The “thing” that good Braille readers have and poor Braille readers don’t: A relation to developmental dyslexia

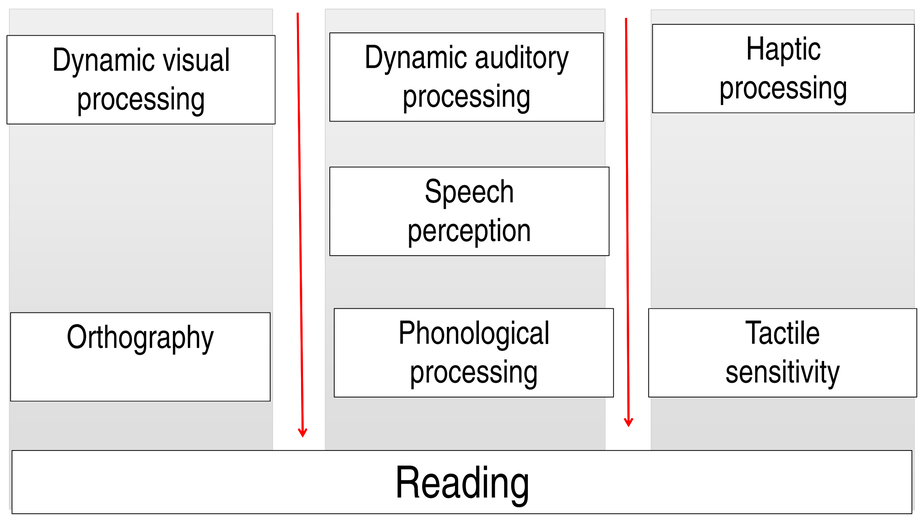
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Introduction

Like many sighted children struggling with learning to read, a proportion of children with visual impairment have specific Braille reading difficulties which cannot be easily explained. Some of these difficulties may stem from the inherent complexity of the Braille code, but it appears that not all Braille reading difficulties simply reflect an unavoidable consequence of the use of such a complicated reading medium. The possible existence of **Braille dyslexia** has been proposed.

We are using the framework of **Temporal Information Processing Deficit Theory of Developmental Dyslexia** to investigate the relational patterns between cognitive and temporal processes behind Braille- and print reading.



Materials and Methods

Participants:

- Normal intelligence (IQ > 85)
- No deficiencies in audiology
- Speak Dutch and Estonian as their first language respectively

	Braille Readers	Print Readers
Estonia	n= 12	n= 12
	age 171 months, stdev 39,5	age 167 months, stdev 40,7
Belgium	n=14	n=13
	age 233 months, stdev 67	age 219 months, stdev 31
The Netherlands	n=18	n=18
	age 161 months, stdev 36	age 163 months, stdev 36

Testing battery:

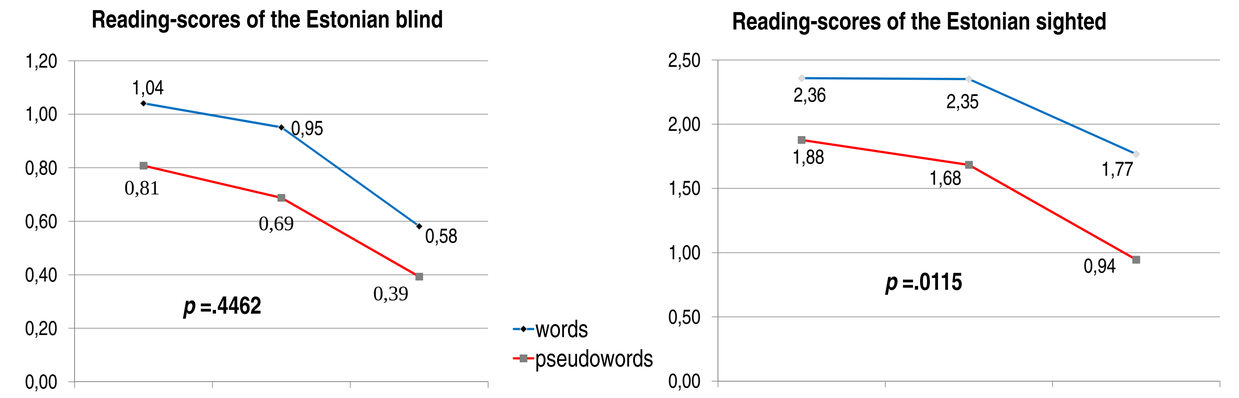
1. *Reading-ability:* (word reading test; pseudo-word reading test – 3 syllable condition 1, 2, 3-4). Accuracy and speed were assessed.
2. *Speech perception:* (Words-in-noise perception)
3. *Phonological processing:*
   - **Phonological awareness**: (phoneme deletion task, spoonerism)
   - ***Verbal short-term memory*** (pseudo-word repetition task, digit span forward task) Accuracy and reaction time were assessed.
   - **Rapid automatic naming** (digits and letters)
4. *Dynamic auditory processing:* (2Hz frequency modulation detection task FM)
5. *Tactile sensitivity:* (Grating Orientation task GOT).

