Pragmatics—A Rich Domain for the Study of Meta-Reasoning

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Abstract. Pragmatic reasoning tasks reveal that meta-reasoning is not only essential as a quality check of higher-order mental performance but also for the selection of appropriate strategies to solve problems for which more than a single normatively correct solution exists. Our analysis shows that pragmatic rules often dominate the logic of other normative rules, as illustrated in the context of the Wason-Selection Task. Various other paradigms corroborate the importance of meta-reasoning for strategy selection to disambiguate pragmatically uncertain problems that allow for different pragmatic interpretations. The remainder of this chapter elaborates on Peter Wason's warning to refrain from too restrictive, overdetermined theoretical accounts of findings for which simpler explanations are available, framing of decisions and choice, the ratio bias and the related denominator neglect, anomalies in causal-impact judgments, metacognitive myopia in advice taking, and the ultimate sampling dilemma. We believe that meta-reasoning is sorely needed in present and future research on complex problem solving tasks, as depicted in the work of Joachim Funke (2010, 2014).

Several decades ago, one of the authors felt enormous resistance against the argument that language can be causally antecedent to cognition (Semin & Fiedler, 1988), quite in the spirit of linguistic relativity (Fiedler, 2008a). In the meantime, the one-sided dogma that language causally reflects cognition but not

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vice versa, gave rise to a more flexible meta-theory, which covers the impact on judgments and decisions of verbal quantifiers (Budescu & Wallsten, 1995; Teigen & Brun, 2000), framing effects (Kahneman & Tversky, 2000), lexical priming (Fiedler et al., 2005), and saying-is-believing effects (Higgins & Rholes, 1978). Yet, in these paradigms, the role of language is almost exclusively confined to priming basic mental functions. The message conveyed in the present article says that linguistic pragmatics can even determine mental activities at the highest level, namely, metacognitive regulation of reasoning and problem solving activities.

Two Major Functions of Meta-Reasoning

Modern approaches (Ackerman & Thompson, 2017; Koriat, 2019; Petty et al., 2007; Sternberg, 2021) have broadened the domain of metacognitive research to include meta-reasoning in addition to meta-memory. The resulting novel perspective of meta-cognitive research is no longer confined to studying such “classical” metacognitive cues as fluency, ease of retrieval, subjective confidence studied in the context of paired-associate learning, or elementary judgments of almanac tasks. Rather, it is now generally acknowledged that the highest level of systematic mental operations—captured by the term reasoning—calls for similar quality checks as elementary learning and memory tasks. In other words, meta-reasoning involves monitoring and control (Nelson & Narens, 1994) of reasoning inferences – conceived as an insurance of thinking, reasoning and problem solving (Funke, 2010, 2014) against slips of attention and superficial, error-prone thought processes.

The present article goes one more decisive step further, focusing on a second major function of meta-reasoning. In addition to the a-posteriori detection and correction of questionable or invalid reasoning results, an equally prominent function of meta-reasoning is strategy selection. Given that more than one solution path is available to tackle a problem, a super-ordinate meta-reasoning perspective is required to select the best-suited strategy. The remainder of this chapter is devoted to this highly prominent function of meta-reasoning.

To tackle the super-ordinate aim of meta-cognitive regulation, it is first essential to understand that more than a single normative solution exists for most reasoning problems, including scientific reasoning. Consider, for illustration, the manner in which people estimate the believability of cognitive inferences or statements. How likely is it that an ingratiating compliment reflects an honest feeling or judgment, rather than a deceptive attempt?

Language-driven strategy selection. On the one hand, believability and veracity judgments could depend strongly on lexical cues and the context of verbal communication. Research on the linguistic category model (Fiedler, 2008b; Semin & Fiedler, 1988) has shown that language users' truth judgments and their verification inferences depend crucially on the linguistic tools used to express social behavior (i.e., the compliment). Verifying a manifest action verb (to compliment, to ingratiate, to flatter, to insult) depends crucially on situation and person information (e.g., whether it involves *strangers* or *intimate friends*, taking place in the *office* or in the *bedroom*). In contrast, an effective way to verify trait adjectives is to assess the semantic consistency or similarity of multiple traits (e.g., whether a person described as *friendly* is also *rewarding*, *kind*, *benign*, *cheerful*, and *not unfair*). Thus, the use of lexical categories can determine the selection of cognitive inference rules for verifying the truth or credibility of communicated statements.

Pragmatic World Knowledge, Beyond Lexical Meanings

The focus of the present chapter is on the role of pragmatic world knowledge in meta-reasoning, conceived as selection of problem solving strategies in line with a language culture's sensitivity for pragmatic context information, which is to a considerable extent wired into the lexicon and into a sophisticated set of situated communication rules.

Social conventions versus normative knowledge. In a meta-analysis of verbal, non-verbal, and para-verbal cues used in over 150 lie-detection studies, Hartwig and Bond (2011) demonstrated that social conventions can dominate normative rules. Applying Zuckerman, DePaulo, and Rosenthal's (1981) lens-model analysis to lie detection, Hartwig and Bond (2011) assessed each cue's ecological validity (i.e., the cue's actual diagnosticity or statistical relationship to the objective truth criterion) and the coefficient of cue utilization (i.e., the weight given to each cue in participants' subjective truth judgment). While all ecological validities were quite modest (see filled black bars in Fig. 1), reflecting the limited ecological validity of cues to lie detection, the most impressive and most telling result of the meta-analysis was that cue-utilization coefficients (open bars) were regularly higher than ecological validities. Human lie detectors' clichés or collective agreement about the weighting of cues in subjective truth judgments were stronger by magnitudes than the cues' actual diagnostic value. For instance, there was wide agreement among participants that gaze aversion or object fidgeting (e.g., nervous playing around with jacket buttons or pens) are valid indicators of lying, although the actual diagnostic value of these cues was close to zero.

