Metacognition as a Domain of Skill

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Abstract

This paper presents a framework for understanding metacognition as a distinct domain of skill, drawing on established research in motor and cognitive domains. It proposes that metacognitive expertise shares key characteristics with other skill domains, including goal-directed action, hierarchical organization, declarative and procedural knowledge, and automatization. By integrating theoretical and empirical insights, this paper aims to establish a comprehensive model of metacognitive skill development, with implications for research and practical applications in education, therapy, and beyond.

Keywords: metacognition; metacognitive skill; skill; learning

Introduction

Interest in metacognition has grown alongside the emergence of information-processing models of human cognition. Metacognition, or "thinking about thinking" (Flavell, 1979), continues to be a prominent area of research in cognitive science within fields such as psychology, education, and AI. While metacognition has been shown to be an improvable skill, its characterization as a domain of skill remains underdeveloped. To help articulate metacognition as a distinct domain of expertise, this paper situates metacognitive skill alongside traditional domains of motor skill and cognitive skill, specifying its unique properties, gradability, and hierarchical structure. Drawing on frameworks that identify shared characteristics of skill domains (Shepherd, 2021) and dual-system theories of metacognition (Thompson, Evans, & Frankish, 2009), I argue that metacognitive expertise shares core principles with other skill domains while pursuing distinct goals, such as attentional control, emotional regulation, and meta-learning.

Through a synthesis of theoretical and empirical work, I outline the knowledge structures and control mechanisms that give rise to metacognitive skill, mapping its development from deliberate instruction-following to automatic, proceduralized responses. The discussion clarifies and refines our understanding of metacognition as a domain, its ideals of success, and the interplay between deliberate control and automaticity. By articulating the foundational characteristics of metacognitive skill, this paper aims to advance both theoretical frameworks and practical applications for metacognitive skill across diverse contexts.

Theoretical frameworks are vital to scientific progress as they unify empirical findings, guide research, and establish conceptual foundations (Kuhn, 1962). Ideally, a theoretical framework for metacognitive skill would integrate research, distinguish it from general cognition, inform applications, and clarify how improvements in monitoring and control occur. *First*, this paper outlines key characteristics shared by different skill domains, including goal hierarchies, control, and action restrictions. *Second,* metacognitive skill is positioned within this framework, demonstrating its alignment with existing models while highlighting its unique properties. *Third,* the gradability of metacognitive skill is examined across success rates, goal breadth, and adaptability.

While research affirms metacognition's role in enhancing cognitive performance (de Boer et al., 2018), a key question remains: what characteristics define metacognition as a distinct domain of skill? This paper aims to address this question, contributing to Schraw's (2000) call for a "unified theory of metacognition."

Characteristics of Skill Domains

In this section, I outline the fundamental attributes that define skill domains across diverse fields. Whether in driving, chess, or attentional control, skill domains share core components, including specialized knowledge, hierarchical goal structures, and constraints on both action-types and applicable circumstances. Identifying these shared characteristics provides a conceptual framework for positioning metacognition within the broader landscape of skill, enabling a more precise articulation of its distinct actions, contexts, and objectives.

This discussion is drawn in large part from the research of Joshua Shepherd (2021) and his work on action domains, which begins by emphasizing control as a fundamental component of any skill. In this view, one cannot exercise a skill S without possessing control over behaviors involved in exercising S. Researchers widely agree that skilled action requires agents to possess high levels of control over their activity within a domain, often requiring years of practice.

Ideals, Goals and Actions

Shepherd characterizes control as the agent's ability to flexibly and consistently align their behavior with a planned course of action, which is measured by an ideal of success. An ideal qualifies actions based on their outcomes or overarching goal and serves as a fundamental element of any action domain. Control, in this sense, depends on causal factors that enable an agent to reliably execute actions in alignment with their ideal or overarching goals and the plans to achieve them. Some action domains have only one ideal of success, while others consist of more than one ideal. For instance, the overarching ideal or goal in chess is to checkmate one's opponent, while gymnastics involves a combination of ideals such as form, gracefulness, and complexity of routine.

