Tongue Shape Complexity in Children with Speech Sound Disorders
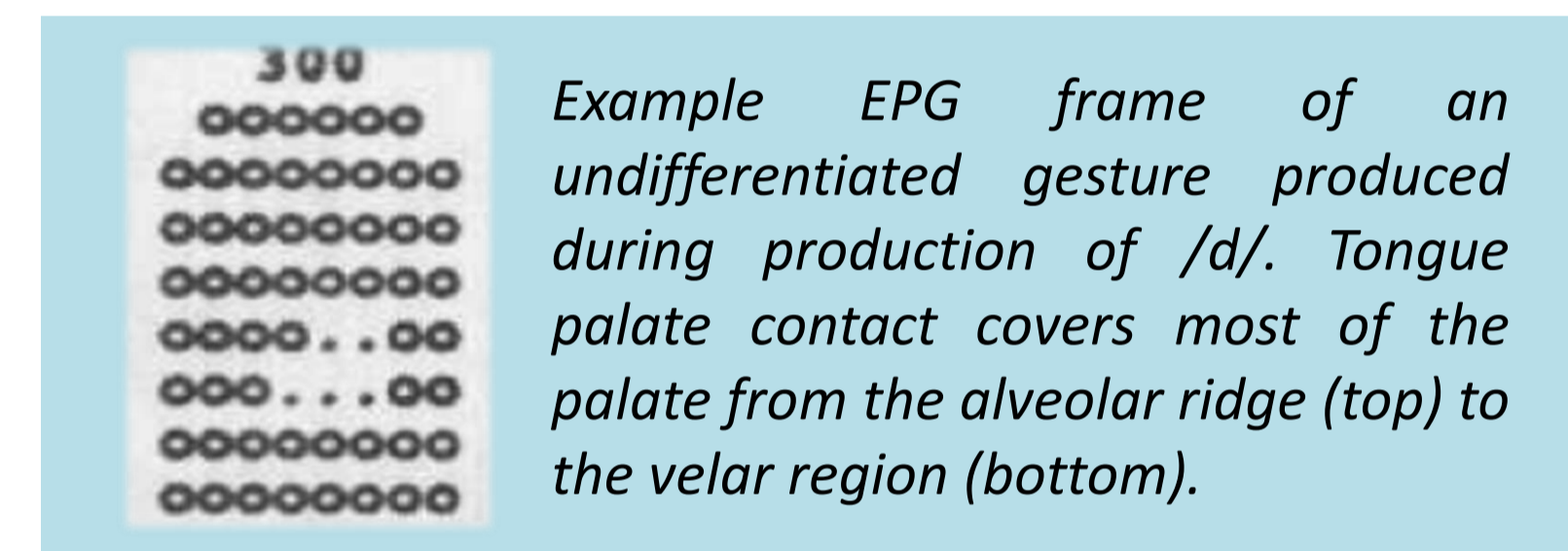
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University of **Strathclyde** Humanities & Social Sciences

Background

- An 'undifferentiated lingual gesture' is a simple tongue shape with fewer inflections than needed. [1]
- Young children and children with Speech Sound Disorder (SSD) have been shown to have more 'undifferentiated lingual gestures'. [1, 2]
- 'Undifferentiated lingual gestures' were first described using electropalatography (EPG). [1]

