

# Combined visuo-spatial and verbal cues improve procedural learning and retention in Developmental Coordination Disorder



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## Background

The present study investigates to what extent procedural learning is affected by motor deficits (Developmental Coordination Disorder = DCD), reading deficits (Developmental Dyslexia = DD) or both (DCD+DD or NF1 = Neurofibromatosis type 1, a genetic disorder that can associate motor and reading deficits). In DCD as well as in DD, the deficit in procedural learning seems to depend on methodological conditions (Wilson et al., 2003; Gheysen et al., 2011; Gabbay et al., 2012). For example, in DD, procedural learning is preserved with visuo-spatial stimuli but impaired when stimuli are letters (Gabbay et al., 2012). On this basis, the aim of the present study is to compare procedural learning with visuo-spatial stimuli and/or letters in DCD, DD, DCD+DD, NF1 and typically-developing (TD) children.

**Hypothesis: Procedural learning deficit depends on the modality of stimuli and the nature of neurodevelopmental disorder**

→ **Procedural learning deficit in Visuo-spatial modality for DCD and DCD+DD, in Letter modality for DD and DCD+DD and in Visuo-spatial+Letter modality for DCD+DD and NF1 compared to TD children**

## Protocol

### Participants

19 TD, 11 DCD, 24 DD, 14 DCD+DD and 19 NF1 right-handed children aged 8 to 12 years (9 years 11 months ± 1 year 2 months)

### Experimental task and design

Children practiced a bimanual SRTT. They had to respond as quickly and accurately as possible to stimuli appearing on a computer screen by pressing the corresponding key in 3 conditions (Fig. 1): Letter / Visuo-spatial+Letter / Visuo-spatial

For each condition, a sequence of 10 stimuli was repeated but the participants were not aware of it. Sequences and conditions were counterbalanced between participants

For the 3 Conditions, participants performed 6 blocs  
 B1 to B4 → 10 x repeated sequences  
 B5 → 10 x randomized sequences  
 B6 → 10 x repeated sequences

### 3 Conditions: Letter / Visuo-Spatial + Letter / Visuo-spatial

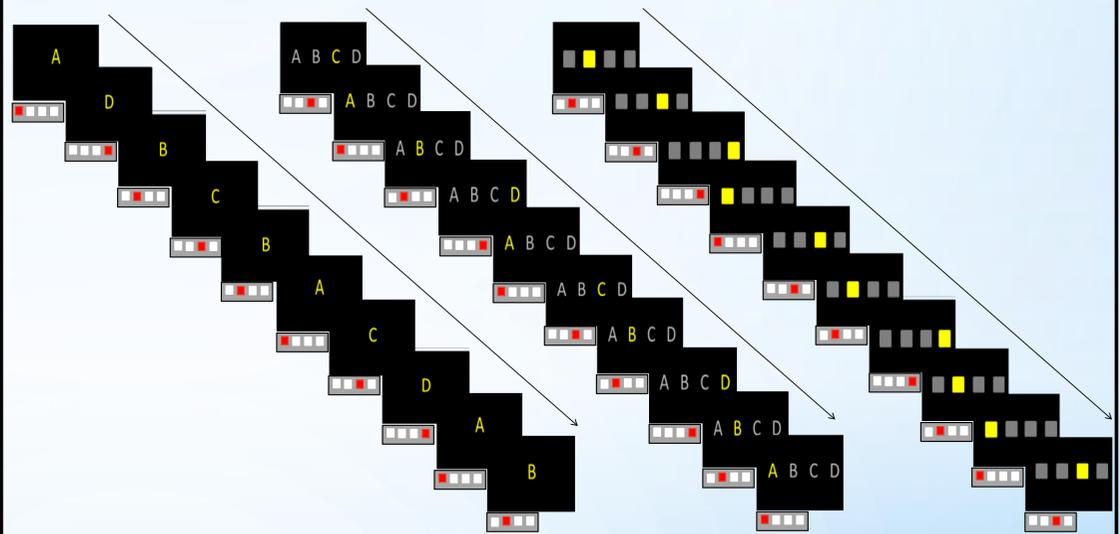


Fig.1. Illustration of the three repeated sequences in 3 conditions: Letter, Visuo-spatial + Letter and Visuo-spatial

