

Do Children With ADHD Have Deficits in Set Shifting Abilities?

Irwin, L. N., Wells, E. L., Soto, E. F., & Kofler, M. J.

Department of Psychology, Florida State University, Tallahassee, Florida

Introduction

- The phenotypic behavioral presentation of ADHD may be driven by deficits in executive function(s) (Barkley, 1997; Rapport et al., 2009; Kasper et al., 2012; Chacko et al., 2014)
- Set Shifting is a core executive function (EF) involving the ability to flexibly shift back and forth between tasks or mental sets (Miyake et al., 2012)
- Set Shifting is associated with:
 - Academic Performance (Benedetto-Nasho & Tannock, 1999)
 - Social Competence (Kofler et al., 2015)

Set Shifting in ADHD

- Meta-analysis suggests that set shifting may be impaired in ADHD ($d = .46-.55$; Willcutt et al., 2005); however, there is mixed evidence in pediatric ADHD samples (Goldberg et al., 2005; Holmes et al., 2010; Lawrence et al., 2004; Oades & Christiansen, 2008). Potentially due to:
 - Construct Invalidity (WCST & TMT-B; Snyder et al., 2015)
 - Task Impurity (Alderson et al., 2010, 2017; Karalunas et al., 2012; Kofler et al., 2013; Raiker et al., 2017)

Current Study

- Examined set shifting in children with ADHD using an experimental design that provided robust control for non-shifting processes involved in completing set shifting tasks
- We hypothesized that shift costs would be significantly larger in the ADHD group (i.e., ADHD-related impairments in set shifting)

Method

Participants

- 8-13 year old children
- Carefully diagnosed ADHD
- ADHD ($n = 33$) vs. Non-ADHD ($n = 32$)

