Journal of Experimental Child Psychology 172 (2018) 59–72

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

Task switching costs in preschool children and adults

Anna Peng *, Natasha Z. Kirkham, Denis Mareschal

Department of Psychological Sciences, Birkbeck University of London, London WC1E 7HX, UK

A R T I C L E I N F O

Article history:
Received 1 June 2017
Revised 25 January 2018

Keywords:
Task switching
Development
Cognitive flexibility
Preschool children
Selective attention
Executive function

A B S T R A C T

Past research investigating cognitive flexibility has shown that preschool children make many perseverative errors in tasks that require switching between different sets of rules. However, this inflexibility might not necessarily hold with easier tasks. The current study investigated the developmental differences in cognitive flexibility using a task-switching procedure that compared reaction times and accuracy in 4- and 6-year-olds with those in adults. The experiment involved simple target detection tasks and was intentionally designed in a way that the stimulus and response conflicts were minimal together with a long preparation window. Global mixing costs (performance costs when multiple tasks are relevant in a context), and local switch costs (performance costs due to switching to an alternative task) are typically thought to engage endogenous control processes. If this is the case, we should observe developmental differences with both of these costs. Our results show, however, that when the accuracy was good, there were no age differences in cognitive flexibility (i.e., the ability to manage multiple tasks and to switch between tasks) between children and adults. Even though preschool children had slower reaction times and were less accurate, the mixing and switch costs associated with task switching were not reliably larger for preschool children. Preschool children did, however, show more commission errors and greater response repetition effects than adults, which may reflect differences in inhibitory control.

* Corresponding author.
E-mail address: cpeng01@mail.bbk.ac.uk (A. Peng).

https://doi.org/10.1016/j.jecp.2018.01.019

Introduction

To negotiate our way adaptively in a dynamic environment, we need to be able to shift and focus our attention appropriately. This ability has been studied in both children and adults, revealing that both groups, depending on the context, can show task switching difficulties, albeit in different performance outcomes (cf. Diamond & Kirkham, 2005; Kirkham, Cruess, & Diamond, 2003). In adult studies, participants show reaction time costs when switching between relatively simple cognitive tasks (e.g., identifying either a target form or a target color in a sequence of letters). Developmental studies have looked at similar costs in young children in terms of errors or perseverative performance. Indeed, numerous studies have shown that 3- and 4-year-old preschool children have great difficulty in switching attention between tasks when instructed to do so but that this ability improves greatly between 5 and 6 years of age (e.g., Carlson, 2005; Cepeda, Kramer, & Gonzalez de Sather, 2001; Chevalier, Sheffield, Nelson, & Clark, 2013; Zelazo, Frye, & Rapus, 1996; Zelazo, Müller, Frye, & Marcovitch, 2003). This line of work has underpinned research showing that the ability to attend selectively and to voluntarily shift one's attention is central to the development of executive control (Garon, Bryson, & Smith, 2008). However, a number of methodological and conceptual issues limit the conclusions that can be drawn from this work.

First, it might seem reasonable to assume that both developmental and adult studies are investigating the same processes, and indeed both lines of research connect their findings to attention and cognitive control. There are, however, important differences in the experimental paradigms that can be used with young children and those used with adults, making direct comparisons difficult. Paradigms developed for young children, such as the Dimensional Change Card Sort (DCCS; Zelazo et al., 1996), the Day–Night Stroop task (Gerstadt, Hong, & Diamond, 1994), the Spatial Conflict task (Davidson, Amso, Anderson, & Diamond, 2006), and the Shape School task (Blaye & Chevalier, 2011; Chevalier & Wiebe, 2011; Espy, 1997), are normally considered appropriate for preschool children because performance improves to ceiling level across childhood. These tasks traditionally measure perseveration errors and *accuracy*. However, due to the novel elements in the tasks presented to the children (e.g., lack of feedback, stimulus conflict), it is not clear that the results are comparable to those of the adult studies. Moreover, in adult studies, switching between two simple and often familiar and well-practiced cognitive tasks produces reliable *reaction time* (RT) costs and, to a lesser degree, accuracy costs. Thus, it remains unclear whether and how performances on these tasks relate to one another across development.

A second major challenge in this domain is the lack of consensus on what the appropriate measures and tasks are for a given age when measuring cognitive control in children (e.g., Best & Miller, 2010; Carlson, 2005). Large individual differences in performance exist even within a specific age group. Thus, because chronological age is a crude proxy for the level of development, when the performance measure is also crude (e.g., pass/fail), it can be difficult to tease apart age-associated differences from individual differences in attentional control. We know, for instance, that some 3-year-olds can pass the DCCS task, whereas some others show great difficulty in shifting attention to the other target dimension. In addition, when presented with a new set of stimuli, among the children who failed the standard DCCS task, some continued to perseverate on the first dimension in the new set, whereas others successfully shifted to the new dimension (Hanania, 2010). Potential explanations for the disparate performances among the 3-year-olds are individual differences in cognitive control and/or other experience-dependent knowledge acquisition as well as other unspecified situational factors in the experimental context. Although it is not clear what best differentiates the subgroups of the perseverators, what is clear is that variability in task-performance often goes beyond what chronological development could account for, and such an observation presents a great challenge to the developmental theory of cognitive flexibility.

Third, error-based cognitive tasks are typically applicable to only a narrow range of ages because of the ceiling effect. This is at odds with the fact that cognitive development occurs on a protracted timescale (e.g., Fair et al., 2009; Giedd et al., 1999). In contrast, timed cognitive tasks can be used across a broad age range and are also sensitive to different experimental conditions. Indeed, many developmental studies have reported continuous development on simple speeded cognitive tasks such as