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So many options, so little control: Abstract representations can reduce selection demands to increase children's self-directed flexibility

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ABSTRACT

Children often struggle to behave flexibly when they must use self-directed goals (e.g., doing homework without prompting) rather than externally driven goals (e.g., cleaning up when told). Such struggles may reflect the demands of selecting among many potential options, as required for self-directed control. The current study tested whether (a) 6-year-old children show difficulty in selecting among competing semantic representations, (b) providing category labels designed to reduce selection demands improves performance, and (c) such benefits transfer to self-directed flexibility. Selection was measured using the blocked cyclic naming task for the first time with children. Pictures were named repeatedly in either homogeneous blocks from the same category (e.g., all animals), which create high selection demands due to spreading semantic activation and engage effortful cognitive control, or mixed blocks with each picture from a different category. Children showed robust difficulty in selecting among options, as indexed by response time (RT) differences between homogeneous and mixed blocks. Providing subcategory labels designed to reduce selection demands by distinguishing among same-category items (e.g., "A cow is a farm animal. A cat is a pet.") improved selection. Providing superordinate categories (e.g., "A cow is an animal. A cat is an animal.") also improved selection, but these benefits were less robust, and subcategory labels led to greater benefits than superordinate category labels on a subsequent verbal fluency task. These results support a role for subcategory representations in reducing selection demands to aid self-directed flexibility while suggesting that

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some children may use superordinate category labels to activate subcategory representations on their own.

Introduction

A fundamental part of growing up is going beyond routines. Children become increasingly skilled over the first years of life at overcoming well-learned habits or their desires in the moment to instead act on longer term goals (e.g., to stop playing and start putting away toys before going outside). Doing so requires actively maintaining goals in working memory, which provide top-down support for goal-relevant thoughts and behaviors, allowing children to break out of habits and switch from one task to another (e.g., Davidson, Amso, Anderson, & Diamond, 2006; Marcovitch, Boseovski, & Knapp, 2007; Munakata, Chatham, & Snyder, 2012; Towse, Lewis, & Knowles, 2007). Children's early successes often occur with exogenous (externally driven) goals (e.g., putting away toys when told) and only later occur with endogenous (self-directed) goals (e.g., working through a series of homework tasks without being prompted). For example, 4-year-olds can switch to a new rule for sorting cards when an adult tells them when to switch and what the new rule is (e.g., Zelazo, 1996). However, when children are told to sort cards in "a new way" without being told what rule to switch to, children younger than 7 years perseverate, continuing to use the old rule (e.g., Jacques & Zelazo, 2001; Smidts, Jacobs, & Anderson, 2004).

With tasks that require even more self-direction, performance continues to improve through adolescence (Ardila, Rosselli, Matute, & Guajardo, 2005; Kavé, 2006; Kavé, Kigel, & Kochva, 2008; Matute, Rosselli, Ardila, & Morales, 2004; Riva, Nichelli, & Devoti, 2000; Sauzéon, Lestage, Raboutet, N'Kaoua, & Claverie, 2004). For example, in the verbal fluency task, participants are asked to say as many items as they can in 1 min from a category (e.g., animals). To generate many words, participants must both cluster (produce words within semantic subcategories) and switch (shift between subcategories) (e.g., Troyer, Moscovitch, & Winocur, 1997). Thus, people must endogenously detect the need to switch (e.g., when they cannot think of more zoo animals) and select what to switch to (e.g., pets, farm animals, ocean animals) without any external cues as to when to switch and what to switch to. Children often fail, for example, naming five zoo animals and declaring that there are no more animals even though they know many other types of animals (Snyder & Munakata, 2010).

What makes such self-directed flexibility more demanding and later to develop than externally driven flexibility? One possibility is that self-directed control requires selecting among many options. In externally driven tasks, participants are told what to do and/or when to do it, so selection demands are minimal. In contrast, when there are multiple options (e.g., multiple animals to choose among), competition among them must be resolved in order to select a response, a process that is time-consuming and relies on prefrontal cognitive control mechanisms (e.g., Hirshorn & Thompson-Schill, 2006; Snyder, Banich, & Munakata, 2011).

This idea that selection demands contribute to the later mastery of self-directed flexibility has been tested in the verbal fluency task with children (Snyder & Munakata, 2010). Before completing a verbal fluency task (e.g., name all the animals you can think of), 5-year-old children were provided with either (a) subcategories (farm animals, zoo animals, and ocean animals) designed to reduce selection demands or (b) exemplars (e.g., goat, rhinoceros, whale). Subcategory labels were expected to activate associated abstract representations, which provide top-down support for the associated subcategory members. Such support should reduce selection demands by focusing searches within a subcategory (e.g., on the more limited pool of zoo animals as opposed to all animals; Fig. 1A) or, when a subcategory is exhausted, by focusing searches among remaining subcategories (e.g., among the small set of remaining animal subcategories) and then within the chosen subcategory. As predicted, providing children with subcategory labels before completing verbal fluency helped them to subsequently endogenously switch among subcategories more than children given exemplars (Snyder & Munakata, 2010). This benefit extended to subcategories that were not provided. Thus, subcategory labels appear to reduce selection demands to aid endogenous control in children.