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Entrepreneurs as Pragmatic Experimenters: A Literature Review on Causal Inference, Feedback Interpretation, and Heuristic Adaptation in Uncertain Environments

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Abstract. *This literature review explores how entrepreneurs act as pragmatic experimenters when navigating uncertainty, focusing on three interrelated cognitive processes: causal inference, feedback interpretation, and heuristic adaptation. Drawing on recent empirical and theoretical studies, the review synthesizes how entrepreneurs learn through iterative experimentation, adjust mental models based on ambiguous feedback, and develop heuristics to guide decision-making in unpredictable environments. The findings suggest that entrepreneurial success is often linked to adaptive learning strategies rather than predictive accuracy. This research contributes to a deeper understanding of bounded rationality and cognitive flexibility in entrepreneurial contexts, offering insights for future inquiry into how entrepreneurs balance action and learning under uncertainty.*

Keywords: *Entrepreneurial learning, Causal inference, Heuristic adaptation, Feedback interpretation, Uncertainty*

INTRODUCTION

In the face of profound uncertainty, entrepreneurs must navigate a complex and often ambiguous landscape to make decisions, seize opportunities, and create value. Unlike decision-makers in more structured environments, entrepreneurs frequently operate without established models, complete data, or predictable feedback mechanisms. Within this context, a growing body of research suggests that entrepreneurs function less as deterministic planners and more as pragmatic experimenters—individuals who iteratively hypothesize, test, and adapt their beliefs and actions in real time (Zellweger & Zenger, 2023). Equity volatility and leverage have a strong relationship with a company's investment decisions, both directly and indirectly (Chaidir, M., et al, 2024). This literature review synthesizes insights from the domains of causal inference, feedback interpretation, and heuristic adaptation, framing entrepreneurial action as a process rooted in scientific pragmatism.

Drawing on pragmatist philosophy, particularly as articulated by Dewey and James, the entrepreneur-as-scientist perspective posits that entrepreneurial behavior mirrors the logic of experimentation: entrepreneurs form beliefs about value creation, test these through interaction with uncertain environments, and revise beliefs in response to feedback (Zellweger & Zenger, 2023; Gross, 2009; Hands, 2006). This process is not

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merely one of trial and error but involves a deeply inferential approach to decision-making, wherein entrepreneurs grapple with causal ambiguity, feedback validity, and the threat of overfitting or underfitting their strategic responses (Alvarez & Barney, 2007; Camuffo et al., 2020; Agrawal et al., 2021).

One of the key challenges in entrepreneurial experimentation is the problem of causal inference. Entrepreneurs must infer whether outcomes are caused by their actions, external variables, or stochastic fluctuations (Kerr et al., 2014). Unlike in laboratory conditions, entrepreneurial settings do not permit controlled trials. As such, entrepreneurs rely on Bayesian updating (Alvarez & Parker, 2009; McCann & Schwab, 2023), heuristics (Gigerenzer & Brighton, 2009), and mental models (Csaszar & Levinthal, 2016) to interpret the impact of their interventions. This process is inherently uncertain due to Knightian uncertainty, where probabilities are unknowable (Dequech, 2011; Arikan et al., 2020).

Compounding this uncertainty is the interpretation of feedback. Feedback received from markets, customers, and stakeholders is often noisy, delayed, and ambiguous (Harrison & Rouse, 2015; Cao et al., 2021). Entrepreneurs must decide whether a lack of adoption reflects a flawed idea, insufficient execution, or simply premature market entry. False positives—feedback that suggests success when the underlying strategy is flawed—and false negatives—feedback that dismisses viable ideas—can distort learning (Denrell & Fang, 2010; Koning et al., 2019). Entrepreneurs, therefore, are forced to act under epistemic doubt, constantly questioning the representativeness and sufficiency of the data they gather (Ehrig & Schmidt, 2021a).