Goals often require subgoals to achieve, and entail a hierarchical goal structure where goals and tasks are organized according to their conduciveness to the ideal of success. For instance, in basketball, the goal of scoring the most points requires subgoals, such as shooting accurately and defending against opponents' attempt to score. These in turn are supported by further subgoals such as ball handling and footwork. Subgoals can be ordered according to their importance or centrality to higher goals, that is, according to their conduciveness to success. While some subgoals are critical to success, others are peripheral and their contributions are minor. Specific goals and subgoals within a domain require particular action-types for their achievement. The appropriate behaviors and actions possess causal properties that consistently lead to the attainment of goals.

Expertise typically involves agents being skilled at more than one specific action and instead require proficiency in a cluster of action-types. These clusters tend to support each other both heterarchically and hierarchically. Skills that are clustered heterarchical occur simultaneously. For instance a tennis player's forehand serve is improved when combined with a particular body position. Action-types may also be organized hierarchically, or linearly, such as a basketball player's skillful dribbling toward the basket supporting an eventual layup. In the case of cognitive skills such as math, basic addition and division are required to solve more complex equations. The goal and task structures of motor and cognitive domains of skill depend on their conduciveness to their ideals of success or overarching goal. Certain action-types, like aiming, are shared across multiple domains, such as archery and football, demonstrating a partial fluidity between domains.

Restrictions help to define and regulate skill development. Action-type restrictions limit permissible behaviors within a domain, as seen in sports rules (e.g., soccer players cannot use hands) or professional guidelines (e.g., medical procedures must follow ethical protocols). Circumstance-type restrictions constrain where and when skills can be applied, such as playing fields in sports or syntax rules in programming.

The ability of an agent to reliably align their actions with goal-oriented plans is a critical characteristic shared across skill domains, including motor, cognitive, and as we will see, metacognitive.

Knowledge

Skilled actions are shaped by domain-specific and task-specific knowledge. Experts possess robust internal models of their domain, which are crucial for controlling complex actions. Christensen et al. (2016) refer to these as "causal control models." While not always necessary, domain-specific knowledge enhances planning and execution. For example, chess experts rely on knowledge of goals and action-types, such as piece movements and strategic deployment (de Groot, 1978).

Internal models represent causal relationships within a domain, allowing agents to predict outcomes and select appropriate actions. A driver, for instance, relies on an internal model of surrounding vehicles, adjusting their behavior based on changing characteristics like speed, size, and maneuverability. These models support the selection of success-conducive plans — mental representations outlining sequences of actions directed toward a goal. For instance, fire-building techniques range in their effectiveness, and one's expertise involves refining the most efficient approach.

The literature on skill often distinguishes between two primary forms of expert knowledge — declarative and procedural (Fitts, 1964; Dreyfus & Dreyfus, 1985; Stanley & Williamson, 2001). *Declarative knowledge* is formatted propositionally, and encompasses facts, rules, and explicit strategies relevant to a domain. For instance, building a fire requires knowledge of the step-by-step procedures, while chess players must understand the appropriate rules about moves. This form of explicit knowledge enables an individual to articulate conditions for success and the strategies needed to achieve goals, but does not necessarily execute the actions themselves.

Procedural knowledge, by contrast, is implicit and often non-verbal, relating to the specific process of executing tasks within a domain. It encompasses motor and procedural representations that direct and control actions that reliably result in goal attainment. For example, a tennis player may use declarative knowledge to learn proper serving techniques, while procedural knowledge enables the player to physically execute the serve with timing and precision. Procedural knowledge develops and is refined through practice, becoming increasingly automatic, fluid, and efficient.

