The role of inner speech in Goal processing in children with ADHD

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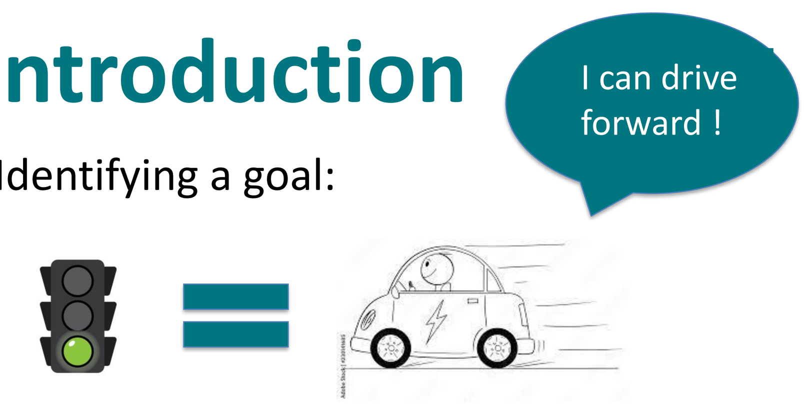
Introduction

Identifying a goal:



According to the Goal identification framework[1], goal processing involves three different steps:

- Attention to environmental cues
- Goal inference
- Control of thoughts and actions

The **final step in goal processing** involves regulating thoughts and actions directed toward the goal, requiring maintaining it in working memory. *Inner speech* plays a key role in executive control[2] by supporting goal maintenance in working memory during task execution. Verbal repetition of the explicit translation of the goal cue facilitates goal maintenance, enabling quicker inference and more efficient action [3; 4].

Developmentally, children gradually transition from external speech to internalized verbal regulation between the ages of 5 and 9. Younger children benefit from overt verbalization[3], whereas by age 9, inner speech is sufficiently developed, and overt verbalization rather induces a cognitive cost compared to a "silent" condition, due to dual-task interference [5]. Therefore, during development, the most effective strategy becomes subvocal repetition (adult-like strategy) [4].

However, children with ADHD are assumed to have a ***deficit in inner speech***[6], which should impair goal maintenance and behavior regulation. As a result, they may continue relying on external verbal strategies, similar to younger children.

Aims

- Better understanding of the role of inner speech in goal processing in ADHD.
- Assessing how different experimental conditions involving goal verbalization affect task performance in children with ADHD compared to typically developing peers.
- Examining whether children with ADHD show a developmental delay in benefiting from verbalization as a regulatory strategy.

