Received: 3 September 2021 | Accepted: 7 September 2023

DOI: 10.1111/joop.12467

ARTICLE

the british psychological society
promoting excellence in psychology

# Challenging the doctrine of "non-discerning" decision-making: Investigating the interaction effects of cognitive styles

**Bjørn Tallak Bakken**[1] | **Mathias Hansson**[1] | **Thorvald Hærem**[2]

[1]Department of Organisation, Leadership, and Management, Inland Norway University of Applied Sciences, Rena, Norway

[2]Department of Leadership and Organizational Behaviour, BI Norwegian Business School, Oslo, Norway

**Correspondence**
Bjørn Tallak Bakken, Department of Organisation, Leadership, and Management, Inland Norway University of Applied Sciences, P. O. Box 400, Elverum 2418, Norway.
Email: bjorn.bakken@inn.no

## Abstract

The impact of intuitive and analytic cognitive styles on task performance is a much-debated subject in the scientific discourse on decision-making. In the literature on decision-making under time pressure, intuition has been regarded as a fast and frugal tool. At the same time, the heuristics and biases tradition sees intuition as a source of errors, implying that more analytic decision-makers are less biased and better performers. We conducted two studies of the effects of interplay between intuitive and analytic cognitive styles on decision-making in a simulated wicked learning environment. The results of the first study revealed that the high-performing individuals were those who exhibited a strong preference for both cognitive styles, as well as those who showed a lack of preference for both. Individuals with a strong preference for only one of the styles were outperformed. In the second study, we replicated these findings in a team context. Post-hoc, we found that cognitive ability correlated highly with performance for the two high-performing style combinations but not for the two low-performing style combinations. Our results indicate that flexible style preferences boost the effect of cognitive ability, while strong preferences for a single style may entrench even those with high cognitive abilities.

**KEYWORDS**

analysis, cognitive styles, crisis management, decision-making, intuition, wicked learning environment

**Practitioner points**

- When making decisions in stable or "kind" learning environments, both intuitive and analytic cognitive styles may lead to good decisions. In "wicked" learning environments, however, decision-makers relying on only one of the styles may become entrenched by prior learning and perform poorly.
- In wicked learning environments – where the conditions for decision-making are challenging – our results provide cues for successful cognitive strategies; they indicate that flexible style preferences boost the effect of cognitive ability, while strong preferences for a single style may entrench even those with high cognitive abilities.
- Particular attention should be paid to the interplay of cognitive styles when recruiting, developing, and promoting decision-makers. Avoiding entrenchment in style preferences and encouraging flexibility in thinking styles are sought-after qualities for decision-making in wicked learning environments, such as non-routine crisis management.

## BACKGROUND

A key topic in the scientific debate on decision-making concerns the effects of intuitive and analytic cognitive styles on task performance. In the literature on decision-making under time pressure and stress, intuition has been hailed as a powerful tool (e.g. Akinci & Sadler-Smith, 2012; Dane & Pratt, 2007, 2009; Gigerenzer, 2000; Hodgkinson et al., 2008; Klein, 1998, 2003). In contrast, the heuristics and biases tradition sees intuition as a source of error, implying that more analytic decision-makers are less biased and better performers (e.g. Kahneman, 2011; Tversky & Kahneman, 1974).

Pretz (2008) defines cognitive style as "individual differences in the preference to think intuitively or analytically" (p. 556). Pretz's definition aligns well with the more general definition of "consistent individual differences in the ways people prefer to organise and process information" (Martinsen et al., 2020, p. 154). Measures of intuitive and analytic cognitive styles have been developed, validated and applied to study the effects of thinking styles (e.g. Allinson & Hayes, 1996; Betsch, 2008; Hodgkinson, Sadler-Smith, Sinclair, et al., 2009; Pacini & Epstein, 1999; Pretz & Totz, 2007). In a recent meta-analysis examining the effects of analytic and intuitive thinking, Alaybek et al. (2021) found a significant positive effect of analytic style but no effect of intuitive style on performance. This finding contradicts the research stream holding intuition as a "fast and frugal" decision-making style (Gigerenzer, 2000; Gigerenzer et al., 2011; Klein, 1998, 2003, 2008). Alaybek et al. (2021) remarked on the abundance of theorizing about the interactive effects of intuitive and analytic styles and the lack of empirical studies.

Interaction effects are at the core of cognitive style theories. For example, Cognitive-Experiential Self-Theory (CEST; Epstein, 1990) holds that the two dimensions of cognitive style operate synchronously and interactively (Epstein, 1990; Pacini & Epstein, 1999). Several researchers theorize that certain combinations of intuitive and analytic styles are more effective than others (e.g. Allinson & Hayes, 1996; Hodgkinson & Clarke, 2007; Hodgkinson & Sadler-Smith, 2018). Hodgkinson and Clarke (2007), for example, propose that a high–high combination of intuitive and analytic styles makes a decision-maker versatile and able to handle a broader range of challenges. In contrast, a low–low combination indicates a non-discerning decision-maker. Klein (2003) has a different view. He argues that an analytic style would interfere with expert intuition in crisis management and thereby reduce the effectiveness of the intuitive style: "From the perspective of intuitive decision-making, conscious analysis is the bottleneck" (Klein, 2003, p. 68; see also Gigerenzer, 2000; Hodgkinson & Sadler-Smith, 2018; Kahneman & Klein, 2009). Moreover, psychometricians have established that modelling the effects of two variables without including their interaction term produces inaccurate estimates and misleading interpretations of the main effects when a significant interaction effect exists (e.g. Aiken & West, 1991; Nunnally & Bernstein, 1994).

Explicitly modelling the interaction effects, therefore, has the potential to resolve disagreements in the literature on the effects of styles, including Alaybek et al.'s (2021) surprising finding of the non-significant effect of intuition. Since the interaction effect of intuitive and analytic styles is central to the cognitive style research, and empirical studies are lacking, in this article we investigate the following two research questions: First, does the interaction between intuitive and analytic cognitive styles explain performance over and beyond the main effects of the two styles in a volatile, uncertain, complex, and ambiguous (VUCA) environment under time restrictions? Second, we ask whether interacting cognitive styles will predict the effectiveness of individuals' decisions when made in the team context. According to Akinci and Sadler-Smith (2019), decision-making is often a collective undertaking in organizations. Thus, the theoretical and practical implications would be more substantial if extended to the team context.

Based on our findings, we offer three contributions. First, we study cognitive styles in a boundary condition called wicked learning environments, characterized by delayed, lacking, irrelevant, unreliable, and misleading feedback (Hogarth, 2001, p. 208; for a more formal treatment see Hogarth et al., 2015). We found that the interaction effect significantly affected performance beyond the main effects of the separate styles, personality, and cognitive ability. This demonstrates the importance of considering the interaction effect of cognitive style. Second, the interaction effect supports current theorizing about the effectiveness of combinations of styles (e.g. Hodgkinson & Clarke, 2007) but challenges the underlying assumptions describing decision-makers with the combination of styles called "non-discerning." Contrary to the current assumptions, we find that those who score low on preferences for both styles perform equally well as those who score high. The implication is that the current assumptions behind the effect of combinations of styles need to be revised, and so should the label "non-discerning." Finally, we found a shared characteristic among the superior performers: the high–high and low–low scoring groups. Cognitive ability correlated significantly with performance in these two groups but not in the other groups. This explorative finding helps us understand how cognitive styles influence decision-making in VUCA (or wicked learning) environments.

In the following section, we review theories of the relations between intuitive and analytic cognitive styles and task performance to analyse how styles interact in wicked learning environments under time pressure. Next, we present two studies on the interactive effects of the two cognitive styles on task performance. In the first study, we tested our hypotheses about the interaction effects of styles on decision-makers' performance in a simulated crisis management setting. In the second study, we extend the first by testing whether individuals' cognitive styles influence decision-making in a team setting and whether the hypothesized interaction effects persist in the context of teams. Finally, we discuss the results and their implications.

## Theories of intuitive and analytic cognitive styles

Messick (1976) distinguished between cognitive style and cognitive ability. In contrast to cognitive ability, cognitive style controls the way or mode in which individuals think about a particular task. Styles compare to learned habitual strategies (Messick, 1976) and can directly affect task performance (e.g. Pacini & Epstein, 1999). We build on Pacini and Epstein (1999) dual-processing theory of style. They defined styles as a learned preference – an acquired ability and motivation to think intuitively or analytically. The Cognitive-Experiential Self-Theory (CEST) is firmly grounded within the tradition of individual differences and holds that stylistic preferences are relatively stable and reliable individual differences (Epstein, 1990). It posits that individuals may unconsciously and strategically switch between intuitive and analytic modes as required, but stylistic preferences influence the propensity to switch (Louis & Sutton, 1991).

The CEST comes with a questionnaire to measure analytic and intuitive processing preferences, the Rational-Experiential Inventory (REI; Norris & Epstein, 2011; Pacini & Epstein, 1999). The REI is one of the most frequently re-validated and applied dual models of intuitive and analytic cognitive styles

(Akinci & Sadler-Smith, 2013; Alaybek et al., 2021; Hodgkinson & Sadler-Smith, 2003a, 2003b; see also Hodgkinson, Sadler-Smith, Sinclair, et al., 2009) and allows researchers to measure the preference for intuitive and analytic processing on two separate Likert scales. As the two styles are conceptually independent (Norris & Epstein, 2011), the measure allows researchers to explore the possible interaction effects between the two dimensions.

## Effect of intuitive and analytic styles in wicked learning environments

Hogarth (2001) described how we educate our intuition by unconsciously picking up on the regularities of the environment (see also Hammond, 1996; Kahneman & Klein, 2009). Acquired intuitions may be effective in complex environments, given that they are ecologically valid (Gigerenzer, 2000; Hogarth, 2001; Kahneman & Klein, 2009; Klein, 1997, 1998, 2003). Gigerenzer et al. (2011) provide an extensive account of the fast and frugal heuristics research program (see also Gigerenzer et al., 1999; Okoli & Watt, 2018).

Experience educates intuition, increases the mind's capacity for processing and allows vast amounts of information to be handled rapidly (Betsch, 2008; Hogarth, 2001; Klein, 1997; Pretz, 2011). With expert intuition, there is supposedly no trade-off between speed and accuracy, provided that the learning environment produces timely and valid feedback, and that the decision situation is representative of the learning context (Gigerenzer, 2000; Kahneman & Klein, 2009). In contrast, in rapidly changing environments – where the regularities of the environment have changed – increased information gathering and processing leads to better performance (e.g. Eisenhardt, 1989; Kahneman & Klein, 2009).

