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Finding a road less traveled: Combining analysis and intuition to develop novel problem formulations

Chan Hyung Park

Chair of Strategic Management and Innovation, ETH Zurich, Zurich, Switzerland

Correspondence
Chan Hyung Park, Chair of Strategic Management and Innovation, ETH Zurich, 8092 Zurich, Switzerland.
Email: chpark@ethz.ch

Abstract

Research Summary: Novel formulations of strategic problems are key to innovation and exploration. Conventional wisdom suggests that intuitive thinking, rather than rational-analytic thinking, facilitates novel problem formulations. This article proposes that intuitive thinking is insufficient and that novel formulations instead depend on sequencing rational-analytic and intuitive thinking across two phases of the problem formulation task. Two experiments using samples of strategists in organizations support the importance of analysis followed by intuition when developing novel problem formulations. This article advances the "both-and" approach to managerial cognition by investigating how harnessing intuition and analysis in combination may lead to a desirable outcome for a managerial task. This approach moves beyond the typical, "either-or" approach to cognition in past studies, which pit analysis against intuition in achieving desirable outcomes.

Managerial Summary: Unique and potentially contrarian theories on problems—novel problem formulations—are key to innovation, exploration, and value creation. Past research indicates that strategists should rely on intuition and gut feeling rather than

analysis to boldly develop novel problem formulations. I propose that intuition alone can lead to premature, obvious conclusions. This article instead claims that novel formulations depend on combining analysis and intuition in a specific sequence. Analysis helps identify hidden needs and pain points that allow strategists to think of diverse possibilities for underlying causes. Intuition helps strategists boldly utilize these ambiguous, unstructured symptoms based on subjective beliefs to develop novel problem formulations. Two experiments with real-world strategists support the arguments.

KEYWORDS

behavioral strategy, exploration, knowledge creation, problem formulation, theory-based view

1 | INTRODUCTION

Novel formulations of strategically important problems are vital for exploration and innovation to build competitive advantages (Casson, 1982; Felin & Zenger, 2009, 2017; Nickerson et al., 2007; Nickerson & Argyres, 2018). Novel problem formulations are uncommon judgments or "theories" on potential causes based on available symptoms of problems—observable deviations from expectations (Baer et al., 2013; Felin & Zenger, 2009; Park & Baer, 2022). Even when strategists face the same problems and are in the same problem spaces, those with novel problem formulations are more likely to avoid exploitation of the same resources and strategies that other strategists use and explore new possibilities in creating value (Felin et al., 2021; March, 1991; Patvardhan & Ramachandran, 2020; Posen et al., 2018).

Conventional wisdom indicates that intuitive thinking—the associative, affective, and experiential form of thinking (Dane & Pratt, 2007)—is the foundation for novel formulations of strategically important problems (Alvarez & Porac, 2020; Keynes, 1937; Knight, 1921; Nickerson et al., 2007). Managerial cognition research indicates that intuitive thinking allows individuals to draw upon their idiosyncratic experiences, beliefs, and values to entertain diverse possibilities and make unexpected judgments (Dane & Pratt, 2007, 2009), such as novel problem formulations. However, meta-analyses from psychology (Phillips et al., 2016) and managerial cognition (Alaybek et al., 2022) do not substantiate this conventional view. An important reason is that intuitive thinking encourages framing biases (e.g., representative or recency biases) (Phillips et al., 2016). These biases lead individuals to focus on a narrow set of information cues (symptoms) and jump to immediate, obvious conclusions (formulations). Indeed, past research indicates that novel problem formulations depend on finding distant—hidden and often overlooked—symptoms (Gary et al., 2012; Gavetti et al., 2005; Grimes & Vogus, 2021; Nickerson & Argyres, 2018). In managerial contexts, strategists typically attend to symptoms based on repeatedly used, explicit, and often quantitative market indicators and performance measures. Distant symptoms based on implicit, experiential, and affective cues allow strategists

to "see" what other strategists do not and prime strategists to think of diverse possibilities (Casson, 1982; Cummings & Nickerson, 2021; Nonaka, 1994). Framing biases reduce the likelihood that strategists identify distant symptoms and, by extension, develop novel problem formulations.

In this article, I propose that strategists can harness rational-analytic and intuitive thinking in combination to increase the likelihood of developing novel problem formulations. Given the link between intuitive thinking and framing biases, I posit that rational-analytic thinking—the logical, systematic, and effortful form of thinking (Epstein et al., 1996)—may be beneficial in identifying distant symptoms. Indeed, rational-analytic thinking is related to delaying premature conclusions and conducting a thorough information search (Epstein, 2008, 2010). Nevertheless, the identification of distant symptoms is just a step toward developing novel problem formulations, which depend on two interdependent but distinct phases: attention allocation and judgment (Baer et al., 2013; Brunswik, 1952; Gigerenzer et al., 1991). During the attention allocation phase, strategists focus on their problem spaces to identify relevant symptoms of problems. During the subsequent judgment phase, strategists select subsets of symptoms they believe to be important from the pool of identified symptoms to theorize potential causes (Csaszar, 2018; Nickerson et al., 2012). Novel problem formulations depend not only on identifying and being aware of distant symptoms, but also on utilizing them when forming judgments.

I propose that, once distant symptoms are found, intuitive thinking rather than rational-analytic thinking is beneficial in utilizing them during the judgment phase to facilitate novel problem formulations. Rational-analytic thinking encourages individuals to seek logical, "right" judgments based on formal logic and evidence (Epstein et al., 1996). Rational-analytic thinking is thus related to filtering out ambiguous cues (e.g., distant symptoms) that do not fit into formal, explicit, and established models (Jordan et al., 2007; Pailhès & Kuhn, 2021). Intuitive thinking underpins affective, experiential processes such as associations, metaphors, and analogies (Dane & Pratt, 2007). These processes prioritize cues with affective and experiential characteristics that "fit" intuitive (affective and experiential) processes (Dane & Pratt, 2009; Epstein, 2008, 2010). Once distant symptoms are identified, strategists reliant on intuitive thinking may thus gravitate toward these symptoms that may trigger associations with analogous problems or past events to develop idiosyncratic problem formulations.

Synthesizing the arguments above, this article offers an informed intuition model. The central claim of this model is that rational-analytic thinking during the attention allocation phase increases the likelihood of finding distant symptoms; these symptoms feed into and inform intuitive thinking to facilitate novel problem formulations during the judgment phase. Two experiments based on samples of entrepreneurs, executives, and managers support the model. In the studies, strategists reliant on rational-analytic thinking during the attention allocation phase and intuitive thinking during the judgment phase formulated problems with greater novelty than other strategists.

This article contributes to managerial cognition research. The informed intuition model suggests that the conventional wisdom on intuitive thinking may not be wrong. Instead, the predominant "either-or" approach to managerial cognition may be. Most studies in management and psychology pit rational-analytic thinking against intuitive thinking in achieving desirable outcomes in managerial tasks (e.g., System I versus System II thinking) (Kahneman, 2011; Phillips et al., 2016). However, managerial tasks are often complex and depend on multiple, interdependent phases or steps (Laureiro-Martínez et al., 2023; Simon, 1987). Given that each phase may benefit from different cognitive processes, effective outcomes in managerial settings

could hinge on matching different forms of cognition for specific phases of tasks. This article focuses on one particular task. Nevertheless, the current research opens up new questions on how analysis and intuition can be harnessed in combination to achieve desired outcomes in other managerial contexts, advancing the "both-and" approach to managerial cognition (Hodgkinson & Sadler-Smith, 2018).

Moreover, this article provides insights into the early stages of knowledge creation and exploration by identifying cognitive microfoundations of novel problem formulations. These insights contribute to the knowledge-based view of the firm (the problem-solving perspective, Nickerson & Zenger, 2004; Pereira & Bamel, 2021), entrepreneurship (the theory-based view, Ehrig & Schmidt, 2022; Felin & Zenger, 2009, 2017; Zellweger & Zenger, 2022), and behavioral strategy (organizational learning and problemistic search, Csaszar & Levinthal, 2016; Joseph & Gaba, 2020; Posen et al., 2018). In these streams of research, novel problem formulations are critical for exploration, knowledge creation, and entrepreneurial value creation.

