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A self-regulatory approach to rational decisions: The implemental mindset optimizes economic decision making in situations requiring belief updating

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Abstract

We examined the effects of the deliberative and implemental mindset on decision behavior when decisions require Bayesian updating of beliefs. In the decision task, in some situations Bayes' rule conflicts with a simple reinforcement-based heuristic. Previous research showed that in these situations individuals rely on the faulty heuristic, hence committing many decision errors. We investigated deliberative and implemental mindset effects on the reinforcement heuristic. Results showed that the implemental mindset improved rational decision making. Participants in an implemental mindset exhibited decreased rates of reinforcement errors compared to the deliberative mindset, the neutral mindset, and the baseline condition. We further found that, compared to the deliberative mindset, the implemental mindset was also more beneficial for decision performance in situations where Bayes' rule and reinforcement were aligned.

1 | INTRODUCTION

Research on economic decision making has shown that judgments and decisions often do not result from extensive deliberation and application of well-considered strategies, but rather from spontaneous and implicit processes (Hastie, 2001; Obrecht & Chesney, 2016). As an example, optimal decision making under uncertainty requires the integration of all available information to obtain appropriate probability judgments (beliefs). From a normative point of view, the correct integration of previous (prior) beliefs on the probability of an uncertain event and additional (often new) information is described by Bayes' rule (Bayes & Price, 1763). This rule describes rationality in an economic sense and suggests normatively optimal solutions for each decision task. The tendency to focus on past performance for the evaluation of decisions is relevant for economic and managerial decisions (Ater & Landsmann, 2013), but is also evident for domains as medical decision making (Diwas, Staats, & Gino, 2013). Focusing on past performance is associated with the outcome bias (Baron & Hershey, 1988), by which the evaluation of decisions is only based on outcomes, while other available information is neglected. The outcome bias has negative consequences for manager evaluation and learning in organizations (Dillon & Tinsley, 2008). For instance, imagine that regional manager A obtains much better end-of-year results than regional manager B. This finding might suggest firing manager B. Yet, a rational decision maker would conclude that this decision would ignore previous information and the fact that the regional results are indicative of local market conditions. Therefore, she would rather prefer a proper analysis of the decision situation which might reveal that manager B was facing much harder conditions and conclude to move him to the region of manager A (see Achtziger & Alós-Ferrer, 2014).

Individuals often deviate from Bayes' rule, which requires effortful analytical thinking, and rely on simpler and more automatic processes instead (Achtziger & Alós-Ferrer, 2014;

Achtziger, Alós-Ferrer, Hügelschäfer, & Steinhauser, 2015). One prominent example is reinforcement learning, in which decisions are based on the outcome valence of previous decisions. Decisions that led to success in the past are repeated, and decisions that led to failure are avoided (Skinner, 1938; Thorndike, 1911). This reinforcement heuristic (Charness & Levin, 2005), which corresponds to a "win-stay, lose-shift" principle, might be an effective shortcut in simple decision situations. However, in more complex situations this heuristic will often conflict with the normative rule (i.e., prescribe a different response than Bayesian updating, that is the integration of new and previous information by means of Bayes rule). Previous studies (e.g., Achtziger & Alós-Ferrer, 2014; Charness & Levin, 2005; Hügelschäfer & Achtziger, 2017) showed that, under such a conflict of decision rules, individuals frequently rely on the faulty heuristic, hence committing many decision errors, assumingly because they focus their attention on win/lose outcomes and neglect information on underlying uncertain events.

Psychophysiological evidence suggests that reinforcement processes are related to extremely fast and unconscious brain responses (Holroyd & Coles, 2002). More specifically, a recent EEG study (Achtziger et al., 2015) found that the reinforcement process is evident in the feedback-related negativity, an event-related component of the EEG, observed as early as 250 ms after win/lose feedback on a decision is presented. This finding implies that the reinforcement heuristic corresponds to a very quick, highly automatic preconscious process, in line with evidence that decision errors due to the reinforcement heuristic are much faster than correct decisions (Achtziger & Alós-Ferrer, 2014). These results suggest that the detection of a conflict between opposing decision rules and the inhibition of the automatic process is needed in order to control detrimental reinforcement learning.

Previous research has tried to find ways to support decision makers in controlling the heuristic. Increasing monetary incentives has not proven successful (Achtziger & Alós-Ferrer, 2014), in line with the general observation that higher financial incentives often do not improve decision performance (Camerer & Hogarth, 1999; Jenkins, Mitra, Gupta, & Shaw, 1998). On the contrary, EEG evidence implied that the doubling of financial incentives for successful decision outcomes, which was meant to prevent decision makers from following the simple reinforcement heuristic, even strengthened reinforcement processes in the brain (Achtziger et al., 2015). This is not surprising, since the win/lose feedback becomes more and more prominent as incentives for wins increase. Accordingly, it is necessary to find alternative interventions to control decision makers' reliance on the reinforcement heuristic. The present study investigated whether certain mindsets (certain cognitive orientations that can be induced experimentally) could achieve this. Specifically, we explored the effects of the deliberative and the implemental mindset on decision making (Gollwitzer, 1990, 2012; Hügelschäfer & Achtziger, 2014), which will be described in the following section.

1.1 | Deliberative and implemental mindsets

Early studies found that becoming intensely involved with performing a given task activates the cognitive procedures that are conducive to task completion (Gollwitzer, 2012). Mindset is described as a certain type of cognitive orientation which facilitates successful performance of the task to be addressed in each action phase in the course of action (Achtziger & Gollwitzer, 2018). The model of action phases (Gollwitzer, 1990) claims that the course of action can be differentiated in distinct phases which are related to different mindsets, i.e., types of information processing that are appropriate to the action phase at hand. Previous research has corroborated the model's assumption. For instance, deliberating a choice ("Should I change my field of study or not?") versus thinking about a personal project in terms of a plan ("How, when, and where should I go on vacation in Spain?") can influence individuals' cognitions and actions (Gollwitzer, 1990, 2012; for an overview, see Achtziger & Gollwitzer, 2018).