Results

The non-parametric Wilcoxon t-test revealed that the sighted read significantly faster than blind both words and pseudo-words on each syllable condition **(p<.0001).** There is, however, no difference between the two groups in reading accuracy **(Words p=.909; Pseudo-words p=.870)**.

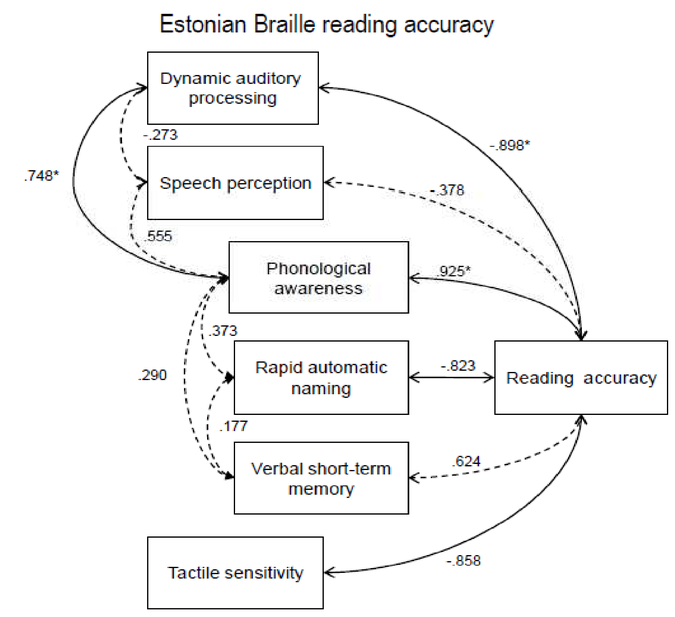
Variables		Mean for Braille	Mean for Print	Pr > |t|
Phonological awareness	Accuracy	0,11	-0,10	.765
	Speed	0,28	-0,26	.301
Verbal short term memory		0,15	-0,13	.430
RAN		- 0,51	0,47	.026
Speech perception - Words in noise		0,21	-0,19	.180
Dynamic auditory processing (FM)		- 0,29	0,23	.082
Tactile sensitivity (GOT)		- 0,50	0,42	.001
Verbal intelligence		0,14	-0,13	.242

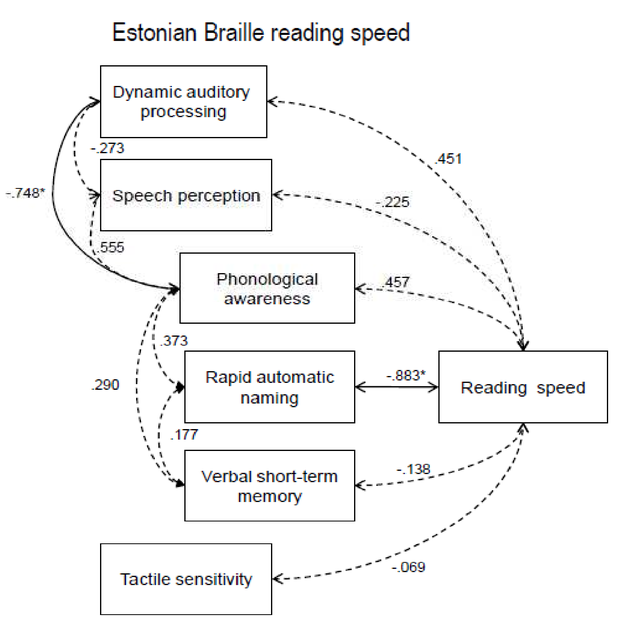
Since reading accuracy was very high in both groups (ceiling effect), we created a reading-score (number of correctly read words per second) to investigate the patterns in performance across different syllable conditions.