Proceduralization

Skill acquisition entails a process of automatization, where an agent's actions transition from deliberate cognitive control to more automatic execution (Fitts & Posner, 1967; Anderson, 1982). In dual-system theories, this is described as a transition from System-2 cognitive processes, which are effortful and driven by declarative knowledge, to System-1 operations, which are more automatic and procedurally driven (Kahneman & Frederick, 2004). This process, also known as proceduralization, plays a key role in the refinement of both motor skills and cognitive skills (Ford, Hodges, & Williams, 2005; Anderson, 1982; Tenison & Anderson, 2016).

At the core of proceduralization is the shift from declarative to procedural knowledge. Early in learning, individuals rely heavily on declarative, explicitly accessible facts and rules to consciously guide performance. Through repeated practice, this slow and effortful retrieval process is progressively replaced by procedural knowledge, which enables faster and more efficient task execution with minimal cognitive effort (Fitts & Posner, 1967; Dreyfus & Dreyfus, 1985; Kim & Ritter, 2015). This process enhances fluency and adaptability, enabling experts to operate effectively in dynamic and unpredictable contexts.

Importantly, expertise does not eliminate cognitive control entirely. Instead, routine elements of performance become automatic, while higher-order processes are reserved for error detection, strategy refinement, and goal adjustment (Fridland, 2019).

While some domains require the automatization of a narrow range of specialized skills (e.g., a baseball pitcher refining throwing mechanics), others require the integration of a broader set of skills (e.g., a trial lawyer combining reasoning, persuasion, and speaking). In both cases, skill is gradable, varying in proficiency, success rate, task range, and adaptability. To possess partial skills means an agent excels in certain dimensions while being less developed in others, which highlights another important aspect of skill — its gradability.

Gradability of Skill

The gradability of skill means that an agent can possess varying levels of proficiency within a domain. Shepherd (2021) propose three principal dimensions along which a skill may vary: the success-rate at achieving goals (height), the range of goals achieved (breadth), and performance across diverse circumstances (depth).

The dimension of *height* refers to the agent's actual success-rate at goals central to a domain. A higher success-rate in achieving goals typically reflects greater skill. Priority is often given to actions that contribute more to overall success, or to central goals within the domain.

The dimension of *breadth* involves the agent's success-rate across the various goals within a domain. An agent is considered more skilled if they can maintain higher success across a larger range of action-types or sub-skills, with greater emphasis placed on more central goals.

The dimension of *depth* evaluates the range of circumstances under which an agent can maintain good performance. This entails the flexibility of skill, differentiated from the brittleness of habit, where the control of action can adapt to novel situations reliably, such as golfers adapting to changing wind conditions and terrain. The more varied the situations in which an agent can demonstrate strong height and breadth, the greater their skill.

These three dimensions interact and contribute to a more nuanced understanding of skill, with the ideal being high performance across all dimensions. This provides insight into how an agent exerts control to flexibly and consistently align their actions with a goal-oriented plan, whether motor, cognitive, or metacognitive.

Metacognition

First introduced by Flavell (1979) in his research on metamemory, metacognition was initially defined as "one's knowledge concerning one's own cognitive processes" (p. 232). Since then, the term has expanded to involve a wider range of processes, and can be broadly construed as both the monitoring and control of cognitive operations (Proust, 2019; Shea et al., 2014; Wells, 2019). *Metacognitive monitoring* refers to the capacity to perceive and identify cognitive states for the purposes of regulating those states or directing behavior. This can include awareness of our own thoughts and epistemic feelings, such as the feeling of knowing or uncertainty. *Metacognitive control* refers to the active regulation of cognitive states or processes toward the attainment of metacognitive goals.

The interaction between these processes allows for reciprocal adjustments, enabling individuals to monitor and control cognitive processes like attention, emotions, and learning. For example, one may notice their attention drifting while driving and use metacognitive control to refocus. In the same situation, one might identify a distracting emotion and self-regulate through deep breathing or calming techniques. Similarly, a new driver may struggle to remember the correct sequence of actions for changing lanes and use an acronym to help with recall.

