

# Debiasing Management Decisions: Overcoming the practice/theory gap within the managerial decision process

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Practitioner's stream

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**Abstract:** The impact of cognitive biases on (managerial) decisions has been recognized over the last decades with a recent surge due to the COVID-19 based policy making. This article analyzes existing debiasing techniques to mitigate the influence of cognitive biases on (managerial) decisions and links the theoretical perspective with the practice. As debiasing techniques have a surprisingly little awareness among managers a card-sort experiment was applied to search for a more practice-oriented understanding and structure of debiasing techniques with the goal of developing a framework that helps practitioners to integrate debiasing techniques more easily in their decision processes. The result of the experiment shows 9 clusters of debiasing techniques (checklists, preparation, what if?, group debiasing, reason analogically, in-process debiasing, starting viewpoints, involvement, and calibration) which can be implemented in different phases of a decision process and thus may help to improve (managerial) decisions in times of uncertainty.

**Keywords:** Debiasing, management decisions, framework, card sorting

## 1. Introduction

Managerial decisions are influenced by the psychological context of decision makers (Bateman & Zeithaml, 1989) and are prone to cognitive biases (Barnes, 1984; Das & Teng, 1999; Lovallo & Kahneman, 2003; Powell, Lovallo, & Fox, 2011; Schwenk, 1984; Simon, 1987). The need to reduce the impact of these biases in strategy workshops and episodes has been recognized by strategy scholars (Hodgkinson, Whittington, Johnson, and Schwarz, 2006; Hodgkinson and Clarke, 2007; Jarzabkowski and Kaplan, 2015). Debiasing a managerial decision-making process and improving decision quality (at least in terms of process quality) both require corrective interventions (Bazerman & Moore, 2009): interventions that prevent, recognize and reduce the impact of biases.

A recent survey with German companies showed that less than 40% of the managers are aware of cognitive biases and according debiasing techniques and that 75% of the companies have no institutionalized debiasing processes in their decision-making (Kreilkamp et al., 2020). This result from practice contrasts the long tradition of recognizing cognitive biases and research on debiasing in psychology and management literature (Fischhoff, 1982; Schwenk, 1984; Tversky & Kahneman, 1974). Such a gap between knowledge in theory and practice shows that theoretical known knowledge about debiasing has still a long way to go to be recognized in managerial practice.

And the influence of cognitive biases is not reduced to managerial decisions, but all decisions under uncertainty as the COVID-19 induced policy making shows: “A pandemic of cognitive bias” (Landucci & Lamperti, 2020). Cognitive biases like identifiable victim effect, optimism bias, present bias, omission bias (Halpern et al., 2020), confirmation bias (Garcia-Alamino, 2020), information bias and action bias (Ramnath et al., 2020), premature closure, availability, framing (DiMaria et al., 2020) influence effective policy making. Overconfidence biases like miscalibration, better-than-average effect, illusion of control, optimism bias, representation bias, risk aversion, herding behavior (bandwagon) effect individual financial behavior during the COVID-19 crisis (Bansal, 2020). Cognitive biases affect clinical treatments (Zagury-Orly & Schwartzstein, 2020) with the need to recognize and address bias in COVID-data interpretation (Berenbaum, 2021). And, “biased media coverage, incomplete and asymmetric information, personal experiences, fears, inability to understand and interpret statistics, and other cognitive biases lead to distorted risk judgments” (Bagus et al., 2021).

Thus, the impact of the COVID-19 crisis, its volatility, uncertainty, complexity and ambiguity, raises the need to mitigate this effect (Halpern et al., 2020) in all kind of decisions similar to classical managerial decisions.

As a consequence of the little awareness of debiasing techniques in managerial practice, the goal of this article is to add the practitioner’s perspective on debiasing. It aims to identify those debiasing techniques which are experimentally explored and support decision makers, practitioners and strategists and develop a pragmatic and practice-oriented framework for debiasing (management) decisions.

In a first step we develop an overview on existing debiasing literature, approaches, and techniques. In a second step we confront practitioners with the identified debiasing techniques and – by using a card sorting experiment – analyze how they structure these and link them to ideal types of cognitive biases. This leads to a third step, the synthesis, the development of a practice-oriented framework of

homogenous – and thus easier to understand and implement – clusters of debiasing techniques for decision practice.

## **2. Debiasing: Theoretical Background**

The idea of debiasing managerial decisions follows a long research tradition. Reducing the influence of cognitive biases on decision-making has been of interest for scholars from various research backgrounds. In the area of cognitive psychology, Fischhoff (1982) provided a first framework of debiasing methods based on three assumptions responsible for cognitive biases: faulty tasks, faulty judges, and a mismatch between judges and tasks. Further insights into the influence of cognitive biases and overviews of debiasing approaches have been developed, among others, by Keren (1990), Arkes (1991), Larrick (2004), and Soll, Milkman, and Payne (2015). Management scholars emphasized the impact of debiasing on the quality of management decisions (Bazerman & Moore, 2009; Kaufmann et al., 2010; C. R. Schwenk, 1995) and the impact of debiasing on returns (Kahneman, Lovallo, & Sibony, 2011; Lovallo & Sibony, 2010).

The concept of debiasing combines the acceptance of “a normative – descriptive gap” in decision behavior (Larrick, 2004, p. 316) and the “decision-aiding techniques that help to debias decision-making through the elimination or at least mitigation of judgement and decision biases” (Kaufmann et al., 2010, p. 793). A bias is a “systematic deviation from normative reasoning” (Stanovich, 1999, p. 33) and, following the Meliorist position, shows a gap between the normative decision behavior (“objective standard” (Soll et al., 2015, p. 925) or “ideal standard” (Baron, 2000, p. 33)) and the actual descriptive behavior in decisions. Debiasing thus helps to make decision-making more predictive (Larrick, 2004, p. 317).

Debiasing techniques exist in a wide range: from training interventions (Morewedge et al., 2015), to a change in the choice architecture (Thaler & Sunstein, 2008), or cognitive strategies like consider alternatives (Fischhoff, 1982). A common attribute is “debiasing requires intervention” (Larrick, 2004, p. 318). Thus, what interventions (internal, on oneself, and external) are theoretically recognized as debiasing techniques?

### **2.1 Decision Readiness**

A precondition for successful decision-making is decision readiness. Soll, Milkman, and Payne (2015, pp. 930–931) describe decision readiness as the capability of type 2 processing to perform the deliberate functions in judgement and decisions. Type 2 processing «monitors the quality» of type 1 decisions and judgements (Kahneman & Frederick, 2002, p. 51). This follows the dual-process theory which is highly recognized by scholars in cognitive psychology (Evans, 2008; Evans & Stanovich, 2013; Gilovich, Griffin, & Kahnemann, 2002; Kahneman, 2003; Kahneman & Frederick, 2002; Stanovich, 2009; Stanovich et al., 2016).

Three factors determine the decision readiness and the basic capability of deliberately switching from type 1 to type 2 processing: a) the degree of fatigue and distraction, b) emotions and visceral influences, and c) individual differences in intelligence, training and thinking styles (Soll et al., 2015, pp. 929–930). As a consequence, first interventions to debias focus on the establishment of decision readiness in two ways: 1) by addressing the aspects of fatigue and distractions on the decision-making process and 2) by addressing (and choosing) the mindware of the decision maker(s). The mindware is defined as “the knowledge, rules, procedures, and strategies that can be retrieved and used to transform decoupled

representations” (Stanovich et al., 2016, p. 34), thus determined by intelligence, training and thinking styles and affecting the impact of emotions and visceral influences (see figure 1).

## 2.2 Decision Process

Further challenges of debiasing involve the override detection and the sustained cognitive decoupling (Stanovich et al., 2016, p. 43). The success of type 1 processing heuristics depends on an environment providing valid and available cues for the decision (Kahneman & Klein, 2009), a “benign environment” (Stanovich et al., 2016, p. 18). To override a type 1 decision the decision maker needs to recognize the bias (activate override) and be able to initiate the cognitive decoupling with the simulation of alternatives, thus successfully activating type 2 processing. This

leads to a third and a fourth intervention point for debiasing: 3) enabling the override of type 1 processing, and 4) supporting the cognitive decoupling. Figure 1 shows an overview of the four intervention points of successful debiasing approaches. As the first two interventions focus mainly on preconditions and prerequisites of decision-making, this article will focus on *interventions during the decision-making process itself*. Existing debiasing approaches to address basic decision readiness (interventions points 1 and 2) are: workplace and environment (Croskerry et al., 2013), training and education (Bazerman & Moore, 2009; Fischhoff, 1982; Larrick, 2004; Montibeller & Winterfeldt, 2015; Soll et al., 2015), creating a general bias awareness (Arkes, 1991; Kaufmann et al., 2010) or simply by replacing the decision makers (Fischhoff, 1982).

## 3. Debiasing approaches and techniques during the decision process

Based on Fischhoff’s (1982) emphasize on faulty judges and faulty tasks, Soll, Milkman, and Payne (2015) structured debiasing techniques into two types of debiasing modes during the decision process, modify the person (decision maker), and modify the environment (decision frame). Larrick (2004) structured debiasing techniques into four main approaches: motivational, cognitive, structural, and technological.

A systematic literature analysis following existing overviews of debiasing techniques (Bazerman & Moore, 2009; Fischhoff, 1982; Kaufmann et al., 2010; Larrick, 2004; Montibeller & Winterfeldt, 2015; Soll et al., 2015) led to the identification of 20

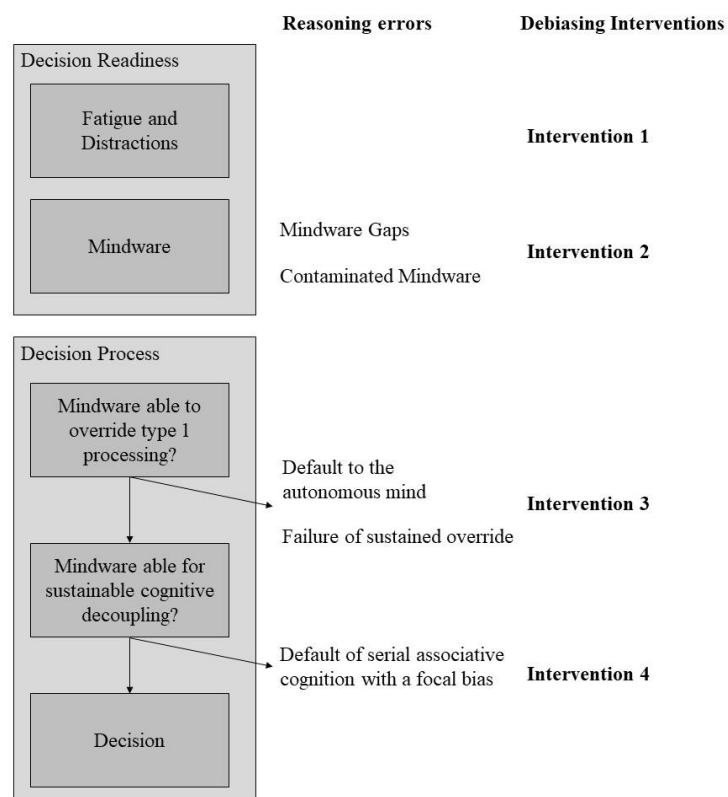


Figure 1: Debiasing interventions, own representation based on Stanovich et al, 2016, p. 56)

different debiasing techniques recognized by literature. By adapting and combining the classification logics of Larrick (2004) and Soll et al. (2015) we clustered the theoretically acknowledged debiasing techniques during managerial decision-making processes (see figure 2):