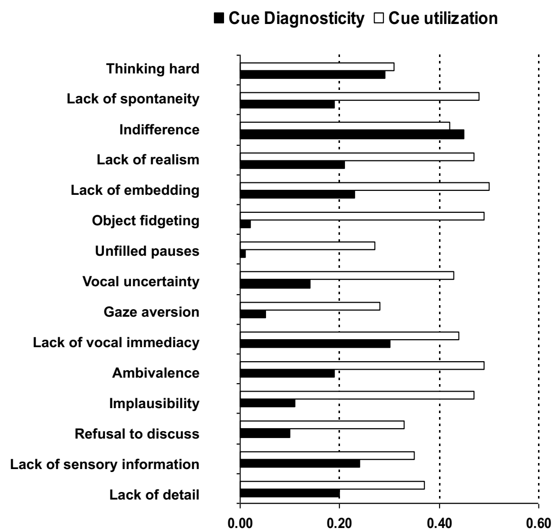

Figure 1. *Ecological validities (cue diagnosticities) and cue-utilization coefficients of prominent cues to lie-detection in a meta-analysis by Hartwig & Bond (2011)*

Meta-Reasoning and Normative Selection

Thus, collective conventions about what seems to discriminate a lie from the truth create social realities, the importance of which should not be underestimated. Regardless of the cues' "true" diagnosticities, an applicant in a job interview or a defendant in a court trial should seek eye contact and avoid object fidgeting, to prevent lie detectors from drawing wrong but highly predictable inferences.

Pragmatically, then, knowledge of socially shared clichés can be more important than the normatively correct cue diagnosticities. Adaptive meta-reasoning entails world knowledge (or meta-knowledge) about social conventions when knowledge about unquestionable normative criteria is not available. Meta-reasoning calls for a realistic insight that it is hardly possible to distinguish lies from truthful communication. And still, in distinct pragmatic contexts, when it comes to practical advice and instructions for job applicants or eyewitnesses one has to recognize that even invalid cues can be of key instrumental importance for trust and persuasion. What determines success of job applicants, defendants, and witnesses is subjective credibility rather than normatively determined "objective" credibility. Thus, the domain of meta-reasoning transcends the domain of normative criteria. By pointing to the social conventional nature of "reality", the meta-reasoning perspective also transcends the confines of cognitive psychology and highlights political surplus meanings of conformity, opposite to Hannah Ahrendt's (1963) reminder of the obligation to be disobedient (Fiedler, 2021).

What we have discussed so far is nothing but a prelude to understanding the crucial role of meta-reasoning in logical reasoning tasks, as inspired by decades of fruitful research in the tradition of the so-called *Wason Selection Task* (WST; Wason, 1968; Evans & Over, 2004, Chapter 5)—one of the most studied tasks in the history of cognitive psychology. The WST was first conceived as a test of the Popperian idea that science progresses by refuting rather than confirming hypotheses. The aim of the present chapter is to demonstrate that the meta-reasoning perspective offers enlightening solutions to even the most prominent paradigm of cognitive psychology, as well as to its most crucial meta-theoretical question, the question of normativity. Given multiple normative criteria, how is the appropriate norm to be chosen? The same insights will be the focus of later sections dealing with other reasoning paradigms.

In the classical, abstract version of the WST, participants are presented with four cards, with numbers on one side, and letters on the other side. Only one side is exposed. Their task is to test a conditional rule of the form ‘If *p*, then *q*’, for example, ‘If there is an A on one side of a card, then there is a 6 on the other side’. The cards typically show the values for *p, not-p, q* and *not-q*; for example, A, H, 6, 8, respectively. Participants’ task is to turn over all the cards—and only the cards—necessary to determine if the conditional rule is true or false. The normatively correct solution, according to propositional logic, is to turn over the *p* card and the *not-q* card—in this case, A and 8, since these are the cards that can refute the rule (A in case there is something other than 6 on the other side, and 8 in case there is an A on the other side). Typically, no more than 10 percent of participants select this correct double option. Most participants *match* (Evans, 1972)—they select the cards mentioned in the rule, in this case A and 6, the *p* card and the *q* card, respectively. The most prevalent responses by far are either *p* alone, or *p* and *q*. Participants who do select the *p* and *not-q* cards tend to be more cognitively able and motivated (Stanovich, 1999). Matching cards are selected faster than non-matching cards, eliciting higher *Feelings of Rightness* (Thompson et al., 2013).

A flurry of experimental variations followed, with various takes on versions that facilitated performance. For a while, research appeared to favor a *thematic facilitation* hypothesis, the idea that participants perform better when the materials are concrete rather than abstract, but this interpretation was soon undermined by spectacular failures to replicate. It rather turned out that for the conditional rule to be understood, it should be *deontic*—it should depict socially meaningful regulations. Deontic logic is the logic of permissions and obligations, with logical operators such as ‘should’, ‘must’, ‘allowed’ and ‘forbidden’ (McNamara, 2022). The most well-documented deontic version of the selection task is the *drinking age* task, using the rule ‘If a person drinks beer, then this person is over 19 years of age' (Griggs & Cox, 1982), with cards depicting a person on one side and a beverage on the other side. For the cards Beer, Coke, 22, and 16 (*p, not-p, q, not-q*, respectively), about 75% of participants selected the normatively correct *p, not-q* (Beer, 16) cards. They easily understood that they have to check whether people who drink beer are under 19 and that 16-year old (or younger) people must not drink beer. The same goes for Cosmides's (1989) social contract task ('If a man eats cassava root then he must have a tattoo on his face'), the deontic meaning of which is only understood if participants know pragmatically that cassava is an aphrodisiac and that in this culture only married men have a face tattoo.

The WST offers a good opportunity to examine normativity issues in the context of meta-reasoning. The relevant logic for the deontic task is not the normative rule of propositional reasoning but deontic logic – which is pragmatically more appropriate for this kind of task. As a prominent example, consider Oaksford and Chater's (1994) Bayesian interpretation: when the aim is to select the card providing the optimal data rather than the one refuting the rule, the *p* and *q* selections become (given a few extra premises) perfectly normative.

The WST is not unique in casting normative solutions into question. In almost every single research paradigm in reasoning and decision making, more than one normative solution is applicable. This begs the question of *arbitration*: which one normative system should be selected, if at all? One possibility is *descriptivism* (Elqayam, 2012; Elqayam & Evans, 2011): this is the idea that normative considerations do not advance research in the psychology of reasoning. Rather, research is best led by clearly describing the rational act. This does not necessarily mean abandoning the notion of rationality. With a descriptivist approach, whether an act is rational or not is judged by its practical effectiveness, for instance, whether it contributes to the agent achieving her goals (also known as instrumental rationality, or rationality$_1$, in the terminology proposed by Evans & Over, 1996).