Metacognitive skill refers to the ability to monitor and control one's own cognitive processes (Van der Stel & Veenman, 2010). These skills represent higher-order cognitive abilities that regulate thoughts, emotions, and mental processes. Empirical research suggests that metacognitive ability can be improved through practice and training (Meher, Baral, & Bhuyan, 2021). For example, educational interventions can enhance problem-solving, self-regulation, and academic performance (Zimmerman & Schunk, 2011), while attentional processes can be strengthened through repeated practice (Posner et al., 2015). Metacognitive training, including mindfulness techniques, can also improve cognitive control and emotional regulation, as demonstrated in Cognitive Behavior Therapy (CBT; Dobson, 2013) and Metacognitive Therapy (MCT; Normann & Morina, 2018), both of which support the regulation of maladaptive thoughts and emotions (Wells, 2019). Many psychiatric disorders, like anxiety and depression, reflect deficits in metacognitive skill, making its development a promising therapeutic approach distinct from purely pharmacological or discursive methods (Zawidzki, 2019).

Metacognition as a Domain

This section connects the previously discussed domain-general characteristics of skill to the specific properties of metacognition, highlighting its unique goals, knowledge, and action-types. While the literature covers a broad range of metacognitive abilities including metamemory, metaperception, and metareasoning, this discussion focuses on paradigmatic examples of metacognitive skill in attentional control, emotional regulation, and meta-learning.

Metacognitive Ideals, Goals and Actions

Expert metacognitive control requires the ability to flexibly and reliably align mental actions with a plan, evaluated against an ideal of success. This ideal represents an overarching standard for an optimal outcome in a specific metacognitive subdomain (e.g., an ideal attentional, emotional state, or learning outcome).

Within the literature on attentional skill training, various ideals of success are studied, ranging from achieving a maximally stable narrow focus to an inclusive open-monitoring (Favre-Bulle et al., 2024; Eberth et al., 2019). In this context, metacognitive control involves continuously monitoring and adjusting one's mental actions to align with overarching goals and subgoals. Metacognitive goals are goals directed at one's own mental processes, such as maintaining attentional focus or adopting attitudes like nonreactivity and disidentification (Lange, 2025). Some ideals allow for a plurality of goals, while others may encompass only a single goal. For example, achieving stable focus may involve training attention on specific sensory modalities, such as sight, sound, or the breath.

The attainment of metacognitive goals is supported by subgoals and their corresponding action types. Typically, metacognitive subgoals that best support the ideal of success are prioritized. In developing stable narrow focus, subgoals may include ignoring irrelevant stimuli and preventing mind-wandering. Subgoals can be trained independently, with action-types applied both hierarchically (e.g., clearing the mind before focusing) and heterarchically (e.g., simultaneously focusing and resisting mind-wandering).

Emotional regulation similarly involves controlling mental actions to achieve an ideal state, such as one entirely free from anxiety (Gross, 2014; Eberth et al., 2019). Various approaches can be used to achieve these ideals, including cognitive reappraisal and mindfulness techniques (Dobson, 2013; Wells, 2019). For instance, in managing anxiety, subgoals may include identifying emotional triggers and reducing reactivity to them. These subgoals can be trained independently through additional subgoals and action types, some of which may transfer from other metacognitive domains like attentional training.

From this, it follows that metacognitive skills in attentional control and emotional regulation encompass a diverse range of goals, subgoals, and mental action types. Similar to motor and cognitive skills, metacognitive skill relies on factors that enable reliable control of mental actions, aligning them with plans, goals, and ideals of success. Repeated practice of these deliberate mental actions enables agents to achieve their metacognitive goals more consistently, effectively, and flexibly.

