Error corrections in children with ADHD and DCD

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Introduction

Movement inaccuracy has been observed in Children with Attention Deficit hyperactivity Disorder (ADHD) and with Developmental Coordination Disorder (DCD). This inaccuracy is attributed to response inhibition deficit in ADHD (Barkley, 1997) and efference copy deficit in DCD (Katschmarsky et al., 2001; Wilson et al., 2001). Presence of these deficits was investigated by examining the ability of children with ADHD and/or DCD in movement corrections to superceding stimuli in crossed and uncrossed double-step tracking tasks.

Aims of this study are to determine:

(1) How children with ADHD and/or DCD respond to superseding step stimuli.

(2) How is visuo-spatial error information updated?

(3) The nature of the response inhibition and efference copy deficits underlying motor dysfunctions in ADHD and DCD respectively.

Methods

Participants

A total of 72 children were recruited from primary schools in Perth metropolitan area. There were 52 males and 20 females with age ranged from 9.76 years to 12.67 years (M = 11.04, SD = 0.77). All children were of normal to corrected vision, normal hearing, no neurological disorder, and no current injury or permanent disability to their upper limbs. The children were placed into the comparison (n = 26), ADHD (n = 18), DCD (n = 12) and ADHD/DCD (n = 16) using the following measures.

Measures

- Australian Twin Disruptive Behaviours Scale (ADBS; Levy & Hay, 2001)
- Conners' Parent Rating Scale (CPRS-R; Conners, 1997)
- Conners' Teacher Rating Scale (CTRS-R; Conners, 1997)
- Developmental Coordination Disorder Questionnaire (DCDQ; Wilson et al., 1998)
- McCarron Assessment of Neuromuscular Development (MAND; McCarron, 1982)

Double-step tracking task

- Participants were required to capture a target that jumped to different locations twice in succession
- Two step conditions: single- and double-step
- 3 interstimulus intervals of 40, 140 and 220m
- In crossed task: 2 target positions at 101.60 mm on each side of homebase with a total of 120 randomised trials
- In uncrossed task: 3 target positions at 203.20mm, 101.60mm and 50.80mm on same of homebase with a total of 150 randomised trials

Amplitude transition function (ATF)

An ATF plots amendments to the amplitudes of the initial step response as a function of the determinant time interval (D). This measure reflects the actual processing time available after the onset of the second target step stimulus (Becker & Jürgens, 1979). Depending on the duration of DTI, three types of amplitude responses could be obtained. A deficit in efference copy would affect the ability to produce a corrective response whereas a deficit in response inhibition would affect the ability to cancel the direction of the movement.

Results

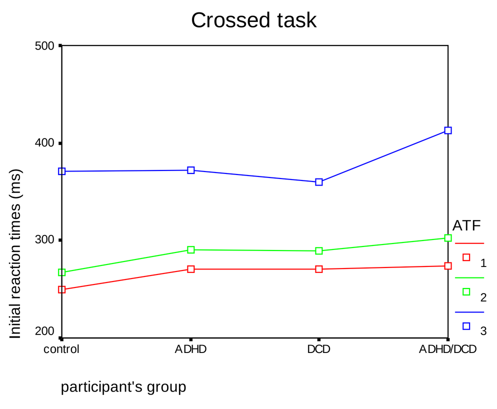
For each step pattern (Crossed and uncrossed) three 4 x 3 x 2 univariate mixed design ANOVA were conducted on initial reaction times (RTi) determinant time interval (DTI) and accuracy to the second step. The independent groups factor was diagnosis (comparison, ADHD, DCD, ADHD/DCD). The repeated measures factors were ATF response type (IAR,IMAR, FAR) and second step position (crossed:101.60mm, 101.60mm) or (uncrossed: 101.60mm, 50.80mm).

There was no statistically significant main effect for groups in each of the following analyses presented.

Crossed Task

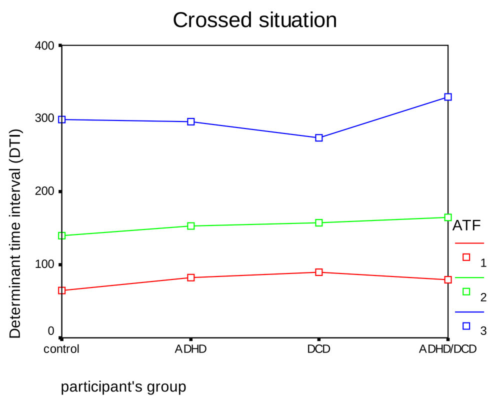
RTi

The main effect for ATF response type on RTi Was statistically significant, F (1.46, 81.46) = 164.57, p = .001, partial η2 = 0.75. RTi for IARs (M = 265.99ms) was significantly shorter than IMARs (M = 287.36ms), which was shorter than FARs (M = 378.91ms). This result is consistent with inhibition of a directional response.



