ESCP EUROPE
BUSINESS SCHOOL

ESCP EUROPE
WORKING PAPER

No. 57 - March 2011

Concepts of Rationality in Management Research

From Unbounded Rationality to Ecological Rationality

by Jörn Basel and Rolf Brühl

ESCP EUROPE
BUSINESS SCHOOL

ESCP EUROPE
WORKING PAPER

No. 57 March 2011

Concepts of Rationality in Management Research
From Unbounded Rationality to Ecological Rationality

by Jörn Basel and Rolf Brühl

ISSN: 1869-5426

AUTHORS

Dipl.-Psych. Jörn Basel
Chair of Management Control
ESCP Europe
Business School Berlin
Heubnerweg 6, 14059 Berlin
Germany
T: +49 (0) 30 / 3 20 07-139
F: +49 (0) 30 / 3 20 07-107
joern.basel@escpeurope.de

Prof. Dr. Rolf Brühl
Chair of Management Control
ESCP Europe
Business School Berlin
Heubnerweg 6, 14059 Berlin
Germany
T: +49 (0) 30 / 3 20 07-136
F: +49 (0) 30 / 3 20 07-107
rolf.bruehl@escpeurope.de

EDITOR

Heubnerweg 6, 14059 Berlin, Germany
T: +49 (0) 30 / 3 20 07-0
F: +49 (0) 30 / 3 20 07-111
workingpaper-berlin@escpeurope.de
www.escpeurope.eu

ABSTRACT:
This paper sketches important concepts of rationality. It concentrates on bounded rationality and provides descriptions of the heuristics and bias program and of the fast and frugal heuristics program by Gerd Gigerenzer and colleagues (Gigerenzer, 2002; Gigerenzer, Todd, & the ABC Research Group, 1999; Todd & Gigerenzer, 2000). One objective is to link the underlying concept of ecological rationality in judgment and decision making with the field of management research. This area has been mostly dominated with ideas of the heuristics and biases program coined by Daniel Kahneman and Amos Tversky (2000), with an emphasis of irrationality and lapses of peoples judgments and decisions. After an overview of the historic development in this debate on rationality, this paper presents a sketch of the fast and frugal heuristic program as well as short impressions from two management disciplines in order to illustrate the fruitfulness. The paper concludes with the description of dual-process models as a potentially unifying approach of both programs and their promising research potential.

KEYWORDS: Managerial Judgment and Decision Making, Heuristics and Biases, Bounded Rationality, Ecological Rationality

ACKNOWLEDGEMENTS: We kindly thank Florian Dost, Martin Oetting and Jens Sievert for their helpful comments on earlier drafts of this paper.

CONTENTS

"A comprehensive account of human judgment must reflect the tension between compelling logical rules and seductive non-extensional intuitions."

(Tversky & Kahneman*, 1983, p. 313 f.)*

"Human reasoning and behavior are ecologically rational when they are adapted to the environment in which humans act. This definition is in stark contrast to classical definitions of rationality, according to which reasoning and behavior are rational when they conform to norms of logic, statistics, and probability theory."

(Rieskamp & Reimer, 2007, p. 273*)*

"Although historically, philosophers and other scholars have stressed the importance of (logical) reasoning to achieve rationality, there has been a recent fashion for emphasizing instead the value of reliance on intuition. From a dual-process perspective, neither view is correct."

(Evans, 2010a, p. 323)

1. Introduction

Judgment and decision making (JDM) topics currently enjoy a high popularity in academia. Interdisciplinary societies such as the *Society for Judgment and Decision Making* (SJDM, formed in 1986) report constantly increasing memberships. Scholars from various management disciplines such as marketing, organizational sciences and management control are interested in accurate descriptive and prescriptive models, in order to understand what are good choices and how to improve decision quality and avoid errors (Bazerman & Moore, 2009). For most of the twentieth century economics set the benchmark for rationality concepts in management disciplines. However, for the last three decades a strong influence from psychology has been shaping the field in management research as well as in economics (DellaVigna, 2009). Therefore, today most of the theories and models in JDM have a strong emphasis on psychological theories and concepts. This comes as no surprise as, for example, Tetlock (2002, p. 451) highlights that "research on judgment and choice has become psychology's leading intellectual export to the social sciences as to a host of applied fields".

The public also seems to be highly interested in these issues, which can be illustrated with the success stories of popular science books like *The Paradox of Choice* (2004) by Berry Schwartz, *Blink* (2005) by Malcolm Gladwell, *Predictably Irrational* (2008) and *The Upside of Irrationality* (2010) by Dan Ariely or most recently *How we decide* by Jonah Lehrer (2010).

In management research, most notably the research program labeled heuristics and biases (prospect theory), coined by Daniel Kahneman and Amos Tversky (1981), had a high impact as in almost all other fields of social sciences (Keren & Teigen,

2004). For an example of its popularity, the famous article "Prospect theory: an analysis of decision under risk" published in *Econometrica*, in 1979 by Kahneman and Tversky, is the most cited article of this journal, with the impressive record of over 1,800 citations until 1996 (Laibson & Zeckhauser, 1998). A strong reference towards this research program in management studies is often made through the prefix "behavioral"; be it behavioral finance (Thaler, 1993), behavioral accounting (Siegel & Ramanauskas-Marconi, 1989), or behavioral economics[1] in general (Camerer, Loewenstein, & Rabin, 2003; Mullainathan & Thaler, 2000; Heukelom, 2007b). The success of this ground-breaking theory of judgment under uncertainty was crowned with the award of the Nobel Prize for Economics to Daniel Kahneman in 2002.[2]

The emphasis on decision errors and biases was, however, criticized for missing the point that decisions in the real world do not work according to the laws of logic and that the described norms of the heuristics and biases program are content blind (for early critique see Gigerenzer, 1991; Lopes, 1992). From the viewpoint of programs like natural decision making (Klein, 1993), fast and frugal heuristics (Gigerenzer & Todd, 1999) or evolutionary psychology (Cosmides & Tooby, 1994), it was clear that the ascription of rationality or irrationality should not be left to logic or probability theory and thus these programs open up new research agendas for rationality.

Following the critique on imposing a too high standard of rationality on social actors, the important next step in decision research came in the late nineties with the introduction of a new program by Gerd Gigerenzer and colleagues (Gigerenzer, 2002; Gigerenzer et al., 1999) called fast and frugal heuristics. This proposal states that under limited resources (e.g. time and money) fast and effective decision strategies can beat complex utility maximization calculations. This concept builds upon the pioneering work of Herbert Simon (1955) on bounded rationality and on concepts that suggest adaptive behavior and simple decision making as successful strategies when making inferences (e.g. Payne, Bettman, & Johnson, 1993; Hogarth, 1987; Dawes, 1979).

Proclaiming this revolutionary shortcut in JDM, this proposition emphasizes ecological rationality instead of biases, errors and illusions and thus it switches away from logic and probability as normative benchmarks. In summary, studying ecological rationality should reveal "in which environments a given strategy is better than other strategies (better – not best – because in large worlds the optimal strategy is unknown)" (Gigerenzer & Gaissmaier, 2011, p. 456). Goldstein and Gigerenzer (2002) argue that from an ecological rationality point of view, informational structures of the environment are taken into account and these structures are integrated in an adaptive way into bounded decision capabilities.

As a handy metaphor for this program Gigerenzer (e.g. Gigerenzer, 2006) quotes Nobel Prize laureate Herbert Simon, who stresses that "human rational behavior (and the physical behavior of all physical symbol systems) is shaped by a scissors whose blades are the structure of task environments and the computational capabilities of the actor" (Simon, 1990, p. 7). Following this picture, Kahneman and Tversky focus on just one blade, namely our brain, which is indeed not a computer that can work

---

1 The "behavioral" approach can also be distinguished from experimental economics in that traditional axioms of economics are rejected both positively and normatively (Heukelom, 2007b). Furthermore behavioral economics is not focused on just one single method of experiments (Loewenstein, 1999).

2 Amos Tversky died in 1996, thus the prize was only awarded to Daniel Kahneman.

with the principles of unbounded rationality and perfect logic. Thus the brain is an easy victim to all kinds of biases and lapses. However, scholars who favor the concept of ecological rationality stress analyzing both blades: the cognitive capabilities of human beings and the environment in which they operate.

Advocates of the fast and frugal program argue that, under certain circumstances, these so called biases (e.g. the reliance on heuristics as mental shortcuts) represent evolved and adaptive mechanisms of human behavior and cognition. Consequently, they can be highly efficient if applied in appropriate situations. In this context Gigerenzer and Todd (1999) and Gigerenzer and Selten (2002) coined the term "the adaptive toolbox", as a metaphor for the human capability to make good and efficient inferences[3] in a fundamentally uncertain world. Thus, broadly speaking this program aims to show in which situations different decision strategies, like fast and frugal heuristics, work to a sufficient degree.

In the following article, we will provide an overview of the main concepts of rationality in management research. However, we will focus on the concept of bounded rationality. The concept of rationality is deeply rooted in economics and thus this economic interpretation is often taken as a blueprint for how rationality has to work. However, rationality as a concept has many facets and is one of the broadest concepts used in the social sciences. One of the main features of broad concepts is that they lack necessary properties, which is often misinterpreted as being ill-defined. Moreover, its different usage in disciplines like philosophy, economics, sociology and management research adds to the impression of an incoherent concept. One objective of this paper deals with entangling different strands of rationality and explaining their function in management research.[4]

The aim of this paper is threefold. Firstly, we will present three different strands of rationality: unbounded rationality, bounded rationality and ecological rationality. Thus categorizing research in rational behavior and decision making will allow us to map important contributions in JDM research and hint at their implication for management research. Secondly, we explain the concept of ecological rationality which is embedded in the program of fast and frugal heuristics and emphasize its relevance to management research. As a relatively new concept to management research we discuss the current status of ecological rationality and add first applications to management research. Thirdly, we will broaden the view on JDM research and show how in the future it should contribute to management research. Specifically, we will discuss one promising approach: dual-processing theories. Scholars with this research approach intend to reconcile different visions of bounded rationality.

The remainder of this paper is organized in the following manner. We will start with a short introduction as to how, according to the philosophy of social science, we should explain action, which is the core business of social sciences like management research. This will reveal the importance of rationality as a concept in the social sciences. We will then shortly outline unbounded rationality and show its differences to

[3] According to Weber and Johnson (2009) "inferences" are judgments about the world using logic and often imperfect and uncertain information. Since for inferences a unique criterion exists their accuracy can be evaluated. Preferences address problems without such an external criterion of success (as in matters of taste), thus a calculation of accuracy is not possible in this case. However, since both draw on the same cognitive processes (E. U. Weber & Johnson, 2009) the studies described in this work can be applied for both inferences and preferences.

[4] One possibility of coping with terminological problems would be to abandon the necessary condition concept and apply concepts like Ludwig Wittgenstein's notion of family resemblance (Wittgenstein, 1953).

the programs which aim at explicating bounded rationality. In chapter 2.2 we will analyze and discuss both programs – the heuristics and bias program and the fast and frugal program – which are in the centre of JDM research - and the notion of bounded rationality. Advocates of both programs tend to overestimate differences between them. However, we will conclude this paper with dual-process theories which offer a promising research agenda to reconcile both programs.

2. Concepts of rationality

2.1 Rationality in philosophy and the social sciences

2.1.1 Explaining and understanding social action

Social scientists aim at explaining human action which is not mere behavior. Central to the explanations of social action are the intentions (objectives) and beliefs of social actors (Rosenberg, 2008). If humans behave purposefully or intentionally[5] we coin this behavior "action" (M. Weber, 1947). Therefore, action is a theoretical concept of the social sciences which we ascribe to social actors. We will use Hempel and Oppenheim's (1965) deductive-nomological-model (DN-model) of explanation to illustrate the role of rationality in explaining social action.

A DN-model which is capable of explaining action encompasses premises (explanans) and a conclusion (explanandum). There must be several ingredients to a successful explanation.

a. Law: A social law as a general rule about the objectives, beliefs and which action to take.
b. Antecedents: objectives and beliefs of the social actors.
c. The action as a consequence.

Fig. 1: Explaining action with the DN-model (adapted from Brühl, 2010, p. 53)[6]

Explanans:		
Law (L):		$(O \wedge (O \rightarrow A)) \rightarrow A$
Antecedents:		
- objective of i	Actor i wishes to obtain objective O_i	O_i
- beliefs of i	Actor i beliefs that action A_i is necessary to realize O_i	$O_i \rightarrow A_i$
Explanandum:	Actor i acts A_i	A_i

We will not discuss the feasibility of the DN-model[7], but will demonstrate why rationality is a central concept in explaining social action. However, we will also discuss why it is a problematic concept. Deductive inferences preserve the truth and if all premises are true then the conclusion will also be true. Central to the DN-model of explanation

[5] Intentional processes are not necessarily conscious processes, even goal selection may work unconsciously (Dijksterhuis & Aarts, 2010).

[6] If in Fig. 1 the law (L) is omitted, we get the intentional explanation of Georg von Wright (1971) which is very near to explanations of action of lay persons (folk psychology).

[7] For a thorough analysis of different approaches to explanation Salmon (1989), more recent contributions are discussed in Psillos (2007).

is the truth of the social law: all actors with the objective (O) and the belief that A is necessary to realize O, will act in accordance with A. Therefore, our first intuition of rationality is that social actors act intentionally and are able to give reasons as to why they act in the observed manner. Fig. 1 exhibits objectives and beliefs of social actors as reasons for their actions. Consequently, the basic notion of rationality is that social actors have reasons (objectives and beliefs) for their actions.