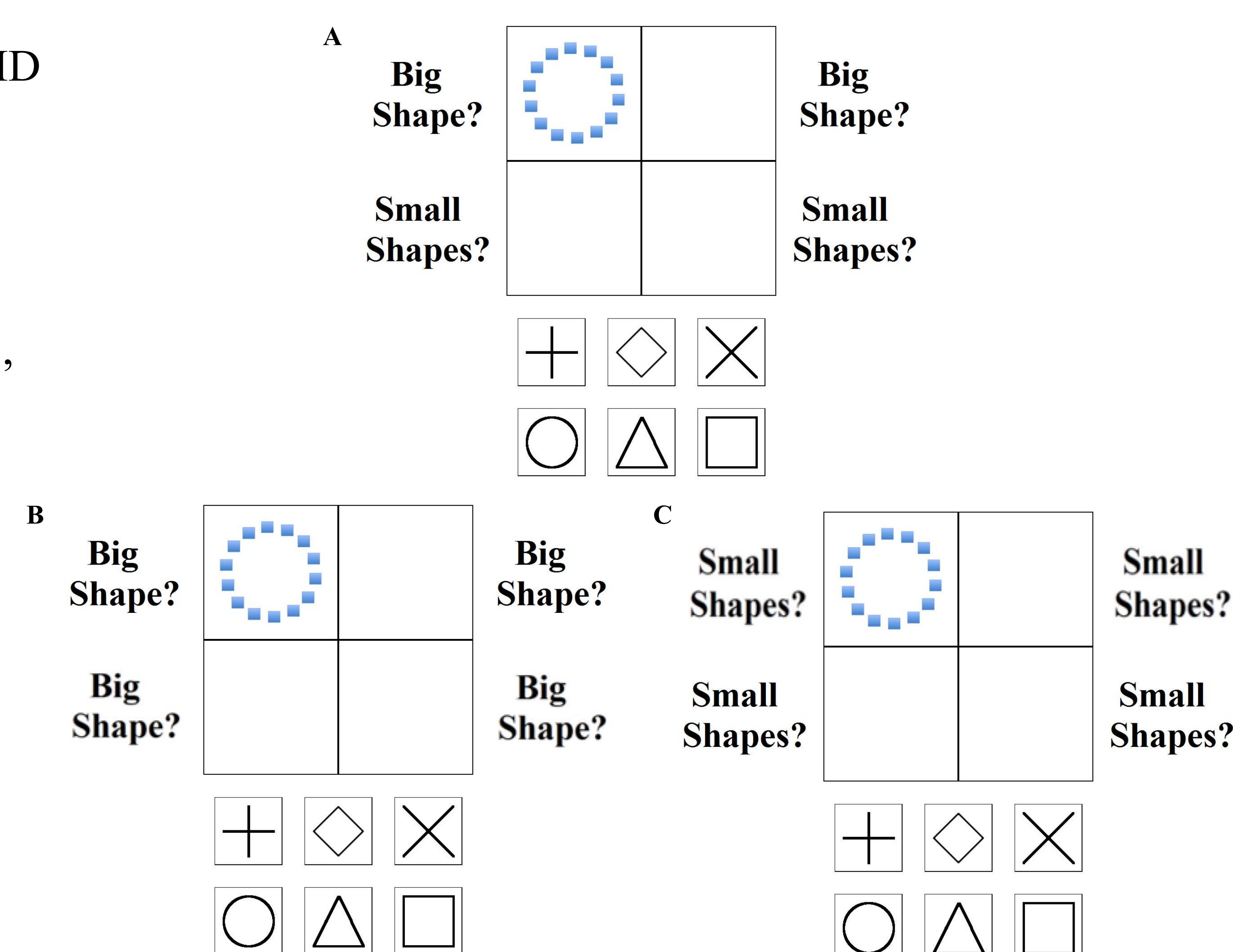
Tasks

- Global-Local* – Set Shifting condition
- Global-Global* – Control 1 condition
 - Controls for ADHD-related impairments on choice response tasks (Kofler et al., 2013)
- Local-Local* – Control 2 condition
 - Controls for inhibition demands due to prepotent fixation on global (relative to local) stimulus features (Poirel et al., 2011)

Dependent Variables

- Speed shift cost = $RT_{\text{shift}} - RT_{\text{no-shift}}$
- Accuracy shift cost = $\text{Errors}_{\text{shift}} - \text{Errors}_{\text{no-shift}}$

Figure 1. A sample trial from the global-local task (A), global-global task (B), and local-local task (C).



Results

Speed Shift Costs

- 2x3 ANOVA revealed that the experimental manipulation was successful (task main effect, $p < .001$, $\omega^2 = .13$)
 - Global-local task elicited greater speed shift costs than did the control conditions
- No evidence of shifting deficits in ADHD as demonstrated by a non-significant group main effect ($p = .21$) and a non-significant interaction between task and group ($p = .65$)

Accuracy Shift Costs

- 2x3 ANOVA revealed a significant group by task interaction ($p = .014$; $\omega^2 = .04$) and group main effect ($p = .016$; $\omega^2 = .07$)
 - ADHD group demonstrated significantly more errors than the Non-ADHD group, but only during the shifting task ($p = .015$; $p = .018$)

Figure 2. A theoretical model of the executive and nonexecutive processes required for successful performance on the global-local task.