Example EPG frame of an undifferentiated gesture produced during production of /d/. Tongue palate contact covers most of the palate from the alveolar ridge (top) to the velar region (bottom).
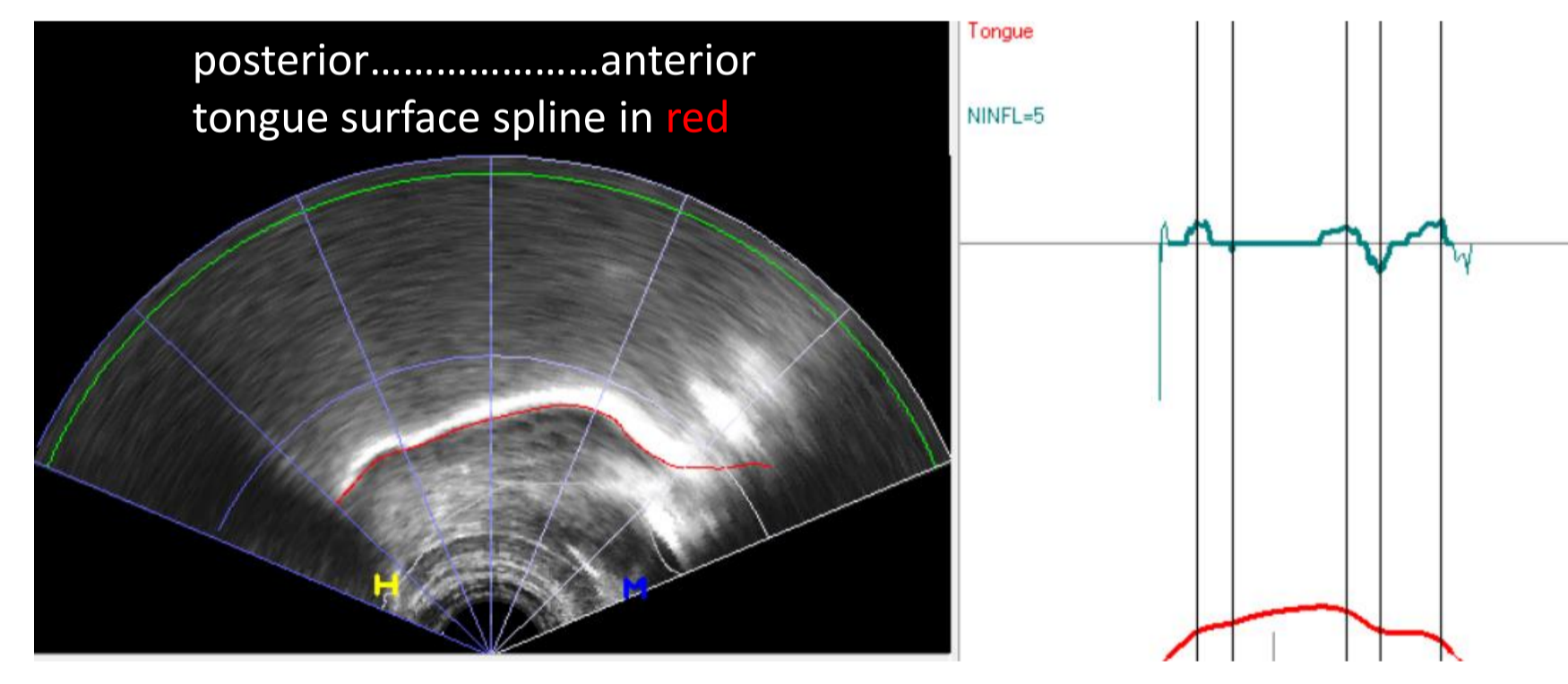
- A new metric for measuring lingual complexity using UTI is the NINFL measure (Number of INFLections). [3]
- This study compares the lingual complexity of children with typical development (TD) and SSD across ages and consonants.
- We hypothesise that lingual motor skill maturity (higher age) and low SSD severity or TD (% Tokens Correct per consonant or PTC) are linked with more complex tongue shapes (high NINFL).

Participants

Group	• Children with Speech Sound Disorders from [4]	Group	• Typically developing children from [5]
n	• 23	n	• 28
Age	• 5;2 to 12;11	Age	• 5;8 to 12;10

