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Strengthening the Foundations of Entrepreneurial Mindset: a Neuroentrepreneurship Approach

Renforcer les fondements de l'état d'esprit entrepreneurial: une approche du neuro-entrepreneuriat

Abstract

This article examines the three key components of the entrepreneurial mindset (EM)—cognition, behaviour, and emotion—and their complex interplay. We introduce **neuroentrepreneurship**, a contemporary approach that applies neuroscience methods to explore the brain structures and mechanisms underlying EM. Highlighting the use of tools like fMRI and EEG, we outline how these technologies could be employed to address current research questions in EM. Finally, we discuss the potential contributions of a neuroentrepreneurship approach to both academic research and entrepreneurial training.

Abstract

*Cet article aborde les trois composantes clés de l'esprit entrepreneurial (EM)—la cognition, le comportement et l'émotion—ainsi que leur interaction complexe. Nous présentons **le neuro-entrepreneuriat**, une approche moderne qui utilise les neurosciences pour explorer les structures cérébrales et mécanismes sous-jacents de l'EM. En soulignant l'usage d'outils comme l'IRMf et l'EEG, nous décrivons comment ces technologies pourraient répondre aux questions actuelles de recherche dans l'EM. Enfin, nous discutons des contributions possibles du neuro-entrepreneuriat à la recherche académique et à la formation entrepreneuriale.*

Key ideas

- Discussing the interplay of cognition, behaviour, and emotion as the key components of entrepreneurial mindset (EM).
- Introducing neuroentrepreneurship to unravel brain structures and mechanisms underlying EM.
- Outlining how tools like fMRI and EEG could contribute to addressing the open questions in EM research.
- Briefly offering insights applicable to entrepreneurial training.

The Triad of the Entrepreneurial Mindset

Entrepreneurship is the “process meant to actualize desired and believed-to-be-possible futures involving the improvement of an individual’s, team’s, or organization’s socioeconomic position”¹. It is an effortful sequence of goal setting, information-seeking, action-planning and execution/monitoring/feedback. Frese & Gielnik ² describe the iterative nature of these sequences as crucial towards establishing any new venture—from innovation and ideation in the pre-launch phase; to resource acquisition during the launch phase; to the post-launch phase geared towards sustainable growth. The authors further suggest that *cognitive*, *motivational*, and *emotional* factors synergistically precede such entrepreneurial actions. Kuratko et al.³ also suggest that cognition and emotional factors along with entrepreneurial behaviour comprise the core aspects of the entrepreneurial mindset (EM; Figure 1).

Each triad component reinforces and shapes the others, strengthening the EM over time. *Cognition* acts as the facilitator and enabler in guiding *actions* and *emotions*. Similarly, *behaviour* influences cognition and emotion as entrepreneurs recursively refine their *mental models* and *emotional responses* based on real-world feedback through repetitive engagement with their environment throughout their activities. *Emotions* impact both thought processes and actions (i.e., cognition and behaviour respectively) as an entrepreneur's emotional state can alter their *perceptions* and *choices*. Such a self-reinforcing cycle also reflects how disruption in one of these aspects could impact an entrepreneur’s ability to *think, feel, or act*.

¹ Stratos Ramoglou & Jeffery S. McMullen, “What Is an Opportunity?”, *Acad. Mgmt. Rev.* (2024).

² Michael Frese & Michael M. Gielnik, ‘The Psychology of Entrepreneurship’, *Annu. Rev. Organ. Psychol. & Organ. Behav.* (2023).

³ Donald F. Kuratko et al., ‘Unraveling the Entrepreneurial Mindset’, *Small Bus. Econ.* (2021).