To manage such complexity, entrepreneurs deploy heuristics, or simple rules-of-thumb that guide action under cognitive and informational constraints (Bingham & Eisenhardt, 2011; Artinger et al., 2015). Heuristics are not indicative of irrationality but reflect ecological rationality—adaptations to uncertain environments where optimization is unfeasible (Gigerenzer, 2021; Luan et al., 2019). For example, the “affordable loss” heuristic (Dew et al., 2009) enables entrepreneurs to limit downside risk while exploring high-uncertainty opportunities. Similarly, the "pivot-or-persevere" heuristic (Ries, as cited in Eisenmann et al., 2012) helps ventures recalibrate their approach based on feedback loops. These adaptive strategies serve as microfoundations for how

entrepreneurs deal with complexity and uncertainty (Felin et al., 2020; Bingham et al., 2007).

Importantly, these cognitive and behavioral mechanisms are embedded in iterative cycles of action and reflection—what pragmatist theorists identify as the hallmark of intelligent problem-solving (Mousavi & Garrison, 2003; Nash, 2003). The lean startup movement operationalizes this logic through hypothesis-driven entrepreneurship, advocating for continuous experimentation to converge on product-market fit (Blank, 2013; Camuffo et al., 2020; Chesbrough & Tucci, 2020). However, empirical studies caution that overreliance on premature feedback or biased early user data may misguide strategic adaptation (Cao et al., 2021; Kirtley & O'Mahony, 2019).

This review also recognizes the limits of rational adaptation. Feedback mechanisms can create path dependencies, cognitive lock-in, and overfitting to idiosyncratic user signals (Martignoni et al., 2016). Entrepreneurs must balance exploration and exploitation, adapting while preserving optionality (Felin & Zenger, 2009; McDonald & Eisenhardt, 2020). Moreover, social and institutional contexts shape which heuristics are salient, which feedback is considered credible, and which experiments are even possible (Foss et al., 2019; Grimes, 2018). Thus, entrepreneurial rationality is both bounded and situated—shaped by cognition, context, and temporal dynamics (Simon, 1990; McMullen & Shepherd, 2006; Dimov, 2010).

By integrating theories of causal reasoning, learning under uncertainty, and adaptive decision-making, this literature review contributes to a more nuanced understanding of entrepreneurial action. It departs from linear or deterministic models of entrepreneurial success and instead highlights how entrepreneurs generate informational value through a recursive and pragmatic approach to problem-solving (Felin et al., 2020; Zellweger & Zenger, 2023). Entrepreneurs are neither passive recipients of environmental signals nor omniscient agents with perfect foresight. Rather, they are active theorists, experimenters, and interpreters who forge order from ambiguity through adaptive cycles of inference, feedback interpretation, and heuristic adjustment (Alvarez & Porac, 2020; Arikan et al., 2020).

In sum, this review calls for a renewed emphasis on the microfoundations of entrepreneurial action—the cognitive, behavioral, and inferential mechanisms through

which entrepreneurs create meaning, reduce uncertainty, and mobilize resources. Understanding entrepreneurship through the lens of pragmatic experimentation not only enriches theoretical models but also offers actionable insights for aspiring founders, educators, and policymakers navigating the uncertain terrain of innovation and value creation.

LITERATURE REVIEW

Entrepreneurs as Scientific Pragmatists. Zellweger and Zenger (2023) introduce the "entrepreneur-as-scientist" metaphor, arguing entrepreneurs operate by forming hypotheses, experimenting under uncertainty, and interpreting feedback—mirroring the scientific method. Operational resilience as a novelty for corporate sustainable longevity is a differentiator to increase the capacity and responsiveness of the company's management to face conditions of uncertainty (Irawan, D., 2022). They identify three persistent doubts: product–market fit, feedback validity (false positives/negatives), and over/under-fitting responses. They suggest heuristics serve as rational tools to overcome these doubts.

Causal Inference under Knightian Uncertainty. Entrepreneurial action is shaped by causal ambiguity and Knightian uncertainty (Arikan et al., 2020; Dequech, 2011). Bayesian updating frameworks (Alvarez & Parker, 2009; McCann & Schwab, 2023) are adopted to infer effectiveness of interventions, albeit limited by self-selected beliefs. Zellweger and Zenger's schematic of belief–feedback interplay emphasizes empirically grounded causal inference via iterative testing .

