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Numerical abilities in the deaf child, the role of language and short-term memory.

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Background

- ✓ Research on numerical abilities in deaf children (DC) is scarce and results are contradictory.
- ✓ The education type, the presence of cochlear implants, the language level or short-term memory (STM) skills, have been put forward as explanatory factors for differences in mathematics between DC and hearing children (HC).

The aims of the present study

- ✓ To investigate the development of **formal numerical abilities** in young DC with cochlear implants, **following regular education**.
- ✓ To clarify the link between **formal numerical abilities** and other related **cognitive factors** (as language and verbal STM), while controlling for education, age, gender and non-verbal cognitive level.

Methodology

Participants

- 23 DC & 23 HC attended the same mainstream schools in Belgium or France.
- They are matched for age, sex and non-verbal ability (*Matrix*^a).
- Other cognitive abilities, as language (*Peabody*^b) and verbal STM^c were assessed as well.

Means (SD) with group comparison test parameters are reported below:

Characteristics	DC	HC	Statistical analyses	
Chronological age in years	9.1 (1.9)	9.1 (1.7)	$t(44) = .07$	$p = .941$
Matrix subtest ^a , T score	53.2 (8.8)	53.2 (6.6)	$t(44) = .00$	$p = 1.000$
Language (<i>Peabody</i> ^b), raw score	86.6 (23.5)	114.5 (27.5)	$t(44) = -3.70$	$p = .001$
Verbal STM ^c	6.74 (2.0)	8.0 (2.2)	$t(44) = -2.05$	$p = .047$

^a Matrix subtest, Wechsler and Naglieri (2009).

^c Digit span forward, Wechsler (2005).

^b Peabody, Dunn et al. (1993).

Measures

Formal numerical abilities

- Counting aloud^d (as far as possible, from x, from x to y, backwards and by steps).
- Reading numbers aloud^d (3 'single-digit', 9 'two-digits' & 8 'three-digits' numbers).
- Writing numbers to dictation^d (3 'single-digit', 9 'two-digits' & 8 'three-digits' numbers).
- Number fact tests^e (+ and - subtests, 1 min per condition).

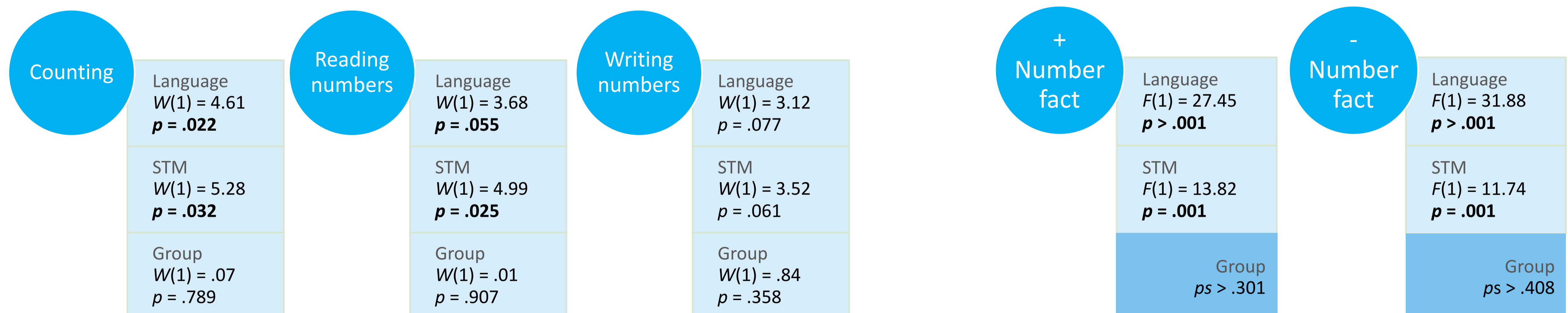
Success rate, means (SD) with group comparison test parameters are reported below:

Formal numerical abilities	DC	HC	Statistical analyses	
Counting ^e (success rate)	47.8 %	73.9 %	$\chi^2(1) = 3,29$	$p = .070$
Reading numbers (success rate)	60.9 %	82.6 %	$\chi^2(1) = 2,68$	$p = .102$
Writing numbers (success rate)	47.8 %	82.6 %	$\chi^2(1) = 6,13$	$p = .013$
+ Number fact ^e (total/min)	14.8 (7.0)	19.0 (7.4)	$t(44) = -1.97$	$p = .055$
- Number fact ^e (total/min)	11.8 (5.8)	15.4 (7.9)	$t(44) = -1.72$	$p = .093$

^d Counting tasks, Van Nieuwenhoven et al. (2008).

^e Tempo Test Rekenen (TTR), De Vos (1992).

Results



Wald test logistic regression : Regarding *counting* and *reading numbers abilities*, the variables *language* and *STM* are significant as they add some incremental value to the model. On the contrary, the *group* fails to add value and do not affect the model in any meaningful way. Regarding *writing numbers*, the 3 variables (*language*, *STM* & *group*) share common variance. Although each effect is not significant any more in the presence of the others, note that *language* and *STM* are close to the threshold.

ANCOVA : When *language* and *STM* are introduced as covariates, the *group* effect disappears. These two variables predict the scores on the two *number fact tests*.

Conclusion

- ✓ This study demonstrates that, when DC and HC are **well paired for age, sex, non-verbal abilities**, as well as for **education type** :
 - No association or difference are found between **groups of children** (DC versus HC) and **formal numerical abilities**, except for writing numbers. Further analysis should be conducted to determine the origin of this difference between DC and HC.
 - **Language** and **STM** can predict a child's score for those formal numerical abilities.
 - These data must be taken into account when caring for and educating deaf children.