know their preferences beforehand;
- b. a wise combination of 'professional judgment' and 'decision analysis' will probably be most acceptable to the parties in a 'big risk' controversy;
- c. safety decision problems can be ordered from small- to large-scale, and different methods/principles are suited for different types of problems;
- d. there is a variety of different 'decision approaches' which can be conveniently ordered along two dimensions: (1) standard setting (and testing) versus explicit decision analysis, and (2) a technocratic versus socio-craic way of handling the decision problem.
- e. large-scale risk problems not only demand explicit decision analysis, but also force the participation of groups having high stakes in the decision.

Our primary recommendation to the sponsors of this project - two government departments - was to stimulate the development and application of 'good' social decision procedures tailored to different types of safety problems.



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UTILITY, UTILITARIANISM AND JUSTICE

(Maurizio Mori - Lorenzo Peccati)⁽¹⁾

A B S T R A C T

We use an approach to von Neumann-Morgenstern utility in order to give a simple model for individual preferences.

We consider some problems concerning the use of these individual preferences to obtain a utilitarian social choice function.

The main tool suggested to evaluate the parameters of a social choice function is a general agreement about a fiscal system.

It is also described the possibility to cast Rawl's theory of justice in a utilitarian frame under current hypothesis about the shape of von Neumann-Morgenstern cardinal utility curve.

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Effects of Decision Training Among Managers and Professional Staff in Two Large Organisations.

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The efficacy of aids to decision making has received little or no attention in the published literature of psychology or management science. The supposed usefulness of training in techniques of decision decomposition is a largely untested assertion. It has been argued by the proponents of such techniques that "institutionalization" of the method in practice systematically facilitates higher quality decisions in the organisation. The purpose of the study outlined here was to examine the effects of such training in two large Australian organisations. The two organisations participated as part of a broader study of decision making in conditions of uncertainty. The organisations, Australia Post and Shell Australia, differ markedly in their organisation structure and the extent to which each has been involved in training in decision aiding.

Australia Post is a steeply hierarchical bureaucratic organisation with only limited exposure to decision aiding techniques. Shell Australia is characterised by a much flatter organisation structure and has been systematically training managers and professionals in decision decomposition techniques for ten years.

It could be expected that if claims made by the proponents of such aids are indeed valid, that subjects trained in a systematic procedure for decomposing decision tasks would report a more structured approach to information processing in such tasks than subjects with no training. Furthermore it would be reasonable to expect differences between the organisation in which decision aiding had been institutionalized and that in which a pilot training program only had been introduced.

27 randomly selected trained subjects from each organisation were matched with untrained subjects. Data was collected from each subject concerning their decision making activities using a combination of anonymous

questionnaire, researcher completed questionnaire and structured interview.

A principal components analysis of the questionnaire data from all subjects revealed six identifiable factors accounting for 75% of total variance. A discriminant analysis of the six principal factors failed to identify any statistically significant differences between trained and untrained subjects. No significant differences were found between organisations on any of the six factors.

Trained subjects in both organisations were significantly more goal oriented and frustrated by lack of goal clarity. Trained subjects in each organisation were significantly less satisfied with senior managements' effectiveness in reducing uncertainty in the organisation.

The effects of training in decomposition techniques as an aid to decision making processes in organisational contexts appear to be equivocal. The apparent frustration resulting from lack of goal clarity is a persistent effect among trained subjects.

Significant Sex and Age differences were identified in 3 of the 6 principal factors.

K. Friman & H.C. Blomqvist: On the Information Basis and Subjective Uncertainty of Inflationary Expectations. An Empirical Study.

Abstract

The purpose of this paper was to throw light on factors affecting the dispersion of individual inflationary expectations and the subjective uncertainty with which they are held. The sample of respondents was selected among business school students, 170 people altogether. Substantial differences between individual expectations were found despite the rather homogeneous sample. Systematic differences were found, however, only between first-year and "older" students, while there did not seem to be differences between men and women. A comparison of different proxies of uncertainty revealed, by and large, a good consistency and that first-year students and women are more uncertain than "older" students and men, respectively.

The expected rate of inflation could be explained fairly well by the perceived actual rate. Furthermore, the "age" of the respondent was a significant additional explanatory variable, suggesting that "younger" and "older" students might base their expectations on somewhat different sources of information.

There was a positive relation between uncertainty, measured as the interval estimate of the expected rate of inflation, and the inflation rate. Moreover, the perceived uncertainty about actual inflation was a significant explanatory variable. We did not succeed to "explain" very much of the variation in the individual estimates with our models, however.

A General Model of Judgemental Forecasting

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In this paper we describe and evaluate recent work on judgemental forecasting. We will be concerned with problems of structuring scenarios and with the evaluation of probabilistic forecasts. We will focus on problems of eliciting consistent, coherent and valid judgemental forecasts and we will describe the ways in which forecasting can be improved - either by aiding forecasters to make improved forecasts or by selection of those people with an ability to make realistic forecasts of the future.

Human judgement has been studied for many years by cognitive psychologists interested in decision-making and a general, but recently disputed, conclusion has been that human judgement is sub-optimal in many ways (Wright 1984, 1985). People have been shown to be inconsistent forecasters in that forecasts obtained by different methods (eg by point estimates, odds or reference bets) produce divergent assessments when converted to a common metric. Incoherence is common when recomposed probabilities of unions and intersections of events are compared to their holistic equivalents. People have also been shown to be "supradditive" when assessing the component probabilities of a set of mutually exclusive and exhaustive events.