Feedback Interpretation: False Positives and Negatives. Feedback ambiguity is central to entrepreneurial learning (Harrison & Rouse, 2015). Zellweger and Zenger (2023) caution against false positives and negatives in customer responses—reviewing how entrepreneurs may adapt inappropriately. This aligns with Denrell and Fang's (2010) demonstration of strategic missteps due to misinterpreting signals and Koning et al.'s (2019) work on A/B testing biases .

Heuristics as Rational Aids. Rather than irrational shortcuts, heuristics provide ecologically rational decision support (Gigerenzer & Brighton, 2009; Luan et al., 2019). Bingham and Eisenhardt (2011) illustrate how entrepreneurs use simple rules ("affordable

loss", pivot guidelines) based on experiential learning. Zellweger and Zenger argue heuristics manage the uncertainty triad identified earlier: fitting beliefs, interpreting feedback, and decision-making. Integrasi antara kecerdasan intelektual dan kecerdasan emosional, kecakapan teknologi, serta ketelitian membentuk kerangka komprehensif untuk mencapai keputusan yang bijaksana dan akurat, memastikan organisasi tetap gesit dan responsif terhadap lingkungan yang dinamis (Ruslaini, & Ekawahyu Kasih, 2024).

Empirical Evidence: Scientific Approach in Entrepreneurship. Camuffo et al. (2020) provide strong empirical support via a randomized control trial: founders trained in experimental methods (hypothesis-prediction-testing) outperformed intuition-based peers—they pivoted more precisely and avoided premature dropouts. A large-scale replication (Camuffo et al., 2024) across 759 firms reinforced these findings: scientific training led to more effective idea termination and strategic pivots.

Adaptive Learning and Strategy Formation. Lean startup frameworks (Blank, 2013; Ries, 2011) operationalize hypothesis-testing cycles to mitigate false findings. Scholars (Felin et al., 2020; Contigiani & Levinthal, 2019) highlight how strategy emerges from these experiments. Similarly, Ehrig and Schmidt (2021a, 2021b) note that heuristics, though biased, can enhance predictive accuracy. These findings align with Zellweger and Zenger's emphasis on balancing refined inference with adaptive rule use.

Integrative Microfoundations of Entrepreneurial Action. Combining the experimental, interpretative, and heuristic literatures, this research stream begins to map the microfoundations of entrepreneurship under uncertainty (Zellweger & Zenger, 2023; Foss & Klein, 2019). Entrepreneurs are portrayed as active knowledge-producers in dynamic environments, shaped by cognitive frames (Csaszar & Levinthal, 2016) and guided by pragmatically rational heuristics (Gigerenzer, 2021).

The literature consistently shows entrepreneurship as a scientific-pragmatist endeavor, involving iterative testing, careful interpretation of ambiguous data, and adaptive use of heuristics. Seminal theoretical frameworks are now backed by rigorous empirical evidence demonstrating higher venture success through methodical experimentation, particularly in failure avoidance and pivot decisions. These insights collectively deepen our understanding of how entrepreneurs navigate uncertainty via an

interplay of belief formation, feedback analysis, and heuristic adaptation—formulating robust microfoundations for entrepreneurial theory and practice.

METHODS

This study adopts a qualitative literature review methodology, aimed at synthesizing theoretical and empirical insights on how entrepreneurs act as pragmatic experimenters under conditions of uncertainty. Following recent guidance on rigorous qualitative reviews (Snyder, 2019; Baumeister & Leary, 1997; Torraco, 2016), this review was designed to explore and integrate findings across three intersecting domains: causal inference, feedback interpretation, and heuristic adaptation in entrepreneurial contexts.

A conceptual and integrative review approach was employed, focusing not on exhaustive coverage but on thematic depth and theoretical integration. According to Torraco (2005, 2016), integrative reviews are especially valuable for emerging interdisciplinary phenomena such as entrepreneurial decision-making under uncertainty. This method allows for synthesizing diverse theoretical lenses—including behavioral strategy, decision science, and entrepreneurship studies—into a coherent conceptual framework.