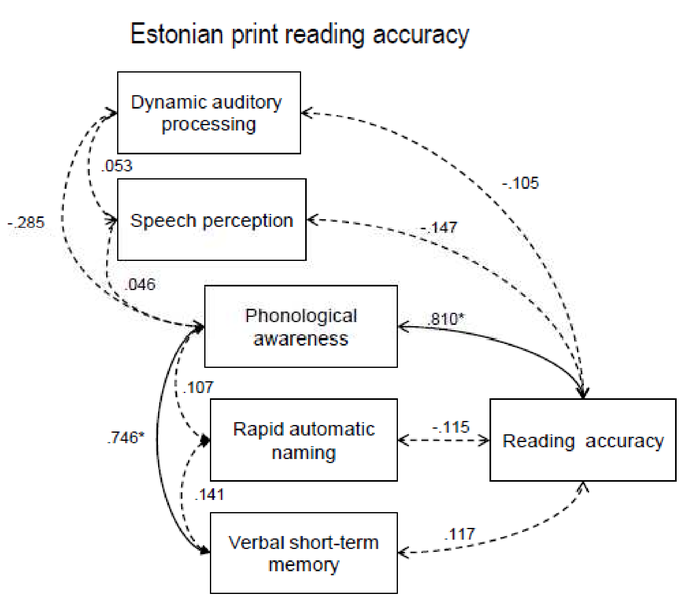


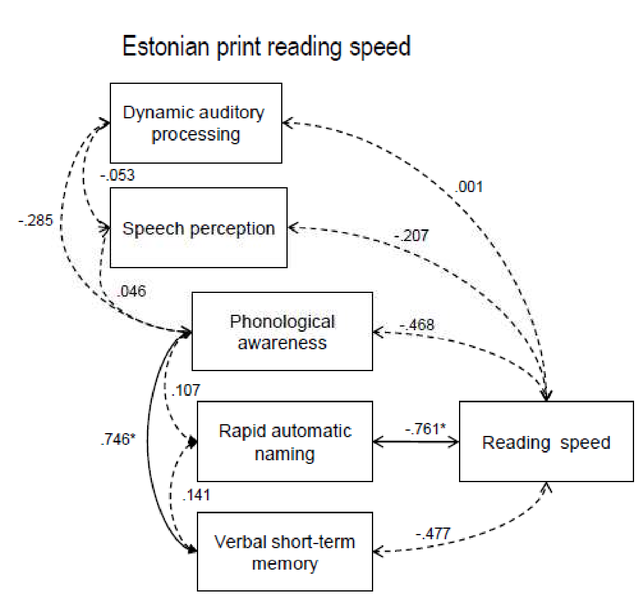
Mixed model analysis revealed that in the Braille group there’s no significant pattern difference between reading words and pseudo-words, indicating that similar strategy is used for reading both (phonological route). In the group of print readers, however, there’s a significant pattern difference between reading words and pseudo-words, indicating that different strategies might be used (visual route for words and phonological route for pseudo-words).

Path- analysis (partial correlations)









Non-significant partial correlations between the connected variables, while controlling for all the other connections.

Significant partial correlations between the connected variables, while controlling for all the other connections ($p < .10$; $*p < .05$)

Discussion

Based on the results of the current study it can be assumed that Braille readers use a similar strategy for reading both words and pseudo-words, while print readers do not. This is also predictable given the sequential nature of Braille. However, it seems that Braille readers have developed a specific prediction system, which speeds up the reading of meaningful text and reveals the pseudo-word reading effect, which is also observable in print readers. The path analysis shows that reading speed and accuracy are determined by related but different cognitive processes. In the blind the finger sensitivity is highly correlated only with reading accuracy not with speed. The phonological awareness seems to predict reading accuracy in both groups, which is expandable by the literally phonemic orthographic structure of Estonian language. Analysing word and pseudo-word reading accuracy separately reveals that in the blind group the phonological awareness is significantly correlated to both word- **($r = 0.82$, $p = .02$)** and pseudo-word reading **($r = 0.75$, $p = .05$)** , while in the sighted group there’s a correlation only to reading long pseudo-words **($r = 0.78$, $p = .004$).** Additionally, the path analysis demonstrates that in the blind group there’s a significant correlation between dynamic auditory processing and reading accuracy. Auditory processing seems also to predict phonological awareness, which is not the case in the sighted group. RAN predicts reading speed significantly in both groups. In the group of blinds however, it is not entirely clear, whether RAN measures the speed of lexical retrieval or is it a combination of hand movement strategy and finger sensitivity.

In conclusion, it can be said that the “thing” that good Braille readers have and poor Braille readers don’t seems to be a combination of sensitive fingers and highly developed phonological awareness skills.

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