Studies of the validity of judgemental forecasts have involved measuring calibration. For a person to be perfectly calibrated, assessed probability should equal percentage correct over a number of assessments of equal probability. Recently, Wright (1982) has shown that calibration of forecasts differs from that of probabilities given to veracity of general knowledge propositions.

We now have evidence that the imminence of a forecast period, the time duration of a forecast period, and the subjective desirability and perceived controllability of the events to be forecast exert influences on probability assessment and subsequent calibration.

Contd...

In addition we also know that individuals are consistent in their forecasting performance across a range of situational manipulations.

The research reviewed in this paper can be seen to address separately the construction of scenarios, the elicitation of consistent and coherent probability forecasts and the validation of judgemental forecasts. However, if a scenario is incomplete but accepted as realistic, then subsequent probability forecasts may be inappropriate. Similarly, if probability forecasts are inconsistent they cannot be coherent or valid. In turn, coherent forecasts may not be valid. In short, we believe that the focus of research on judgemental forecasting should now turn to the validation of forecasts. Forecasting aids such as our program "FORECAST" (Wright, Ayton and Whalley, 1984) aid resolution of inconsistent and incoherent forecasts and so provide a base-line for valid or well-calibrated judgements.

In order to see if our general model of the judgemental forecasting process is valid psychologically many questions have yet to be answered. Scenario generation requires identification of a plausible set of events. Thus the processes labelled in our sequential description of the forecasting process may be interdependent in other respects. Quite how these stages interact remains a matter of speculation at present but our judgemental forecast is that these problems will become a subject of future research.

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COMMUNICATING RISK AND OTHER ANALYSES TO DECISION MAKERS

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The problem of information display and presentation is one of the most serious problems standing in the way of more extensive and effective use of decision science. The vast majority of risk and other formal analyses developed do not clear minimal display requirements; viz. that the user adequately understands what the analysis can tell him that is useful for his purposes. This would be sufficient to guarantee the failure of the analysis as a practical aid, and failure is indeed more common than success.

Information display needs to be considered more generally as part of communication between decision makers and analysts, which may include communication of users' needs *before* an analysis is conducted, since this may affect the assimilation of information that then gets produced. This can be viewed as a problem of "human engineering" of analytic products, which we have argued since the early '70's, is the most critical failing in getting them used. In fact, we believe that human engineering should represent at least half the total effort that goes into decision-oriented analysis, and it rarely gets more than 5%.

A comprehensive communication methodology is proposed to help decision makers understand and use risk analyses for varied policy-making activities. The communication methodology covers: "bottom-line" utility and risk (both baseline and conditional on various options); the determinants of risk and their interrelationships; and the interpretation of risk analyses, in particular, uncertainty, sensitivity, and the integration of judgmental with other information.

An information presentation system is discussed within a broader framework of procedural guidelines. These guidelines address: matching information to user problems; formulating and formatting given items of information; appreciating the uncertainty, sources of evidence, and implications of the information; determining appropriate institutional arrangements; and managing the flow of information in both directions between user and analysis. Dis-

tinctive modeling concepts include: use-specific macro-models; plural analysis; making the black box transparent; alternative concepts and measures of uncertainty; and user override of variables within the model.

The goal is to produce a communication technology that is both practical and theoretically well founded. It builds on earlier DSC work in risk and regulatory analysis, in computerized decision aids, and on its interdisciplinary background in statistical decision theory, cognitive psychology and computer science. Applied material is used to stimulate and test methodological innovation. The communication methodology is exercised in the context of existing risk analyses and adapted to selected policy-making needs and regulatory case studies. The ultimate consequences of this research should include more extensive and more productive use of risk and decision analyses by both governmental and industrial organizations, and, more generally, an improvement in the practice of decision science through enhanced methods for its communication.

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Knowledge and Data in Predictive Judgement**Janet A. Sniezek****Johnson Graduate School of Management****Cornell University**

Judgements of quantitative variables can be made from any combination of empirical data, personal knowledge, or expert knowledge. In predictive judgement, the value of a criterion variable Y_e at time $t + k$ is estimated at time t . Generally, historical data based on values of the criterion at times $t - 1, t - 2, \dots, t - n$ are available. Human judges will interpret these data according to available knowledge about the variable and events pertaining to it. Knowledge may be limited to personal observations and assumptions, or may also include a collection of facts and reasonably valid assertions, i.e. expert knowledge. The purpose of this paper is to examine the manner in which knowledge and data interact in predictive judgement.

The proposed model describes how knowledge is applied in the process of making judgements of historical data. These judgements, evaluatory or descriptive in nature, result in new derived subjective values of historical and current criterion data. The operations to generate predictions are then applied to the derived, not actual, data values. The model shows how this interaction between knowledge and data should lead to predictable effects on judgement extremity, confidence, and perceived risk. Implications for judgement with expert systems are discussed.

Data in support of the model are obtained from a laboratory study of predicted prices of nine stocks by 99 judges. Two factors were varied experimentally: amount of information about the stock (a full page expert report from Standard & Poor, stock name only, or no information) and amount of historical stock price data. Results show that knowledge and data interact to produce more extreme judgements and higher confidence without an accompanying increase in prediction accuracy.

INFERENCES, SUBJECTIVE PROBABILITY AND FREQUENCY OF CORRECT ANSWERS:
A COGNITIVE APPROACH TO THE OVERCONFIDENCE PHENOMENON

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Calibration is a method to evaluate singular subjective probabilities empirically by means of relative frequencies. The subjects usually have to solve a large number of almanach-type questions and then to assign a subjective probability to each of the items. With this method usually "overconfidence" emerges, that is, subjective probability judgments are higher than justified by the relative frequency of correct answers for each class of items with a given subjective probability.