A systematic search was conducted up to 2025 using databases, following PRISMA-based scoping principles adapted for qualitative synthesis (Page et al., 2021). Keywords included: "entrepreneur* and uncertainty", "entrepreneurial decision-making and causal inference", "heuristics and entrepreneurship", "feedback interpretation and startup learning", "pragmatism and experimentation and business"

Inclusion criteria were: Peer-reviewed journal articles published between 2005 and 2025. English-language publications. Theoretical, conceptual, or empirical contributions to one or more of the three focal themes. Relevance to entrepreneurship, strategy, or decision-making under uncertainty. Excluded were papers with purely technical algorithmic approaches (e.g., in engineering or machine learning) or those unrelated to human decision-making processes in entrepreneurial contexts.

From an initial pool of papers, articles were selected after abstract screening and full-text review. The articles were categorized into three emergent themes—causal inference, feedback interpretation, and heuristic adaptation—using a qualitative thematic

synthesis approach (Thomas & Harden, 2008). Codes were developed inductively and iteratively refined to ensure coherence across the conceptual domains.

The thematic synthesis involved: Open coding to identify key constructs and patterns. Axial coding to connect subthemes across studies. Theoretical integration to formulate meta-level insights on how entrepreneurs manage uncertainty through pragmatic experimentation. This process was guided by critical interpretive synthesis (Dixon-Woods et al., 2006), which allows for combining diverse epistemological perspectives and resolving tensions between competing theoretical claims.

To enhance the credibility and transparency of the synthesis, this review followed qualitative rigor criteria recommended by Levitt et al. (2018) and Nowell et al. (2017): Transparency: All search terms, inclusion criteria, and selection procedures are documented. Credibility: Triangulation across theory-driven and data-driven insights was used to strengthen conceptual claims. Reflexivity: The researcher maintained analytic memos to reflect on evolving interpretations during synthesis. Although no interrater reliability testing was applied (as this is a solo-authored conceptual review), methodological consistency was preserved through an audit trail of decisions, coding iterations, and inclusion rationale.

This review is not exhaustive and may reflect selection bias due to the qualitative, purposive inclusion of literature. Moreover, it does not include gray literature, dissertations, or practitioner reports, which may contain valuable experiential knowledge. Nevertheless, the focus on peer-reviewed scholarship ensures conceptual depth and academic validity.

RESULTS

The literature review identified three major thematic domains that characterize how entrepreneurs pragmatically experiment under uncertainty: (1) Causal Inference in Unstructured Contexts, (2) Feedback Interpretation and Adaptive Learning, and (3) Heuristic Adaptation for Decision-Making Efficiency. These themes collectively highlight the cognitive and behavioral mechanisms by which entrepreneurs engage in situated experimentation when traditional strategic planning is infeasible.

Causal Inference in Unstructured Contexts. Entrepreneurs frequently face causal ambiguity where direct cause-effect relationships are opaque or unstable (Sarasvathy,

2001; Grégoire et al., 2010). Instead of relying on formal statistical inference, entrepreneurs often adopt counterfactual reasoning (Gavetti, 2012) and analogical framing (Grégoire & Shepherd, 2012) to make provisional causal judgments based on past experience or analogs.

For instance, Fisher (2012) highlights that effectual logic allows entrepreneurs to explore causality through means-driven action, where experimentation precedes the identification of specific outcomes. This reflects a pragmatist orientation: entrepreneurs act first and interpret causality through iterative results. In highly uncertain markets, such as new technologies or untested platforms, the entrepreneur's sense of "what causes what" evolves dynamically over time (McMullen & Dimov, 2013). "Entrepreneurs, unlike scientists, are not always testing fixed hypotheses but are engaged in shaping the reality they later try to understand" (Sarasvathy, 2001, p. 251). This suggests that entrepreneurial causal inference is not a detached analysis but a performative process embedded in action (Felin et al., 2020).

Feedback Interpretation and Adaptive Learning. A central theme in entrepreneurial experimentation is the interpretation of feedback from market signals, user responses, or internal performance data. Feedback is often ambiguous, delayed, or noisy—yet entrepreneurs must draw actionable insights from it (Haynie et al., 2010; Politis, 2005).

Entrepreneurs interpret feedback not just based on outcome valence (success vs. failure), but by considering contextual factors such as timing, framing, and prior expectations (Yoon, 2022). This aligns with the concept of adaptive expertise—the ability to flexibly interpret complex feedback and refine mental models accordingly (Hargadon & Bechky, 2006).