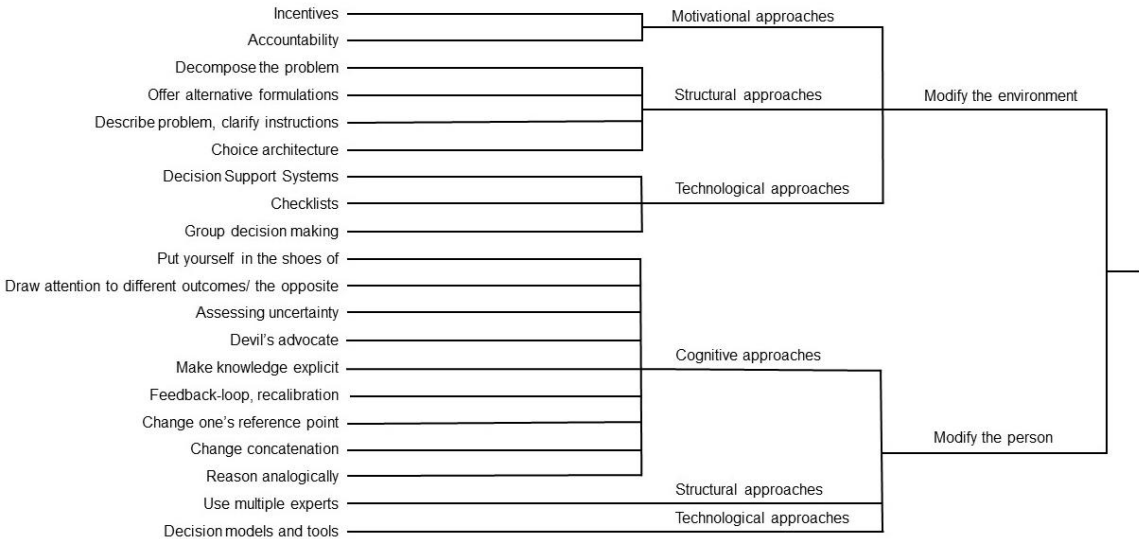


Figure 2: Theoretically developed clustering of debiasing techniques (structured as a dendrogram)

### 3.1 Modify the environment

#### 3.1.1 Motivational approaches

*Incentives* for the decision makers, as for example having higher stakes or involvement in the decision (Arkes, 1991; Harkness et al., 1985; Petty & Cacioppo, 1984), or performance-contingent incentives (Stone & Ziebart, 1995) support the debiasing for cognitive biases which are promoted by the lack of thinking motivation or thinking effort. Incentives influence the “amount, sequence, and variability of information processing” (Stone & Ziebart, 1995, p. 251). As a consequence, this technique works for strategy-based errors where (too) simple heuristics are applied (Arkes, 1991; Harkness et al., 1985). But for biases which are not caused by insufficient attention like verification biases (overconfidence) or attribution-based errors incentives seem not work and can even have a negative backfire effect (Soll et al., 2015; Stone & Ziebart, 1995).

The *accountability* of a decision maker for her decisions in front of a third party is another way to increase the motivation to invest more cognitive capacity in decision-making (Soll et al., 2015). Accountability reduces biases promoted by hasty thinking, attributional biases, overprecision, anchoring, sunk costs, order effects, but does not seem to work for ambiguity bias, loss aversion, base rate neglect, insensitivity to sample size which are even amplified by outcome accountability (Lerner & Tetlock, 1999). A strong difference is recognized between the effect of outcome accountability vs. process accountability. Lerner and Tetlock (1999) suggest process accountability to be favored as outcome accountability may promote the need for self-justification and increases escalation of commitment and the reliance on salient and easy justified dimensions of the decision (Soll et al., 2015).

### 3.1.2 Structural approaches

*Decomposing a problem* by restructuring the components of a decision into smaller/simpler problems or changing the sequence of the problems has a “significant effect on the selection and use of heuristics” (Coupey, 1994, p. 96). The decomposition of the elements of a decision can reduce overconfidence, control illusion, anchoring effects, order effects and attenuate availability biases (Ashton & Kennedy, 2002; Kaufmann et al., 2010; Montibeller & Winterfeldt, 2015).

The debiasing techniques of *offer alternative formulations* (for the problem) and *describe problem, clarify instructions* were both first mentioned by Fischhoff (1982). Until now there is little research on those two approaches showing how and where they may work to debias decisions. Fischhoff (1982) suggested that the technique of describing the problem and clarify instructions may mitigate the influence of faulty tasks. For the technique “offer alternative formulations”, Payne, Bettman, and Schkade (1999) suggest to ask a question in multiple different ways to identify inconsistencies in or missing pieces of information (availability) or scale effects.

A *choice architecture* like setting a default, choosing in advance, partitioning resources or planned interruptions is helpful to support the override of intuitive and impulsive type 1 decisions (Soll et al., 2015). These techniques, nudges, help against status quo bias, inertia in decisions (Thaler & Sunstein, 2008), loss aversion, and present bias/empathy gaps (Soll et al., 2015).

### 3.1.3 Technological approaches

*Decision support systems* (DSS), computerized aids, like the use of different information displays (graphs, feedback, data visualizations, display of different patterns) helps to reduce biases like framing, representativeness biases, and ambiguity in information acquisition (Bhandari et al., 2008; Larrick, 2004; Lim & Benbasat, 1997). But it seems as anchoring/adjustment effects are robust in the context of a DSS (George & Duffy, 2000).

The use of *checklists* to debias decisions is recommended for overly simplistic or hasty thinking (Soll et al., 2015), recall errors (Hales & Pronovost, 2006), as checklists enhance the recognition of overlooked details and alternatives (Shimizu et al., 2013).

The benefit of *group interaction* during the decision making process like brainstorming, the integration of different perspectives (also supporting other debiasing approaches like “consider alternatives”) or the stimulation of creativity by combining different actors helps to overcome omission and availability biases and to deal with anchoring and gain-loss biases (Montibeller & Winterfeldt, 2015). The recursive social influence within the group supports active error checking, synergies in thinking, and has a statistical effect: to raise the sample size of decision makers. This combination of the possibility of averaged forecasting, different mindsets and experiences help to reduce confirmation biases, availability, too hasty option generation and evaluation (Larrick, 2004).

## 3.2 Modify the person

### 3.2.1 Cognitive approaches

A deliberate perspective shift by *putting oneself in the shoes of*, taking an outsiders view or making predictions what other will do reduces control illusions (Faro & Rottenstreich, 2006; Kaufmann et al., 2010), decreases stereotype views and

prejudices and other social thought like ingroup bias or attributional biases (Galinsky & Moskowitz, 2000b; Kaufmann et al., 2010), loss aversion (Białek & Sawicki, 2014; Li et al., 2017), and self-serving biases (Kaufmann et al., 2010).

The strongest theoretical evidence for all debiasing techniques exists for the approach of *drawing attention to different outcomes*. By considering and generating alternative situations, considering the opposite or using a pre-mortem analysis for one's own decisions and its consequences and potential outcomes, decision makers can actively reduce verification biases like overconfidence, confirmation bias, anchoring, hindsight, and control illusion (Adame, 2016; Arkes, 1991; Babcock et al., 1997; Epley & Gilovich, 2005; Hirt et al., 2004; Kaufmann et al., 2010; Koriat et al., 1980; Kray & Galinsky, 2003; Lord et al., 1984; Mussweiler et al., 2000; Slovic & Fischhoff, 1977; Soll et al., 2015; Veinott et al., 2010). This technique further helps to enhance likelihood assessments and judgmental biases (Heiman, 1990; Kaufmann et al., 2010; Koonce, 1992), mitigate the influence of opportunity cost neglect (Frederick et al., 2009), and functional fixedness (Galinsky & Moskowitz, 2000a). It is also seen to support the generation of alternatives and options (Keeney, 2012; Montibeller & Winterfeldt, 2015) and reduces the effect of framing, an attitude-decision gap, and recall biases (Payne et al., 1999).

*Assessing one's own uncertainty* on decision-relevant matters calibrates individual knowledge and thus helps to reduce overconfidence (Soll et al., 2015). This calibration improves the awareness of an overly confident self-view on one's knowledge and leads to a better judgement accuracy (Welsh et al., 2007).

The application of the *devil's architect* technique, the active, non-emotional representation of formal dissent in decision-making by one party, has been demonstrated to mitigate biases of information acquisition and verification biases. Information biases like attentional biases, availability, biased information search, shared information bias or information neglect (Herbert & Estes, 1977; Schulz-Hardt et al., 2002) can be reduced as a devil's advocate helps to balance information seeking (Schulz-Hardt et al., 2002). This characteristic also supports the reduction of a confirmation bias, overconfidence, bandwagon effects and planning fallacies (Cosier, 1978; Herbert & Estes, 1977; Schulz-Hardt et al., 2002; Schweiger et al., 1989; Schwenk & Cosier, 1993; Schwenk & Valacich, 1994). A side effect of the application of a devil's advocate is a potential lower satisfaction with the outcome of a (group's) decision-making and the outlook of a future collaboration (Schwenk & Cosier, 1993).

To correct a mismatch between judges and tasks, Fischhoff recommends "respondents to express what they know explicitly, rather than letting it remain "in the head"" (Fischhoff, 1982, p. 427). Until yet, this *make knowledge explicit* approach has seen few research attempts to show if and how it really helps to improve decision making.

Another cognitive approach are quick *feedback-loops* to recalibrate responses during the decision-making process. Decision aids like frequent and continuous feedback lead to a "greater understanding, performance and application" of knowledge in decisions (van Brussel et al., 2020) and thus helps to mitigate association based errors like framing, representativeness, and ambiguity (Arkes, 1991; Bhandari et al., 2008).

The deliberate *change and addition of reference points* for the decision, reframing information concerning gains and losses, is recognize to decrease the influence of

gain/loss biases like loss aversion (Arkes, 1991; Soll et al., 2015). The active framing of information (negatively or positively) also influences recency and primacy effects (Rutledge, 1995).

A second technique which helps to reduce gain/loss biases is *changing the concatenation* of the decision items. The rearrangement of related items of a decision changes the gain/loss perspective (Arkes, 1991; Thaler & Sunstein, 2008). For example, instead of “we raise the market share, then, as a consequence, we decrease the production costs” a change of concatenation would lead to “we decrease the production costs, then, as a consequence, we raise the market share”.