Social psychologists tend to interpret overconfidence as one of the many indicators of human inferential shortcomings. In contrast to this generalizing viewpoint, we postulate a more precise item specific analysis based on specific hypotheses about the cognitive processes behind the data.

The conceptual framework of this analysis is a cognitive process model that, summarizing several suggestions in the literature, distinguishes three phases: 1) problem solving, 2) development of subjective certainty, 3) translation into quantities.

The role of probabilistic inferences for 1) the correctness of items and 2) the subjective probability is analysed. If the knowledge representation can be understood, overconfidence can be predicted specifically only for a certain kind of items ("misleading" items), whereas even underconfidence can be predicted for other items.

Two types of 2-alternative geography items, resembling those used in former calibration research, were constructed to test the predictions, a) seven items concerning the population of large cities (e.g. "Which city has more inhabitants: Islamabad or Hyderabad"), and b) five items concerning the North-South-Relation of large cities (e.g. "Which city is more North: Rome or New York?"). Specific models for both types of items predict subjective probability and solution probability, and therefore over- and underconfidence.

The data of 43 subjects are compatible with the model.

The results show that the content of the knowledge structure of the individuals determines subjective probability as well as solution probability. For these two relevant variables not the quantity of evidence, but the quality of evidence, its content, is decisive. Models with predictive capacity for calibration can be constructed for inferences on propositional knowledge as well as for inferences on analogical represented knowledge.

The effect of "wrong knowledge", resulting in significant tendencies for wrong answers and solution probabilities $< .50$, is discussed.

In a second experiment the usual overconfidence phenomenon was replicated for singular probability ratings in the usual calibration paradigm. But, when asked for their frequentistic judgment about the same performance, subjects tended to be underconfident. Further considerations of subjective probabilities should try to explain the discrepancy between the two viewpoints of the same subjects on the same performance.

Judgement revision and the "locking in" phenomenon

Stuart Wooler & Lawrence D. Phillips

Hypothesis generation and judgement revision in the light of feedback was studied in a 'real world' task context - that of assessing fire risks for commercial premises - by adapting a computer-based 'expert system' for fire insurance underwriting (Phillips & Wisniewski, 1983) for experimental use. Subjects underwent training in fire risk assessment and subsequently performed a 4 stage judgemental task on each of 10 fire risks, employing information derived from fire surveyors' reports, as follows:

- 1) PRESCREEN - by deciding whether the risk is a priori acceptable or not.
- 2) CLASSIFY - into 1 of 9 possible classes of commercial premises.
- 3) ASSESS - evaluate the quality of the premises on 6 criteria.

On the basis of the above information input by the subject into the computer-based expert system, a risk rate (in the form of a number of pence per hundred pounds insured) was generated by the system. In the light of this, and the accompanying information presented on the VDU (see experimental conditions below), subjects were required to:

- 4) ACCEPT RISK, REVISE RISK or PASS ON RESPONSIBILITY FOR RISK TO A SUPERVISOR. REVISE RISK involved subjects iterating back to modify judgements at one or more of the PRESCREEN, CLASSIFY or ASSESS stages.

The experiment was conducted under 4 conditions which differed in the amount of information which accompanied the risk rate:

- i) no additional information displayed
- ii) inferential information displayed - consisting principally of a posterior probability distribution over 5 levels of risk from 'Poor' to 'Excellent' (derived from the priors built in to the system and from the information input by the subject), giving the subject some insight into the system's reasoning which led to the generated rate.
- iii) credibility information displayed. The credibility value is a model checking device (defined as the proportion of all possible combinations of assessments on 6 criteria made at the ASSESS stage which are less likely than the combination describing the current risk), where a low credibility value flags the subject that reconsideration of the risk may be necessary.
- iv) inferential information plus credibility information displayed.

A two stage hypothesis generation and revision model is presented which is supported by the data from this study - according to which judgment makers first assign a problem to a generic category or problem type, and then employ pre-stored information about the problem type to help in developing a specific detailed representation of the current problem (cf. von Winterfeldt, 1980). Presentation of

inferential and credibility information had considerable effect in increasing subjects' tendency to revise their opinions about the specific representation of the current problem (credibility information being more influential than inferential), but had no effect on subjects' revisions of the assignment of risks to generic categories. Subjects remained "locked in" to generic hypotheses about the data generator regardless of the nature and amount of presented information. The implications of this study for understanding intuitive hypothesis generation and testing - in particular the work of Gettys et al. (1980) - are discussed.

"Rigging" surveyors' reports so that some were more likely to give rise to low credibility values and others to 'non-normal' probability distributions provided further support that subjects were highly sensitive to the presented stimuli.

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TESTING AND REVISING HYPOTHESES: STRATEGY AND STRUCTURE

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Hypothesis testing has interested behavioral scientists and philosophers of science because it is seen as a central process in the formation of scientific and everyday theories, and in the ability to learn from experience. The task we focus on in our research is "rule discovery." Here, the goal is to determine the features that distinguish instances with a certain target property from those without it.

Wason (1960) invented an often-used rule discovery task with sets of three numbers as instances (e.g. 2,4,6). The experimenter has a defining rule by which some of these "triples" are targets, and some are not. After an initial example is given, subjects propose other triples, and the experimenter indicates whether or not they fit the defining rule. In this way, subjects test their hypotheses about what the rule must be. Subjects test instances they hypothesize to be targets ("+"tests") much more often than hypothesized non-targets ("-tests").