Another possibility is to develop a meta-normative theory tool for strategy selection. This is what Schurz and Hertwig (2019) did. Arguing that intuition alone is a dubious guide to norm selection, they suggested *cognitive success* as an alternative route. Cognitive success is a technical term, defined as the cognitive component of practical rationality, the rationality of achieving one's goals. Schurz and Hertwig argue that a precondition to practical rationality is the ability to predict how actions lead to consequences. The actual formula to compute cognitive success can be quite complex, involving a trade-off of precision and generalizability. To illustrate, analyses of predictions of the outcomes of football matches demonstrated that a 'take the best' heuristic (i.e., selecting the most superior option in terms of a single most valid cue) outperformed other selection strategies in a pragmatically striking manner: while its precision was suboptimal, its generalizability turned out to be highest. Note that cognitive success as defined by Schurz and Hertwig seems to offer a potentially useful measure for theorists, but it falls short of a *descriptive psychological* model portraying how reasoners select a norm in reality.

A more psychological approach to norm selection can be found in Skovgaard-Olsen et al. (2019), who developed the 'scorekeeper task' to measure norm preference. This task gauges normatively reflected attitudes. It relies on a vignette of a dialogue between fictional protagonists, who are portrayed as participants in a paid experiment. Each protagonist justifies a specific norm as the basis for their responses. The norms were formed according to theories of conditionals (conditionals are sentences of the form *if p, then q*). The fictional protagonists responded either in conformity to a norm based on conditional probability, or based on reason relations. In a norm based on conditional probability, conditionals are evaluated based on the probability of *q* given *p*; for example, for the sentence 'If global warming continues, London will be flooded', we would estimate the probability that London will be flooded given that global warming continues.

In contrast, when the norm is based on reason relations, reasoners test if *p* raises the probability of *q;* in this case, if global warming raises the probability of London being flooded. Participants were instructed to indicate whether payment for participation should be awarded or withheld from the protagonists based on the justifications. What Skovgaard-Olsen et al. show is that responses on a range of tasks are consistent with the specific norm that participants favor in the scorekeeper task. For example, when participants favored the protagonist expressing a reason relation, they tended to disagree that 'If global warming continues, London will be flooded' logically follows from 'Global warming will continue and London will be flooded'. This inference, *p and q; therefore, if p then q* (also known as 'centering'), is valid for conditional probability, but not for reason relations. The advantage of this paradigm is its sensitivity to individual differences and the potential for accommodating multiple norms. The downside is the lack of psychological explanation of the norm selection *process*; that is, why and how some participants select norm A, whereas others select norm B.

In conclusion, the WST task offers a useful paradigm to study the disambiguation of reasoning norms, both for theorists as well as for reasoners.

In the preceding sections on judgments of credibility and logical correctness, we have already seen how meta-reasoning serves both functions announced at the outset. In addition to the quality check and error correction of one's own reasoning products, an equally important function of meta-reasoning is strategy selection, that is, selecting of reasonable strategies of problem solving, dependent on the contextualized interpretation of a problem that is essentially ambiguous. A major requisite of the strategy-selection capacity is the emancipated wisdom that more than one reality and more than one best normative rule exist at the same time, depending on the framing of the problem at hand.

Meta-Reasoning Supports Strategy Selection

In this section, we elaborate further on this crucial meta-cognitive ability, with particular reference to the fact that analyzing the same problem at different aggregation levels will often call for different "correct solutions". Emancipation amounts to understanding and tolerating the co-existence of more than one truth. As in the preceding section, we shall see that a pragmatic perspective on meta-reasoning has the potential to enrich different paradigms of cognitive research on reasoning.

Another lesson from Peter Wason: Consider the following sketch of another piece of seminal research by Peter Wason (1960), in which participants have to discover a rule that underlies a series of stimuli. Let us assume that the sequence '1', '2', '4' has been already confirmed as fitting the rule in question. On each of the following trials, participants can suggest a possible candidate stimulus, and they receive feedback about whether the suggested stimulus fits the rule or not. A typical response on the next trial would be '8', and the feedback would be positive: 'Yes, 8 indeed fits the rule'. On the next trial, a typical response would be '16', again followed by positive feedback. When, the next suggestion, '32', is again met with confirmatory feedback, the vast majority of all participants are perfectly certain that the rule is 2^N (2 to the power of N).

Indeed, this is a correct solution, but many other, weaker solutions might also be correct. The correct solution might be super-linearly increasing integer numbers, or increasing integer numbers, or simply increasing numbers, real numbers, or maybe numbers, or alphanumerical symbols, or anything. Normally, nobody tested and ruled out the possibility that less restrictive solutions may also be correct. Wason (1960) felt that the preference for too strong overdetermined hypotheses, and the insensitivity for less specific, weaker or broader hypotheses is very common. People fail to understand that simpler and less restrictive hypotheses can also be correct and can provide more parsimonious accounts than more sophisticated hypotheses in a hierarchically ordered set of nested hypotheses.

For an up-to-date example (see Fiedler, Kutzner & Krueger, 2012), the notion of mortality salience relies on the experimental demonstration that if participants are exposed to a funeral, or if they write a short vignette about their own mortality, they exhibit a marked conservative shift in political opinions and in verbal expressions of interests and values (Greenberg et al., 1994; Weise et al., 2008). As more and more experiments provided convergent validation for a conservative shift induced by mortality salience, especially after the nine-eleven trauma in the US, hardly anybody would cast the validity of this interpretation into doubt. But could not the weaker possibility that any existential emotion (e.g., birth of a baby, opposite to death) may also induce a conservative shift, or that other traumatic experiences (unrelated to mortality) may foster conservative values? Would reminding people of their incompleteness (of which mortality is but a special case) have a similar effect, or may simply inducing a Zeigarnik effect (i.e., leaving an experimental task incomplete) be sufficient for a conservative shift (Wicklund & Braun, 1990)?