Adapting analogies from previous cases and situations supports the mitigation of simplified or narrow option generation and the evaluation of options in decision making (Bazerman & Moore, 2009; Schwenk, 1984). The *analogical reasoning*, comparing the decision situation to other, analog, situations, simulations or cases facilitates learning and transfer effects to extend the range of possible alternatives (Loewenstein et al., 1999).

### 3.2.2 Structural approaches

The consultation of third parties during the decision process, like *multiple experts* or external advice, debiases decision-making and especially mitigates confirmation bias, illusion of control and availability biases (Meissner & Wulf, 2016; Montibeller & Winterfeldt, 2015). Graf et al. (2012) recommend external advice with people not personally involved as involved consultants may increase the impact of social comparison and irrationality of decision-makers.

### 3.2.3 Technological approaches

*Decision models and tools* like simple pro and con tables, writing a list, linear models, causal maps, decision trees, multiattribute analyses, or decision instructions like warnings are often easy to apply and help to switch from type 1 reasoning to type 2 reasoning. These tools help to mitigate the use of oversimplified decision heuristics in information acquisition, option generation and evaluation (Larrick, 2004; Payne et al., 1999; Soll et al., 2015), myopic problem representation biases (Montibeller & Winterfeldt, 2015), and the effects of sunk costs and escalating commitment (Ohlert & Weißenberger, 2020).

## 4. Applying a Practice Perspective on Debiasing

### 4.1 Research Questions and Hypothesis

From these 20 debiasing techniques explored in research over the last 40 years surprisingly few have had an impact on contemporary decision processes in companies. As Kreilkamp et al. (2020) showed, 75% of the companies do not have an institutionalized debiasing process and over 63% of the companies do not use debiasing countermeasures in their decision-making processes. This leads to two major questions:

1. How would practitioners structure debiasing techniques when they connect these techniques with potential flaws in their decision-making process? Is it the same as the theoretical research-based literature or do they use a different, maybe more natural and practice-oriented structure which can help to better implement the understanding of debiasing in practice? This leads to our hypothesis:

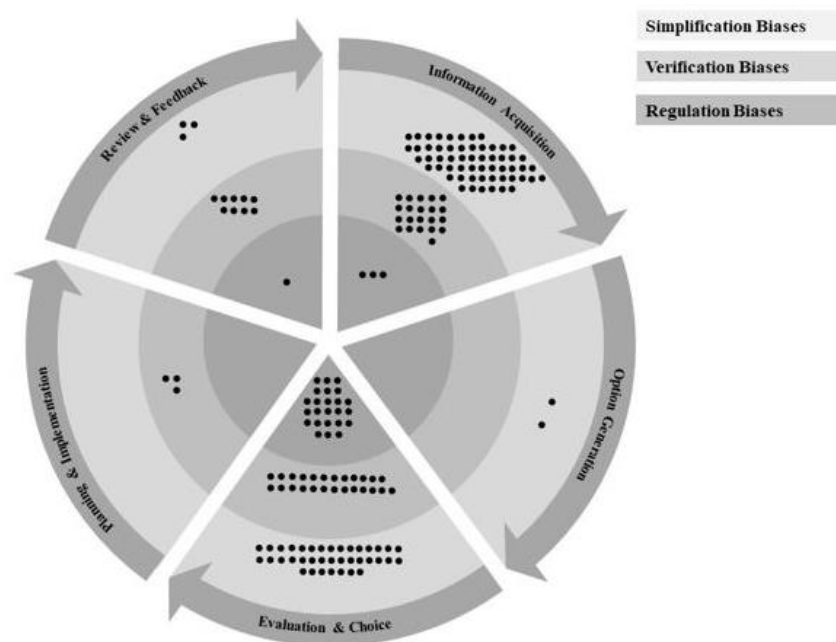
*H1: Managers structure debiasing techniques similar to the suggestion of the theoretical literature (modify person/environment, cognitive, motivational, technological, and structural approaches).*

2. Which debiasing techniques are applied in practice and with what results?

To answer these questions, we conducted a card-sorting experiment to test the hypothesis H1 (and used the Rand index to compare the similarity of the theoretical derived and the practice-oriented knowledge structure) combined with a survey on managers.

## 4.2 Experimental Design

Card sorting is a variation of the q-methodology which “combines the strengths of both qualitative and quantitative methods” (Brown, 1996, p. 561). Thus, it can help to elicit the perceived (subjective) connection between the different debiasing techniques, and 15 ideal types of cognitive biases and debiasing methods. These ideal types of biases derive from a classification scheme using and combining two dimensions, the managerial perspective (the phases of a managerial decision making process) and the psychological perspective (the motivational background of a cognitive bias, simplification, verification, and regulation biases (Oreg & Bayazit, 2009)) to provide a framework to arrange potential flaws of managerial and strategic decision-making (Eppler & Muntwiler, 2021, see figure 3).



1. Simplified information acquisition (57/187); Nr. 1.1 – 1.57; Example: Availability bias
2. Simplified option generation (2/187); Nr. 2.1 – 2.2.; Example: Functional fixedness
3. Simplified evaluation and choice (37/187); Nr. 3.1 – 3.37; Example: Hot-hand fallacy
4. Simplified planning and implementation (0/187)
5. Simplified review and feedback (3/187); Nr. 5.1 – 5.3; Example: Outcome bias
6. Self-confirmatory information acquisition (21/187); Nr. 6.1 – 6.21; Example: Confirmation bias
7. Self-confirmatory option generation (0/187)
8. Self-confirmatory evaluation and choice (25/187); Nr. 8.1 – 8.25; Example: Illusion of control
9. Self-confirmatory planning and implementation ((3/187); Nr. 9.1 – 9.3; Example: Planning fallacy
10. Self-confirmatory review and feedback (9/187); Nr. 10.1 – 10.9; Example: Hindsight bias
11. Loss/Gain lens in information acquisition (3/187); Nr. 11.1 – 11.3; Example: Framing effect
12. Loss/Gain lens in option generation (0/187)
13. Loss/Gain lens in evaluation and choice (24/187); Nr. 13.1 – 13.24; Example: Loss aversion
14. Loss/Gain lens in planning and implementation (0/187)
15. Loss/Gain lens in review and feedback (1/187); Nr. 15.1; Choice-supportive bias

Figure 3: Overview typology of cognitive biases (Eppler & Muntwiler, 2021)

Card sorting is a “relative simple, inexpensive method of gaining insight into user preference for the organization of information” (Hannah, 2005, p. 13). This research uses the methodology of closed card sorting. Open (or free) card sorting is sorting “p objects into a subject chosen number (c) of groups/categories” (Coxon, 1999, p. 3), analyzed with a hierarchical cluster analysis to elicit how the participants organize the items (Nawaz, 2012). Closed card sorting refers to the pre-grouping of categories by the researcher and the participants putting the items into the pre-defined groups (Fincher & Tenenber, 2005; Hannah, 2005). In this case the analysis of correlation is used to show topic agreement (Paul, 2014).

The participants were asked to allocate the 20 debiasing techniques to the 15 ideal types of cognitive biases (from figure 3) – according to their understanding how good these techniques work to mitigate a specific ideal type (hindsight from experience). Additionally, all participants were asked if and how successful the 20 debiasing techniques are applied in their companies.

## 5. Results

### 5.1 Card-Sorting

To reach a correlation of 0.90 a minimum of 15 users is needed (Tullis & Wood, 2004). Our experiment included 16 managers (with a median of 10 – 15 years of experience) from 10 countries, 14 different industries. Five of the participants were females, 11 males. As post experimental talks exposed, the understanding of cognitive biases and debiasing techniques was very heterogenous among the participants which is in line with the findings of the study by Kreilkamp et al. (2020).

The principle of card sorting is “(1) that all objects in the same category are considered to have a higher similarity to each other than they do to other objects and (2) that the categories themselves are considered to be maximally distinct and separated” (Coxon, 1999, p. 56).

To measure the proximity between the debiasing approaches based on the sorting by the participants a co-occurrence or similarity matrix is recommended, as it provides a “useful graduation of similarity compared with the dichotomous “belonging/ not belonging” characteristic of a single sorting” (Coxon, 1999, p. 43). Table I shows the co-occurrences of all 20 debiasing techniques.

(Incentives)																				
	Accountability	Decompose the problem	Offer alternative formulations	Describe problem	Choice architecture	Put yourself in the shoes of	Decision Support Systems	Checklists	Group decision making	Draw attention to different outcomes/opposite	Assessing uncertainty	Devil's advocate	Make knowledge explicit	Feedback-loop, recalibration	Change one's reference point	Change concatenation	Reason analogically	Use multiple experts	(Decision models and tools)	
Accountability	0.0563																			
Decompose the problem	0.1805	-0.0525																		
Offer alternative formulations	0.0216	-0.2139	0.2252																	
Describe problem	0.1021	-0.1638	0.6396	-0.1458																
Choice architecture	-0.0999	-0.4128	0.1297	0.5436	-0.024															
Put yourself in the shoes of	0.267	-0.0461	-0.2161	-0.2196	0.1331	-0.4419														
Decision Support Systems	0.0037	0.1848	0.6886	-0.0675	0.484	0.0361	-0.0095													
Checklists	0.0621	-0.1887	0.5254	-0.0449	0.2525	0.0485	-0.4569	0.0882												
Group decision making	-0.3708	0.2916	-0.3315	-0.1425	-0.2518	0.1553	-0.4752	-0.4975	0.007											
Draw attention to different outcomes/opposite	-0.2804	-0.4284	0.0901	-0.2148	0.2744	0.086	-0.1575	0.1382	0.2116	-0.147										
Assessing uncertainty	-0.0569	0.1433	0.0919	0.0723	-0.1942	0.187	-0.1228	0.0968	-0.0573	0.181	0.3715									
Devil's advocate	-0.568	0.4254	-0.3924	-0.5762	-0.1734	-0.2183	-0.2199	-0.032	-0.0429	0.4761	-0.0086	-0.243								
Make knowledge explicit	0.247	-0.2884	0.0342	0.2256	-0.1227	0.5305	-0.1452	0.0342	-0.1325	0.0186	0.0143	0.2339	-0.2736							
Feedback-loop, recalibration	0.4134	0.3039	-0.3447	-0.014	-0.1773	-0.057	0.2106	-0.1453	-0.2934	-0.1097	-0.4733	-0.5438	0.2152	0.1088						
Change one's reference point	-0.2352	-0.2625	-0.2949	-0.2702	-0.415	0.1597	-0.2	0.0048	-0.2729	0.0688	0.2455	0.1849	0.2026	0.1914	-0.2241					
Change concatenation	0.0512	-0.3965	-0.0114	0.2706	0.3778	0.2437	0.1607	-0.3483	-0.0792	0.1281	0.0524	-0.0254	-0.3602	0.3704	-0.3096	-0.4114				
Reason analogically	0.0916	0.1354	-0.3695	0.0841	0.0494	0.155	-0.0066	-0.2048	-0.1169	0.0754	-0.1188	-0.2236	0.0697	-0.2618	0.304	-0.2879	0.1975			
Use multiple experts	-0.1246	-0.2736	0.0304	-0.2264	0.2244	0.0929	0.0459	0.2167	-0.304	-0.0636	-0.0634	-0.3491	0.1363	0.0047	-0.0971	0.5812	-0.0968	-0.1811		
Decision models and tools	-0.0509	-0.5421	-0.0883	0.4019	-0.2375	0.637	-0.2385	0.3016	-0.0516	0.189	0.1131	0.2195	-0.392	0.2463	-0.2114	0.3946	0.09	0.0379	0.0842	

Table I: Co-occurrences (similarities) of the 20 debiasing techniques

In a second step the data was hierarchical clustered following Ward’s linkage method (Ward, 1963). Hierarchical clustering uses pairwise proximities (Coxon, 1999) to develop a “binary tree-based data structure called the dendrogram” (Aggarwal & Reddy, 2014, p. 88), which then helps to analyze the data by splitting the tree at different levels.

