Trends in
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Spotlight

Pre- and post-decision signals of certainty in changing minds

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In a recent study, Goueytes and colleagues combined computational modeling with intracranial recordings to dissect the neural basis of confidence and changes of mind. They reveal a temporally organized, spatially distributed hierarchy of evidence accumulation, with pre-decisional signals in the pre-supplementary motor area (preSMA) and post-decisional signals in the insula. This reframes metacognition as a distributed and dynamic process.

Decisions are rarely final. We weigh the evidence, commit, and yet doubt often lingers, sometimes prompting us to revise our course of action. As Jorge Luis Borges noted, 'doubt is one of the names of intelligence': what may appear as a lack of decision might be in fact a metacognitive virtue. Seen this way, confidence is not merely a byproduct of choice but an evolving signal, open to revision and capable of shaping behavior as new information comes to light.

How we monitor and reason about our own decisions stands as a core topic in contemporary cognitive sciences, and represents part of the study of metacognition. Two main traditions have framed this capacity. One conceives it as a Bayesian computation of uncertainty – or confidence – implemented by probabilistic neural mechanisms of perception. The other emphasizes higher-order access to internal states, highlighting its role in the conscious appraisal of mental processes and in judging our own behavior. Beyond these traditions, recent work underscores metacognition as a domain-general controller of behavior across cognitive functions, a generality that positions it as a transdiagnostic trait [1]. Confidence and changes of mind provide a privileged testbed where all these perspectives converge.

In Bayesian frameworks, confidence is typically taken as the posterior probability of being correct. Yet its exact nature and computation remain debated: some accounts treat confidence as a direct readout of the choice process [2], others combine this readout with stimulus uncertainty or evaluative signals [3], and still others regard it as a construct emerging only after the decision itself [4]. Behavioral and electroencephalographic (EEG) studies have suggested that confidence may rely on evidence accumulation both before and after a decision, but they lack sufficient spatial precision to map these processes across specific cortical regions. Functional magnetic resonance imaging (fMRI), in turn, provides brain-wide coverage but is limited in temporal resolution, making it difficult to disentangle pre- from post-decisional dynamics. As a result, the question of how the timing and neural substrates of confidence and changes of mind align – and whether they share a common mechanism – remained largely unresolved. In a recent study, Goueytes and colleagues [5] directly addressed these issues by integrating intracranial electrophysiology with computational modeling. The authors combined computational modeling with stereotactic EEG (sEEG) in 24 individuals with drug-resistant epilepsy [5]. This approach offers a unique combination of millisecond temporal precision and fine-grained spatial resolution, which allowed the authors to track evidence accumulation directly in the human cortex. The experimental design was equally potent: participants performed a visual motion discrimination task while reporting their confidence, and computer mouse trajectories were tracked to capture directional shifts as a proxy for changes of mind in real time. This approach builds on earlier work using continuous motor tracking to reveal covert decision revisions [6]. Unlike previous studies that assessed confidence only before or after a choice, this paradigm captured the full dynamics of decision, confidence, and revision as they unfolded in real time.

The findings reveal a striking division of labor across cortical regions. In the preSMA, evidence-accumulation activity tracked confidence from stimulus onset up to the moment of decision, pointing to a pre-decisional role (Figure 1). By contrast, in the insula, similar signatures extended beyond the decision itself, consistent with an after-commitment mechanism. This anatomical dissociation was captured by a computational model of evidence accumulation, which reproduced decisions, response times, confidence ratings, and changes of mind using both pre-decisional and post-decisional evidence-accumulation dynamics. This highlights that post-decisional evidence accumulation is not just a behavioral afterthought but a core computational component of metacognitive monitoring, essential for models aiming to account for both confidence and changes of mind [7]. Notably, in the study by Goueytes and colleagues, changes of mind occurred in roughly 10% of trials, when computer mouse trajectories reversed mid-response, and were predicted by the same dynamics observed in the preSMA, insula, and orbitofrontal cortex. Together, these results place confidence and changes of mind within a dynamic framework of evidence accumulation unfolding before and after choice.

Perhaps less highlighted in the original report, but no less striking, is the finding that evidence-accumulation signals are