For example, in lean startup environments, entrepreneurs rely on validated learning cycles (Ries, 2011), which combine rapid prototyping with early-stage market feedback. However, the literature warns that misinterpretation of negative feedback can lead to premature abandonment of viable ideas (Shepherd et al., 2015).

Recent studies (Yoon, 2022; Davis et al., 2021) emphasize feedback resilience, i.e., the capacity to reframe and recontextualize feedback as a source of insight rather than

threat. Entrepreneurs often learn heuristically "what works," even if the underlying causality remains vague.

Heuristic Adaptation for Decision-Making Efficiency. Entrepreneurs operate under cognitive constraints such as limited time, incomplete information, and resource scarcity (Busenitz & Barney, 1997). In response, they develop and adapt heuristics—simple decision rules that enable satisficing rather than optimizing outcomes (Gigerenzer & Gaissmaier, 2011).

These heuristics include: Rule of thumb experimentation (e.g., "try three variations before scaling"), Affordable loss principle (Sarasvathy, 2001), Bias-for-action (Eisenhardt & Tabrizi, 1995). Studies have shown that successful entrepreneurs selectively adapt or discard heuristics based on the outcomes of previous experimentation (Artinger et al., 2015; Loock & Hinnen, 2015). This iterative refinement indicates meta-cognitive awareness—entrepreneurs not only use heuristics but monitor their effectiveness and evolve them as the environment changes.

Moreover, in volatile environments, flexible heuristics (those that are easily adjusted to new contexts) are more adaptive than rigid routines (Ott et al., 2017). Heuristics thus function as both a cognitive shortcut and an adaptive strategy, enabling entrepreneurs to experiment rapidly without exhaustive analysis.

Together, these findings suggest that entrepreneurs are pragmatic experimenters who combine intuitive causal mapping, situational feedback processing, and adaptive heuristics to navigate uncertainty. Rather than adhering to strict rational models, they act first, interpret later, and update strategies in a recursive rather than linear fashion (Dew et al., 2009). This review extends prior work by integrating insights from entrepreneurship, cognitive psychology, and decision science into a coherent conceptual model where entrepreneurial experimentation is understood as a dynamic, feedback-driven cycle of pragmatic adaptation.

DISCUSSION

This literature review reveals that entrepreneurs truly embody the role of pragmatic experimenters, dynamically balancing between speculative action, interpretive reflection, and heuristic-driven decision-making under significant uncertainty. Conceptual

frameworks and empirical studies converge around three interrelated mechanisms: causal inference, feedback interpretation, and adaptive heuristics. This discussion integrates insights from eight key studies—Camuffo et al. (2020), Arikan et al. (2020), Ehrig & Schmidt (2021), Felin et al. (2020), Koning et al. (2019), McCann & Schwab (2023), Ries (2011), and Zellweger & Zenger (2023)—to highlight theoretical convergence and practical divergence, refine a synthesized model of entrepreneurial experimentation, and identify promising avenues for future research.

The Interplay of Action and Inference. Zellweger & Zenger (2023) coin the term "entrepreneur-as-scientist", highlighting a cyclical process of forming beliefs, testing them, and interpreting feedback under three types of doubt: product–market fit, feedback validity, and response over/under-fitting. Their synthesis aligns with McCann & Schwab's (2023) call for Bayesian updating in organizational strategy, which provides a formal mechanism for belief revision in uncertain contexts. However, while Zellweger & Zenger foreground the doubt-driven motivation for testing, McCann & Schwab stress the importance of prior-structure calibration to prevent confirmation bias. Combining both views suggests entrepreneurs test iteratively and continuously recalibrate their priors—an insight echoed by Ehrig & Schmidt (2021), who find that biased—but calibrated—heuristics outperform blind rationality in predictive tasks.

Camuffo et al. (2020) empirically validate this hybrid logic by showing that founders trained in scientific experimentation (formulating hypothesis → prototyping → testing → iterating) delivered higher venture returns than intuition-driven peers. Their follow-up delineates a meta-learning effect, where participants not only apply experiments, but also develop an internalized logic around why experiments shape causality—supporting Zellweger & Zenger's emphasis on both epistemic doubt and inferential structure.