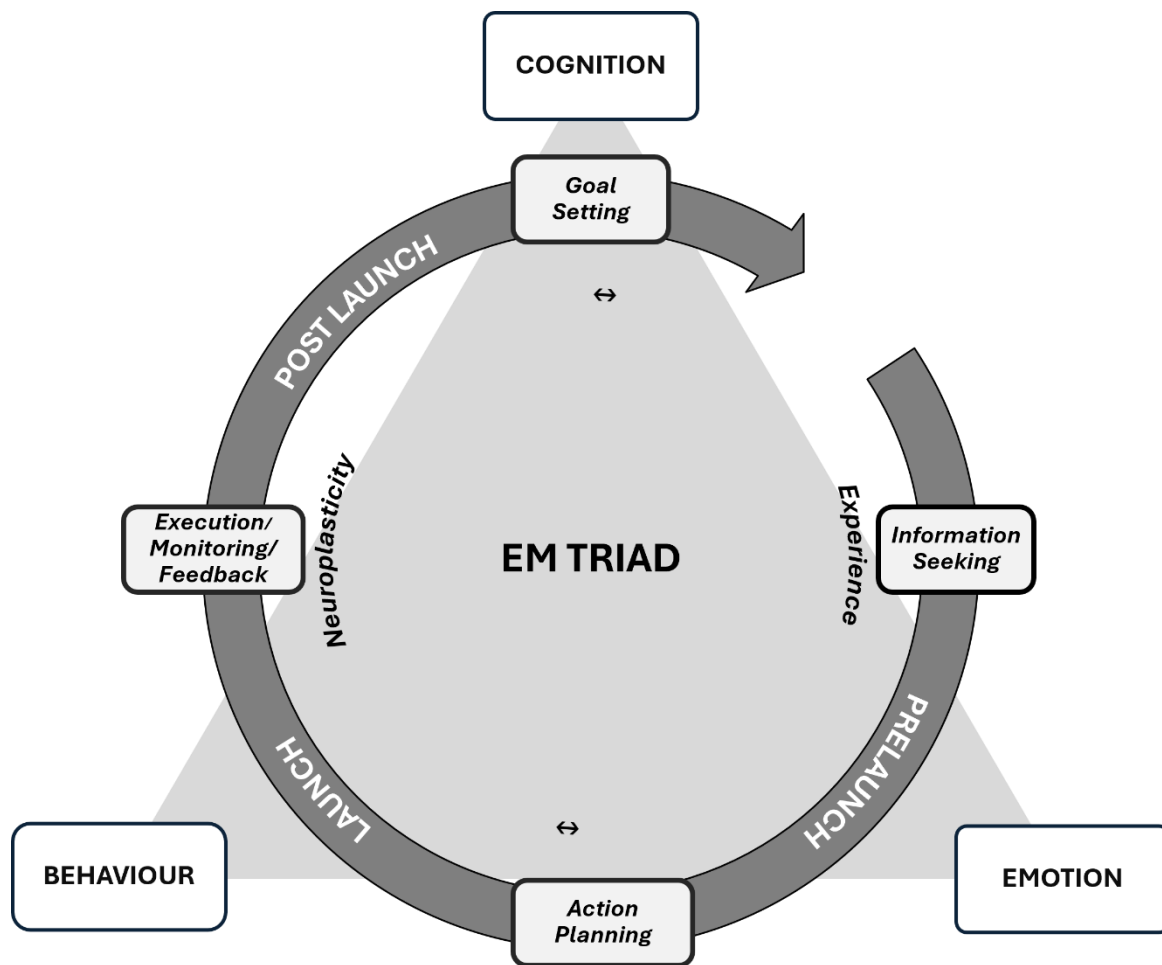


Figure 1 The triad of the entrepreneurial mindset—cognition, behaviour, and emotion—captures the interplay between cognition, behaviour(action), and emotional regulation in the entrepreneurial process (goal setting, information-seeking, action planning and execution/monitoring/feedback). **Cognition** shapes opportunity evaluation, decision-making, and growth strategies. **Behaviour** translates intentions into actions, enabling opportunity identification, risk-taking, and value creation. **Emotion** influences entrepreneurial persistence, well-being, and adaptability in navigating uncertainty.