The deliberative mindset emerges when people start thinking about an unresolved personal problem that is still a wish or desire, thinking of the pros and cons of both before deciding whether to realize it or not. When individuals deliberate which of their wishes they want to turn into reality, they are assumed to consider both the feasibility and desirability of the wishes (Gollwitzer, 1990, 2012). In the deliberative mindset, participants are supposed to process feasibility-related information realistically and weigh the pros and cons (desirability) impartially to identify the goal that is both attractive and attainable. In this mindset, individuals tend to remain unbiased in their information processing (Bayer & Gollwitzer, 2005; Gollwitzer, 1990, 2012; Harmon-Jones & Harmon-Jones, 2002; Taylor & Gollwitzer, 1995). Further, individuals in a deliberative mindset are supposed to have realistic expectancy-value considerations and realistic evaluations of their own skills (Heckhausen & Gollwitzer, 1987; Gollwitzer, 1990). In line with these expectations, previous research showed that the deliberative mindset can reduce risk-seeking behavior (Dörflinger, Martiny-Hünger, & Gollwitzer, 2017), lead to moderate expectancies about performance in risk choice tasks (Rahn, Jaudas, & Achtziger, 2016b), and result in low levels of overconfidence on general knowledge (Hügelschäfer & Achtziger, 2014).

The implemental mindset originates as soon as the deliberation process described above has been completed and a goal is chosen (Gollwitzer, 1990, 2012; Heckhausen & Gollwitzer, 1987). In this state of mind, individuals start to plan the realization of the chosen goal, i.e., they consider action steps that should bring them closer to this goal. In support of striving for this goal, individuals in an implemental mindset tend to exhibit selective and biased information processing by concentrating on information on the feasibility of this goal, while ignoring information about the desirability and information that might hint at failing in goal striving (Gollwitzer, 1990, 2012). Cognitions in an implemental mindset are characterized by optimism and confidence in own skills (e.g., Gagné & Lydon, 2001a; Hügelschäfer & Achtziger, 2014), which leads to an increased motivation to act on the respective goal (e.g., Brandstätter, Giesinger, Job, & Frank, 2015; Taylor & Gollwitzer, 1995). Recently, Rahn et al. (2016a) found eye-tracking evidence suggesting increased levels of achievement motivation in the implemental mindset. In a study on lottery choice, for instance, Rahn et al. (2016a) reported more fixations of all available information (probabilities and outcomes of lotteries) in the implemental mindset compared to the deliberative mindset and a control condition. These authors concluded from their results that decision makers in an implemental mindset were more focused on the task, searched for all kinds of goal-relevant information more often and more intensely, and processed it more deeply than deliberating participants. This was especially the case when decisions were rather difficult.

2 | THE PRESENT RESEARCH

The fact that the deliberative and implemental mindset affect information processing and behavior differently could be relevant for decision making under uncertainty, especially in situations characterized by conflicting decision strategies (reinforcement heuristic vs. Bayes' rule), in which usually high rates of errors are observed (Achtziger & Alós-Ferrer, 2014; Hügelschäfer & Achtziger, 2017; see above). Being in a specific mindset could either optimize or impair decision making in those difficult situations, and hence reduce or increase decision performance without people being aware of it.

The aim of the present study was to investigate the effects of two mindsets, the deliberative and the implemental mindset, on decisions in an incentivized economic belief-updating task. We relied on the task described in Charness and Levin (2005) and further developed by Achtziger and Alós-Ferrer (2014). This task is especially well suited to create two types of decision situations. In one type, the rational decision strategy to maximize expected payoff (i.e., integrating prior probabilities and new information by following Bayes' rule) conflicts with the reinforcement heuristic. In these situations, repeating successful decisions ("win-stay") and switching to an alternative option after failure ("lose-shift") hence can be defined as an error because base rate information is neglected. In the second type of situations, the two decision strategies are aligned (i.e., prescribe choosing the same option) and decisions are rather easy.

In previous research, decision errors (defined as deviations from Bayes' rule) in alignment situations were usually rare (Achtziger & Alós-Ferrer, 2014; Charness & Levin, 2005; Hügelschäfer & Achtziger, 2017) and are defined as "understanding errors." In contrast, under conflict between Bayes' rule and the reinforcement heuristic participants often followed the simple heuristic instead of Bayes' rule, which was not surprising in view of the high automaticity of reinforcement learning (Achtziger et al., 2015; see above). The interpretation of this type of errors as "reinforcement errors" was supported by the observation that not presenting affective (i.e., positive or negative) feedback on a decision outcome (win/lose), and hence making it impossible to rely on the reinforcement heuristic, led to a strong decrease of errors rates (Achtziger & Alós-Ferrer, 2014; Charness & Levin, 2005). Previous research also tested whether increasing monetary incentives for rational decision making (following Bayes' rule instead of the reinforcement heuristic) found that doubling monetary incentives even strengthened reinforcement processes as observed in electrophysiological evidence (Achtziger et al., 2015). Yet, if decision makers were asked explicitly to set the goal to analyze feedback (i.e., the decision outcomes win/lose) on the decisions carefully decreased unwanted reinforcement learning in this paradigm, while forming an if–then plan (implementation intention; Gollwitzer, 1999) geared at suppressing disappointment over negative outcomes increased it (Hügelschäfer & Achtziger, 2017). Note that these goals and if–then plans (implementation intentions; Gollwitzer, 1999; Achtziger & Gollwitzer, 2018, for an overview) explicitly focused on increasing decision performance using certain strategies. Put differently, participants in research by Hügelschäfer and Achtziger (2017) were completely aware that the goals they set or the if–then plans they formed prior to the decision task were strategies supposed to increase their decision performance and, consequently, their payoffs. The present study, however, intended to explore the effects of mindset inductions on economic decision making. Mindset inductions based on mindset theory (Gollwitzer, 1990) do not refer explicitly to the subsequent task on which their impact is tested. They are also not semantically related to each other. Instead, the idea is that mindsets influence subsequent tasks due to carry over effects of the processes they instigated. Thus, participants are typically not told (and are not aware) that the mindset induction could have some effects on subsequent tasks. In our study, participants were not told that the mindset task could improve or impair their decision performance. This was a strong difference to research by Hügelschäfer and Achtziger (2017).

We claimed that decision makers in an implemental mindset might be less likely to ignore valuable information relevant for optimizing decisions under uncertainty due to their enhanced achievement motivation (Brandstätter et al., 2015; Rahn et al., 2016a, 2016b), that leads to increased effort, a strong focus on the task, and gathering all information relevant for a good decision performance (Rahn et al., 2016a). For instance, Rahn et al. (2016a) measured eye movements in a lottery choice task and observed that participants in an implemental mindset fixated all kinds of goal-relevant information (outcomes and their probabilities in lottery choice tasks) more often than control participants and participants in a deliberative mindset. Implemental mindset participants also invested more time in information processing than control and deliberative mindset participants in this study. Note that eye movement data also reflect the effort that participants invest in a task and how deep they process the information and hence suggested that being in an implemental state of mind increases effort, and depth of information processing compared to the deliberative mindset and a control condition.