This preference for +tests (often called "confirmation bias") can lead to a false belief in a rule that is overly restricted. There may be target instances that the hypothesis misses, and only -tests can reveal these false-negative errors. We have shown, however, that the consequences of a "+test heuristic" depend greatly on the characteristics of the particular problem (Klayman & Ha, 1984). In the present study, we examine several factors that could affect the nature of people's hypothesis testing strategies and the effectiveness of a given strategy. First, we consider the relation of hypothesized to correct rule (Figure 1). Different types of tests are useful in each case: +tests reveal false positives (overlapping and surrounding

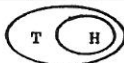
Figure 1.

T = Target set specified

by defining rule

H = Instances specified

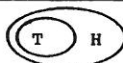
by hypothesized rule



Embedded
hypothesis



Overlapping
hypothesis



Surrounding
hypothesis

hypotheses), whereas -tests reveal false negatives (embedded and overlapping hypotheses). We examined the use of +tests and -tests in each environment, and the response to feedback from each. We also considered a more sophisticated type of test, in which the current hypothesis is tested against an alternative.

We used 18 different combinations of initial example and defining rule, using sets of numbers and sets of cities. To begin, each subject was given one of the initial examples (e.g., "the triple '2,5,8' fits the rule"), and he wrote down an initial "best guess" about what the defining rule was. He then

wrote out a new triple, and what it was he was "trying to find out." The experimenter indicated whether the new triple fit the defining rule, and the subject wrote down his current (possibly revised) best guess about the rule. This procedure was repeated for 18 triples. The subject received a bonus payment for every trial on which the best guess was correct.

Overall, subjects solved about half the problems. Those who failed at the task were even more disposed to +tests than were the successful problem solvers (15/18 versus 9/18). Alternative-tests accounted for 6 of 18 tests for successful problem solvers, and 2 of 18 for non-solvers. Thus, successful hypothesis testing was also associated with a willingness to test alternatives. We analyzed the 18 trials in three blocks: trials 1 to 6, 6 to 12, and 12 to 18. People who started a block with an overlapping or surrounding hypothesis were as likely to end up with an embedded hypothesis as a correct one. Those in the embedded condition tended to stay embedded. At the end, of the 26 subjects who failed to solve the problem, 17 had embedded hypotheses.

These results confirm the most basic finding of Wason's study and others like it. Hypothesis-testers are adept at discovering cases that fit their hypothesis but not the correct rule. They are much less adept at finding correct cases that their hypothesis misses. Thus, they often end up with an overly restricted hypothesis. However, subjects did not necessarily take an unsophisticated approach. Many subjects carefully tested the limits of their hypotheses. Also, subjects sometimes spontaneously shifted hypotheses, without being confronted with negative feedback, and then tested a new, broader hypothesis with +tests.

Another aspect of the larger hypothesis testing process is how people use feedback to guide the generation of revised hypotheses. The results of our experiment suggest that hypotheses have a sort of "natural order" (cf. Mervis & Rosch, 1981). Rules that are either much broader or much narrower than this natural level will be difficult to discover. Second, some features of a rule are naturally more "salient." The results of hypothesis testing lead the tester to add, subtract or change features of the hypothesis. Using independent assessments of salience, we found that more salient features are more likely to be added, and less likely to be dropped. Thus, there is a continuous interplay between hypothesis testing and hypothesis generation.

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Thu 9.20

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Towards a motivational account of cognitive biases

The number of studies which demonstrate existence of diverse cognitive biases in human judgment seems to have reached the climax. Whereas psychology of the 60-ties was almost entirely devoted to demonstrating the basic rationality of human lay mind, psychology of the late 70-ties, and particularly that of the 80-ties is set upon proving the reverse : we all err, we are prone to numerous illusions, fallacies, biases, effects etc., all of them violating some normatively prescribed rule of information processing. The present author has managed to identify over 30 of such stable tendencies in human judgment, all of them carrying an explicit label pointing to its non-normative character. They come from diverse areas of psychology, the domain of probabilistic reasoning being by no means the exclusive one as they include : attributional thinking and causal reasoning, covariation assessment, estimation of control and controllability, logical reasoning, hypotheses testing, attitude change, asymmetry of positive and negative evaluative judgments, influence of affect and evaluation upon human thinking etc. Two monographs which give a review of the phenomena, Nisbett's and Ross' (1980), and Kahneman's and Tversky's (1982), by no means exhaust the list.

It seems, however, that while we are relatively well acquainted with the phenomenon itself and with diversity of the forms it can take, we are also faced with an equal diversity of its explanations. The latter vary from a simple critic of human cognitive limitations (cf. Kahneman and Tversky 1982), which is sometimes enriched with indications on how to make up for at least some of them (Nisbett et al. 1983), through more or less exhaustive defending of lay cognitive rules which points to the adaptive goals those can serve (cf. Bjorkman 1984, Kruglansky 1983, White 1984), to a brave attack upon the very axioms of normative prescriptions supposed to underlie lay reasoning, together with formulation of an original, non-classic logic of human inference (Cohen 1977, 1982).

The present author's sympathies lie with the latter approaches. Following are the main ideas of the paper :

1. Out of the diversity of cognitive biases some are supposed to be more essential for understanding the way in which human lay mind works than others which, in turn, are claimed to be inferrable from the former ones. It is postulated that the most crucial cognitive bias which can account for over 20 of erroneous judgmental tendencies hitherto noted is human proclivity to ignore the base-rate information while making probabilistic judgments and to focus instead on singular information.

2. It is hypothesized, however, that the neglect of base-rate information is not an error as it has been suggested by normatively oriented researchers but a deeply rooted tendency with high biological significance. The tendency is responsible for the ability on the part of human organisms to structure their environment in terms of the "figure-ground" relations which, in turn, is a prerequisite of taking on a directed action, ascribing it an affective valence, and protecting the dominant direction of the action against competing alternative courses which could disrupt the process altogether. As such the tendency should be pronounced with respect to involving content areas and objects which bear affective significance while it should be diminished with respect to events which are either affectively neutral or, for that reason or another, should be neutralized.