For skilled intuition to develop, two conditions must be met: the environment must provide sufficient ecologically valid cues, and there must be an opportunity to learn the regularities of the situational patterns (Hogarth, 2001; Kahneman & Klein, 2009; Klein, 1997, 2003). Skilled intuition would, therefore, thrive in an environment with regularities in the form of routine crises – crises that frequently develop with recognizable characteristics and regularities with immediate feedback for learning. In wicked learning environments (Hogarth, 2001) or volatile, uncertain, complex and ambiguous environments (referred to as VUCA), there are few recognizable regularities and limited opportunities for feedback and learning. Consequently, the conditions for developing and applying skilled intuition are not present (Kahneman & Klein, 2009).

In wicked learning environments, the predictions of cognitive style theories become unclear. Such environments represent a particularly interesting boundary condition because they are tangent to the context for which Klein (1997, 2003) developed the Recognition-Primed Decision (RPD) model. Wicked learning environments differ from Klein's context by challenging the basic conditions for developing and applying skilled intuition. Moreover, the requirements for the effectiveness of analytic thinking are also challenged since a clear framework is not available and the time required for analytic thinking is missing.

## Effect of combinations of styles in wicked learning environments

Although researchers often argue in favour of the intuitive style over the analytic one under time–pressure conditions (e.g. Evans, 2008), this does not automatically imply that an analytic style negatively influences performance. As the two styles are conceptualized as independent dimensions, a significant preference for one style does not imply a low preference for the other (Epstein, 1990). Stanovich and West (2000) demonstrated that preferences for how we think influence how we are biased; analytic and intuitive thinking lead to different task construals. Construals triggered by intuition are highly contextualized, personalized and socialized, whereas analysis serves to decontextualize and depersonalize problems. Hence, analytical processing is more adept at representing tasks regarding rules and underlying principles (Stanovich, 1999; Stanovich & West, 2000). Consequently, an intuitive style can provide alternative ideas and information that support and enhance analytic thinking. Conversely, a mentally demanding analytic thinking style can correct maladaptive behaviour induced by an intuitive thinking style and help identify rules and underlying principles. As analysis involves logical and conscious processing, an individual with a high preference for analysis tends to expend more cognitive effort over a more extended period than an individual with a low preference for analysis (e.g. Hogarth, 2001). The obvious drawback is that under time pressure and increased complexity, analytic decision-makers would lack time to process all information logically and consciously and might fail to reach a decision.

Hodgkinson and Clarke (2007, see also Langley, 1995) discuss how people with specific combinations of cognitive styles process information. They theorized that individuals high on the analytic dimension and low on the intuitive dimension tend to approach problems step-by-step, as they are conscious of details. Individuals high on the intuitive dimension and low on the analytic dimension are recognized as "big picture-conscious." Individuals low on both dimensions are labelled as "non-discerning," supposedly deploying only a minimum of cognitive resources when making decisions. The last of the four categories constitute the high-high individuals, or the "cognitively versatile." Decision-makers within this category switch more readily between intuitive and analytic processing modes, thereby efficiently adjusting to the changing demands of the situation (Hodgkinson, Sadler-Smith, Burke, et al., 2009).

Shiloh et al. (2002) provided a different view. They found that decision-makers who scored high on both styles and those who scored low on both styles were most prone to the effect of framing and concluded that these groups were more sensitive to the context (Shiloh et al., 2002). In a dynamic setting, sensitivity to context is often a critical capacity (Klein, 2003) and not just a bias. In a wicked learning environment, neither analytic rules nor intuitive shortcuts are valid. Therefore, rigid adherence to a single style can lead to entrenchment, whereas the motivation to switch between styles may offer an advantage.

The motivation for switching differs across style preferences. Those who score high on both styles may find it stimulating to switch because both styles are viewed positively, whereas those who score low on both styles may switch because of indifference. The low–lows may also enjoy additional advantages over readily switching. The indifference between styles may make the latter group more sensitive to task demands than the preference for particular thinking styles. Consequently, low–low scores indicate greater independence from thinking styles and a stronger focus on task demands. We will explore the possible synergistic effects between the two styles. For instance, when one style is high, it is beneficial for performance that the other style is also high. Conversely, when one style is low, it is helpful for performance that the other style is also low. Similar to standing in a boat in a heavy sea, muscles automatically work synergistically to balance the body.

In conclusion, we can formulate the following hypothesis on the relations between intuitive and analytic styles and their interactive effect on task performance in wicked learning environments.

> **H1.** When individuals make decisions in a wicked learning environment, analytic cognitive style moderates the relation between intuitive cognitive style and task performance, such that the relation is negative for actors low on analytic style; and positive for actors high on analytic style.

## STUDY 1: INTERACTIVE COGNITIVE STYLES IN INDIVIDUAL DECISION-MAKING

In the first study, we tested this hypothesis (H1) and assessed whether a moderated relation exists between intuitive and analytic styles on task performance. We designed a microworld to simulate a wicked learning environment (Hogarth, 2001) with a high degree of VUCA (Brehmer & Dörner, 1993). The simulated environment constitutes a highly controlled laboratory-like microworld, where everyone engages in tasks within the same environment, resources, information and time limits (Davison et al., 2012).

# Study 1 method

## Sample and procedures

The *N* in Study 1 is 749 observations of 107 participants, each solving seven tasks. Thirty three (31%) were military officers from a Norwegian military academy specializing in army operations, and 74 participants were students from a Norwegian business school. The average age was 23.4 for military officers and 23.8 for business students. A total of 85% of business students were studying at the BSc level and 15% at the MSc level.

The study was conducted in a laboratory setting. Two to five days before the participants came to the laboratory, they responded to the Pacini and Epstein (1999) REI inventory, the NEO FFI inventory (Costa & McCrae, 1992) and questionnaires for other background variables. The questionnaires were administered using Confirmit, an electronic administration tool.

Participation was voluntary, and the data-gathering procedure followed the ethical guidelines for informed consent by the Norwegian Centre for Research Data (NSD) and in compliance with the EU's General Data Protection Regulation (GDPR).

The study included the following activities, which took place in this sequence: an oral introduction to the crisis management simulation (15 min), a simulation practice session (10 min) and a simulation session (25 min).

## Simulated decision environment

To establish the content and nomological validity of the tasks, we interviewed three senior instructors and four experienced officers in crisis management at Norwegian military academies (Army and Air Force). Using cognitive task analysis (Crandall et al., 2006), we mapped the behavioural requirements of the task (Wood, 1986). The three instructors independently reviewed and contributed to the task material, including the properties of available resources, task descriptions and performance measures.

Based on this analysis, we designed the simulated environment as a set of 12 crisis management tasks covering two domains. The first five tasks pertain to rescue operations, the following five to security operations and the final two combine the two domains. The first two tasks in each domain are warm-up tasks, and the first of the two combined domain tasks is also a warm-up task. We used the NASA task-load index (TLX) to norm workload, including time pressure and mental demands (Hart & Staveland, 1988). The overall TLX score was .60 on a scale from 0 to 1. The temporal demand score was .71, and .52 for mental demand, indicating high perceived time pressure (Hart & Staveland, 1988).

The participants were asked to manage the crises by allocating the right amount and types of resources accurately and timely. The resource allocation task consists of selecting the correct type of resource, selecting the nearest location with this resource available and choosing the proper role and capacity for the resources. They failed the task if the resources allocated were of the wrong types or roles or arrived too late. As the task progresses, the decision-maker can monitor the resources, constantly survey new information, and change the resource allocation decision if relevant. The individual decision maker controls the following resources: transportation helicopters (bell type), rescue helicopters (SeaKing type), surveillance aircraft (Orion type) and fighter aircraft (F-16 type). A message indicating the nature of the incident, including a map symbol indicating its location, triggers each task. For example, a message can read: "The Emergency Central reports that a flood has been building up gradually in the [name] river close to [location] and has caused several houses to be trapped in flood water between river banks." Following the message, the participant allocates the resources needed to alleviate the incident, and points are given for allocating the resources at the right time and amount.

## Measures

### *Task performance*

The dependent variable was a measure of individual performance on the seven tasks in the crisis management simulation. We created a formula to calculate these scores. The score is based on the correctness of the type, function, quantity and speed of resource allocation (faster is better). Resource requirements change as the situation intensifies, thus reflecting the time dimension (it pays off to make quick decisions). This formula was unknown to the participants. The scores ranged from 0 (no correct actions taken) to 100 (perfect performance). The Cronbach's alpha reliability was .65.

### *Intuitive and analytic cognitive style*

We assessed the independent variables using the Rational-Experiential Inventory (REI; Pacini & Epstein, 1999). This is a 40-item version of the original REI based on Epstein' (1990) Cognitive-Experiential Self-Theory (CEST), scored on a 5-point scale ranging from 1 (definitely not true of myself) to 5 (definitely true of myself). Cronbach's alpha for the intuitive scale was .87, and .80 for the analytic scale. Sample items that measure analytic preferences include: "I enjoy intellectual challenges," and "I enjoy solving problems that require hard thinking." Sample items that measure intuitive preferences include: "I believe in trusting my hunches," and "I trust my initial feelings about people" (Pacini & Epstein, 1999, p. 976).

### *Control variables*

We statistically controlled for cognitive ability, the Big Five factors, and experience to investigate how intuitive and analytic styles predict performance beyond these variables.

*Big five*. The personality variables of the five-factor model were measured by the 60-item NEO-FFI inventory, a shortened version of the NEO PI-R inventory (Costa & McCrae, 1992; Le et al., 2011). Each factor was computed according to the scoring manual without STEN conversion.

*Cognitive ability*. We measured cognitive ability using the Cattell Reasoning B-scale from Cattell's 16PF version 5 (OPP Ltd, 1994). The scale comprises 15 tasks, each with three answer alternatives, where one of the alternatives is correct. The scale correlates well with general IQ tests (Cattell & Schuerger, 2003). The sum of the raw scores, with one point per correct answer, was used in the regression analysis (Cattell & Schuerger, 2003).

*Experience*. We used experience as a control variable to account for the possible performance effects of between-participant differences in educational and professional backgrounds. This variable is dummy-coded as 0 for business school experience and 1 for military academy experience.