Earlier results also suggested that the effects of the deliberative mindset are often similar to those of the control condition (e.g., Rahn et al., 2016b; Henderson, de Liver, & Gollwitzer, 2008). This makes sense because participants in a control condition also might start thinking about what might be going on in an experiment, deliberating on different ideas what the aim of the study might be. Thus, one could argue that they might also be in "generalized state of uncertainty" experienced prior to an experiment (Gagné & Lydon, 2001b, p. 1151). This might also be true for a neutral mindset (Gagné & Lydon, 2001b; see below).

Based on this previous research, we suggested that our participants in the implemental mindset would be more likely to integrate all available information of a complex decision (i.e., base rates and upcoming new information about the decision situation) by applying Bayes' rule. In contrast, control participants and participants in a neutral condition as well as in the deliberative mindset would do so less. Consequently, implemental mindset participants would optimize their decisions, resulting in fewer reinforcement errors, compared to participants in the other conditions. The latter participants were expected to use a simple decision rule (reinforcement heuristic) instead of Bayes' rule because they were less motivated to gather and use all valuable information about the decision situation. Using a simple reinforcement heuristic in the control condition, a neutral and the deliberative mindset condition would in turn result in more deviations from Bayesian updating than in the implemental mindset condition and produce more reinforcement errors than the implemental mindset.

In summary, we assumed that implemental participants would carefully integrate all available information relevant for optimizing their decisions. They would use Bayes' rule instead of automatically following a simple reinforcement heuristic. Implemental mindset participants (in contrast to other participants) would consider both prior probabilities of outcomes and new information (feedback on their decisions). Consequently, they would commit fewer reinforcement errors than participants in the deliberative and in the neutral mindset and as control participants as well (see below).

We did not predict differential effects of the mindsets on error rates in case of alignment of the reinforcement heuristic and Bayes' rule. Since in these situations, error rates are generally very low (typically not more than 5%; see Achtziger & Alós-Ferrer, 2014; Achtziger et al., 2015; Charness & Levin, 2005; Hügelschäfer & Achtziger, 2017), there is no need (and not much room) for an improvement of decision making. We implemented two control conditions against which decision behavior in the deliberative and the implemental mindset condition was compared. First, we ran a baseline condition in which decision makers immediately worked on the probability-updating task, without undergoing any mindset induction. By design, this condition differed from the two mindset conditions by participants spending less time (because they did not work on an additional task) before starting with the belief-updating task. Therefore, we also ran a neutral mindset condition to exclude the possibility that any differences in the decision performance in the belief-updating task between the mindset conditions and the baseline were simply due to a confound between time spent before the decision task and mindset manipulations. This condition was called neutral because we did not expect the instigation of any specific cognitive or motivational processes that would carry over to the decision task. Accordingly, we expected that decision behavior in the baseline and in the neutral mindset condition would not differ. Previous research on mindset theory (Gollwitzer, 1990, 2012) only rarely included a neutral mindset condition. Note that some of the studies that included a neutral mindset condition did not find different effects between this condition and the deliberative mindset (e.g., Henderson et al., 2008). Further, Rahn et al. (2016b) did not observe any performance differences (monetary profit) between the deliberative mindset and the control condition. Hence, we predicted that rates of reinforcement errors would be lower in the implemental mindset condition compared to the remaining three conditions, that is, the deliberative mindset condition, the neutral mindset condition, and the baseline condition.

3 | METHOD

3.1 | Participants

128 participants were recruited via ORSEE (Greiner, 2015) among the student population of a university, excluding students majoring in psychology and non-native speakers. In exchange for participation, they received a payment based on the outcomes of their decisions (see below) plus a show-up fee of 7.5 Euros. Three participants were excluded from data analysis. Two participants, one in the deliberative mindset condition and one in the implemental mindset condition, did not properly follow the instructions of the mindset inductions and provided a very abstract personal concern respectively personal goal, which were unsuitable for the mindset manipulation task. Another participant in the neutral mindset condition was excluded because her reported age of 71 constituted an extreme outlier in our student sample. Thus, 125 participants (65 females, age range 18–36, M = 22.67, SD =2.85) were considered for data analysis, 32 in the baseline condition, 31 in the neutral mindset condition, 31 in the deliberative mindset condition, and 31 in the implemental mindset condition. Average earnings were 19.50 Euros (SD =0.78) including the show-up fee.

3.2 | Decision task

The decision task was based on the paradigm introduced by Charness and Levin (2005), as developed in Achtziger and Alós-Ferrer (2014; for details see also Hügelschäfer & Achtziger, 2017). Participants were presented with two urns, the left urn, and the right urn, both filled with 6 balls which could be black or white. The urns were presented on the computer screen, with masked colors for the balls (see Figure 1).

The task consisted of choosing one of the two urns (left or right) by pressing one of two keys on a keyboard, where upon the program drew one of the balls from the chosen urn randomly and the color of the drawn ball (black or white) was revealed. Depending on counterbalancing, the participant was paid for drawing black or white balls only. Participants earned 18 cents for every successful draw. In each round, the participant made two draws with replacement. After the color of the first drawn ball was revealed, the ball was replaced into the respective urn and the participant was asked to choose the left

