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We know what stops you from thinking forever: A metacognitive perspective

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Abstract

This commentary addresses omissions in De Neys' model of fast-and-slow thinking from a metacognitive perspective. We review well-established meta-reasoning monitoring (e.g., confidence) and control processes (e.g., rethinking) that explain mental effort-regulation. Moreover, we point to individual, developmental and task design considerations that affect this regulation. These core issues are completely ignored or mentioned in passing in the target article.

Main text

This commentary addresses several major omissions in De Neys's "working model". We predominantly focus on gaps in the conceptualisation of the "switch feature" and stopping deliberative processes (S2).

Metacognitive research deals with the monitoring and control of thinking processes (Nelson & Narens, 1990). More than thirty years of research have dealt with the processes that inform subjective assessments of success (e.g., confidence) and the subsequent decisions (e.g., to rethink, see Fiedler et al., 2019). Of particular relevance is the *meta-reasoning* framework (Ackerman & Thompson, 2017), which is mentioned briefly in section 4.4. By using well-established metacognitive concepts, this framework opens the "black box" of mental effort regulation. It details monitoring and control processes that take place in the early intuitive reasoning stages (S1) separately from the deliberative stages (S2), including processes discussed in the target article and more.

First, the processes covered by the "switch feature" are discussed in length in the literature initiated by Thompson et al. (2011) using the two-response paradigm with *Feeling of Rightness* judgment (FOR, mentioned in section 4.4; Ackerman & Thompson, 2017). FOR is the metacognitive judgment that accompanies the initial response that comes to mind. It has been considered to *trigger the switch between S1 and S2* and found to predict S2 engagement (e.g., Thompson et al., 2013).

A further issue is that the proposed model is incomplete in that the alleged "switch mechanism" is considered to depend entirely on the relative activation levels of competing intuitions and the mysterious "deliberation threshold". In fact, a variety of *situational and personal factors* have been found to affect metacognitive control decisions, such as reasoning time and response choice. Specifically, task design, such as instructions to reason logically (e.g., Ferreira et al., 2006; Morsanyi et al., 2009), cognitive load (De Neys, 2006; Morsanyi et al., 2014), and time pressure (Sidi et al., 2017), as well as individual characteristics, such as thinking dispositions (Cacioppo et al., 1996), cognitive ability (e.g., Stanovich & West, 2000), task-relevant knowledge (e.g., Chiesi et al., 2011; Stanovich & West, 2008), and anxiety levels (e.g., Beilock & DeCaro, 2007; Primi et al., 2018) affect reasoning time and response choice. Thus, any model explaining the "switch feature" should incorporate and account for the contextual and individual factors that influence the reasoning process.

Second, the target article discusses stopping deliberative processes (S2) and reverting to S1. An overlooked issue, though, is *when to stop S2 and provide a response*. Within the metacognitive literature, several models address stopping effortful thinking: the discrepancy reduction models (Nelson & Narens, 1990), the region of proximal learning (Metcalfe & Kornell, 2005), and the Diminishing Criterion Model (DCM, Ackerman, 2014; see Ackerman et al., 2020, for a review). According to the most recent model, the DCM, stopping thinking efforts is guided by a combination of two stopping criteria: (a) Confidence in each considered answer is compared to a desired confidence level. Importantly, this stopping criterion dynamically drops as people deliberate longer, reflecting compromising on expected success. (b) A time limit for thinking about each task item, beyond which people are reluctant to think any further (see also Hawkins & Heathcote, 2021).

Third, based on the suggested model, "System 2 deliberation will extend for as long as the uncertainty remains above the threshold" (section 3.4). Thus, under substantial uncertainty people are *doomed to think forever*. Nevertheless, a totally overlooked aspect is when *people opt out* (e.g., "I don't know") or turn to external help (see Ackerman, 2014, Undorf et al., 2021). In particular, considering children and novices brings to the fore that people looking at unfamiliar problems may not have any available heuristics to activate. Developmentally, there is a blurry line between deliberative and intuitive processes (Osman & Stavy, 2006) in that responses that can be given quasi automatically by adults may require cognitive effort for children (Morsanyi & Handley, 2008) and may become established by learning (Fischbein, 1987; Gauvrit & Morsanyi, 2014). De Neys briefly considers lack of S1 response (section 2.1.5). Another possibility is that people may activate a series of distantly related heuristics, but none of these would be sufficiently strong to offer an answer. In contrast, according to the DCM, when people get to a pre-set time limit, they may prefer opting out over providing a low confidence response. This topic was discussed in metacognitive research already in the 90's (Koriat & Goldsmith, 1996) and was further developed since then (see Undorf et al., 2021). Thus, there are processes that prevent people from thinking forever.

Forth, De Neys asks in the introduction "how do we know that we can rely on an intuitively cued problem solution" and mentions that "the internal switch decision is itself intuitive in nature". In metacognitive terms, these intuitions are based on heuristic cues that underly all metacognitive judgments (Koriat, 1997). Metacognitive judgments *combine* an extensive amount of features (Undorf & Bröder, 2021), including individual self-perceptions and beliefs ("beyond my expertise"), task characteristics (time pressure), and item characteristics

(conclusion believability) that may influence, and sometimes mislead, metacognitive judgments (see Ackerman, 2019). Given the wide-spread biases in judgments like FOR and confidence (Thompson et al., 2013), considering potential misleading factors must be incorporated in any model of switch and stopping mechanisms.

Finally, from a developmental perspective, adults have a larger repertoire of heuristics and better ability to integrate them into their cognitive and metacognitive processes than children (Koriat et al., 2014). However, in the proposed model, the more heuristics are considered, the longer the thinking process that deals with potential conflicts among them. This contrasts with the traditional role assigned to reasoning heuristics - that they offer immediately available (and highly compelling) responses *immediately* (e.g., Evans, 2006), which is why they are considered to be adaptive and essential parts of the cognitive architecture.

In sum, the proposed model ignores well-established bodies of literature that address the central issues it was meant to cover. Particularly, metacognitive research offers switch and stopping rules, heuristic processes, individual characteristics, and developmental trajectories required for describing the complex processes underlying reasoning.

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