Nevertheless, Fig. 1 illustrates only a basic scheme as to how to explain action and leaves room for different interpretations of rationality.

1. Rationality as an a priori principle: one interpretation of rationality is that human action is necessary rational (Mises, 1966). Because rationality has the function of an a priori principle it is not possible to empirically falsify it. Logically, the law (L) is a tautology and thus it is analytically true (i.e., it is true regardless of the truth value of A or O). Usually, normative theories, like most economic theories, are based on this notion of rationality.
   Economic theories of rationality concentrate on the beliefs of social actors and impose a lot of hypothetical beliefs on them. For instance, they have consistent, stable preferences and are able to rank all alternatives or they have unlimited computational power etc. All this leads to a version of Fig. 1 where the beliefs of the actor have to be extended with all the added demands on the preferences of the social actor.
2. Rationality as a theoretical concept: in this interpretation rationality is a theoretical concept which is embedded in a behavioral theory (on judgment and decision making) and is linked to empirical concepts (indicators) from which it gains its empirical meaning. Thus, it is empirical research which models the social actors.
   Psychological research has taken this road and has, for instance, shown that social actors systematically violate assumptions of economic rationality. This is mainly the reason why scholars from psychology have taken alternative routes.

Of course, this dichotomy can be seen as a continuum with both interpretations as opposite poles and a variety of possible concepts of rationality in-between. This can be expressed differently as: there are a variety of models of rationality which vary in the assumptions they make about rational action and in the way they conduct research.

Both interpretations span the discussion in different disciplines, but in the following discussion we will discuss research contributions which mainly focus on the second interpretation. However, we will outline the first interpretation because scholars who engage in behavioral research object to basic assumptions of the economic interpretation of rationality.

2.1.2 Varieties of rationality: from unbounded to bounded rationality

One tipping point for the social sciences in the twentieth century was the publication of *Theory of Games and Economic Behavior* in 1944 by John von Neumann and Oskar Morgenstern, because it provided the framework to balance utility, in the description of human preferences, with money. Doing this, von Neumann and Morgenstern ex-

tended Daniel Bernoulli's (1738/1954) psycho-physical concept of cardinal utility theory (CUT)[8] and introduced expected utility theory (EUT).

This theory states that our decisions are guided by subjective value and it is that, not utility, (as laid out by CUT) that is the basis for human (rational) behavior – rather than the maximization of monetary income. Friedman and Savage (1948), for example, were able to explain both risk-seeking and risk-averse behavior referring to an expected utility function; this would not have been possible using only CUT. This change in the way individuals base their (economic) decisions is interpreted by some scholars as the comeback of homo economicus into social sciences (Heukelom, 2005). Thus, using EUT as a yardstick allows for labeling deviations from expected utility as irrational behavior.

The term homo economicus itself (or economic man) was originally coined by critics of the work of John Stuart Mill in the late nineteenth century (Persky, 1995), and represents the prototype of rational (and self-interested) behavior in classical economic theory. The principles of rational (economic) behavior stressed by von Neumann and Morgenstern can be summarized in five axioms (Fishburn, 1981), which illustrates the belief system of social actors (acting like homo economicus) in Fig. 1.[9]

1. If confronted with several options, social actors are able to use a form of preference ordering (order of preferences).
2. If social actors prefer one option over another, this option is chosen (choice of preferences).
3. Preferences of social actors are consistent; no contradictions occur (transitivity of preferences).
4. Preferences of social actors are independent from other options or considerations (independence of preferences).
5. Preferences of social actors are not subject to changes no matter how they are presented as long as they are logically equivalent (invariance of preferences).

The first question, arising from these assumptions, is how is this normative model of a social actor reached by real human beings? The second question asks, is this normative model an adequate model for social science theories of human decision making? The next sections therefore aim to clarify if these assumptions are maintained and how departures from this ideal model are explained.

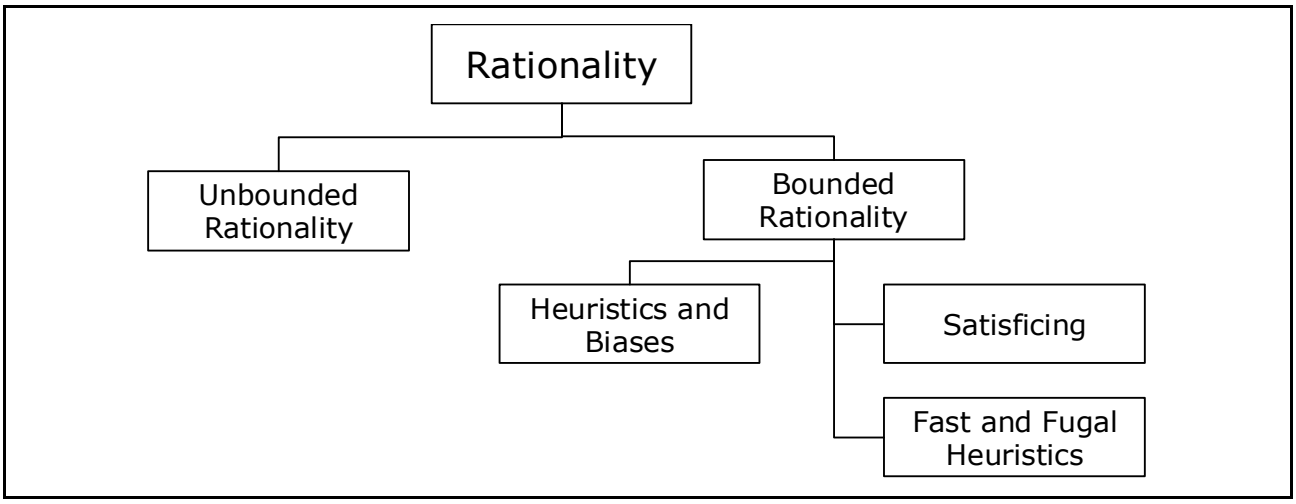
For homo economicus, successful decision making is thus closely related to the norms of neo-classical theories of human decision behavior. In other words: unbounded (economic) rationality is fulfilled if all five assumptions are met and this defines a rational action (see Fig. 1). If we assume however, that rationality can be understood in other forms of successful decision making, and, of course this will highly depend on what counts as successful, different paths can be drawn of how an obviously broad concept of rationality is achieved. This view, as illustrated in Fig. 2, distinguishes between different concepts of rationality. In particular it separates between those models that propagate unbounded rationality and those that rely on bounded rationality (Gigerenzer & Selten, 2002).

---

[8] Bernoulli stressed in his writings that money has diminishing value. This means that enjoyment does not increase proportionately with increase in wealth (Larrick, 1993). Bernoulli justified this hypothesis by arguing that money gets less valuable, when all basic needs (like food, clothes and a home) have been met. This results in the fact that additional wealth can only add less and less utility (which is also known as the classic concept of diminishing marginal utility in economics (Bell, 1967).

[9] For a more elaborated explanation of rationality within EUT see Hastie and Dawes (2010, p. 244 ff.).

Fig. 2: Concepts of rationality (adapted from Gigerenzer, 2002)



On the one side, the unbounded rationality concept (the prototype of homo economicus) refers to concepts in which human judgment and decision making incorporate a kind of a microprocessor which calculates the (optimal) outcome. A caricature of this concept is a description of a super chip driven human agent that knows all the odds and is a perfect Bayesian calculator or as Thaler and Sunstein state: "Homo economicus can think like Albert Einstein, store as much memory as IBM's Big Blue, and exercise the willpower of Mahatma Gandhi" (Thaler & Sunstein, 2008, p. 6). Some models use an optimization under constraints approach, however, that does not change the capabilities of homo economicus. The optimization under constraints model states that we search for further information until the costs exceeds the benefits (for an example see Stigler, 1961). This modification of the unbounded concept however leads to an infinite regress, because all the benefits and costs have to be computed somehow – and how shall a bounded mind conduct such sophisticated estimations? Rieskamp and Otto (2006, p. 207) thus call this symptomatic issue "the recursive homunculi problem of deciding how to decide".

The notion of bounded rationality, as introduced by Herbert Simon in the 1940s, is focused on how we deal with the limitations of social actors as human beings (Simon, 1945). Two paths are depicted in Fig. 2. First, heuristics and biases deploy norms from the neo-classical approach and benchmark humans with respect to these axioms (Kahneman & Tversky, 2000). Satisficing, a blend of sufficing and satisfying, is concentrated on finding solutions that are good enough and departs from the ideal of optimization (Simon, 1955). Finally, advocates of fast and frugal heuristics go a step beyond satisficing and point out that under certain circumstances these descriptive models can be seen as a normative standard (Gigerenzer et al., 1999). Gigerenzer and Gaissmaier (2011, p. 454) define heuristic as "a strategy that ignores part of the information, with the goal of making decisions more quickly, frugally, and/or accurately than more complex methods". This way they make a clear distinction between their view on mental shortcuts and the one provided by Kahneman and Tversky (2000).

In the following section we will concentrate on the concept of bounded rationality and on the two paths of this concept: satisficing and fast and frugal heuristics.

2.2 Bounded rationality – Origins and development

2.2.1 Origin of bounded rationality

The idea of unbounded rationality assumes that people have unlimited computational power, time and knowledge (and from a management perspective you could also include unlimited money, if taken into account that most information in management settings, like benchmark studies, are not available for free). This form of omniscience leads to the final decision which maximizes the expected utility. Economic models, supposing unbounded rationality are drawn from homo economicus, which is the underlying principle of all neoclassical economic models (Morgan, 2006): maximizing expected utility and statistical Bayesian models. It seems obvious that the assumption of unbounded rationality is an unrealistic yardstick for human reasoning in the real world.

Contrary to this objection, maybe due to its economic connotation (Becker, 1976), this approach is frequently found when authors in management JDM books use the term bounded rationality (e.g. Bonner, 2008; Bazerman & Moore, 2009). Bazerman and Moore, for instance, provide with their book *Judgment and Managerial Decision Making*, (2009, p. 2-3) a guide for rational decision making: These authors argue that a rational decision maker "will identify all relevant criteria in the decision making process" and that "an optimal search continues only until the cost of the search outweighs the value of the added information". Some of the advice from these authors even sounds like a description of the concept of unbounded rationality, when they stress: "the rational decision maker carefully assesses the potential consequences on each of the identified criteria of selecting each of the alternative solutions".[10] However, this is not the meaning of bounded rationality because, as already mentioned, an optimization under constraints approach does not relieve social actors of the heavy burden of homo economicus.

Herbert Simon, who primarily studied behavior in organizations, is considered to be the father of the term bounded rationality (Selten, 2002; Simon, 1945). According to Simon (for a summary see Simon, 1993), human agents have only limited information processing capabilities and are therefore not able to perform perfectly rational decisions (in the sense of unbounded rationality). In particular, their knowledge to evaluate consequences and alternatives of possible decisions, lacks a deeper understanding of all relevant factors. Simon (1979, p. 502) in particular differentiates between an external uncertain world and our innate bounded cognitive capabilities:

> *"Rationality is bounded when it falls short of omniscience. And the failures of omniscience are largely failures of knowing all the alternatives, uncertainty about relevant exogenous events, and inability to calculate consequences."*

Furthermore Simon points out that our cognitive limitations have the consequence that we will not reach optimal decisions; instead we use satisficing decisions as our personal (and more realistic) yardstick. Simon (1997, p. 295) states:

> *"A decision maker who chooses the best available alternative according to some criterion is said to optimize; one who chooses an alternative that*

[10] In some cases this modification is also compared with Friedman and Savage's (1948) as-if assumption. According to these scholars, people are not actually calculating all odds etc., but they behave as if they would do so and as if they compute somehow a form of expected utility.

meets or exceeds specified criteria, but that is not guaranteed to be either unique or in any sense the best, is to satisfice."

Thus, Simon's concept of bounded rationality and satisficing in a nutshell would be the following statement: a perfect and ideal solution might exist for our problems, but because of our bounded mind we are not able to conduct the necessary cognitive steps to reach this goal. Paying respect to this fact, we use satisficing decisions and systematically deviate from ideals of unbounded rationality. With this strategy, we can reach satisfactory but not perfect outcomes.

This approach is supported by the theory of the second best (Lipsey & Lancaster, 1956). According to this classic theory, simply getting closer to an optimization, does not necessarily lead to better overall decisions. Following this theory, it pays if a single condition cannot be reached (e.g. to high costs, lack of skills), to also depart from the other conditions and to reach this way a second-best outcome (i.e. a satisficing outcome).

In Simon's view it is important to recognize that social sciences are always both normative and descriptive, compared to natural sciences that are only descriptive. Thus, we cannot simply describe the decision making of humans without having a normative standard in mind. Simon sees social sciences in the same vein as engineering, where the goal is not only to describe how a bridge is build, but to construct the most efficient bridge possible with the available resources. This fundamentally distinguishes Simon's view from classic economists like Savage (1954), who mainly use normative methods without considering actual human behavior (Heukelom, 2007a).