2 | THEORY

2.1 | Novel problem formulations

Novel formulations of strategically important problems—idiosyncratic judgments or "theories" on their potential causes—are key to exploration, innovation, and value creation (Felin & Zenger, 2009; Nickerson et al., 2007; Posen et al., 2018). Assuming that strategists have identified a specific problem space they want to search, the process of developing judgments or formulations involves two phases: identifying information cues about a phenomenon (attention allocation phase) and utilizing them to reach a conclusion (judgment phase) (Brunswik, 1952; Csaszar, 2018; Csaszar & Laureiro-Martínez, 2018; Csaszar & Ostler, 2020; Gigerenzer et al., 1991). The attention allocation phase involves identifying observable symptoms that together characterize the problem (Csaszar, 2018). Since strategically important problems are often ill-structured and unfamiliar to strategists, strategists rely on the symptoms to understand the problem space (Nickerson & Argyres, 2018). During the subsequent judgment phase, strategists select subsets of symptoms they view to be important and utilize them to theorize potential causes (Baer et al., 2013). Two critical conditions for novel problem formulations are finding hidden, distant symptoms that other strategists overlook and utilizing them to form judgments on novel potential causes (Felin et al., 2021; Felin & Zenger, 2009, 2017). Strategists who "see" symptoms that other strategists overlook can entertain and imagine novel possibilities. If they also utilize these symptoms to reach conclusions and form judgments, they develop novel problem formulations. Such formulations enable strategists to then explore unexpected or contrarian possibilities even when they and other strategists are in the same problem spaces (Posen et al., 2018).

Common, obvious problem formulations can be efficient and useful when the problems are routine and solutions are predictable (Gigerenzer & Gaissmaier, 2011; Kahneman & Klein, 2009). However, common problem formulations typically lead people to form responses to problems that align with the majority and existing models. These responses thus tend to result in inflexible, exploitative solutions with incremental improvements in novelty and usefulness (Christensen et al., 2016; Cornelissen & Werner, 2014; Felin et al., 2019). After reviewing research related to problemistic search, organizational learning, and innovation, Posen et al. (2018, p. 237) thus concluded that they "consider organizational action as exploratory, not

TABLE 1 Key terms and definitions.

Construct	Definition
Symptoms	Information cues that deviate from expectations (Cyert & March, 1963)
Problem formulation	Judgments or theories on potential causes based on identified symptoms of problems (Felin & Zenger, 2009; Nickerson & Argyres, 2018; Park & Baer, 2022).
Rational-analytic thinking	Conscious, logical, and effortful form of thinking (Epstein et al., 1996)
Intuitive thinking	Experiential, unconscious, and associative form of thinking (Epstein et al., 1996)
Identification of distant symptoms	Identifying often overlooked or hidden symptoms (Nickerson et al., 2007; Shin & Grant, 2021)

on the basis of solution novelty, but rather, on the basis of the novelty of the problem [formulation]." Many practitioners (e.g., entrepreneurs and venture capitalists) have also embraced the value of novel problem formulations in driving innovation and entrepreneurial value creation (Kupor, 2019; Tamaseb, 2021; Thiel & Masters, 2014). Table 1 contains definitions of key terms in this article.

If strategists have complete information, knowledge, and time, they can comprehensively formulate their problems by identifying most of the relevant causes and then diagnose central root causes to develop optimal solutions (Csaszar & Ostler, 2020; Gavetti et al., 2012; Park & Baer, 2022). However, strategically important problems often come with knowledge and time constraints (Nickerson & Argyres, 2018). Strategists who attempt to be comprehensive may seek and wait for valid models to find the "right," root causes and avoid missing relevant causes (Alvarez & Porac, 2020; March, 2006). These models emerge after other strategists have repeatedly and successfully solved the problems to prove the models (Cornelissen & Werner, 2014; von Krogh et al., 2000). Therefore, pursuing comprehensiveness may reduce the likelihood of exploration and innovation (Keynes, 1937).

One example demonstrating the value of novel problem formulations is the story of Jim McKelvey, co-founder of Block (formerly called Square). He identified a problem when he experienced difficulty accepting credit card payments while working as a small-scale glassblower in the United States. These payments had to go through existing financial transaction platforms that demanded high fees, which small merchants could not easily accommodate. Most small-scale merchants who experienced the pain point immediately formulated the problem as a result of their limited financial resources to pay for the fees. In contrast, McKelvey analyzed the problem further and found that Visa and MasterCard designed their fee structures for large organizations with low fraud rates, strong credits, and reliable and large transaction volumes. The structures thus penalized small-scale merchants who did not meet the criteria. McKelvey used the symptoms to formulate his problem as the result of lacking financial transaction systems optimized for small-scale merchants. He then founded Block with Jack Dorsey to build one such system (McKelvey, 2020).

2.2 | Extant research on the origins of novel problem formulations

How can strategists develop novel problem formulations? The conventional wisdom among scholars is that intuitive thinking is beneficial under information and time constraints,

particularly when strategists are trying to generate outcomes with novelty (Alvarez & Porac, 2020; Dane & Pratt, 2009; Knight, 1921). Researchers tend to divide human cognition into two forms: rational-analytic and intuitive thinking (e.g., James, 1997; Lieberman, 2007; Petty & Cacioppo, 1986; Sloman, 1996; Strack & Deutsch, 2004). Rational-analytic thinking is effortful, conscious, and logical, while intuitive thinking is unconscious, associative, affective, and experiential (Epstein et al., 1996).[1] Psychology and management scholars typically view strategists as relying on either rational-analytic or intuitive thinking for different tasks (Blattberg & Hoch, 1990; Hall et al., 2015; Louis & Sutton, 1991). Rational-analytic thinking is often related to superior performance in numerical analysis and complex decision-making when relevant information and models are available or can be found. Intuitive thinking enables individuals to rely on idiosyncratic beliefs and values to entertain novel possibilities and act despite incomplete information and without logical proof (Dane & Pratt, 2007; Epstein, 2010).

Despite the widely accepted link between intuitive thinking and novelty, large-scale meta-analyses from psychology (Phillips et al., 2016) and management (Alaybek et al., 2022) did not substantiate this relationship. Empirically, intuitive thinking had an overall null effect on the novelty of judgments or ideas. An important reason for this counterintuitive result is that intuitive thinking is affective and compels individuals to reach conclusions quickly, encouraging framing biases (Phillips et al., 2016). Framing biases include representative bias (focusing on obvious cues), recency bias (focusing on the most recently observed cues), and anchoring bias (focusing on the first cues) (Tversky & Kahneman, 1974). These biases lead individuals to quickly conclude their information search after attending to a narrow set of apparent cues and jump to obvious conclusions.

These biases would reduce the likelihood that strategists would identify distant symptoms of strategic problems, which are essential for novel problem formulations. In managerial settings, strategists first observe obvious symptoms such as deviations in explicit performance indicators (e.g., equity ratio, cash flow, sales) that are readily available, familiar, and widely used (Felin & Zenger, 2017; Grimes & Vogus, 2021). Whereas these symptoms tend to be explicit, quantitative, and based on familiar indicators or measures, distant symptoms tend to be implicit, experiential, and affective (Nickerson et al., 2007; Nonaka & von Krogh, 2009). As these symptoms may require strategists to experience the problems directly, interact with individuals who experience them, or reflect on their feelings, many strategists do not identify them. Precisely because most strategists do not find them, however, these symptoms allow strategists to see what other strategists do not and reach idiosyncratic judgments (Casson, 1982; Felin et al., 2021; Shin & Grant, 2021). Framing biases would reduce the likelihood of identifying these symptoms, thereby encouraging obvious conclusions based on widely known indicators and models.