## Analysis, Results & Discussion

### Variable:

→ **Reaction Time (RT)** is the time difference between the stimulus and the correct responses

### Analysis ( $p < .05$ ):

- ANOVA Group (5) x Condition (3) x Bloc (B1 to B4) on the RT to test the *general learning*
- *t*-test on the RT between B4 (repeated sequence) and B5 (randomized sequence) to test the *specific learning*
- *t*-test on the RT between B5 (randomized sequence) and B6 (repeated sequence) to test the *retention*

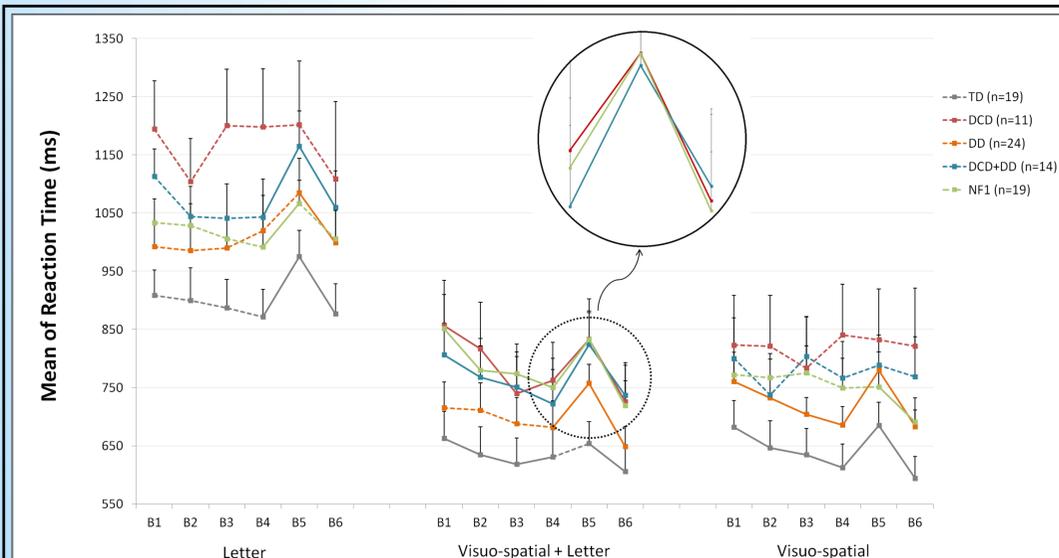


Fig.2: Mean (± SE) RT for on each bloc of the 3 conditions for TD, DCD, DD, DD+DCD and NF1.

Figure 2 represents the RT mean for the 5 groups on the 3 conditions: Filled lines represent significant differences between bloc. Dotted lines represent nonsignificant differences between bloc.

Considering that procedural learning of the sequence corresponds to a general learning (decrease RT from B1 to B4), a specific learning (increase RT from B4 to B5) and a retention (decrease RT from B5 to B6):

### In Visuo-spatial condition :

The TD and DD children learned the sequence

### In Visuo-spatial + Letter condition :

The DCD, DCD+DD and NF1 children learned the sequence

### In Letter condition :

No group learned the sequence

Procedural learning depends on the modality of the stimuli and the neurodevelopmental disorder. In particular, children with DCD and DCD+DD present impaired procedural learning with visuo-spatial stimuli (Gheysen et al., 2011) but preserved procedural learning with combined visuo-spatial stimuli and letters. Correlations with neuroimaging data (volume of crucial cortical and subcortical structures) will be analyzed to understand how combined visuo-spatial and verbal cues improve procedural learning and retention in DCD with or without comorbidity.