The mortality example highlights the fact that experimental treatments (like going to a funeral) are never pure treatments of only one independent variable; they always manipulate a whole hierarchy of increasingly general variables, of which the focal variable of interest is only a special case. A mortality treatment is always a special case of incompleteness. Conversely, mortality is a general version of more specific meanings of mortality (related to bodily weakness, survival, religion, specific causes of death). A super-ordinate meta-reasoning function is required to disambiguate the appropriate aggregation level. This meta-reasoning function is not only essential for experimental research on mortality salience but for a wide range of everyday judgments and decisions, to disambiguate health risks, probabilities, life expectancies, or product price levels. For instance, one's personal risk of being the victim of a traffic accident depends crucially on the aggregation level used to estimate our risk (e.g., the entire population or an individual's distinct life setting). No objective norms disburden the meta-reasoning function of the crucial obligation to select an aggregation level.

The pragmatics of framing effects: The notion of framing effects motivated prospect theory (Kahneman & Tversky, 1979, 2000), the most prominent decision theory in behavioral science. For instance, in the so-called Asian-disease problem, participants are to take the role of a health politician who is to choose the better program against a threatening Asian disease:

Program I: 200 hundred people survive for sure

Program II: 1/3 chance that 600 people survive; or else nobody survives

Because of prospect theory's sigmoid value function—saving 600 people is worth less than saving 3 times 200 people—the theory predicts risk-averse choices in a positive survival frame. A majority of all people go for the riskless option; they prefer Program I over Program II. However, when equivalent options are framed in terms of losses (dead people) rather than gains (survival), most participants no longer prefer the save option.

Program III: 400 people die for sure over the risky option

Program IV: 1/3 chance that 0 people die; 2/3 chance that 600 die

Thus, loss framing, unlike gain framing, renders people risk-seeking rather than risk-averse. McKenzie and Nelson (2003) provided an intriguing pragmatic account of framing effects and of the Asian disease problem in particular. Drawing on the analogy to a glass that is both half-full and half-empty, they assumed and corroborated empirically that a common pragmatic interpretation of the phrase 'X% will survive' is that at least X% will survive, but maybe more. So the glass is (at least) X% full. In contrast, the phrase '(100–X% will die)' is commonly interpreted to mean that at least 100 - X% will die, but maybe more. Thus, a meta-reasoning interpretation of the ordinary pragmatic meaning of verbal quantifiers—a typical function of meta-reasoning—offers a simple and straightforward account of framing effects in decision and choice.

Ratio Bias, Denominator Neglect, Proportional Change

The impact of meta-reasoning on higher-order cognitive problem solving is particularly enhanced when no normative accuracy criterion is available, or when normative algorithms are not feasible. Meta-reasoning is then sorely needed to select a boundedly rational heuristic (Simon, 1990). For instance, consider the common phenomenon of ratio bias (Denes-Raj & Epstein, 1994) or the related phenomena of denominator neglect (Reyna & Brainerd, 2008) or sample size bias (Price & Matthews, 2009). When participants are given a choice between two lotteries, Lottery A offering 1/10 chances (out of 10) to win $10 and Lottery B offering 10/100 chances (out of 100) to win the same amount, the majority of participants typically choose the larger lottery. Although the ratio of the winning numerator divided by the set-size denominator is the same for both lotteries (1/10 = 10/100), the larger lottery is more attractive because the larger numerator offers more diverse possibilities to win; the equally larger denominator seems to be neglected.

Many similar findings provide convergent evidence for the preference of the same proportion in a ratio of absolutely larger numbers. Risks appear higher when framed in ratios of numerically large numbers (Price et al., 2006), mental calculation reflects larger estimated sums when the number of additive components increases (Smith & Price, 2010), or the assessment of changing proportions depends strongly on changes in sample size (Fiedler et al., 2016). Increases in proportional quantities (e.g., in proportions of wins) are easy to detect when absolute sample sizes increase too but not when sample sizes decrease. By analogy, decreases in sample size are easy to detect when sample sizes decrease but not when sample sizes increase. People confuse quality and quantity. They do not understand that having many arguments is not the same as better arguments, or that many Amazon ratings need not be more positive than fewer ratings of other products (Powell et al., 2017).

Ratio biases (or related confusions of proportions and sample size) constitute a major challenge for meta-reasoning. To understand why, imagine the task of assessing in a series of n binary observations the proportion of one focal attribute level, such as winning rather than losing, rainy rather than sunny days, or delayed rather than punctual trains. Assessing the proportion of focal outcomes requires a count of the number of focal outcomes (e.g., k wins) in the numerator, which must be divided by n, the total number of outcomes (sample size) in the denominator. The increment encoded for every elementary observation of a focal outcome is $1/n$. The smaller the sample size, the stronger the impact of elementary outcomes. If sample size is very small (e.g., $n = 2$), the weight given to an elementary outcome is $1/n = 1/2$. If sample size is medium (e.g., $n = 10$), large (e.g., $n = 50$) or very large (e.g., $n = 300$), the incremental weight decreases (to $1/10$, $1/50$, and $1/300$, respectively). So, when experiencing a sample proportion, meta-reasoning can only update a proportional frequency observed in a growing sample when the size of the sample is known beforehand. Because it is unrealistic to assume that people can keep track of the size of all ongoing samples, the meta-reasoning regulation of proportional encoding must resort to a simplifying heuristic.

One radical simplification is to engage in summation rather than averaging, counting only the focal outcomes in the numerator, regardless of the total sample size in the denominator. Summation will of course produce an extremely strong ratio bias; the same proportion (of, say 80% focal outcomes) will appear much stronger in a large sample of $n = 100$ (yielding 80 focal versus 20 non-focal outcomes) than in a small sample of $n = 10$ (yielding only 8 versus 2 focal outcomes).

More likely than a radical summation strategy is a compromise of summation and averaging, based on the correction of the numerator sum by an estimated n as observed on the previous trial. A testable implication of this algorithm, supported by Fiedler et al. (2016), is that the same sample proportion will subjectively appear smaller (larger) if sample size on the preceding trial was large (small). In any case, judgments of proportional quantities highlight the importance of meta-reasoning heuristics when the present n is unknown beforehand.