Metacognitive Knowledge

Skilled metacognitive control largely depends on domain-specific metacognitive knowledge — metarepresentations — a propositional form of declarative knowledge that refers to cognitive or metacognitive properties (Shea et al., 2014; Proust, 2019). Metarepresentations help build internal models that capture the key attributes, processes, and causal relationships within a metacognitive subdomain. Metacognitive causal control models are essential for metacognitive skill, as they allow agents to predict and select the appropriate mental actions to achieve metacognitive goals. For instance, the development of attentional control relies on internal causal models that represents the target of focus, the relevant mental actions needed to sustain attention, and potential obstacles such as mind-wandering (Jahn et al., 2023). Emotional regulation can also be supported by causal knowledge of monitoring strategies that reliably reduce intrusive thoughts (Wells, 2019). By leveraging these models, individuals can dynamically adjust their strategies in response to obstacles, enhancing their ability to attain metacognitive goals. A model that explicitly represents the appropriate sequence of mental actions needed to achieve a goal can also take the form of a plan or metacognitive instructions (meta-instructions).

Metacognitive knowledge differs from metacognitive skill, as it does not necessarily lead to the automatic deployment of metacognitive processes (Veenman & Elshout, 1999). In any domain, executing declarative instructions relies on procedural knowledge to carry out the task. Similarly, through repeated practice of metacognitive instructions, domain-specific and task-specific procedural knowledge is developed and refined into more skillful forms. Veenman et al. (2006) argue that metacognitive skills are best understood as domains of procedural knowledge. For example, attentional training techniques may start as declarative metaknowledge but become fluent through practice, building the procedural knowledge required for automatic execution (Anderson, 2016). Zawidzki (2019) similarly views metacognitive skill as a form of skilled know-how, akin to physical or cognitive skills, but specifically focused on regulating one's own cognitive processes, including attention and emotion.

Dual-process Metacognition

Researchers have found it useful to adopt a dual-process approach to metacognition, distinguishing between two levels with distinct functions and types of representation (e.g., Koriat, 2000; Arango-Muñez, 2011; Proust, 2013). System-1 metacognitive control largely operates through fast, implicit, and procedurally-driven processes. These involve operations that are less consciously accessible and more automatic, such as attention guided by metacognitive feelings like fluency (ease of processing).

System-2 metacognitive control is directed by slower, explicit metacognitive knowledge (metarepresentations). These processes are more deliberate, effortful, and demand greater working memory. Conceptually-driven metacognitive control is more amenable to intentional cultivation, as in cases of learning strategies for regulating one's attention, emotion, or reasoning processes (Jahn et al., 2023; Richards & Gross, 2000; Fletcher & Carruthers, 2012). This tractability is the rationale for focusing on System-2 processes within our characterization of metacognitive skill.

While System-2 and System-1 processes are often discussed separately, research suggests that high-level metacognitive skill emerges from their dynamic interplay. Evidence indicates that dual-process metacognition is amenable to the same process of skill automatization seen in other dual-process accounts. With practice, System-2 metacognitive instructions can become increasingly automatic, displaying characteristics more closely associated with System-1 (Conway-Smith & West, 2022). Mental actions that are initially deliberate, effortful, and conceptually-driven can transition to become more procedurally-driven and automatic.

Experiments by Ramamurthy and Blaser (2017) demonstrate what they refer to as "procedural attention." In their study, participants were given instructions on how and where to direct their attention, which, with practice, became automatically directed toward the rehearsed locations. This was presented as evidence for an "offline" attentional selection mode i.e., cognitively unsupervised and automatic. The authors noted that this mode is "analogous to the procedural memory that guides skilled motor behavior" (p. 1).

Metacognitive skills initiated through System-2 processes offer greater adaptability to novel situations. For instance, deliberate practice of attentional techniques can improve the ability to allocate attention effectively across diverse contexts (Jahn et al., 2023). In contrast, System-1 processes that are not intentionally trained tend to remain automatic but stimulus-dependent. For example, when attention becomes habitually directed toward entertainment or phone scrolling, focus is likely to remain confined to those specific contexts (Choi et al., 2021). This type of metacognitive automaticity is largely involuntary and lacks the flexibility that characterizes high-level expertise.