A neuroentrepreneurship approach to EM

The dynamic interplay between cognition, behaviour, and emotion within the EM suggests a deep adaptability, not only in thought and action but in brain structure and function as well. This adaptability is linked to neuroplasticity, the brain's ability to reorganize and strengthen its networks in response to experiences⁴. A growing body of research on brain plasticity (Voss et al., (2017)) has shown that extensive

⁴ Moheb Costandi, *Neuroplasticity* (MIT Press, 2016).

experience and specialized training can shape cognition, leading to both structural and functional brain adaptation⁵. For example, London taxi drivers, who undergo extensive navigation training, display structural changes in brain regions involved in spatial cognition⁶. Similarly, professional musicians exhibit enhanced connectivity between brain hemispheres, particularly in the corpus callosum, which facilitates coordination between cognitive and motor functions⁷, and is crucial for higher-order cognitive function like cognitive flexibility. Comparable changes have been observed in chess professionals and expert meditators, whose years of practice refine cognitive processes. These findings highlight how expertise reshapes the brain, optimizing cognitive functioning in specialized domains.

Despite increasing evidence that neuroplasticity underpins expertise development, entrepreneurship research has been notably slow to adopt neuroscientific perspectives. To our knowledge, scholars have yet to examine how entrepreneurial experience—particularly among habitual entrepreneurs—may reshape brain structure and function, facilitating adaptive decision-making (DM). This gap is especially evident in our understanding of the neural mechanisms that underlie the dynamic interplay of cognition, behaviour, and emotion—the core components of the EM triad (*Figure 1*).

One example of a study using neurosciences to explore the cognitive component comes from Laureiro-Martínez & Brusoni⁸ who used a tailored neurocognitive task paradigm to examine how decision-makers balance exploiting known opportunities with exploring new ones. The authors identified distinct cognitive patterns for each strategy: exploiting opportunities uses rapid, intuitive processing for efficient decisions,

⁵ Patrice Voss et al., 'Dynamic Brains & Neuroplasticity', *Front. Psychol.* (2017).

⁶ Eleanor A. Maguire et al., 'Navigation-Related Changes in Taxi Drivers' Hippocampi', *PNAS* (2000).

⁷ Gottfried Schlaug et al., 'Increased Corpus Callosum Size in Musicians', *Neuropsychologia* (1995).

⁸ Daniella Laureiro-Martínez & Stefano Brusoni, 'Cognitive Flexibility & Adaptive Decision-making', *Strateg. Mgmt. J.* (2018).

while exploring new ones involves deliberate, analytical reasoning. These findings highlight the role of cognitive flexibility in switching strategies to improve performance in dynamic environments.

In yet another neuroscientific study, Lahti et al.⁹ explored the emotional aspect of the EM, comparing the bond entrepreneurs form with their ventures to parental attachment. The study showed how emotions like self-confidence and attachment impact judgment and DM, highlighting emotions' crucial role in entrepreneurial behaviour.

While these studies lay the groundwork, much remains to be explored in understanding EM. Building on this contribution, we put forward the agenda to integrate neuroscientific tools for a deeper exploration of the EM triad thus more precisely capturing its cognitive, emotional, and behavioural components.

A brief detour: primer on common neuroscientific techniques

Various neuroscientific tools can provide unique insights into the brain's structure, function, and neural activity related to the EM and its components. We have categorized the notable techniques into three main groups: neuroimaging, electrophysiological, and neurostimulation methods (Table 1).

Broadly, neuroimaging techniques like functional magnetic resonance imaging (fMRI), and electrophysiological methods, like electroencephalography (EEG) record brain activity¹⁰. These tools help identify brain regions and networks involved in cognitive, emotional, and behavioural processes relevant to the EM. In contrast, neurostimulation techniques, like transcranial magnetic stimulation (TMS), modulate

⁹ Tom Lahti et al., 'Why and How Do Founding Entrepreneurs Bond with Their Ventures?', *J. Bus. Venturing* (2019).

