Sixty-four or four-and-sixty? 
The influence of language and working memory on children’s number transcoding

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Introduction

Transcoding is a great challenge for children— and especially so in inversed number languages, where the ten-unit order is inverted in number words. Error rates are very high (47%) and inversion errors are very frequent (50%) when German-speaking children have to write down Arabic numbers (Zuber et al., 2009).

The children’s transcoding performance was best predicted by executive working memory (WM), and—in a lesser degree—by visuospatial WM.

We extended this study by:
- comparing Dutch- and French-speaking children
- selecting the least and most skilled transcoders
- increasing the number of WM tasks

Experiment 1

Participants

• 57 Dutch-speaking children between 7 and 9 years old, 26 ♂ and 31 ♀
• 60 French-speaking children between 7 and 9 years old, 28 ♂ and 32 ♀

Procedure

All children completed a group-administered dictation of one-, two-, and three-digit Arabic numbers.

Results

• The error rate was equally large in Dutch- and French-speaking children (29% & 25% in 7 year olds and 12% & 9% in 8 year olds)
• The percentage of inversion errors differed significantly:

![Bar chart showing difference in inversion errors between 7 and 8 year olds for Dutch and French-speaking children]

Experiment 2

Participants

• 49 Dutch-speaking children of 8 years old, 27 ♂ and 22 ♀
• 38 French-speaking children of 8 years old, 18 ♂ and 20 ♀

Procedure

• Step 1: Dictation of Arabic numbers (all children).
• Step 2: Selection of the 10 least and 10 most skilled transcoders in each language group, based on the number of transcoding errors.
• Step 3: Testing the WM of these children:
  - Phonological: Digit span forward & Letter span forward
  - Visuospatial: Corsi Blocks forward & Mazes Memory
  - Executive: Digit span backward, Letter span backward, Corsi Blocks backward, & Sun Moon Stroop

Results

• Logistic regression analysis on transcoding performance
• Linear regression analysis on the % inversion errors
• Linear regression analysis on the less skilled transcoders’ % errors

Predictors

- Executive WM
- Visuospatial WM
- Phonological WM
- Intelligence
- Language
- Age

Dependent variables

- Type of transcoder (more or less skilled)
- Error % (in less skilled transcoders)
- Inversion error % (in all children)

Conclusions

• Transcoding is more difficult for children speaking an inversed number language; they make more inversion errors
  → This may affect the development of (automatic) links between the number word system (“sixty-four”) and the Arabic number system (64)
  → Further evidence for a possible link between transcoding ability and learning disorders such as dyscalculia (Van Loosbroek et al., 2009)
  → Is this also true for children in a non-inversed number language system?
• Children having fewer executive WM resources are more susceptible to be less skilled transcoders.
• Less-skilled transcoders having fewer phonological WM resources make more transcoding errors.
• Visuo-spatial WM did not play a significant role in our study ↔ Zuber et al.’s (2009) study, where visuospatial WM predicted non-inversion errors.