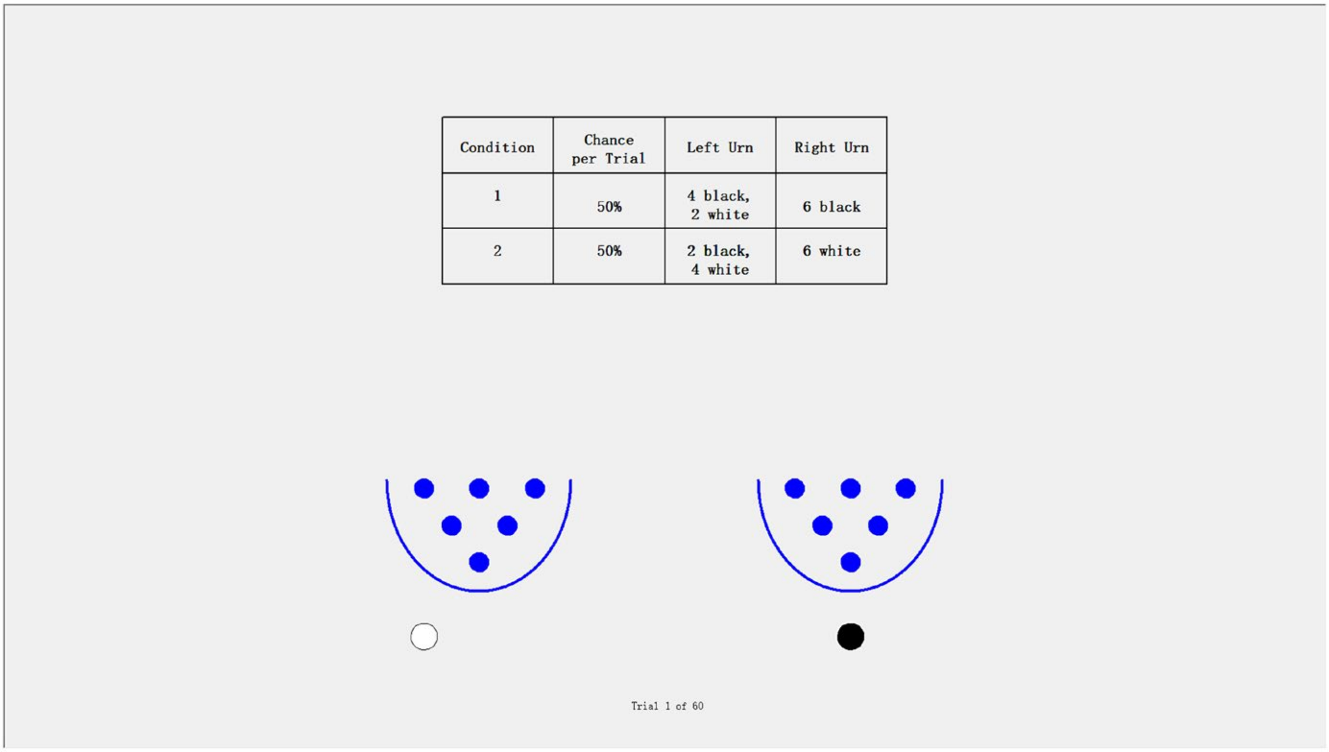

FIGURE 1 Screenshot of the decision-task interface

or right urn for a second draw. Again, a ball was randomly extracted from the chosen urn and paid if it was of the appropriate color.

The distribution of black and white balls in the two urns varied depending on the state of the world (*Up* and *Down*) which was not revealed to the participant. Participants knew that both states had a prior probability of 50% and that the state of the world was constant across the two draws of one round but was randomized according to the prior for each new round. This means that the first draw was uninformed, but by observing the result of the first draw (black or white ball) the decision maker could draw conclusions about the most likely state of the world. Table 1 presents the distribution of balls in the two urns for a participant who was rewarded for drawing black balls (in the other counterbalance condition, i.e., being rewarded for a white ball, the distribution of balls was the opposite).

A person who decides rationally in a Bayesian sense would update the prior of 50% (on the state of the world) after observing the color of the first drawn ball (i.e., feedback on her decision), and would base the second draw on the derived posterior probability of the state of the world to maximize expected payoffs. A person who relies on the reinforcement heuristic, however, would follow the "win-stay, lose-shift" principle. She would stay with the same urn if it has yielded a rewarded ball (= positive feedback) in the first draw; otherwise (in case of drawing a non-rewarded ball; after negative feedback) she would choose the other urn ("shift") for the second draw (see Achtziger & Alós-Ferrer, 2014).

According to the distribution of black and white balls in the urns, after a first draw from the right urn Bayes' rule and the reinforcement heuristic were aligned. In this case, the ball revealed the state of the world perfectly (the right urn contained balls of only one color; see Table 1) and the prescription for the second draw was simple: stay with the right urn in case of having drawn a rewarded ball, otherwise switch to the left urn. We classified the (rare) mistakes after a first draw from the right urn as *understanding errors*.

TABLE 1 Urn compositions depending on the state of the world

State (Prob)	Left Urn	Right Urn
Up (50%)	●●●●○○	●●●●●●
Down (50%)	●●○○○○	○○○○○○

Note. For a participant who is paid for black balls

In contrast, a first draw from the left urn did not fully reveal the current state of the world, but its outcome (color of the ball) could be used as information to update prior beliefs about the state of the world. By design, when drawing from the left urn in the first draw, Bayesian updating and the reinforcement heuristic were directly opposed; both decision strategies conflicted. Simple computations show that, to maximize the expected payoff, the decision maker should switch to the right urn after drawing a rewarded ball and stay with the left urn after drawing a non-rewarded ball.[1] If a participant committed a mistake in this context, this error was classified as a *reinforcement error* since the reinforcement heuristic

[1]For example, if a black ball was extracted from the left urn, the updated probability of being in the state "up" was (1/2)(4/6)/[(1/2)(4/6) + (1/2)(2/6)] = 2/3, hence choosing the left urn again delivered an expected payoff of (2/3)(4/6) + (1/3)(2/6) = 5/9, while switching to the right urn delivered a higher expected payoff of (2/3)(1) + (1/3)(0) = 6/9 (see Alós-Ferrer, Hügelschäfer, & Li, 2015; Hügelschäfer & Achtziger, 2017).

obviously dominated a choice that would be in accordance with Bayes' rule.

Participants repeated the two-draw decisions 60 times (i.e., there were 60 rounds in total). Following Charness and Levin (2005) and Achtziger and Alós-Ferrer (2014), we included both forced first draws (where the choice of the urn was dictated by the computer program) and free first draws (where participants could choose the urn in the first draw on their own). Forced first draws were originally implemented in order to ensure a sufficient number of first draws from the left urn (which were the interesting situations with conflicting decision strategies), since a Bayesian decision maker would always start with the right urn if possible to maximize the joint expected payoff for the two draws (see Hügelschäfer & Achtziger, 2017). In addition, more recent studies have shown systematic differences in behavior between forced and free draws (e.g., Alós-Ferrer, Hügelschäfer, & Li, 2017), which might be due to different feelings of autonomy (Alós-Ferrer, Hügelschäfer, & Li, 2016). To avoid confounding forced choices and learning effects, participants made forced draws and free draws alternately.