Ward’s linkage method “is based on a classical sum-of-squares criterion, producing groups that minimize within-group dispersion at each binary fusion” (Murtagh & Legendre, 2014, p. 275). This method is recommended by Ferreira and Hitchcock (2009) as it shows the highest Rand index in most situations, and Hirano et al. because of its “highest accuracy and coverage” (Hirano et al., 2004, p. 164). The outperformance of Ward’s linkage method is also shown by Punj and Stewart (1983).

The application of this linkage method resulted in the dendrogram in figure 4:

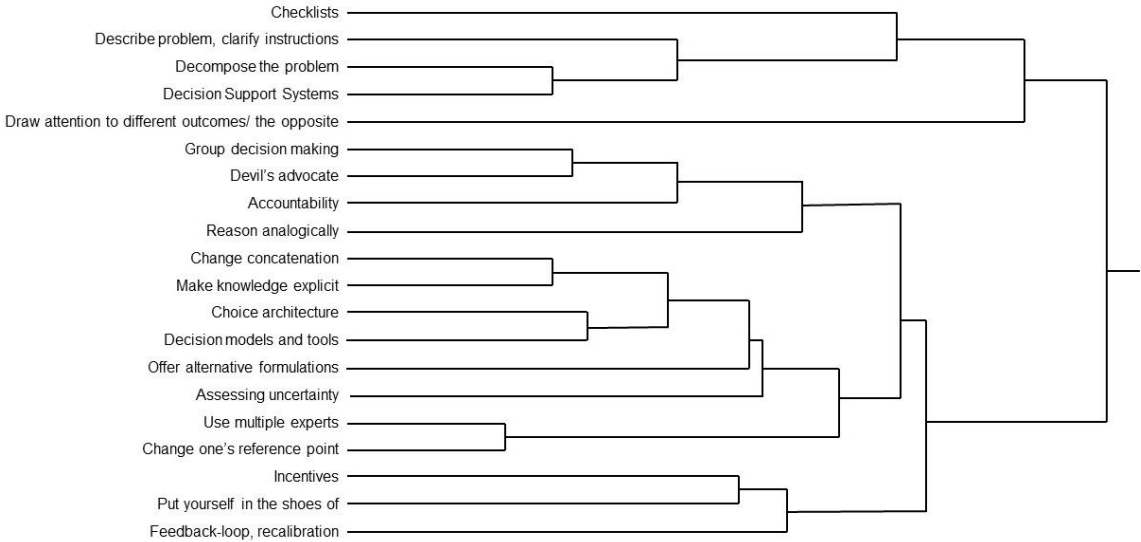


Figure 4: Dendrogram of the card-sorting results (Ward’s linkage method)

The comparison with the clustering of the theoretical developed structure of debiasing approaches (figure 2) shows a distinguishable difference of clusters (proximities and distances of the objects). The Rand index of similarity (Rand, 1971) comparing both clusterings (each with 6 main clusters; 114 pairs are in both clusterings in different clusters, 11 pairs are in both in the same cluster, and 65 pairs differ between the clusterings) results in 0.66 (with 1.0 for identical clusters), and thus rejecting hypothesis H1. Managers *do not follow the theoretical structure* of debiasing approaches when linking them to different ideal types of biases. This finding confirms a theory/practice gap in debiasing and may be one explication why debiasing in practice finds less support than could be expected (Kreilkamp et al., 2020).

**5.2 Survey**

The results of the survey mirror those of the study of Kreilkamp et al. (2020). According to it the most used debiasing techniques are risk analysis, critical discussion, accountability, and change of perspective (more than 50 % of the companies). Post-hoc decision analysis (feedback-loop), Decision Support Systems and decision models are the least used debiasing techniques. These results are mainly confirmed by the results of our survey (see figure 5).

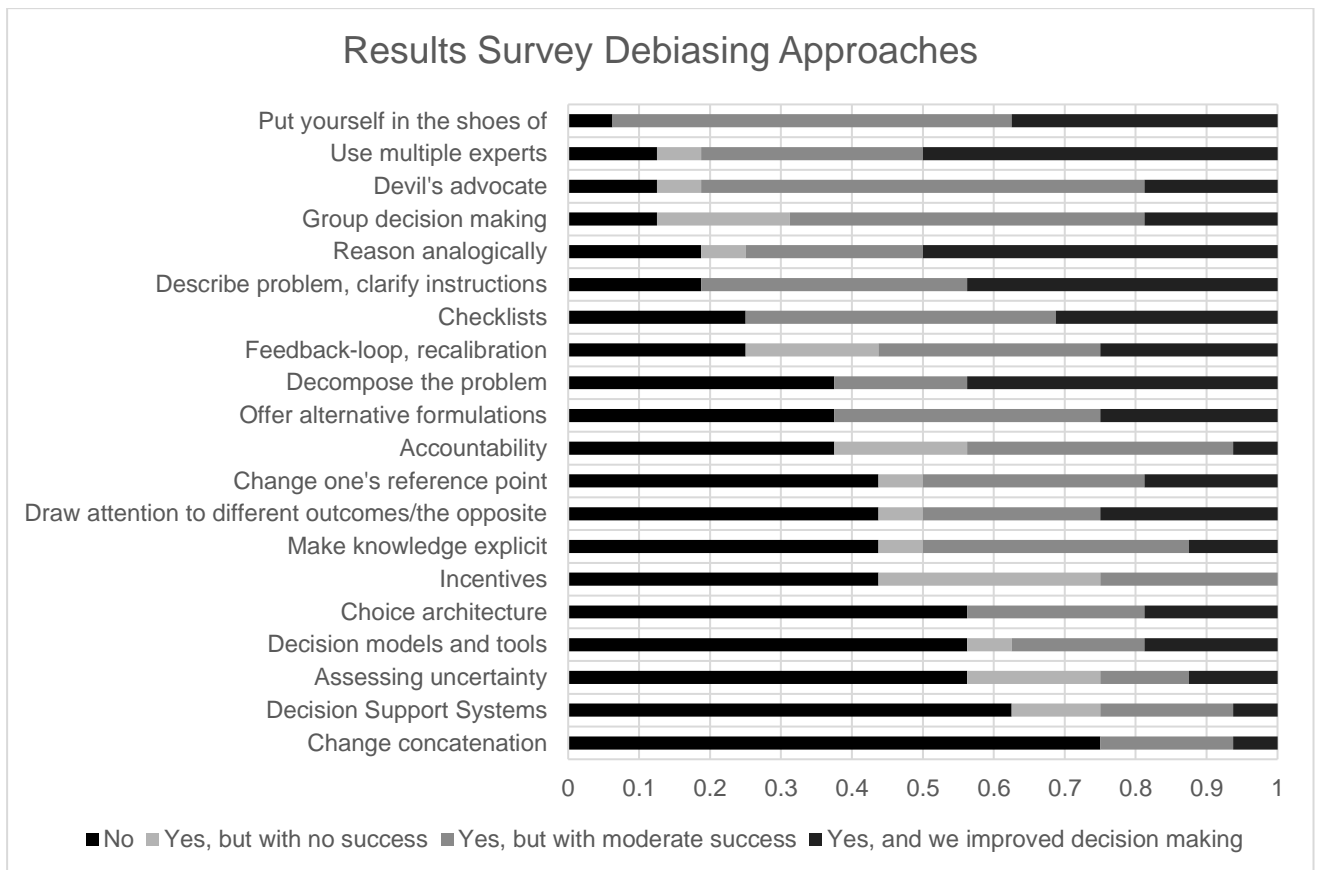


Figure 5: Debiasing approaches used in managerial practice

The debiasing techniques mostly used and recommendable by practitioners are *put yourself in the shoes of*, *describe problem/clarify instruction*, *use multiple experts*, *devil's advocate*, *checklists*, *reason analogically*, *group decision making*, *decompose the problem*, and *offer alternative formulations*.

## 6. Practice-oriented framework of debiasing techniques – towards a practice oriented debiasing procedure

### 6.1 Finding clusters

As the clustering of debiasing techniques from the practitioner's view led to a different result than the theoretical clustering, the resulting dendrogram from the experiment needs a more detailed analysis with the goal of identifying homogenous and identifiable clusters. Clusters that lead practitioners towards a better understanding and knowledge of debiasing techniques and when to use them in managerial decision processes.

The elaboration and definition of cluster from an experimental-based dendrogram is considered to be "fuzzy" and arbitrary as there are few guidelines how to cluster a dendrogram (Punj & Stewart, 1983) and "interpretation is dependent on the underlying context of the problem" (Milligan & Cooper, 1987, p. 349). Harrigan states that the "researcher must decide how many clusters provide the most meaningful portrayal of the data" (Harrigan, 1985, p. 62) based on a process starting with a first approximation using the Ward's method (figure 4) followed by an iterative partitioning process with an external validation: "a demonstration that the clusters are useful in some larger sense" (Punj & Stewart, 1983, p. 145).

The analysis and interpretation of the resulting dendrogram leads to 6 potential “cuts”, 1) leading to no clustering at all (as each technique represents its own cluster), 2) resulting in 15 clusters, 3) in 12 clusters, 4) in 9, 5) in 6 clusters, and 6) in 3 clusters. As cuts 1 – 3 do not lead to a useful sum of clusters (too many for practical use) and cut 6 leads to a very heterogenous and big cluster versus two small ones, cuts 4 and 5 both show homogenous and not too many different clusters (see figure 6) thus applicable for managerial practice.