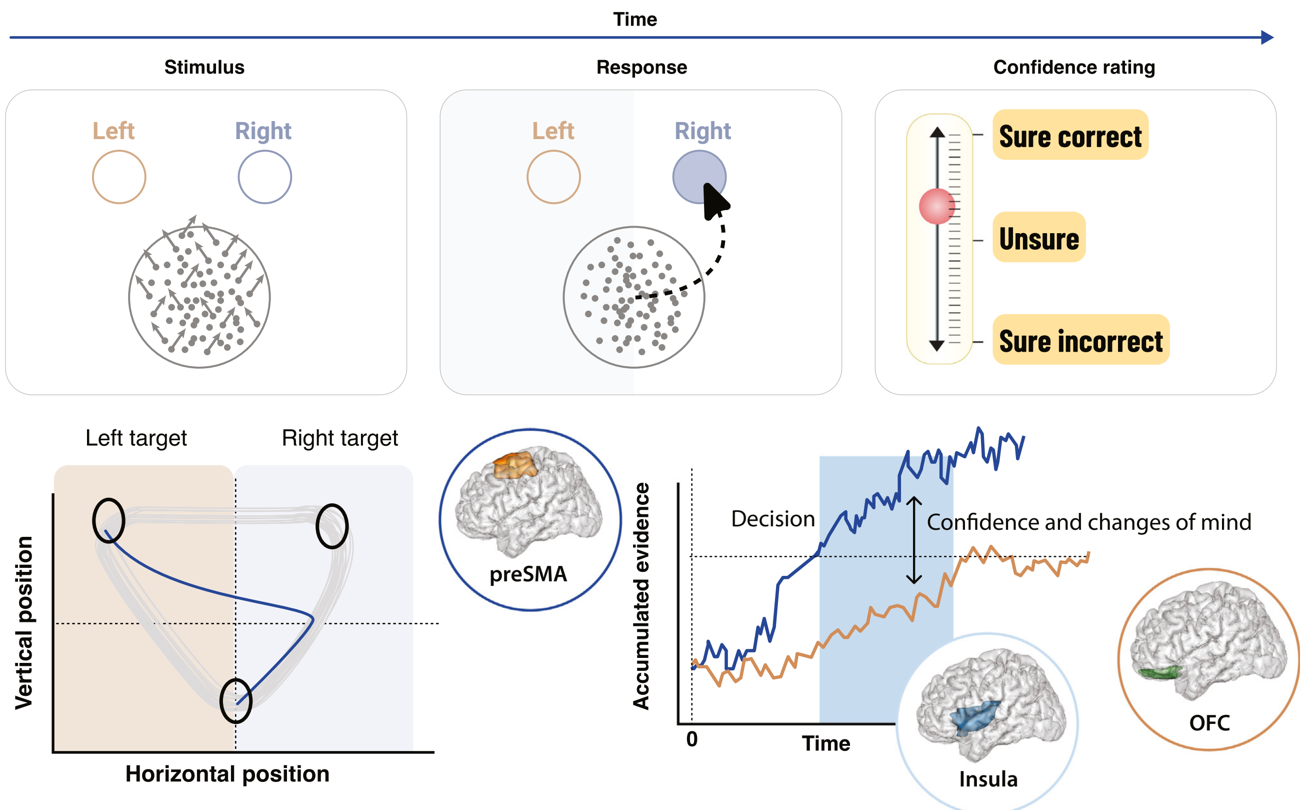

Figure 1. Neural dynamics of confidence and changes of mind in perceptual decision-making. In a recent study, Goueytes and colleagues combined intracranial recordings with computational modeling to examine the temporal dynamics of confidence and changes of mind in humans [5]. Top: participants judged the net motion direction of a random-dot stimulus, responded by moving a computer mouse toward the targets, and rated their confidence on a continuous scale. Bottom left: mouse trajectories revealed changes of mind when movements curved initially toward the non-chosen option. Bottom right: modeling of neural data indicated a temporally organized hierarchy of evidence accumulation that supported decisions, confidence judgments and change-of-minds. The pre-supplementary motor area (preSMA) encoded evidence-accumulation activity from stimulus onset up to the moment of decision; other areas, such as the insula and the orbitofrontal cortex (OFC), were involved in post-decisional evidence accumulation. Together, these findings highlight distributed and temporally ordered neural mechanisms underlying metacognitive control of decisions. Modified from [5].

widespread across the cortex. This suggests that the mechanisms supporting confidence and changes of mind are not confined to a single canonical region but rather distributed more widely. Foundational work in primates established the parietal cortex as a prime locus of evidence accumulation: neurons in the lateral intraparietal area ramp up with incoming sensory evidence, and their final state at the time of choice predicts both the decision and its associated confidence [8]. In humans, this view was reinforced by EEG studies focusing on the centro-parietal positivity as a marker of accumulation [9]. The study by Goueytes and colleagues, however, broadens this picture. By leveraging wide intracranial coverage, the authors reveal that confidence and changes of mind are not restricted to a parietal hub but also arise in frontal and fronto-insular regions. This distributed profile suggests that metacognitive monitoring may emerge from a network of accumulators – rather than being reducible to a single cortical signature – with a defined temporal organization.

One of the most decisive contributions of the study by Goueytes and colleagues lies in the unveiling of this temporal hierarchy in metacognitive monitoring. Pre-decisional accumulation in the preSMA appears to track uncertainty as evidence unfolds, providing an early estimate of confidence that can shape the imminent choice. By contrast, the insula extends accumulation into the post-decisional period, sustaining confidence signals and enabling changes of mind. This temporal dissociation suggests that metacognition is not a unitary process but unfolds in stages: fast monitoring that prepares the decision, and slower monitoring that allows for revision.

Beyond the authors' main focus, these findings resonate with a broader view of metacognition as embodied and interoceptive, echoing the idea that introspection itself may be a form of interoception [10]. The insula and orbitofrontal cortex – both central nodes of interoceptive networks – emerged as loci where evidence accumulation supports these second-order computations. This perspective suggests that monitoring our choices is inseparable from monitoring our internal states, drawing on bodily signals.

By combining a clever task, computational modeling, and intracranial recordings, Goueytes and colleagues have provided neurophysiological evidence that confidence and associated changes of mind can be understood as arising from temporally distinct phases of evidence accumulation: pre-decisional signals in the preSMA and post-decisional signals in the insula. These findings provide direct evidence for a temporal hierarchy that positions metacognition as a dynamic cascade unfolding across distributed cortical regions rather than a single locus. From a computational perspective, the study reinforces the view that confidence is best modeled as a distributed, temporally structured process. More broadly, it contributes to a growing literature linking metacognition with embodied and interoceptive dynamics, offering further mechanistic insight into how the brain evaluates not only the world, but also its own decisions.

Declaration of interests

The authors declare no competing interests.

Declaration of generative artificial intelligence and artificial intelligence-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT only to improve readability and English language. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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