KEY FINDINGS

As age and percentage tokens correct (PTC) increase in SSD, tongue shape complexity of /ɹ/, /ʃ/, /t/ also increases. But there is also evidence of negative relationship between complexity and age/PTC for some consonants.
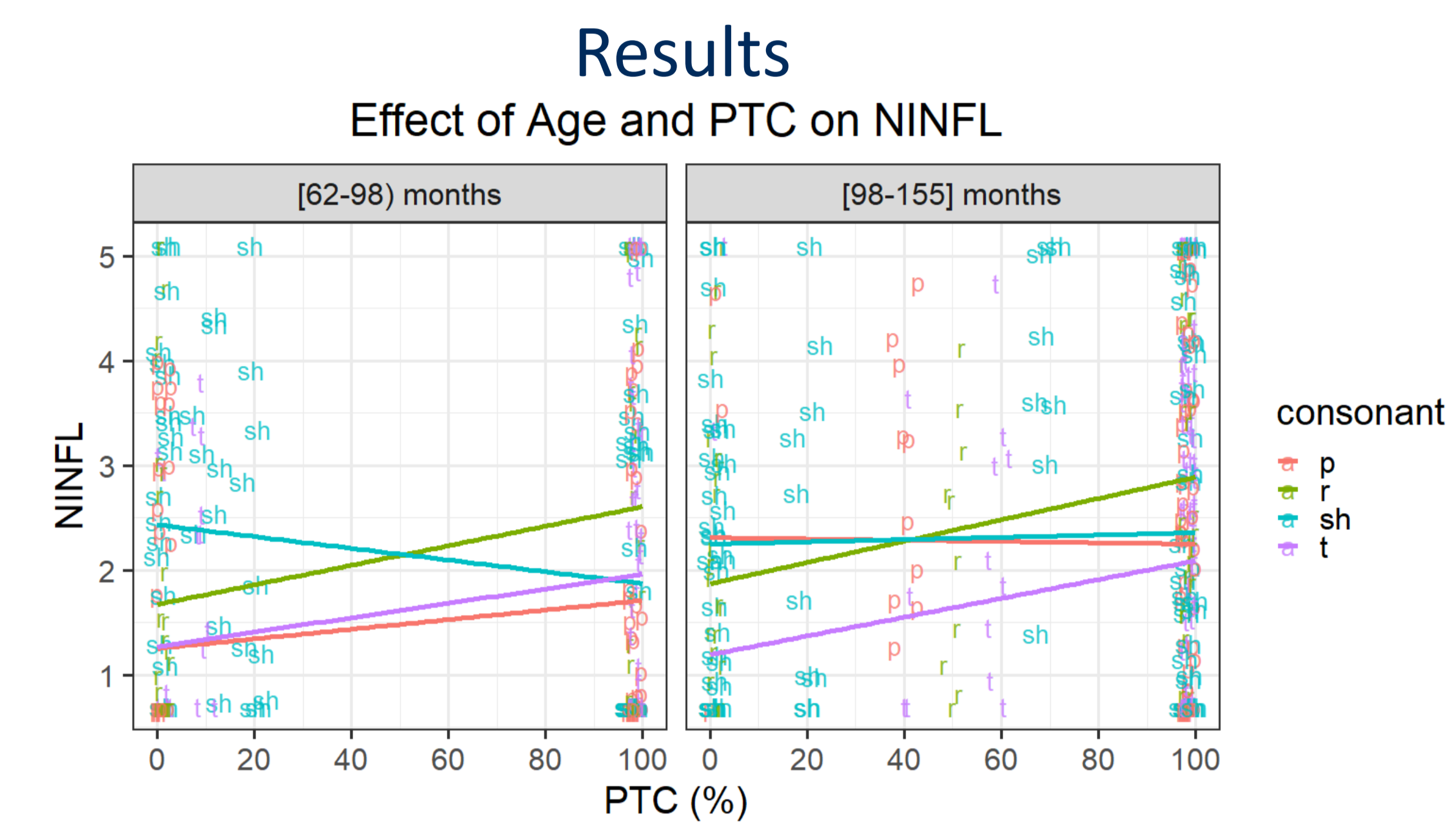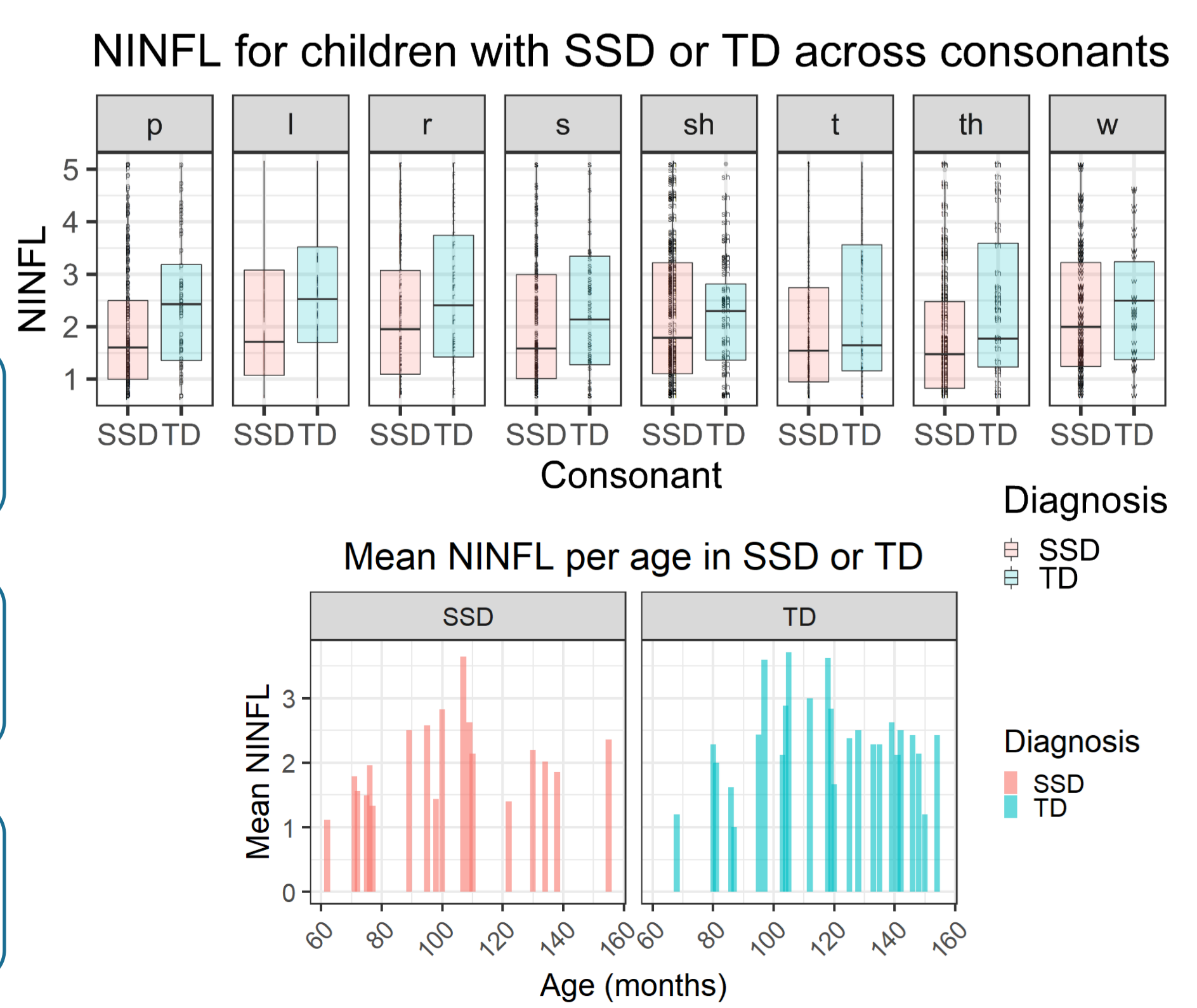
Data and Methods

