$p < .10$ for this contrast.) Finally, even if the U-shaped effect is reliable, its origin need not lie in conscious reflection. A real possibility, and one that Marcovitch and Zelazo consider, is that it results from habituation. That is, infants may be more likely to correctly search at B on the first B trial after many A trials than after an intermediate number of A trials because after many A trials they habituate and, as Marcovitch and Zelazo suggest, start responding randomly. They rule this explanation out because, it is claimed, Marcovitch *et al.*'s (2002) participants showed consistency of response on B trials, i.e. 'once a correct response was produced, all subsequent responses were correct' (Marcovitch & Zelazo, 2008, p. 12). In fact, while most infants in the 2002 study did show this consistency, 41% did not! Furthermore, the observed level of consistency of response may arise from infants' attending to the novel event (hiding at location B) following habituation. Thus, the evidence for conscious reflection as a mediator of correct performance remains weak.

What, then, can we take from the HCSM? First, despite the above criticisms, Marcovitch and Zelazo deserve praise for using their model to generate a series of novel predictions, and in so doing illustrating the utility of formal methods in theory construction within developmental cognitive science. Whether the authors' predictions are unique to the HCSM is unclear, but only the development of complete specifications of competing accounts will resolve this issue. More positively, Marcovitch and Zelazo's survey of A not B models and theories highlights important commonalities across the models – namely that all existing models involve two systems or layers, with the lower being modulated by the higher, and the higher coming on stream later in development. These commonalities represent significant progress in our understanding of development, and clarify the areas of debate. A useful theory of development of EF must, however, do more than posit a single construct at the higher level. It must decompose that construct and relate it more directly to theories of adult EF.

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

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

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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.

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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Dynamic executives

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

Processes that drive change in behavior and processes that conserve against change are everywhere evident in the human cognitive system. Change in behavior emerges most fundamentally as a consequence of changing sensory input. New sensory events pull attention, internal activation, and behavior in new directions; however, new sensory events also activate memories of related events and in this way may pull the system toward past behavior. Stability is also a strong force in our cognitive system because the processes that constitute cognition endure in time and thus each new moment emerges out of and is often integrated with the just previous state of the system. The bringing of the past into the present is so ubiquitous in cognition – in priming, in memory interference, in assimilatory effects in perception, in generalization – that we often overlook the fundamentally perseveratory nature of even mature cognition. This 'perseveratory' aspect, this pull to the past, is, as William James (1890/1950) pointed out, also the foundation of the coherence of mind itself; and this perseveration, even by infants in the A-not-B task, is a significant developmental achievement in its own right (Clearfield, Dineva, Smith, Diedrich & Thelen, 2008).

The widespread interest in 'executive control' derives in part from the idea that something more – something *different* – is required to explain the task-specific and adaptive flexibility evident in mature human cognition. This is the main idea of the Hierachical Competing Systems Model (HCSM): the 'something special' is rule-like representations, reflection and consciousness. These certainly sound special, but would they seem so special if they were grounded in well-specified cognitive and neural processes? And, if they were so grounded, what would it mean about what is developing? Insights into these questions emerge not from considering how HCSM differs from competing process accounts, namely Munakata's (1997, 1998) latent-active memory account and Dynamic Field Theory (DFT; e.g. Clearfield *et al.*, 2008), but rather by considering what HCSM shares with those process-based accounts.

Munakata's account is built on the idea of two kinds of memories that operate at different times scales; the pre-switch task (searching at A) creates a longer-lasting, but latent memory, that is activated by the context cues post-switch and, thus, competes with the weaker transient memory for the new event (hiding at B). For younger infants, the reactivated latent memory wins out; for older infants, the transient memory is maintained and augmented through strong recurrent connections. Critically, these recurrent connections (linked to the activity of the

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