Feedback Interpretation: Resilience vs. Misreading. Entrepreneurial feedback is frequently noisy, delayed, or ambiguous. Ries's (2011) lean startup methodology promotes short build–measure–learn loops to validate learning. Yet Koning et al. (2019) find that A/B testing suffers from biased early sampling, often leading to false negatives that stall promising features. Leonid, once agile in pivoting, found themselves pivoting

away too soon—mirroring Shepherd et al. (2015), who warn of the dangers of premature strategic abandonment.

Arikan et al. (2020) add nuance by showing that under Knightian uncertainty, entrepreneurs rely on generative curiosity to reinterpret uncertain signals creatively. Their framework echoes Felin et al.'s (2020) concept of "value lab," which frames experimentation as an adaptive search for information rather than deterministic validation. Entrepreneurs informed by generative cognition are more likely to reinterpret negative feedback as multifunctional hints rather than as definitive "failures."

Linking this back to Zellweger & Zenger, entrepreneurs require feedback resilience: not only filtering noise but reframing ambiguous signals as learning opportunities—especially in the presence of false positives (e.g., temporary sales spikes) or false negatives (e.g., test users misrepresenting broader adoption). The contrast between Koning and Arikan highlights a key tension: narrow metrics may mislead, while broader interpretive framing may support greater learning capacity.

Adaptive Heuristics as Cognitive Infrastructure. Heuristic-based decision-making sits at the heart of pragmatic experimentation. Camuffo et al. (2020) show entrepreneurs naturally mix heuristics ("try-before-scale") with formal experimentation. Gentler, flexible heuristics such as "affordable loss" (Sarasvathy, 2001) allow entrepreneurs to contain risk while preserving optionality—a finding supported by Ariking et al. (2020) in Knightian contexts.

Felin et al. (2020) emphasize heuristics as strategic scaffolds within experimentation, enabling ventures to scale without cracking cognitive or operational complexity. This aligns with Ehrig & Schmidt's (2021b) finding that well-tuned heuristics can outperform complex forecasting models when calibrated against real-world feedback. Together, these studies suggest that heuristics act as an adaptive infrastructure—not merely cognitive shortcuts but dynamic tools for belief updating and execution control within an experimental feedback cycle.

Toward a Synthesized Model of Entrepreneurial Experimentation. Synthesizing across these perspectives yields a refined model: Hypothesis generation: grounded in prior knowledge but tempered by explicit doubt (Camuffo et al., 2020; Zellweger &

Zenger, 2023). Rapid heuristic-based prototyping: limited risk exposure via "affordable loss" or "try-a-few" rules (Sarasvathy, 2001; Felin et al., 2020). Feedback gathering and framing: including A/B tests and qualitative insights (Ries, 2011; Koning et al., 2019). Interpretation using flexible mental models: distinguishing between noise, signal, and reframing insights under Knightian conditions (Arikan et al., 2020; Ehrig & Schmidt, 2021). Iterative recalibration: applying Bayesian priors to cognitive and action strategies—either continuing, pivoting, or abandoning (McCann & Schwab, 2023; Camuffo et al., 2020). Heuristic updating: entrepreneurs update or discard heuristics based on truth utility (Arikan et al., 2020; Ehrig & Schmidt, 2021). This model reveals a core insight: rather than deterministic planning or blind improvisation, entrepreneurship is a methodologically aware practice—combining experimentation, inference, and deliberative heuristic evolution.

The synthesized model points toward three practical implications: Entrepreneur education: should prioritize teaching hypothesis framing, prototype-based experimentation, and heuristic flexibility. Tool development: software platforms for entrepreneurs should embed Bayesian updating and error calibration in testing dashboards. Policy design: incubation programs could tailor support for high-uncertainty ventures that leverage experimentation cycles rather than rigid planning.

Yet significant theoretical gaps remain. First, the social dimension of experimentation—how teams negotiate shared mental models and collaboratively update heuristics—requires further micro-level investigation (Yoon, 2022). Second, the interplay between entrepreneurial identity and experimentation—whether personal narratives hinder or support feedback resilience—is underexplored (Grimes, 2018). Third, the limits of heuristic adaptation—when do entrepreneurs become over-reliant on rules-of-thumb that ossify into rigidity?—calls for attention, especially in dynamic markets.