As automatization transforms slow, effortful strategies into fast, automatic responses, it offloads tasks from working memory, freeing cognitive resources for higher-level control. This enables cognitive reinvestment, where working memory can be redirected toward planning, error detection, or adapting to novel situations (Masters, 1992).

The flexibility of automatized metacognitive strategies is partly due to reduced working memory demands, allowing for ongoing monitoring and adaptation to cognitive challenges, such as attention lapses or emotional reactions. Just as an experienced driver can adjust to changing road conditions, skilled metacognitive agents can adapt their mental actions to novel distractions and variations in cognitive and emotional states (Posner, Rothbart, & Tang, 2015).

Stages of Metacognitive Skill Learning

Research indicates that metacognitive skill development follows established models of skill acquisition, progressing from deliberate, effortful control to automatic, fluent performance (Conway-Smith, West, & Mylopoulos, 2023). This section explores how metacognitive skills become more automatic over time, focusing on the types of knowledge that support this progression.

Building on classic skill acquisition theories in motor and cognitive domains, metacognitive skill begins in the *declarative stage*, where individuals rely on explicit, consciously applied strategies to regulate cognitive processes (Fitts, 1964; Anderson, 1982). At this phase, metacognitive actions require significant working memory, as learners must deliberately recall and apply strategies for monitoring attention, regulating emotions, or assessing comprehension. For instance, a novice learning an attentional control technique may consciously follow instructions to maintain a stable focus, such as repeatedly redirecting their awareness to a specific target when their mind wanders.

As practice continues, the *associative stage* involves the gradual proceduralization of metacognitive strategies. Metacognitive instructions become increasingly integrated with procedural knowledge, allowing them to be executed more efficiently and with less conscious effort. Instructions that once required conscious effort become more refined and automatic over time. For example, an individual practicing cognitive reappraisal to regulate emotions may initially follow structured steps but, over time, learn to assess and adjust emotions intuitively.

In the *automatic stage*, metacognitive processes become highly automatic, requiring minimal conscious oversight. At this phase, procedural knowledge allows for quick and efficient metacognitive monitoring and control in response to environmental or cognitive cues. For instance, an experienced meditator may effortlessly refocus their attention when distractions arise, without consciously recalling specific instructions. Similarly, a skilled learner may automatically detect comprehension difficulties and adjust their reading approach without explicit reflection.

These three stages capture an important process of metacognitive skill learning, though they do not encompass the full complexity of skill acquisition. Metacognitive proceduralization follows a structured trajectory, moving from deliberate, effortful control to automatic, fluid execution.

It is important to emphasize that while metacognitive proceduralization reduces cognitive effort and enhances efficiency, expert metacognitive control does not eliminate the need for conscious oversight. Instead, deliberate control remains available for higher-order regulation, such as detecting anomalies, refining strategies, or adapting to novel challenges. For example, an expert may seamlessly regulate their focus under routine conditions, yet can engage explicit monitoring processes when faced with unexpected demands, such as heightened stress or unfamiliar problems (Zimmerman & Schunk, 2011).

Partial Skills

In some metacognitive domains, agents may require only partial skills to succeed, while others necessitate a broader range of metacognitive strategies. For example, achieving single-pointed focus may only demand resistance to mind-wandering, while maintaining broader attentional goals — like open monitoring, or impermanence perception — may require a cluster of skills, including metacognitive sensitivity, adaptability, and the ability to shift focus flexibly. To possess partial metacognitive skills means to excel in certain subdomains while being less developed in others, underscoring the gradability of metacognitive expertise.

Gradability

Metacognitive skills are gradable, meaning that monitoring and control processes can vary in proficiency. Here, the gradability of attentional control is examined across three key dimensions: success rate (height), breadth of achieving goals, and adaptability across circumstances (depth).

