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A View from Mindreading on Fast-and-Slow Thinking

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10 ABSTRACT: (60 words)

De Neys' incisive critique of empirical and theoretical research on the exclusivity feature underscores the depth of the challenge of explaining the interplay of fast and slow processes. We argue that a closer look at research on mindreading reveals abundant evidence for the exclusivity feature—as well as methodological and theoretical perspectives that could inform research on fast and slow thinking.

11 MAIN TEXT

De Neys opposes the 'exclusivity feature', on which fast and slow processes are 'exclusively tied' to particular responses. De Neys explains that 'there is no solid empirical ground for the exclusivity assumption'—this is the 'fundamental problem' of the target article. However, with respect to empirical evidence, De Neys mentions mindreading only in passing. Will a closer look at mindreading give him reason to reconsider the exclusivity assumption?

Methodologically, the studies De Neys relies on mostly involve observing direct, explicit choices, as is typically the case in research on reasoning. In mindreading research, by contrast, the norm is to observe both indirect implicit and direct explicit behaviours generated by a single scenario. These include anticipatory looking and verbal responses (Clements & Perner, 1994), early mediolateral motor activity and purposive action (Zani et al., 2020), response times and choices (Edwards & Low, 2017), or curvature and initiation time of computer-mouse movements (Van der Wel et al., 2014). In Clements and Perner's seminal study, 3-year-olds correctly looked in anticipation of the

belief-based action of an agent even though they gave incorrect explicit verbal predictions about where the agent will go to search for the object. The case for accepting that certain eye movements can index a fast mindreading process that is largely unchanging over development is strengthened by evidence that anticipatory looking in infants (Meristo et al., 2012) and younger and older adults (Grainger et al., 2018) show a similar pattern. Slow mindreading as indexed by verbal deliberations is scaffolded by culture, language and building of schemas and causal representations (Christiansen & Michael, 2016), and exhibits distinctive developmental trajectories.

None of this directly undermines De Neys' critique of the exclusivity feature. But a fruitful strand of developmental research relies on the method of signature limits (Carey, 2009). A signature limit of a process is a pattern of responses that the process generates which are incorrect or suboptimal (hence 'limit') and which no other process under consideration would generate (hence 'signature'). Butterfill & Apperly (2013) argued on theoretical grounds that some fast processes for tracking others' mental states are likely to generate incorrect predictions about beliefs involving mistakes about numerical identity. And in support of this, Low and Watts (2013) found that whilst 3-year-olds, 4-year-olds and adults show correct looking behaviour in an object-location false-belief task, the same participants showed incorrect looking behaviour in an object-identity false-belief task. The switch from processing a location false-belief task to a numerical-identity false-belief task did not influence the usual age-related improvements in participants' explicit verbal judgements, as predicted. This is not just a hint that there is more than one process: seeing the same signature limit in adults as in infants (Edwards & Low, 2019; Fiske et al., 2017; Woo & Spelke, 2021), we infer that the fast process (and the conditions in which it occurs and the outputs it generates) does not completely overlap with the slow process (though not everyone would agree; Thompson, 2014). You cannot reject the exclusivity feature and use the method of signature limits. The view from mindreading therefore indicates that the exclusivity assumption is solidly grounded after all.

Given that the empirical basis for rejecting the exclusivity assumption is tenuous – at least in the context of mindreading research – it is important to evaluate the theoretical considerations offered by De Neys. He argues that, given the plausibility of automatization, any conclusion arrived at by a slow process could, in principle at least, also be arrived at by a fast process. However, this theoretical argument is less challenging than it first appears. Automatization tells us that any conclusion arrived at by a slow process could be arrived at by *some* fast process but not *which* fast processes could arrive at that conclusion.

Here we face a problem. A model of the interplay of fast and slow processes is needed, as De Neys argues. But De Neys' own elegant model is unavailable because it 'forces us to get rid of exclusivity' (p. 24). Further, developmental evidence speaks against it. On De Neys' model, the slow process should only be triggered if fast processes generate conflicting responses, leading to uncertainty. But consider children's responses to a mindreading context set up by Ruffman et al. (2001). The children watched Ed acquire a false belief. They were then invited to place bets on which of two slides Ed would come down. Their bets revealed they felt no uncertainty (younger children went all in on the wrong slide). But Ruffman et al. also measured children's anticipatory looking as Ed was about to emerge, and this measure indicated a correct prediction. We take the betting to index a slow process and the looking to index a fast process. In this case we seem to have neither conflict among fast processes nor uncertainty (although of course we cannot entirely rule this out).