Experimental evidence also indicates that strategists who rely on the same information likely form consensus and common conclusions (Csaszar & Laureiro-Martínez, 2018). Organizational studies and psychology research instead link broad attention toward diverse

[1]Cognitive scholars tend to follow either the default-interventionist or parallel-competitive view of cognition. The former view posits that intuitive thinking is the default mode of thinking and rational-analytic thinking needs to intervene in intuitive thinking for some tasks (e.g., Evans, 2008; Kahneman, 2011). The parallel-competitive model posits that the two modes of cognition are active at the same time, but what is relatively more activated and dominant guides actions and behaviors. Recent empirical research indicates that the latter view is a more realistic representation of cognition (Alaybek et al., 2022; Dane et al., 2011; Phillips et al., 2016; Pretz, 2008). I take the parallel-competitive view in this paper. When I mention that strategists "rely on" or "use" one form of thinking, I mean that one form of thinking is more strongly activated than the other. In theory and studies, I do not assume that individuals rely on intuitive thinking by default.

information cues to novel solutions (Baer et al., 2021; Dane & Pratt, 2009; Shin & Grant, 2021). Qualitative and experimental studies in strategic decision-making contexts also indicate that identifying distant information cues is critical in forming uncommon strategies for managerial problems (Calabretta et al., 2017; Gary et al., 2012).

2.3 | Informed intuition model

Past research summarized above indicates that novel problem formulations depend on distant symptoms, but intuitive thinking would not help identify them. Building on this baseline, I propose that rational-analytic thinking increases the likelihood that strategists identify distant symptoms. Rational-analytic thinking counteracts framing biases by delaying conclusions and encouraging more extensive, thorough, and effortful information searches (Phillips et al., 2016). Lab experiments found that rational-analytic thinking led individuals to seek more diverse information sources compared to intuitive thinking (De Grada et al., 1999; Godek & Murray, 2008). Similarly, a negotiation study found that individuals who engaged in rational-analytic thinking did not follow obvious decision heuristics (e.g., divide by half) as individuals engaged in intuitive thinking did. Instead, rational-analytic thinking led the participants to reflect on available information and uncover the hidden needs of their counterparties (Ten Velden et al., 2010). Furthermore, psychology experiments reported that rational-analytic thinking rather than intuitive thinking increased the likelihood that individuals reject readily available but inadequate views to develop independent opinions (Amit & Sagiv, 2013; De Dreu, 2003; Kruglanski, 1989; Livi et al., 2015). Finally, experimental and survey-based studies by management scholars revealed that careful attention to and systematic analysis of problems were key to the identification of often overlooked but relevant information (Baer et al., 2021; Laureiro-Martínez & Brusoni, 2018; Shin & Grant, 2021). The set of findings indicates that rational-analytic thinking would lead to deliberate attention toward difficult-to-identify but pertinent information cues, such as distant symptoms.

> **Hypothesis 1.** Rational-analytic thinking rather than intuitive thinking during the attention allocation phase is positively related to the identification of distant symptoms.

Although the meta-analyses (Alaybek et al., 2022; Phillips et al., 2016) failed to substantiate the link between intuitive thinking and novelty, I propose that intuitive thinking still has a place in developing novel problem formulations once distant symptoms are identified. Given that the process of developing problem formulations entails attention allocation and judgment phases, identifying and being aware of distant symptoms is insufficient for novel problem formulations. Strategists also need to utilize them when formulating problems during the judgment phase. I posit that the cautious, careful nature of rational-analytic thinking may help identify distant symptoms but also result in filtering out these symptoms when making judgments. Strategists reliant on rational-analytic thinking tend to make judgments based on formal, validated models with explicit and established logic that can be justified to other stakeholders (Benner & Tripsas, 2012; Grimes & Vogus, 2021; Townsend et al., 2018). This process leads individuals to consciously focus on factual, quantitative, and validated information rather than opinions, feelings, or other ambiguous cues (Epstein, 2010; Park & Baer, 2022) such as distant symptoms.

In contrast, intuitive thinking may empower individuals to leverage their subjective experiences, beliefs, and values to utilize distant symptoms. Intuitive thinking prioritizes affective, experiential cues that "fit" intuitive—experiential, affective—processes (Damasio, 1994;

Epstein, 2008). Intuitive thinking relies on these cues to form associations, metaphors, and analogies that are rooted in subjective feelings and beliefs that events at hand and events from the past are similar (Damasio, 1994; Dane & Pratt, 2007; Knight, 1921). These associative processes allow strategists to form novel syntheses and entertain new possibilities more flexibly when events or experiences do not have logical links (Dijksterhuis & Nordgren, 2006; Zhong et al., 2008). Strategists reliant on intuitive thinking are thus likely to focus on symptoms that evoke affective responses or associations with past experiences or events rather than on quantitative indicators to run formal, precise analyses.

Psychology experiments support this view, highlighting that intuitive thinking increases reliance on implicit beliefs compared to rational-analytic thinking (Jordan et al., 2007; Pailhès & Kuhn, 2021). Neuroscience research also reported that individuals whose brain regions related to intuitive thinking were damaged could not make decisions based on ambiguous information (Damasio, 1994). The evidence thus suggests that intuitive thinking may be critical in utilizing distant symptoms. Simulation studies in management have also found that strategists responded to novel challenges (with limited information) more adaptively if they relied on analogies and associations (Gavetti et al., 2005). In contrast, field data from sources ranging from NASA to healthcare hackathons supports the view that innovators who favor formal, structured models often generate incremental, exploitive strategies and solutions (Christensen et al., 2016; Lifshitz-Assaf, 2018; Park et al., 2023).

A potential concern for intuitive thinking in strategic contexts is that the form of thinking is often related to biased judgments. I submit that (framing) biases can indeed be problematic during the attention allocation phase, wherein they can hinder strategists' ability to identify a broad range of relevant information cues. Even during the judgment phase, if the goal is to find the "right" and rational answers that other stakeholders can understand and accept, strategists may benefit from rational-analytic rather than intuitive thinking (De Dreu, 2003; Epstein et al., 1996; Livi et al., 2015). However, strategists looking to explore benefit from introducing their personal beliefs or values at some point, because following the established, widely known, rational paths would likely lead to exploitation (Alvarez & Porac, 2020; Knight, 1921; March, 2006). When strategists have identified distant symptoms and aim to develop novel problem formulations, I maintain that biases and idiosyncrasies are beneficial rather than detrimental during the judgment phase. Table 2 summarizes the roles of rational-analytic and intuitive thinking during the attention allocation and judgment phases. Figure 1 illustrates the hypotheses of this article.

> **Hypothesis 2.** Intuitive thinking during the judgment phase moderates the positive relationship between distant symptom identification and novelty of problem formulation, such that the relationship is stronger when strategists rely on intuitive thinking.

TABLE 2 Effects of intuitive and rational-analytic thinking on attention allocation and theorization phases.

Phase	Intuitive thinking	Rational-analytic thinking
Attention allocation	Encourage framing biases	Avoid framing biases
Judgment	Judgment based on subjective beliefs and values	Judgment based on formal, structured, and explicit models

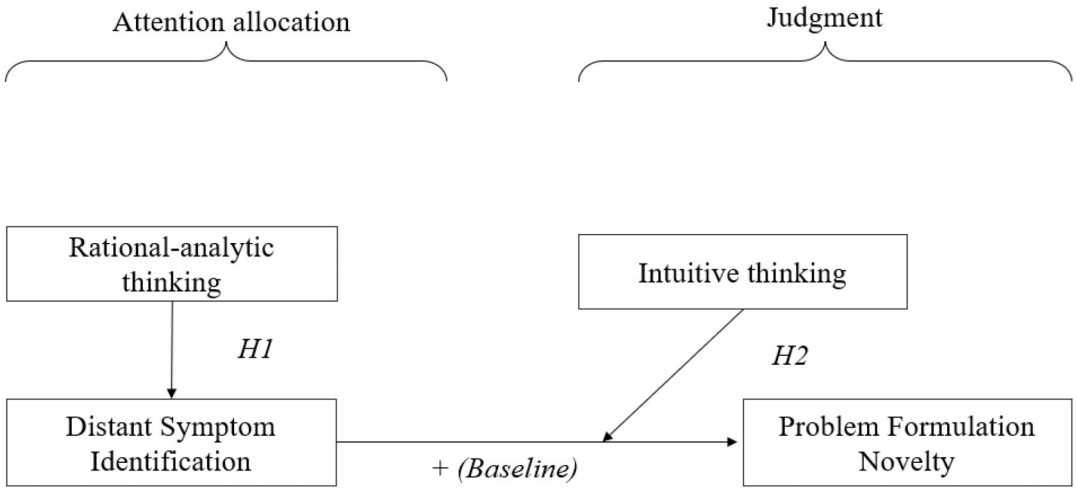

FIGURE 1 Summary of model and hypotheses.

