

Numerical abilities in Williams syndrome

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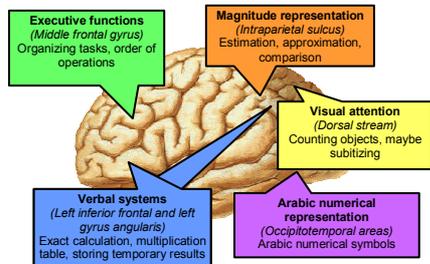


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1. The aim

Williams syndrome (WS) is a genetic developmental disorder with relatively bad parietal systems and relatively good verbal systems (Bellugi et al. 2000). The main aims of this study were to draw a more comprehensive picture about the numerical abilities in WS and test some reaction time (RT) methods in revealing developmental impairments.

2. Mental systems in numerical tasks



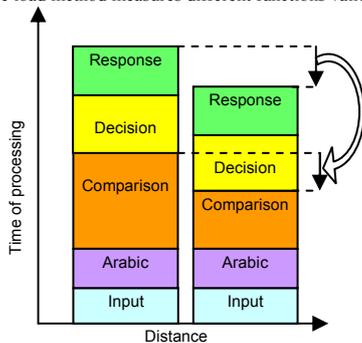
3. Tasks and subjects

Task	Mental system
Simple addition (e.g. $6 + 3 = 8$)	Verbal retrieval
Simple multiplication (e.g. $5 * 4 = 20$)	Verbal retrieval
Number comparison (e.g. $7 > 2$)	Magnitude system
Dot counting	Visual functions
Multiple object tracking	Visual functions

7 WS subjects, 14 DC subjects (11 years), 11 control subjects (10 years) took part.

4. A new RT measurement: selective load method

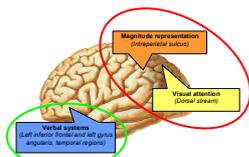
There is a problem with measuring mean reaction time (RT): if a subject is slow in a task (e.g. in number comparison) we cannot conclude surely that the slow RT is the consequence of a single function impairment (in this example the magnitude system), or multiple systems can contribute to the long RT. An alternative RT measurement extends the idea of subtraction method by Donders and the additive factor method of Sternberg (1969). The RT consists of multiple steps and some RT effects are the result of the quickening of a specific stage (see figure below). The difference between two RT data reflects the difference between the slow and quick processing time of that specific stage. This is a more direct method to measure the performance of a specific system, instead of measuring the whole RT. Former validation data show that selective load method measures different functions validly (Krajcsi, 2005).



6. Conclusion

1. WS children show a clear dissociation of the verbal and the parietal functions.

Task	Mental system
Simple addition ✓	Verbal retrieval ✓
Simple multiplication ✓	Verbal retrieval ✓
Number comparison ✗	Magnitude system ✗
Dot counting ✗	Visual functions ✗
Multiple object tracking ✗	Visual functions ✗



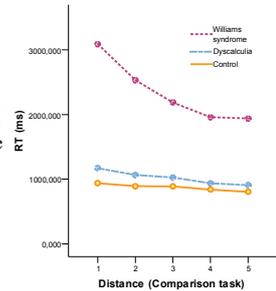
2. The main cause of DC is not the deficit of the magnitude system.

3. Some RT methods were tested.

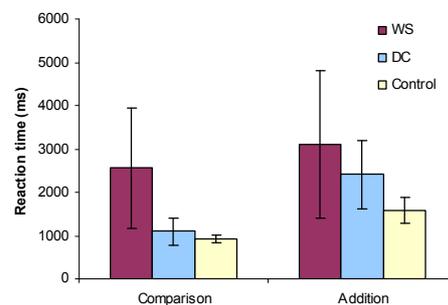
- The **selective load method** is more sensitive to the variance of a specific system, than the conventional RT measurement.
- Reversed RT pattern** never could be observed, therefore, it is not useful in measuring impairments.
- Traditional **mean RT** is more usable when **relative differences** (or normalized data) are used.

4a. Results: RT pattern

Butterworth (2002) suggested that the deficit of a system will produce the lack of the well known RT effects of that system. Several effects were investigated (like distance in comparison, size in addition, Stroop in comparison, etc.) but **no reversed effect was found**.

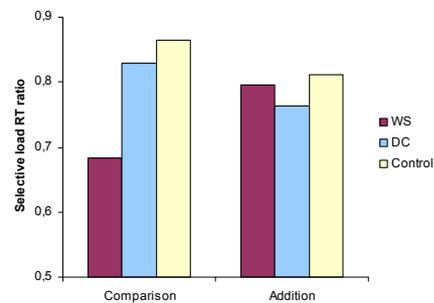


4b. Results: Mean RT



The same **WS > DC > Control** pattern was found in every task. However, if the control data were taken as a base for normalizing the data, **WS children were extremely impaired in comparison and dot counting**, but only **mildly impaired in addition and multiplication**.

4c. Results: Selective load RT ratio



With traditional RT data a **WS > DC > NC** RT pattern can be seen. Though with selective load method in addition task **WS = DC = NC** pattern and in comparison task **WS > DC = NC** pattern can be observed, reflecting a **bad mental number line and relatively intact verbal systems in WS**, that is in a strong agreement with the recent non numerical WS literature. These results draw a finer picture of the systems required for numerical abilities in WS.

7. References

Bellugi, U., Lichtenberger, L., Jones, W., & Lai, Z. (2000). The neurocognitive profile of Williams syndrome: A complex pattern of strengths and weaknesses. *Journal Of Cognitive Neuroscience*, 12, 17-29.
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