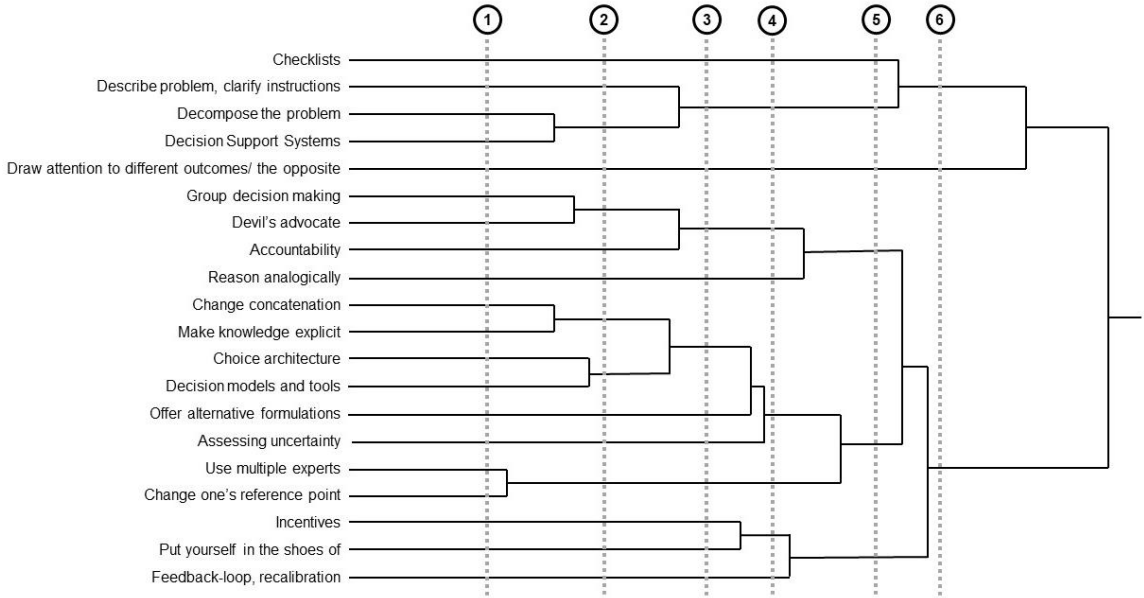


Figure 6: Cuts to cluster the dendrogram of debiasing techniques

The main difference between 9 or 6 clusters is whether the techniques of “reason analogically” should be part of the cluster with “group decision making”, and the technique of “multiple experts”/change of reference point is part of the bigger cluster with “choice architecture” etc. and if the “feedback-loop” technique is placed in the cluster with “incentives”. The consideration of the differences in the practical application of these debiasing techniques indicates towards 9 clusters of debiasing techniques from a practitioner’s view (see figure 7).

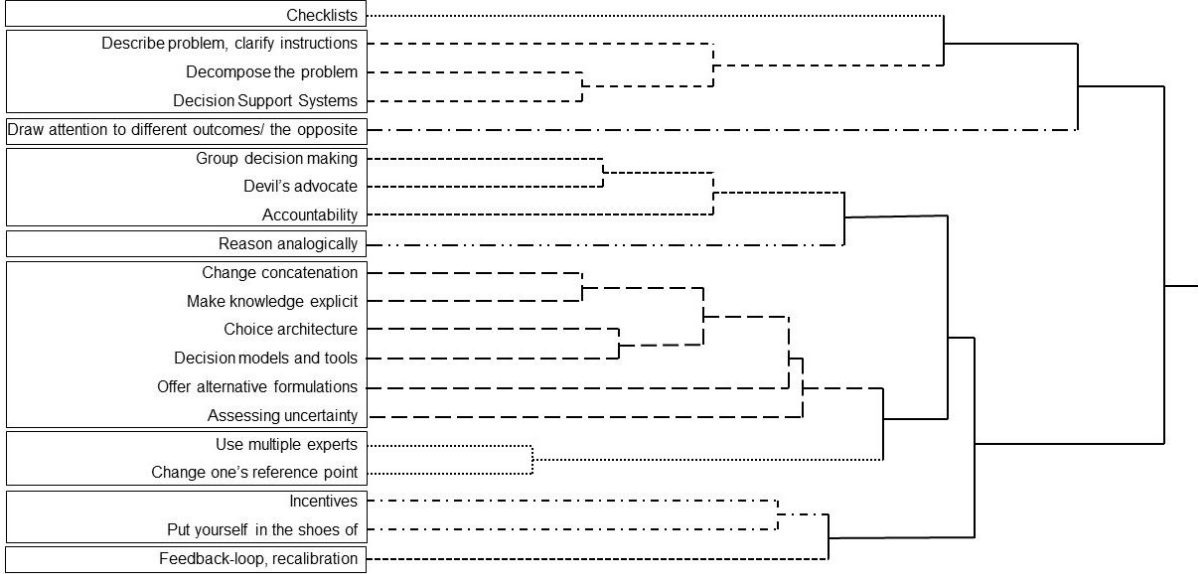


Figure 7: 9 Clusters of debiasing techniques

## 6.2 Towards a new structure to understand debiasing management decisions

To develop a more practice-oriented framework of debiasing techniques we use these 9 clusters as a basis to link theoretical knowledge concerning the applicability of these techniques for certain biases with the perspective and experience of practitioners – based on the ranking of the mean cluster values from the card-sorting experiment for each of the 9 clusters (checklists, preparation, what if?, group debiasing, reason analogically, in-process debiasing, starting viewpoints, involvement, and calibration – see table II). This leads to two major insights: a) when which debiasing technique may make sense in a decision process, and b) potential gaps in research and communication of research results versus practice.

Cluster	Technique	Works for theory	Works for practice	Theory-/practice gap
Checklists	Checklists	<ul style="list-style-type: none"> <li>• Simplified thinking processes (Soll et al., 2015)</li> <li>• Recall biases (Hales &amp; Pronovost, 2006)</li> <li>• Problem-solving set, identify alternatives (Shimizu et al., 2013)</li> </ul>	<ul style="list-style-type: none"> <li>• Simplified evaluation &amp; choice biases</li> <li>• Simplified planning &amp; implementation biases</li> <li>• Risk-averse implementation biases</li> </ul>	None
Preparation	Describe problem, clarify instructions	<ul style="list-style-type: none"> <li>• Faulty tasks (Fischhoff, 1982)</li> </ul>	<ul style="list-style-type: none"> <li>• Simplified information acquisition biases</li> <li>• Simplified planning &amp; implementation biases</li> <li>• Simplified evaluation &amp; choice biases</li> <li>• Self-confirmatory evaluation &amp; choice biases</li> </ul>	None
	Decompose the problem	<ul style="list-style-type: none"> <li>• Recency/primacy (Ashton &amp; Kennedy, 2002)</li> <li>• Selection and use of heuristics (Coupey, 1994)</li> <li>• Overconfidence, availability, anchoring (Montibeller &amp; Winterfeldt, 2015)</li> <li>• Control illusion, availability, framing, sunk cost effects (Kaufmann et al., 2010)</li> </ul>		
	Decision support systems	<ul style="list-style-type: none"> <li>• Framing, representativeness, ambiguity (Bhandari et al., 2008)</li> <li>• Biases information acquisition (Larrick, 2004)</li> <li>• Representativeness (Lim &amp; Benbasat, 1997)</li> </ul> <p>Works NOT for Anchoring/adjustment (George &amp; Duffy, 2000)</p>		
What if?	Draw attention to different outcomes, consider the opposite, consider	<ul style="list-style-type: none"> <li>• Anchoring (Adame, 2016; Epley &amp; Gilovich, 2005)</li> <li>• Explanation bias, hindsight, overconfidence, likelihood judgements (Hirt et al., 2004)</li> </ul>	<ul style="list-style-type: none"> <li>• Risk-averse planning &amp; implementation biases</li> <li>• Self-confirmatory evaluation biases</li> </ul>	<i>Use for debiasing self-confirmatory planning &amp; implementation biases</i>

	alternative situations, generating alternatives, pre-mortem analysis	<ul style="list-style-type: none"> <li>• Confidence judgments, confirmation bias (Koriat et al., 1980)</li> <li>• Hindsight, logical problem solving, social judgement, availability, salience (Lord et al., 1984)</li> <li>• Anchoring (Mussweiler et al., 2000)</li> <li>• Hindsight (Slovic &amp; Fischhoff, 1977; Soll et al., 2015)</li> <li>• Narrow option generation (Keeney, 2012)</li> <li>• Opportunity cost neglect (Frederick et al., 2009)</li> <li>• Likelihood assessments (Heiman, 1990; Koonce, 1992)</li> <li>• Confirmation bias (Kray &amp; Galinsky, 2003)</li> <li>• Functional fixedness (Galinsky &amp; Moskowitz, 2000a)</li> <li>• Framing, problematic valuation effects, attitude-decision gap, memory/recall biases (Payne et al., 1999)</li> <li>• Narrow option generation (Montibeller &amp; Winterfeldt, 2015)</li> <li>• Confirmation bias, availability, self-serving biases (Babcock et al., 1997)</li> <li>• Overconfidence, planning illusion, illusion of control (Veinott et al., 2010)</li> <li>• Judgmental biases, control illusion, hindsight, anxiety based biases, planning fallacy (Kaufmann et al., 2010)</li> <li>• Association-based biases (Arkes, 1991)</li> </ul>	<ul style="list-style-type: none"> <li>• Loss/gain lens in information acquisition biases</li> <li>• Simplified evaluation &amp; choice biases</li> <li>• Simplified information acquisition biases</li> <li>• Loss/gain lens in review &amp; feedback biases</li> <li>• Simplified planning &amp; implementation biases</li> <li>• Self-confirmatory option generation biases</li> <li>• Self-confirmatory information acquisition biases</li> </ul>	<i>in practice not recognized</i>
Group debiasing	Group decision making	<ul style="list-style-type: none"> <li>• Omission, overconfidence, availability bias, anchoring, gain-loss biases (Montibeller &amp; Winterfeldt, 2015)</li> <li>• Confirmation bias, availability, simplified option generation, simplified evaluation &amp; choice (Larrick, 2004)</li> </ul>	<ul style="list-style-type: none"> <li>• Self-confirmatory planning &amp; implementation biases</li> <li>• Loss/gain lens in review and feedback biases</li> <li>• Self-confirmatory information acquisition biases</li> </ul>	None
	Devil's advocate, formal dissent, search for	<ul style="list-style-type: none"> <li>• Biased information search, confirmation bias, attentional bias, shared information bias, narrow option generation,</li> </ul>		

	discrepant information,	bandwagon effect, overconfidence (Schulz-Hardt et al., 2002) <ul style="list-style-type: none"> <li>• Confirmation bias, congruence bias (Schwenk &amp; Cosier, 1993; Schwenk &amp; Valacich, 1994)</li> <li>• Confirmation bias, narrow option generation (Schweiger et al., 1989)</li> <li>• Availability, confirmation bias, planning fallacy, information neglect (Herbert &amp; Estes, 1977)</li> <li>• Judgmental biases, planning biases (Cosier, 1978)</li> </ul>		
	Accountability, second-order judgement	<ul style="list-style-type: none"> <li>• Sunk cost effects (Soll et al., 2015)</li> <li>• Attributional biases, anchoring, conjunction fallacy, overprecision (Lerner &amp; Tetlock, 1999)</li> <li>• Process accountability decreases the need for self-justification ((Lerner &amp; Tetlock, 1999)</li> </ul> <p>Works NOT for</p> <ul style="list-style-type: none"> <li>• “Accountability is likely to strengthen reliance on salient or easily justified dimensions, such as outcome probabilities in choice” (Larrick, 2004, p. 323)</li> <li>• Base rate neglect, insensitivity to sample size, preference reversals, ambiguity, attraction effect, loss aversion (Lerner &amp; Tetlock, 1999)</li> <li>• “Accountability is unlikely to help when cognitive laziness is not the root source of bias” (Soll et al., 2015, p. 935)</li> </ul>		
Reason analogically	Reason analogically	<ul style="list-style-type: none"> <li>• Simplified option generation, simplified evaluation of options (Bazerman &amp; Moore, 2009; Loewenstein et al., 1999)</li> <li>• Narrow option generation (Schwenk, 1984)</li> </ul>	<ul style="list-style-type: none"> <li>• Loss/gain lens in review and feedback biases</li> <li>• Self-confirmatory planning &amp; implementation biases</li> <li>• Simplified evaluation &amp; choice biases</li> <li>• Simplified information acquisition biases</li> <li>• Simplified review &amp; feedback biases</li> </ul>	<i>Research on implication for regulation biases (loss/gain lens) and verification biases (self-confirmatory planning &amp; implementation, evaluation &amp; choice), review &amp;</i>

