# TASK-SWITCHING IN CHILDREN: A DEVELOPMENTAL STUDY


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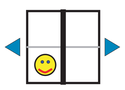
## How does the ability of young children to switch tasks compare with that of adults? What changes are seen between 5 and 11 years?

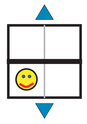
### Meiran's (1996) Task Adapted for Young Children

**Task A**



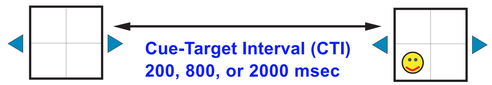
Is target on the Right or Left?

**Task B**



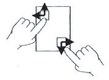
Is target in the Top or Bottom half?

**At the start of each trial, Cues appeared indicating the Relevant Dimension (Task) for the Current Trial: Vertical or Horizontal.**




**Participant was to press the response key corresponding to the location of the smiley face. The same two keys were used for both dimensions: "7" for up or left; "3" for down or right.**

2-key response setup




**The first & last trial blocks were single-task blocks (12 trials each).**

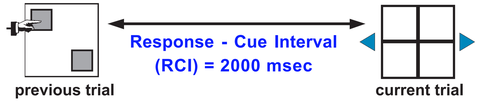
**Blocks 2 & 3 were mixed-task blocks (48 trials each), pseudo-random order of trials.**

**Extensive counterbalancing ensured equal numbers within and across every class of trials.**

**Number of trials was small to accommodate young children's short attention spans.**

**Our Pilot showed that Passive Dissipation effects of the preceding trial were minimized with a Response-Cue Interval (RCI) of 2000 msec. Switch costs were not further reduced with a longer RCI.**

**To look only at Active Preparation and Residual Costs, we set the RCI at 2000 msec to be able to eliminate the Passive Dissipation component.**




**146 Participants:**

- **126 children (roughly 18 at each age [5, 6, 7, 8, 9, 10 & 11 years])**
- **20 adults (ages 20-23 years)**
- **Equal numbers of males & females at each age.**

### Do Children Show the Same Pattern of Switch Costs as Older Adults, I ?

**Compared to Younger Adults, Older Adults show:**

**Much Larger Reaction Time (RT) Costs comparing Mixed Blocks to Single-Task Blocks (i.e., much larger Global Switch Costs than young adults)**

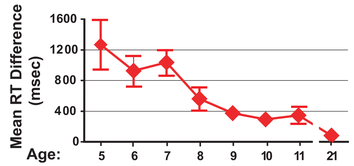
**Similar RT Costs Comparing Switch and Non-Switch Trials (i.e., same Local Switch costs as young adults)**

MEAN DIFFERENCE IN **RT** MEAN DIFFERENCE IN **ACCURACY**

**GLOBAL SWITCH COSTS (MIXING COSTS)**

**Mixed-Task Blocks** (ABBABAAABB) **vs. Single-Task Blocks** (AAAAAAAA)

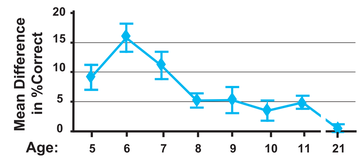
**(ALL TRIALS)**




Even adults showed a significant RT cost.
( $t(15) = 4.59$, $p < .0001$ ).

But children showed a much larger cost. Even the oldest children (11 yrs) showed a much greater RT cost than adults ( $t(25) = 3.36$, $p < .0001$ ).

The RT global switch cost declined over age ( $F(7,143) = 76.65$, $p < .0001$ ).




Children were correct on fewer trials in Mixed-Blocks than in Single-Blocks.

Adults were correct on almost all trials.

Even the 11-year-olds showed a greater accuracy cost than adults ( $t(25) = 4.515$, $p < .0001$ ).

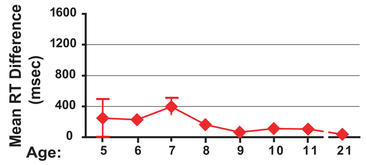
The accuracy global switch cost declined over age ( $F(7,137) = 6.77$, $p < .0001$ ).

All of the statements above concerning Mixed Blocks vs. Single-Task Blocks are also true if one compares only the Non-Switch Trials in the Mixed Blocks to trials in the Single-Task Blocks.

**LOCAL SWITCH COSTS**

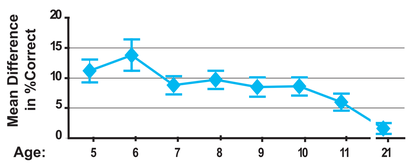
**Switch Trials** (A**B**B**A**B**A**AA**B**B) **vs. Non-Switch Trials** (AB**B**ABA**AA**B**B**)

**(All Within Mixed Blocks)**




There was no significant RT cost at any age.

Children did not show significantly greater RT cost than adults.