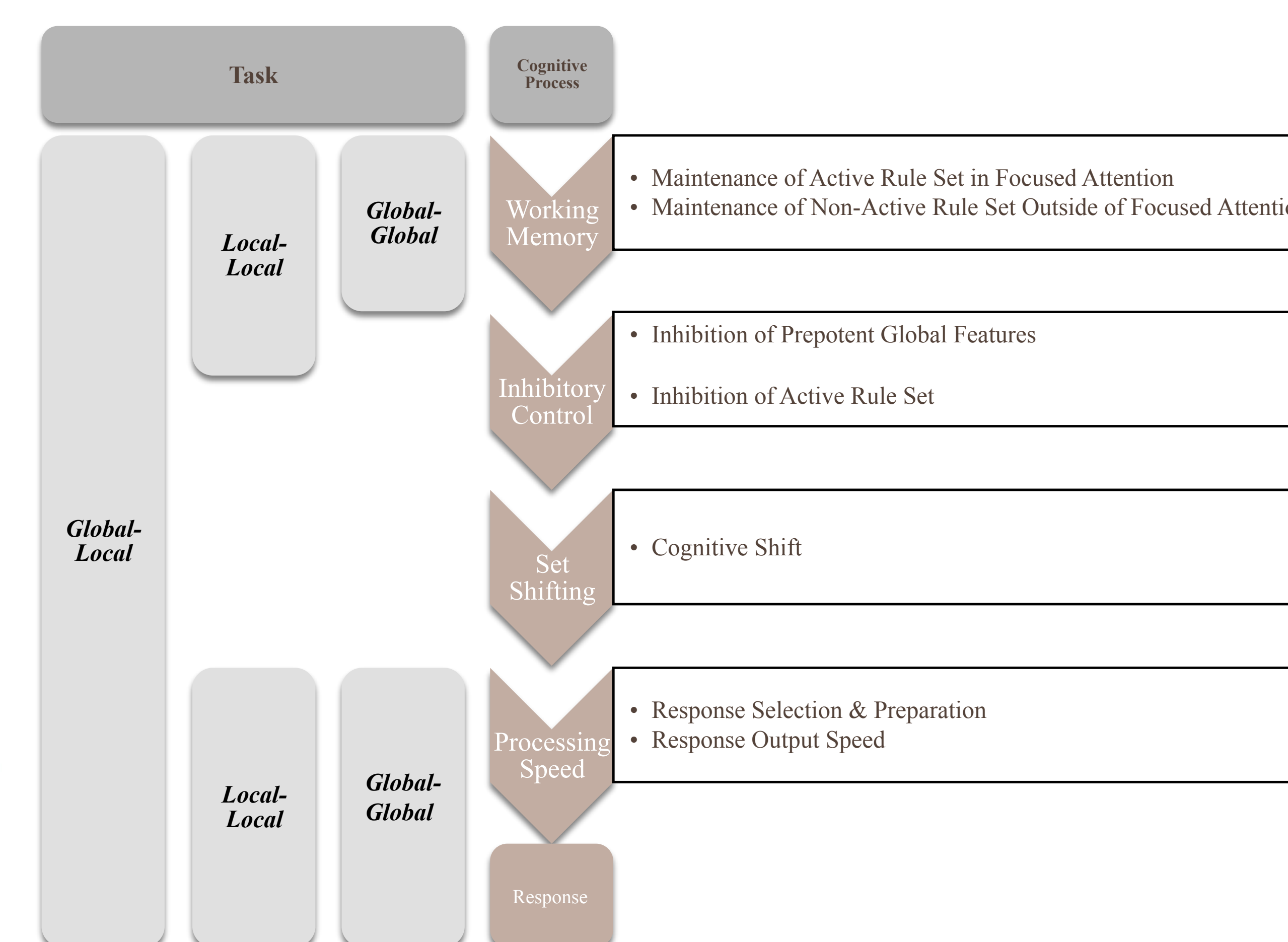


Figure 3. A graph of mean speed shift costs for the ADHD and Non-ADHD groups during the global-global, local-local, and global-local tasks.

