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Editorial: Advances in metacognition and reflection

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Editorial on the Research Topic
Advances in metacognition and reflection

Metacognition, first coined in the literature in the 1970s by Flavell (1976) has been the focus of diverse disciplines (e.g., developmental, cognitive, and educational psychology, psychiatry, and criminal justice) because of its substantial, positive impact on development and learning in these fields. We know it is critical for greater and deeper learning and positive life outcomes (e.g., prisoner rehabilitation: Gois and Kane, 2025; academics: He et al., 2024; trauma-related treatment: Wiesepape et al., 2025) but we also know that it is rarely explicitly taught or fostered in formal or informal learning contexts and its development rarely occurs naturally. In fact, in Flavell's unveiling of this term, which has kept us all busy for many decades since, he focused not on its abundance but on how it is most conspicuous (and negatively impactful) in its absence:

> "Resnick and Glaser's research provides us with some striking examples of children failing to solve problems for which they possess the necessary solution procedures. They ought to solve these problems, we think, and yet they do not. Why not? My own guess on the matter originates in the expected place, namely, the area in which I have done most of my recent research and thinking. This area is the development of metacognition." (Flavell, 1976, p. 232).

Historical perspective

Although the official unveiling of the term "metacognition" is relatively new (Flavell, 1976, 1979), there is a long history of references to similar concepts such as reflection or introspection, traces of which can be seen as far back as the musings of Plato, Aristotle, and Simonides. John Locke, in 1690, introduced greater specification by distinguishing "reflection" as a more important and privileged form of thinking than other forms or "sensations" that do not tend to produce "long-lasting ideas" or a deep, reflective type of cognitive processing. Furthermore, early educators such as John Dewey had similar ideas. In his Pedagogic Creed (Dewey, 1897), Dewey stated his belief that the learning process would be disorganized and unsystematic (and thus not "educative") if left unexamined and that looking within one's psychological processes would lead to educative leverage. It is likely that the influx of behaviorism into the field of psychology and education in the early 20th century is related to the hiatus in the focus on research and theorizing about metacognition and reflection and, similarly, to the resurgence of this focus shortly after the shift from behaviorism to cognition with the "cognitive revolution" of the 1950s. This shift resulted in the consequential work of developmental psychologist Flavell

and his contemporaries. The zeitgeist was substantial and led to a greater convergence and alliance between the fields of psychology and education, making this body of literature more interdisciplinary and, ultimately, leading to greater contextualization, developmental appropriateness, and ecological validity in the study of metacognition. The rapidly growing body of extant meta-reviews (e.g., Eberhart et al., 2025; He et al., 2024; Norman et al., 2019; Ohtani and Hisasaka, 2018) and primary research (e.g., Coughlin et al., 2022; Desoete and De Craene, 2019; Fu and Qi, 2025; Özçakmak et al., 2021) on metacognition and reflection provide robust evidence of their strong and unique predictive power for important outcomes. Although metacognitive processes have been studied for at least five decades, it is only in recent years that this investigation has included infancy and early childhood, with initially promising and, in 2025, robustly positive and strong results (e.g., Chen et al., 2023; Gourlay et al., 2020; Marulis and Nelson, 2021; van Loon and Roebers, 2024; Whitebread and Neale, 2020). This shift is not only developmentally inclusive but also has critical implications for improving developmental and life trajectories based on the greater cognitive malleability in the early years of development. This Research Topic further elucidates early childhood metacognitive processes contributing to a comprehensive understanding of their developmental trajectory.