## Analytic approach

We applied multilevel linear modelling to address the dependency between repeated tasks nested within individuals. This approach helps avoid bias in estimating standard errors, confidence intervals and ecological fallacy (Snijders & Bosker, 2011). We used a two-level random intercept model. The clustering on Level 2 reflects the seven tasks performed by individuals. We used the restricted maximum likelihood estimator (REML) to fit the model. To produce model fit indices and the likelihood ratio test, we refitted the model with a maximum likelihood estimator (ML). To conduct all analyses, we used R (version 4.2.2) and RStudio with the lme4 package for multilevel modelling and the interaction package for interaction plots and Johnson–Neyman analysis.

## Study 1 results

In Table 1, we present the descriptive statistics: means, standard deviations and correlations. Approximately 31% of the participants had military experience with crisis management beyond basic training

**TABLE 1** Means (*M*), standard deviations (*SD*) and correlations (Study 1).

| | *N* | *M* | *SD* | *α* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Cognitive ability | 107 | 9.36 | 2.8 | | 1 | | | | | | | |
| 2. Neuroticism | 107 | 17.59 | 6.8 | .76 | −.14 | 1 | | | | | | |
| 3. Extraversion | 107 | 32.28 | 5.1 | .69 | .03 | −.50*** | 1 | | | | | |
| 4. Openness | 107 | 27.1 | 7.0 | .76 | .20* | .15 | .04 | 1 | | | | |
| 5. Agreeableness | 107 | 29.94 | 5.8 | .71 | .10 | −.32*** | .24* | .02 | 1 | | | |
| 6. Conscientiousness | 107 | 33.65 | 6.8 | .87 | .04 | −.21* | .27** | .17 | .26** | 1 | | |
| 7. Intuitive CS | 107 | 3.34 | .52 | .80 | .00 | −.16 | .29** | −.13 | .15 | −.01 | 1 | |
| 8. Analytic CS | 107 | 3.73 | .43 | .87 | .31** | −.05 | .07 | .36*** | .03 | .48*** | −.09 | 1 |
| 9. Task performance | 749 | 44.89 | 26.9 | .65 | .17*** | −.09* | .07 | −.09* | .02 | −.14*** | .10** | −.07 |

*Note*: Significance levels (all two-tailed): *$p < .05$; **$p < .01$; ***$p < .001$.

(these were officers at the military academy). The mean for the analytic style was 3.73 (min 2.2, max 4.7) and 3.34 (min 2.1, max 4.5) for the intuitive style. Cognitive ability ($r=.17$, $p<.001$) correlated positively with task performance. Intuitive cognitive style correlated positively with task performance ($r=.10$, $p<.01$). In contrast, the analytic style correlated negatively and was non-significant ($r=-.07$, $p=.07$). Three of the Big Five factors, Neuroticism, Openness and Conscientiousness, all correlated negatively with task performance.

The intraclass correlation for the null model was .08. The repeated-measures analysis is presented in Table 2. Neither the intuitive nor the analytic style had a significant main effect on task performance (Model 3: $b=1.83$, $p=.37$, and $b=-.99$, $p=.73$ respectively). The interaction between the intuitive and analytic styles was significant (Model 3: $b=12.47$, $p<.01$). Thus, the main effects cannot be interpreted in isolation (Aiken & West, 1991). The significant $\chi^2$ change from Model 2 to Model 3 ($\chi^2\Delta=8.42$, $p<.01$) supports H1, postulating an interaction effect between intuitive and analytic styles.

To interpret the interaction effect, we followed Aiken and West's (1991) prescriptions. Figure 1 illustrates the interaction pattern between the intuitive and analytic styles. The two simple slopes in Figure 1 are plotted for one standard deviation above and below the mean. In line with H1, the simple slopes show that when participants are high on the analytic style (one *SD* above the mean), the relation between intuitive style and task performance is positive (upward sloping). When participants were low on analytic style (one *SD* below the mean), the relation between intuitive style and task performance was negative (downward sloping).

We used the Johnson–Neyman technique to identify the regions of significance for the two slopes (Johnson & Neyman, 1936). Figure 2 illustrates how the slope of the relation between intuitive style

**TABLE 2** Repeated measures analysis (Study 1).

| | **Model 1** | | **Model 2** | | **Model 3** | |
|---|---|---|---|---|---|---|
| | **Est.** | ***p*** | **Est.** | ***p*** | **Est.** | ***p*** |
| Regression coefficients (fixed effects) | | | | | | |
| Intercept | 33.28** | .008 | 33.37* | .012 | 34.93** | .007 |
| Cognitive ability | 1.64*** | <.001 | 1.72*** | <.001 | 1.66*** | <.001 |
| Experience | 5.66* | .027 | 5.21* | .044 | 6.16* | .015 |
| Neuroticism | −.05 | .796 | −.06 | .743 | −.08 | .643 |
| Extraversion | .45 | .058 | .37 | .133 | .33 | .161 |
| Openness | −.27 | .096 | −.22 | .187 | −.24 | .142 |
| Agreeableness | .15 | .437 | .10 | .609 | .06 | .738 |
| Conscientiousness | −.51** | .003 | −.45* | .020 | −.39* | .039 |
| Intuitive CS | | | 2.49 | .232 | 1.83 | .367 |
| Analytic CS | | | −2.06 | .491 | −.99 | .734 |
| ICS × ACS | | | | | 12.47** | .005 |
| Variance components (random effects) | | | | | | |
| $\sigma^2$ | 662.37 | | 662.37 | | 662.37 | |
| $\tau_{00\ \text{subject}}$ | 11.35 | | 11.38 | | 4.20 | |
| Model summary | | | | | | |
| Deviance (−2LL) | 6994.7 | | 6992.6 | | 6984.2 | |
| AIC | 7014.7 | | 7016.6 | | 7010.2 | |
| $\chi^2\Delta$ | | | 2.16 | .340 | 8.42** | .004 |

*Note*: Observations = 749, $N_{\text{subjects}}=107$; *$p<.05$; **$p<.01$; ***$p<.001$.

Abbreviations: ACS, analytic cognitive style; CS, cognitive style; ICS, intuitive cognitive style.

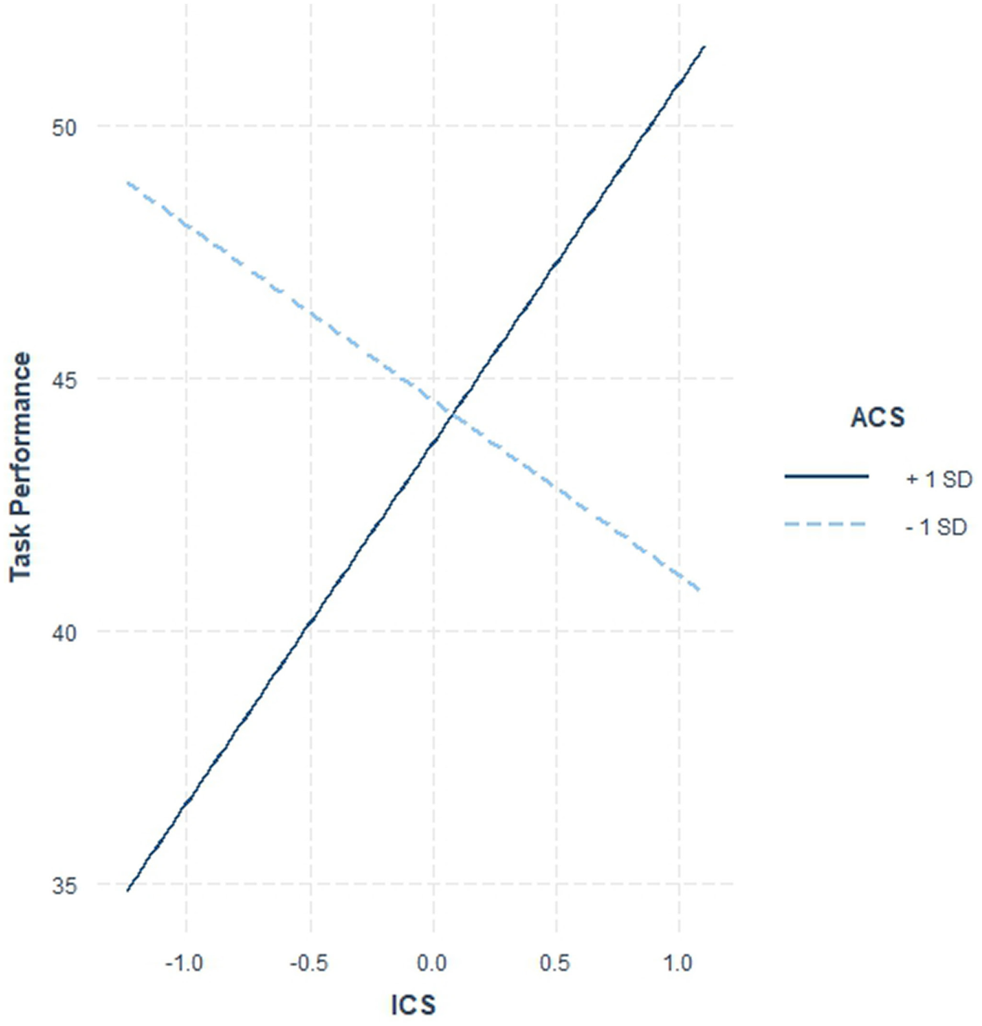


**FIGURE 1** Simple slopes analysis, Study 1. Abbreviations: ACS, analytic cognitive style; ICS, intuitive cognitive style.

and performance varies as a function of analytic style. When analytic style was *outside* the interval [−.84, .18], the slope of intuitive style was significant at $p < .05$. Specifically, when analytic style is lower than −.84, the slope for intuitive style is significantly negative. It was significantly positive at values above .18. The range of observed values for analytic style (centred) is [−1.53, .92], and the standard deviation (*SD*) is .43.

In summary, the Johnson–Neyman analysis supports H1: When individuals make decisions in a wicked learning environment, analytic style moderates the relation between intuitive style and task performance, such that the relation is negative for actors low in analytic style and positive for actors high in analytic style.