¹⁰ David Juárez-Varón et al., 'Neuroentrepreneurship', *Int. Entrep. Mgmt. J.* (2024)

brain activity to establish causal links between brain regions and entrepreneurial functions like opportunity recognition or DM under uncertainty¹⁰.

[Insert Table 1 here]

Table 1 Common neuroscientific techniques : a primer

Method		Description	Relevance for the field	
			Theoretical	Practical
Neuroimaging	Functional Magnetic Resonance Imaging (fMRI)	Tracks changes in blood flow to active brain regions during tasks.	<ul style="list-style-type: none"> ●Reveals factors in entrepreneurial DM and risk-taking¹¹. 	<ul style="list-style-type: none"> ●Aligns entrepreneurship with social neuroscience¹³.
	Structural/ Anatomical MRI	Provides high-resolution images of brain structures.	<ul style="list-style-type: none"> ●Providing objective data reduces bias¹². 	
Neurostimulation	Transcranial Magnetic Stimulation (TMS)	Uses magnetic pulses to excite or inhibit specific brain regions temporarily.	<ul style="list-style-type: none"> ●Temporarily disrupts brain regions to study attention, DM, and emotions. 	<ul style="list-style-type: none"> ●Stimulation could enhance performance. ●Non-invasive, applicable to healthy participants.

¹¹ Thomas C. Powell, 'Neurostrategy', *Strateg. Mgmt. J.* (2011).

¹² Stefan Volk & William J. Becker, 'How Insights From Neuroeconomics Can Inform Organizational Research', *Schmalenbach Bus. Rev.* (2014).

¹³ John T. Cacioppo, 'Social Neuroscience', *Am. Psychol.* (2002).

	Transcranial Direct Current Stimulation (tDCS)	Applies low electrical currents to modulate excitability in brain areas.	<ul style="list-style-type: none"> ● Stimulation allows to study memory and risk-taking¹⁴. 	<ul style="list-style-type: none"> ● Improves cognitive skills in high-pressure situations¹⁴. ● Affordable, portable tool for research and training¹⁵.
Electrophysiology	Electroencephalography (EEG)	Records electrical activity along the scalp in real time.	<ul style="list-style-type: none"> ● Explores financial DM and market responses¹⁶. 	<ul style="list-style-type: none"> ● Portable, and cost-effective¹⁵. ● Studies stress and failure responses to build resilience.

¹⁴ Pripfl, Jürgen et al. 'Effects of tDCS on Risky Decision Making Are Mediated by "Hot" and "Cold" Decisions, Personality & Hemisphere'. *Eur. J. Neurosci.* (2013)

¹⁵ Ruff, Christian C. & Scott A. Huettel. 'Experimental Methods in Cognitive Neuroscience'. *Neuroeconomics* (2014).

¹⁶ Armando F. Rocha et al., 'EEG Activity Associated to Investment Decisions', *J. Behav. Brain Sci.* (2015).

	Eye-Tracking (ET)	Measures eye movement patterns during visual tasks.	<ul style="list-style-type: none"> ●Tracks attention in DM and opportunity recognition¹⁷. ●Reveals biases in information interpretation¹⁸. 	<ul style="list-style-type: none"> ●Optimizes presentation of business information. ●Supports training interventions¹⁹.
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¹⁷ Jef Naidoo et al., 'The Eye as a Window to the Soul', *Research Handbook on Strategic Entrep.* (2022).

¹⁸ Martin Meißner & Josua Oll, 'The Promise of Eye-Tracking Methodology in Organizational Research', *Organ. Res. Methods* (2019).

¹⁹ Lina Kaminskiene et al., 'Applying Eye-Tracking Technology in the Field of Entrepreneurship Education', *Springer* (2023).