3. It is thus claimed, in line with argumentation provided by Cohen (1977) that people will generally tend to function in line with the non-classic, "Baconian" probabilistic calculus which is not based on a frequential conception of probability, as this carries an overall higher pragmatic significance in situations which call for action involvement. However, in contrast to Cohenian argument, it is also hypothesized that people will be able to switch to such a manner of information processing which does take base-rate information into account and thus has a "frequential" character (be it "Pascalian" - to use Cohen's terminology once more - or any other). This should happen when for adaptive reasons the direction of the action taken is to be reflected upon and corrective measures are to be taken with respect to it.

4. Theoretical argumentation for these claims will be developed and empirical arguments collected within several domains of psychology (e.g., attribution theory, decision making, and clinical social psychology) will be presented to support this line of reasoning.

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Intransitivity in Choice Behavior

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Transitivity is a compelling desideratum of choice and preference. Perhaps no reason for being transitive is as intuitively compelling as the very requirement for transitivity itself. Nonetheless, distinct penalties attach to intransitive choice patterns, most notably their non-extendability, their vulnerability to agenda manipulation, and their exploitability as a money pump. These difficulties attend intransitive choices irrespective of the setting in which such choices might be encountered. Nonetheless, in the domain of social choice, even though the majority rule is not transitive, it has remained one of the most attractive rules for integrating individual preferences into social decisions, and its use is not considered irrational. One question this paper will explore is why our intuitions differ about the acceptability of intransitivities in individual versus in group choice.

However, even in individual choice, the observation of intransitive choice cycles (i.e., the observation that some decision maker consistently chooses A over B, B over C, and C over A) cannot always be taken to indicate an intransitive preference, and is not necessarily a pattern upon the detection of which the decision maker would wish to alter any of the choices in the cycle — or would know how to. We offer a classification of choice settings in which systematic intransitivity might be observed in individual choice.

1. The individual decision maker may be acting as proxy to a group, blurring somewhat the distinction between individual and group choice. Consider, for example, a benevolent dictator making decisions on behalf of her subjects, who wishes to choose for them that which they would have chosen for themselves.

2. The choice set may consist of multi-attribute alternatives, which might be difficult to evaluate independently. For example, each dimension may be only ordinally ordered, and the values of the alternatives on the various dimensions be incommensurable. In such cases, the decision maker might substitute an additive difference rule for an independent evaluation procedure. Such rules, if they are non-linear

(e.g., the majority rule and the lexicographic semi-order), will not be transitive. There are sound psychological reasons to expect that sometimes non-linear additive difference rules might appear attractive to the decision maker faced with certain multi-attribute alternatives, especially if their intransitivity is not transparent.

2. The intransitivity may be a direct reflection of some objective property of the alternatives. For example, random variables A, B, and C exist such that $p(A > B) > .5$, $p(B > C) > .5$, and $p(C > A) > .5$. If one wishes to maximize the probability that the alternative of one's choice will exceed the rejected alternative -- and some payoff structures call for such maximization as optimal -- then A should be chosen when the choice set is A and B, B should be chosen when the choice set is B and C, and C should be chosen when the choice set is A and C. Concrete examples will be provided.

The above examples provide paradigmatic cases when intransitivity might be observed in individual choice. Clearly, real-life choice problems where intransitivity is exhibited will not always be clearly and uniquely classifiable into these categories. Hence, it will not always be clear what changes to recommend, if indeed any, when intransitive choices are observed in individual choices. Some guidelines for diagnosing the causes of such intransitivities are discussed, as well as some thoughts on the common presumption that intransitive choice is irrational.

Decision Support System CLASS(CLASSification System)

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ABSTRACT

Problem of classification by a human being of a set of objects, characterized by multicriteria estimates is wide spread in human practice. Medical diagnostics is one of the tasks of such class.

In this article a new method for diagnostic decision support system construction is described. It is based on a direct classification by an experienced expert of possible diagnostic signs. Characteristic features of this approach are the following:

- 1) natural language for gaining expert information (we don't use subjective probabilities, points, belonging functions, et.c.);
- 2) completeness of developed decision rule - decision classes are defined for each possible combination of diagnostic signs;
- 3) specially developed method for rational choice of mostly informative questions for interviewing an expert. This allows substantial (in 30-50 times) decrease of a number of questions, necessary to build a decision rule;
- 4) for each decision class (for each disease) sets of main and auxiliary diagnostic signs are defined. Main ones are used while making a diagnosis, auxiliary ones - for its more precise definition (differential diagnosis);
- 5) special procedures to check and correct contradictions in experts' information based on additional interviewing of an expert.

The system designed was used in a number of practical tasks: construction of expert medical systems, development of a system for R and D results evaluation.

DECISION JUSTIFICATION, INFORMATION STRUCTURE AND THE CHOICE OF DECISION RULES.

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People not only make decisions, they frequently must justify them to others as well. Justifying a decision can grosso modo take two forms: first, an argumentation in terms of the qualities of the chosen alternative and second, an argumentation in terms of the process that has been followed to arrive at the decision. Obviously, the second form is the most interesting one from viewpoint of decision theory, for it contains information about the decision making procedures that are used during the decision. An important question in this respect is, whether the way decisions are made depends on the known need to justify these decisions afterwards.