Height in the context of metacognitive skill refers to an individual's success rate in achieving metacognitive goals. Higher proficiency in sustaining attention, for example, indicates greater skill in this subdomain. Priority is generally given to actions that most effectively contribute to this central goal. In attentional training, concentration on a target of focus takes precedence over peripheral subgoals like clearing the mind. In emotional regulation, sustained attention may serve as a secondary goal, supporting broader objectives such as perceiving the impermanence of emotions.

Breadth captures an agent's success across various metacognitive goals and subgoals. Greater attentional skill is expressed as proficiency across multiple attentional action-types, such as resisting intrusive thoughts and maintaining open monitoring. Similarly, emotional regulation skills that enhance impermanence perception rely on a broad set of attentional capacities, including focused attention, open awareness, and non-reactive observation.

Depth reflects the ability to maintain metacognitive control across diverse and dynamic circumstances. It measures how well an agent adapts their mental actions to novel challenges. For example, an individual with a depth of attentional skill can sustain focus across different cognitive tasks, environments, and emotional states.

The skill development of a novice in emotional regulation training illustrates this framework. Initially, they exhibit limited height (low success rate), narrow breadth (few skills), and shallow depth (limited adaptability to complex or changing emotional states). Novices often begin by applying a domain-specific metacognitive plan, typically introduced by an instructor, therapist, or another form of structured guidance. Through repeated practice, they gradually develop greater breadth, height, and depth of skill. Another example involves attention training, where a novice may struggle to maintain focus for extended periods and frequently become distracted. Their initial goal attainments, such as brief moments of sustained attention, are evaluated against an ideal of success, serving as a benchmark for progress in both the quality and duration of attentional stability.

Restrictions

Restrictions on metacognitive action-types and the contexts in which they are applied influence both the development and practical use of metacognitive skills.

Action-type Restrictions. Metacognitive skill is inherently constrained by the types of mental actions an agent can perform. These boundaries define what is possible within metacognitive domains and guide skill refinement. For instance, equanimity, a key component of emotional regulation, requires focusing on the impermanence of physical sensations rather than visual or auditory stimuli (Wongpakaran et al., 2021). In this case, the target of focus is critical to achieving desired metacognitive outcomes. Certain restrictions also differentiate legitimate metacognitive actions from external enhancements. For example, while caffeine may improve attention, it does not constitute a metacognitive action. Similarly, metacognitive expertise excludes pharmacological interventions, as they bypass skill development and do not improve deliberate, self-directed cognitive processes.

Circumstance-type Restrictions. The effectiveness of metacognitive training is also shaped by environmental and situational constraints. Novices require controlled, low-distraction settings — dim lighting, silence, or the absence of emotionally charged stimuli — to develop attentional focus and emotional regulation. In contrast, experts can sustain metacognitive control in more dynamic and unpredictable environments, demonstrating greater adaptability and depth of expertise. These restrictions evolve alongside skill development. A novice meditator may struggle to maintain focus in a noisy environment, while an expert can sustain equanimity even within chaos, such as during emotionally charged interactions or high-stakes situations. This underscores the importance of tailoring metacognitive training to match an individual's level of expertise.

Conclusion

This paper establishes metacognition as a distinct skill domain that shares core principles with motor and cognitive skills. By framing metacognition as a domain of skill, it bridges theoretical and empirical research, offering insights into attentional control, emotional regulation, and meta-learning. It argues that metacognitive expertise involves structured, goal-directed action, hierarchical organization, and the gradual transition from deliberate control to more automatic responses.

Future research should investigate the neural correlates of metacognitive proceduralization to determine whether they align with established patterns in motor and cognitive skill learning. Additionally, studies could assess the timing and accuracy of learning in different metacognitive subdomains, like attentional control and metamemory, to evaluate whether their proceduralization follows similar trajectories. This could involve using behavioral and neural measures, like eye-tracking and EEG, to capture these transitions.

By articulating the foundational components of metacognitive skill, this paper offers a conceptual foundation that can help guide empirical research and support the design of practical training approaches, with implications for education, therapy, and beyond.

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