3.3 | Procedure

The study was conducted in group sessions at the university's laboratory using z-Tree (Fischbacher, 2007). A session lasted about 1.5 hours. Participants were randomly assigned to one of the four mindset conditions (baseline vs. neutral vs. deliberative vs. implemental) and one of two counterbalance conditions (payment for black balls vs. payment for white balls).

At the beginning of each session, participants were asked to read the instructions of the decision task carefully. Those described the rules of the decision task in detail, including screenshots of the computer program. Afterward participants answered several control questions to ensure they understood the rules of the decision task properly. Next, they proceeded with the mindset induction task, before continuing with the decision task immediately afterward. The decision task took around 10 minutes. Subsequently, participants filled in a computerized questionnaire, which included the Self-Esteem Scale (Rosenberg, 1965), a mood scale consisting of eight adjectives (see Taylor & Gollwitzer, 1995), a measure of relative perceived risk (Perloff & Fetzer, 1986), the Faith in Intuition scale (Epstein, Pacini, Denes-Raj, & Heier, 1996), and demographic questions including two items on self-evaluated knowledge in statistics/stochastics.

For participants in the baseline condition, the procedure was slightly different. Those participants started the decision task directly after answering the control questions. After the decision task, they conducted a filler task, which was the same as the neutral mindset manipulation task. Hereby, we ensured that the total duration of the experiment was comparable to the remaining conditions, so that the hourly payment rates were comparable among all four conditions. This was important from a behavioral-economics perspective as it rules out the possibility that any behavioral differences between conditions might stem from a different magnitude of monetary incentives, and accordingly different effects of incentives on effort and task performance.

3.4 | Mindset manipulations

In order to induce the deliberative and implemental mindsets, we used the classical method by Gollwitzer and Kinney (1989), which has been frequently used in previous studies (e.g., Bayer & Gollwitzer, 2005; Gollwitzer & Bayer, 1999; Hügelschäfer & Achtziger, 2014; Rahn et al., 2016a). For the neutral mindset manipulation, we followed Harmon-Jones and Harmon-Jones (2002) and Henderson et al. (2008). Participants provided all their answers by means of a computerized questionnaire.

Deliberative mindset participants were asked to state their currently most important, unresolved personal issue in the form of "Should I do X, or shouldn't I?" They then listed short-term and long-term positive and negative consequences of what could happen in case they acted or did not act on this personal issue. Afterward, participants rated the valence of each consequence on an 11-point scale ranging from "very negative" to "very positive" and estimated the probability of its occurrence (in %) by typing in an integer number between 0 and 100.

In the *implemental mindset* condition, participants reported their currently most important goal, for which they had decided to strive, but had not planned how to do this yet. They stated this goal in the format of "I want to do X!" Then, they were requested to break down their goal into five to seven action steps. Afterward, participants were asked to elaborate each action step in detail by describing when, where, and how they were planning to carry out each action step.

In the *neutral mindset* condition, participants were asked to think about an ordinary day in their life and to report at least seven things that they normally do during a typical day (see Harmon-Jones & Harmon-Jones, 2002). Note the same task was performed by participants in the baseline condition as a filler task *after* the decision task.

4 | RESULTS

4.1 | Equivalence of conditions

We found no differences in mood, self-esteem, perceived other-own risk to negative events, faith in intuition, self-evaluations of knowledge in statistics, or percentage of females and males among the four groups (according to one-way ANOVAs and chi-square test, all $ps \geq .235$).[2] Hence, there were no differences between the conditions that could explain our findings alternatively.

[2]One might wonder why we did not find mindset effects on mood, self-esteem, perceived risk etc.as reported in the study of Taylor and Gollwitzer (1995). Note that Taylor and Gollwitzer measured these variables immediately after mindset inductions while we measured them after the decision task. For this reason, mindset effects on these dependent variables were not expected. We only used them as control variables that might also affect economic decision making.

4.2 | Analysis of error rates

For all the tests reported below, the unit of analysis is the individual-level error rate. That is, for each participant and each relevant class of errors, we computed the participant's percentage of errors and treated it as one observation. To compare error rates across conditions (baseline vs. neutral vs. deliberative vs. implemental), that is, to examine the effect of mindset manipulations on individual error rates, we conducted non-parametric[3] Kruskal–Wallis tests. For further pairwise comparisons of error rates, we relied on non-parametric, two-tailed Wilcoxon Rank-Sum tests. Multiple comparisons were adjusted by Simes' test. We adopted G*Power (Faul et al., 2007) to run statistical power analyses for the pairwise comparisons. According to the manual of G*Power, the asymptotic relative efficiency (A.R.E) method is appropriate to the power analysis and Cohen's *d* is used as the effect size index.

Using the same decision paradigm, Achtziger and Alós-Ferrer (2014) as well as Charness and Levin (2005) found that forced first-draw decisions resulted in more second-draw errors. Further, previous research showed that second-draw decisions after free first draws and after forced first draws can create different feelings of autonomy (see Alós-Ferrer et al., 2016) and that psychological manipulations may affect one type more than the other (Alós-Ferrer et al., 2017). Therefore, we also ran all tests separately for decisions after free first draws and forced first draws. We found that first-stage free choices were not different across experimental conditions (see also error frequencies reported in Table 2), hence any differences in second-draw decisions between the different mindset conditions were not due to selection effects. Specifically, the rate of left-urn choices in the first draw when choice was free was not significantly different between participants in the deliberative mindset (N = 31, M = 20.97, SD =33.20, Mdn =3.33), implemental mindset (N = 31, M = 26.56, SD =36.33, Mdn =3.33), neutral mindset (N = 31, M = 18.82, SD =29.46, Mdn =3.33), and baseline condition (N = 32, M = 20.10, SD =26.18, Mdn =11.67) according to a Kruskal–Wallis test, $\chi^2(3) = 0.61$, $p = .895$.

4.3 | Mindset effects on reinforcement errors

Table 2 presents error frequencies in percent for second draws, depending on mindset condition. Consistent with previous studies (Achtziger & Alós-Ferrer, 2014; Charness & Levin, 2005), error rates in case of conflict were considerably higher than those in case of alignment. Over all participants, in case of alignment between Bayes' rule and reinforcement 150 out of 4815 decisions (3.12%) were incorrect, as opposed to 1123 out of 2685 decisions (41.82%) when both strategies conflicted. Figure 2 depicts participants' average individual second-draw error rates in case of conflict between the reinforcement heuristic and Bayes' rule depending on mindset condition.