Summarizing the hypotheses above, this article offers the informed intuition model. The central claim of the model is that rational-analytic thinking during attention allocation helps identify distant symptoms; these distant symptoms may feed into and inform intuitive thinking during the judgment phase to facilitate novel problem formulations. Rather than pitting one form of cognition against the other, this model examines how and why a combination of rational-analytic and intuitive thinking may lead to outcomes that may not be likely with only rational-analytic or intuitive thinking. This "both-and" approach may help reconcile the conventional wisdom on the value of intuitive thinking in driving novelty with the conflicting results from the meta-analyses. The conventional wisdom may be a result of selective attention toward cases in which individuals have identified distant information cues before they relied on intuitive thinking to make judgments. Indeed, studies that directly ask research participants to rely on intuitive or rational-analytic thinking tended to find that intuitive thinking leads to obvious responses (e.g., Newstead et al., 2002; Raab & Laborde, 2011). In comparison, past studies that suggest a positive relationship between intuitive thinking and novelty typically examine subjects who have already identified distant and diverse information cues before they relied on intuitive thinking to make judgments (Dane & Pratt, 2009; Huang & Pearce, 2015).

3 | STUDY 1: METHODS

3.1 | Sample, design, and procedures

Study 1 is a randomized field experiment held during an idea incubation program for entrepreneurs and firm executives in the consumer sector (*Mean* of Age = 37.84, Female = 26%; $N = 167$[2]). Study 1 used a 2×2 between-subject experiment design, in which I manipulated cognition (either rational-analytic or intuitive) during the attention allocation and judgment

[2]Power analysis for an experiment with four conditions given a medium effect size (Cohen's $f = 0.25$), a power of 0.80, and a significance level of 0.05 reported that I need around 39 subjects per condition, or 156 in total.

phases. Most participants were primary decision-makers in firms that sold products and services on online platforms like Taobao. The incubation training program was designed to help strategists find and solve new problems and opportunities to create value and profit. Such accelerative idea generation and problem-solving programs have become popular and important among practitioners and scholars (e.g., Hallen et al., 2020).

I conducted Study 1 over the first 2 days at the conference so the participants could have the time to identify distant symptoms. I sent out the Qualtrics link to the experiment materials on the first day of the conference, when the attendees registered and settled down for the conference. The link contained the instructions for the attention allocation phase and the materials to manipulate cognition. Then, I sent out the content for the judgment phase and corresponding manipulations early the next day. This design limits the influence of conference lectures and sessions on the participants' answers, which officially started after the participants filled out the experiment materials for problem formulation. Strategists in this study were eager to identify new problems to be solved and willing to engage in the experiment materials, which the conference organizer emphasized as crucial in increasing the value they would gain from the conference.

3.1.1 | Tasks and manipulation

The instruction for attention allocation asked the participants to identify potential customers' needs and pain points, which are symptoms of the customers' problems. The instruction for judgment asked the strategists to identify underlying causes. The actual instructions were the following:

Attention allocation: Often, important opportunities come from finding and solving needs or pain points that other people neglect and do not solve. Please think about needs or pain points (indicators of underlying problems) that you have come across in recent years, but existing products and services do not solve...These needs or pain points can be within or outside your industry, and you may not know what the solutions should be. What were the pain points or needs, who were experiencing them, and when...?

Judgment: Yesterday, you wrote down the needs or pain points that you have observed but existing products and services were yet to resolve. *Today*, *please explain what may be causing the needs and pain points*.

Consistent with previous research, the manipulations of cognition relied on formal instructions (Dane et al., 2011; Dane & Pratt, 2007). Each participant underwent two manipulations (after the attention allocation instruction and then after the judgment instruction).

Rational-analytic thinking (attention allocation): Please think analytically and rationally when answering the questions. Provide logical arguments and/or concrete evidence to support your answers. Please do not make judgments relying on your intuition.

Intuitive thinking (attention allocation): Please rely on your gut feelings to answer the questions. Use your intuition and write down what *you* personally feel is the right answer. Please do not search for logical, rational explanations for your answer.

Rational-analytic thinking (judgment): Please use logic to formulate the needs or pain points. Provide logical arguments and/or concrete evidence to support your answers. Please do not make judgments relying on your intuition.

Intuitive thinking (judgment): Please rely on your gut feeling to formulate the needs or pain points. Use your intuition and write down what *you* personally feel is the right answer. Please do not search for logical, rational explanations for your answer.

Since the informed intuition model focuses on the role of rational-analytic thinking during attention allocation and intuitive thinking during judgment, I created categorical variables, Analytic Attention (1 if in the rational-analytic thinking condition during attention allocation), and Intuitive Judgment (1 if in the intuition condition during judgment).

3.2 | Measures

3.2.1 | Identification of distant symptoms

Two coders familiar with the industry evaluated the degree to which distant symptoms were identified during the attention allocation phase from a Likert scale of 1 = *only common symptoms* to 5 = *included highly uncommon, distant symptoms* (ICC(1) for agreement = .82, ICC(2) for reliability = .90). Each coder had more than a decade of experience organizing and supervising acceleration programs targeted toward strategists in the consumer sector. Given the high convergence in evaluation, the final measure, Distant Symptoms, was based on the average of the coders' ratings.

One example of distant symptom identification is the following. An executive analyzed the high cost of advertising on Taobao, which ranked search results for consumers based on how much the firms paid. This system resulted in price competition among firms and continuous increases in the price of advertisements. Rather than only looking at the increasing advertisement cost, the executive interviewed his customers on Taobao and learned that they relied on the search rankings because they could not otherwise trust the products' quality—a distant symptom that other merchants overlooked.

3.2.2 | Manipulation checks

I added manipulation check questions after the attention allocation and judgment phases. The questions used existing scales from Novak and Hoffman (2009). The scales started with the following sentences: "Please answer the following questions. When finding the pain points and framing them..." The measures of rational-analytic thinking depended on the answers to the following: "I reasoned things out carefully," "I approached the task analytically," and "I arrived at my answer by carefully assessing the information" (Cronbach's alphas after the attention allocation and judgment phases = .76 and .81). The measures of intuitive thinking relied on the answers to the following: "I relied on my sense of intuition," "I used my gut feelings," and "I trusted my hunches" (Cronbach's alphas after the attention allocation and judgment phases = .86 and .71). The scales ranged from 1 = *Strongly Disagree* to 5 = *Strongly Agree* for all measures. I averaged the responses to the questions to form the final measures of cognition.

3.2.3 | Novelty of problem formulation

The dependent variable is novelty of problem formulations. Two experienced coders from the training program rated the formulations strategists generated in terms of novelty (from 1 = *not at all novel* to 7 = *highly novel*). These coders were different from the coders who evaluated symptom distance. Given high convergence in the answers between the coders (ICC(1) for

agreement = .81, ICC(2) for reliability = .90), I averaged novelty across the two evaluators for subsequent analyses. To illustrate, the executive who interviewed his consumers formulated his problem as a lack of effective ways to build trust between customers and small-scale or new merchants with little track record. This theory deviated from the typical formulation of optimizing cost efficiency. Over the next few years, the novel formulation led the entrepreneur to build a digital platform that allowed small merchants to build trust with consumers through individual brand ambassadors, bypassing the high cost of advertisements.