			<ul style="list-style-type: none"> <li>• Loss/gain lens in option generation biases</li> <li>• Self-confirmatory evaluation &amp; choice biases</li> </ul>	<i>feedback biases</i>
In-process debiasing	Change concatenation	<ul style="list-style-type: none"> <li>• Psychophysically based errors, gain/loss biases (Arkes, 1991)</li> <li>• Gain/loss biases (Thaler &amp; Sunstein, 2008)</li> </ul>	<ul style="list-style-type: none"> <li>• Simplified option generation biases</li> <li>• Loss/gain lens in planning &amp; implementation biases</li> <li>• Loss/gain lens in option generation biases</li> <li>• Simplified information acquisition biases</li> </ul>	<i>Use for debiasing verification biases (variations of overconfidence) and regulation biases (loss/gain lens in evaluation &amp; choice) in practice not recognized</i>
	Make knowledge explicit	<ul style="list-style-type: none"> <li>• Mismatch between judges and tasks (Fischhoff, 1982)</li> </ul>		
	Choice architecture (nudges)	<ul style="list-style-type: none"> <li>• Inertia, status quo (Thaler &amp; Sunstein, 2008)</li> <li>• Reference point/loss aversion, present bias (choosing in advance, precommitment) (Soll et al., 2015)</li> </ul>		
	Decision models and tools (e.g. linear)	<ul style="list-style-type: none"> <li>• Use of simplified heuristics, memory/recall biases, availability, narrow option generation (Larrick, 2004)</li> <li>• Information acquisition biases, attentional bias, scaling effects (Payne et al., 1999)</li> <li>• Simplified heuristics, cluster illusion (Soll et al., 2015)</li> <li>• Myopic problem representation biases (Montibeller &amp; Winterfeldt, 2015)</li> <li>• Sunk costs, escalation of commitment (Ohlert &amp; Weißenberger, 2020)</li> </ul>		
	Offer alternative formulations	<ul style="list-style-type: none"> <li>• Influences of scale compatibility, inconsistencies in information (availability) (Payne et al., 1999)</li> </ul>		
	Assessing uncertainty, improving judgement accuracy	<ul style="list-style-type: none"> <li>• Overconfidence (Soll et al., 2015; Welsh et al., 2007)</li> </ul>		
Starting Viewpoints	Use multiple experts	<ul style="list-style-type: none"> <li>• Confirmation bias, overconfidence, availability (Montibeller &amp; Winterfeldt, 2015)</li> <li>• Illusion of control, overconfidence (Meissner &amp; Wulf, 2016)</li> </ul>	<ul style="list-style-type: none"> <li>• Self-confirmatory information acquisition biases</li> <li>• Self-confirmatory option generation biases</li> <li>• Simplified information acquisition biases</li> </ul>	None
	Change one's reference	<ul style="list-style-type: none"> <li>• Psychophysically based errors, gain/loss biases (Arkes, 1991)</li> </ul>		

	point, add new gains and losses, reframe gains and losses	<ul style="list-style-type: none"> <li>• Loss aversion (Soll et al., 2015)</li> <li>• Recency/primacy (Rutledge, 1995)</li> </ul>	<ul style="list-style-type: none"> <li>• Loss/gain lens in option generation biases</li> <li>• Loss/gain lens in information acquisition biases</li> <li>• Loss/gain lens in evaluation &amp; choice biases</li> <li>• Loss/gain lens in planning &amp; implementation biases</li> <li>• Loss/gain lens in review &amp; feedback biases</li> </ul>	
Involvement	Incentives (raising the cost of using the suboptimal decision strategy, strong involvement with results of decision)	<ul style="list-style-type: none"> <li>• Strategy-based errors (Arkes, 1991, p. 492)</li> <li>• Too strong reliance on heuristics (Harkness et al., 1985)</li> <li>• Number of arguments (attentional bias), (Petty &amp; Cacioppo, 1984)</li> <li>• Clerical and memorization tasks (Larrick, 2004)</li> <li>• Frequency assessments, anchoring/adjustment, (Stone &amp; Ziebart, 1995)</li> </ul> <p>Works NOT for:</p> <ul style="list-style-type: none"> <li>• Overconfidence, prevent preference reversals, decrease the frequency of conjunction fallacy” (Stone &amp; Ziebart, 1995)</li> <li>• Association-based errors (Arkes, 1991)</li> <li>• “Biases that are not primarily caused by lack of effort or insufficient attention. Monetary incentives can even backfire in some instances by leading people to “think harder but not smarter”” (Soll et al., 2015, p. 935)</li> </ul>	<ul style="list-style-type: none"> <li>• Loss/gain lens in option generation biases</li> <li>• Simplified review &amp; feedback biases</li> <li>• Self-confirmatory review &amp; feedback biases</li> <li>• Loss/gain lens in evaluation &amp; choice biases</li> <li>• Loss/gain lens in information acquisition biases</li> <li>• Loss/gain lens in review &amp; feedback biases</li> </ul>	<i>Use for debiasing simplification biases (information acquisition, evaluation &amp; choice) in practice not recognized</i>
	Put yourself in the shoes of, take an outsider's view	<ul style="list-style-type: none"> <li>• Simplified evaluation and choice biases, prejudice/stereotyping, self-serving bias, anchor bias, control illusion (Kaufmann et al., 2010)</li> <li>• Control illusion (Faro &amp; Rottenstreich, 2006)</li> <li>• Stereotyping, social thought, ingroup bias, attribution biases (Galinsky &amp; Moskowitz, 2000b)</li> </ul>		

		<ul style="list-style-type: none"> <li>• Loss aversion (Bialek &amp; Sawicki, 2014; Li et al., 2017)</li> </ul>		
Calibration	Feedback-loop on decisions, provide personalized feedback, recalibrate their responses	<ul style="list-style-type: none"> <li>• Framing, representativeness, ambiguity (Bhandari et al., 2008)</li> <li>• Association-based biases (Arkes, 1991)</li> <li>• Confirmation bias (van Brussel et al., 2020)</li> <li>• Faulty judges (Fischhoff, 1982)</li> </ul>	<ul style="list-style-type: none"> <li>• Simplified feedback &amp; review biases</li> <li>• Self-confirmatory feedback &amp; review biases</li> <li>• Loss/gain lens in feedback &amp; review biases</li> <li>• Self-confirmatory option generation</li> </ul>	None

Table II: Clustered debiasing techniques and where they work

By following the suggestion of Soll et al. (2015) to structure debiasing into “decision readiness” and “decision process”, the combination of the concept of debiasing interventions from Stanovich et al. (2016) and the results of the card-sorting experiment allows a more practice-oriented framework for debiasing interventions in managerial decision processes (figure 8):

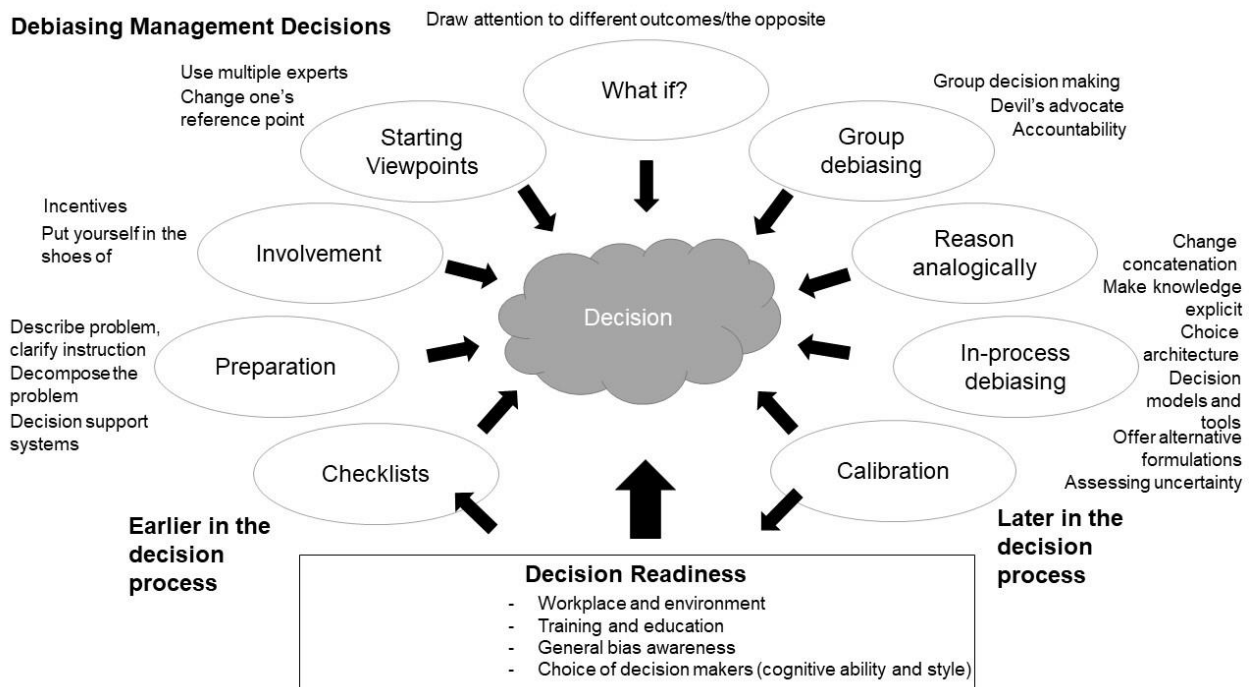


Figure 8: Overview debiasing management decisions - a practitioners' view

## 7. Conclusion and Limitations

The integration of a practice-oriented – or problem-oriented – perspective in debiasing research showed a different structure to understand debiasing techniques than the theoretical literature would provide. This new structure allows a debiasing framework closer to the managerial practice, easier to understand. Thus, it offers a chance that this way of understanding and structuring debiasing techniques may help to make managers aware of the flaws of decision biases and to show them what they can do before and during a decision process to mitigate the influence of these biases

on managerial decisions, to improve the communication and implementation of debiasing techniques in (managerial) decision-making practice.