First-draw errors: a Bayesian optimizer should always start with the right urn if given a choice and failing to do so is a mistake, which we call a first-draw error.

Alignment: Reinforcement heuristic and Bayes' rule are aligned.

Conflict: Reinforcement heuristic and Bayes' rule are in conflict.

There was a tendency of the mindset condition to affect reinforcement error rates, $\chi^2(3) = 6.79$, $p = 0.079$. Pairwise comparisons revealed that this tendency might be due to reduced error rates for implemental participants. The rate of reinforcement errors in the implemental mindset condition (N = 31, M = 29.83, SD = 27.78, Mdn = 26.67) tended to be lower compared to the baseline (N = 32, M = 47.85, SD = 30.28, Mdn = 46.67), $z = 2.40$, $p_{adj} = .085$, Cohen's $d = 0.620$, power(1-ß) = 0.817 (with significance level of 0.1), and the deliberative mindset condition (N = 31, M = 46.39, SD = 29.44, Mdn = 46.67), $z = 2.19$, $p_{adj} = 0.085$, Cohen's $d = 0.579$, power(1-ß) = 0.763 (with significance level of 0.1). The comparison with the neutral mindset condition (N = 31, M = 43.23, SD = 32.51, Mdn = 36.84) missed significance, $z = 1.54$, $p_{adj} = 0.245$. All other pairwise comparisons yielded no significant differences (p_{adj} s ≥ 0.758).

When we split the tests conditional on free first draws and forced first draws, the result showed a significant effect of mindset condition on reinforcement error rates after forced first draws

TABLE 2 First- and second-draw error frequencies depending on condition

		Second draw	
Condition	First draw	Alignment	Conflict
Baseline	20.10% (960)	2.25% (1247)	52.15% (673)
Neutral	18.82% (930)	3.03% (1220)	43.44% (640)
Deliberative	20.97% (930)	6.58% (1200)	44.55% (660)
Implemental	26.56% (930)	0.52% (1148)	28.09% (712)
Overall	21.60% (3750)	3.12% (4815)	41.82% (2685)

Note. The number of observations is in parentheses (*n*).

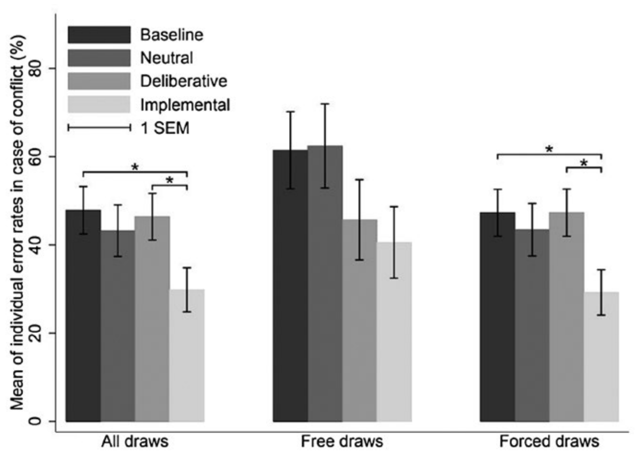

FIGURE 2 Means of individual second-draw error rates in case of conflict, depending on mindset condition. $^*p < 0.10$

[3]We relied on non-parametric tests since error rates did not follow a normal distribution. The distribution of this variable was skewed, and further (naturally) bounded between 0 and 100. Accordingly, the requirements for parametric tests were not fulfilled.

(i.e., in trials in which participants were forced to draw from the left urn), $\chi^2(3) = 7.80$, $p = 0.050$. Pairwise comparisons confirmed that now reinforcement error rates in the implemental mindset condition ($N = 31$, $M = 29.25$, $SD = 28.53$, $Mdn = 26.67$) were significantly lower compared to the baseline ($N = 32$, $M = 47.29$, $SD = 30.07$, $Mdn = 46.67$), $z = 2.53$, $p_{adj} = .053$, Cohen's $d = 0.615$, power(1-ß) = 0.812 (with significance level of 0.1) the deliberative mindset condition ($N = 31$, $M = 47.31$, $SD = 29.73$, $Mdn = 53.33$), $z = 2.38$, $p_{adj} = .053$, Cohen's $d = 0.620$, power(1-ß) = 0.812 (with significance level of 0.1) but not lower than in the neutral mindset condition ($N = 31$, $M = 43.44$, $SD = 33.15$, $Mdn = 40.00$), $z = 1.68$, $p_{adj} = 0.184$. All other pairwise comparisons yielded no significant differences, with p_{adj}s ≥ 0.692. For decisions after free first draws, the effect of mindsets on reinforcement error rates did not become significant, $\chi^2(3) = 3.64$, $p = 0.303$. Hence, the mindset effects on reinforcement errors, i.e., the reduction of errors by means of an implemental mindset (compared to the control condition and the deliberative mindset condition, but not compared to the neutral mindset), were mainly driven by decisions after forced first draws.

4.4 | Mindset Effects on understanding errors

Average individual error rates in case of alignment of the reinforcement heuristic and Bayes' rule (i.e., rates of understanding errors) are presented in Figure 3. According to a Kruskal–Wallis test, they were significantly affected by the mindset manipulations, $\chi^2(3) = 7.98$, $p = 0.046$. Pairwise comparisons showed that this effect was mainly due to an increased rate of understanding errors for participants in the deliberative mindset condition compared to the implemental mindset condition. Error rates in the deliberative mindset ($N = 31$, $M = 8.64$, $SD = 17.27$, $Mdn = 0$) were significantly higher compared to the implemental mindset ($N = 31$, $M = 0.63$, $SD = 1.60$, $Mdn = 0$, $z = 2.67$, $p_{adj} = .045$, Cohen's $d = 0.653$, power(1-ß) = 0.756 (with significance level of 0.05)). All other comparisons did not yield significant differences, with p_{adj}s ≥.211.