There was a significant cost in accuracy for children at every age but not for adults.

Costs decreased continuously over age ( $F(7,137) = 24.6$, $p < .0001$ ).

However, even by 11 years, children were not yet at adult levels ( $t(25) = 4.51$, $p < .0001$ ).

- **Children showed much larger RT costs than young adults on Mixed Blocks vs. Single-Task Blocks (Global Switch Costs) -- just as is found with older adults (Kray & Lindenberger, 2000; Mayr, 2000; Mayr & Liebscher, *submitted*).**
- **Children showed similar RT costs to young adults when comparing Switch and Non-Switch Trials -- just as is found with older adults (*ibid*).**
- **However, we found no Local RT Switch Cost in either children or adults (contrary to the findings of others) perhaps because of our long intervals before and after the cue.**
- **Children showed greater Global AND Local Switch Costs in error rate than adults.**

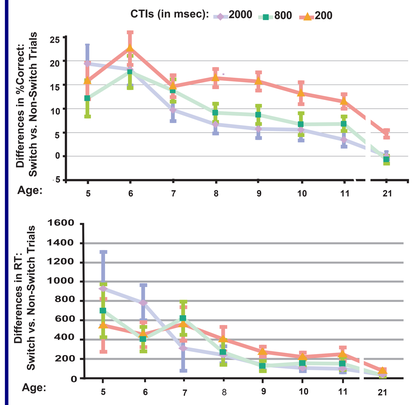
### Do Children Show the Same Pattern as Older Adults, II?

**Compared to Young Adults, Older Adults show:**

**Similar Preparatory Component to Switch Costs**

**Disproportionately Large Residual Component**

Since switch costs were no greater at the next-to-the-longest Cue-Target Interval (CTI) than at the longest (800 vs. 2000 msec), those 2 CTIs evidently gave children as much time as they could use to prepare for an upcoming switch. All of the remaining switch cost should be due to the residual component (the cost that remains no matter how long is allotted for active preparation).




No significant difference at any age in performance at 800 and 2000 msec either in speed or accuracy.

(Randomly intermixing CTIs may have minimized differences between them in performance (Mayr & Keele, 2000), though the significantly higher %correct switch costs at the shortest CTI [200 msec] would seem to argue against that.)

- **Even at the longest CTI (2000 msec), children of all ages showed significantly greater switch costs than adults.**
- **Hence, like older adults (Mayr & Keele, 2000), children showed greater residual switch costs than adults.**

Residual costs are usually thought to reflect that the reconfiguration process cannot be completed until ***after*** the stimulus appears; active preparation can take you only so far. Diamond suggests that the reconfiguration process may be complete ***before*** the stimulus appears; seeing a stimulus relevant to different responses in the two tasks may ***create*** a problem.

For example, on Zelazo's (1996) card sorting task, 3-year-olds appear to have completed their reconfiguration (they can tell you what the new criterion is & how to sort by it) yet when the stimulus actually appears, the previously correct dimension grabs their attention and they sort according to that (see Kirkham, Cruess, & Diamond, *submitted*).

**Can children even as young as 5 years switch between tasks?**

Yes.

5-year-olds were correct on roughly 80% of trials within mixed blocks and over 70% of the switch trials.

**Children show greater global switch costs than adults.**

Just knowing that they will have to switch on the some trials causes children to respond more slowly & make more errors (even on non-switch trials in mixed blocks) relative to their performance on trials in single-task blocks than is seen in adults.

**Children show greater local switch costs than adults.**

Children make significantly more errors on switch trials than on non-switch trials. Adults do not.

**Children show greater residual switch costs than adults.**

Even when given as much time as they can use to prepare for a task switch, children make more errors on switch trials than on non-switch trials. Adults do not.

**Is the best way to assess task switching in adults (RT), also the best way to assess it in children?**

No.

Adults show asymptotic accuracy levels; %correct is an insensitive measure for adults.

Children err more; accuracy is a sensitive measure of switch cost for them.

Because children's RTs can be quite variable, & because children often respond impulsively even when they don't know the answer, RT can be a less sensitive measure of switch cost for them than is accuracy.

**Prefrontal cortex appears to be one of the neural substrates for task switching.**

Patients with prefrontal cortex damage are impaired at task switching (Diedrichsen *et al.,* 2000; Owens *et al.*, 1993). Prefrontal cortex activation increases on switch trials when the stimulus is relevant to different responses on the 2 tasks (Konishi *et al.,* 1999a, b; Landau *et al.*, 2001).

Even children of 11 years are not yet at adults levels in task switching performance. That is consistent with the protracted developmental timecourse of prefrontal cortex maturation, which continues past age 11 into early adulthood (Giedd *et al.*, 1999; Huttenlocher, 1979, 1990; Huttenlocher & Dabholkar, 1997; Sowell *et al.*, 1999a, b, 2001).


References provided upon request