Causal-Impact Reasoning

Recent findings on causal-impact judgment offer another intriguing explanation for why proportional quantities are so difficult to administrate. The causal impact of X on Y is a measure of the extent to which a shift in a causal variable (ΔX) induces a shift in an effect variable (ΔY). To measure the impact of a poisonous substance in animal food, one can calculate the ratio (ΔY = number of dead animals)/(ΔX = amount of poison added). Causal impact is doubled if the same amount of poison kills twice as many animals. By the same ratio logic, causal impact can be doubled if half the amount of poison kills the same number of animals. Causal impact is thus maximal when a minimal cause (ΔX) produces a maximal effect (ΔY). However, the judgments of causal impact are not maximized when a weak cause induces a strong effect but when a strong cause induces a strong effect (Fiedler et al., 2011; Hansen et al., 2013). Countless submitted articles are rejected because reported effects are too weak, but not when the treatments required to induce the same effect are too strong. If a weak manipulation of ΔX is sufficient to induce a strong effect in ΔY, this is not considered superior to the case of a strong ΔX inducing a strong ΔY, disregarding the underlying proportional logic.

Why should this be so? Why is experienced causal impact maximal when a high ΔX and a high ΔY maximize the covariance but not when a small ΔX and a high ΔY maximize the ratio? A plausible answer is that in many real-life settings, people are jointly engaged in detecting causes and assessing their impact. They cannot experience the impact of a cause that they do not detect in the first place. Thus, if a very subtle remark or a hardly detectable non-verbal gesture is enough to frustrate another person, leading to severe aggression, the impact of the remark or gesture may be high, but it may go unnoticed. The aggression is much more likely to be explained as a causal consequence of a very strong frustration or provocation, the operation of which is highly detectable. Thus, according to this meta-reasoning account, proportional quantities may be so difficult to assess because the need to detect quantities when reasoning about quantities lets covariances dominate ratios.

Meta-Reasoning as a Precondition for Rational Reasoning

Although an extensive discussion of meta-reasoning as a precondition for rational decision and choice is beyond the scope of this article, we will cover at least two aspects of rationality, namely, adaptive advice taking and the "ultimate sampling dilemma".

Meta-reasoning and advice taking: Almost all informed judgments and decisions in the 21st century—whether in the area of health, law, investment, traveling, consumer choices, or scientific research—depend crucially on peer or expert advice. Hardly any problem can be handled based on our first-hand experience alone. Rather, our decisions and actions depend crucially on second-hand information reflecting our peers' experience or expert knowledge about health risks, investment chances, legal constraints, ecological costs, or product quality. In other words, virtually all decisions involve advice taking and social communication, making advice taking a truly collective endeavor. Granting that advice givers may not always be honest, cooperative, competent, or in full command of a logical principle (like Bayesian calculus), but may sometimes be dishonest, pursuing their own vested interests, or simply be incompetent and logically incapable, it would be naïve and irrational to blindly follow each and every advice opinion. To distinguish valid from invalid advice, one of the most prominent meta-reasoning tasks of a rational and mature advice taker is to "separate the wheat from the chaff", that is, to identify and follow useful advice and to discard and not adopt invalid or deceptive advice. Note that this social-communication skill is nothing but an interpersonal variant of the more general skill to distinguish between trustworthy and error-prone strategies and pragmatic problem framings. For instance, rational advice taking must be sensitive to advice givers' information sources, their own costs and benefits, to experts' explanation of their good reasons for advice, to social validation and consistency of multiple advice, and—more generally – to the advice givers' reasoning, above and beyond the advice proper.

Yet, a growing body of research on meta-cognitive myopia (Fiedler, 2012; Fiedler et al., 2019; Fiedler et al., 2023) reveals that advice takers are often naïve and uncritical, falling prey to obviously invalid advice. For example, even when a medical experts' health risk estimate is obviously informed by biased or blatantly erroneous study samples, and even when they are explicitly informed and explained that and why an advice is misleading and false, they continue to follow the obviously invalid advice (Fiedler et al. 2019). The impact of metacognitive myopia is reminiscent of perseverance experiments (Ross et al., 1975), in which participants who are explicitly debriefed about a deceptive feedback (e.g., feedback of their utter failure on a test) continue to be influenced by the wrong feedback. Perhaps, an even more compelling analogy can be found in Tversky and Kahneman's (1974) seminal anchoring experiment, showing that numerical anchors can exert massive influences on participants' quantitative estimates (e.g., of the number of African nations in the UN), even when anchors are generated randomly by a roulette wheel.

Ultimate sampling dilemma: The "ultimate sampling dilemma" (Fiedler, 2008c) relates metacognitive myopia to the aforementioned WST problems in conditional reasoning. Participants could freely sample any information and as much information as they liked from a knowledge base represented on a computer. They were to play the role of a leading manager of an organization, whose task was to evaluate prior customers' positive (+) or negative (−) feedback about three providers (P_1, P_2, P_3) in two product domains (computers C; telecommunication T). In the universe of all entries in the knowledge base, the same 2:1 ratio of + to − valence held for all providers and product domains. The distribution of domains was also $2(C) : 1(T)$ and the distribution of providers was $4P_1 : 2P_2 : 1P_3$. Thus, all three distributions were skewed but all contingencies were zero, as the distributions of each variable remained constant across all levels of all other variables. On every trial of the sampling task, participants could not constrain the information search (calling for a random draw from the entire knowledge base), or they could constrain the information search in as many variables they liked. For instance, they could ask for a randomly drawn experience with P_1 (delivering a + or − evaluation in C or T), or for a − experience with P_3 in domain C, etc.

The resulting samples and the participants' evaluations of providers depended dramatically on the hypotheses they were testing. If their task was simply to arrive at comparative evaluations of all three providers, the resulting samples and the final evaluations constantly reflected the preponderance of positive outcomes. However, because the expected number of (predominantly) positive evaluations sampled about P_1 was four times as frequent as for P_3, and twice as frequent as for P_2, their final preferences were $P_1 > P_2 > P_3$, accordingly. If they were to test the hypothesis that (the most infrequent) provider P_3 may differ from the other two, they sampled mostly P_3 entries and therefore associated the prevalent + entries with P_3 more than with the other providers. If the task was to figure out the origin of most complaints with or deficits of purchased items, they focused on − outcomes and found that the vast majority of negative outcomes originated in P_1. Focusing on negative outcomes thus led to a reverse preference order: $P_1 < P_2 < P_3$.