3.3 | Study 1: Results and discussion

Table 3 contains descriptive statistics and correlations among the variables. Table 4 contains the means and standard deviations for Distant Symptoms and Novelty across conditions. The manipulation check questions indicated that the manipulations of cognition were successful. During the attention allocation phase, participants in the rational-analytic thinking condition reported greater use of rational-analytic thinking ($Mean = 3.49$, $SD = 0.69$) than those in the intuitive thinking condition ($Mean = 3.14$, $SD = 0.91$), ($M_{difference} = 0.35$, 95% $CI = [0.11, 0.61]$, $t(154.29) = 2.87$, $p = .00$, $d = 0.44$). Participants in the rational-analytic thinking condition relied less on intuitive thinking ($Mean = 3.07$, $SD = 0.83$) than those in the intuitive thinking condition ($Mean = 3.73$, $SD = 0.81$), ($M_{difference} = 0.66$, 95% $CI = [-0.90, -0.42]$, $t(161.94) = -5.41$, $p = .00$, $d = 0.84$). During the judgment phase, participants in the rational-analytic thinking condition reported greater use of rational-analytic thinking ($Mean = 3.70$, $SD = 0.60$) than the participants in the intuitive thinking condition ($Mean = 3.24$, $SD = 0.83$), ($M_{difference} = 0.46$, 95% $CI = [0.24, 0.68]$, $t(149.98) = 4.11$, $p = .00$, $d = 0.64$). Participants in this condition also reported that they relied less on intuitive thinking ($Mean = 3.70$, $SD = 0.81$) than those in the

TABLE 3 Study 1: Means, standard deviations, and correlations.

Variable	Mean	*SD*	1	2	3	4	5	6
1 Analytic Attention	0.50	0.50						
2 Intuitive Judgment	0.50	0.50	−.01					
3 Distant Symptoms	1.91	0.98	.35	−.02				
4 Novelty	2.72	1.20	.22	.07	.48			
5 Years of Work	7.51	5.96	−.13	−.02	−.25	−.11		
6 Age	37.84	6.49	.08	−.04	.03	.06	.35	
7 Gender	0.26	0.44	.11	.06	.10	.09	.07	.00

TABLE 4 Study 1: Means and standard deviations.

Cognition	Distant symptoms mean (*SD*)	Novelty mean (*SD*)
Analytic-Intuitive	2.15 (1.03)	3.28 (1.48)
Analytic-Analytic	2.36 (1.11)	2.69 (1.17)
Intuitive-Intuitive	1.65 (0.87)	2.32 (1.00)
Intuitive-Analytic	1.50 (0.59)	2.58 (0.93)

intuitive thinking condition (*Mean* = 3.96, *SD* = 0.64), ($M_{difference}$ = 0.26, 95% *CI* = [−0.48, −0.04], *t*(157.95) = −2.33, *p* = .02, *d* = 0.36).

I first tested Hypothesis 1. Research participants who were in the rational-analytic thinking condition during the attention allocation phase identified more distant symptoms (*N* = 83, *Mean* = 2.25, *SD* = 1.07) than those in the intuitive thinking condition (*N* = 84, *Mean* = 1.58, *SD* = 0.74) (*t*(146.03) = 4.74, 95% *CI* = [0.39, 0.96], *p* = .00, *d* = 0.73). Given the Likert scale of 1 to 5, the difference in the ratings indicates that the raters viewed the symptoms identified by participants in the rational-analytic thinking condition to be nearly twice as distant as those in the intuitive thinking condition. These results support Hypothesis 1.

I then tested Hypothesis 2. A two-way ANCOVA without the interaction between Distant Symptoms and Intuitive Judgment reports the main effects for Distant Symptoms ($F(1, 164) = 48.92$, $p = .00$, partial $\eta^2 = 0.23$) and Intuitive Judgment ($F(1, 164) = 1.16$, $p = .28$, partial $\eta^2 = 0.01$). A two-way ANCOVA with the interaction between Distant Symptoms and Intuitive Judgment reported the main effects of Distant Symptoms ($F(1, 163) = 51.44$, $p = .00$, partial $\eta^2 = 0.24$) but not Intuitive Judgment ($F(1, 163) = 1.22$, $p = .27$, partial $\eta^2 = 0.01$) on Novelty. The interaction between Intuitive Judgment and Distant Symptoms ($F(1, 163) = 9.46$, $p = .00$, partial $\eta^2 = 0.05$) indicates that research participants who theorized causes with intuitive thinking and with distant symptoms developed novel problem formulations. Figure 2 illustrates the relationship. These results support Hypothesis 2.

The informed intuition model indicates that strategists in the Analytic Attention and Intuitive Judgment condition would most likely generate novel problem formulations. Pairwise contrasts across the four possible conditions (the analytic-intuitive, analytic-analytic, intuitive-analytic, and intuitive-intuitive thinking conditions) also report that strategists in the analytic-intuitive condition developed formulations with greater novelty (*N* = 41, *Mean* = 3.28,

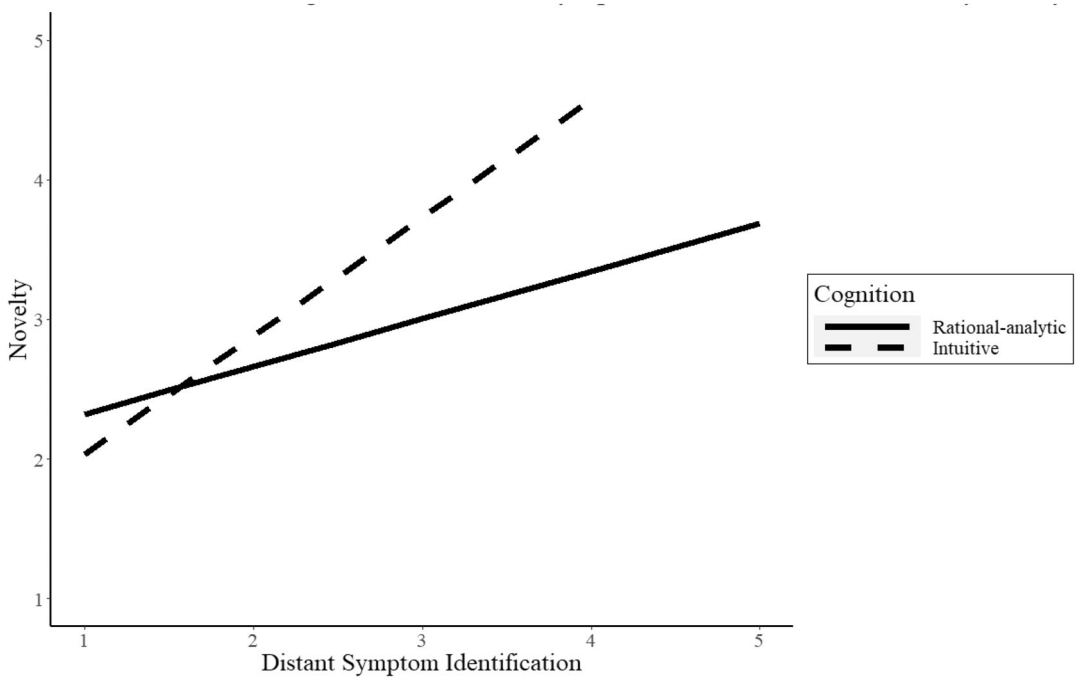

FIGURE 2 Effects of cognition and distant symptom identification on novelty, Study 1.