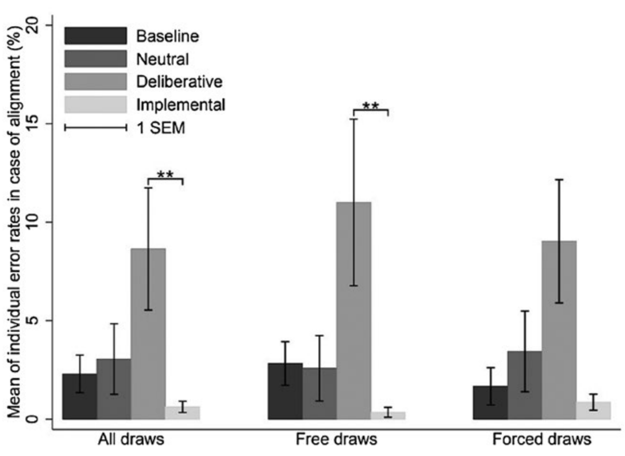

FIGURE 3 Means of individual second-draw error rates in case of alignment, depending on mindset condition. $^{**}p < 0.05$

When splitting the tests conditional on free first draws and forced first draws, a significant effect of mindset condition on understanding error rates was observed for free first draws, $\chi^2(3) = 8.41$, $p = .038$. Pairwise comparisons for free first draws revealed the same pattern as for pooled draws: understanding error rates in the deliberative mindset ($N = 30$, $M = 11.00$, $SD = 23.17$, $Mdn = 0$) were significantly higher compared to the implemental mindset ($N = 28$, $M = 0.35$, $SD = 1.34$, $Mdn = 0$), $z = 2.75$, $p_{adj} = 0.036$, Cohen's $d = 0.638$, power(1-ß) = 0.706 (with significance level of 0.05) but not higher than in the neutral mindset condition ($N = 31$, $M = 2.58$, $SD = 9.24$, $Mdn = 0$, $z = 1.69$, $p_{adj} = 0.183$). Note that the reduced sample sizes resulted from some participants who never started with the right urn when first draws were free. Hence, they provided no data for the comparison of understanding error rates after free first draws between mindset conditions. All other pairwise comparisons were not significant, with p_{adj}s ≥ 0.166.

For understanding errors after forced first draws, there was also a tendency for mindset effects, $\chi^2(3) = 6.75$, $p = 0.080$. Yet pairwise comparisons missed significance, with p_{adj}s ≥ 0.231. In summary, when Bayes' rule and reinforcement were aligned, understanding error rates in the deliberative mindset condition were higher than in the implemental mindset condition. This pattern of result was based on decisions after free draws, but not on decisions after forced first draws. Thus, being in a deliberative state of mind seemed to increase understanding error rates if decision makers are free in their choice. Note that in general understanding errors tended to be lowest for participants in an implemental mindset.

4.5 | Decision times

Besides errors, we recorded the time participants took for making second-draw decisions. We replicated the observation by Achtziger and Alós-Ferrer (2014) that decisions were significantly slower under conflict vs. alignment. As a rather exploratory analysis, we tested for effects of the mindset manipulations on decision times in order to look into decisions processes instigated by the mindset inductions to complete the picture of mindset effects on decision making. We computed non-parametric[4] Kruskal–Wallis tests on individual mean decision times with mindset condition (baseline vs. neutral vs. deliberative vs. implemental) as a between factor, separately for conflict and alignment, and further split by forced vs. free first draw and correct vs. erroneous decisions. However, none of the Kruskal–Wallis tests was significant (ps ≥ 0.251), except for decision times of understanding errors, $\chi^2(3) = 11.24$, $p = 0.011$, and understanding errors after forced first draws, $\chi^2(3) = 10.95$, $p = 0.012$. Since those tests were based on very low numbers of observations in each condition (e.g., $N = 5$ in the implemental mindset condition) due to the very low rate of understanding errors, the results cannot be interpreted in a

[4]Again, the reason for relying on non-parametric tests was the extremely skewed distribution of decision times, which violated the assumption of normally distributed data necessary for computing parametric tests.

meaningful way. Accordingly, we conclude that the mindset manipulations did not particularly affect decision times. Note that in a recent study, Hügelschäfer and Achtziger (2017) also observed that motivational manipulations (goal intentions and implementation intentions) affected decision behavior without affecting decision times.

5 | DISCUSSION

Resisting automatic processes of reinforcement learning is not easy, and at the same time decision makers have often difficulties updating their beliefs in accordance with Bayes' rule. Hence, it is not surprising that they commit many errors in case a simple reinforcement heuristic conflicts with the normative rule of Bayes (Achtziger & Alós-Ferrer, 2014; Charness & Levin, 2005; Hügelschäfer & Achtziger, 2017). There seem to exist some strategies that improve rational decision making in this case. For instance, decision makers can be prevented from relying on the detrimental reinforcement heuristic by not providing positive or negative feedback on decisions (Achtziger & Alós-Ferrer, 2014) or by asking them to set goals that instigate analytical thinking processes (Hügelschäfer & Achtziger, 2017).

Note that the latter strategy explicitly focused on improving decision performance, which contrasts with mindset manipulations as the one we used in the present study. Participants in research by Hügelschäfer and Achtziger (2017) were asked to set the goal or form the implementation intention to increase their decision performance. Due to these instructions, decision makers were aware that the goals and implementation intentions were related to the decision task. The purpose of the present study, however, was to test whether well-established interventions as mindset manipulations that do not explicitly refer to a subsequent task, also affect succeeding economic decisions. To answer this question, we investigated the effects of the deliberative and the implemental mindset on economic decisions. We provided evidence that mindset manipulations could be useful in psychology, behavioral economics, and neuroeconomics to control unwanted heuristics without explicitly saying that this intervention should improve economic decisions. Our findings were supposed to increase the awareness that economic decisions could benefit from some cost-neutral planning tasks completed prior to decisions. That has some implications for managers. They might improve their decision performance even in complex situations (e.g., in decisions under uncertainty) by planning a project right before they make their choices.

We induced the implemental mindset as described in mindset theory (Gollwitzer, 1990, 2012; Achtziger & Gollwitzer, 2018, for an overview) in order to decrease decision error rates in complex situations that require the integration of base rates with new information. Results showed that the implemental mindset controlled automatic processes of reinforcement learning, leading to increased decision performance compared to a control (baseline) condition and the deliberative mindset. The neutral mindset condition that served as an additional control condition also showed a tendency to reduce automatic reinforcement error rates. This finding was unexpected and requires some further exploration in the future.