One of the major credits of Simon's work is that he always insisted that these postulates (like the theory of subjective utility [SEU theory]) might not fit empirical data. In one of his last publications Simon (2000, p. 25) resumes his research program on bounded rationality:

> *"Bounded rationality is simply the idea that the choices people make are determined not only by some consistent overall goal and the properties of the external world, but also by the knowledge that decision makers do and don't have of the world, their ability or inability to evoke that knowledge when it is relevant, to work out the consequences of their actions, to conjure up possible courses of action, to cope with uncertainty (including uncertainty from the possible responses of other actors), and to adjucate among their many competing wants. Rationality is bounded because these abilities are severely limited. Consequently, rational behaviour in the real world is as much determined by the "inner environment" of the world people's minds, both their memory contents and their processes, as by the "outer environment" of the world on which they act, and which acts on them."*

The tricky part to describing human decision making properly, stems from Simon's (1990) above mentioned scissor metaphor.[11] In line with this picture, the term bounded can be interpreted in two ways. On the one hand management scholars may con-

[11] Describing the environment as an objective entity, as in Simon's approach, is, for instance, criticized by Weick (1979), who called into question (from an enactment/sense making point of view), that this entity can only be practically comprehended by a decision maker. From a constructivist perspective, he argues that rather decision makers mostly create their own constraints through an constructive process (see also Hodgkinson & Healey, 2008).

sider limitations of the environment, like information costs (for example, a survey to find out employee satisfaction can be costly) or the difficulty of even gathering specific information (for example, which products are used by a competitor in order to conduct a benchmark). On the other hand, management scholars may consider cognitive limitations of the human agent, for example limitations in memory storage and imperfect evaluation of statistical information by the management.

However, Simon did not start a research program with empirical research on these issues. As a consequence the concept spread in different research areas with different meanings and different approaches to incorporate bounded rationality into other research programs (Klaes & Sent, 2005). In behavioral economics, for instance, bounded rationality is more in line with mainstream economics as Simon had in mind. Looking at the current state of behavioral economics Sent (2004, p. 750) states: "Simon's ideas are missing from the more recent development". According to Sent (2004) behavioral economics mainly relies on the heuristic and biases program from Kahneman and Tversky.

2.2.2 Heuristics and biases

2.2.2.1 Research on heuristics and biases

This program was to a large extent initiated in the late 1970s and early 1980s by the research of Daniel Kahneman and Amos Tversky. They showed that human JDM cannot be accurately described in the terms of unbounded rationality, similar to the computer metaphor, as mentioned in the previous section. The central point of their position is that our judgments and decisions systematically depart from ideals of logic and probability theory and, thus, from rational behavior. Logic and probability theory laid the ground on which the homo economicus and its prototype of utility maximizer (and EUT) stand and which served as the dominant economic research program until the 1970s (Van der Rijt, 2006). The main thrust of Kahneman and Tversky's research revealed EUT limitations in various scenarios within this approach, however, the axioms of unbounded rationality remained as yardsticks and as a normative frame (for reviews of EUT limitations see e.g. Camerer, 1992; Harless & Camerer, 1994).

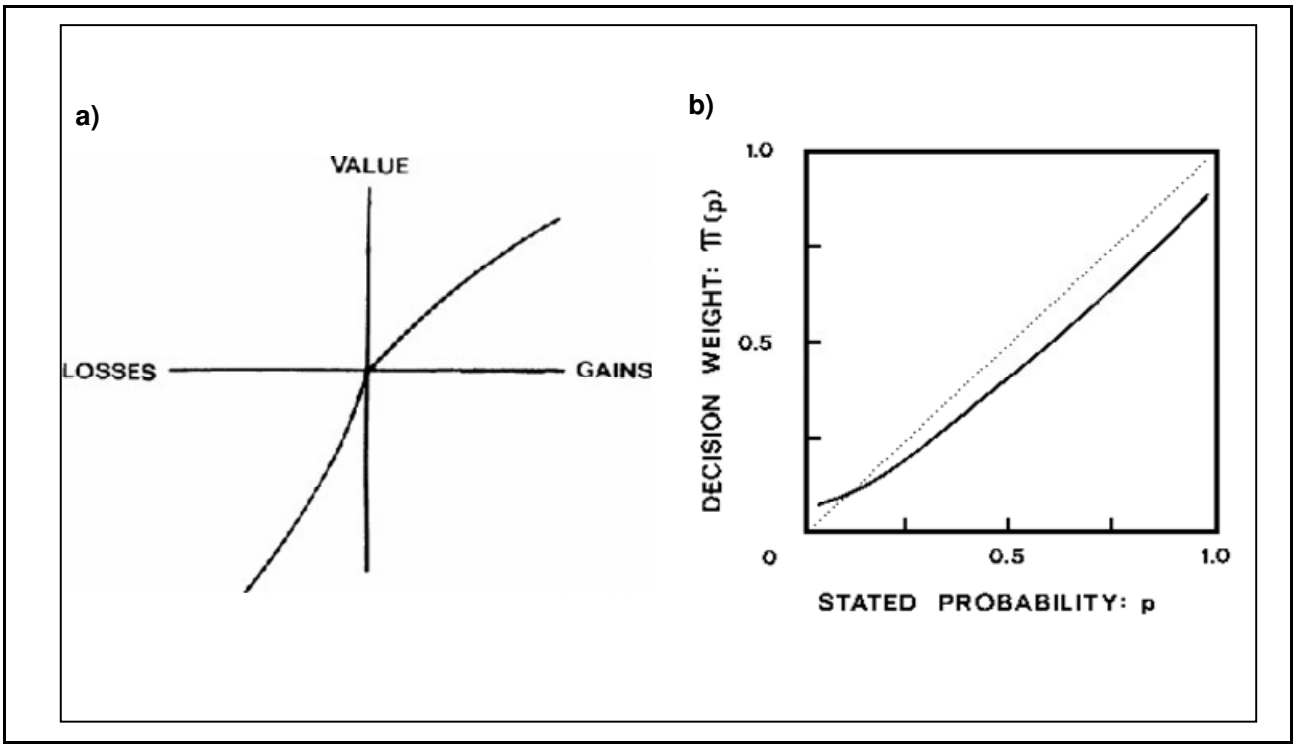
Kahneman and Tversky supported their bold hypothesis with a series of experiments, which showed that biases in decisions under risk occur when people estimate subjective values and probabilities in the light of gains and losses, and with respect to a subjective point of reference. These results can be summarized in two classic graphs, which provide a descriptive picture of judgment under risk[12] and the foundation of what is called prospect theory (see Fig. 3). For example, the subjective value of a five hundred Euro win is smaller than the subjective value of a five hundred Euro loss. This bias is not only valid for monetary incentives, consistent with Kahneman and Tversky (2000), it also explains why people fall victim to framing effects and are prone to loss aversive behavior.

Gains and losses, as central reference points (and not final levels of wealth), are key issues when people regularly overestimate small probabilities of potentially posi-

[12] In decisions under risk the possible probabilities are known (e.g. the flip of a coin). In decisions under uncertainty the probabilities, however, remain unknown. In the earlier versions prospect theory only addressed decisions under risk, decisions under uncertainty were implemented later into the theory (Kahneman & Tversky, 2000). This is relevant for settings of management decisions, since here risks are often unknown and thus managers face a high level of uncertainty.

tive (e.g. buying lottery tickets) and negative outcomes (e.g. signing an insurance). Compared to these unlikely events (see Thaler & Sunstein, 2008) medium to large probabilities are typically underestimated, as described in the weighting function.

Fig. 3: Value- (a) and weighting function (b) (Kahneman & Tversky, 1979, p. 279, 283)



Other than these deviations from rationality axioms, people also fall victim to their limited cognitive capabilities. These limitations lead people in the view of Kahneman and Tversky to use heuristics which, due to their simplifying character, lead to a list of errors in our decision making (see Tab. 1). Heuristics are, according to Kahneman and Frederick (2002), frequently used shortcuts in which a difficult question is answered by substituting it for a shorter one. One of the first descriptions of heuristics appears in 1972, when Kahneman and Tversky (1972, p. 431) state:

> *"People do not follow the principles of probability theory in judging the likelihood of uncertain events. Apparently, people replace the laws of chance by heuristics."*

In addition to the tendency to overestimate small risks and to underestimate high risks, the most mentioned and cited errors and biases by Kahneman and colleagues are: conjunction fallacy, overconfidence bias, base-rate fallacy (and base-rate neglect), representativeness, availability and anchoring (for a summary see Gilovich & Griffin, 2002; Keren & Teigen, 2004; Bazerman & Moore, 2009).[13]

[13] The summary of errors and biases listed here and in Tab. 1 can be easily extended. For instance Eisenführ and Weber (2003) list in addition to the above mentioned summary: certainty effects, disappointment effects, illusion of control, mental accounting, regret effects, resolution of uncertainty, splitting-bias, status quo-bias, sunk costs and winner's curse as additional labels for non-rational behavior (Eisenführ & Weber, 2003). However this long list has raised the critique that research on JDM is reduced to a quest for "the error of the day" (Goldstein, 2010).

Tab. 1: Some biases resulting from heuristics (Bazerman & Moore, 2009, p. 41)

Bias	Description
Biases emanating from the availability heuristic	
Ease of recall	Individuals judge events that are more easily recalled to be more numerous than events of equal frequency, whose instances are less easily recalled.
Retrievability	Individuals are biased in their assessments of the frequency of events based on how their memory structures affect the search process.
Biases emanating from the representativeness heuristic	
Insensitivity to base rates	When assessing the likelihood of events, individuals tend to ignore base rates if any other descriptive information is provided – even if the information is irrelevant.
Insensitivity to sample size	When assessing the reliability of sample information, individuals frequently fail to appreciate the role of sample size.
Misconceptions of chance	Individuals expect that a sequence of data generated by a random process will look "random", even when the sequence is too short for those expectations.
Regression to the mean	Individuals tend to ignore the fact that extreme events tend to regress to the mean on subsequent trial.
The conjunction fallacy	Individuals falsely judge that conjunctions are more probable than a more global set of occurrences of which the conjunction is a subject.
Biases emanating from the confirmation heuristic	
The confirmation trap	Individuals tend to seek confirmatory information for what they think is true and fail to search for disconfirmatory evidence.
Anchoring	Individuals make estimates for values based upon an initial value and typically make insufficient adjustments from that anchor when establishing a final value.
Con/disjunctive-events bias	Individuals exhibit a bias towards overestimating the probability of conjunctive events and underestimating the probability of disjunctive events.
Overconfidence	Individuals tend to be overconfident of the infallibility of their judgments when answering moderately to extremely difficult questions.
Hindsight and the curse of knowledge	After finding out whether or not an event occurred, individuals tend to overestimate the degree to which they would have predicted the correct outcome. Furthermore, individuals fail to ignore information they possess that others do not when predicting other's behavior.

The origin of this program is strongly linked with the notion of human beings as intuitive statisticians. This means that in order to maximize certain criteria people do so

based on probabilistic information. Thus, the mind represents information in a probabilistic way when making decisions according to this framework. This assumption is important because it allowed Kahneman and Tversky to provide both a normative and a descriptive theory of choice (and its differences); a distinction that was not well-established particularly in economics, where no special attention was given to developing an explicitly descriptive model. This outline is summarized by Heukelom (2005, p. 7):

> *"If man is considered to be an intuitive statistician, and if the world is considered to present itself to the individual in terms of probabilistic information of uncertain events, a decision that deviates from the theoretically optimal decision becomes a failure of the system, or an error of judgment."*

The heuristics and biases program[14] claims bounded rationality as well as its proper theoretical foundation (e.g. Camerer, 1998)[15], since this program stresses errors that result from our limited cognitive capacity. Deviations from the ideal of optimization are viewed by proponents of this paradigm as failures that, at least up to a certain level, can be corrected[16] and even must be corrected in order to gain good (and rational) decisions (for prescriptive consequences resulting from heuristics and biases see Thaler & Sunstein, 2008; Tversky & Koehler, 1994).

2.2.2.2 Critical assessment

The heuristics, resulting from our limited cognitive capabilities, as described by Kahneman and Tversky, are not considered as efficient solutions, rather (in the best case) as second best and quick-and-dirty techniques compared to a proper logical analysis. Many empirical findings corroborate the robustness of these deviations and show that social actors systematically deviate from the standard model of economics (DellaVigna, 2009). However, there is a current debate as to how this program can be put in line with Simon's view of an ecological rationality that includes both cognitive and environmental factors (Lopes, 1992; Sen, 2002).[17]

Moreover, some of the so-called errors and illusions are being dispraised for being too imprecise and for lacking a deeper explanation of how and when these errors actually work (Fiedler, 1988; Funder, 1987; Gigerenzer, Hertwig, Hoffrage, & Sedlmeier, 2008). The criticism stresses that heuristics and biases can be understood more as a vague label than as a proper and testable model (Gigerenzer, 1996). Moreover, to classify behavior into categories of rationality or irrationality solely depends on the norms of rationality (Cohen, 1981). Advocates of the fast and frugal program highlight that using unrealistic yard sticks for human decision making will always lead to a pic-

---

14 This program is also labelled "cognitive illusions program" which is an analogy towards optical illusions like the Müller-Lyer illusion (Kahneman & Tversky, 1996, p. 582).

15 But it is worth to note that even optimization under constraints is described by some authors as a proper model of bounded rationality (e.g. Arrow, 2004).

16 The prescriptive principles of this approach are for example manifested in what is called "libertarian paternalism" by Thaler and Sunstein (2003).