SD = 1.48) compared to those in the analytic-analytic condition (*N* = 42, *Mean* = 2.69, *SD* = 1.17), (*t*(76.04) = 2.01, 95% *CI* = [0.01, 1.17], *p* = .05, *d* = 0.44), the intuitive-analytic condition (*N* = 42, *Mean* = 2.58, *SD* = 0.93), (*t*(67.08) = 2.56, 95% *CI* = [0.15, 1.24], *p* = .01, *d* = 0.57), and the intuitive-intuitive condition (*N* = 42, *Mean* = 2.32, *SD* = 1.00), (*t*(70.25) = 3.45, 95% *CI* = [0.40, 1.51], *p* = .00, *d* = 0.76). Strategists in the analytic-intuitive condition formulated their problems with around 49% greater novelty than strategists in other groups. The differences in novelty across the other three conditions were not significantly different (*p* = .12 for the rational-rational and intuitive-intuitive conditions, *p* = .64 for the rational-rational and intuitive-rational conditions, *p* = .22 for the intuitive-intuitive and intuitive-rational conditions).

Study 1 offers causal evidence that supports the informed intuition model. Still, the study has limitations. First, the participants in the study formulated different problems. In the context of Study 1, the conference organizers stated that asking participants to formulate the same problem would have disinterested them. The participants were at the conference to solve their specific problems rather than someone else's. However, another study that asks participants to formulate the same problem would strengthen the paper, as the ratings of distant symptom identification and novel problem formulations would be more consistent and reliable across participants. This design can also reduce the possibility that some participants have already worked on their problems before the study. Study 2 addresses these limitations.

4 | STUDY 2: METHODS

4.1 | Sample, design, and procedures

Consistent with Study 1, Study 2 used a 2 × 2 between-subject design. I manipulated cognition during the attention allocation and judgment phases, yielding four conditions: analytic-analytic, analytic-intuitive, intuitive-analytic, and intuitive-intuitive. I used Prolific Academics to recruit a sample of mid-to-high managers in the United States, working in large corporations (*Mean* of Age = 40.89, Female = 43%, *N* = 160). Participants were randomly assigned to one of the four conditions. The study was preregistered.[3]

Study 2 relied on the case study discussed in Nickerson and Argyres (2018). This case is about a beer distributor, Lang, whose problem can be formulated differently based on the symptoms readers identify and utilize. Identifiable symptoms include declining sales and other financial performance indicators, deteriorating relationships with local partners and customers, and Lang's tension with his son, who works for Lang's company. Based on the symptoms they identify, readers may formulate Lang's problem as uncertainty in entering a new tequila business, difficulties in building new distribution channels, or challenges in succession planning for a family business. The first two formulations are based on the more obvious, "surface" level symptoms, such as declining sales. The last formulation depends on distant symptoms that most readers and students overlook, such as the age of Lang (likely to be between 60 and 70), which creates the urgent need to find a successor (Nickerson & Argyres, 2018).

[3]Preregistration is at: https://osf.io/z3tkf/?view_only=41b8adf554e64046813d107e9535c4f3.

4.1.1 | Tasks and manipulation

Consistent with Study 1, the instruction for the attention allocation phase asked the participants to identify Lang's needs and pain points—symptoms of his problem. The instruction for the judgment phase asked the study participants to theorize underlying causes of the identified symptoms. Specifically, the instruction for attention allocation asked the participants to "write down the needs and pain points you see: that is, what seems problematic for Lang?" The instruction for judgment asked the participants to answer the following: "What is the underlying cause of Ed Lang's problems?"

Consistent with previous research, Study 2 manipulates cognition through direct instructions (Dane et al., 2011; Dane et al., 2012; Skarlicki & Rupp, 2010):

Rational-analytic thinking (attention allocation phase): Please analyze and reflect on the case. Please do not rely on intuition, or first impression. In other words, you need to carefully appraise and rationally evaluate the situation. It is important for you to remain objective and avoid being influenced by your personal feelings or emotions.

Intuitive thinking (attention allocation phase): Please rely on intuition, or first impression. Please do not search for logical, rational explanations for your answer but instead rely on your gut feeling. In other words, you need to trust your intuition about the situation and make judgments based on your gut feelings.

Rational-analytic thinking (judgment phase): Please carefully appraise and rationally evaluate the situation. It is important for you to remain objective and avoid being influenced by your personal feelings or emotions.

Intuitive thinking (judgment phase): Please trust your intuition about the situation and evaluate the situation based on your gut feelings. It is important to be open to your 'gut instinct' reactions when answering this question.

Consistent with Study 1, I created categorical variables, Analytic Attention (1 if in the rational-analytic thinking condition during attention allocation, 0 if not), and Intuitive Judgment (1 if in the intuition condition during judgment) to test the hypotheses of this article.

4.2 | Measures

4.2.1 | Distant symptom identification

Two coders familiar with the case study and blind to the hypotheses evaluated the degree to which distant symptoms were identified during the attention allocation phase from a Likert scale of 1 = *only common symptoms* to 5 = *included highly uncommon, distant symptoms* (see Online Appendix for the coding scheme). Given the high convergence in evaluation between the coders (ICC(1) for agreement = .74, ICC(2) for reliability = .85), the final measure, Distant Symptoms, was based on the average from the coders.

4.2.2 | Manipulation checks

Consistent with Study 1, the manipulation check questions were based on Novak and Hoffman (2009). The scales started with the following sentences: "When answering the question above..." The measures of rational-analytic thinking depended on the answers to the following: "I reasoned things out carefully," "I approached the task analytically," and "I arrived at my answer

by carefully assessing the information" (Cronbach's alphas after the attention allocation and judgment phases = .89 and .94). The measures of intuitive thinking relied on the answers to the following: "I relied on my sense of intuition," "I used my gut feelings," and "I trusted my hunches" (Cronbach's alphas after the attention allocation and judgment phases = .97 and .97). The scales ranged from 1 = *Strongly Disagree* to 5 = *Strongly Agree* for all measures. I averaged the responses to the questions to form the final measures of cognition.

4.2.3 | Novelty of problem formulation

The dependent variable is novelty of problem formulations. Two new coders who were not involved in other ratings and were unaware of the hypotheses rated the formulations strategists generated (from 1 = *not at all novel* to 5 = *highly novel*). The raters used the coding scheme described in Online Appendix. Given the high convergence in the ratings between the coders (ICC(1) for agreement = .74, ICC(2) for reliability = .85), I averaged the measure of novelty from the coders to create the final measure of Novelty.

4.3 | Study 2: Results and discussion

Table 5 contains descriptive statistics and correlations among the variables. Table 6 contains the means and standard deviations for Novelty and Distant Symptoms across conditions. The manipulation check questions indicated that the manipulations of cognition for attention allocation and judgment phases were successful. During the attention allocation phase, participants in the rational-analytic thinking condition reported greater use of rational-analytic thinking

TABLE 5 Study 2: Means, standard deviations, and correlations.

Variable	Mean	*SD*	1	2	3	4	5
1 Analytic Attention	0.49	0.50					
2 Intuitive Judgment	0.49	0.50	.00				
3 Distant Symptoms	2.64	1.02	.32	−.02			
4 Novelty	2.22	0.95	.13	.16	.22		
5 Age	40.89	11.37	−.14	−.08	.00	.01	
6 Gender	1.43	0.51	.02	.10	−.04	−.04	.06

[Correction added on 13 August 2024, after first online publication: In Table 5, the values '1.13, .12, .15, and .02' under 'SD, 1, 2, and 4' have been updated to '1.02, .13, .16 and .01' in this version.]

TABLE 6 Study 2: Means and standard deviations.

Cognition	Distant symptoms mean (*SD*)	Novelty mean (*SD*)
Analytic-Intuitive	2.95 (1.19)	2.59 (1.04)
Analytic-Analytic	2.99 (0.86)	2.10 (0.96)
Intuitive-Intuitive	2.30 (0.89)	2.15 (0.83)
Intuitive-Analytic	2.34 (0.96)	2.05 (0.89)

[Correction added on 13 August 2024, after first online publication: In Table 6, the values under 'Distant symptoms mean (*SD*)' have been updated in this version.]