The results also show gaps in the “theory-practice relationship”: The debiasing power of “involvement” techniques are not recognized in practice for the debiasing of simplification biases, same for the “what if?”-technique for self-confirmatory planning and implementation biases and the impact of “in-process debiasing” techniques on verification and regulation biases. This calls for a better transfer of research results towards the managerial practice.

On the other hand, the practitioner’s view recommends more research on the debiasing technique of “reason analogically” as they see debiasing potential on regulation and verification biases.

Further research could also provide more insights about how facilitation techniques like visualization support the application of the debiasing techniques in practice and lead to a stronger and institutionalized implementation of debiasing processes in managerial decision making.

One background reason for this research is also a limitation: The managers show limited understanding of both biases and debiasing techniques and overall a very heterogenous knowledge of these matters. Some techniques were well known but others like “change concatenation” needed explanation and were probably not fully understood by all participants. This depended on the personal expertise and individual background of the participants.

A second limitation is the number of participants, especially for the survey. Even if the findings are in line with the study of Kreilkamp et al. (2020) extending the scope of participants will help to get more insights about the real knowledge on debiasing techniques in managerial practice.

Nevertheless, the integration of the “victim’s perspective” on debiasing techniques allows a new and more natural, practice-oriented understanding of debiasing. The resulting debiasing framework and overview may help for the communication and implementation in future projects to reduce the impact of cognitive biases in managerial decisions and thus making decisions better.

## References

- Adame, B. J. (2016). Training in the mitigation of anchoring bias: A test of the consider-the-opposite strategy. *Learning and Motivation, 53*, 36–48.
- Aggarwal, C., & Reddy, C. (2014). *Data Clustering* (C. Aggarwal & C. Reddy (eds.)). Chapman and Hall/CRC.
- Arkes, H. R. (1991). Costs and benefits of judgment errors: Implications for debiasing. *Psychological Bulletin, 110*(3), 486–498.
- Ashton, R. H., & Kennedy, J. (2002). Eliminating recency with self-review: the case of auditors' 'going concern' judgments. *Journal of Behavioral Decision Making, 15*(3), 221–231.
- Babcock, L., Loewenstein, G., & Issacharoff, S. (1997). Creating Convergence: Debiasing Biased Litigants. *Law & Social Inquiry, 22*(4), 913–925.
- Bagus, P., Peña-Ramos, J. A., & Sánchez-Bayón, A. (2021). COVID-19 and the Political Economy of Mass Hysteria. *International Journal of Environmental Research and Public Health, 18*(4), 1376.
- Bansal, T. (2020). Behavioral Finance and COVID-19: Cognitive Errors that Determine the Financial Future. *SSRN*, accessed 3.3.2021.
- Barnes, J. H. (1984). Cognitive Biases and Their Impact on Strategic Planning. *Strategic Management Journal, 5*(2), 129–137.
- Baron, J. (2000). *Thinking and deciding*. Cambridge Cambridge University Press.
- Bateman, T. S., & Zeithaml, C. P. (1989). The Psychological Context of Strategic Decision: A Model and Convergent Experimental Findings. *Strategic Management Journal, 10*(1), 59–74.
- Bazerman, M. H., & Moore, D. A. (2009). *Judgment in managerial decision making*. Hoboken, N.J. Wiley.
- Berenbaum, M. R. (2021). On COVID-19, cognitive bias, and open access. *Proceedings of the National Academy of Sciences, 118*(2), e2026319118.
- Bhandari, G., Hassanein, K., & Deaves, R. (2008). Debiasing investors with decision support systems: An experimental investigation. *Decision Support Systems, 46*(1), 399–410.
- Białek, M., & Sawicki, P. (2014). Can taking the perspective of an expert debias human decisions? The case of risky and delayed gains. *Frontiers in Psychology, 5*, 989.
- Brown, S. R. (1996). Q Methodology and Qualitative Research. *Qualitative Health Research, 6*(4), 561–567.
- Cosier, R. A. (1978). The effects of three potential aids for making strategic decisions on prediction accuracy. *Organizational Behavior and Human Performance, 22*(2), 295–306.
- Coupey, E. (1994). Restructuring: Constructive Processing of Information Displays in Consumer Choice. *Journal of Consumer Research, 21*(1), 83–99.
- Coxon, A. P. M. (1999). *Sorting data: Collection and analysis*. Sage.

- Croskerry, P., Singhal, G., & Mamede, S. (2013). Cognitive debiasing 2: impediments to and strategies for change. *BMJ Quality & Safety*, *22*, ii65–ii72.
- Das, T. K., & Teng, B. S. (1999). Cognitive biases and strategic decision processes: an integrative perspective. *Journal of Management Studies*, *36*(6), 757–778.
- DiMaria, C. N., Lee, B., Fischer, R., & Eiger, G. (2020). Cognitive Bias in the COVID-19 Pandemic. *Cureus*, *12*(7), e9019–e9019.
- Epley, N., & Gilovich, T. (2005). When effortful thinking influences judgmental anchoring: differential effects of forewarning and incentives on self-generated and externally provided anchors. *Journal of Behavioral Decision Making*, *18*(3), 199–212.
- Eppler, M. J., & Muntwiler, C. (2021). BIASMAP – Developing a Visual Typology and Interface to Explore and Understand Decision-Making Errors in Management. *Proceedings of the 4th International Conference on Human Interaction and Emerging Technologies (IHET - AI 2021), April 28-30, 2021, Strasbourg*, (forthcoming).
- 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., & Stanovich, K. E. (2013). Dual-Process Theories of Higher Cognition: Advancing the Debate. *Perspectives on Psychological Science*, *8*(3), 223–241.
- Faro, D., & Rottenstreich, Y. (2006). Affect, Empathy, and Regressive Mispredictions of Others' Preferences Under Risk. *Management Science*, *52*(4), 529–541.
- Ferreira, L., & Hitchcock, D. B. (2009). A Comparison of Hierarchical Methods for Clustering Functional Data. *Communications in Statistics - Simulation and Computation*, *38*(9), 1925–1949.
- Fincher, S., & Tenenber, J. (2005). Making sense of card sorting data. *Expert Systems*, *22*(3), 89–93.
- Fischhoff, B. (1982). Debiasing. In D. Kahnemann, P. Slovic, & A. Tversky (Eds.), *Judgment under uncertainty: Heuristics and biases* (pp. 422–444). Cambridge, MA, Cambridge University Press.
- Frederick, S., Novemsky, N., Wang, J., Dhar, R., & Nowlis, S. (2009). Opportunity Cost Neglect. *Journal of Consumer Research*, *36*(4), 553–561.
- Galinsky, A. D., & Moskowitz, G. B. (2000a). Counterfactuals as Behavioral Primes: Priming the Simulation Heuristic and Consideration of Alternatives. *Journal of Experimental Social Psychology*, *36*(4), 384–409.
- Galinsky, A. D., & Moskowitz, G. B. (2000b). Perspective-taking: Decreasing stereotype expression, stereotype accessibility, and in-group favoritism. *Journal of Personality and Social Psychology*, *78*(4), 708–724.
- Garcia-Alamino, J. M. (2020). Human biases and the SARS-CoV-2 pandemic. *Intensive & Critical Care Nursing*, *58*, 102861.
- George, J. F., & Duffy, K. (2000). Countering the anchoring and adjustments bias with decision support systems. *Decision Support Systems*, *29*(2), 195.

- Gilovich, T., Griffin, D., & Kahnemann, D. (2002). *Heuristics and biases. The psychology of intuitive judgment*. Cambridge University Press.
- Graf, L., König, A., Enders, A., & Hungenberg, H. (2012). Debiasing competitive irrationality: How managers can be prevented from trading off absolute for relative profit. *European Management Journal*, 30(4), 386–403.
- Hales, B. M., & Pronovost, P. J. (2006). The checklist—a tool for error management and performance improvement. *Journal of Critical Care*, 21(3), 231–235.
- Halpern, S. D., Truog, R. D., & Miller, F. G. (2020). Cognitive Bias and Public Health Policy During the COVID-19 Pandemic. *JAMA*, 324(4), 337–338.
- Hannah, S. (2005). *Sorting Out Card Sorting: Comparing Methods for Information Architects, Usability Specialists, and Other Practitioners*. University of Oregon.
- Harkness, A. R., DeBono, K. G., & Borgida, E. (1985). Personal involvement and strategies for making contingency judgments: A stake in the dating game makes a difference. *Journal of Personality and Social Psychology*, 49(1), 22–32.
- Harrigan, K. R. (1985). An application of clustering for strategic group analysis. *Strategic Management Journal*, 6(1), 55–73.
- Heiman, V. B. (1990). Auditors' Assessments of the Likelihood of Error Explanations in Analytical Review. *The Accounting Review*, 65(4), 875–890.
- Herbert, T. T., & Estes, R. W. (1977). Improving Executive Decisions by Formalizing Dissent: The Corporate Devil's Advocate. *Academy of Management Review*, 2(4), 662–667.
- Hirano, S., Sun, X., & Tsumoto, S. (2004). Comparison of clustering methods for clinical databases. *Information Sciences*, 159(3), 155–165.
- Hirt, E. R., Kardes, F. R., & Markman, K. D. (2004). Activating a mental simulation mind-set through generation of alternatives: Implications for debiasing in related and unrelated domains. *Journal of Experimental Social Psychology*, 40(3), 374–383.
- Hodgkinson, G. P., Whittington, R., Johnson, G., & Schwarz, M. (2006). The Role of Strategy Workshops in Strategy Development Processes: Formality, Communication, Co-ordination and Inclusion. *Long Range Planning*, 39(5), 479–496.
- Hodgkinson, Gerard P., & Clarke, I. (2007). Exploring the cognitive significance of organizational strategizing: A dual-process framework and research agenda. *Human Relations*, 60(1), 243–255.
- Jarzabkowski, P., & Kaplan, S. (2015). Strategy Tools-in-use: A Framework for Understanding Technologies of Rationality in Practice. *Strategic Management Journal*, 36(4), 537–558.
- Kahneman, D., & Klein, G. (2009). Conditions for Intuitive Expertise: A Failure to Disagree. *American Psychologist*, 64(6), 515–526.
- Kahneman, Daniel. (2003). A perspective on judgment and choice: Mapping bounded rationality. *American Psychologist*, 58(9), 697–720.
- Kahneman, Daniel, & Frederick, S. (2002). Representativeness revisited: Attribute