17 This is a complex task because Simon is author of more than 650 publications (Heukelom, 2007a) and it is obviously easy to misinterpret his writings, mainly for the reason that he contributed to almost every field within organizational studies (Mirowski, 2002).

ture of a highly biased and misguided agent (Todd, 2007).[18] With respect to the norms used by the heuristics and biases program McKenzie (2003, p. 405) thus notes: "When a rational model fails to describe behavior, a different rational model, not different behavior, might be called for." By the same token Gigerenzer´s earlier critique (1997, p. 206) of the heuristics and biases program extends this statement by arguing that "it should be clear that the single trenchant conclusion reached by heuristics-and-biases program, namely that people are all too bad at reasoning, is itself, to a large degree, an illusion fostered by all-too-narrow norms of sound reasoning."

Moreover, some early critics point out that methodological issues play a crucial part, when demonstrating human irrationality (Cohen, 1981). From a philosophy of science point of view, some of the propositions of this program are questioned for making predictions that explain every possible outcome. For example, the same bias (representativeness) accounts in the hot-hand fallacy and in the gambler's fallacy for two completely different (even contrary) outcomes (Ayton & Fischer, 2004). The gambler's fallacy describes the illusion of a player that, for example, in game of roulette after a series of black the chances increase for red in the next round. The hot-hand fallacy is the other way round and is used as an explanation, for example, in basketball, arguing that a player who already scored several times is therefore more likely to score the next time. Results like this question the explanatory power of the heuristics and biases program, because using ex-post explanations is neither feasible (Popper, 1959), nor an adequate way for making possible prescriptive conclusions and raises the question of "how persuasive is a good fit"(Roberts & Pashler, 2000).

Proponents of naturalistic decision making (NDM) like Gary Klein (Klein, 1993; Lipshitz, Klein, Orasnu, & Salas, 2001) criticize the heuristic and biases program. The goal of NDM researchers is to investigate the intuition of experts, using mostly recognition-primed decision techniques, which they also claim is in line with Simon's (1993) suggestions regarding explanations of human behavior. Like Gigerenzer and colleagues they point out that intuition works as a fruitful way to make decisions. NDM advocates stress that their program is more in line with an ecological view of human behavior, than with an emphasis of biases, as laid out by the heuristics and biases camp.

However, it should be noted that the heuristics and bias program revealed important insights in human JDM. We can now see more clearly that cognitive restrictions cause human errors and mistakes. The use of heuristics is a human strategy to reduce cognitive effort and needs to be studied more thoroughly. Moreover, this program stimulated research which tries to show the merits of heuristics in human JDM: the fast and frugal heuristics program.

[18] With respect to cultural influence factors some researchers like Matsumoto (2007), point out that classical norms for rationality are products of a Western way of thinking. For example self-consistency over an individual's life is not a necessary condition for rationality in some other cultures. A further scholarly reflection of culture and related issues would however be beyond the scope of this work. For an overview of the influence cultural factors on judgment and decision making see Weber and Hsee (2000).

2.2.3 Heuristics and ecological rationality

2.2.3.1 Fast and frugal heuristics

As an alternative to the heuristics and bias program, and to cope with a highly complex and uncertain environment and with limited time and knowledge, Gigerenzer and colleagues (Gigerenzer et al., 1999) proposed a number of heuristics as strategies in making inferences. These, by definition simple (Shah & Oppenheimer, 2008), heuristics use evolutionary based skills to adaptively make use of environmental structures. Since their working principles are rooted in the environment, their process follows an ecological rationality rather than an unbounded (economic) rationality. With this move heuristics are shifting away from the negative reputation they earned through much of the behavioral decision research. This fresh look at heuristics describes their quality depending upon their ability to interact with the environment and is in line with the original Greek meaning of the term heuristic, which can be translated as "serving to find out" (Gigerenzer & Gaissmaier, 2011).[19] Gigerenzer and Gaissmaier (2011, p. 454) define heuristic as "a strategy that ignores part of the information, with the goal of making decisions more quickly, frugally, and/or accurately than more complex methods." This concept of judgment and decision making has some typical characteristics:

- It is a multiple strategy approach which is searching for different strategies according to the environment, task and cognitive capabilities (adaptive toolbox).
- Heuristics deliberately ignore information and this is operationalized by Shah and Oppenheimer: "1. Examining fewer cues. 2. Reducing the difficulty associated with retrieving and storing cue values. 3. Simplifying the weighting principles for cues. 4. Integrating less information. 5. Examining fewer alternatives" (Shah & Oppenheimer, 2008, p. 209)." It is important to mention that not all five aspects are necessary components of a definition of heuristics, but as a minimum one of the five has to be fulfilled.
- Gigerenzer and Gaissmaier attribute goal achievement to heuristics – more quickly, frugally and/or accurately – which is redundant as frugal hints again to information reduction. Moreover, it is problematic to enclose goals into the definition because it does not account for what happens if a strategy does not reach one goal or all three goals.

Consequently, goals of heuristics should be looked at separately and the definition should rely on the criteria by Shah/Opppenheimer. In reference to Fig. 1 (p. 4) it is also important to highlight that heuristics in Gigerenzer´s view are neither as-if models of optimization, nor solely descriptions of results – they are rules that describe the (problem-solving) process, in a fast and frugal fashion. They also fundamentally depart from concepts of rationality, like unbounded rationality and optimization under constraints. Furthermore, they go beyond the satisficing heuristics of Simon (1979), because they are not necessarily second best choices – they can even outperform complex calculations under certain circumstances. An example will illustrate how heuristics are seen in this program.

[19] An unprejudiced view on heuristics is also found in the work of early Gestalt psychologist Max Wertheimer (1945), who argues that heuristic methods can be understood as "looking around in order to guide search".

One of the heuristics in the adaptive toolbox is the take-the-best heuristic (TTB), coined by Gigerenzer and Goldstein (1996). We can describe this heuristic with five steps.

1. The first step is pure recognition of the cue. For example, if a social actor is asked which company produces more cars out of Volvo or Khodro, she will choose Volvo, simply because she has heard of it.
2. The second step is the search for the values of the cues.
3. The third step uses the discrimination rule. A cue discriminates if one has a positive value and the other has not. This can be illustrated again with the car example: is one type available at carscout24.com (positive cue value) and the other not (negative cue value)?
4. The fourth step is the cue-substitution principle and it states that if the cues do not discriminate go back to step two.
5. The last step is called maximizing rule for choice and it states that if no cue discriminates then choose randomly.

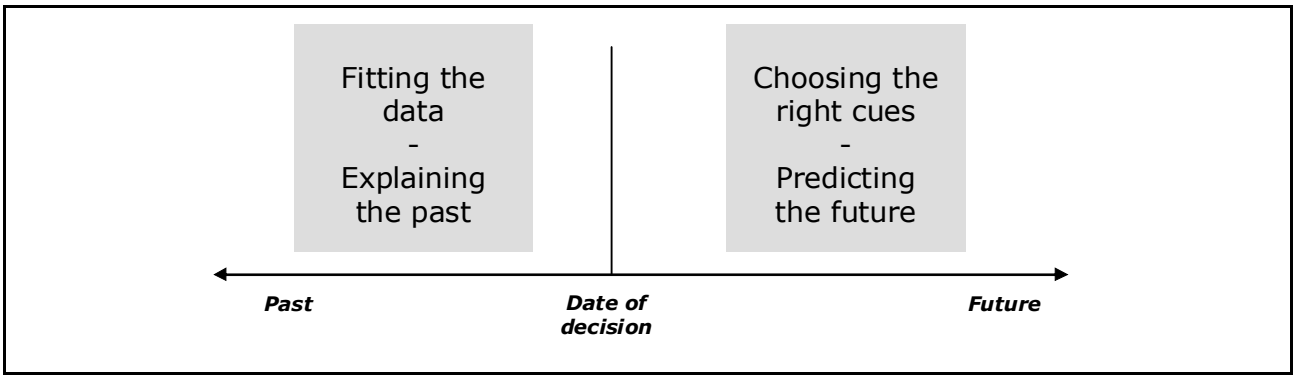
The important point in this lexicographic search strategy is that leaving out information can actually be helpful in making good inferences (compared to algorithms like multiple regression analysis or tallying for example). In order to make accurate predictions and to guide the decision maker, heuristics necessarily have three elements: a search rule, a stopping rule and a decision rule.

The ideal environmental structure to make simple heuristics like TTB work in terms of efficiency and robustness, is mathematically described by Martignon and Hoffrage (1999). This environment is characterized by non-compensatory information. This means that the cue weights (meaning how high the validity of the cue is) exponentially decrease, for example from 1.0 to 0.5 to 0.25 to 0.125 (…). In such an environment no other algorithm (like Dawes's rule or Minimalist[20]) can outperform the TTB heuristic.

The next crucial feature of heuristics is the distinction between fitting and predicting. It is obvious that in order to explain the past ex post (fitting), it is helpful to use as many cues as possible. This may be the reason why we have got better at understanding the causes of the recent financial crisis; besides all the ad-hoc/post-hoc explanations that are not of any use. Despite all the good explanations of the past, there are serious problems to using these explanations to predict the next big crash ex-ante. One reason for this is called "noise" by cognitive scientists and refers to information that is either redundant or that has no predictable value at all (nevertheless it can be expensive in terms of time and money). The danger of including too many informational cues of this type is called over-fitting.

[20] Dawes rule (adapted from Robyn Dawes "improper linear models" [Dawes, 1979]), is a compensatory strategy where the positive cue values are added and negative ones are subtracted. Franklin's rule multiplies each cue value by its weight and sums the total (Hogarth, 1987). The minimalist heuristic only relies on the direction of the cues. It takes the last heuristic and remembers the last successful application and uses the same strategy again.

Fig. 4: Fitting the data versus predicting an uncertain future



Other heuristics, which are supposed to be included in the adaptive toolbox and that are empirically supported are: recognition heuristic, default heuristics and earlier heuristics such as tallying, tit-for-tat, imitate the successful (for an overview of different heuristics including empirical findings see Gigerenzer & Brighton, 2009).

The efficiency of heuristics is not a brand new subject for all fields of study and is, for instance, well documented in social contexts, where tit-for-tat as a fast and frugal strategy was shown to be highly efficient (Axelrod, 1984), as well as simple rules (clearly evolutionary based) like imitate-the-majority (Boyd & Richardson, 2005) or imitate-the-successful (Boyd & Richardson, 2005). These social heuristics use evolved and learned capabilities and are reduced to a minimalist set of building blocks.[21]

2.2.3.2 Bounded minds and ecological rationality

Why do some heuristics work quite efficiently? According to Gigerenzer and Todd the working principle (that also accounts for the less-is-more effect) behind efficient heuristics is ecological rationality (Gigerenzer & Todd, 2008). In line with Berg (2010) a decision or judgment is ecological rational when it can exploit structures of the environment. This exploitation works systematically and, thus, it is not a random process. In addition, the simplicity of the heuristic structure guarantees its robustness, which is shown in the ability to generalize dynamic and uncertain environments. This is of interest to management research because we have to keep in mind that the use of heuristics is not intended to fit a data set of the past. Contrary, heuristics are used to make predictions in a highly uncertain world. Nevertheless, is ecological rationality different from bounded rationality?

Chase, Hertwig and Gigerenzer (1998, p. 212) describe ecological rationality and bounded rationality as separate constructs:

> *"We argue that to discover how the mind works, and how well, we need to understand how the mind functions under its own constraints – its bounded rationality – and how it exploits the structure of the social and physical environments in which it must reach its goals – its ecological rationality."*

Hoffrage and Reimer (2004, p. 442) use the same distinction and add to this approach that "Models of ecological rationality describe the structure and the representation of

[21] This is in line with evolutionary psychology which states that humans have "neurocognitive adaptions designed for social exchange" (Cosmides & Tooby, 2005, p. 590).

information in actual environments and their match with mental strategies, such as bounded rational heuristics."

The interaction of adaptive minds with an uncertain environment (as the core element of ecological rationality) is also mentioned by Vernon Smith (2003, p. 470), who points out in his Nobel Memorial Lecture in 2002:

> *"Ecological rationality uses reason – to examine the behavior of individuals based on their experience and folk knowledge, who are 'naïve' in their ability to apply constructivist tools to the decisions they make; to understand the emergent order in human cultures; to discover the possible intelligence embodied in the rules, norms, and institutions of our cultural and biological heritage that are created from human interactions by not by deliberate human design. People follow rules without being able to articulate them, but they can be discovered."*

The fruitful interplay of cognition and environment may also be illustrated by what is called situated cognition (Robbins & Aydede, 2009; and for a discussion of situated cognition in management research see Wrona, 2008). Followers of this program point out that the context (respectively environment) is not a passive entity which is perceived by social actors. Rather, situated cognition is embedded in the context and, especially in social contexts, it is described as a reciprocal interaction with individual cognition.

Scholars of ecological rationality and those of situated cognition agree that context may influence cognitive processes and that these processes definitely use elements of the context. Another aspect of agreement is that situated cognition has a broad definition of what constitutes context, which is in line with ecological rationality. For example, both see social behavior as relevant context (Hertwig & Herzog, 2009). However, compared to ecological rationality, approaches of situated cognition do not tell us how individual minds exploit the structures of the context. The cognitive structures described by situated cognition-oriented scholars are seen to be directly influenced by the context. For ecological rationality this is not the case, because the cognitive structures (e.g. working memory) are rooted in an evolutionary development and thus do not object to a direct transformation.

2.2.3.3 Heuristics for management decisions

In the following we want to give some impressions of how fast and frugal heuristics might work in two areas of management research. We indicate possible research by reflections on bounded rationality, descriptions of situations and scenarios. They are intended as first impulses for researchers who want to further investigate decision principles in their disciplines. Therefore, the empirical evidence is transferred from other studies and is not exclusive to this field.

