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When in competition against engrained habits, is conscious representation sufficient or is inhibition of the habit also needed?

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The hierarchical systems model of Marcovitch and Zelazo successfully combines elements from (a) a competing model Diamond has proposed since 1985 (Diamond, 1985, 2001), (b) a competing model Munakata put forward in 1998, and (c) the seminal notion of 'representational redescription' developed by Karmiloff-Smith (1979, 1992). Like Diamond (but unlike Munakata) Marcovitch and Zelazo hypothesize that the pull to make an incorrect response comes from a conditioned tendency, or habit, to repeat a previously successful response, and is presumably subcortical in origin. Munakata conceptualized that pull as coming from latent memories, cortical in origin. Like Munakata (but unlike Diamond) Marcovitch and Zelazo hypothesize that the pull to repeat the previous response loses the battle with a mental representation of the reward's correct location when the latter is sufficiently strong. Diamond has hypothesized that winning against that pull requires *both* mental representation of the correct answer *and* inhibition or dampening of that darn pull. Like Karmiloff-Smith, Marcovitch and Zelazo argue that over the course of development mental representations undergo a recursive process and become represented at progressively more and more explicit and consciously accessible levels.

Interesting notions put forward by Marcovitch and Zelazo that were not presaged by others include that experience reaching at A strengthens *both* the habit strength to repeat that response *and* the probability of being reflective. Another interesting notion is that 'reflection [i.e. consciousness] is necessary' for correct A-not-B performance, and hence presumably that 9- or 10-month-olds who perform perfectly across A-not-B trials with minimal delays are capable of such reflection or consciousness. The authors seem to imply that conflict monitoring by the anterior cingulate (ACC), which triggers prefrontal cortex (PFC) to exert greater cognitive control, reflects 'a deliberate and conscious decision' to exert top-down control. There is no evidence that such ACC recruitment of PFC is always accompanied by conscious awareness, but that is testable.

One point is unclear to me. Do Marcovitch and Zelazo conceive of working memory, on the one hand, and making deliberate and conscious choices, on the other, as one function or two? I see only two factors in their model – habit strength and conscious mental representation. Infants in the first year succeed on the A-not-B task over longer and longer delays. Does that mean that they are also becoming more and more deliberate or conscious? Conceptually, one could imagine these to be separable. I am not sure on what basis Marcovitch and Zelazo seem to group them together.

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This is a commentary on Marcovitch and Zelazo (2008).

As interesting as the synthesis presented here is, the target article does not appear to say anything the authors have not already said. The authors say they are putting forth hypotheses and predictions, but those should refer to things not yet investigated (they should predict what one would find), whereas most of what are offered are postdictions (explanations for past findings).

Computational models repeatedly indicate that representation or working memory is sufficient without inhibitory control (e.g. Kimberg & Farah, 1993; Munakata, 1998; Cohen, Dunbar & McClelland, 1990), but real life seems to indicate otherwise. Until children are 9 years old, inhibitory control is harder for them than is holding mental representations in mind (e.g. Davidson, Amso, Anderson & Diamond, 2006). Computational models have been used to make similar claims in the language domain – models indicate that improved activation of appropriate meanings causes activation of inappropriate meanings to decline (McClelland & Kawamoto, 1986; Waltz & Pollack, 1985). However, Gernsbacher and Faust (1991) found that activation and inhibition can be dissociated in language – as inappropriate meanings decrease in activation, appropriate meanings do *not* increase in activation. Certainly at the neural level, more and more studies are showing that dopamine excitatory activation in prefrontal cortex is insufficient by itself and needs to be complemented by gabaergic inhibition (e.g. Lapish, Kroener, Durstewitz, Lavin & Seamans, 2007).

Miyake, Friedman, Emerson, Witzki, Howerter and Wager's (2000) influential factor analysis found inhibition to be an independent dimension of executive functioning. The present authors skirt that when they say, ‘To solve the [A-not-B] task, children must represent the object's current location, keep this information in mind, and then use it to guide their search. These elements also correspond to the latent variables associated with executive functions in adults reported by Miyake *et al.* (2000).’ How do they correspond? Where is the role for inhibition in this account of the requirements for success on the A-not-B task?

There are other claims in the target article that gave me pause as well. An example is the claim that ‘simulations of older children (and *a fortiori* adults) must begin with stronger recurrent weights than the stimulations of successful infants’. Why must they? I see no reason. Presumably, the A-not-B testing situation would be as novel to an adult or older child as to an infant. The claim that ‘the A-not-B error can only result if … there is no conscious reflection at the moment of search’ seems a bit over-stated. Certainly if there is insufficient conscious reflection an error could occur, but is that the *only* time an error might occur?

Whatever reservations one may have, however, certainly the target article is yet one more example of how brilliantly Zelazo and his colleagues think and write.

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