## Study 1 discussion

The interaction patterns show that participants with the low–low and high–high style combinations stand out as the best performers. Conversely, the low intuitive–high analytic participants performed the worst. That the high–high combination is associated with high performance coincides with Hodgkinson

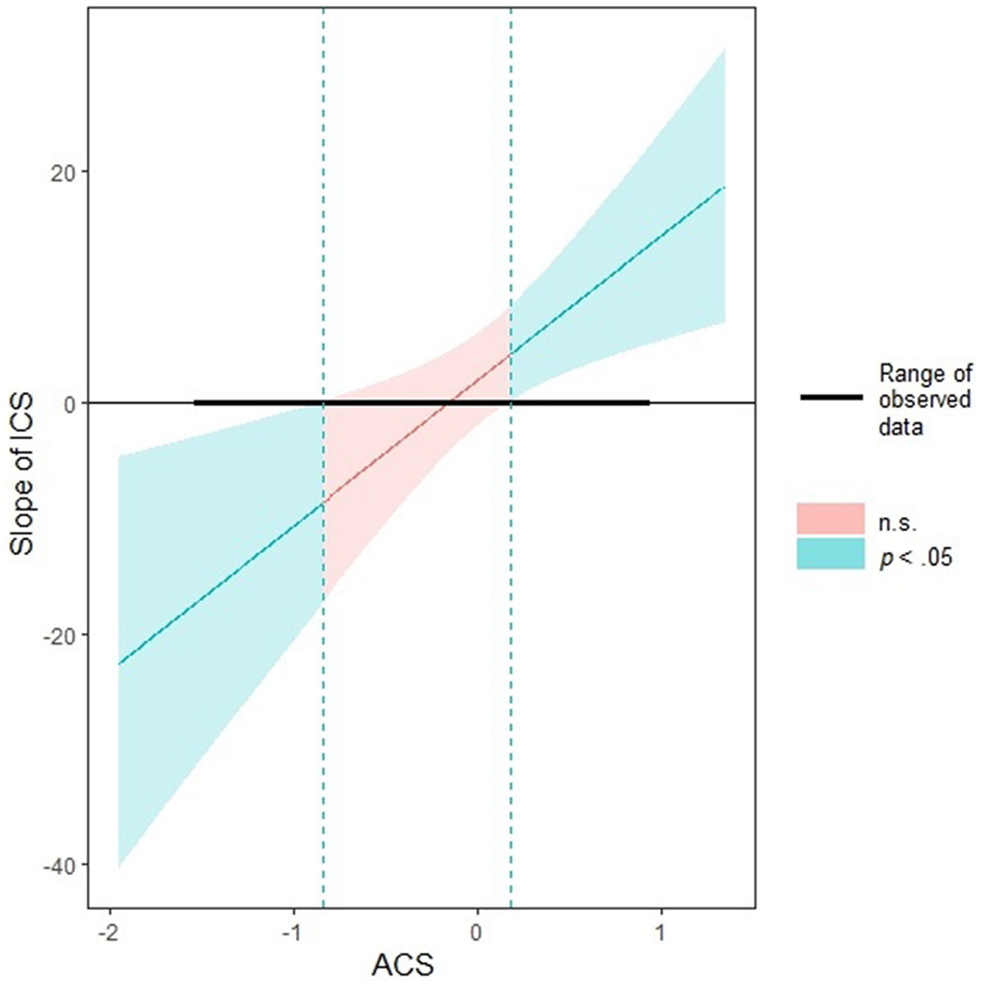


**FIGURE 2** Johnson–Neyman analysis, Study 1. Abbreviations: ACS, analytic cognitive style; ICS, intuitive cognitive style.

and Clarke (2007) predictions of cognitive versatility in a strategy context. That the low–low combination, the non-discerners, performs equally well as the versatile (high–high) in our VUCA setting conflicts with the assumptions concerning the non-discerners. Thus, this finding inspires a reinterpretation and new theorizing about the low–low combination.

First, it seems to be a mistake to assume that a low preference for both intuitive and analytic styles implies that they cannot engage in a complex task. A weak preference for a style does not imply that the decision-makers cannot think, just that they do not have a strong preference for any of the two styles. They may still be able to think hard and well. Moreover, since cognitive styles become habitualized over time (Hogarth, 2001; Messick, 1984), a strong preference for a particular style may imply a trajectory for entrenchment (Dane, 2010; Luchins, 1942). Those who strongly prefer one style may be more prone to entrenchment, while those with a mixed preference are more likely to avoid entrenchment by switching styles. Being high–high or low–low implies they can self-correct by switching between styles and reducing biases by continuously reframing interpretations (e.g. Soll et al., 2015).

In Study 1, we analysed the interaction effects between cognitive styles in individual decision-making. In organizations, decision-making is often a collective undertaking (Akinci & Sadler-Smith, 2019). Managers construct teams to organize better decision-making. A long tradition within social psychology has established that social influence in teams is strong and significant. To further understand the interactive effects of cognitive style in a wicked learning environment, we asked in Study 2 whether the social influence of teams will dilute the effect of individuals' interacting cognitive styles.

# STUDY 2: INDIVIDUALS' INTERACTIVE COGNITIVE STYLES IN A TEAM CONTEXT

Team context changes the dynamics of decision-making (e.g. Kozlowski & Ilgen, 2006). Asch (1956) found that individuals conformed to the group when decision-makers made their decisions publicly in groups. Janis (1971) argued that groups often engage in groupthink because of social cohesion and group dynamics. Researchers have found that social conformity is also significant in distributed teams (Haines, 2014; Haines & Cheney Mann, 2011; Postmes et al., 1998). Since teams can alter the outcome of individuals' decision-making, it is worth exploring whether this extends to diluting the effect of cognitive styles. If social influence is strong, we would expect individuals in the group to think and perform more similarly, thus eliminating differences caused by individuals' cognitive styles.

Although team members are exposed to social influence, individual decisions are not continuously available to the rest of the team, which may decrease social influence (Asch, 1956). From our discussion of cognitive style theories, we would expect to find the same pattern as in Study 1. Thus, we have two competing sets of theories and two competing hypotheses.

> **H2a.** When individuals make decisions in the context of teams in a wicked learning environment, the social influence in the team is significant, rendering the effect of individual styles on performance insignificant.

> **H2b.** When individuals make decisions in the context of teams in a wicked learning environment, analytic style moderates the relation between intuitive style and task performance, such that the relation is negative for actors low on analytic style; and positive for actors high on analytic style.

## Study 2 method

### Sample and procedures

The *N* in Study 2 is 141 observations of 49 students, each solving three tasks (scenarios). Participants were recruited from the same business school as in Study 1 and grouped into three-person teams. Due to random technical issues, six incomplete observations were removed from the sample. The average age of the participants was 24.5, with 33% male students. While 31% in the first study had military experience beyond basic training, only 2% of this sample had such experience. This change in sampling ensured that participants did not have expert heuristics and therefore perceived the context as more wicked.

We followed the same data-gathering procedure as in Study 1 concerning the NSD guidelines and GDPR. We administered the study in a laboratory setting. We included the following sequence of activities: a short presentation of the crisis management simulation (15 min), a simulation practice session (10 min) and three simulation sessions (20 min each).

### Simulated decision environment

The microworld, the simulated wicked learning environment, encompasses counter-terrorism at an operational command level and is similar to the simulation used in Study 1. The goal is to protect oil rig installations on the coastline of Norway. The task requirements included information exchange, monitoring and coordination. The critical aspects of this simulation resemble the team effectiveness laboratory developed by Hollenbeck et al. (2002) and Hansson et al. (2023). The simulated environment plays out in three 20-min scenarios with similar difficulty levels. Each player has a specific role with a unique and complementary set of capabilities. The roles are Orion, a surveillance airplane to detect vessels; Patrol, a coastal fast patrol boat to search vessels; Frigate, a military vessel able to attack and eliminate threats. The game's outcome depends on the individual performance of the three roles. The players are separated from each other; the only communication is through the built-in chat or email functionality. The participants were randomly assigned to different roles and teams. We used the NASA task load index (TLX) to norm the workload for this task as well (Hart & Staveland, 1988). The average TLX score was .51 on a scale from 0 to 1. The temporal demand was .53, and the mental demand was .47, indicating that the tasks in Studies 1 and 2 had a comparable overall workload.

## Measures

Before coming to the laboratory, the participants responded to questionnaires administered through Qualtrics Survey Software, including the Pacini and Epstein (1999) REI inventory, the five-factor model and several background variables.

### *Task performance*

Task performance is an individual measure combining equally weighted action and time scores ranging from −40 to 100. A performance score of 100 indicates a perfectly performed task, while a negative score of −40 reflects the penalties given for faulty actions, such as attacking a vessel that is not hostile. The team performs better when everyone does their job, and vice versa. Hence, measuring individuals' cognitive styles and performance provides a good understanding of their contribution to the team's performance. The Cronbach's alpha reliability was .55, which we consider acceptable since it is based on only three tasks.

### *Intuitive and analytic cognitive style*

As in Study 1, we used Pacini and Epstein's (1999) 40-item Rational-Experiential Inventory to assess cognitive style preference. Cronbach's alpha reliability in our sample for the intuitive scale was .86, and .89 for the analytic scale.

### *Control variables*

We controlled again for the Big Five as measured with the 60-item NEO-FFI and cognitive ability using Cattell's Reasoning B-scale. Experience was dummy-coded as 0 for no military experience and 1 for military experience. This control variable allows us to account for the possible effects of crisis management training from the military.

## Analytic approach

We used the same analytical approach and statistical packages as in Study 1. To address the dependency between repeated tasks nested within individuals, and individuals nested within groups, we apply multilevel linear modelling. We use a three-level random intercept model, where the clustering on Level 3 reflects group membership and Level 2 reflects the nestedness of the three repeated scenarios (Level 1) in individuals.

# Study 2 results

Table 3 contains descriptive statistics. On average, the participants reported being more analytically oriented than intuitive, as in Study 1 (mean = 3.64, min 2.6, max 5.0 vs. mean = 3.26; min 2.0, max 4.4 respectively).

**TABLE 3** Means (*M*), standard deviations (*SD*) and correlations (Study 2).

| | *N* | *M* | *SD* | *α* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Cognitive ability | 49 | 10.26 | 2.63 | | 1 | | | | | | | |
| 2. Neuroticism | 49 | 19.0 | 5.68 | .81 | .08 | 1 | | | | | | |
| 3. Extraversion | 49 | 28.87 | 3.88 | .78 | −.13 | −.41** | 1 | | | | | |
| 4. Openness | 49 | 28.17 | 5.89 | .70 | .11 | −.23 | .37** | 1 | | | | |
| 5. Agreeableness | 49 | 31.36 | 4.73 | .59 | −.31* | −.01 | .24 | −.05 | 1 | | | |
| 6. Conscientiousness | 49 | 31.67 | 6.42 | .86 | .12 | −.14 | .37** | .13 | .01 | 1 | | |
| 7. Intuitive CS | 49 | 3.26 | .47 | .86 | .12 | −.09 | .02 | .02 | .10 | −.24 | 1 | |
| 8. Analytic CS | 49 | 3.64 | .52 | .89 | .23 | −.54*** | .46*** | .54*** | −.27 | .30* | −.15 | 1 |
| 9. Task performance | 141 | 24.59 | 21.2 | .55 | .11 | −.07 | .15 | .15 | .05 | .09 | .28*** | .06 |

*Note*: Significance levels (all two-tailed): *$p < .05$; **$p < .01$; ***$p < .001$.