Management controllers – unbounded rational?

German scholars developed different concepts of management control.[22] In one of these concepts the main function of management control is seen by Weber and Schäf-

[22] For an analysis of the situation in German management control research see Messner, Becker, Schäffer and Binder (2008).

fer in securing the rationality of the decision process and the final decisions made by the top management (J. Weber & Schäffer, 2008).[23] After reviewing all the limitations people face due to their bounded rationality, it seems more than plausible to assume that these limitations also affect management controllers in their daily tasks. In the light of these findings, how are they able to secure rationality of the top management? One implication from the above statement may be that management controllers are able to secure rational decision making because they have a well learned capability to recognize and evaluate cues from their environment. Therefore, the normative stance of management control gives room for two interpretations.

1. In line with the heuristics and biases program, management controllers secure rationality because they know of the biases and, hence, they are able to make them disappear. This leads to the picture of management controllers as experienced experts in human JDM who are devoid of errors and biases.
2. Management controllers tend to be ecological rational since they systematically exploit structures of information in the environment (see Goldstein & Gigerenzer, 2002).

In our view, both interpretations have their merits. However, it is an empirical matter and it has yet to be shown in studies how management controllers act in reality. Despite these two opposing views it seems appropriate to assume that management controllers do not have privileged access towards rational decision making. Research should focus on descriptive models of how management controllers assist in decision making. When, for example, do they use heuristics? What kind of search strategies do management controllers use and how can they be compared to those of managers?

Considering, for example, an investment decision scenario, where management controllers have to calculate the value of several performance indicators, empirical studies indicate that an information overload can lead to a poor decision quality (Volnhals & Hirsch, 2009) or at least to an inefficient use of the available information (Basel, 2010). It is very likely that this danger can be reduced using fast and frugal heuristics like take-the-best in management accounting. In this way a management controller can avoid wasting precious time and money on evaluating too many cues and only base his decision on one single cue with the best validity. Of course requirements like non-compensatory cue weights (Martignon & Hoffrage, 1999) ideally have to be given in order that this kind of strategy can outperform more complex calculations. Here as well we have to keep in mind that very little information in management settings is free: benchmarks or employee surveys usually cost both time and money. Even if more data of this kind is gathered it still can be found to be useless or misinterpreted for several reasons. This seems to be a promising field of research because management controllers often face a highly uncertain and dynamic environment.

Marketing – the convincing power of n =1

Imagine the following scenario[24]: social actors want to buy a new car and the only important criteria they take into account is life expectancy. Since Scandinavian cars have an excellent reputation regarding this kind of criteria they finally end up deciding

[23] From the viewpoint of the information function, management controllers are labeled "chief information officer" (Link, 2002, p. 39).

[24] This and the following story are slight adaptations of Gigerenzer (1991, p.106ff).

between a Saab and a Volvo. First, they take a look at a magazine called "Cars and Technique" and see that in a big sample of over five hundred cars Volvo scored slightly higher than Saab. They are happy and think that they have made a good decision, having decided on the Volvo. Unfortunately, the day they planned to meet the car dealer they meet a car-loving neighbor on the street. He tells them that his brand new Volvo just broke down.

Now, do they still buy the Volvo? According to heuristics and biases they should do so, since the car of the neighbor just counts as n =1 compared to the over five hundred cars in the test. If they now switch to Saab they are, according to this approach, a victim of base rate neglect bias. However it often seems that social actors make this base rate neglect with good reason. A short episode from our human history might illustrate why personal statements are sometimes preferred over large number statistics (for an overview in evolutionary based approaches see Cosmides & Tooby, 1997).

Imagine humans living with their tribe in the middle of a rainforest. As their children grow up they teach them one survival skill (since they are busy hunting they only have time for a single skill): either climbing trees or swimming. The wise medicine man tells them that last year, of all the known tribes in the forest, twelve children died after falling from a tree, but only two had been killed by a crocodile during their swimming sessions. Following this advice, they are just walking down to the river when they meet a neighbor who tells them that he heard rumors about a big fat crocodile in their area.

Again, social actors probably follow the single opinion. This might be explained with accessibility of the event, but coming back to "Simon's scissors" we conclude, that the second opinion fitted better to their personal environment and they may make smarter decisions if they take into account ecological rationality (i.e. exploiting their social environment). In this case ecological rationality may reach its better fit and have the possibility to be more adaptive (they have had a dialogue with their neighbor) based on a form of competence trust that seems to be related to the closeness of the source and the non-commercial interests of it.

This social heuristic which is of particular interest for marketing aspects could look like the following: trust the person most that has the most similarities with you – like living in the same area, having the same preferences etc. and who is considered as competent in this field (due to their specific access to some media forms etc.). This kind of TTB heuristic could possible outwit many large scale statistics for the same reasons as described above. The working principle behind an opinion leader could be that he has privileged access to media information. This information is ecologically correlated with the cue value (for example, the opinion leader is the moderator in a chat group and frequently recognizes when new issues come up). This also might be the working principle behind effective word-of-mouth propaganda (Oetting, 2009) and the effectiveness of opinion leaders (Weimann, Tustin, van Vuuren, & Joubert, 2007), especially when we know certain base rate rates but nevertheless seem to ignore them.

2.2.3.4 Critique

The fast and frugal heuristics program has been established as an alternative to the heuristics and bias program. However, despite the many studies for the use of fast and frugal heuristics in real life and laboratory settings, and a trend towards more

evolutionary descriptions of human judgment and decision making, there are several doubts regarding this program.

For example, Oppenheimer (2003) points to the fact that actual decision making involves usually far more calculations, than the simple mechanism described by Gigerenzer and colleagues. This finding is also picked up by Hilbig and Richter (2010), who argue that within the description of fast and frugal heuristics, it remains unclear how adaptive heuristics are selected (the so-called strategy selection problem). In addition, they present empirical evidence that the recognition heuristic is only one applied strategy among many. Thus, Gigerenzer and Brighton's (2009, p. 134) claim that "a majority of participants consistently followed the recognition heuristic" is not fully empirically supported.[25] Hilbig (2010) furthermore highlights that the adaptive toolbox needs to be more précised on the process level of reasoning and that even more complex mechanisms do not enforce severe information costs.

Secchi and Bardone (2010) even suggest that the idea of bounded rationality in general needs an update, because new technologies and social resources were not integrated in this concept, when it was coined by Herbert Simon in the 1940s and 1950s. These authors propose that scholars should switch to a new approach called "extendable rationality", which would allow for integrating technological advances into our concept of rationality. Moreover, since ecological rationality requires some implicit learning function, how exactly this learning (of heuristics) can be measured, or even improved, remains vague. This is true in particular for settings that are more complex like organizations and elaborate decision issues, for example mergers and acquisitions. Because most empirical studies of heuristics focus on small scale problems and well defined issues, future research should bear this in mind and aim to increase external validity by investigating real scenarios (Salas, Rosen, & DiazGranados, 2010).

To conclude the different aspects of this critique, the challenges for fast and frugal heuristics can be summarized into two categories:

1. The first addresses the nature of heuristics itself: how many types exist? Are individual differences important (Stanovich & West, 2000)? For example, Scoot and Bruce (1995, p. 820) state that "decision style is not a personality trait but a habit based propensity to react in a certain way in a specific decision context". Are some people more ecological rational and thus more successful than others? Is this, for example, one of the reasons why Apple is so successful, because managers of the company constantly adapt their products to a complex changing environment, where simple and intuitive rules are preferred over complex calculations?
2. The second challenge concerns the application of fast and frugal heuristics and is of special interest for management research. Are there normative/prescriptive consequences from working principles, like less-is-more, and how do management scholars have to re-think their assumptions regarding rationality and optimal decisions?

Gigerenzer (2007) stresses that the fast and frugal program describes how real people solve real problems. Therefore, it seems important to collect as many empirical examples of applications in real management contexts. However, until now there have not been many studies of this kind. One of the few studies is that of Wübben and Wan-

[25] The same result, that not a majority of subjects used fast and frugal heuristic when making inferences, was also stressed in another study by Newell, Weston and Shanks (2003) that took a closer look at the TTB heuristic.

genheim (2008), who showed that in retail marketing fast and frugal heuristics, predicting non-active consumers, can be more efficient than complex binomial distribution models. In a recent finance study by DeMiguel, Garlappi and Uppal (2009) they showed that a naïve 1/N rule of portfolio selection is not outperformed by more sophisticated methods.

Nevertheless, the most important insight from the large existing body of research on bounded rationality is, to be successful, in a fundamentally uncertain world, managers sometimes have no other choice than to rely on their adaptive capabilities in thinking and deciding. There is growing evidence that the human mind is equipped with efficient strategies for this search which stems from our evolutionary past (Cosmides & Tooby, 1994; Tooby & Cosmides, 2005).

3. Rationality in judgment and decision making - Dual process models as a unifying approach

3.1 Different concepts of rationality – are they mutually exclusive?

In this concluding chapter we want to frame the different programs and show their commonalities. Therefore, we do not stress their differences, but show how they might reasonably be linked.[26] However, we will focus on the concepts of bounded rationality and will not elaborate on the link to unbounded rationality, concepts which exist for instance, in economics.[27]

Starting with the distinction made by Chase, Hertwig and Gigerenzer (1998) between bounded and ecological rationality, we illustrate the main component of ecological rationality with Fig. 5. As already stressed, within ecological rationality it is of utmost importance to look at how the environment influences the tasks (c) and how the environment shapes and has shaped the cognitive capacities of social actors (b) (Elio, 2002). The key critique on the heuristics and bias program is its main reliance on the relationship between tasks and cognitive capacities of social actors (a).

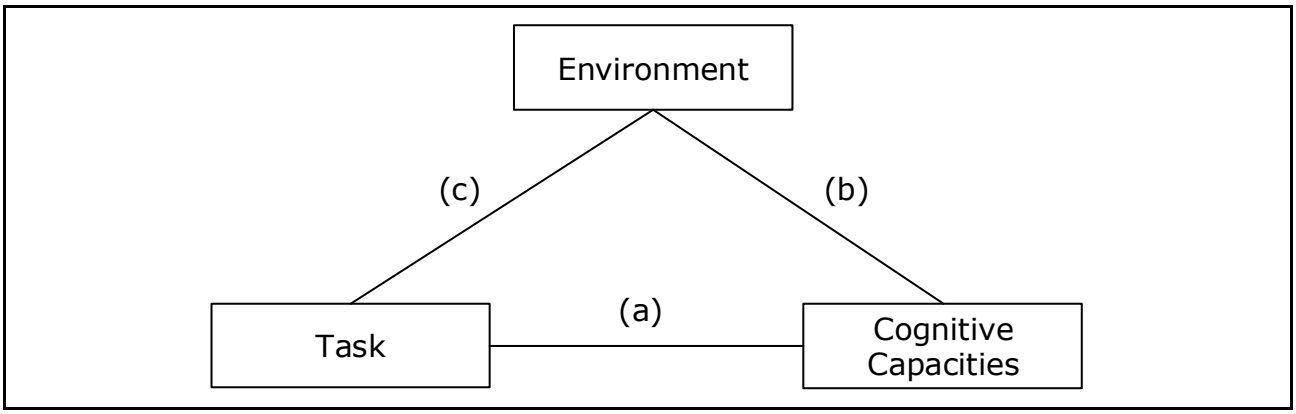
However, in our view both programs show us not only the pitfalls, but also the merits of human reasoning. Humans do not constantly err, because they use biased heuristics, nor do humans constantly engage in efficiently exploiting their environment – because they use fast and frugal heuristics. A more realistic picture looks like this: humans have an evolutionary past in which they constantly learned and adapted to their biological and social environment and this shaped their cognitive capacities. For instance, they learned to detect cheaters in social exchange situations which indicates a special heuristic for this important task in a social environment (Cosmides & Tooby, 2005). In addition, humans are not error free and, even more importantly; they face a wide range of tasks in a modern technological environment. Research shows that if humans are not familiar with those tasks they make errors when trying to solve them but, if they were tutored a lot of those problems disappeared. Eventually, both programs could profit from a wider framework of reasoning which we will illustrate next.

---

[26] See the reviews of this dispute as well as amendments in line with our suggestions in Samuels, Stich and Bishop (2002) and Samuels and Stich (2004).

[27] Since Simon's original publications of bounded rationality many suggestions have been discussed as to how to integrate bounded rationality in social and economic analysis, see for example contributions by Williamson (1985), Lindenberg (1992), Conlisk (1996), or by Smith (2003) and a short overview in Bendor (2001).

Fig. 5: Simon's scissors explicated



3.2 Dual-process models of reasoning

According to Stanovich and West (2000) our judgment and decision making is partitioned into two main categories labeled System 1 and System 2 (see Tab. 2).[28] On the one side, System 1 is characterized by automatic, effortless and associative processes and is particularly relevant in affective contexts. The System 2 working principle on the other side is best described as controlled, deductive and dominated by serial processing. Both are working concurrently and it is important to acknowledge that the reliance of System 1 on automatic processes does not necessarily mean that this System is less capable than System 2. As an example of the power of System 1 Sloman (1996) mentions chess grandmasters, who are able to conduct perfect moves after a short glimpse on the board. Despite the reflective nature of System 2, this system can lead to wrong decisions as well, for the reason that people simply apply the wrong rules.[29]

In order to integrate the fast and frugal heuristics view by Gigerenzer and his research group into this model, Kahneman and Frederick (2002) suggest that these heuristics fall into System 2, however, they suggest a dynamic relationship. First, heuristics are spontaneously initiated by System 1 and then later adopted by System 2 (as they are a seen as a deliberate strategy). Biases, like the conjunction fallacy, occur when System 2 does not correct intuitive errors by System 1. In line with this explanation the approach of Gigerenzer (1991) of letting "cognitive illusions disappear", can be attributed to System 2 that in these cases used the salience of some cues to correct the biases of System 1. This approach can be considered as a possible solution to integrate the competing views on intuitive judgments and the usefulness of heuristics.

