

Verbal timing deficits in stuttering

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Stuttering

- Is a neurodevelopmental disorder characterized by a rhythmic deficit in form of involuntary interruptions of the onward flow of speech (WHO, 2015)
- disruptions are audible and/or visible
- 3 major symptoms (core behavior): blockades, prolongations and repetitions
- affects 5-8% of school-aged children, in 1 % of the cases it persists into adulthood (Yairi & Ambrose, 2013)

Blockades

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Prolongations

Piiiiizza

Repetitions

Pi-pi-pizza

Timing deficits in stuttering

- Models posit that a core problem lies in deficient auditory-motor integration or the forward modeling of speech.
- Fluency inducing conditions (singing, paced speech, shadowed speech) help persons who stutter (PWS) to speak fluently, maybe by enhancing rhythmic structure and temporal predictions during speech production (Etchell et al., 2014; Harrington, 1988).



Research aim & focus:

Investigate whether verbal predictive timing deficits can be found in a group of **children and adolescents** who stutter, with a special focus on potentially altered syllable timing in a paced speech paradigm

Stimuli & Procedure

- All participants were German-native speaking and had - besides stuttering - no other speech or cognitive impairments

unpaced trial: participants uttered the syllables/words at a comfortable pace as **steady and evenly** as possible - without specification on the tempo

- paced trial:**
 - participants had to time **one syllable/word per tone of the metronome**
 - Tasks: utter simple and complex syllables ("ba" and "bla") and read two lists of 53 concrete monosyllabic words with either simple or complex onsets in synchrony with an external beat (i.e., a metronome)
 - inter-onset-intervals (IOI) of the beat : 750ms for the syllable task and 900ms for the wordlists

Participants who stutter	Control group
40 German-speaking children and adolescents (6 fem.) ø age = 12.5 years, SD = 2.6	40 German-speaking children and adolescents (6 fem.) ø age = 12.2 years, SD = 2.5

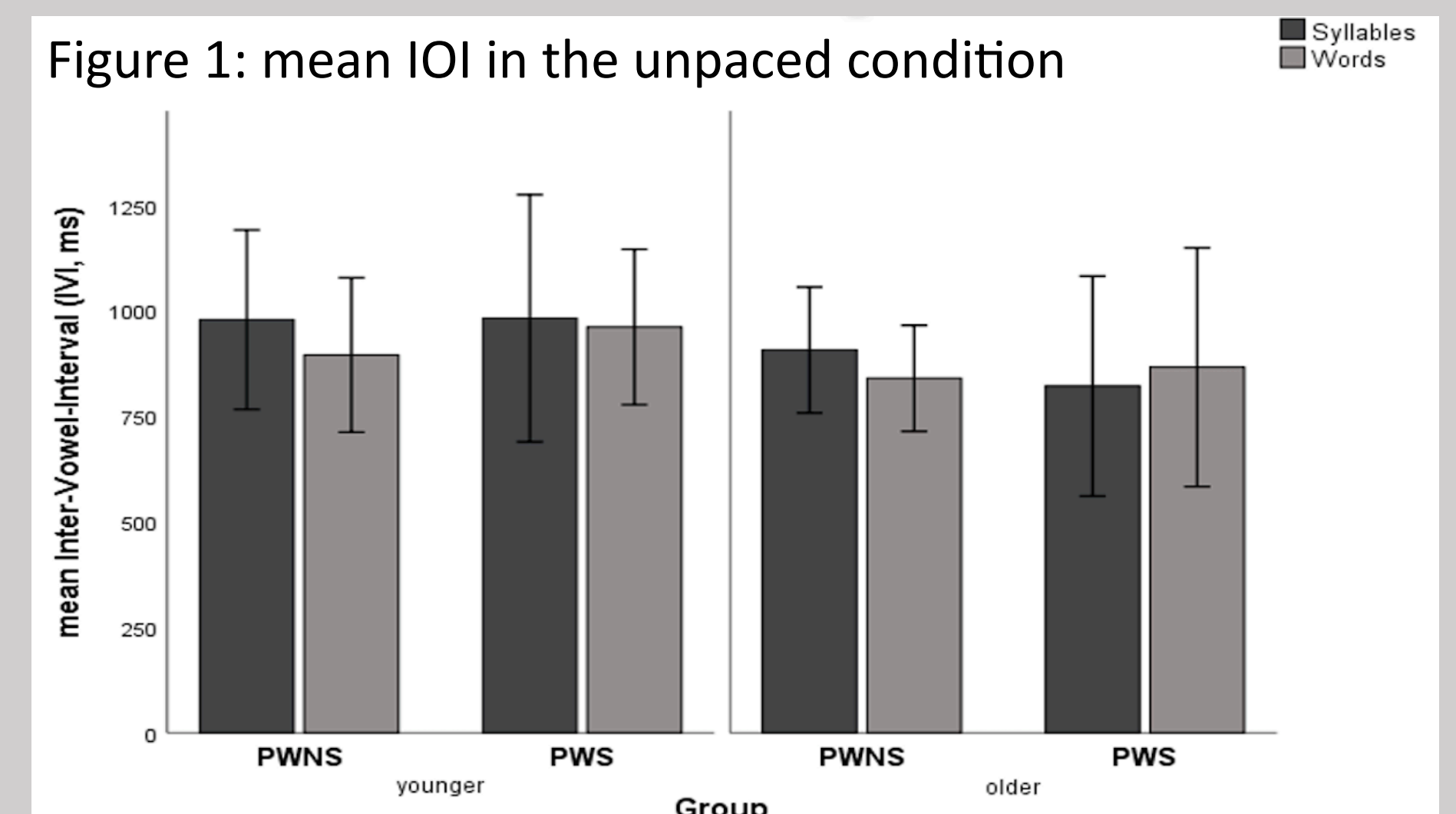
Analyses

- unpaced reading:** Inter-Vowel-Intervals (IVIs) and the variability (Coefficient of Variation) of these IVIs
- paced conditions:** synchronization consistency and accuracy (by evaluating the time of the vowel and syllable onset and relating it to the time of the metronome using circular statistics (see Falk et al., 2015))