Cognitive ability ($r = .11$, $p = .21$) correlated positively with task performance but was non-significant. As in Study 1, there was a positive correlation between intuitive style and task performance ($r = .28$, $p < .001$). The correlation between analytic style and task performance was positive, although not significant ($r = .06$, $p = .47$). None of the Big Five factors correlated significantly with task performance in Study 2.

The intraclass correlation for the null model in Study 2 was .25, indicating a significant social influence, as the grouping in teams explained 25% of the variance in individual performance. The results of multilevel modelling are presented in Table 4. As in Study 1, neither intuitive nor analytic style had a significant main effect on task performance (Model 3: $b = 4.31$, $p = .34$, and $b = -1.79$, $p = .75$ respectively). Like in Study 1, the interaction between intuitive and analytic styles was significant (Model 3: $b = 30.06$, $p < .001$), implying that the main effects cannot be interpreted in isolation (Aiken & West, 1991). There was a significant $\chi^2$ change from model 2 to model 3 ($\chi^2\Delta = 17.20$, $p < .001$). The interaction between individuals' cognitive styles also significantly influenced individuals' performance in the team setting. Thus, we found support for H2b and rejected H2a, although we found a significant effect on individual performance from grouping individuals in teams.

We followed Aiken and West (1991) prescriptions to interpret the interaction effect. Figure 3 illustrates the interaction pattern between the Intuitive and Analytic styles. The two simple slopes in Figure 3 are plotted for one standard deviation above and below the mean. In line with H2, and as in Study 1, the analysis of the simple slopes illustrates that when participants were high on analytic style (one *SD* above the mean), the relation between intuitive style and task performance was positive (upward sloping). When participants had low scores for analytic style (one *SD* below the mean), the relation between intuitive style and task performance was negative (downward sloping).

**TABLE 4** Repeated measures analysis (Study 2).

| | **Model 1** | | **Model 2** | | **Model 3** | |
|---|---|---|---|---|---|---|
| | **Est.** | ***p*** | **Est.** | ***p*** | **Est.** | ***p*** |
| Regression coefficients (fixed effects) | | | | | | |
| Intercept | −9.47 | .734 | −12.98 | .635 | −34.94 | .152 |
| Cognitive ability | 1.18 | .154 | .70 | .406 | .59 | .431 |
| Experience | −2.61 | .873 | −3.79 | .810 | −5.03 | .727 |
| Neuroticism | .09 | .823 | .23 | .585 | .31 | .424 |
| Extraversion | .44 | .516 | .28 | .687 | .88 | .163 |
| Openness | −.05 | .899 | .09 | .827 | .51 | .180 |
| Agreeableness | .43 | .376 | .26 | .593 | .06 | .883 |
| Conscientiousness | −.12 | .733 | .24 | .504 | .23 | .471 |
| Intuitive CS | | | 11.54* | .013 | 4.31 | .336 |
| Analytic CS | | | −1.03 | .871 | −1.79 | .749 |
| ICS × ACS | | | | | 30.06*** | <.001 |
| Variance components (random effects) | | | | | | |
| $\sigma^2$ | 340.52 | | 341.67 | | 332.38 | |
| $\tau_{00\ \text{subject:group}}$ | 29.41 | | 15.83 | | .00 | |
| $\tau_{00\ \text{group}}$ | 107.99 | | 89.01 | | 40.36 | |
| Model summary | | | | | | |
| Deviance (−2LL) | 1244.0 | | 1236.2 | | 1219.0 | |
| AIC | 1266.0 | | 1262.2 | | 1247.0 | |
| $\chi^2\Delta$ | | | 7.72* | .02 | 17.20*** | <.001 |

*Note*: Observations = 141, $N_{\text{subjects}} = 49$, $N_{\text{groups}} = 18$. *$p < .05$; **$p < .01$; ***$p < .001$.
Abbreviations: ACS, analytic cognitive style; CS, cognitive style; ICS, intuitive cognitive style.

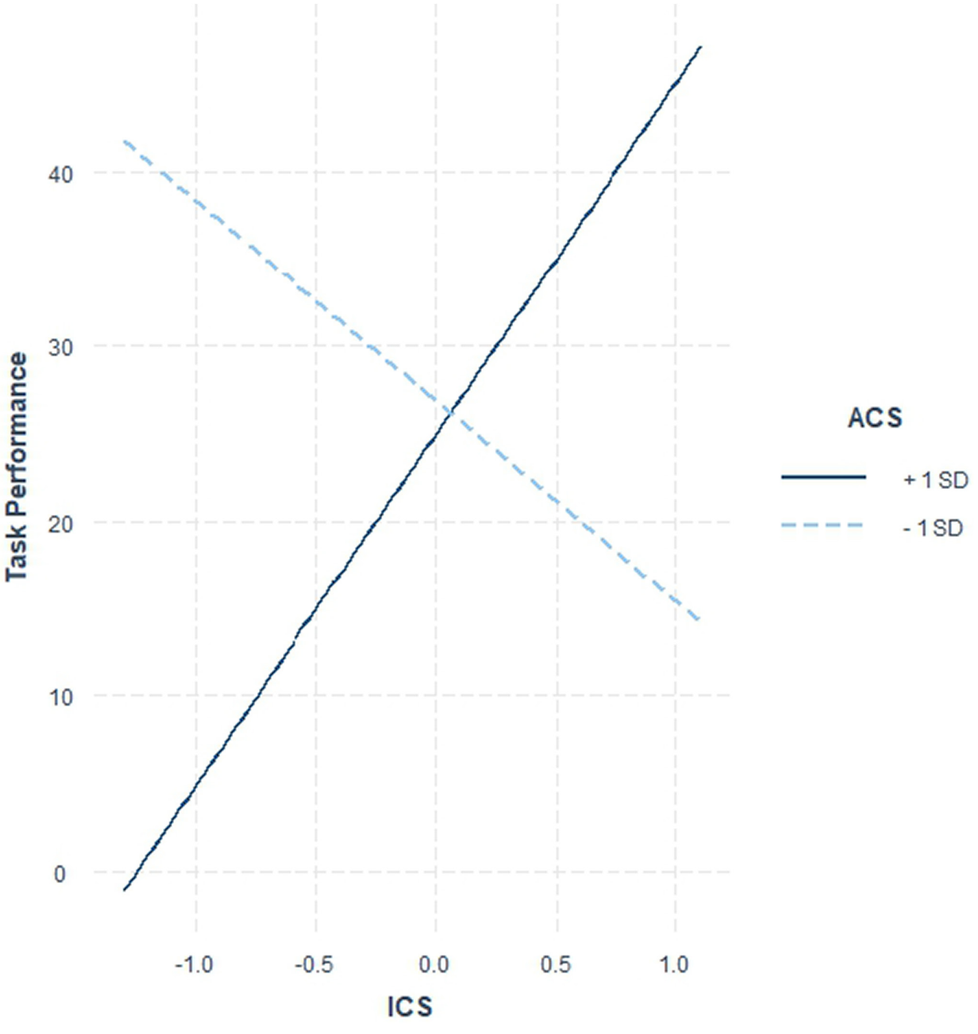


**FIGURE 3** Simple slopes analysis, Study 2. Abbreviations: ACS, analytic cognitive style; ICS, intuitive cognitive style.

We used the Johnson–Neyman technique (Johnson & Neyman, 1936) to identify the regions of significance for the two slopes. Figure 4 illustrates how the slope of the relation between intuitive style and task performance varies as a function of analytic style. When the analytic style was outside the interval [−.65, .13], the slope of the intuitive style was significant at $p < .05$. Specifically, when the analytic style is lower than −.65, the slope for the intuitive style is significantly negative. It is significantly positive at values above .13. The range of observed values for the analytic style (centred) is [−1.09, 1.36], and the standard deviation (*SD*) is .52.

In summary, the Johnson–Neyman analysis supports H2b: for low levels of analytic style, intuitive style is negatively related to performance, and for high levels of analytic style, intuitive style is positively related to performance.

## Study 2 discussion

The team setting did not dilute the effect of individuals' interacting cognitive styles, although individuals' performance correlated within teams. Still, the interaction between the individual team members'

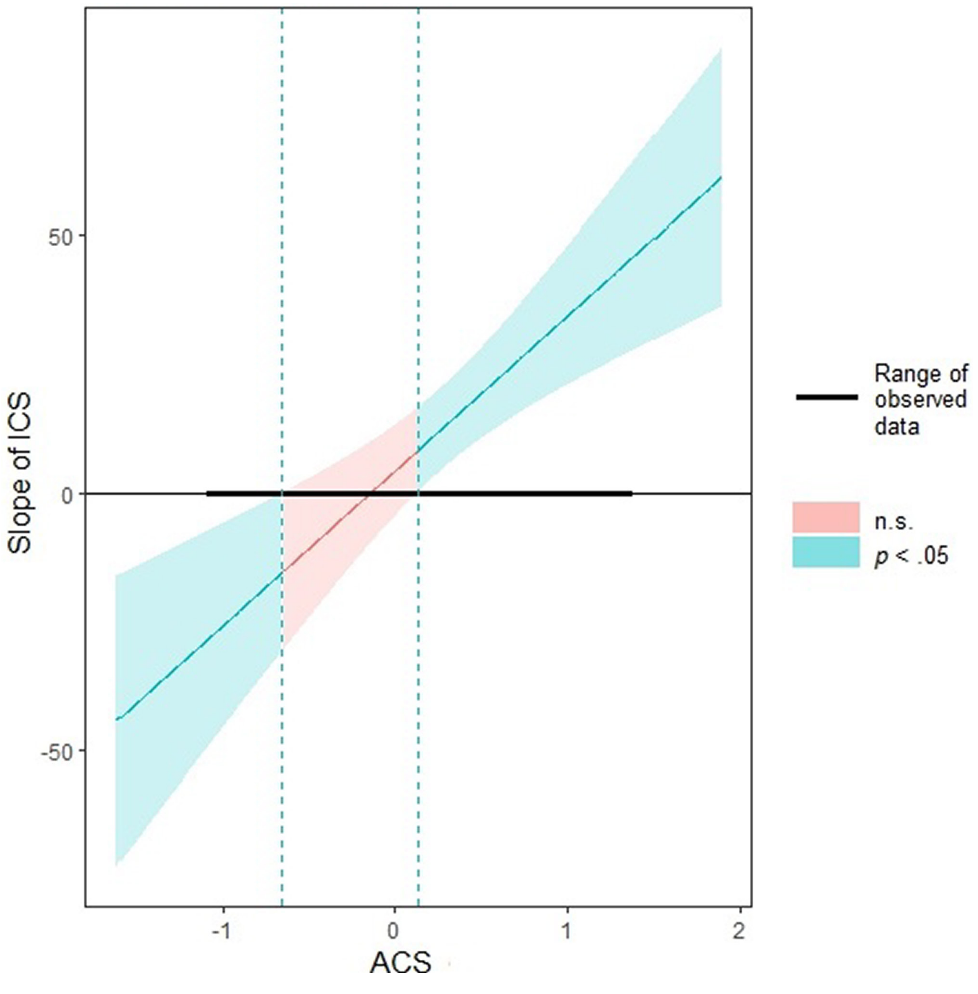


**FIGURE 4** Johnson–Neyman analysis, Study 2. Abbreviations: ACS, analytic cognitive style; ICS, intuitive cognitive style.