In the full paper we study this problem by investigating the decision rules people did use in a decision making experiment in which one half of the subjects was told that they had to justify their decision making afterwards to a panel of experts and the other half not. Roughly speaking the hypotheses to be tested were based on the assumption that people tend to reduce cognitive strain in decision making by employing less effort evoking decision (non-compensatory) rules, unless they must justify their decisions to other people. Justification asks for a more balanced or reasoned decision making process, mostly leading to the use of rules requiring more effort. Since cognitive strain will also be lowered if the necessary information is better structured, more difficult rules can in that case be used without spending more efforts. So, a stronger tendency in the application of the more difficult compensatory rules must be expected when highly structured information is available.

To be sure of the decision rule people did use in the experiment, they had to choose one of four procedurally described rules, each reflecting a different decision strategy: the average (AV) rule, the least objections (LO) rule, the conjunctive (CON) rule and the lexographic (LEX) rule. All participants had to decide according to the selected rule five different political scenarios to pull the Dutch economy out of the recession. These scenarios were presented in two different formats: one format had a "story-like" structure containing political and economic considerations, three political measures, and the effects of these measures on ten critical economic and political variables (the low-structure condition). The other format contained exactly the same story but, in addition, the information was structured in the form of a matrix in which the measures and the effects on the ten critical variables were outlined clearly (the high-structure condition). Taken together, this leads to a two by two factorial design with the justification conditions as factors.

Forty participants, screened on some basic knowledge about political and economic matters, were sampled from the population of Amsterdam. After training these subjects in the use of the four decision rules, the experimental conditions were introduced and the subjects were invited to select one of the four rules for deciding which of the five scenarios they should prefer. After this had been done all the subjects were interviewed on the same questions; one half by a panel, the other half by a questionnaire.

The experimental conditions did lead to effects. Analysis of variance showed that subjects in the justification condition found the task significantly more difficult, while subjects in the high structure condition found it much more easy to use the procedural descriptions of the decision rules. No manifest influence of the need to justify was found on the selection of the decision rules. Only a latent effect in the direction of the more stringent decision rules was noticed for the justification condition. The high vs low structure condition did show a significant effect in the direction of selecting compensatory rules more frequently in the high structure case, though this was mainly due to the significant greater preference for the LO rule in this condition. This finding could be explained by the fact that the information was structured in such a way that it permitted by far the easiest "mapping" onto the LO rule. It provides an explanation too for the stronger latent effect on this condition towards more pessimistic rules.

From the results it becomes clear that our assumption about subjects simplifying the task when possible, is refuted. Nearly one third of the subjects selected the average rule and they were equally distributed over the experimental conditions. Furthermore no differences did occur in the number of attributes used. We strongly got the impression that it is not "social pressure" or "cognitive strain" that matters, but familiarity with a rule. The average rule seems deeply "socialized" and that could be the reason why people adhere to it, even when it is difficult to apply.

As a last point we stress that the structure of information definitely seems to influence decision making behavior. A point that is often overlooked when experimental results are generalized. Specific information structures can elicit decision behavior that would possibly not have occurred when another information structure is available for the same decision making task. A word of caution is therefore justified when decision making experiments are designed (see also Phillips, 1983).

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**Ambiguity and the Market for Protective Services:
A Psychological Perspective**

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As originally demonstrated by Ellsberg (1961), uncertainty or ambiguity concerning probabilities can have important effects on hypothetical choices made between urns. However, the ability to explore ambiguity in more ecologically relevant settings has been hampered by the lack of psychologically-based theories that predict the conditions under which ambiguity will or will not affect decisions. A recent exception is the ambiguity model developed by Einhorn and Hogarth (in press). In the Einhorn-Hogarth (EH) model, it is assumed that ambiguous probabilities are assessed by way of an anchoring and adjustment process. Specifically, people first anchor on an initial estimate and then adjust this by mentally simulating/imagining other values the probability could take. It is further assumed that the net impact of this adjustment process is affected by (a) perceptions of ambiguity (the greater the perceived ambiguity, the more mental simulation is involved), and (b) attitudes toward ambiguity in the circumstances. This latter variable captures the notion that in imagining alternative values of the probability, people may accord more (or less) weight to values greater (or smaller) than the initial estimate. Responses predicted by the EH model are represented algebraically by a nonlinear function of the initial probabilities that is regressive with respect to the latter and governed by two parameters that capture, respectively, perceived ambiguity and attitudes toward ambiguity in the circumstances. It is important to note that in addition to predicting ambiguity aversion, the model also predicts situations where ambiguity will be preferred.

Since the EH model predicts circumstances under which probability assessments will or will not be affected by ambiguity, there are several reasons why it is illuminating to examine the market for protective services from this perspective. First, prices provide an operational dependent variable that can be linked directly to assessed probabilities. Second, even if buyers and sellers of these services agree on the same initial probabilities, differences in perceived ambiguity and attitudes toward ambiguity can induce significant asymmetries. This paper explores the implications of these asymmetries for

two types of market, futures and insurance. For the former, the notions of "ambiguity sensitive" and "ambiguity insensitive" positions are introduced with respect to "gambles" involving mixed payoffs (i.e., possibilities of gains and losses). These notions are then used to examine the effects of taking certain positions in futures markets and to explore how agents can systematically exploit the positions of others, or conversely be exploited. Predictions of the EH model for insurance decision making are explored by considering asymmetries between perceptions as well as attitudes toward ambiguity by buyers and sellers. These lead, inter alia, to predictions of when buyers (consumers) and sellers (firms) are more or less likely to agree on prices for insurance and where firms can exploit consumers' willingness to pay. Predictions of the EH model in respect of both futures and insurance are supported by experimental data using economically sophisticated subjects.