[28] There is an on-going discussion about the components of the mind (Keren & Schul, 2009). Here we only differentiate between dual-process and dual-systems approaches with the latter being the more comprehensive component of the mind (Frankish, 2010).

[29] Sloman (1996, p. 11 ff) lists various examples from different research contexts. For instance the occurrence of simultaneous contradictory beliefs, like the famous "Linda" conjunction fallacy (Kahneman & Tversky, 2000). According to Sloman people often report, when confronted with the evidence that it is less likely that Linda is both a lawyer and a feminist (compared to the single condition): "I know it is less likely but it feels so wrong just to choose one single condition".

Tab. 2: Characterization of Systems 1 and 2 (Kahneman & Frederick, 2002)

System 1 (intuitive)	System 2 (reflective)
Process characteristics	
Automatic	Controlled
Effortless	Effortful
Associative	Deductive
Rapid, parallel	Slow, serial
Process opaque	Self-aware
Skilled action	Rule application
Content	
Affective	Neutral
Causal propensities	Abstract
Prototypes	Sets
Concrete, specific	Abstract

Still, we have to clarify the role of ecological rationality in this dual-process model of reasoning. This is relevant, because obviously both systems can lead to successful decisions and it is challenging to infer descriptive implications from this model.[30] One possible option is to refer to the experience of social actors. Exploiting the environment (i.e. to behave ecological rational) is not synonymous with learning, rather, learning is a pre-condition to exploiting the information of the environment. We guess that only experienced social actors will be able to decide if a heuristic will be satisfying and when to switch to more effortful rule-based reasoning.

If this account is true, then the idea of ecological rationality is another way to explore under which circumstances experienced managers (in marketing, management control or human resources) make efficient decisions and recommendations, and under which circumstances they also commit biases (Kahneman & Klein, 2009). This could be used to explain when heuristics are useful (Gigerenzer & Brighton, 2009) and when they might mislead the decision maker (Kahneman & Tversky, 2000). One promising avenue of research is in clarifying how System 1 and System 2 interact and when System 2 processes override processes of System 1 (Stanovich, 2010).[31] As we have outlined in this paper, management scholars should pay attention to cognitive

[30] Although Gigerenzer and Regier (1996) express doubts about the integration of fast and frugal heuristics into the broader perspective of dual-process models of reasoning (as suggested for example by Sloman, 1996; Epstein, 1994; Chaiken & Trope, 1999), the differences between the views of Gigerenzer and colleagues on the one side and Kahneman on the other side can be classified in terms of degree and not as two mutually exclusive views of human decision making (Frey & Benz, 2004).

[31] Evans theorizes on a more general two mind hypothesis and argues against a chief executive model of the mind, however, he also distinguishes between a reflective and an intuitive mind (Evans, 2010b).

processes of social actors. This could contribute in practice towards knowing how to create an environment that encourages social actors to freely express and act according to managers' "gut feelings" and heuristics.

Furthermore, for management research, it would be interesting to discover if heuristics represent efficient tools in dealing with daily challenges and how they are actually used (Astebro & Elhedhli, 2006). For example, it has been shown in several studies that our ability to make accurate (effective) forecasts is inadequate (e.g. Hsee & Zhang, 2004) and it seems promising to compare heuristic estimations against these (more elaborate) forecasts. In a dual-process setting this research could contribute to the interplay of heuristics and effortful reasoning in realistic management settings.

As in any growing field of research, there is a lack of coherence between the labels of dual-processes or dual-systems (see for instance tables 1 and 2 in Evans, 2008, p. 257). For instance, the model from Tab. 2 provides no deeper explanation of how the underlying cognitive processes work (it is not a process model) and how one system merges into another (Keren & Schul, 2009). In this case, a further explication is necessary of how heuristics (as System 1 mechanisms) co-exist and co-work with more rule-based systems (System 2). Further research will show if dual-process theories yield enough progressive energy to fuel this research program of judgment and decision making in management.

Literature

Ariely, D. (2008). *Predictably irrational: The hidden forces that shape our decisions*. New York: Harper.

Ariely, D. (2010). *The upside of irrationality: The unexpected benefits of defying logic at work and at home*. New York: Harper.

Arrow, K. J. (2004). Is bounded rationality unboundedly rational? Some ruminations. In M. Augier & J. G. March (Eds.), *Models of a man. Essays in memory of Herbert A. Simon* (pp. 47-55). Cambridge: MIT Press.

Astebro, T., & Elhedhli, S. (2006). The effectiveness of simple decision heuristics: forecasting commercial success for early-stage ventures. *Management Science, 52*(3), 395-409.

Axelrod, R. (1984). *The evolution of cooperation*. New York: Basic Books.

Ayton, P., & Fischer, I. (2004). The hot hand fallacy and the gambler's fallacy: Two faces of subjective randomness? *Memory & Cognition, 32*(8), 1369-1378.

Basel, J. S. (2010). Can less-be-more in management accounting?, *Behavioral Decision Research in Management (BDRM) Conference*. Carnegie Mellon University: Pittsburgh.

Bazerman, M. H., & Moore, D. A. (2009). *Judgment in managerial decision making* (7 ed.). New York: Wiley.

Becker, G. (1976). *The economic approach to human behavior*. Chicago: University of Chicago Press.

Bell, J. F. (1967). *A history of economic thought*. New York: Ronald Press.

Bendor, J. (2001). Bounded rationality. In N. J. Smelser & P. B. Baltes (Eds.), *International Encyclopedia of the Social & Behavioral Sciences* (pp. 1303-1307). Amsterdam: Elsevier.

Berg, N. (2010). Behavioral economics. In R. C. Free (Ed.), *21st century economics: a reference handbook* (Vol. 2, pp. 861-872). Los Angeles: Sage.

Bernoulli, D. (1738/1954). Exposition of a new theory on the measurement of risk. *Econometrica, 22*(1), 22-36.
Bonner, S. E. (2008). *Judgment and decision making in accounting*. Upper Saddle River: Pearson.
Boyd, R., & Richardson, P. J. (2005). *The origin and evolution of cultures*. New York: Oxford University Press.
Brühl, R. (2010). Handlungserklärungen in einer erkenntnispluralistischen Methodologie. Betriebswirtschaftliche Handlungstheorien und Methodenkombinationen. In T. Wrona & G. Fandel (Eds.), *Mixed Methods - Konzeptionelle Überlegungen*. *Zeitschrift für Betriebswirtschaft, 80*, 44-76.
Camerer, C. (1992). Recent test of generalizations of expected utility theory. In W. Edwards (Ed.), *Studies in risk and uncertainty: No. 2. Utility theories: Measurement and applications* (pp. 207-251). Norwell: Kluwer.
Camerer, C. (1998). Bounded rationality in individual decision making. *Experimental Economics, 1*(2), 163-183.
Camerer, C., Loewenstein, G., & Rabin, M. (2003). *Advances in behavioral economics. The roundtable series in behavioral economics*. Princeton: Princeton University Press.
Chaiken, S., & Trope, Y. (1999). *Dual-process theories in social psychology*. New York: Guilford Press.
Chase, V. M., Hertwig, R., & Gigerenzer, G. (1998). Visions of rationality. *Trends in Cognitive Sciences, 2*(6), 206-214.
Cohen, L. J. (1981). Can human irrationality be experimentally demonstrated? *Behavioral and Brain Sciences, 4*(3), 317-331.
Conlisk, J. (1996). Why bounded rationality? *Journal of Economic Literature, 34*(2), 669-700.
Cosmides, L., & Tooby, J. (1994). Better than rational: evolutionary psychology and the invisible hand. *American Economic Review, 84*(2), 327-332.
Cosmides, L., & Tooby, J. (1997). Dissecting the computational architecture of social inference mechanisms. In G. Bock & G. Cardew (Eds.), *Characterizing human psychological adaptations* (pp. 132-158). Chichester: Wiley.
Cosmides, L., & Tooby, J. (2005). Neurocognitive adaptions designed for social exchange. In D. M. Buss (Ed.), *The handbook of evolutionary psychology* (pp. 584-627). Hoboken: Wiley.
Dawes, R. M. (1979). The robust beauty of improper linear models in decision making. *American Psychologist, 34*(7), 571-582.
DellaVigna, S. (2009). Psychology and economics: evidence from the field. *Journal of Economic Literature, 47*(2), 315-372.
DeMiguel, V., Garlappi, L., & Uppal, R. (2009). Optimal versus naive diversification: How inefficient is the 1/N portfolio strategy? *Review of Financial Studies, 22*(5), 1915-1953.
Dijksterhuis, A., & Aarts, H. (2010). Goals, attention, and (un)consciousness. *Annual Review of Psychology, 61*, 467-490.
Eisenführ, F., & Weber, M. (2003). *Rationales Entscheiden* (4 ed.). Berlin: Springer.
Elio, R. (2002). Issues in common sense reasoning and rationality. In R. Elio (Ed.), *Common sense, reasoning and rationality* (pp. 3-36). New York: Oxford University Press.
Epstein, S. (1994). Integration of the cognitive and the psychodynamic unconscious. *American Psychologist, 49*(8), 709-724.
Evans, J. S. B. T. (2008). Dual-Processing accounts of reasoning, judgment, and social cognition. *Annual Review of Psychology, 59*, 255-278.

Evans, J. S. B. T. (2010a). Intuition and reasoning: a dual-process perspective. *Psychological Inquiry, 21*(4), 313-326.
Evans, J. S. B. T. (2010b). *Thinking twice. Two minds in one brain*. Oxford: Oxford University Press.
Fiedler, K. (1988). The dependence of the conjunction fallacy on subtle linguistic factors. *Psychological Research, 50*(2), 123-129.
Fishburn, P. C. (1981). Subjective expected utility: A review of normative theories. *Theory and Decision, 13*, 139-199.
Frankish, K. (2010). Dual-process and dual-system theories of reasoning. *Philosophy Compass, 5*(10), 914-926.
Frey, B. S., & Benz, M. (2004). From imperialism to inspiration: A survey of economics and psychology. In A. Marciano, J. B. Davis & J. Runde (Eds.), *Elgar companion to economics and philosophy* (pp. 61-83). Cheltenham: Elgar.
Friedman, M., & Savage, L. J. (1948). The utility analysis of choices involving risk. *Journal of Political Economy, 56*(4), 279-304.
Funder, D. C. (1987). Errors and mistakes: Evaluating the accuracy of social judgment. *Psychological Bulletin, 101*(1), 75-90.
Gigerenzer, G. (1991). How to make cognitive illusions disappear: Beyond "heuristics and biases." *European Review of Social Psychology, 2*, 83-115.
Gigerenzer, G. (1996). On narrow norms and vague heuristics: A reply to Kahneman and Tversky (1996). *Psychological Review, 103*(3).
Gigerenzer, G. (1997). Bounded rationality: Models of fast and frugal inference. *Swiss Journal of Economics and Statistics, 133*(2/2), 201-218.
Gigerenzer, G. (2002). The adaptive toolbox. In G. Gigerenzer & R. Selten (Eds.), *Bounded rationality: the adaptive toolbox* (pp. 38-50). Cambridge: MIT Press.
Gigerenzer, G. (2006). Bounded and rational. In R. J. Stainton (Ed.), *Contemporary debates in cognitive science* (pp. 115-133). Oxford: Blackwell.
Gigerenzer, G. (2007). *Gut feelings: The intelligence of the unconscious*. New York: Viking.
Gigerenzer, G., & Brighton, H. (2009). Homo heuristicus: Why biased minds make better inferences. *Topics in Cognitive Science 1*(1), 107-143.
Gigerenzer, G., & Gaissmaier, W. (2011). Heuristic decision making. *Annual Review of Psychology, 62*, 451-482.
Gigerenzer, G., & Goldstein, D. G. (1996). Reasoning the fast and frugal way: Models of bounded rationality. *Psychological Review, 23*(4), 650-669.
Gigerenzer, G., Hertwig, R., Hoffrage, U., & Sedlmeier, P. (2008). Cognitive illusions reconsidered. In C. R. Plott & V. L. Smith (Eds.), *Handbook of experimental economics results. [Volume 1]* (pp. 976-986). Amsterdam: North Holland.
Gigerenzer, G., & Regier, T. (1996). How do we tell an association from a rule? Comment on Sloman (1996). *Psychological Bulletin, 119*(1), 23-26.
Gigerenzer, G., & Selten, R. (2002). Rethinking rationality. In G. Gigerenzer & R. Selten (Eds.), *Bounded rationality: the adaptive toolbox* (pp. 1-12). Cambridge: MIT Press.
Gigerenzer, G., & Todd, P. M. (1999). Fast and frugal heuristics: the adaptive toolbox. In G. Gigerenzer, P. M. Todd & The ABC Research Group (Eds.), *Simple heuristics that make us smart* (pp. 3-34). New York: Oxford University Press.
Gigerenzer, G., & Todd, P. M. (2008). Rationality the fast and frugal way: Introduction. In C. R. Plott & V. L. Smith (Eds.), *Handbook of experimental economics results. [Volume 1]* (pp. 976-986). Amsterdam: North Holland.
Gigerenzer, G., Todd, P. M., & the ABC Research Group. (1999). *Simple heuristics that make us smart*. New York: Oxford University Press.