Bridging research gaps: proposal for future EM studies

These tools can be used independently or in combination with physiological measurements (e.g., heart rate, skin conductance), tasks, and self-reports to provide complementary, granular insights into how the cognitive, behavioural, and emotional aspects of the EM interact. The choice of the most suitable research design depends on the research question. In this context, Table 2 consolidates key open queries within the current scope of EM research²⁰, and suggests how neuroentrepreneurship could help bridge these gaps. Where possible, we draw on seminal paradigms from prior studies in adjacent fields to strengthen the foundations of our proposed inquiries.

[Insert Table 2 here]

²⁰ Daspit, Joshua J et al. 'Entrepreneurial Mindset'. *J. Small Bus. Mgmt.* (2023)

Table 2 Illustration of potential neuroentrepreneurship approaches to EM queries. (The implicated triad components are in bold)

	Open Query	Rationale	Proposal	Exemplar (seminal) application
1	How do cognitive processes within the EM influence DM under uncertainty? (Beugre (2016) ²¹)	The DM processes of entrepreneurs are often influenced by an individual's mindset, which can shape their responses to situations of risk and uncertainty. Understanding the underlying cognitive mechanisms is crucial to exploring how EM facilitates entrepreneurial behaviour.	fMRI could be used to identify brain regions activated during DM tasks involving risk or uncertainty— to help pinpoint areas responsible for processing risk-related stimuli. Additionally, EEG could be used to measure brain waves and response times when entrepreneurs make quick decisions, providing insights into the mental state underlying dynamic risk-taking behaviour.	Gambling Tasks: Numerous studies have used fMRI to investigate the neural correlates of DM under uncertainty in the context of gambling. These studies often examine brain regions associated with risk assessment, reward anticipation, and loss aversion (Bechara et al., (1994) ²²).
2	What emotional states are linked to different types of entrepreneurial mindset?	Identifying the emotional underpinnings of different types of EM could help tailor nudges to improve behavioural outcomes.	EEG could record emotional responses in real-time, detecting changes in brainwave activity associated with emotional regulation. Additionally, fMRI could examine emotional reactions to	'Distraction' and 'Reappraisal' (Gross (1998) ²⁴) are widely used paradigms to study emotion regulation and its adaptive consequences; and can be used with EEG to investigate the neural

²¹ Constant Beugre, 'A Neurocognitive Model of Entrepreneurial Opportunity', *Routledge* (2016).

²² Antoine Bechara et al., 'Insensitivity to Future Consequences Following Damage to Human PFC', *Cognition* (1994).

²⁴ James J. Gross, 'Antecedent- and Response-Focused Emotion Regulation.', *J. Pers. Soc. Psychol.* (1998).

	(Newman et al. (2021) ²³)		high-stakes/stress-inducing tasks by observing changes in activity of brain areas involved in emotional processing.	mechanisms underlying emotional modulation.
3	What are the neural correlates of overconfidence in entrepreneurs, and how does this affect risk-taking behaviour ? (Sharma et al., (2021) ²⁵)	Overconfidence is considered a driver of risk-taking behaviour with potential success/failure consequences. Understanding the neural basis of overconfidence in EM can provide insights into how this trait shapes entrepreneurial behaviour and outcomes.	Both MRI techniques and EEG can be used to investigate the neural correlates of overconfidence by observing how the brain processes self-evaluations and risk-taking decisions by examining the corresponding brain areas involved in risk and reward processing.	Balloon Analog Risk Task is a commonly used paradigm to study risk-taking behaviour (see Lejuez et al., (2003) ²⁶) that can be used in tandem with neuroimaging/electrophysiology tools.
4	What role does self-regulation play in the emotional and behavioural regulation of an	Since EM requires high levels of self-regulation of emotional and behavioural responses during stress or uncertainty, understanding how self-regulation mechanisms operate	EEG and fMRI could help measure real-time emotional responses and capture brain regions involved in self-regulation and emotional control in simulations or tasks of high stakes.	Stroop Task is a classic cognitive task that measures the ability to inhibit prepotent responses and can be employed using fMRI or EEG to investigate the neural correlates of

²³ Alexander Newman et al., 'Entrepreneurial Passion', *Appl. Psychol.* (2021).