Thus, approaching the same distribution in the data base from different vantage points led to systematically different judgments and preferences, reflecting massive metacognitive myopia effects. Although the actual positivity rates were similarly prevalent for all three providers, participants in the latter condition were blind for the fact that their own biased information search had solicited mainly negative experiences, the majority of which were related to the most frequent provider P_1.

In other words, metacognitive myopia blinded them for a distinct self-generated sampling bias. Insensitivity for sampling biases constitutes a major deficit in meta-reasoning, affording a massive obstacle on the way to rationality (Fiedler, 2008; Fiedler et al., 2023).

Conclusions

To summarize, our discussion of meta-reasoning in pragmatic problem solving, when different pragmatic framings suggest different normative solutions to the same problem, not only highlighted the crucial role of meta-reasoning in strategy and norm selection. Rather, we have also seen that a meta-reasoning approach is sorely needed to understand reasoning in a world in which the existence of objectively correct norms is an exception rather than a rule. The adaptive function of meta-reasoning in the context of higher-order cognitive problem solving tasks of the type portrayed in Funke's (2010, 2014) work must not be reduced to a quality check based on monitoring and control of actually conducted reasoning processes. In addition to the retrograde quality-check of already conducted problem solving operations, meta-reasoning is at least as essential for strategy selection in the first place and for the disambiguation of a pragmatically uncertain problem situation.

Although our review of pertinent research was far from being exhaustive, our discussion included a variety of prominent findings. We started from the Wason Selection Task and Peter Wason's warning to refrain from too restrictive, overdetermined theoretical accounts of findings for which simpler and less restrictive explanations are possible. In the remainder of this chapter, we illustrated the interface of meta-reasoning for high-level cognitive reasoning tasks with reference to various prominent paradigms: the framing of decisions and choice, the ratio bias and the related denominator neglect, anomalies in causal-impact judgments, metacognitive myopia in advice taking, and the ultimate sampling dilemma.

Meta-reasoning and rationality: The evidence reviewed across all these paradigms converges in the conclusion that meta-reasoning is at the heart of a theoretically useful conception of rationality. Although we do not want to prescribe nominal definitions of central conceptions in behavioral research, we want to point out that defining rationality in terms of pragmatic sensitivity and broadminded strategy selection strikes us as theoretically more fruitful than an orthodox economic definition in terms of payoff maximization. Meta-reasoning is particularly suited to understanding (ir)rationality in everyday behavior. The last decade saw a flourishing of reasoning research into issues such as belief in fake news, anti-science ideation, epistemically suspect beliefs (e.g., Čavojová et al., 2020; Pennycook et al., 2020), and what Stanovich (2009) calls "contaminated mindware", beliefs that undermine rational pursuit of one's own interests. Such beliefs correlate with epistemic goals rather than with cognitive ability; for example, Actively Openminded Thinking (Stanovich & Toplak, 2023) is a strong predictor.

Future prospects: We believe that the interface of meta-reasoning and pragmatics bears the potential for future research in many other domains, such as collective rationality, construal-level theory and psychological distance, group decision making, and research on such modern topics as fake news and debunking (Chan et al., 2017; Unkelbach et al., 2019). Performance in all these domains or paradigms depends on the meta-cognitive insight that more than one norm or correct solution may co-exist, and that meta-reasoning is sorely needed to deal with the indeterminacy of such problems.

Last but not least, our meta-reasoning perspective raises some political perspectives about all citizens' obligation to be sensitive to pragmatic aspects of social contracts, the conventionalized nature of social and political reality, and the validity of information spread on the social media. Although the evidence we have reviewed here does not directly speak to these important political issues, we nevertheless hope that our chapter helps to sensitize people to understand that meta-reasoning constitutes a sorely needed tool for political emancipation.

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References

Ackerman, R., & Thompson, V. A. (2017). Meta-reasoning: Monitoring and control of thinking and reasoning. *Trends in Cognitive Sciences*, *21*(8), 607–617. https://doi.org/10.1016/j.tics.2017.05.004

Ahrendt, H. (1963). *Eichmann in Jerusalem: A report on the banality of evil*. Faber & Faber.

Budescu, D. V., & Wallsten, T. S. (1995). Processing linguistic probabilities: General principles and empirical evidence. *Psychology of Learning and Motivation, 32*, 275–318. https://doi.org/10.1016/s0079-7421(08)60313-8

Čavojová, V., Šrol, J., & Jurkovič, M. (2020). Why should we try to think like scientists? Scientific reasoning and susceptibility to epistemically suspect beliefs and cognitive biases. *Applied Cognitive Psychology*, *34*(1), 85–95. https://doi.org/10.1002/acp.3595

Chan, M. S., Jones, C. R., Hall Jamieson, K., & Albarracín, D. (2017). Debunking: A meta-analysis of the psychological efficacy of messages countering misinformation. *Psychological Science*, *28*(11), 1531–1546. https://doi.org/10.1177/0956797617714579

Cosmides, L. (1989). The logic of social exchange: Has natural selection shaped how humans reason? *Cognition*, *31*, 187–276. https://doi.org/10.1016/0010-0277(89)90023-1

Denes-Raj, V., & Epstein, S. (1994). Conflict between intuitive and rational processing: When people behave against their better judgment. *Journal of Personality and Social Psychology, 66*(5), 819–829. https://doi.org/10.1037//0022-3514.66.5.819

Elqayam, S. (2012). Grounded rationality: Descriptivism in epistemic context. *Synthese*, *189*(1), 39–49. https://doi.org/10.1007/s11229-012-0153-4

Elqayam, S., & Evans, J. St. B. T. (2011). Subtracting 'ought' from 'is': Descriptivism versus normativism in the study of human thinking. *Behavioral and Brain Sciences*, *34*(5), 233–248. https://doi.org/10.1017/s0140525x1100001x

Evans, J. St. B. T. (1972). Interpretation and matching bias in a reasoning task. *Quarterly Journal of Experimental Psychology*, *24*, 193–199. https://doi.org/10.1080/00335557243000067

Evans, J. St. B. T., & Over, D. E. (2004). *If*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780198525134.001.0001

Fiedler, K. (2008a). Language: A toolbox for sharing and influencing social reality. *Perspectives on Psychological Science*, *3*(1), 38–47. https://doi.org/10.1111/j.1745-6916.2008.00060.x