cognitive styles significantly affected individuals' performance, as in Study 1. Thus, conformity and group dynamics did not crowd out the effect of individuals' cognitive styles. This finding is interesting because we might have expected the opposite based on social conformity research, and the finding provides some insight into the level of conformity that influences individuals' cognitive processing in this setting. Moreover, in Study 2, we replicated the findings from Study 1, supporting Epstein, 2003, p. 7) proposed utility of switching between styles: "Each system has advantages and disadvantages, and the advantages of one can offset the disadvantages of the other." Again, the low-lows performed as well as the high-highs. To further understand this finding, we performed a post-hoc analysis.

## Post-hoc theorizing and analysis

Cognitive style is often described as a learned method or habit for solving problems (Hodgkinson & Clarke, 2007; Messick, 1976; Pacini & Epstein, 1999). When the environment changes or is wicked, previously learned methods may not work (e.g. Dane, 2010; Klein, 1997), and the decision maker may become entrenched in ecologically invalid methods.

When existing methods and heuristics are ineffective, decision-makers might do better by relying on their cognitive ability to solve the problem. Individuals with higher scores on Cattell's B-scale tend to

**TABLE 5** Post-hoc analyses.

| | $N$ | Cognitive ability $M$ ($SD$) | Task performance $M$ ($SD$) | $r_{CA,TP}$ | $p$ |
|---|---|---|---|---|---|
| Study 1 | | | | | |
| HH | 133 | 10.8 (2.53) | 50.3 (24.4) | .26** | <.01 |
| HL | 84 | 7.5 (3.06) | 43.9 (24.9) | .19 | .08 |
| LH | 140 | 10.2 (1.84) | 36.1 (26.8) | .06 | .51 |
| LL | 112 | 8.5 (2.63) | 46.6 (28.7) | .27** | <.01 |
| Others | 280 | 9.18 (2.83) | 43.6 (27.1) | .16** | <.01 |
| Study 2 | | | | | |
| HH | 20 | 12.2 (1.42) | 39.1 (17.4) | .69*** | <.001 |
| HL | 26 | 9.12 (2.57) | 20.8 (18.4) | .02 | .93 |
| LH | 23 | 9.91 (3.70) | 17.4 (21.6) | −.18 | .43 |
| LL | 12 | 9 (2.95) | 21.7 (17.6) | .67** | .02 |
| Others | 60 | 10.5 (2.02) | 24.7 (22.2) | −.14 | .30 |

*Note*. High = one-quarter of an *SD* above the mean; Low = one-quarter below the mean.

Abbreviations: HH, high intuitive style, high analytic style; HL, high intuitive style, low analytic style; LH, low intuitive style, high analytic style; LL, low intuitive style, low analytic style.

Significance levels (all two-tailed): *$p < .05$; **$p < .01$; ***$p < .001$.

perform better on tasks requiring fluid intelligence, that is, seeing relationships independent of previous specific practice (Cattell, 1971). Those with low motivation to think analytically and intuitively may rely less on style, allowing their cognitive ability to play a more significant role. If so, we expect higher correlations between cognitive ability and performance in the cognitively flexible high–high and low–low groups than in the other groups.

To explore this idea, we conducted a simple post-hoc analysis comparing the correlations between cognitive ability and performance across the 2 × 2 style combinations, dividing the participants into four style groups (we have entered the corresponding Hodgkinson & Clarke, 2007, p. 246) labels in parentheses): high intuitive–high analytic (Cognitively versatile); low intuitive–low analytic (non-discerning); high intuitive–low analytic (Big picture conscious); and low intuitive–high analytic (Detail conscious). We created these groups by selecting observations one-quarter of the standard deviation above and below the mean values to retain sufficient observations in each group for the analysis. For example, if participants score above this threshold on intuitive style and below on analytic style, they will be categorized as high intuitive–low analytic, or high–low for short. We created an additional group called "others" for the remaining observations that fell outside the defined range. Table 5 presents the results.

In Table 5, Study 1, we observe that the high–high group has the highest score for cognitive ability, and the low–low group has the lowest. However, the correlations between cognitive ability and performance were the highest for these two groups. The correlation between cognitive ability and performance was significant for both the high–highs ($r = .26$, $p < .01$) and low–lows ($r = .27$, $p < .01$). Equally interesting, the correlation between cognitive ability and performance was non-significant in the high–low and low–high groups. We found the same pattern in Study 2. Together, these results support our post-hoc reasoning about a possible cognitive entrenchment effect for those with a strong preference for a specific style and more leeway for the high–high and low–low groups' cognitive ability.

# GENERAL DISCUSSION

Our objective was to examine the relation between the interaction of intuitive and analytic styles and task performance in a crisis management context perceived as having a wicked learning structure (Hogarth, 2001). Across both studies, we found a significant interaction effect where analytic style moderated the effect of intuition so that low–lows were the best performers, together with high–highs (Figures 1 and 3). The interaction was significant after controlling for the Big Five personality factors, cognitive ability and experience. In Study 2, we found that social influence did not dilute the interaction effect. Our study adds to the interpretation of Alaybek et al.'s (2021) meta-analytic finding of no main effects of intuitive style, demonstrating Aiken and West's (1991) point about how interaction effects, if not analysed, may hide the effects of the interacting variables.

Our findings extend current theories of cognitive styles to a boundary condition: wicked learning environments with time pressure. Earlier theorizing indicates that in a wicked learning environment, prior experiential learning will be less ecologically valid and, consequently, intuition less effective (Gigerenzer, 2000; Hogarth, 2001). Therefore, an analytic approach in wicked learning environments should be equally problematic because established rules are challenged or invalid. Hence, relying on either style alone would not suffice. Instead, the observed interaction patterns support Hodgkinson and Clarke (2007) and Hodgkinson and Healey's (2011) predictions about the high–high group. They hypothesized superior performance for the high–high group owing to their cognitive flexibility, arguing that a strong preference for both styles makes it easier to adapt to task requirements. The literature is more pessimistic about the performance of the low–low group. However, our findings contradict and extend established theories on this point: the low–low group performs as well as the high–high group.

How can these groups with opposing preferences for both styles perform equally well? Moreover, why are they much better than the two groups with strong preferences for only one of the styles? The high–high and the low–low groups share a nondominant preference and, thus, are assumed to be cognitively flexible and able to switch styles effortlessly. Perhaps the most obvious speculation is that both groups have the same motivation to switch between styles. In contrast, a dominant preference may dampen the motivation to switch since the preference for the other style is comparatively lower.

There is some empirical support for cognitive flexibility theorizing in prior studies. Shiloh et al. (2002) found that participants with low–low and high–high combinations of styles demonstrated greater sensitivity and adaptation to environmental cues and frames, which may be critical when the learning environment is wicked. Tversky & Kahneman, 1981, p. 453) illustrated the framing effect with the following example: "Veridical perception requires that the perceived relative height of two neighbouring mountains … should not reverse with changes of vantage point." By analogy, our study reflects a setting where the mountain's actual height is unavailable from any vantage point. Therefore, the switching styles shift vantage points and help to understand the situation better.

To further understand the mechanisms behind the effect of switching styles, it is necessary to define cognitive styles as a learned method. The accumulation of repetitions of successful resolutions leads to the habitualization of specific response patterns and the mechanization of thought processes (Luchins, 1942). A method developed in a specific environment may become a mental set or entrenchment in another environment (e.g. Dane, 2010; Luchins, 1942). Intuitive and analytical styles reflect pre-learned response patterns (Anderson, 1996). Moreover, Wolin (1960) considered method as an intellectual strategy for processing and argued that "method is the salvation of puny men [sic]" (p. 383), and in stable environments simplifying and routinizing procedures can ensure top performance. However, when the environment and laws change – such as in a wicked learning environment – the method is no longer a salvation. Then, high motivation for a cognitive style may be the opposite of salvation; it can be a cognitive entrenchment for highly able decision-makers. Thus, in a wicked learning environment, the labels "Intuitively entrenched" and "Analytically entrenched" add to the understanding of Hodgkinson and Clarke (2007) labels "Big picture conscious" and "Detail conscious" respectively.

Decision-makers' confirmation-seeking propensity and a strong preference for a single style may increase the probability of entrenchment (Dane, 2010; Luchins, 1942; Rudolph et al., 2009). The low–lows may be less entrenched because they are not firmly committed to any style and perform better than those with a dominant preference. We can further speculate that the high–highs' strong preference for both styles may avoid entrenchment through their cognitive flexibility and more active switching. In our post-hoc analysis, we found that entrenchment constrains the potential of decision-makers' cognitive ability. Specifically, we observed that cognitive ability did not correlate with performance for those firmly committed to only one style. For those without a dominant preference (the high–high and low–low groups), there was a significant positive correlation. Therefore, commitment to only one style seems to constrain cognitive ability. In contrast, the low–low and high–high groups leverage their cognitive ability better.

There seem to be both similar and different mechanisms behind the superior performance of the high–highs and low–lows. Both are assumed to be cognitively flexible, but low–lows are less committed to styles and may be more unbiased explorers in environments that do not behave as expected. The low–lows find less motivation in thinking intuitively and analytically and may take a more distanced and unentrenched perspective on the task. Conversely, high–highs may overcome entrenchments by effortless shifting between their styles.