²⁵ Gagan Deep Sharma et al., 'Neuroentrepreneurship', *Entrep. Reg. Dev.* (2021).

²⁶ C.W. Lejuez et al., 'Evaluation of the BART as a Predictor of Adolescent Real-world Risk-taking Behaviours', *J. Adolesc.* (2003).

	entrepreneurial mindset? (O'Shea et al. (2017) ²⁷)	within the context of EM can help identify why some entrepreneurs thrive under pressure while others struggle.		inhibitory control ²⁸ . The affective Stroop task specifically measures the inhibition of emotional information.
5	What are the cognitive and emotional mechanisms that differentiate high-performing entrepreneurs from those who struggle? (Javadian et al. (2022) ²⁹)	While some entrepreneurs are highly successful, others struggle despite having similar resources. Identifying the cognitive and emotional mechanisms that distinguish high-performing entrepreneurs from their counterparts could be critical in identifying traits or mindsets that predict entrepreneurial success.	Eye Tracking (ET) could be used to study how successful entrepreneurs focus their attention during DM processes. The patterns of gaze fixation and visual attention could reveal underlying cognitive strategies. Combining it with EEG could further elucidate underlying brain network differences in emotional regulation and reward processing that aid high-performing entrepreneurs.	Multiple object tracking ³⁰ is a versatile paradigm for studying sustained visual attention in a dynamic world. It can be employed as ET and EEG-based tasks to assess interactions between emotion and attentional load impacting performance.
6	How does cognitive load influence the	When entrepreneurs are overwhelmed with too many	fMRI and EEG can be used to measure changes in brain activity	The N-back task is a commonly used paradigm to manipulate

²⁷ Deirdre O'Shea et al., 'Self-Regulation in Entrepreneurs', *Organ. Psychol. Rev.* (2017).

²⁸ George Bush et al., 'Cognitive and Emotional Influences in Anterior Cingulate Cortex', *Trends in Cogn. Sci.* (2000).

²⁹ Golshan Javadian et al., 'Taking the Pulse', *Group & Org. Mgmt.* (2022).

³⁰ Zenon W. Pylyshyn & Ron W. Storm, 'Tracking Multiple Independent Targets', *Spatial Vision* (1988).

<p>entrepreneurial mindset, especially in high-stress environments (emotion)? (Ahmed et al. (2022)³¹)</p>	<p>decisions, their ability to maintain a clear mindset and make sound decisions is affected. Understanding how EM is affected by cognitive load, especially in high-stress situations, is important for understanding fatigue/burnout in entrepreneurship.</p>	<p>associated with cognitive load. This can help identify the brain networks involved in handling high-stress situations and how those with different EMs manage stress or cognitive overload differently.</p>	<p>cognitive load and can be used in fMRI or EEG to investigate the neural correlates of cognitive load. See Pessoa, (2009)³² for its empirical frameworks.</p>
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³¹ Ali E. Ahmed et al., 'Integrating Psychological Resilience, Stress, and Coping in Entrepreneurship', *Entrep. Theory Pract.* (2022).

³² Luiz Pessoa, 'How Do Emotion and Motivation Direct Executive Control?', *Trends Cogn. Sci.* (2009).

An illustration: Exploring the cognitive flexibility of experienced entrepreneurs

Integrating research on higher-order cognitive processes offers a valuable framework for unifying the triad of cognition, behaviour, and emotion within the entrepreneurial mindset (EM). These advanced mental abilities—like strategic DM, adaptive learning, action initiation, and the ability to adjust to novel or uncertain situations—are crucial for entrepreneurs navigating complex and unpredictable environments when routine skills or behaviours fall short. Higher-order cognitive functions like cognitive flexibility (CF), which refers to the ability to shift thinking and behaviour in response to changing contexts³³, are particularly relevant. CF enables entrepreneurs to pivot strategies, overcome challenges, and capitalize on new opportunities. By framing EM within these higher-order cognitive processes, we gain a more holistic understanding that encompasses not only cognitive patterns but also the emotional and behavioural responses that drive entrepreneurial action.