Results

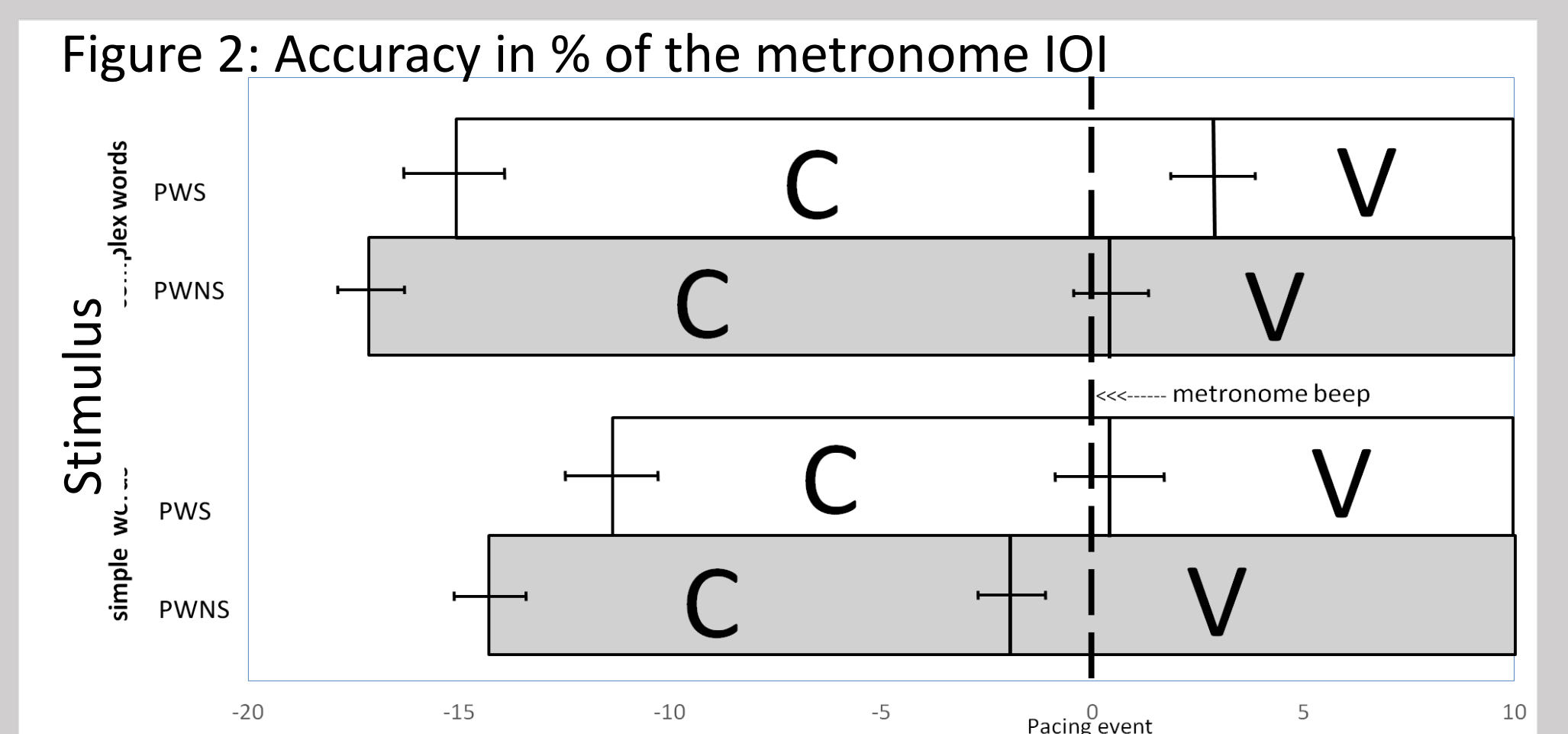
Unpaced speech

- participants who do not stutter (PWNS) chose a faster tempo for words (~ 860 ms IOI) than for syllables (~ 950ms, $p < .01$)
- no difference between stimuli in PWS and PWNS (~ 910 ms IOI) (see figure 1)
- no group differences present concerning CV of IVIs



Paced speech

- mean word/syllable duration was included as a covariate in the analyses (ANCOVA: participants who stutter showed slower word/syllable production times compared to the control group)
- no differences** between groups concerning the **consistency of synchronization**
- significant differences in the **onset-vowel timing to the beat**: PWS display larger positive lags between vowels and the pacing beat than PWNS across all pacing conditions ($F(1,64) = 7.91, p = .007, \eta^2 = .110$)
- significantly **later syllable onset** in PWS than in PWNS ($F(1,61) = 5.27, p = .025, \text{partial } \eta^2 = .079$)
- PWS consistently **timed their speech production later** to the beat compared to the control group (see figure 2)
- no differences between age groups in accuracy
- significantly more variability in children (9-12 years) when reading words (in unpaced and paced conditions) than adolescents (13-17 years), probably due to less mature reading skills



Conclusion

The observed timing delay in PWS - a result of at least two temporal processes:

- altered temporal predictions** in individuals who stutter that may lead to delayed temporal targets during production (Harrington, 1988) or
- more **unreliable timing mechanisms** which may generate delays in the activation of syllable motor programs during articulation in PWS (Civier et al., 2013)
- results support the idea of **altered timing** in young speakers who stutter
- question for future research: Are these of motor or predictive timing origin?

Selected references

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