Conceptualization and measurement

Observing a set of family portraits, Sir Arthur Conan Doyle's fictional Sherlock Holmes, declaring himself a connoisseur of the arts, remarked on their high artistic quality and, ever the reflective thinker, continued to analyze his assessment of the portraits with the following: "I know what is good when I see it, and I see it now" (Doyle, 1902; p. 93). Perhaps the more known, definitely more modern, and non-fictional instance of this concept occurred in 1964 with U.S. Supreme Court Justice Potter Stewart's explanation of how he determined (i.e., measured) obscene material not protected under the First Amendment, which was essentially, "I know it when I see it." At first glance, these statements elicit something nebulous without a defined set of characteristics, but the idea that "I" (seemingly referring to someone with expertise or authority over a matter) will be able to reliably identify this "something" is also powerful. In the case of this Research Topic, the "something" of focus–advancing our understanding of metacognition and reflection–is particularly important given the consistent, robust, and positive impact these skills have across development and types of learning. The inherent challenge, then, is to reverse engineer this knowledge into operationalized indicators. Since its debut in the literature, there have been calls for achieving a universally agreed-upon conceptualization of what "metacognition" is and is not. The challenges of this endeavor are as great as the rewards. On the one hand, the challenges and difficulties include contradictory findings and limited or no coherence; on the other hand, the benefits include convergent evidence across disparate methods and the emergence of a developmental trajectory for metacognition and reflection. To this end, we have seen decades of rigorous research yet, in some ways, we are no closer to a consensus. I suggest is that we direct our attention to a new charge: Rather than focusing on the struggle to achieve full *unity*, we focus on achieving conditional (contingent and adaptive), calibrated (precise), and *unified* (internally consistent) conceptualizations of metacognitive processes. Collaborative efforts such as this Research Topic reflect this type of pivot and represent metacognition for its complexity and strength.

In the Editorial of a previous Research Topic on metacognition in the *International Electronic Journal of Elementary Education* (Desoete and Özsoy, 2009), capturing metacognition was compared to the murkiness of Scotland's Loch Ness monster. For the sake of argument, I will posit that the authors of this Editorial were referring to the *sightings* (i.e., measurements) of the popular "monster" that are purported to have begun in 565 AD. In this case, it follows that there is something there; something is being seen (previous scientific explanations include boat wakes and other sea creatures such as large eels or water birds, and non-scientific explanations include mythology and intentional hoaxes) and perhaps some would say they would "know it when they see it."

Metacognition was first conceptualized (in the 1970s) as "thinking about thinking," or metacognitive knowledge followed by the addition of regulation of cognition (Brown, 1978, 1987), monitoring and control (Nelson and Narens, 1990) and more recently, motivational, and affective processes (Efklides, 2011). In practice, these conceptualizations translated into a 3-part skill set (plan, monitor, evaluate) (Fogarty, 1994). Their culmination is a broad conceptual agreement of metacognition as the knowledge, regulation, and monitoring of cognitive processes.

An apt analogy for the measurement of metacognition can also be found in black holes within the domain of the physical sciences. The history of the study of black holes has moved from mathematics to physics and from theory (general relativity) to simulations and experiments to telescopic evidence (Oldham and Auger, 2016). Similarly, the study of metacognition has evolved from an abstract conceptualization of the existence of "something" that was hard to pin down but had clear effects to the emergence of (sometimes contradictory) theories and models to the use of more precise and comprehensive measurement tools such as systematic observational coding protocols, computer hardware and software, eye-tracking, and electroencephalogram (EEG). Through these advances, like black holes that have powerful interactions with things around them but can only be seen with special equipment, we have not only been able to fine-tune and calibrate the conceptualization and measurement of metacognitive processes but have also gained a much deeper understanding of their importance for to successful learning and other life outcomes. In both cases, as measurement tools and methods have advanced, so have our understandings and applications.

Specific analogical comparisons between metacognition and black holes or the folklore of the Loch Ness monster may be a bridge too far; nonetheless, these converging ideas across disparate spheres underlie the concept of the existence of an important and impactful "something" (e.g., quality of art; obscenity; Nessie; black holes; metacognition). The important point here is the abstraction of an increasingly measurable "something" at the core of its domain.

TABLE 1 Advancing and calibrating our understanding of metacognition and reflection: important characteristics and findings of nine Research Topic articles.