Fiedler K. (2008b). The implicit meta-theory that has inspired and restricted LCM research: Why some studies were conducted but others not. *Journal of Language and Social Psychology, 27*(2), 182–196. https://doi.org/10.1177/0261927x07313656

Fiedler, K. (2008c). The ultimate sampling dilemma in experience-based decision making. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *34*(1), 186–203. https://doi.org/10.1037/0278-7393.34.1.186

Fiedler, K. (2012). Meta-cognitive myopia and the dilemmas of inductive-statistical inference. In B. H. Ross (Ed.), *The psychology of learning and motivation* (Vol. 57, pp. 1–55). Elsevier. https://doi.org/10.1016/B978-0-12-394293-7.00001-7

Fiedler, K. (2021). A non-populist perspective on populism in psychological science. In J. P. Forgas, W. D. Crano, & K. Fiedler (Eds.), *The psychology of populism* (pp. 174–194). Routledge. https://doi.org/10.4324/9781003057680

Fiedler, K., Freytag, P., & Unkelbach, C. (2011). Great oaks from giant acorns grow: How causal-impact judgments depend on the strength of a cause. *European Journal of Social Psychology*, *41*(2), 162–172. https://doi.org/10.1002/ejsp.750

Fiedler, K., Hütter, M., Schott, M., & Kutzner, F. (2019). Metacognitive myopia and the overutilization of misleading advice. *Journal of Behavioral Decision Making*, *32*(3), 317–333. https://doi.org/10.1002/bdm.2109

Fiedler, K., Kareev, Y., Avrahami, J., Beier, S., Kutzner, F., & Hütter, M. (2016). Anomalies in the detection of change: When changes in sample size are mistaken for changes in proportions. *Memory & Cognition*, *44*(1), 143–161. https://doi.org/10.3758/s13421-015-0537-z

Fiedler, K., Kutzner, F., & Krueger, J. I. (2012). The long way from α-error control to validity proper: Problems with a short-sighted false-positive debate. *Perspectives on Psychological Science*, *7*(6), 661–669. https://doi.org/10.1177/1745691612462587

Fiedler, K., Prager, J., & McCaughey, L. (2023). Metacognitive myopia: A major obstacle on the way to rationality. *Current Directions in Psychological Science*, *32*(1), 49–56. https://doi.org/10.1177/09637214221126906

Fiedler, K., Schenck, W., Watling, M., & Menges, J. I. (2005). Priming trait inferences through pictures and moving pictures: The impact of open and closed mindsets. *Journal of Personality and Social Psychology*, *88*(2), 229–244. https://doi.org/10.1037/0022-3514.88.2.229

Funke, J. (2010). Complex problem solving: A case for complex cognition? *Cognitive Processing*, *11*(2), 133–142. https://doi.org/10.1007/s10339-009-0345-0

Funke, J. (2014). Analysis of minimal complex systems and complex problem solving require different forms of causal cognition. *Frontiers in Psychology*, *5*, Article 739. https://doi.org/10.3389/fpsyg.2014.00739

Greenberg, J., Pyszczynski, T., Solomon, S., Simon, L., & Breus, M. (1994). Role of consciousness and accessibility of death-related thoughts in mortality salience effects. *Journal of Personality and Social Psychology, 67*(4), 627–637. https://doi.org/10.1037/0022-3514.67.4.627

Griggs, R. A., & Cox, J. R. (1982). The elusive thematic materials effect in the Wason selection task. *British Journal of Psychology*, *73*, 407–420. https://doi.org/10.1111/j.2044-8295.1982.tb01823.x

Hansen, J., Rim, S., & Fiedler, K. (2013). Psychological distance and judgments of causal impact. *Journal of Experimental Social Psychology*, *49*(6), 1184–1189. https://doi.org/10.1016/j.jesp.2013.05.012

Hartwig, M., & Bond, C. F., Jr. (2011). Why do lie-catchers fail? A lens model meta-analysis of human lie judgments. *Psychological Bulletin*, *137*(4), 643–659. https://psycnet.apa.org/doi/10.1037/a0023589

Higgins, E. T., & Rholes, W. S. (1978). "Saying is believing": Effects of message modification on memory and liking for the person described. *Journal of Experimental Social Psychology*, *14*(4), 363–378. https://doi.org/10.1016/0022-1031(78)90032-X

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47*, 263–291. https://doi.org/10.1142/9789814417358_0006

Kahneman, D., & Tversky, A. (Eds.) (2000). *Choices, values, and frames.* Cambridge University Press. https://doi.org/10.1017/cbo9780511803475.002

Koriat, A. (2019). Confidence judgments: The monitoring of object-level and same-level performance. *Metacognition and Learning*, *14*(3), 463–478. https://doi.org/10.1007/s11409-019-09195-7

McKenzie, C. R., & Nelson, J. D. (2003). What a speaker's choice of frame reveals: Reference points, frame selection, and framing effects. *Psychonomic Bulletin & Review, 10*(3), 596–602. https://doi.org/10.1037/e537102012-428

McNamara, P. (2022). Deontic logic. In E. N. Zalta (Ed.), *Stanford Encyclopedia of Philosophy* (Fall 2022 edition). Stanford University. https://plato.stanford.edu/archives/fall2022/entries/logic-deontic/

Nelson, T., O., & Narens, L. (1994). Why investigate meta-cognition? In J. Metcalfe & A. Shimamura (Eds.), *Meta-cognition: Knowing about knowing* (pp. 1–25). MIT Press. https://doi.org/10.7551/mitpress/4561.003.0003

Oaksford, M., & Chater, N. (1994). A rational analysis of the selection task as optimal data selection. *Psychological Review*, *101*, 608–631. https://doi.org/10.1037//0033-295x.101.4.608

Pennycook, G., Cheyne, J. A., Koehler, D. J., & Fugelsang, J. A. (2020). On the belief that beliefs should change according to evidence: Implications for conspiratorial, moral, paranormal, political, religious, and science beliefs. *Judgment and Decision Making*, *15*(4), 476–498. https://doi.org/10.1017/s1930297500007439

Petty, R. E., Briñol, P., Tormala, Z. L., & Wegener, D. T. (2007). The role of metacognition in social judgment. In A. W. Kruglanski & E. T. Higgins (Eds.), *Social psychology: Handbook of basic principles* (2nd ed., pp. 254–284). Guilford Press.