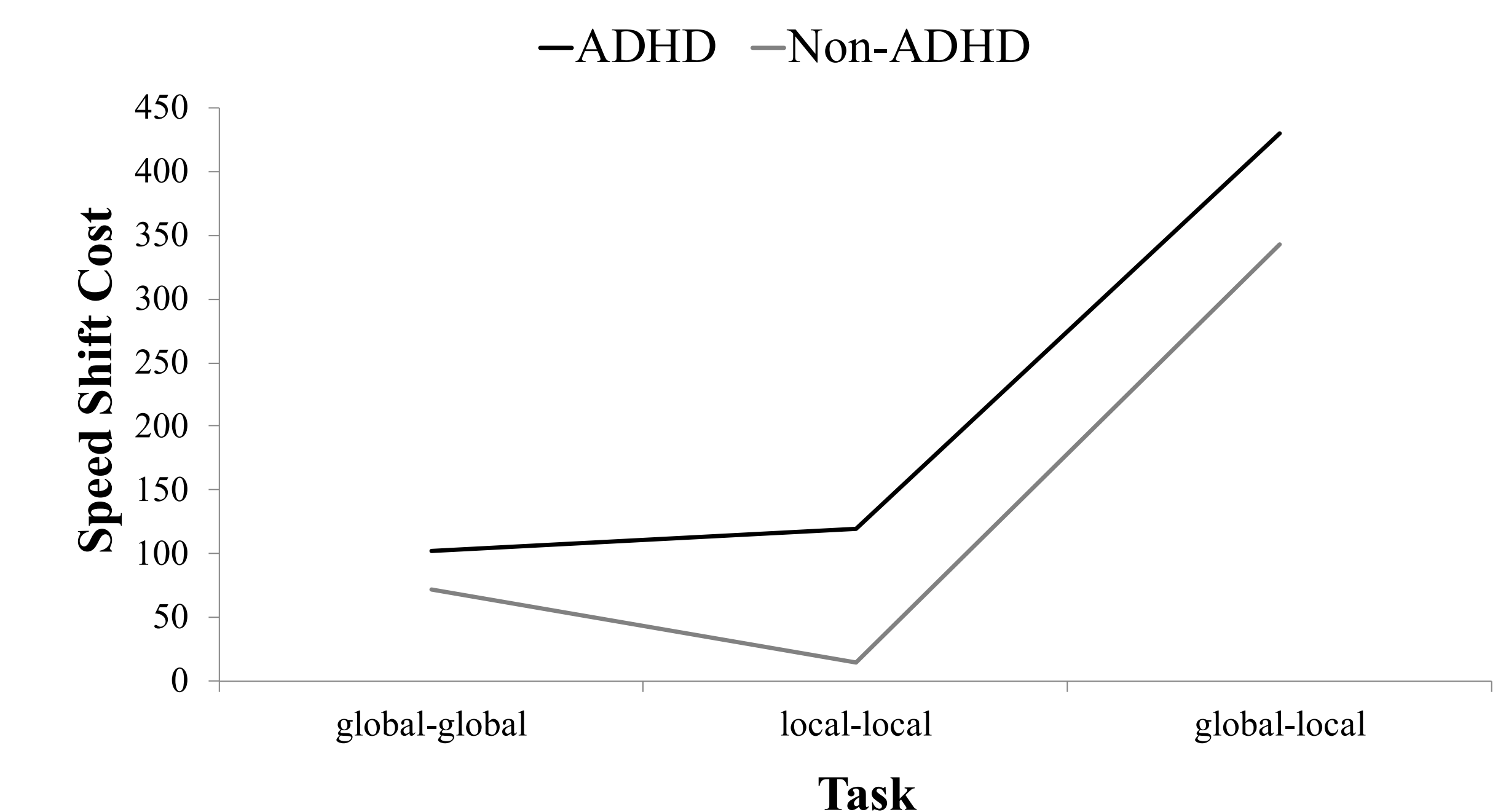
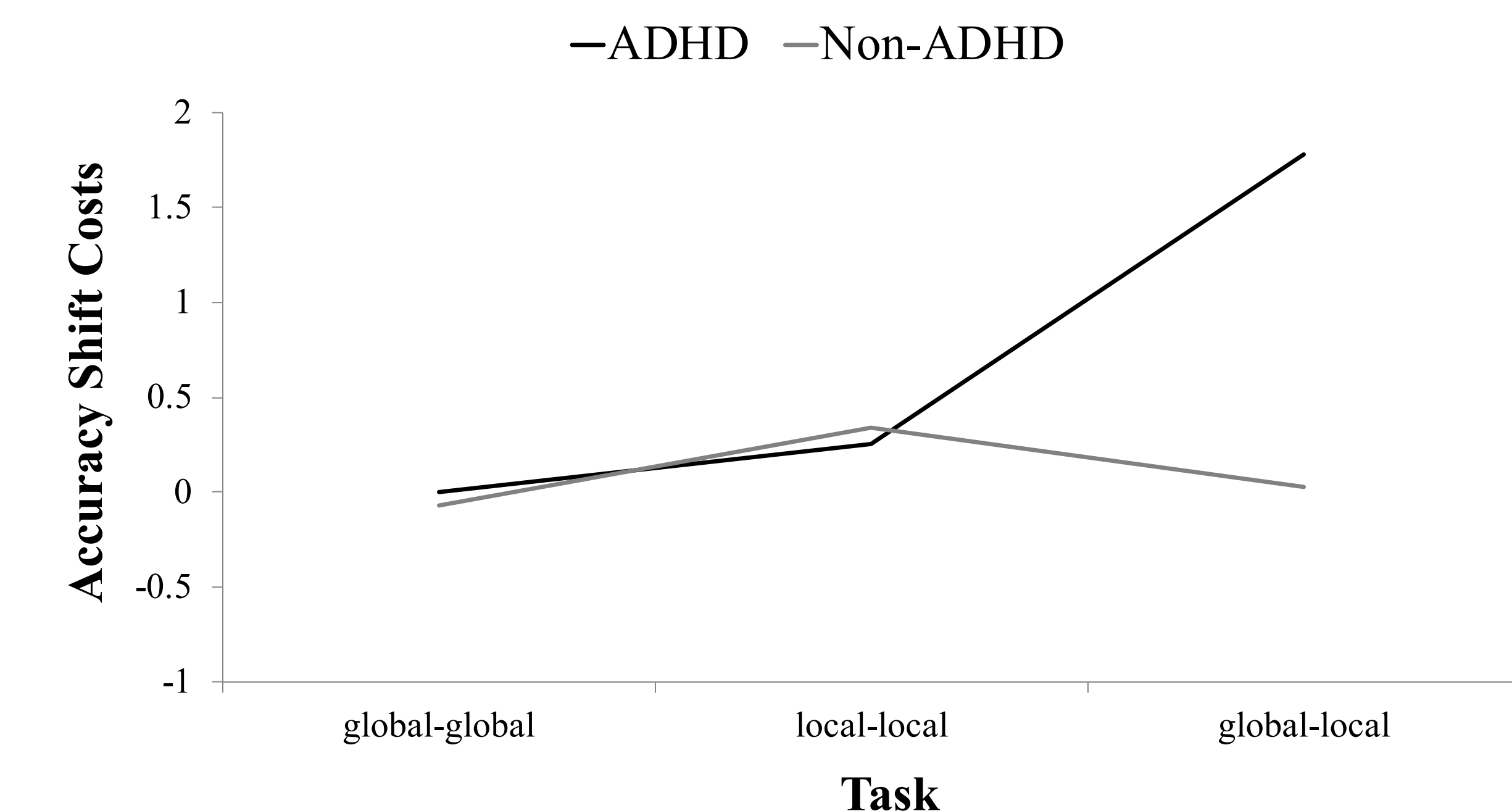


Figure 4. A graph of mean accuracy shift costs for the ADHD and Non-ADHD groups during the global-global, local-local, and global-local tasks.



Conclusion

- These results indicate that children with ADHD exhibit impairments in accuracy but not speed when required to flexibly shift between two competing rule sets
- Finding a significant interaction for accuracy, but not speed, indicates that poor performance on set shifting tasks is attributable to impaired working memory and/or inhibitory control abilities despite intact set shifting abilities
 - i.e., children with ADHD have difficulty consistently maintaining competing rule sets and/or inhibiting prepotent responses, but are able to shift as quickly as their peers when these prerequisites are met