Positing that CF plays a central role in EM, our research group has recently published initial studies exploring how this process can deepen our understanding of EM. Using cognitive neuroscience techniques, these studies highlight CF as an example of a higher-order cognitive process that unites cognition, emotion, and behaviour within EM. In the first study, Ooms et al. (2024)³⁴ used fMRI to examine brain activity during rest. Results showed that habitual entrepreneurs exhibited stronger connectivity between brain regions associated with CF and exploration-exploitation optimization compared to non-entrepreneurs. This suggests that entrepreneurial experience may shape neural networks linked to flexible thinking. In the second study, Ooms et al.,

³³ John P. Dennis & Jillon S. Vander Wal, 'The Cognitive Flexibility Inventory', *Cogn. Ther. Res.* (2010).

³⁴ Frédéric Ooms et al., 'Advancing (Neuro)Entrepreneurship Cognition Research Through Resting-State fMRI', *Entrep. Theory Pract.* (2024).

(2024)³⁵ observed that there are differences in CF between habitual entrepreneurs and non-entrepreneurial managers, indicating that entrepreneurial experience may enhance CF through neuroplasticity.

By enabling entrepreneurs to pivot in response to changing circumstances, CF provides a foundation for innovative thinking and strategic DM. While the findings offer a preliminary exploration, they are intended to inspire future research that leverages multifaceted cognitive neuroscience methods to map the neural and cognitive underpinnings of EM in entrepreneurial DM. As neuroentrepreneurship evolves, it promises to deepen our understanding of the cognitive and neural mechanisms driving entrepreneurial thought and action, offering practical insights into how entrepreneurs can develop skills to thrive in unpredictable, fast-changing environments.

Towards the broader scope

An in-depth understanding of the cognitive, behavioural, and emotional processes—along with their corresponding brain regions—underlying the EM can significantly impact entrepreneurship education and professional development. Neuroentrepreneurship, using advanced neuroscientific tools, offers insights into how key cognitive processes, like CF, evolve from novice to experienced entrepreneurs¹⁰. By identifying adaptive strategies and skills needed to navigate entrepreneurial uncertainties, this research can inform educational programs that cultivate resilience, adaptability, and DM. Additionally, neuroscience can reveal the brain structures and functions, illuminating the “how” and “why” behind strategies to mitigate cognitive biases, enhance emotional regulation, and refine strategic thinking, contributing to a

³⁵ Frédéric Ooms et al., 'Entrepreneurial Neuroanatomy', *J. Bus. Venturing Insights* (2024).

new generation of entrepreneurs with both practical skills and awareness of the mental frameworks driving success¹³.

While neuroentrepreneurship provides valuable insights into the cognitive and neural mechanisms of entrepreneurial DM, several limitations must be addressed. Critics warn against speculative interpretations of neural data, stressing the importance of caution when drawing conclusions from brain imaging³⁶. Additionally, much of the research relies on controlled laboratory settings, which lack ecological validity³⁷ and fail to capture the complexities of real-world DM. Another key limitation is the tendency to isolate entrepreneurial cognition without considering broader social, cultural, and domain-specific factors, potentially leading to an incomplete understanding of what drives entrepreneurial success. To address these challenges, future research should use multimodal approaches that integrate neural, physiological, and behavioural data, alongside psychosocial and environmental variables. Longitudinal and real-world studies are also necessary to enhance ecological validity and bridge the gap between experimental findings and practical entrepreneurship.

³⁶ Craig M. Bennett & Michael B. Miller, 'How Reliable Are the Results from fMRI?', *Ann. NY Acad. Sci.* (2010).

³⁷ Nicos Nicolaou et al., 'Exploring the Potential and Limits of a Neuroscientific Approach to Entrepreneurship', *Int. Small Bus. J.* (2019).

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