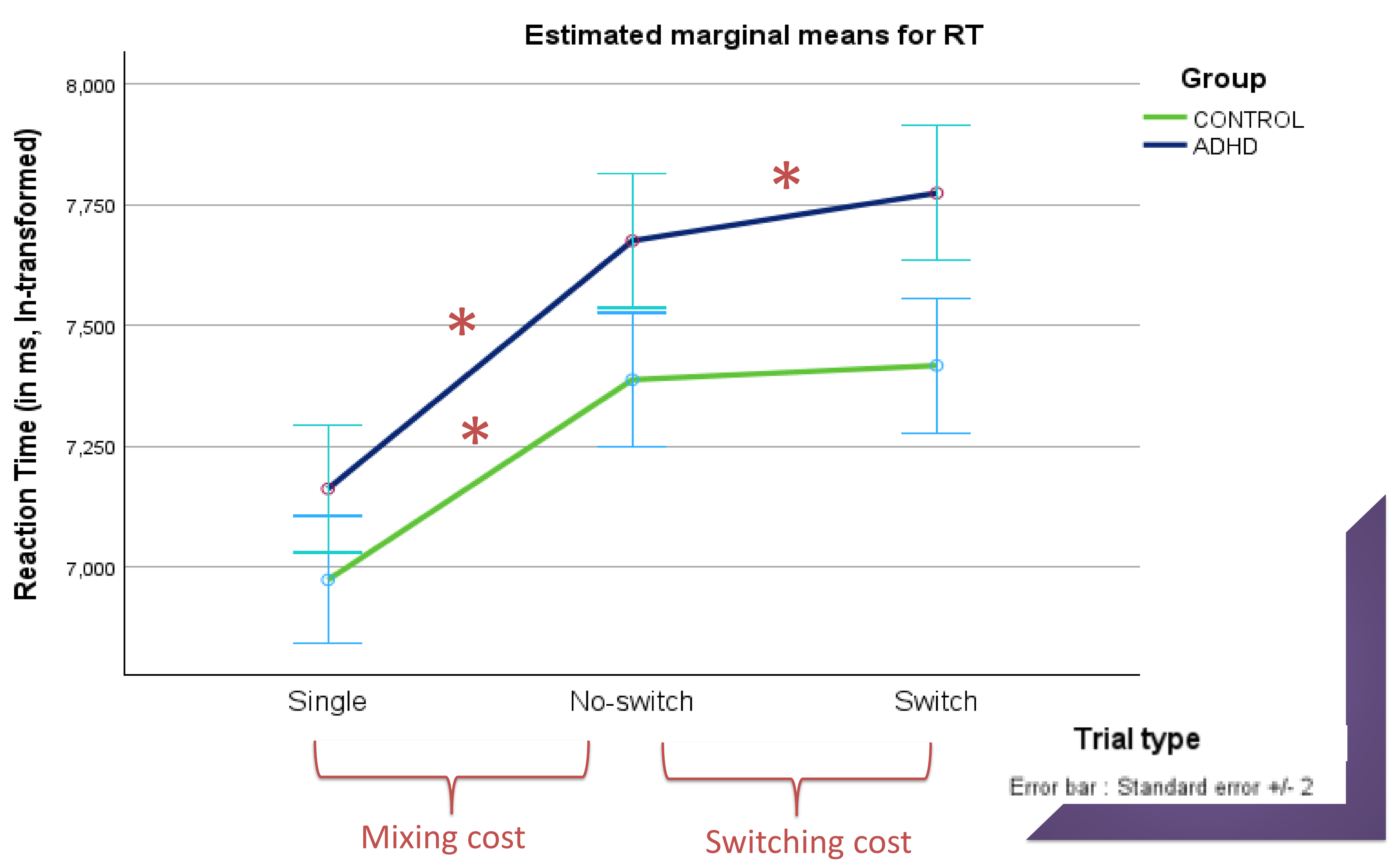
Preliminary results

<u>Accuracy</u>: Repeated measures ANOVA

- ***Group***: F(1,22) = 4.15, p = .05 ; ADHD < CTRL
- ***Condition***: F(1,62) = 6.92, p = .005 ; Sil < Verba , A Supp < Verba , Sil ≈ A supp
- ***Trial type:*** F(1,63) = 33.00, p = < .001 ; Switch < No- Switch < Single
- None of the interactions with groups reached significance

<u>RTs</u>: Repeated measures ANOVA

- ***Group***: F(1,22) = 9.69, p = .005 ; CTRL < ADHD
- ***Condition***: F(1,83) = 5.04, p = .01 ; Sil ≈ Verba, Sil < A Supp, Verba ≈ A Supp
- ***Trial type***: F(1,25) = 159.62, p = < .001 ; Single < No-Switch < Switch
- ***Trial type x Group***: <u>marginal trend</u>: F(1,25) = 3.44, p = .066, η^2_p = 0.135
- No other interaction with group was significant



References:

[1] Chevalier. Current Directions in Psychological Science, 2015
[2] Baron & Arbel. Perspectives of the ASHA Special Interest Groups, 2022
[3] Chevalier et al. Psychologie Française, 2014
[4] Miyake et al. Acta Psychologica, 2004
[5] Lucenet et al. Developmental Psychology, 2014
[6] Barkley. Psychological Bulletin, 1997
[7]: Meiran. Journal Of Experimental Psychology Learning Memory And Cognition, 1996
[8] Chevalier & Blaye. Developmental Psychology , 2009

Methodology

12 children with ADHD and 12 typically developing children from 7 to 10 years old, matched pairwise on