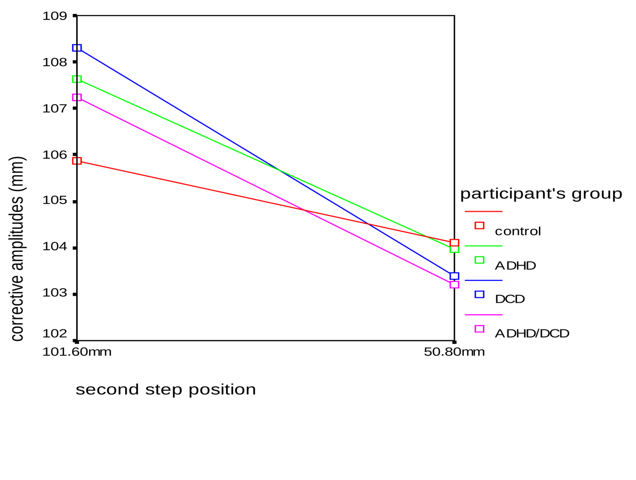
DTI

The main effect for ATF responses on DTI was statistically significant, F (1.72, 96.15) = 534.10, p = .001, partial η2 = 0.91. DTI for IARs (M = 78.54ms) was significantly shorter than IMARs (M = 153.23ms), which was shorter than FARs (M = 299.52ms). This result is consistent with a continuous updating of visuo-spatial information. Initial amplitude varies as a function of D in a way consistent with the ATF.



Accuracy

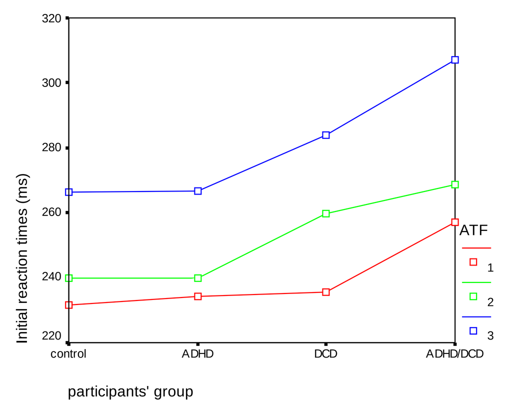
There was a statistically significant main effect for second step, F (1.46, 81.46) = 164.57, p = .001, partial η2 = 0.75. The participants were able to make the corrections in relation to the second step location regardless of the initial amplitudes.



Uncrossed task

RTi

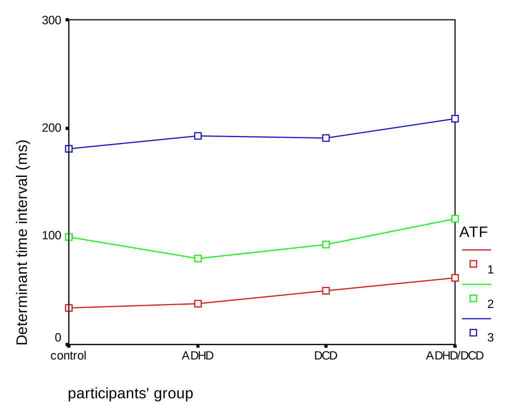
The main effect for ATF responses on RTi was statistically significant, F (1.66, 56.48) = 31.07, p = .001, partial η2 = 0.48. RTi for IARs (M = 239.61ms) was significantly shorter than IMARs (M = 252.02ms), which was shorter than FARs (M = 281.00ms).



Uncrossed task

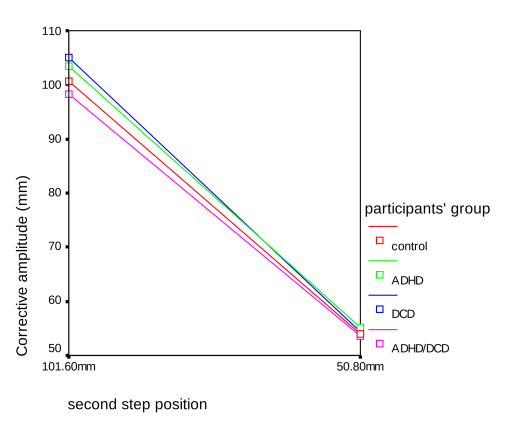
DTI

The main effect for ATF responses on DTI was statistically significant, F (1.86, 63.17) = 239.44, p = .001, partial η2 = 0.88. DTI for IARs (M = 45.87ms) was significantly shorter than IMARs (M = 97.03ms), which was shorter than FARs (M = 193.42ms).



Accuracy

The main effect for second step position was statistically significant, F (1.46, 81.46) = 164.57, p = .001, partial η2 = 0.75. The participants were able to produce a response to the second step location regardless of the initial amplitudes.



Conclusion

The findings in this study suggest that the amplitude of an initial double-step response varies as a function of DTI in all groups in the crossed and uncrossed situations. For the crossed stimuli, all groups produced a bimodal reaction times distribution. This result suggests that children are able to inhibit an initial response in one direction and reprogram the response in the opposite direction. For uncrossed stimuli, initial response amplitude varied systematically as a function of DTI. The results are consistent with the continuous updating or averaging of error information. Since the Corrective response was accurate with respect to the second target, it is hypothesised that all groups had recourse to an efference copy.

References

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