Powell, D., Yu, J., DeWolf, M., & Holyoak, K. J. (2017). The love of large numbers: A popularity bias in consumer choice. *Psychological Science*, *28*(10), 1432–1442. https://doi.org/10.1177/0956797617711291

Price, P. C., & Matthews, T. V. (2009). From group diffusion to ratio bias: Effects of denominator and numerator salience on intuitive risk and likelihood judgments. *Judgment and Decision Making, 4*(6), 436–446.

Price, P. C., Smith, A. R., & Lench, H. C. (2006). The effect of target group size on risk judgments and comparative optimism: The more, the riskier. *Journal of Personality* *and Social Psychology*, *90*(3), 382–398. https://doi.org/10.1037/0022-3514.90.3.382

Reyna, V. F., & Brainerd, C. J. (2008). Numeracy, ratio bias, and denominator neglect in judgments of risk and probability. *Learning and Individual Differences*, *18*(1), 89–107. https://doi.org/10.1016/j.lindif.2007.03.011

Ross, L., Lepper, M. R., & Hubbard, M. (1975). Perseverance in self-perception and social perception: Biased attributional processes in the debriefing paradigm. *Journal of Personality and Social Psychology*, *32*(5), 880–892. https://psycnet.apa.org/doi/10.1037/0022-3514.32.5.880

Schurz, G., & Hertwig, R. (2019). Cognitive success: A consequentialist account of rationality in cognition. *Topics in Cognitive Science*, *11*(1), 7–36. https://doi.org/10.1111/tops.12410

Semin, G. R., & Fiedler, K. (1988). The cognitive functions of linguistic categories in describing persons: Social cognition and language. *Journal of Personality and Social Psychology*, *54*(4), 558–568. https://psycnet.apa.org/doi/10.1037/0022-3514.54.4.558

Simon, H. (1990). Invariants of human behavior. *Annual Review of Psychology, 41*, 1–19. https://psycnet.apa.org/doi/10.1146/annurev.ps.41.020190.000245

Skovgaard-Olsen, N., Kellen, D., Hahn, U., & Klauer, K. C. (2019). Norm conflicts and conditionals. *Psychological Review*, *126*(5), 611–633. https://doi.org/10.1037/rev0000150

Smith, A. R., & Price, P. C. (2010). Sample size bias in the estimation of means. *Psychonomic Bulletin & Review*, *17*(4), 499–503. https://doi.org/10.3758/pbr.17.4.499

Stanovich, K. E. (1999). *Who is rational? Studies of individual differences in reasoning*. Lawrence Elrbaum Associates. https://doi.org/10.4324/9781410603432

Stanovich, K. E. (2009). *What intelligence tests miss: The psychology of rational thought*. Yale University Press. https://doi.org/10.12987/9780300142532

Stanovich, K. E., & Toplak, M. E. (2023). Actively open-minded thinking and its measurement. *Journal of Intelligence*, *11*(2), 27. https://doi.org/10.3390/jintelligence11020027

Sternberg, R. J. (2021). Meta-intelligence: Understanding, control, and coordination of intelligence, creativity, and wisdom. In R. M. Holm-Hadulla, J. Funke, & M. Wink (Eds.), *Intelligenz – Theoretische Grundlagen und praktische Anwendungen.*

Heidelberger Jahrbücher Online (Vol. 6, pp. 473–488). Heidelberg University Publishing. https://doi.org/10.17885/heiup.hdjbo.2021.1.24399

Teigen, K. H., & Brun, W. (2000). Ambiguous probabilities: When does *p*=0.3 reflect a possibility, and when does it express a doubt? *Journal of Behavioral Decision Making*, *13*(3), 345–362. https://doi.org/10.1002/1099-0771(200007/09)13:3%3C345::AID-BDM358%3E3.0.CO;2-U

Thompson, V. A., Evans, J. S., & Campbell, J. I. D. (2013). Matching bias on the selection task: It's fast and feels good. *Thinking & Reasoning*, *19*(3–4), 431–452. https://doi.org/10.1080/13546783.2013.820220

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, *185*(4157), 1124–1131. https://doi.org/10.1126/science.185.4157.1124

Unkelbach, C., Koch, A., Silva, R. R., & Garcia-Marques, T. (2019). Truth by repetition: Explanations and implications. *Current Directions in Psychological Science*, *28*(3), 247–253. https://doi.org/10.1177/0963721419827854

Wason, P. C. (1960). On the failure to eliminate hypotheses in a conceptual task. *The Quarterly Journal of Experimental Psychology*, *12*, 129–140. https://doi.org/10.1080/17470216008416717

Wason, P. C. (1968). Reasoning about a rule. *Quarterly Journal of Experimental Psychology, 20*, 273–281. https://doi.org/10.1080/14640746808400161

Weise, D. R., Pyszczynski, T., Cox, C. R., Arndt, J., Greenberg, J., Solomon, S., & Kosloff, S. (2008). Interpersonal politics: The role of terror management and attachment processes in shaping political preferences. *Psychological Science*, *19*(5), 448–455. https://doi.org/10.1111/j.1467-9280.2008.02108.x

Wicklund, R. A., & Braun, O. L. (1990). Creating consistency among pairs of traits: A bridge from social psychology to trait psychology. *Journal of Experimental Social Psychology*, *26*(6), 545–558. https://doi.org/10.1016/0022-1031(90)90055-q

Wüstenberg, S., Greiff, S., & Funke, J. (2012). Complex problem solving—More than reasoning? *Intelligence*, *40*(1), 1–14. https://doi.org/10.1016/j.intell.2011.11.003

Zinke, K., Zeintl, M., Rose, N. S., Putzmann, J., Pydde, A., & Kliegel, M. (2014). Working memory training and transfer in older adults: Effects of age, baseline performance, and training gains. *Developmental Psychology, 50*(1), 304–315. https://doi.org/10.1037/a0032982

Zuckerman, M., DePaulo, B. M., & Rosenthal, R. (1981). Verbal and nonverbal communication of deception. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 14, pp. 1–57). Academic Press. https://doi.org/10.1016/S0065-2601(08)60369-X