These points explain why considering low–lows as non-discerning is too simplistic and misleading. Moreover, the operationalization of cognitive styles was based on Pacini & Epstein, 1999, p. 976) scale. A closer look at key items does not support the non-discerning label for low–lows. If you disagree with the following REI-items: "I enjoy solving problems that require hard thinking; Thinking hard and for a long time about something gives me little satisfaction (reversed); I prefer complex problems to simple problems," and simultaneously: "I believe in trusting my hunches; I trust my initial feelings about people; Using my gut feelings usually works well …", it does not imply that you cannot think. Such preferences merely imply that the low–lows are not firmly committed to any of the styles. Thus, they are cognitively independent, less biased by stylistic preferences, and therefore perhaps more open to the characteristics of the task environment.

## Limitations and directions for future research

Cognitive style researchers measure individual differences in preferences for cognitive processing but do not measure the actual cognitive processes used while solving a task. This study identifies correlations between interactions of styles and performance but cannot link this correlation to participants' actual cognitive processes. The cognitive style research tradition generally assumes a relation between preference and processing. However, we know it is possible to deviate from what we prefer, and future research should investigate when, how much and in which situation we deviate. However, it may be challenging to measure cognitive processing. The development and application of such measures is an exciting avenue for future research. Such measures are in high demand and would help bridge cognitive style and cognitive processing theories. Recent technological developments have provided digital tools that supplement and support more established techniques, such as think-aloud verbal protocols (e.g. Prime & Le Masurier, 2000).

A general criticism of using computer games with simulated environments is that the task differs from those that participants would face in the real world. An essential point, however, in using a simulated environment is the ability to select the mechanisms of interest from the real world and design a controllable environment where these mechanisms stand out similarly for all participants (Brehmer & Dörner, 1993). Our simulation ensured all participants were presented with the same wicked task environment, which would not have been possible in a field study. Experts' heuristics affect their perceptions of the environment (e.g. Haerem & Rau, 2007; Hogarth, 2001; Kahneman & Klein, 2009; Salas & Klein, 2001). Thus, a possible reason for the somewhat increased interaction effect in Study 2 is that almost all participants were novel to the context and perceived higher degrees of volatility, uncertainty, complexity and ambiguity. The more homogenous sample of novices in Study 2 seems to have strengthened the internal validity and increased the effect of interacting cognitive styles. Moreover, the effect of combinations of cognitive styles probably depends on the conditions we have only controlled and not manipulated, such as differing levels of task complexity, time pressure, phase, or stage in the problem-solving process. For example, a very high time pressure might favour less switching since a strong preference for a single style will avoid the extra cognitive effort involved in switching styles. All these factors are prime candidates for future studies of boundary conditions for the effects of cognitive styles in various crisis management contexts.

# CONCLUSION

A conclusion from our two studies of decision-making in wicked learning environments (Hogarth, 2001), or VUCA environments, is that the interaction effect of intuitive and analytic cognitive styles affects task performance beyond the main effects of the separate styles, the Big Five personality factors, domain experience and cognitive ability. Our analysis clarifies why cognitive style research often produces inconclusive and contradictory results, highlighting the importance of including the interaction effects between styles when studying decision-making in wicked learning environments. Extending current theories of intuitive and analytical styles, we describe how cognitive styles can be a mechanism for cognitive flexibility or for cognitive entrenchment. More specifically, our results provide cues for successful cognitive strategies in wicked learning environments; they indicate that flexible style preferences boost the effect of cognitive ability, while strong preferences for a single style may entrench even those with high cognitive abilities. Thus, our studies empirically explore an often-overlooked assumption in cognitive style research – that the interacting cognitive styles, rather than a single style, play a significant role in solving complex and ambiguous problems. For practical purposes, our studies imply that cognitive entrenchment tends to constrain decision-makers' cognitive ability in wicked learning environments. In such environments, the non-entrenched decision-makers seem better at leveraging their cognitive ability. Moreover, our studies indicate that the entrenchment effect depends on the characteristics of the domain and degrees of expertise. Therefore, an intriguing direction for future research lies in exploring the influence of cognitive entrenchment on the utilization of cognitive ability across different decision-making contexts.

## AUTHOR CONTRIBUTIONS

**Bjørn Tallak Bakken:** Conceptualization; data curation; formal analysis; investigation; methodology; project administration; resources; software; supervision; validation; visualization; writing – original draft; writing – review and editing. **Mathias Hansson:** Conceptualization; data curation; formal analysis; investigation; methodology; project administration; resources; software; supervision; validation; visualization; writing – original draft; writing – review and editing. **Thorvald Hærem:** Conceptualization; data curation; formal analysis; investigation; methodology; project administration; resources; software; supervision; validation; visualization; writing – original draft; writing – review and editing.

## ACKNOWLEDGEMENTS

We thank Professors Øyvind Lund Martinsen and Morten Nordmo for contributing to the theoretical rationale for the post-hoc analysis.

## CONFLICT OF INTEREST STATEMENT

None declared.

## DATA AVAILABILITY STATEMENT

The data for this study are available on request from the corresponding author.

## ORCID

*Bjørn Tallak Bakken* https://orcid.org/0000-0002-8800-8140

## REFERENCES

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Sage Publications.

Akinci, C., & Sadler-Smith, E. (2012). Intuition in management research: A historical review. *International Journal of Management Reviews*, *14*(1), 104–122. https://doi.org/10.1111/j.1468-2370.2011.00313.x

Akinci, C., & Sadler-Smith, E. (2013). Assessing individual differences in experiential (intuitive) and rational (analytical) cognitive styles. *International Journal of Selection and Assessment*, *21*(2), 211–221. https://doi.org/10.1111/ijsa.12030

Akinci, C., & Sadler-Smith, E. (2019). Collective intuition: Implications for improved decision making and organisational learning. *British Journal of Management*, *30*(3), 558–577. https://doi.org/10.1111/1467-8551.12269

Alaybek, B., Wang, Y., Dalal, R. S., Dubrow, S., & Boemerman, L. S. G. (2021). The relations of reflective and intuitive thinking styles with task performance: A meta-analysis. *Personnel Psychology*, *75*(2), 295–319. https://doi.org/10.1111/peps.12443

Allinson, C. W., & Hayes, J. (1996). The cognitive style index: A measure of intuition-analysis for organizational research. *Journal of Management Studies*, *33*, 119–135. https://doi.org/10.1111/j.1467-6486.1996.tb00801.x

Anderson, J. R. (1996). *The architecture of cognition, 5*. Psychology Press.

Asch, S. E. (1956). Studies of independence and conformity: I. A minority of one against a unanimous majority. *Psychological Monographs: General and Applied*, *70*(9), 1–70. https://doi.org/10.1037/h0093718

Betsch, T. (2008). The nature of intuition and its neglect in research on judgment and decision making. In H. Plessner, C. Betsch, & T. Betsch (Eds.), *Intuition in judgment and decision making* (pp. 3–22). Lawrence Erlbaum Associates.

Brehmer, B., & Dörner, D. B. (1993). Experiments with computer-simulated microworlds: Escaping both the narrow straits of the laboratory and the deep blue sea of the field study. *Computers in Human Behavior*, *9*(2–3), 171–184. https://doi.org/10.1016/0747-5632(93)90005-D

Cattell, H. E. P., & Schuerger, J. M. (2003). *Essentials of 16-PF assessment*. John Wiley & Sons, Inc.

Cattell, R. B. (1971). *Abilities: Their structure, growth, and action*. Houghton Mifflin.

Costa, P. T., & McCrae, R. R. (1992). *NEO PI-R professional manual*. Psychological Assessment Resources, Inc.

Crandall, B., Klein, G., & Hoffman, R. R. (2006). *Working minds: A practitioner's guide to cognitive task analysis*. MIT Press.

Dane, E. (2010). Reconsidering the trade-off between expertise and flexibility: A cognitive entrenchment perspective. *Academy of Management Review*, *35*(4), 579–603. https://doi.org/10.5465/AMR.2010.53502832

Dane, E., & Pratt, M. G. (2007). Exploring intuition and its role in managerial decision-making. *Academy of Management Review*, *32*(1), 33–54. https://doi.org/10.2307/20159279

Dane, E., & Pratt, M. G. (2009). Conceptualizing and measuring intuition: A review of recent trends. In G. P. Hodgkinson & J. K. Ford (Eds.), *International review of industrial and organizational psychology* (Vol. *24*). John Wiley & Sons.

Davison, R. B., Hollenbeck, J. R., Barnes, C. M., Sleesman, D. J., & Ilgen, D. R. (2012). Coordinated action in multiteam systems. *Journal of Applied Psychology*, *97*(4), 808–824. https://doi.org/10.1037/a0026682

Eisenhardt, K. M. (1989). Making fast strategic decisions in high-velocity environments. *Academy of Management Journal*, *32*(3), 543–576. https://doi.org/10.2307/256434

Epstein, S. (1990). Cognitive-experiential self-theory. In L. A. Pervin (Ed.), *Handbook of personality. Theory and research* (pp. 165–192). The Guilford Press.

Epstein, S. (2003). Cognitive-experiential self-theory of personality. In T. Millon, M. J. Lerner, & I. B. Weiner (Eds.), *Handbook of psychology, personality and social psychology* (vol. 5). John Wiley & Sons.

Evans, J. S. (2008). Dual-processing accounts of reasoning, judgment, and social cognition. *Annual Review of Psychology*, *59*, 255–278. https://doi.org/10.1146/annurev.psych.59.103006.093629

Gigerenzer, G. (2000). *Adaptive thinking: Rationality in a real world*. Oxford University Press.

Gigerenzer, G., Hertwig, R., & Pachur, T. (2011). *Heuristics: The foundations of adaptive behavior*. Oxford University Press.

Gigerenzer, G., Todd, P. M., & the ABC Research Group. (1999). *Simple heuristics that make us smart*. Oxford University Press.

Haerem, T., & Rau, D. (2007). The influence of degree of expertise and objective task complexity on perceived task complexity and performance. *Journal of Applied Psychology*, *92*(5), 1320–1331. https://doi.org/10.1037/0021-9010.92.5.1320

Haines, R. (2014). Group development in virtual teams: An experimental reexamination. *Computers in Human Behavior*, *39*, 213–222. https://doi.org/10.1016/j.chb.2014.07.019

Haines, R., & Cheney Mann, J. E. C. (2011). A new perspective on de-individuation via computer-mediated communication. *European Journal of Information Systems*, *20*(2), 156–167. https://doi.org/10.1057/ejis.2010.70

Hammond, K. R. (1996). *Human judgment and society policy: Irreducible uncertainty, inevitable error, unavoidable injustice*. Oxford University Press.

