Examination of magnitude processing in velo-cardio-facial syndrome: similar acuity in number, space and time processing?

VOSSIUS Line [a], NOËL Marie-Pascale [b], ATTOUT Lucie [b] & ROUSSELLE, Laurence [a]

[a] Department of Psychology, Cognition & Behaviour, University of Liège, Belgium
[b] Psychological Sciences Research Institute, Catholic University of Louvain, Belgium

Université de Liège

Introduction

Some authors proposed that non-numerical magnitude representation processing set the foundation for numerical processing. Walsh (2003) proposed a central magnitude system to process space, time and number.

In the present study, we explored the relationship between numerical and non-numerical magnitude processing in children with a microdeletion 22q11.2, a genetic syndrome also called "velo-cardio-facial syndrome" (VCFS) which often associates visuo-spatial and mathematical learning disabilities.

In 2008, Simon speculated about a possible hypergranularity of spatial and temporal representation in VCFS children that would impede the development of numerical representation.

Aim

• Examining magnitude processing in VCFS children in order to determine whether they exhibit a specific deficit in numerical magnitude processing or a global poorer acuity in processing of spatial, temporal and numerical magnitude dimensions.

• Contrasting different types of numerical magnitude processing in order to assess the impact of presentation format on numerical performance.

Methods

Participants : 23 velo-cardio-facial syndrome (VCFS) children aged 5-18 years (125.6 ±51.7) matched with 23 Typically Developing (TD) children aged 4-14 years (92.8 ±30.5)

→ Paired on a verbal score ("Vocabulary" and "Similarities", WISC IV or WPPSI III)

→ VCFS = TD
   • On a non-verbal score ("Block Design" and "Picture Concepts"),
   • On working memory tasks (letters span, visuospatial span, categospan)
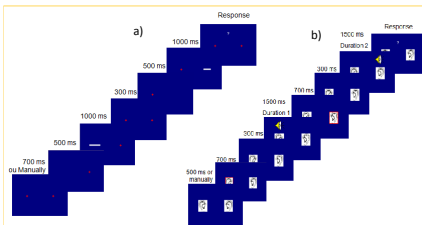   • On single-digit arithmetic fluencies (for older children)

→ VCFS < TD
   • On pictorial additive fluency (for younger children)

Tasks : Quantitative comparison tasks presented in the visual & auditory modalities

Stimuli :
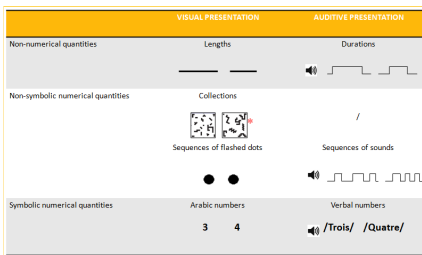
* Controlling for :
   • Cumulative surface area and perimeter of pieces
   • External perimeter

Examples :

a) Lengths
b) Durations

Excepted for the collection comparison task, the stimuli to be compared in the other tasks were presented sequentially in order to match the presentation mode across the visual and the auditory modalities and to equilibrate the load in working memory.

Ratio and distance between numerosities :

→ All tasks : 6 ratios (1/2, 2/3, 3/4, 5/6, 7/8, 8/9)
For each participant and in each magnitude comparison task, the Weber's fraction was calculated to assess numerical and non numerical acuity (non-numerical and non-symbolic numerical comparison tasks).
→ Symbolic numerical comparison only : 3 distances (1, 2, 3)

Presentation order : The task begins with the more discriminable ratio and progressively, other ratios are introduced depending on participant's correct responses rate for each ratio. Each participant does not see all ratio to prevent "guessing responses" and attentional tiredness.

Contact

Line Vossius, student at University of Liege
e-mail: Line.Vossius@student.ulg.ac.be

Results

Weber's fractions (ratios) :

Large variability for all children
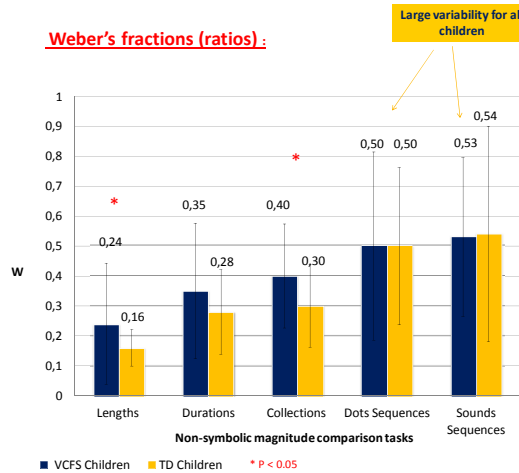
* P < 0.05

Paired T-tests :

Significant group difference in :
• Lengths comparison (p<0.05)
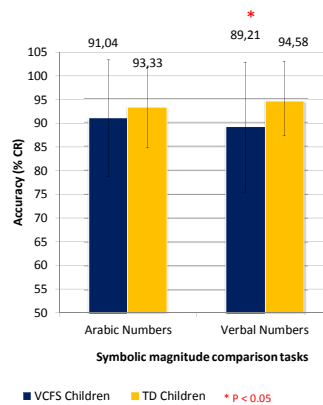• Collections comparison (p<0.05)

Marginally significant group difference in :
• Durations comparison (p<0.10)

No significant group difference in:
• Dots sequences comparison
• Sounds sequences comparison

Accuracy (distances) :

* P < 0.05

Paired T-tests:

Significant group difference in:
• Verbal numbers comparison (p<0.05) in correct responses rate and reaction time

No significant group difference in :
• Arabic numbers comparison in correct response rate and reaction time

No significant group difference in distance effect in both tasks

Discussion

VCFS children demonstrate impairments in quantitative tasks involving visuospatial processing (length or collection comparison). They also tend to display difficulties in duration comparison but the differences remained non-significant.

By contrast, VCFS children do not seem to have any difficulty in comparing the numerosities of a series of flashing dots (no spatial processing) or of sounds. It should be noted that the large variability inherent to these two tasks highlights the difficulty to extract numerical information from sequentially presented stimuli, even for typically developing participants.

In symbolic numerical processing, VCFS children display impairments in verbal numbers comparison but not in arabic numbers processing.

We can conclude that VCFS children demonstrate a global poorer acuity in numerical and non-numerical magnitude processing, especially when stimuli request visuospatial processing.

References

Simon, T. J. (2008). A new account of the neurocognitive foundations of impairments in space, time, and number processing in children with chromosome 22q11. 2 deletion syndrome. *Developmental Disabilities Research Reviews*, *14*(1), 52–58.

Walsh, V. (2003). A theory of magnitude: common cortical metrics of time, space and quantity. *Trends in Cognitive Sciences*, *7*(11), 483–488.