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SUPPORTING PROBLEM STRUCTURING IN STRATEGIC DECISIONS

by

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Abstract

The understanding of the conceptualization of decision problems by stakeholders provides a basis for designing the procedure and for selecting the methods and techniques on supporting the decision making process.

It has been revealed in several studies /Mason, Mitroff, 1981; Kleindorfer, 1984; Vári, Vecsenyi, 1984/ that there can be significant differences in views of the members of an organization concerning /i/ the problem to be solved, /ii/ the objectives and the hierarchy of goals, /iii/ the past and future states and events of the environment, and /iv/ the alternative actions and their consequences.

For exploring and representing these views, several techniques have been developed. Toulmin /1958/ suggested a form of analysis of arguments which was developed by Mason and Mitroff /1980/ for structuring debates on policy issues in organizations. Saris and Gallhofer /1984/ designed a method for determining the structures of the argumentations in foreign policy decisions.

Shank /1975/ developed a method for the graph representation of conceptual information processing, while Axelrod /1976/ suggested the method of cognitive mapping for describing the multilevel structures of decision problems.

How these techniques, and approaches can be used in supporting decision processes? Our paper attempts to offer an analytic tool combining some elements of the above techniques which is

appropriate for framing documents, personal interviews as well as group discussions, with the aim of identifying the different types of uncertainties to be handled in decision support /Berkeley and Humphreys 1982/.

Analysing the cases of supporting real strategic decisions, our paper demonstrates the applications of the suggested tools by stakeholders in conceptualization of the problem, in revealing uncertainties and differences in opinions and also in selecting decision support methods.

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LAY ESTIMATES OF ANNUAL FATALITY RATES

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ABSTRACT

First a summary of research on lay people's estimates of annual deaths due to any kind of causes is presented. A brief outline is given of research done by Lichtenstein, Slovic, Fischhoff, Layman and Combs (1978), Green (1980), Slovic, Fischhoff and Lichtenstein (1979), Vlek and Stallen (1979), Renn (1981), Von Winterfeldt, John and Borchering (1981).

We then discuss three main questions:

- 1) How accurate are lay people's estimates of the number of deaths in an average year compared with the (statistically) recorded mean frequencies (or expert estimates)?
- 2) Can any regularity be found in the (mis)judgements?
- 3) How can consistencies be explained?

We bring forward arguments to show that researchers who claim that lay people estimate absolute annual numbers of deaths reasonably well, base these conclusions on methodologically weak grounds. First, in some of the research logarithmically transformed scores were used, which artificially raise correlations. But, more important, in nearly all studies mentioned above correlation coefficients were used as indications of accuracy, which is highly questionable in our view. Correlation coefficients merely measure linear associations between variables, whatever this linear relation may be. Even if the best fitting regression line strongly deviates from the line $x = y$ a high correlation will still be found.

We suggest a more suitable measure of association, the 'coefficient of identity' (from Zegers and Ten Berge, 1983). This measure, among other things, takes into account absolute differences between judged and true frequencies. After re-analyzing the data from the various studies comparing the correlation coefficients and coefficients of identity the

results in each case are quite different. For example Lichtenstein's data show a drop from 0.71 to 0.10 (using untransformed scores), Vlek's data from 0.84 to 0.25 and Green's data from 0.96 to 0.38 (values of the coefficient of identity can be compared with correlation coefficients and can also range from -1 to +1). We conclude therefore that lay people make poor absolute estimates.

The question of consistency in the (mis)judgements of death frequencies is discussed for each study as well as for all studies taken together, in which case we looked at stimuli which were used in two or more studies. In the former case a fairly high degree of consistency can be found, whereas in the latter cases the overall level of consistency is very low. We evaluate several theoretical explanations to account for these findings. The way stimuli are presented and answers are elicited ('contextual effects') rather than characteristics of stimuli (e.g. the availability of examples) appear to be important factors in determining patterns of misjudgements. For example the range of the presented stimuli in the studies correlates -0.80 with the slope of the regression lines that were found.

MENNO WOLTERS

Decision Making in the European Parliament

The present study reports on both theoretical and empirical activities. A typically theoretical endeavor is the search for the connection between the interspace politics approach to roll call analysis and representatives of two families of decision making theories, Bronner & De Hoog's additive-difference model and Tazelaar's theory of mental incongruity. At the start of the project, the first research problem was formulated as:

- RP₁ How can the interspace politics models of roll call behavior be deduced from, respectively, a decision theory and a theory of cognitive balance?

This slightly more general phrasing of the first central question soon opened the eyes for an integrated approach to the formalization of either theory of individual decision making. The fruit of this activity will be reported in Chapter 2 as the conclusion that Tazelaar's and Bronner & De Hoog's theories are not to be regarded competitors. This in turn affects quite heavily the task that was set for Chapter 3 as:

- RP₂ Which model(s) of roll call behavior provide(s) an optimal description of the roll calls in the European Parliament?

It was originally hoped that the answer to the second research problem would by the same token be a comparative test between the theories of individual decision making. The conclusion of Chapter 2 made this impossible. Instead, Chapter 3 will study the internal validity of the general (combined) theory of decision making in comparison to the interspace politics models, with a multi-method approach of roll call analysis, content analysis, open and structured interviews and questionnaires, and observation. The conclusion of these endeavors is quite negative. Bronner & De Hoog's and Tazelaar's theories of individual decision making do not explain in an adequate and consistent manner what is going on in the European Parliament when it makes a collective decision.