There were several explanations for our findings. Previous research that investigated decision processes through eye-tracking (Rahn et al., 2016a) found indicators of increased achievement motivation after the induction of the implemental mindset (see also Brandstätter et al., 2015). Individuals in an implemental state of mind showed a higher number of fixations of all goal-relevant information in lottery-choice tasks (probabilities and lottery outcomes) than participants in the deliberative mindset, especially when decisions were rather difficult (Rahn et al., 2016a). These earlier results indicated that information search was more intense and information processing more thorough in the implemental mindset compared to the deliberative mindset. Together with other processes that were instigated by the implemental mindset (e.g., more confidence in one's cognitive skills: Hügelschäfer & Achtziger, 2014; the induction of a learning mode when making decisions under uncertainty with success/failure feedback: Rahn et al., 2016b; higher self-esteem and optimism: Taylor & Gollwitzer, 1995), decision processes were supported in a way that they increased decision performance. Hence, when facing conflicts between Bayes' rule and the reinforcement heuristic, participants in an implemental mindset did better in integrating all available information according to Bayes' rule and did not rely on a subset of information (win/loss feedback) only what would have resulted in high rates of reinforcement errors.

Research by Fujita and colleagues (2007) might also contribute to the explanation of our results. These authors reported that the deliberative mindset resulted in a better long-term memory for incidental goal-irrelevant information compared to the implemental mindset. They argued that the open-mindedness in the deliberative mindset might have produced this effect. Fujita et al.'s (2007) finding might illuminate why deliberative mindset participants also tended to generate more understanding error as implemental mindset and control participants (and significantly more of these errors than the neutral mindset) in the present study. They seemed to neglect goal-relevant information (maybe because they also process goal-irrelevant information).

Fujita and colleagues (2007) pointed to the possibility that being in an implemental mindset might promote the processing of all kinds of information that are goal-relevant, while the deliberative mindset fosters the processing of incidental goal-irrelevant information. Fujita and colleagues (2007) referred to Moskowitz (2002) who demonstrated that the processing of goal-relevant information was strongly supported after the (unconscious) activation of a goal. The implemental mindset is claimed to instigate processes of goal-striving since participants in this mindset plan when, where, and how to strive for one of their important goals (Gollwitzer, 1990, 2012). Because of this planning task all kinds of goal-relevant information should be better processed (just as it is the case after the activation of a goal) as in the deliberative mindset, neural mindset, and a control condition. This is what we observed in the present research.

Note that the reduction of reinforcement error rates in the implemental mindset compared to the control and the deliberative mindset condition was mainly based on decisions after forced first draws from the left urn, as opposed to decisions after free draws. Under this condition, decision makers typically commit more errors in the second draw compared to free first draws (Achtziger & Alós-Ferrer, 2014; Charness & Levin, 2005; Hügelschäfer & Achtziger, 2017). The explanation for this observation might be that people are often not motivated to perform well when they have a feeling of low autonomy (Deci & Ryan, 1985). Previous research that used the same probability-updating task as the present study found that decision inertia, the tendency to repeat previous decisions independently of their outcome, was less pronounced when outcomes resulted from forced choices (Alós-Ferrer et al., 2016). Further, a recent study found that, possibly because of the lower subjective autonomy after forced first draws, a framing manipulation impacted decisions after forced first draws to a lesser degree compared to decisions after free draws (Alós-Ferrer et al., 2017). Thus, decisions after forced first draws are usually not easily influenced by psychological interventions. Accordingly, it was impressive that under restricted autonomy decision makers in the present study benefitted from the implemental mindset, presumably since they experienced a boost of achievement motivation in these situations and a deeper processing of available information. Research by Brandstätter et al. (2015) fits quite well in this line of argument. These researchers investigated the effects of different mindsets on how early participants acted on a personal goal (returning a report). They found no differences in completion time between mindset conditions when extrinsic incentives (and accordingly motivation) for returning the report early were very high. In contrast, when motivation was low (no extrinsic incentives for early task completion), participants in the implemental mindset condition completed the task faster than participants in a deliberative mindset. Brandstätter et al. (2015) concluded that an implemental mindset supports successful goal striving by compensating for a lack of motivation.

In our study, the implemental mindset showed some evidence for reducing understanding errors compared to the deliberative mindset. Yet this observation was mainly based on increased understanding error rates in the deliberative mindset condition. Understanding errors are usually interpreted as being caused by a (temporary) lack of concentration or transient lower levels of motivation (Achtziger & Alós-Ferrer, 2014; Hügelschäfer & Achtziger, 2017). These errors were very rare in previous research using the same decision paradigm. Response-time evidence (Achtziger & Alós-Ferrer, 2014) implied that understanding errors result from slow responses and rather controlled processes, implying that they occur when participants "think too much" about a decision. The finding that a deliberative mindset increased understanding errors in the present study suggests that this mindset motivates some people to deliberate too much on easy decisions. This perturbs their concentration and focus on the decision task, resulting in simple failures. In any case, our results implied that participants benefitted from an implemental mindset even in simple situations where decision errors are typically rare. This conclusion was underlined by the fact that, among all experimental conditions, understanding errors were lowest in the implemental mindset. This observation also strengthened the argument of a high level of achievement motivation in this condition and a processing of all available information (i.e., they did not neglect task-relevant information).

The effects of actively inducing specific motivational and volitional states in economic decision tasks that also provided monetary incentives were not much investigated in previous research (see Hügelschäfer & Achtziger, 2017, for an exception). It is often assumed that motivation in the sense of intrinsic achievement motivation is crowded out as soon as monetary incentives for performing well are offered (Ariely, Gneezy, Loewenstein, & Mazar, 2009; Gneezy & Rustichini, 2000). We did not find evidence for this argument in the present study. On the contrary, we observed that inducing the implemental mindset was quite helpful in increasing decision performance even though monetary incentives were provided. Thus, the present study also contributed to the literature on the interplay between intrinsic and extrinsic motivation and the question when these two kinds of motivation might impair or support each other and in turn lead to decreased or increased performance.

6 | CONCLUSION

The induction of the implemental mindset as a cost-neutral intervention to improve decision making in complex economic situations increased decision performance. That was achieved by the reduction of unwanted automatic reinforcement errors. We could show that the implemental mindset promotes the processing of all available goal-relevant information in order to improve decisions. We conclude that in case of cognitive demanding tasks like decisions under uncertainty that involve the application of difficult decision rules, being in an implemental state of mind is more helpful than being in a deliberative mindset. Our findings also have important implications for workplaces that require decisions under uncertainty with high stakes (e.g., managers, clinic staff). Complex decisions in these workplaces could benefit from some planning tasks completed prior to a decision because they increase the quality of a decision.

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