Gilovich, T., & Griffin, D. (2002). Heuristics and biases: Then and now. In T. Gilovich, D. Griffin & D. Kahneman (Eds.), *Heuristics and biases: The psychology of intuitive judgment* (pp. 1-18). Cambridge: Cambridge University Press.
Gladwell, M. (2005). *Blink: The power of thinking without thinking*. New York: Little Brown.
Goldstein, D. G. (2010). What is the field of judgment and decision making (JDM)?, from http://www.decisionsciencenews.com/2010/10/11/what-is-jdm/
Goldstein, D. G., & Gigerenzer, G. (2002). Models of ecological rationality: The recognition heuristic. *Psychological Review, 109*(1), 75-90.
Harless, D. W., & Camerer, C. (1994). The predictive utility of generalized expected utility theories. *Econometrica, 62*(16), 1251-1289.
Hastie, R., & Dawes, R. M. (2010). *Rational choice in an uncertain world. The psychology of judgment and decision making* (2 ed.). Los Angeles: Sage.
Hempel, C. G. (1965). Aspects of scientific explanation. In *Aspects of scientific explanation. And other essays in the philosophy of science* (pp. 331-504). New York: The Free Press.
Hertwig, R., & Herzog, S. M. (2009). Fast and frugal heuristics: Tools of social rationality. *Social Cognition, 27*(5), 661-698.
Heukelom, F. (2005). *The origin of prospect theory, or testing the intuitive statistician.* Tinbergen Institute Discussion Paper (2005-11/2), University of Amsterdam: Amsterdam.
Heukelom, F. (2007a). *What Simon says.* Tinbergen Institute Discussion Paper (2007-005/1), University of Amsterdam: Amsterdam.
Heukelom, F. (2007b). *Who are the behavioral economists and what do they say?* Tinbergen Institute Discussion Paper (2007-020/1), University of Amsterdam: Amsterdam.
Hilbig, B. E. (2010). Reconsidering "evidence" for-fast-and-frugal heuristics. *Psychonomic Bulletin & Review, 17*(6), 923-930.
Hilbig, B. E., & Richter, T. (2010). *Homo heuristicus* outnumbered: Comment on Gigerenzer and Brighton (2009). *Topics in Cognitive Science, 3*(1), 187-196.
Hodgkinson, G. P., & Healey, M. P. (2008). Cognition in organizations. *Annual Review of Psychology, 59*, 387-417.
Hoffrage, U., & Reimer, T. (2004). Models of bounded rationality: The approach of fast and frugal heuristics. *Management Revue, 15*(4), 437-459.
Hogarth, R. M. (1987). *Judgment and choice. The psychology of decision* (2 ed.). Chichester: Wiley.
Hsee, C. K., & Zhang, J. (2004). Distinction bias: Misprediction and mischoice due to joint evaluation. *Journal of Personality and Social Psychology, 86*(5), 680-695.
Kahneman, D., & Frederick, S. (2002). Representativeness revisited: Attribute substitution in intuitive judgment In T. Gilovich, D. Griffin & D. Kahneman (Eds.), *Heuristics and biases: The psychology of intuitive judgment* (pp. 49-81). Cambridge: Cambridge University Press.
Kahneman, D., & Klein, G. (2009). Conditions for intuitive expertise. *American Psychologist, 64*(6), 515-526.
Kahneman, D., & Tversky, A. (1972). Subjective probability: A judgment of representativeness. *Cognitive Psychology, 3*(3), 430-454.
Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47*(2), 263-291.
Kahneman, D., & Tversky, A. (1981). The framing of decisions and the psychology of choice. *Science, 211*(4881), 453-458.

Kahneman, D., & Tversky, A. (1996). On the reality of cognitive illusions. *Psychological Review, 103*(3), 582-591.
Kahneman, D., & Tversky, A. (2000). *Choices, values, and frames*. New York: Sage.
Keren, G., & Schul, Y. (2009). Two is not always better than one. *Perspectives on Psychological Science, 4*(6), 533-550.
Keren, G., & Teigen, K. H. (2004). Yet another look at the heuristics and biases approach. In D. J. Koehler & N. Harvey (Eds.), *Blackwell handbook of judgment and decision making* (pp. 89-109). Malden: Blackwell.
Klaes, M., & Sent, E.-M. (2005). A conceptual history of the emergence of bounded rationality. *History of Political Economy, 37*(1), 27-59.
Klein, G. (1993). *Sources of power: How people make decisions*. Cambridge: MIT Press.
Laibson, D., & Zeckhauser, R. J. (1998). Amos Tversky and the ascent of behavioral economics. *Journal of Risk and Uncertainty, 16*(1), 7-47.
Larrick, R. P. (1993). Motivational factors in decision theories: The role of self-protection. *Psychological Bulletin, 113*(3), 440-450.
Lehrer, J. (2010). *How we decide*. New York: Houghton Mifflin Harcourt.
Lindenberg, S. (1992). The method of decreasing abstraction. In J. S. Coleman & T. J. Fararo (Eds.), *Rational choice theory. Advocacy and critique* (pp. 3-20). Newbury Park: Sage.
Link, J. (2002). Controlling in der Defensive? Die Zuständigkeiten für Informationssyteme im Widerstreit. In J. Weber & B. Hirsch (Eds.), *Controlling als akademische Disziplin* (pp. 39-48). Wiesbaden: Deutscher Studien Verlag.
Lipsey, R. G., & Lancaster, K. (1956). The general theory of second best. *The Review of Economic Studies, 24*(1), 11-32.
Lipshitz, R., Klein, G., Orasnu, J., & Salas, E. (2001). Taking stock of naturalistic decision making. *Journal of Behavioral Decision Making, 14*(5), 331-352.
Loewenstein, G. (1999). Experimental economics from the vantage point of behavioral economics. *The Economic Journal, 109*(2), 25-33.
Lopes, L. L. (1992). Three misleading assumptions in the customary rhetoric of the bias literature. *Theory and Psychology, 2*(2), 231-236.
Martignon, L., & Hoffrage, U. (1999). Why does one-reason work? A case study in ecological rationaliy. In G. Gigerenzer, P. M. Todd & The ABC Research Group (Eds.), *Simple heuristics that make us smart* (pp. 119-140). Oxford: Oxford University Press.
Matsumoto, Y. (2007). Seeking a realistic way of individual decision making. *Global Business and Economics Review, 9*(2/3), 126-150.
McKenzie, C. R. M. (2003). Rational models as theories - not standards - of behavior. *Trends in Cognitive Sciences, 7*(9), 403-406.
Messner, M., Becker, A., Schäffer, U., & Binder, C. (2008). Legitimacy and identity in German management accounting research. *European Accounting Review, 17*(1), 129-159.
Mirowski, P. (2002). *Machine dreams, economics becomes a cyborg science*. Cambridge: Cambridge University Press.
Mises, L. v. (1966). *Human action. A treatise on economics* (3 ed.). Chicago: Henry Regnery.
Morgan, M. S. (2006). Economic man as a model man: ideal types, idealization and caricatures. *Journal of the History of Economic Thought, 28*(1), 1-27.
Mullainathan, S., & Thaler, R. H. (2000). *Behavioral economics.* Department of Economics Working Paper Series (00-27), MIT: Cambridge.

Newell, B. R., Weston, N. J., & Shanks, D. R. (2003). Empirical tests of a fast-and-frugal heuristic: Not everyone "takes-the-best". *Organizational Behavior and Human Decision Processes, 91*(1), 82-96.
Oetting, M. (2009). *Ripple effect. How empowered involvement drives word of mouth*. Wiesbaden: Gabler.
Oppenheimer, D., M. (2003). Not so fast! (and not so frugal!): Rethinking the recognition heuristic. *Cognition, 90*(1), B1-B9.
Payne, J. W., Bettman, J. R., & Johnson, E. J. (1993). *The adaptive decision maker*. Cambridge: Cambridge University Press.
Persky, J. (1995). Retrospectives: The ethology of homo economicus. *The Journal of Economic Perspectives, 9*(2), 221-231.
Popper, K. (1959). *The logic of scientific discovery*. New York: Basic Books.
Psillos, S. (2007). Contemporary perspectives on explanation. In T. A. F. Kuipers (Ed.), *Handbook of philosophy of science: general philosophy of science - focal issues* (pp. 97-173). Amsterdam: Elsevier.
Rieskamp, J., & Otto, P., E. (2006). SSL: A theory of how people learn to select strategies. *Journal of Experimental Psychology: General, 135*(2), 207-236.
Rieskamp, J., & Reimer, T. (2007). Ecological rationality. In R. F. Baumeister & K. D. Vohs (Eds.), *Encyclopedia of Social Psychology* (Vol. 1, pp. 273-274). Thousand Oaks: Sage.
Robbins, P., & Aydede, M. (2009). *The Cambridge handbook of situated cognition*. Cambridge: Cambridge University Press.
Roberts, S., & Pashler, H. (2000). How persuasive is a good fit? A comment on theory testing. *Psychological Review, 107*(2), 358-367.
Rosenberg, A. (2008). *Philosophy of social science* (3 ed.). Boulder: Westview Press.
Salas, E., Rosen, M. A., & DiazGranados, D. (2010). Expertise-based intuition and decision making in organizations. *Journal of Management, 36*(4), 941-973.
Salmon, W. C. (1989). Four decades of scientific explanation. In P. Kitcher & W. C. Salmon (Eds.), *Scientific explanation* (Vol. XIII, pp. 3-219). Minneapolis: University of Minnesota Press.
Samuels, R., & Stich, S. P. (2004). Rationality & psychology. In A. R. Mele & P. Rawling (Eds.), *The Oxford handbook of rationality* (pp. 297-300). Oxford: Oxford University Press.
Samuels, R., Stich, S. P., & Bishop, M. (2002). Ending the rationality wars: how to make dispute about human rationality disappear. In R. Elio (Ed.), *Common sense, reasoning and rationality* (pp. 236-268). New York: Oxford University Press.
Savage, L. J. (1954). *The foundation of statistics*. New York: Wiley.
Schwarz, N. (2004). *The paradox of choice: Why more is less*. New York: Ecco.
Scott, S. G., & Bruce, R., A. (1995). Decision-making style: The development and assessment of a new measure. *Educational and Psychological Measurement, 55*(5), 818-831.
Secchi, D., & Bardone, E. (2010). Does bounded rationality need an update?, *Behavioral Decision Research in Management (BDRM) Conference*. Carnegie Mellon University: Pittsburgh.
Selten, R. (2002). What is bounded rationality? In G. Gigerenzer & R. Selten (Eds.), *Bounded rationality: The adaptive toolbox* (pp. 13-36). Cambridge: The MIT Press.
Sen, A. (2002). *Rationality and freedom*. Cambridge: Harvard University Press.
Sent, E.-M. (2004). Behavioral economics: how psychology made its (limited) way back into economics. *History of Political Economy, 36*(4), 735-760.

Shah, A., K., & Oppenheimer, D., M. (2008). Heuristics made easy: An effort-reduction framework. *Psychological Bulletin, 134*(2), 207-222.
Siegel, G., & Ramanauskas-Marconi, H. (1989). *Behavioral accounting*. Cincinnati: South-Western.
Simon, H. A. (1945). *Administrative behavior. A study of decision-making processes in administrative organization*. New York: The Free Press.
Simon, H. A. (1955). A behavioral model of rational choice. *Quarterly Journal of Economics, 69*(1), 99-118.
Simon, H. A. (1979). Rational decision making in business organizations. *American Economic Review, 69*(4), 493-513.
Simon, H. A. (1990). Invariants of human behavior. *Annual Review of Psychology, 41*, 1-19.
Simon, H. A. (1993). A behavioral model of rational choice. In S. Maital & S. L. Maital (Eds.), *Economics and Psychology* (pp. 229-248). Hants: Edward Elgar.
Simon, H. A. (1997). *Models of bounded rationality. Empirically grounded economic reason* (Vol. 3). Cambridge: MIT Press.
Simon, H. A. (2000). Bounded rationality in social science: Today and tomorrow. *Mind & Society, 1*(1), 25-39.
Sloman, S., A. (1996). The empirical case for two systems of reasoning. *Psychological Bulletin, 119*(1), 3-22.
Smith, V. L. (2003). Constructivist and ecological eationality in economics. *American Economic Review., 93*(3), 465-508.
Stanovich, K. E. (2010). *Decision making and rationality in the modern world*. New York: Oxford University Press.
Stanovich, K. E., & West, R. F. (2000). Individual differences in reasoning: implications for the rationality debate? *Behavioral and Brain Sciences, 23*(5), 645-665.
Stigler, G. J. (1961). The economics of information. *American Economic Review, 69*(3), 213-225.
Tetlock, P. E. (2002). Social functionalist frameworks for judgment and choice: Intuitive politicians, theologians, and prosecutors. *Psychological Review, 109*(3), 451-471.
Thaler, R. H. (1993). *Advances in behavioral finance. The roundtable series in behavioral economics*. New York: Russel Sage Foundation.
Thaler, R. H., & Sunstein, C. R. (2003). Libertarian paternalism. *American Economic Review, 93*(2), 175-179.
Thaler, R. H., & Sunstein, C. R. (2008). *Nudge - improving decisions about health, wealth, and happiness*. New Haven: Yale University Press.
Todd, P. M. (2007). Coevolved cognitive mechanisms in mate search. In J. Forgas, M. G. Haselton & W. v. Hippel (Eds.), *Evolution and the social mind: Evolutionary psychology and social cognition* (pp. 145-159). New York: Psychology Press: Taylor & Francis Group.
Todd, P. M., & Gigerenzer, G. (2000). Précis of simple heuristics that make us smart. *Behavioral and Brain Sciences, 23*, 727-741.
Tooby, J., & Cosmides, L. (2005). Conceptual foundations of evolutionary psychology. In D. M. Buss (Ed.), *The handbook of evolutionary psychology* (pp. 5-67). Hoboken: Wiley.
Tversky, A., & Kahneman, D. (1983). Extensional versus intuitive reasoning: The conjunction fallacy in probability judgment. *Psychological Review, 90*(4), 293-315.
Tversky, A., & Koehler, D. J. (1994). Support theory: A nonextensional representation of subjective probability. *Psychological Review, 101*(4), 547-567.