Although at the start of the project the optimism predominated that at least one of the theories would yet at least partially explain the decision making behavior of the MEPs, a certain difference between purely individual and collective decision making behavior was already expected, as was shown above. That is why and how the five hypotheses of the previous section guide the task set for Chapter 4, to extend the theory in order to cover collective decision making behavior. Thus:

- RP₃ In what respect(s) does parliamentary decision making behavior differ from other human decision making? In conformity with:
- a) the aggregation hypothesis?
 - b) the ideology hypothesis?
 - c) the predictability hypothesis?
 - d) the coalition hypothesis?
 - e) the barrier hypothesis?

Chapter 4 reports about both the theoretical extensions developed with the help of the hypotheses, and a couple of empirical tests against data from the European Parliament. Incomplete as the number of tests is to evaluate the model as a whole, it nevertheless produces some inconsistent results which will be discussed at the end of Chapter 4.

The empirical studies dealt with in Chapters 3 and 4 contain, apart from their theoretical meaning and implications, sufficient descriptive information about the European Parliament to justify a Chapter 5 based on:

- RP₄ Into what direction is the formation of European transnational groups and of coalitions of these groups, inside the European Parliament, developing since 1979?

It is tempting to use the expression "European integration" instead of the vague "direction", but Chapter 5 will show that it is uncertain whether, rather than how, the European Parliament has developed toward more European integration.

Proposal for a specific paper:

*A criterion for the substitutability
of objective procedures for judgments of quality*

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Abstract

In many situations where quality (of, e.g., scientific or artistic plans or products, job or school applicants, property, or even life in general) is to be assessed, a dilemma arises between objective and judgmental procedures. Traditionally, psychological researchers have advocated the dismissal of judgments in these situations; Robyn Dawes, for example, has made a plea for "Slitting the Decision Maker's Throat with Occam's Razor". The arguments in favor of objective procedures are twofold: They tend to be more fair in the sense of equal treatment and transparency, and they tend to be more efficient both in terms of reliability/validity and in terms of cost. The persistence of judgmental approaches can be partly explained from improper motives, such as a discriminatory conspiracy between the judges and the majority of the judges, and the tendency to protect professional authority.

Even so, valid objections against exclusive reliance upon objective procedures can be brought forward. A theoretical objection is that such procedures represent operationalizations of an intended construct (i.e., quality), and are as such more

or less deficient. Specifically, "quality" is a construct with important emergent aspects that by definition cannot be covered by a prearranged procedure. The pragmatic counterpart of this theoretical objection is that objective procedures tend to elicit unintended and often undesirable side effects on the part of the judges, who will strive for a maximum score instead of maximal quality. Objective procedures thus exert a corruptive influence in the sense that the rational subject is tempted to exhibit behavior making a cosmetic angle with truly productive behavior.

The solution to be proposed in the dilemma between objective and judgmental procedures is to apply a more stringent criterion for the substitutability of objective procedures for judgments: Not only should objective procedures be more efficient in terms of their observed validity/reliability in relation to cost; also, their true component should be perfectly correlated with the true component of the judgments, which serve as a criterion. In other words, the objective procedure should not contain reliable variance that is uncorrelated with the judgments, and vice versa. If the procedures are thus equivalent, no unintended side effects will be elicited by the objective procedure. As a consequence, a judgmental approach may be preferred over a more reliable and/or valid objective procedure. If equivalence cannot be demonstrated, attempts should be made to explain the discrepancy in terms of other variables. Conceivably, a satisfactory explanation can be found in some cases. If so, the side effects upon applications of the objective procedure are intentional and may be defended as being desirable.

The paper will discuss some of the many implications of the equivalence paradigm in the areas of judgment of quality, selection, and psychological concept formation.

CONFERENCE PUBLICATION

Selected proceedings will be published in a book edited by Berndt Brehmer, Helmut Jungermann, Peter Lourens and Guje Sevón. The book will be published by North Holland. It is our intention to have the book out during Spring of 1986. This means that there will not be much time for the editorial work, and we therefore ask all those who want to have their papers considered for inclusion in the proceedings to help us by bringing four copies of their papers to the conference and handing them over to the editors at registration.

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for books. Smith, E. and H. Jones, 1964. Evoked potentials and selective attention. Geneva: Atom Press, p. 16.

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Sernadas, Amílcar	Portugal
Sevón, Guje	Finland
Shapira, Monica	Israel
Shapira, Zur	Israel
Sherris, Graham	United Kingdom
vir Singh, Jitendra	Canada
Slovic, Paul	USA
Snizek, Janet A.	USA
Steve, Gerardo	Italy
Strandvik, Tore	Finland
Summala, Heikki	Finland
Svensson, Ola	Sweden
Terlouw, Pieter	The Netherlands
Thaler, Richard	USA
Thüring, Manfred	Federal Republic of Germany
Tyszka, Tadeusz	Poland
Wallin, Jan	Finland
Vári, Anna	Hungary
Vastag, Gyula	Hungary
Vecsenyi, János	Hungary
Weber, Elke U.	Canada
Weber, Martin	Federal Republic of Germany
Vennix, Jac.	The Netherlands
Wennerström, Ewa	Sweden
Verplanken, Bas	The Netherlands
Winterfeldt, Detlof	USA
van den Wittenboer, Godfried	The Netherlands
Vlek, Charles	The Netherlands
Wolters, Menno	The Netherlands
Woller, Stuart	United Kingdom
Wright, George	United Kingdom
Wärneryd, Karl- Erik	Sweden
Zakay, Dan	Israel
de Zeeuw, Gerard	The Netherlands

Australia	2	Italy	7
Austria	1	Japan	1
Canada	5	NL	20
Finland	15	Poland	2
France	1	Portugal	1
FRG	9	Sweden	15
Hungary	5	U.K.	11
Ireland	2	USA	26
Israel	5		