(*Mean* = 4.58, *SD* = 0.54) than those in the intuitive thinking condition (*Mean* = 4.14, *SD* = 0.97), ($M_{difference}$ = 0.44, 95% *CI* = [0.19, 0.68], *t*(125.7) = 3.53, *p* = .00, *d* = 0.56). Participants in the rational-analytic thinking condition relied less on intuitive thinking (*Mean* = 2.55, *SD* = 1.30) than those in the intuitive thinking condition (*Mean* = 4.26, *SD* = 0.89), ($M_{difference}$ = 1.71, 95% *CI* = [1.36, 2.06], *t*(138.09) = 9.66, *p* = .00, *d* = 1.54). During the judgment phase, participants in the rational-analytic thinking condition reported greater use of rational-analytic thinking (*Mean* = 4.54, *SD* = 0.56) than the participants in the intuitive thinking condition (*Mean* = 3.98, *SD* = 1.08), ($M_{difference}$ = 0.44, 95% *CI* = [0.29, 0.83], *t*(116.12) = 4.09, *p* = .00, *d* = 0.65). Participants in this condition also reported that they relied less on intuitive thinking (*Mean* = 2.81, *SD* = 0.90) than those in the intuitive thinking condition (*Mean* = 4.27, *SD* = 1.41), ($M_{difference}$ = 1.46, 95% *CI* = [1.09, 1.83], *t*(136.93) = 7.85, *p* = .00, *d* = 1.23).

I first tested Hypothesis 1. Managers in the rational-analytic thinking condition identified symptoms (*N* = 79, *Mean* = 2.97, *SD* = 1.03) that were more distant when compared to those in the intuitive thinking condition (*N* = 81, *Mean* = 2.32, *SD* = 0.92) (*t*(155.2) = 4.20, 95% *CI* = [0.34, 0.95], *p* = .00, *d* = 0.75). Given that the measure was on a Likert scale from 1 to 5, the difference between the two conditions represented a 49% increase in the raters' evaluations of distance. These results support Hypothesis 1.

I then tested Hypothesis 2. A two-way ANCOVA with Intuitive Judgment and Distant Symptoms revealed a main effect of Intuitive Judgment (*F*(1, 157) = 4.32, *p* = .04, partial η^2 = 0.03) and a main effect of Distant Symptoms (*F*(1, 157) = 8.41, *p* = .00, partial η^2 = 0.05) on Novelty [Correction added on 13 August 2024, after first online publication: In the preceding sentence, the values '4.08' and '8.64' have been updated to '4.32' and '8.41' in this version.]. A two-way ANCOVA with the interaction between Intuitive Judgment and Distant Symptoms revealed a main effect of Intuitive Judgment (*F*(1, 156) = 4.52, *p* = .04, partial η^2 = 0.03). Distant Symptoms had a main effect on Novelty (*F*(1, 156) = 8.80, *p* = .00, partial η^2 = 0.05). Importantly, the interaction between Intuitive Judgment and Distant Symptoms (*F*(1, 156) = 8.40, *p* = .00, partial η^2 = 0.05) and Figure 3 indicate that managers who have identified distant symptoms

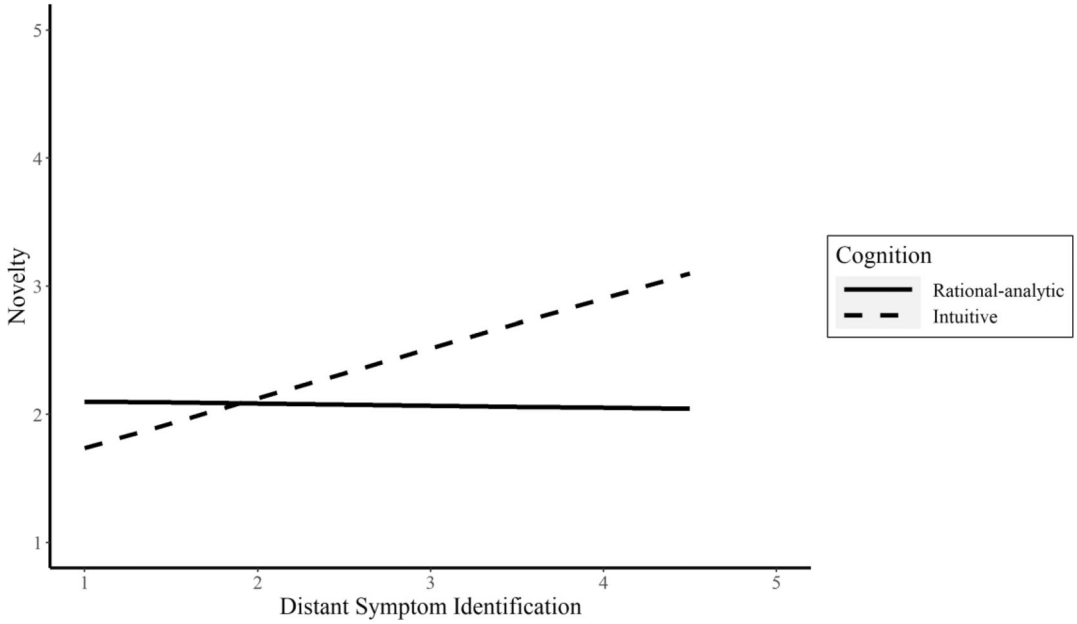

FIGURE 3 Effects of cognition and distant symptom identification on novelty, Study 2.

and used intuitive thinking formulated problems with greater novelty. These results support Hypothesis 2.

The informed intuition model indicates that combining Analytic Attention and Intuitive Judgment is ideal for generating novel problem formulations. Pairwise contrasts across the four possible conditions also report that strategists in the analytic-intuitive thinking condition developed formulations with greater novelty ($N = 39$, $Mean = 2.59$, $SD = 1.04$) compared to the analytic-analytic thinking condition ($N = 40$, $Mean = 2.10$, $SD = 0.96$), ($t(76.00) = 2.17$, 95% $CI = [0.04, 0.94]$, $p = .03$, $d = 0.51$), the intuitive-analytic thinking condition ($N = 41$, $Mean = 2.05$, $SD = 0.89$), ($t(74.62) = 2.49$, 95% $CI = [0.11, 0.97]$, $p = .01$, $d = 0.56$), and the intuitive-intuitive thinking condition ($N = 40$, $Mean = 2.15$, $SD = 0.83$), ($t(72.59) = 2.07$, 95% $CI = [0.02, 0.86]$, $p = .04$, $d = 0.47$). Managers in the analytic-intuitive condition formulated their problems with around 45% greater novelty than managers from other groups. The differences in novelty across the other three conditions were not significantly different ($p = .60$ between the intuitive-intuitive and intuitive-rational conditions; $p = .80$ between the intuitive-intuitive and rational-rational conditions; $p = .80$ between the intuitive-rational and rational-rational conditions). Study 2 relies on a case study, a sample of mid-to-high-level managers, and distinct sets of coders for rating distant symptom identification and problem formulation novelty. Despite the differences, the results are consistent across the studies and support the hypotheses.

Although supportive of the informed intuition model, Studies 1 and 2 still have limitations. In the settings, I cannot rule out the possibility that participants engaged in activities other than developing problem formulations during the duration of the experiments, as no one explicitly monitored their activities. This possibility can be important to rule out because the manipulation instruction for the rational-analytic thinking condition may have led to a greater perceived difficulty of tasks. This greater perceived difficulty may have led to distraction or engagement in these activities, which could have led to higher novelty in problem formulations by allowing novel integration of information gathered from other sources (Dane & Pratt, 2009; Shin & Grant, 2021). To address this concern, I conducted Study 3, an additional experiment in a physical laboratory setting. In this setting, two supervisors were present to ensure participants only engaged with the experiment material for the duration of the study. The study also found results consistent with Studies 1 and 2. The content of Study 3 is in Online Appendix.