- substitution in intuitive judgment. In T. Gilovich, D. Griffin, D. Kahneman, T. Gilovich (Ed), D. Griffin (Ed), & D. Kahneman (Ed) (Eds.), *Heuristics and biases: The psychology of intuitive judgment*. (pp. 49–81). Cambridge University Press.
- Kahneman, Daniel, Lovallo, D., & Sibony, O. (2011). Before you make that big decision... *Harvard Business Review*, 89(6), 50–60.
- Kaufmann, L., Carter, C. R., & Buhrmann, C. (2010). Debiasing the supplier selection decision: a taxonomy and conceptualization. *International Journal of Physical Distribution & Logistics Management*, 40(10), 792–821.
- Keeney, R. L. (2012). Value-Focused Brainstorming. *Decision Analysis*, 9(4), 303–313.
- Keren, G. (1990). Cognitive Aids and Debiasing Methods: Can Cognitive Pills Cure Cognitive Ills? *Advances in Psychology*, 68, 523–552.
- Koonce, L. (1992). Explanation and Counterexplanation during Audit Analytical Review. *The Accounting Review*, 67(1), 59–76.
- Koriat, A., Lichtenstein, S., & Fischhoff, B. (1980). Reasons for confidence. *Journal of Experimental Psychology: Human Learning and Memory*, 6(2), 107–118.
- Kray, L. J., & Galinsky, A. D. (2003). The debiasing effect of counterfactual mind-sets: Increasing the search for disconfirmatory information in group decisions. *Organizational Behavior and Human Decision Processes*, 91(1), 69–81.
- Kreilkamp, N., Schmidt, M., & Wöhrmann, A. (2020). Debiasing as a Powerful Management Accounting Tool? Evidence from German Firms. *Forthcoming Journal of Accounting & Organizational Change*.
- Landucci, F., & Lamperti, M. (2020). A pandemic of cognitive bias. *Intensive Care Medicine*.
- Larrick, R. P. (2004). Debiasing. In D. J. Koehler & N. Harvey (Eds.), *Blackwell Handbook of Judgment and Decision Making*. (pp. 316–337). Malden, MA and Oxford, Wiley-Blackwell.
- Lerner, J. S., & Tetlock, P. E. (1999). Accounting for the effects of accountability. *Psychological Bulletin*, 125(2), 255–275.
- Li, Z., Rohde, K. I. M., & Wakker, P. P. (2017). Improving one's choices by putting oneself in others' shoes – An experimental analysis. *Journal of Risk and Uncertainty*, 54(1), 1–13.
- Lim, L.-H., & Benbasat, I. (1997). The debiasing role of group support systems: an experimental investigation of the representativeness bias. *International Journal of Human Computer Studies*, 47(3), 453.
- Loewenstein, J., Thompson, L., & Gentner, D. (1999). Analogical encoding facilitates knowledge transfer in negotiation. *Psychonomic Bulletin & Review*, 6(4), 586–597.
- Lord, C. G., Lepper, M. R., & Preston, E. (1984). Considering the opposite: A corrective strategy for social judgment. *Journal of Personality and Social Psychology*, 47(6), 1231–1243.
- Lovallo, D., & Sibony, O. (2010). The case for behavioral strategy. *McKinsey*

- Quarterly*, 2, 30–40.
- Lovallo, Dan, & Kahneman, D. (2003). Delusions of Success. *Harvard Business Review*, 81(7), 56–63.
- Meissner, P., & Wulf, T. (2016). Debiasing illusion of control in individual judgment: the role of internal and external advice seeking. *Review of Managerial Science*, 10(2), 245–263.
- Milligan, G. W., & Cooper, M. C. (1987). Methodology Review: Clustering Methods. *Applied Psychological Measurement*, 11(4), 329–354.
- Montibeller, G., & Winterfeldt, D. (2015). Cognitive and Motivational Biases in Decision and Risk Analysis. *Risk Analysis: An International Journal*, 35(7), 1230–1251.
- Morewedge, C. K., Yoon, H., Scopelliti, I., Symborski, C. W., Korris, J. H., & Kassam, K. S. (2015). Debiasing Decisions: Improved Decision Making With a Single Training Intervention. *Policy Insights from the Behavioral and Brain Sciences*, 2(1), 129–140.
- Murtagh, F., & Legendre, P. (2014). Ward's Hierarchical Agglomerative Clustering Method: Which Algorithms Implement Ward's Criterion? *Journal of Classification*, 31(3), 274–295.
- Mussweiler, T., Strack, F., & Pfeiffer, T. (2000). Overcoming the Inevitable Anchoring Effect: Considering the Opposite Compensates for Selective Accessibility. *Personality and Social Psychology Bulletin*, 26(9), 1142–1150.
- Nawaz, A. (2012). A Comparison of Card-sorting Analysis Methods. *APCHI '12. Proceedings of the 10th Asia Pacific Conference on Computer-Human Interaction Vol. 2*, 583–592.
- Ohlert, C. R., & Weißenberger, B. E. (2020). Debiasing escalation of commitment: the effectiveness of decision aids to enhance de-escalation. *Journal of Management Control*, 30(4), 405–438.
- Oreg, S., & Bayazit, M. (2009). Prone to bias: Development of a bias taxonomy from an individual differences perspective. *Review of General Psychology*, 13(3), 175–193.
- Paul, C. L. (2014). Analyzing Card-Sorting Data Using Graph Visualization. *Journal of Usability Studies*, 9(13), 87–104.
- Payne, J. W., Bettman, J. R., & Schkade, D. A. (1999). Measuring Constructed Preferences: Towards a Building Code. *Journal of Risk and Uncertainty*, 19(1), 243–270.
- Petty, R. E., & Cacioppo, J. T. (1984). The effects of involvement on responses to argument quantity and quality: Central and peripheral routes to persuasion. *Journal of Personality and Social Psychology*, 46(1), 69–81.
- Powell, T. C., Lovallo, D., & Fox, C. R. (2011). Behavioral strategy. *Strategic Management Journal*, 32(13), 1369–1386.
- Punj, G., & Stewart, D. W. (1983). Cluster Analysis in Marketing Research: Review and Suggestions for Application. *Journal of Marketing Research*, 20(2), 134–148.

- Ramnath, V. R., McSharry, D. G., & Malhotra, A. (2020). Do No Harm: Reaffirming the Value of Evidence and Equipoise While Minimizing Cognitive Bias in the Coronavirus Disease 2019 Era. *Chest*, 158(3), 873–876.
- Rand, W. M. (1971). Objective Criteria for the Evaluation of Clustering Methods. *Journal of the American Statistical Association*, 66(336), 846–850.
- Rutledge, R. W. (1995). The Ability To Moderate Recency Effects Through Framing Of Management Accounting Information. *Journal of Managerial Issues*, 7(1), 27–40.
- Schulz-Hardt, S., Jochims, M., & Frey, D. (2002). Productive conflict in group decision making: genuine and contrived dissent as strategies to counteract biased information seeking. In *Organizational Behavior and Human Decision Processes* (Vol. 88, Issue 2, pp. 563–586).
- Schweiger, D. M., Sandberg, W. R., & Rechner, P. L. (1989). Experiential Effects of Dialectical Inquiry, Devil's Advocacy and Consensus Approaches to Strategic Decision Making. *Academy of Management Journal*, 32(4), 745–772.
- Schwenk, C. R. (1984). Cognitive Simplification Processes in Strategic Decision-making. *Strategic Management Journal*, 5(2), 111–128.
- Schwenk, C. R. (1995). Strategic Decision Making. *Journal of Management*, 21(3), 471–493.
- Schwenk, C. R., & Cosier, R. A. (1993). Effects of Consensus and Devil's Advocacy On Strategic Decision-Making. *Journal of Applied Social Psychology*, 23(2), 126–139.
- Schwenk, C., & Valacich, J. S. (1994). Effects of Devil's Advocacy and Dialectical Inquiry on Individuals versus Groups. *Organizational Behavior and Human Decision Processes*, 59(2), 210–222.
- Shimizu, T., Matsumoto, K., & Tokuda, Y. (2013). Effects of the use of differential diagnosis checklist and general de-biasing checklist on diagnostic performance in comparison to intuitive diagnosis. *Medical Teacher*, 35(6), e1218–e1229.
- Simon, H. A. (1987). Making Management Decisions: The Role of Intuition and Emotion. *The Academy of Management Executive* (1987-1989), 1(1), 57–64.
- Slovic, P., & Fischhoff, B. (1977). On the psychology of experimental surprises. *Journal of Experimental Psychology: Human Perception and Performance*, 3(4), 544–551.
- Soll, J. B., Milkma, K. L., & Payne, J. W. (2015). A User's Guide to Debiasing. In G. Keren & G. Wu (Eds.), *The Wiley Blackwell Handbook of Judgment and Decision Making* (pp. 924–951).
- Stanovich, K. E. (1999). *Who is rational? Studies of individual differences in reasoning*. Mahwah, NJ, Lawrence Erlbaum Associates.
- Stanovich, K. E. (2009). Distinguishing the reflective, algorithmic, and autonomous minds: Is it time for a tri-process theory? In *In two minds: Dual processes and beyond*. (pp. 55–88). Oxford University Press.
- Stanovich, K. E., West, R., & Toplak, M. E. (2016). *The rationality quotient. Toward a test of rational thinking*. Cambridge, MA, The MIT Press.

- Stone, D. N., & Ziebart, D. A. (1995). A Model of Financial Incentive Effects in Decision Making. *Organizational Behavior and Human Decision Processes*, 61(3), 250–261.
- Thaler, R. H., & Sunstein, C. R. (2008). *Nudge. Improving Decisions About Health, Wealth, and Happiness*. New Haven, CT Yale University Press.
- Tullis, T., & Wood, L. (2004). How Many Users Are Enough for a Card-Sorting Study. *Usability Professionals Association (UPA) 2004 Conference, Minneapolis, Minnesota, June 7-11, 2004*.
- Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, 185(4157), 1124–1131.
- van Brussel, S., Timmermans, M., Verkoijen, P., & Paas, F. (2020). ‘Consider the Opposite’ – Effects of elaborative feedback and correct answer feedback on reducing confirmation bias – A pre-registered study. *Contemporary Educational Psychology*, 60, 101844.
- Veinott, B., Klein, G. A., & Wiggings, S. (2010). Evaluating the Effectiveness of the Premortem Technique on Plan Confidence. *Proceedings of the 7th International ISCRAM Conference*.
- Ward, J. H. (1963). Hierarchical Grouping to Optimize an Objective Function. *Journal of the American Statistical Association*, 58(301), 236–244.
- Welsh, M. B., Begg, S. H., & Bratvold, R. B. (2007). Efficacy of bias awareness in debiasing oil and gas judgments. In D. S. McNamara & J. G. Trafton (Eds.), *Proceedings of the 29th Annual Cognitive Science Society* (pp. 1647–1652). Cognitive Science Society.
- Zagury-Orly, I., & Schwartzstein, R. M. (2020). Covid-19 — A Reminder to Reason. *New England Journal of Medicine*, 383(3), e12.