Children's perseveration: attentional inertia and alternative accounts

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Kirkham, Cruess and Diamond report important findings on children's ability to switch to a new dimension in a card sorting task: When asked to label a relevant feature, 3-year-olds are more likely to switch to the new dimension, and when previously sorted cards are left face-up, 4-year-olds are less likely to switch to a new dimension. These are clever manipulations and interesting results. They contribute to a growing body of data on children's perseveration, which should inform and constrain a variety of theories of the development of flexible behavior.

The theoretical contributions from the paper are less clear, for two reasons. As elaborated below: (1) the proposed account has strengths, but in its current form comes across as somewhat inconsistent, underspecified and circular, and (2) alternative accounts are discounted too readily.

Attentional inertia: consistency, specificity, circularity

The proposed account of children's perseveration focuses on the role of 'attentional inertia' – the difficulty redirecting attention once it is focused on a particular dimension. There is something that feels quite right about this term. Children (and adults) do get stuck in what they attend to and have difficulty overcoming this. However, it is not clear how the proposed account goes beyond this description. The problem stems in part from a lack of consistency and specificity in the presentation of the attentional inertia account. Children's perseveration is variously described as reflecting difficulties in:

- inhibiting a focus on the first aspect of a stimulus that was relevant
- disengaging from a mindset
- refocusing attention
- inhibiting and then switching attention.

These types of descriptions raise a number of questions regarding the claims of the attentional inertia theory. Are inhibiting, disengaging, refocusing and switching identical or separate processes? If they are separate processes, what are the distinctions among them? If they are identical, what is the specific nature of this process? How do these terms go beyond describing the finding that children have difficulty switching to a new dimension when sorting cards? What leads children to have difficulties with the hypothesized process(es), and what changes lead to children's improved performance with age? Answers to these kinds of questions should help to clarify the potential contributions of the attentional inertia account.

In addition, the account as presented seems to rest on circular logic. The paper hypothesizes that: (1) children have problems with attentional inertia, and (2) the experimental manipulations affect attentional inertia. The manipulations influence children's performance, and are therefore taken as support for the attentional inertia theory of children's perseveration. This reasoning is circular, because the manipulations might affect other factors that lead children to perseverate. To provide a compelling demonstration that attentional inertia is at work in children's perseveration, some independent motivation or assessment of the construct of attentional inertia is needed. This would help to clarify what the experimental manipulations are manipulating, and what theories are supported or challenged by the results.

Alternative accounts

To elaborate this point: the label and face-up manipulations might have influenced children's switching via factors emphasized in alternative accounts of children's perseveration. For example, leaving cards face-up might increase the chances that children do not realize the

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rules have changed, consistent with a miscategorization account of perseveration (Aguiar & Baillargeon, 2000). Similarly, the label manipulation could strengthen children's active memory representations of the new rule while the face-up manipulation strengthens their latent memory representation of the old rule, consistent with a memory account of perseveration (Morton & Munakata, 2002a).

The paper discounts such alternatives too readily. For example, the paper argues that because the experimenter emphasizes the rule change and repeats the new rules before each trial, children's perseveration cannot be attributed to memory problems or failure to realize the rules have changed. This logic incorrectly assumes that the experimenter's behavior ensures a particular memory or realization on the part of the child. Following this same logic, one could conclude that the attentional inertia theory of perseveration must be incorrect. That is, because the experimenter draws attention to the new rules at the start of the switch and on each trial, perseveration cannot be attributed to attentional inertia for the old rules. This logic is flawed because simply stating a change in rules or repeating rules does not guarantee that children encode, attend to or remember this information. Thus, alternative accounts cannot be discounted based on the experimenter's behaviors alone.

Another form of discounting relies on an all-or-none characterization of memory accounts: if children demonstrate some form of memory relevant for sorting cards (e.g. correctly answering questions about where cards should be sorted), their memory is fine, so their difficulty must lie elsewhere. However, memory is far from all-or-none. Multiple memory systems exist (e.g. Schacter & Tulving, 1994), and memory can be graded in nature (e.g. Munakata, 2001). Thus, when children succeed on one measure of memory in the card sorting task, this does not mean memory limitations play no role in their perseveration. In particular, children may have limited memory for a new rule, which is sufficient for tasks that do not involve conflict, but insufficient for tasks that involve conflict (Morton & Munakata, 2002b; Munakata & Yerys, 2001). Sorting a card (e.g. a red truck) according to a new rule (e.g. color) requires resolving the conflict between the new rule and the previous rule (shape). In contrast, answering a standard verbal query about the new rule (e.g. 'Where do the red things go in the color game?') does not involve conflict. Neural network models have demonstrated how stronger memory representations are required for the task with greater conflict (Morton & Munakata, 2002a). This analysis correctly predicted that children should have difficulty when conflict is introduced into verbal queries (e.g. 'Where do the red trucks go in the color game?'; Munakata & Yerys, 2001; see also Morton & Munakata, 2002b).[1]

Finally, the paper also discounts memory accounts of perseveration from a biological perspective: the claim is that representations would need to be strengthened to an extent that is biologically implausible to guide behavior in the face of competing responses, so that a separate process of inhibition is required (Diamond, 1998). Although inhibitory processes clearly exist in the cortex (e.g. via inhibitory interneurons), children's perseveration and ultimate success do not necessarily result from deficits and improvements in such inhibitory processes. Instead, an alternative view from the memory perspective is that maintaining information in active or working memory (dependent on prefrontal cortex) supports relevant representations elsewhere in cortex, and through inhibitory interactions throughout cortex, leads other (irrelevant) representations to be less active (Cohen & Servan-Schreiber, 1992; Goldman-Rakic, 1987; Miller & Cohen, 2001; Munakata, 1998; O'Reilly, Braver & Cohen, 1999; Roberts, Hager & Heron, 1994). Thus, what appear to be improvements in inhibition fall out of improvements in memory. From this perspective, developments in memory alone can account for children's improved performance in tasks of flexibility, as demonstrated through neural network models (Morton & Munakata, 2002a; Munakata, 1998).

Conclusions

In summary, the present paper contributes an interesting set of findings on children's perseveration, and a theoretical approach that seems to aptly characterize aspects of perseveration. Further specification of the attentional inertia framework will be useful for clarifying how it goes beyond a description of behaviors to explain the processes underlying perseveration and eventual success. An important step in this process will be to resist all-or-nothing treatments of factors such as memory, to allow a consideration of the powerful role of gradual developments in such factors. Such research efforts should prove valuable in advancing an understanding of developing abilities to behave flexibly and adaptively – arguably one of the most critical aspects of higher level cognition.

[1] Kirkham *et al.* incorporate this finding into their attentional inertia framework, whereas it was motivated by and set up to test an alternative active–latent memory account of perseveration. This highlights the need to specify theories sufficiently so that their unique contributions and predictions can be assessed.

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