5 | GENERAL DISCUSSION

5.1 | Theoretical contributions

The informed intuition model and the two studies offer insights into the cognitive microfoundations of novel problem formulations. The insights are valuable to scholars in behavioral strategy research (organizational learning and problemistic search), entrepreneurship literature (the theory-based view), and the knowledge-based view (the problem-solving perspective) (Camuffo et al., 2020; Ehrig & Schmidt, 2022; Gavetti et al., 2012; Grant, 1996; Zellweger & Zenger, 2022). In behavioral strategy research, novel problem formulations are the basis for exploration (Posen et al., 2018). In entrepreneurship, novel problem formulations are linked to value creation and entrepreneurial success (Felin & Zenger, 2009). In the knowledge-based view, novel problem formulations are critical to radical innovation and knowledge creation (Nickerson et al., 2007).

More broadly, the insights from this article contribute to the research on managerial cognition. Past studies predominantly assume the "either-or" view of cognition, examining and testing whether individuals' reliance on intuitive thinking or rational-analytic thinking during

their tasks resulted in novel outcomes (Alaybek et al., 2022; Phillips et al., 2016). Typical contrasts such as System I versus System II thinking (Kahneman, 2011) and heuristic versus rational approaches (Gigerenzer & Gaissmaier, 2011; Keynes, 1937; Nickerson & Zenger, 2004) are rooted in the same dichotomy. Indeed, ecological rationality research that attempts to find the adaptive match between tasks and cognition has also tended to test whether one form of cognition is inferior or superior to the other for specific tasks (e.g., Luan et al., 2019). Even when scholars mention that managers should "switch cognitive gears" (Louis & Sutton, 1991), they theorize the importance of changing cognition as managers engage in different tasks rather than during phases of a given task. Most studies do not yet consider how harnessing both forms of cognition in combination may lead to more adaptive outcomes.

Although this article focuses on one specific task, it takes an important step toward the "both-and" approach to managerial cognition. The studies in this article indicate that intuition and analysis may have appropriate places in specific phases of a managerial task, and cognition at one phase can also depend on or shape the effects of cognition in other phases. Since managerial tasks tend to be complex and contain multiple phases, investigating the possible, combinatory effects of cognition across phases can deepen the insights into the role of psychology in management. Indeed, in a way, the "both-and" approach is a natural extension of ecological rationality research. This research is rooted in Simon's observation that adaptive outcomes depend on the match between cognition and the nature of the tasks (Gigerenzer et al., 2022). When tasks are complex and consist of interdependent but distinct phases (Simon, 1987, 1991), then a corollary is that adaptive outcomes may depend on a complex combination and sequence of cognition.

5.2 | Practical implications

The informed intuition model is also important for practice. Incubation and acceleration programs for entrepreneurs and strategists have become widespread and popular among practitioners. These programs often rely on structured problem-solving processes that also contain stages or phases in which strategists engage in attention allocation and judgment (Camuffo et al., 2020; Ries, 2011). The informed intuition model can serve as a guideline for these phases when strategists need to develop novel problem formulations. The studies in this article also offer concrete instructions to induce the desired cognition at these phases with little cost or time. Incubator or training program organizers can rely on the instructions in the studies to shift cognition during the process of problem formulation to encourage novel problem formulations. The potential improvements are not trivial. Despite the plethora of formal processes and programs designed to encourage novel problem formulations, entrepreneurs and strategists currently struggle to generate them (Christensen et al., 2016; Felin et al., 2019; Kupor, 2019; Tamaseb, 2021). Because problem formulations fundamentally guide subsequent decision-making and problem solving, greater effectiveness in developing novel problem formulations can yield large benefits for such programs and entrepreneurs.

At the organizational level, the "both-and" approach to managerial cognition may encourage the creation of new problem solving and decision-making processes. For example, strategists prone to rational-analytic thinking may choose to adopt tools effective in associative processes like neural networks (Gavetti & Warglien, 2015; Hopfield, 1982) during the judgment phase. Popular AI models like ChatGPT and Gemini are currently not optimized to detect affective, tacit, and experiential information that characterizes distant symptoms and instead rely on explicit data. So, these tools are of limited use in identifying distant symptoms of strategic problems. Nevertheless, to the extent that strategists have identified distant symptoms and can

inform AI models of the symptoms, these models rooted in neural networks may be useful in forming unexpected analogies that strategists may not have considered. These associations may not lead to radical or new-to-the-world problem formulations as the AI models draw on explicitly recorded and documented events available to other individuals as well. However, given the wealth of examples and past data AI models are built on, many strategists may nonetheless find novel problem formulations that they had not considered through these AI models. These problem formulations can be of sufficient novelty that the use of AI models can offer competitive advantages.

5.3 | Limitations and future directions

While offering valuable insights, this article has important limitations. For example, the paper does not specify how long attention allocation or judgment should take. Objective timestamps (e.g., attention allocation should take 20% of the available time, judgment should take 30%, and the rest should be spent on developing and testing solutions) can be useful. Moreover, strategists may iterate between attention allocation and judgment. Strategists can return to attention allocation after formulating problems if they believe their formulations are not sufficiently novel. Strategists may look for more distant symptoms once they have novel problem formulations, to check and verify their problem formulations. The iterative processes were beyond the scope of this article but are important to investigate as they can lead to more novel problem formulations. Future researchers can also examine the roles of discrete emotions or affective dimensions (e.g., valence, activation) in problem formulation. This article broadly discusses affective processes inherent in intuitive thinking (Dane & Pratt, 2007). However, distinct emotions and dimensions can also influence the process of formulating problems in distinct ways. For instance, high activation emotions (e.g., anger) may help strategists change their form of thinking from rational-analytic to intuitive thinking during the judgment phase.

Researchers may also benefit from a deeper understanding of the relationships between comprehensiveness and novelty of problem formulations. Existing theories suggest that comprehensiveness may be valuable in the context of exploitation, where the central root causes and optimal solutions can be presumably found with thorough information search and analysis (Baer et al., 2013). Novelty in problem formulation is instead linked to exploration. However, comprehensiveness—or the number of potentially relevant, theorized causes—and novelty of problem formulations can be empirically related. Comprehensiveness could also be an important pathway to developing novel problem formulations, as strategists considering numerous causes may stumble upon novel causes. Conversely, strategists motivated to find numerous causes may exert their efforts to find alternative causes that are incrementally different. Therefore, the pursuit of comprehensiveness could prevent strategists from theorizing highly novel causes. A potential future direction of research is thus developing more nuanced models and empirical tests on the relationships between comprehensiveness and novelty of problem formulations.

Finally, future researchers may offer important contributions to the literature on entrepreneurship and the theory-based view by exploring how strategists can effectively test the accuracy and usefulness of their novel problem formulations. Existing research in entrepreneurship recommends that entrepreneurs conduct fast-and-frugal experiments with minimum viable products to quickly test their theories and gather customer feedback (Ries, 2011). However, entrepreneurs with novel problem formulations likely do not yet have clear solutions that they can propose for feedback. Potential customers probably lack clear benchmarks or experiences with similar products to accurately evaluate novel problem formulations and potential solutions (Patvardhan & Ramachandran, 2020). Given the difficulties, evaluating accuracy or usefulness

with objective indicators or measures may not be feasible. Still, Felin and Zenger (2009) suggested that entrepreneurs may test novel problem formulations based on their plausibility through mental simulations or thought experiments. Future scholars may contribute to entrepreneurship research and the theory-based view by empirically testing whether these experiments may lead to changes in behaviors (e.g., rejecting or pivoting problem formulations), and whether these changes lead to superior innovation or entrepreneurial success.

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DATA AVAILABILITY STATEMENT

The data for Study 1 are not available because of a nondisclosure agreement. The datasets for studies 2 and 3 are available at https://osf.io/js6vb/?view_only=f8c2413d68eb44fb843d71bd2b871495.

ORCID

Chan Hyung Park https://orcid.org/0000-0002-2145-1754

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article. [Correction added on 13 August 2024, after first online publication: The supplementary material have been updated in this version.]

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