Hansson, M., Hærem, T., & Pentland, B. T. (2023). The effect of repertoire, routinization and enacted complexity: Explaining task performance through patterns of action. *Organization Studies*, *44*(3), 473–496. https://doi.org/10.1177/01708406211069438

Hart, S. G., & Staveland, L. E. (1988). Development of NASA-TLX (task load index): Results of empirical and theoretical research. *Advances in Psychology*, *52*, 139–183. https://doi.org/10.1016/S0166-4115(08)62386-9

Hodgkinson, G. P., & Clarke, I. (2007). Conceptual note: Exploring the cognitive significance of organizational strategizing: A dual-process framework and research agenda. *Human Relations*, *60*(1), 243–255. https://doi.org/10.1177/0018726707075297

Hodgkinson, G. P., & Healey, M. P. (2011). Psychological foundations of dynamic capabilities: Reflexion and reflection in strategic management. *Strategic Management Journal*, *32*(13), 1500–1516. https://doi.org/10.1002/smj.964

Hodgkinson, G. P., Langan-Fox, J., & Sadler-Smith, E. (2008). Intuition: A fundamental bridging construct in the behavioural sciences. *British Journal of Psychology*, *99*(1), 1–27. https://doi.org/10.1348/000712607X216666

Hodgkinson, G. P., & Sadler-Smith, E. (2003a). Complex or unitary? A critique and empirical re-assessment of the Allinson-Hayes cognitive style index. *Journal of Occupational and Organizational Psychology*, *76*(2), 243–268. https://doi.org/10.1348/096317903765913722

Hodgkinson, G. P., & Sadler-Smith, E. (2003b). Reflections on reflections on the nature of intuition, analysis and the construct validity of the cognitive style index. *Journal of Occupational and Organizational Psychology*, *76*(2), 279–281. https://doi.org/10.1348/096317903765913740

Hodgkinson, G. P., & Sadler-Smith, E. (2018). The dynamics of intuition and analysis in managerial and organizational decision making. *Academy of Management Perspectives*, *32*(4), 473–492. https://doi.org/10.5465/amp.2016.0140

Hodgkinson, G. P., Sadler-Smith, E., Burke, L. A., Claxton, G., & Sparrow, P. R. (2009). Intuition in organizations: Implications for strategic management. *Long Range Planning*, *42*, 277–297. https://doi.org/10.1016/j.lrp.2009.05.003

Hodgkinson, G. P., Sadler-Smith, E., Sinclair, M., & Ashkanasy, N. M. (2009). More than meets the eye? Intuition and analysis revisited. *Personality and Individual Differences*, *47*(4), 342–346. https://doi.org/10.1016/j.paid.2009.03.025

Hogarth, R. M. (2001). *Educating intuition*. The University of Chicago Press.

Hogarth, R. M., Lejarraga, T., & Soyer, E. (2015). The two settings of kind and wicked learning environments. *Current Directions in Psychological Science*, *24*(5), 379–385. https://doi.org/10.1177/0963721415591878

Hollenbeck, J. R., Moon, H., Ellis, A. P. J., West, B. J., Ilgen, D. R., Sheppard, L., Porter, C. O. L. H., & Wagner, J. A. (2002). Structural contingency theory and individual differences. *Journal of Applied Psychology*, *87*(3), 599–606. https://doi.org/10.1037/0021-9010.87.3.599

Janis, I. L. (1971). Groupthink. *Psychology Today*, *5*(6), 43–46, 74–76.

Johnson, P. O., & Neyman, J. (1936). Tests of certain linear hypotheses and their application to some educational problems. *Statistical Research Memoirs*, *1*, 57–93.

Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus & Giroux.

Kahneman, D., & Klein, G. (2009). Conditions for intuitive expertise: A failure to disagree. *American Psychologist*, *64*(6), 515–526. https://doi.org/10.1037/a0016755

Klein, G. (1997). The recognition-primed decision (RPD) model: Looking back, looking forward. In C. E. Zsambok & G. Klein (Eds.), *Naturalistic decision making* (pp. 285–292). Lawrence Erlbaum Associates, Incorp.

Klein, G. (1998). *Sources of power: How people make decisions*. The MIT Press.

Klein, G. (2003). *Intuition at work*. Doubleday Publishing.

Klein, G. (2008). Naturalistic decision making. *Human Factors*, *50*(3), 456–460. https://doi.org/10.1518/001872008X288385

Kozlowski, S. W., & Ilgen, D. R. (2006). Enhancing the effectiveness of work groups and teams. *Psychological Science in the Public Interest*, *7*(3), 77–124. https://doi.org/10.1111/j.1529-1006.2006.00030.x

Langley, A. (1995). Between "paralysis by analysis" and "extinction by instinct". *Sloan Management Review*, *36*, 63–76. https://doi.org/10.1016/0024-6301(95)94294-9

Le, H., Oh, I. S., Robbins, S. B., Ilies, R., Holland, E., & Westrick, P. (2011). Too much of a good thing: Curvilinear relationships between personality traits and job performance. *Journal of Applied Psychology*, *96*(1), 113–133. https://doi.org/10.1037/a0021016

Louis, M. R., & Sutton, R. I. (1991). Switching cognitive gears: From habits of mind to active thinking. *Human Relations*, *44*(1), 55–76. https://doi.org/10.1177/001872679104400104

Luchins, A. S. (1942). Mechanization in problem solving: The effect of Einstellung. *Psychological Monographs*, *54*(6), i–95. https://doi.org/10.1037/h0093502

Martinsen, Ø. L., Kaufmann, G., & Furnham, A. (2020). Cognitive style. In M. Runco & S. Pritzker (Eds.), *Encyclopedia of creativity* (3rd ed., pp. 154–160). Elsevier, Academic Press.

Messick, S. (1976). Personality consistencies in cognition and creativity. In S. Messick (Ed.), *Individuality in learning* (pp. 4–23). Jossey-Bass.

Messick, S. (1984). The nature of cognitive styles: Problems and promise in educational practice. *Educational Psychologist*, *19*(2), 59–74. https://doi.org/10.1080/00461528409529283

Norris, P., & Epstein, S. (2011). An experiential thinking style: Its facets and relations with objective and subjective criterion measures. *Journal of Personality*, *79*(5), 1043–1079. https://doi.org/10.1111/j.1467-6494.2011.00718.x

Nunnally, C. J., & Bernstein, H. I. (1994). *Psychometric theory* (3rd ed.). McGraw-Hill Inc.

Okoli, J. O., & Watt, J. (2018). Crisis decision-making: The overlap between intuitive and analytical strategies. *Management Decision*, *56*(5), 1122–1134. https://doi.org/10.1108/MD-04-2017-0333

OPP Ltd. (1994). *An introduction to the 16PF5 questionnaire*. OPP Ltd.

Pacini, R., & Epstein, S. (1999). The relation of rational and experiential information processing styles to personality, basic beliefs, and the ratio-bias phenomenon. *Journal of Personality and Social Psychology*, *76*(6), 972–987. https://doi.org/10.1037/0022-3514.76.6.972

Postmes, T., Spears, R., & Lea, M. (1998). Breaching or building social boundaries?: Side-effects of computer-mediated communication. *Communication Research*, *25*(6), 689–715. https://doi.org/10.1177/009365098025006006

Pretz, J. E. (2008). Intuition versus analysis: Strategy and experience in complex everyday problem solving. *Memory and Cognition*, *36*(3), 554–566. https://doi.org/10.3758/MC.36.3.554

Pretz, J. E. (2011). Types of intuition: Inferential and holistic. In M. Sinclair (Ed.), *Handbook of intuition research* (pp. 17–27). Edward Elgar Publishing.

Pretz, J. E., & Totz, K. S. (2007). Measuring individual differences in affective, heuristic, and holistic intuition. *Personality and Individual Differences*, *43*(5), 1247–1257. https://doi.org/10.1016/j.paid.2007.03.015

Prime, N. J., & Le Masurier, S. B. (2000). Defining how we think: An investigation of decision making processes in diagnostic radiographers using the "think aloud" technique. *Radiography*, *6*(3), 169–178. https://doi.org/10.1053/radi.2000.0244

Rudolph, J. W., Morrison, J. B., & Carroll, J. S. (2009). The dynamics of action-oriented problem solving: Linking interpretation and choice. *Academy of Management Review*, *34*(4), 733–756. https://www.jstor.org/stable/27760034

Salas, E., & Klein, G. (2001). *Linking expertise and naturalistic decision making*. Lawrence Erlbaum Associates.

Shiloh, S., Salton, E., & Sharabi, D. (2002). Individual differences in rational and intuitive thinking styles as predictors of heuristic responses and framing effects. *Personality and Individual Differences*, *32*(3), 415–429. https://doi.org/10.1016/S0191-8869(01)00034-4

Snijders, T. A., & Bosker, R. J. (2011). *Multilevel analysis: An introduction to basic and advanced multilevel modeling*. Sage.

Soll, J. B., Milkman, K. L., & Payne, J. W. (2015). A user's guide to debiasing. In G. Keren & G. Wu (Eds.), *The Wiley Blackwell handbook of judgment and decision making* (pp. 924–951). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781118468333.ch33

Stanovich, K. (1999). *Who is rational? Studies of individual differences in reasoning*. Lawrence Earlbaum Associates.

Stanovich, K. E., & West, R. E. (2000). Individual differences in reasoning: Implications for the rationality debate? *Behavioral and Brain Sciences*, *23*, 645–726. https://doi.org/10.1017/S0140525X00003435

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

Tversky, A. & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science*, *211*(4481), 453–458. https://doi.org/10.1126/science.7455683

Wolin, S. S. (1960). *Politics and vision: Continuity and innovation in western political thought*. Princeton University Press.

Wood, R. E. (1986). Task complexity: Definition of the construct. *Organisational Behavior and Human Decision Processes*, *37*(1), 60–82. https://doi.org/10.1016/0749-5978(86)90044-0

**How to cite this article:** Bakken, B. T., Hansson, M., & Hærem, T. (2024). Challenging the doctrine of "non-discerning" decision-making: Investigating the interaction effects of cognitive styles. *Journal of Occupational and Organizational Psychology*, *97*, 209–232. https://doi.org/10.1111/joop.12467