Van der Rijt, J.-W. (2006). The ruin of homo oeconomicus. *London School of Economics Working Paper Series*.
Volnhals, M., & Hirsch, B. (2009). Information Overload bei Managern. Implikationen der Informationsüberlastung für das Controlling. *CFO aktuell, 3*(2), 72-75.
von Neumann, J., & Morgenstern, O. (1944). *Theory of games and economic behavior*. Princeton: Princeton University Press.
Weber, E. U., & Hsee, C. K. (2000). Culture and individual judgment and decision making. *Applied Psychology: An International Review, 49*(1), 32-61.
Weber, E. U., & Johnson, E. J. (2009). Mindful judgment and decision making. *Annual Review Psychology, 60*, 53-85.
Weber, J., & Schäffer, U. (2008). *Introduction to controlling*. Stuttgart: Schäffer-Poeschel.
Weber, M. (1947). *Theory of social and economic organization*. New York: Free Press.
Weick, K. E. (1979). *The social psychology of organizing* (2 ed.). New York: Mc Graw-Hill.
Weimann, G., Tustin, D. H., van Vuuren, D., & Joubert, J. P. R. (2007). Looking for opinion leaders: Traditional vs. modern measures in traditional societies. *International Journal of Public Opinion Research, 19*(2), 173-190.
Wertheimer, M. (1945). *Productive thinking*. New York: Harper & Brothers.
Williamson, O. E. (1985). *The economic institutions of capitalism*. New York: Free Press.
Wittgenstein, L. (1953). *Philosophical investigations*. Oxford: Blackwell.
Wright, G. H. v. (1971). *Explanation and understanding*. London: Routledge & Kegan Paul.
Wrona, T. (2008). Kognitive Strategieforschung – State of the Art und aktuelle Entwicklungen In T. Wrona (Ed.), *Strategische Managementforschung: aktuelle Entwicklungen und internationale Perspektiven* (pp. 43-83). Wiesbaden: Gabler.
Wübben, M., & Wangenheim, F. v. (2008). Instant customer base analysis: Managerial heuristics often "get it right". *Journal of Marketing, 72*(3), 82-93.

Working Paper Series
ESCP Europe Wirtschaftshochschule Berlin
ISSN 1869-5426 (from No. 48 onwards)

Formerly: Working Paper Series
ESCP-EAP Europäische Wirtschaftshochschule Berlin
ISSN 1619-7658 (No. 1-47)

The following contributions have already been published:

No. 1 Jacob, Frank (2002): Kundenintegrations-Kompetenz: Konzeptionalisierung, Operationalisierung und Erfolgswirkung.

No. 2 Schmid, Stefan (2003): Blueprints from the U.S.? Zur Amerikanisierung der Betriebswirtschafts- und Managementlehre.

No. 3 Festing, Marion/Hansmeyer, Marie Christine (2003): Frauen in Führungspositionen in Banken – Ausgewählte Ergebnisse einer empirischen Untersuchung in Deutschland.

No. 4 Pape, Ulrich/Merk, Andreas (2003): Zur Angemessenheit von Optionspreisen – Ergebnisse einer empirischen Überprüfung des Black/Scholes-Modells.

No. 5 Brühl, Rolf (2003): Anmerkungen zur Dimensionsanalyse im betrieblichen Rechnungswesen.

No. 6 Wicke, Lutz/Timm, Gerhard (2004): Beyond Kyoto – Preventing Dangerous Climate Change by Continuing Kyoto or by the GCCS-Approach?

No. 7 Pape, Ulrich/Schmidt-Tank, Stephan (2004): Valuing Joint Ventures Using Real Options.

No. 8 Schmid, Stefan/Kretschmer, Katharina (2004): The German Corporate Governance System and the German "Mitbestimmung" – An Overview.

No. 9 Brühl, Rolf (2004): Learning and Management Accounting – A Behavioral Perspective.

No. 10 Wrona, Thomas (2005): Die Fallstudienanalyse als wissenschaftliche Forschungsmethode.

No. 11 Schmid, Stefan (2005): L'internationalisation et les décisions des dirigeants.

No. 12 Schmid, Stefan/Daub, Matthias (2005): Service Offshoring Subsidiaries – Towards a Typology.

No. 13 Festing, Marion/Richthofen, Carolin von (2005): Die Auswahl von Studierenden der Internationalen Betriebswirtschaftslehre.

No. 14 Schmid, Stefan/Kretschmer, Katharina (2005): How International Are German Supervisory Boards? – An Exploratory Study.

No. 15 Brühl, Rolf/Buch, Sabrina (2005): The Construction of Mental Models in Management Accounting: How to Describe Mental Models of Causal Inferences (3rd version).

No. 16 Schmid, Stefan/Machulik, Mario (2006): What has Perlmutter Really Written? A Comprehensive Analysis of the EPRG Concept.

No. 17 Jacob, Frank/Plötner, Olaf/Zedler, Christien (2006): Competence Commercialization von Industrieunternehmen: Phänomen, Einordnung und Forschungsfragen.

No. 18 Schmid, Stefan/Kretschmer, Katharina (2006): Performance Evaluation of Foreign Subsidiaries – A Contingency Framework.

No. 19 Festing, Marion/Lassalle, Julius (2006): Determinanten des psychologischen Vertrags – Eine empirische Untersuchung am Beispiel von Alumni der ESCP-EAP Europäische Wirtschaftshochschule Berlin.

No. 20 Brühl, Rolf/Buch, Sabrina (2006): Einheitliche Gütekriterien in der empirischen Forschung? – Objektivität, Reliabilität und Validität in der Diskussion.

No. 21 Schmid, Stefan/Daniel, Andrea (2006): Measuring Board Internationalization – Towards a More Holistic Approach.

No. 22 Festing, Marion/Eidems, Judith/Royer, Susanne/Kullak, Frank (2006): When in Rome Pay as the Romans Pay? – Considerations about Transnational Compensation Strategies and the Case of the German MNE.

No. 23 Schmid, Stefan/Daub, Matthias (2007): Embeddedness in International Business Research – The Concept and Its Operationalization.

No. 24 Wrona, Thomas/Klingenfeld, Daniel (2007): Current Approaches in Entrepreneurship Research: Overview and Relevance for Management Research.

No. 25 Pape, Ulrich/Schlecker, Matthias (2007): Are Credit Spreads and Interest Rates co-integrated? Empirical Analysis in the USD Corporate Bond Market.

No. 26 Schmid, Stefan (2007): Wie international sind Vorstände und Aufsichtsräte? Deutsche Corporate-Governance-Gremien auf dem Prüfstand.

No. 27 Brown, Kerry/Burgess, John/Festing, Marion/Royer, Susanne/Steffen, Charlotte/Waterhouse, Jennifer (2007): The Value Adding Web – A Multilevel Framework of Competitive Advantage Realisation in Firm-Clusters.

No. 28 Oetting, Martin/Jacob, Frank (2007): Empowered Involvement and Word of Mouth: an Agenda for Academic Inquiry.

No. 29 Buch, Sabrina (2007): Strukturgleichungsmodelle – Ein einführender Überblick.

No. 30 Schmid, Stefan/Daniel, Andrea (2007): Are Subsidiary Roles a Matter of Perception? A Review of the Literature and Avenues for Future Research.

No. 31 Okech, Jana (2007): Markteintritts- und Marktbearbeitungsformen kleiner und mittlerer Personalberatungen im Ausland. Eine empirische Analyse unter besonderer Berücksichtigung internationaler Netzwerke.

No. 32 Schmid, Stefan/Kotulla, Thomas (2007): Grenzüberschreitende Akquisitionen und zentrale Konsequenzen für die internationale Marktbearbeitung – Der Fall Adidas/Reebok.

No. 33 Wilken, Robert/Sichtmann, Christina (2007): Estimating Willingness-to-pay With Different Utility Functions – A Comparison of Individual and Cluster Solutions.

No. 34 Jacob, Frank/Lakotta, Jan (2008): Customer Confusion in Service-to-Business Markets – Foundations and First Empirical Results.

No. 35 Schmid, Stefan/Maurer, Julia (2008): Relationships Between MNC Subsidiaries – Towards a Classification Scheme.

No. 36 Bick, Markus/Kummer, Tyge-F./Rössing, Wiebke (2008): Ambient Intelligence in Medical Environments and Devices – Qualitative Studie zu Nutzenpotentialen ambienter Technologien in Krankenhäusern.

No. 37 Wilken, Robert/Krol, Lena (2008): Standardisierung von Werbung in Printanzeigen: Der Vergleich von Studenten und Nicht-Studenten am Beispiel von Norwegen.

No. 38 Schmid, Stefan/Daniel, Andrea (2008): Cross-Border Mergers and their Challenges – The Case of Telia.

No. 39 Jacob, Frank/Oguachuba Jane (2008): Kategorisierung produktbegleitender Dienstleistungen in der Automobilindustrie.

No. 40 Festing, Marion/Müller, Bernadette/Yussefi, Sassan (2008): Careers in the Auditing Business – A Static and Dynamic Perspective on the Psychological Contract in the Up-or-out System.

No. 41 Schmid, Stefan/Grosche, Philipp (2008): Glokale Wertschöpfung im Volkswagen-Konzern – Auf dem Weg zu mehr Dezentralisierung bei Produktion und Entwicklung.

No. 42 Schmid, Stefan/Grosche, Philipp (2008): Dezentrale Zentralisierung – Rumänien im Zentrum der Wertschöpfung für Renaults Logan.

No. 43 Schmid, Stefan/Grosche, Philipp (2008): Vom Montagewerk zum Kompetenzzentrum – Der Aufstieg von Audis Tochtergesellschaft im ungarischen Györ.

No. 44 Brühl, Rolf/Horch, Nils/Orth, Mathias (2008): Der Resource-based View als Theorie des strategischen Managements – Empirische Befunde und methodologische Anmerkungen.

No. 45 Bick, Markus/Börgmann, Kathrin/Schlotter, Thorsten (2009): ITIL Version 3 –Eine Betrachtung aus Sicht des ganzheitlichen Wissensmanagements.

No. 46 Schmid, Stefan/Dauth, Tobias/Kotulla, Thomas (2009): Die Internationalisierung von Aldi und Lidl – Möglichkeiten und Grenzen bei der Übertragung von im Inland erfolgreichen Geschäftsmodellen auf das Ausland.

No. 47 Schmid, Stefan (2009): Strategies of Internationalization – An Overview.

No. 48 Schmid, Stefan/Grosche, Philipp (2009): Konfiguration und Koordination von Wertschöpfungsaktivitäten in internationalen Unternehmen – Ein kritischer Beitrag zum State-of-the-Art.

No. 49 Alexander, Julia/Wilken, Robert (2009): Consumer-Related Determinants in Product Bundling – An Empirical Study.

No. 50 Schmid, Stefan/Kotulla, Thomas (2009): The Debate on Standardization and Adaptation in International Marketing and Management Research – What Do We Know, What Should We Know?

No. 51 Festing, Marion/Maletzky, Martina/Frank, Franziska/Kashubskaya-Kimpelainen, Ekaterina (2010): Creating Synergies for Leading: Three Key Success Factors for Western Expatriates in Russia.

No. 52 Schmid, Stefan (2010): Do We Care about Relevance in the International Business Field? On Major Problems of Transferring Our Research to Management Practice.

No. 53 Plötner, Olaf/Lakotta, Jan/Jacob, Frank (2010): Differentiating Market Offerings Using Complexity and Co-Creation: Implications for Customer Decision-Making Uncertainty.

No. 54 Pape, Ulrich/Schlecker, Matthias (2010): Analyse von Credit Spreads in Abhängigkeit des risikofreien Referenzzinssatzes.

No. 55 Schmid, Stefan/Dost, Ruben (2010): Export als zentrale Internationalisierungsstrategie – Der Fall des türkischen Unternehmens Arçelik.

No. 56 Brühl, Rolf (2010): Kennzahlen für die Zielkostenkontrolle: vom Zielkostenindex zur relativen Zielkostenabweichung.

No. 57 Basel, Jörn/Brühl, Rolf (2011): Concepts of Rationality in Management Research. From Unbounded Rationality to Ecological Rationality.