Is there an alternative to De Neys' model? The key is to understand what other than conflict in fast processes might trigger (and halt) slow processes. One candidate is low cognitive fluency. In Ruffman et al.'s (2001) study, asking children to choose in which of two locations to place their bets interrupts their processing and so triggers deliberation; as they reason through the problem (Ed will go where his chocolate is), they regain cognitive fluency. Because this does not require that slow processes concerning a question are driven by fast processes generating responses to the same question, this proposal leaves room for discretion whereby individuals are free to make explicit judgements which conflict with implicit responses. Just as the developmental evidence indicates.

In sum, widening De Neys' view to consider mindreading highlights the potential of more diverse methods than commonly employed in research on reasoning, and points toward empirical and theoretical obstacles to the proposed advance. Taking a step back, though, we find ourselves on common ground with De Neys: his critique shows both that more evidence is needed and that the interplay of fast and slow processes is truly a deep problem.

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15. ALPHABETICAL REFERENCE LIST (APA STANDARD)

Butterfill, S. A., & Apperly, I. A. (2013). How to construct a minimal theory of mind. *Mind and Language*, 28(5), 606–637.
<https://doi.org/10.1111/mila.12036>

Carey, S. (2009). *The origin of concepts*. New York, NY: Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780195367638.001.0001>

Christensen, W., & Michael, J. (2016). From two systems to a multi-systems architecture for mindreading. *New Ideas in Psychology*, 40(A), 48–64.
<https://doi.org/10.1016/j.newideapsych.2015.01.003>

Clements, W. A., & Perner, J. (1994). Implicit understanding of belief. *Cognitive Development*, 9(4), 377–395.
[https://psycnet.apa.org/doi/10.1016/0885-2014\(94\)90012-4](https://psycnet.apa.org/doi/10.1016/0885-2014(94)90012-4)

Edwards, K., & Low, J. (2017) Reaction time profiles of adults' action prediction reveal two mindreading systems. *Cognition*, 160, 1–16.
<https://doi.org/10.1016/j.cognition.2016.12.004>

Edwards, K., & Low, J. (2019). Level 2 perspective-taking distinguishes automatic and non-automatic belief-tracking. *Cognition*, 193, 104017.
<https://doi.org/10.1016/j.cognition.2019.104017>

Fizke, E., Butterfill, S. A., van de Loo, L., Reindl, E., & Rakoczy, H. (2017) Are there signature limits in early theory of mind? *Journal of Experimental Child Psychology*, 162, 209–224. <https://doi.org/10.1016/j.jecp.2017.05.005>

Grainger, S. A., Henry, J. D., Naughtin, C. K., Comino, M. S., & Dux, P. E. (2018). Implicit false belief tracking is preserved in late adulthood. *Quarterly Journal of Experimental Psychology*, 71(9), 1980–1987.

<https://doi.org/10.1177/1747021817734690>

Low, J., & Watts, J. (2013). Attributing false beliefs about object identity reveals a signature blind spot in humans' efficient mind-reading system. *Psychological Science*, 24(3), 305–311.

<https://doi.org/10.1177/0956797612451469>

Meristo, M., Morgan, G., Geraci, A., Lozzi, L., Hjelmquist, E., Surian, L., & Siegal, M. (2012). Belief attribution in deaf and hearing infants. *Developmental Science*, 15(5), 633–640. <https://doi.org/10.1111/j.1467-7687.2012.01155.x>

Ruffman, T., Garnham, W., Import, A., & Connolly, D. (2001). Does eye gaze indicate knowledge of false belief: Charting transitions in knowledge. *Journal of Experimental Child Psychology*, 80(3), 201–224.

<https://doi.org/10.1006/jecp.2001.2633>

Thompson, J. R. (2014). Signature limits in mindreading systems. *Cognitive Science*, 38(7), 1432–1455. <https://doi.org/10.1111/cogs.12117>

van der Wel, R. P., Sebanz, N., & Knoblich, G. (2014). Do people automatically track others' beliefs? Evidence from a continuous measure. *Cognition*, 130(1), 128–133. <https://doi.org/10.1016/j.cognition.2013.10.004>

Woo, B., & Spelke, E. (2021). Limits to early mental state reasoning: Fourteen-to 15-month-old infants appreciate whether others can see objects, but not others' experiences of objects. *Proceedings of the Annual Meeting of the Cognitive Science Society*, 43, 1914–1920.

<https://escholarship.org/uc/item/42n9x4n3>

Zani, G., Butterfill, S. A., & Low, J. (2020). Mindreading in the balance: Adults' mediolateral leaning and anticipatory looking foretell others' action preparation in a false-belief interactive task. *Royal Society Open Science*, 7(1), 191167. <https://doi.org/10.1098/rsos.191167>