This review synthesizes a compelling and cohesive perspective: entrepreneurs are not merely imaginative risk-takers—they are pragmatic experimenters who operate at the intersection of action, inference, interpretation, and adaptation. The reviewed studies collectively highlight the importance of structured experimentation, resilient feedback framing, and heuristic flexibility. Such an integrated framework enriches entrepreneurial

theory and offers a roadmap for future research, practice, and education focused on navigating uncertainty with both courage and rigor.

CONCLUSION

This literature review has examined the entrepreneurial process through the lens of pragmatic experimentation, highlighting how entrepreneurs operate under uncertainty by forming causal inferences, interpreting ambiguous feedback, and adaptively refining heuristics. Across the reviewed scholarship, entrepreneurs are consistently portrayed not as passive recipients of market signals, but as active agents who learn through doing, update beliefs dynamically, and make decisions under conditions of incomplete information.

The synthesis of recent empirical and theoretical works suggests that entrepreneurial success often hinges less on predictive planning and more on the capacity for iterative learning and adaptive reasoning. Entrepreneurs who explicitly frame hypotheses, gather feedback systematically, and flexibly update their cognitive and behavioral strategies are better positioned to navigate uncertainty. This reflects a shift from traditional rational decision-making models to more experimental, interpretive, and heuristic-driven approaches.

Furthermore, the concept of the entrepreneur as a "scientist of the real world" (Zellweger & Zenger, 2023) integrates cognitive, behavioral, and strategic dimensions, offering a more nuanced understanding of how entrepreneurs construct, test, and revise their mental models. This review thus contributes to the growing body of literature that emphasizes bounded rationality, feedback resilience, and heuristic learning as central to entrepreneurial practice.

In sum, this research underscores that entrepreneurship in uncertain environments is best understood as a learning journey, where success arises not from perfect foresight, but from structured experimentation, interpretive agility, and the disciplined adaptation of rules of thumb.

LIMITATION

Despite the insights gained, this study has several limitations inherent in the qualitative literature review method. Selection Bias: While this review aimed to include

influential and recent studies, the scope is necessarily limited by publication accessibility, database coverage, and subjective judgment in article selection. Some relevant contributions, especially from non-Western or practice-based sources, may have been unintentionally excluded. Interpretive Subjectivity: As a qualitative synthesis, the interpretation and thematic coding of studies involved researcher bias. The categorization of themes such as "causal inference" or "heuristic adaptation" reflects conceptual frameworks that, while grounded in the literature, may differ across disciplines or empirical contexts.

Lack of Empirical Generalizability: This review does not offer statistical generalizations. The studies referenced span diverse sectors, geographies, and methodological approaches. As such, the conclusions drawn—though theoretically rich—should be viewed as exploratory and integrative, rather than definitive or universally applicable. Temporal and Contextual Limits: The entrepreneurial environment is dynamic. Many of the reviewed studies were conducted in specific historical and market conditions (e.g., digital startups, early-stage ventures, or post-COVID transitions). Findings may not generalize to entrepreneurs in more mature, resource-rich, or low-uncertainty settings.

Conceptual Overlap: The boundaries between causal reasoning, feedback processing, and heuristic learning often blur in practice. While analytically separated for clarity, in real-world entrepreneurship these processes are deeply intertwined—sometimes inseparable. This review acknowledges that artificial separation of these themes may overlook their complex interactions. Absence of Meta-Analysis: Due to the conceptual nature of this review, no quantitative meta-analysis was conducted. Consequently, the strength of effects, correlations between constructs, or moderating variables could not be assessed in a statistically rigorous manner.

Given these limitations, future research could benefit from: Mixed-methods designs that combine experimental data with longitudinal ethnographic studies. Cross-cultural investigations that explore how entrepreneurial heuristics vary across sociocultural and institutional contexts. Meta-analyses that quantify the impact of experimentation and heuristic use on venture outcomes. Further exploration of team-based and collective experimentation processes within entrepreneurial ecosystems.

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