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, 1986)

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)
  - Intermediate phrases (ips): Minor phrases with a low boundary strength
  - Intonation phrases (IPs): Major phrases with a high boundary strength

Research question

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

Selected References

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Methods

Participants

	Group who stutters (GWS)	Control Group (CG)
Children (9-12)	**13** (Ø age = 10.82, 2 ♀)	**13** (Ø age = 10.88, 2 ♀)
Adolescents (13-17)	**13** (Ø age = 15.02, 2 ♀)	**13** (Ø age = 14.82, 2 ♀)

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

Procedure

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

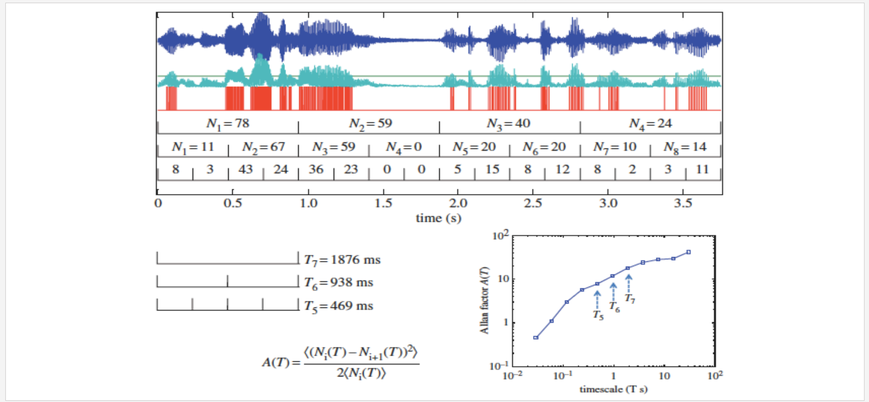

Figure 1. Example for Allan Factor analysis (Kello et al., 2017)

- 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

Results

Local temporal structure

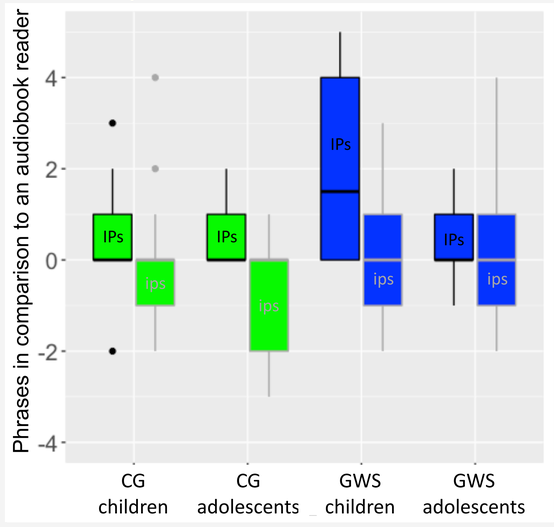

Figure 2. Number of phrases in comparison to an audiobook reader

Children produce more phrases than adolescents ($F(1,48) = 4.931$, $p < 0.05$)

GWS produce more phrases than CG ($F(1,48 = 5.667$, $p < 0.05$)

Main difference in IPs → children who stutter produce significantly more IPs than the audiobook reader

Global temporal structure

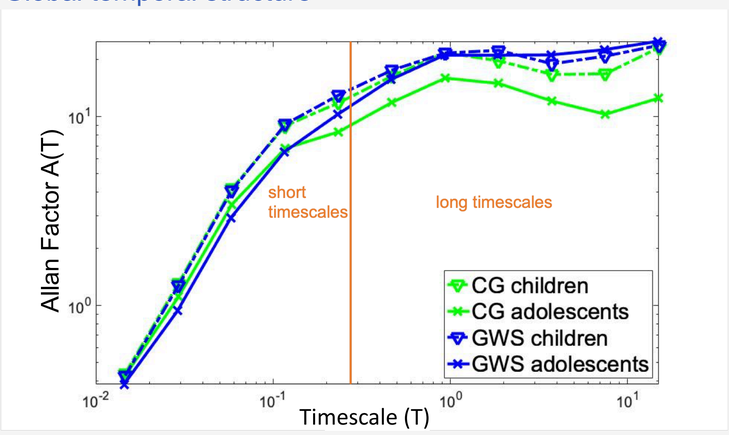

Figure 3. Mean AF functions for children and adolescents who do (GWS) and do not stutter (CG)

AF slopes in **shorter timescales** are steeper in children than in adolescents ($F(1,48) = 7.64$, $p < .01$) and steeper in the GWS compared to the CG ($F(1,48) = 5.955$, $p < 0.05$)

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)