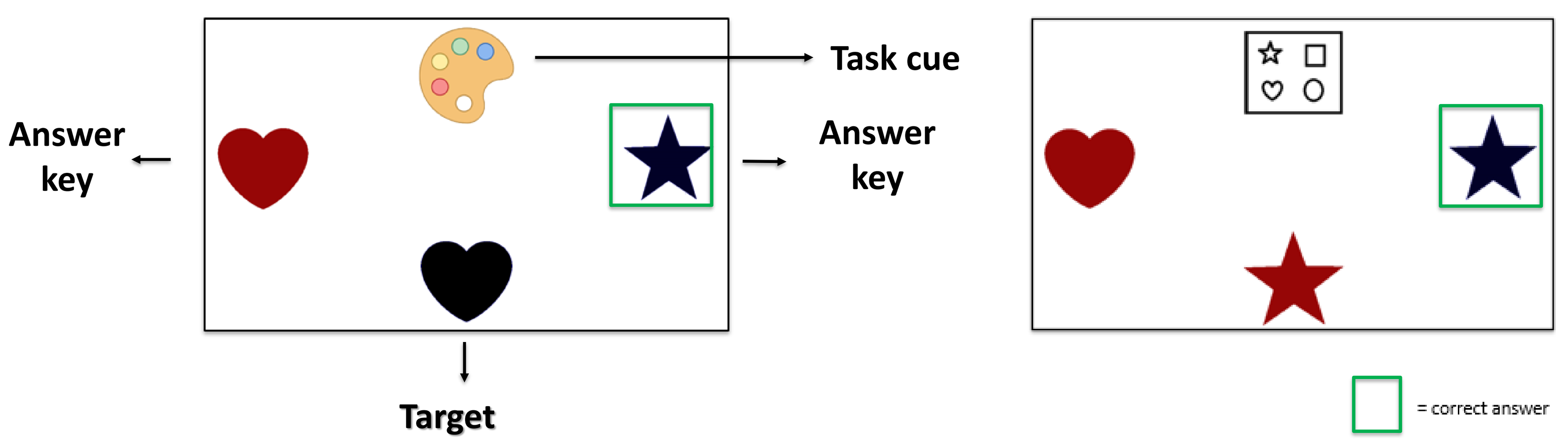
- **Sex** (12 girls, 12 boys)
- **Age** (≤ 3 months difference; M = 9.1 years, SD = 0.9)
- WISC-V "**Similarities subtest"** (≤ 2 scaled scores difference)

Expected final number of participants, based on an a priori sample size calculation (power = .95 ; α = .05 and f = .20): 35 participants per group.

ADHD diagnosis

- Established by a health care professional (neuropsychologist and/or neuropediatrician)
- Supported by questionnaires (CBCL, Conners, DSM-based attention checklist)
- Based on specific inclusion/exclusion criteria (e.g., criteria to exclude neurological injuries: no history of brain injury, no prematurity ≤36 weeks, …)

Advanced Dimensional Change Card Sort task (DCCS), a cued task-switching paradigm:



Children had to match each target to the left or right image (answer keys), based on color or shape depending on a visual cue (a color or shape palette) shown on each trial.

Three verbalization conditions:

- **Verbalization**: the child stated the task goal out loud (*private/external speech*)
- **Silence**: no speaking allowed (*possible inner speech*)
- **Articulatory suppression**: the child sang a nursery rhyme during task

Three blocks by condition:

→ 2 *single-task* blocks (color/shape only and same rule throughout the block)
→ 1 *mixed-task* block (cue randomly switches across trials)

Block type	Trial type	Cue type	Example
Single-task	Single	Same cue/goal throughout block	All color trials
Mixed-task	No-Switch	Same cue/goal as previous trial	Color → Color
Mixed-task	Switch	Cue/goal changes from previous trial	Color → Shape

Two executive costs were computed based on trial type: *Switching cost* (Switch vs. No-switch) and *Mixing cost* (No-switch vs. Single-task).

Conclusion

Children with ADHD showed poorer performances in both accuracy and response time compared to controls, suggesting a less efficient goal processing. These differences could be linked to increased executive costs related to goal switching, as indicated by a marginally significant interaction between trial type and group and further supported by a switching cost observed only in the ADHD group, alongside a shared mixing cost.

However, they do not appear to be driven by variations in the use of inner speech for goal regulation strategies, as both groups are similarly affected by the condition. Interestingly, all children were slower but more accurate when verbalizing, which may indicate that verbalization supports goal stability at the cost of speed.

Nonetheless, this study supports the hypothesis that **children with ADHD may face greater difficulties with goal processing**. They exhibit slower response times, lower accuracy, heightened sensitivity to random modality changes, and greater difficulty switching between modalities.

Further investigation is needed, and data collection is ongoing.

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