Temporal organization during oral reading in children and adolescents who stutter

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Stuttering and reading

• Approximately 2% of school age children and adolescents are affected by stuttering, a motor speech disorder, characterized by a rhythmic deficit (WHO, 2015)

Verbal Non-verbal

• In reading, speech production is particularly affected while comprehension processes are largely preserved (Janssen et al., 1983)

• Persons who stutter read slower (Bloodstein, 1987)

• Altered prosodic patterns
  → difficulties building a prosodic structure around metrically prominent events (Arbisi-Kelm, 2010)
  → more variable intervals between stressed syllables (Bergmann, 1998)

Temporal organization of speech

• Capturing temporal organization in all time frames is important for examining fluent speech production

• Differences in prosody are mirrored in the longer temporal hierarchical timescales and affect temporal clustering (Falk & Kello, 2017)

• Structuring the text into meaningful chunks is called prosodic phrasing (Bolinger, 1989)
  o Intermediate phrases (ips): Minor phrases with a low boundary strength
  o Intonation phrases (IPs): Major phrases with a high boundary strength

Participants

<table>
<thead>
<tr>
<th></th>
<th>Group who stutters (GWS)</th>
<th>Control Group (CG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children (9-12)</td>
<td>13 (Ø age = 10.82, 2♀)</td>
<td>13 (Ø age = 10.88, 2♀)</td>
</tr>
<tr>
<td>Adolescents (13-17)</td>
<td>13 (Ø age = 15.02, 2♀)</td>
<td>13 (Ø age = 14.82, 2♀)</td>
</tr>
</tbody>
</table>

Read an excerpt of a popular German children’s book (690 words, 1063 syllables) (Bergmann, 1998)

Methods

Local temporal structure: Phrasing

• Intonation phrases (IPs) and intermediate phrases (ips)
  were identified in each participants’ rendition of a short excerpt of 3 sentences, using GToBI standards (Baumann et al., 2000)

• The number of phrases was calculated in comparison to the phrasing structure of professional audiobook reader

Global temporal structure: Allan Factor (AF) analysis

• Each recording was downsampled from 44.1KHz to 11KHz

• The Hilbert envelope was computed for each signal

• Envelope peaks were identified above a threshold such that about 55 peak events per second were identified on average

• Allan Factor variance \( A(T) \) was computed for each event series, for timescales \( T \) ranging from about 15ms to 15s. Peak events are clustered in time if \( A(T) > 1 \) and nested if \( A(T) \) increases with \( T \)

Figure 2. Number of phrases in comparison to an audiobook reader

Audio example

Discussion

• Phrasing: Children who stutter seem to struggle with local temporal organization → effect of speech rate or phrase final lengthening?

• AF analysis: Age and group effect on clustering in short timescales may relate to different stages in the maturation of fluent motor coordination → children and GWS display more variable articulatory movements

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Research question

How does stuttering affect the hierarchical temporal organization of oral reading locally and globally?

Selected References


Kello, Ch. T., Dalla Bella, S., Méndez, B. & Bailabusramani, R. (2017). Hierarchical temporal structure in music, speech and animal vocalizations: Jazz is like a conversation, humpback singing like a build-in Morse.