References	Type of paper	Age/development period	Metacognitive component	Summary of results
Allen et al.	Conceptual	N/A	Knowledge (epistemic reflection)	A model of epistemic reflection based on interactivism (knowing is doing and, subsequently, predicts successful interactions with one's environment rather than information processing) was proposed to better explain new representations and conceptual changes emerging from reflection.
Bascandziev et al.	Empirical	4.75–9.5-year-olds	Skills (cognitive reflection and monitoring)	Children's monitoring skills were associated with an understanding of physical science concepts controlling for age, EF, and cognitive reflection underscoring the importance of metacognitive skills (specifically consistency monitoring) for young children's scientific learning.
Buehler and Oeri	Empirical	5–6-year-olds	Skills (monitoring and control/regulation)	Older children ($M = 5.85$ years old) displayed greater metacognitive control than younger children ($M = 5.05$ years old) on a newly developed, ecologically valid, unsolvable problem-solving task, although no age differences were found for metacognitive monitoring. Children showed more metacognitive monitoring and less control in the solvable than in the unsolvable part of the wooden puzzle.
Dutemple et al.	Empirical	5–6-year-olds	Skills (broad explicit and implicit)	Implicit and explicit metacognition (not EF) significantly predicted school readiness beyond age and sex. Correlations were found between explicit metacognition and EF.
Jacobs et al.	Empirical	7–9-year-olds	Skills (control/regulation)	Significant positive correlations were found longitudinally between metacognitive control and arithmetic accuracy in 7-8 year olds. However, post-error adjustments in arithmetic and the working memory tasks were not correlated.
Kim and Carlson	Mini review	Infancy-Adulthood	Skills (monitoring, cognitive reflection, and control/regulation)	To better understand the development of metacognition and reflection from infancy through adulthood, interactions with the environment were systematically examined. Specifically, children's exploration (experimenting with multiple, familiar and unfamiliar, options) and exploitation (sticking with familiar options or those perceived to be most advantageous for maximum reward) behaviors were investigated focusing on the benefits for adaptive learning and decision-making in children.
Kolloff and Roebers	Empirical	6-year-olds	Skills (monitoring)	Memory and nonverbal intellectual ability were found to be related to metacognitive monitoring, although the impacts of nonverbal intelligence were modest, indicating that young children's nonverbal intellectual ability and metacognitive monitoring skills are relatively independent constructs.
Tomasello	Conceptual	Infants and preschool-aged	Skills (control/regulation)	A developmental (What is regulated? How is it regulated? Where is it regulated?) model integrating executive and metacognitive processes was proposed in which executive processes monitor and control action and attention; in turn, metacognitive processes monitor and control these executive processes. Executive processes emerge between 9-12 months of age; metacognitive processes emerge around 3-4 years of age.
Young and Shtulman	Empirical	5–12-year-olds	Skills (cognitive reflection)	Cognitive reflection strongly predicted children's strategic behaviors and interpretation skills and uniquely predicted children's performance beyond age and EF.

As important as art or black holes are to segments of society, so are metacognitive processes. The core aim of this *Advances in Metacognition and Reflection* Research Topic of *Frontiers in Developmental Psychology* was to build on this foundation and endeavor to fill existing gaps in the past four decades of research on metacognitive processes with a chief focus on reflective

processes. As is representative of the literature on metacognition and reflection, the articles in this Research Topic employ diverse theoretical frameworks, methods, and developmental periods yet converge in one critical way: positive and moderate to strong associations and predictions of metacognition and reflection across developmental outcomes, contexts, and perspectives (Table 1). The key contributions thus lie in the elucidation and parsing of specific metacognitive components; the *what*, *why*, *how*, *when*, and for *whom* of detecting effects. In this way, we take a metacognitive approach to the study of metacognition. As we clarify and precisely investigate the conceptualization, operationalization, and measurement of metacognition and its subcomponents, its shape and form will become less amorphous, and we will not only vaguely "know it when we see it" but we will also be able to precisely identify and explicate its elements, associations, and impacts (see Terneusen et al., 2024). Achieving such conditional, calibrated, unified metacognition has important implications at both the basic (creating new knowledge) and applied (teaching, interventions, policies) levels across development, contexts, and individuals, resulting in more efficient and adaptive learning and successful developmental and life outcomes.

Author contributions

LM: Writing – original draft, Writing – review & editing.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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