- SSD: 10 tokens of /p, t, k, ɹ, l, w, s, θ, ʃ/ in an /aCa/ environment, PTC rated in [6]
- TD: 1 token of /p, t, k, ɹ, l, w, s, θ, ʃ/ in an /aCa/ environment, 100% correct

- Synchronised audio and ultrasound data at 100 frames per second.
- A fan-shaped grid (origin at probe centre) giving 42 radial sectors
- Annotations at the point of maximal lingual gesture
- Export of NINFL (values between 1 and 5)

posterior.....................anterior tongue surface spline in red

Example of TD production of /l/ with NINFL = 5. NINFL captures the number of concave to convex inflections in the tongue curve in midsagittal view. [3]'s procedure for calculating NINFL trims retroflex shapes and very small inflections.

NINFL for children with SSD or TD across consonants

Mean NINFL per age in SSD or TD

Age: 11;6 PCC: 6%
/r/ orange, NINFL = 3 [w]
/p/ purple, NINFL = 5 [p]

Age: 10;9 PCC: 80%
/r/ orange, NINFL = 1 [ɹ]
/p/ purple, NINFL = 1 [p]

Results

Effect of Age and PTC on NINFL

- Ordinal mixed models for analysing outcome variable NINFL.
- Model1: TD vs SSD
  - No systematic difference between SSD and TD in NINFL (accounting for age and consonant).
  - Higher age in TD linked to lower NINFL for /l/ vs. /p/

- Model2: Effect of Percent Tokens Correct (PTC) in SSD
  - Significant effects of +Age, -PTC, and Consonant (for +/j/ and -/t/ compared to /p/).
  - Significant double interactions between Age and PTC (-/p/), PTC and Consonants (+/ɹ/, +/ʃ/, +/t/ vs. /p/), Age and Consonant (-/w/ vs. /p/)
  - Significant positive triple interaction between Age, Consonant and Percent Tokens Correct of /ɹ/, /ʃ/, /t/ compared to /p/.

- **The higher the Age and PTC, the higher the NINFL of /ɹ/, /ʃ/, /t/ compared to /p/.**
- **Some evidence of a negative relationship between Age and NINFL (/w/ vs. /p/ in SSD and /l/ vs. /p/ in TD), and Age and PTC (/p/)**

UKRI Engineering and Physical Sciences Research Council CHIEF SCIENTIST OFFICE

References

1. Gibbon, F. E. (1999). Undifferentiated lingual gestures in children with articulation/phonological disorders. *Journal of Speech, Language, and Hearing Research, 42*(2), 382-397.
2. Fletcher, S. G. (1989). Palatometric Specification of Stop, Affricate, and Sibilant Sounds. *Journal of Speech and Hearing Research, 32*(4), 736–748.
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4. Cleland, J., Wrench, A., Lloyd, S., & Sugden, E. (2018). ULTRAX2020: Ultrasound Technology for Optimising the Treatment of Speech Disorders : Clinicians' Resource Manual [Report]. University of Strathclyde.
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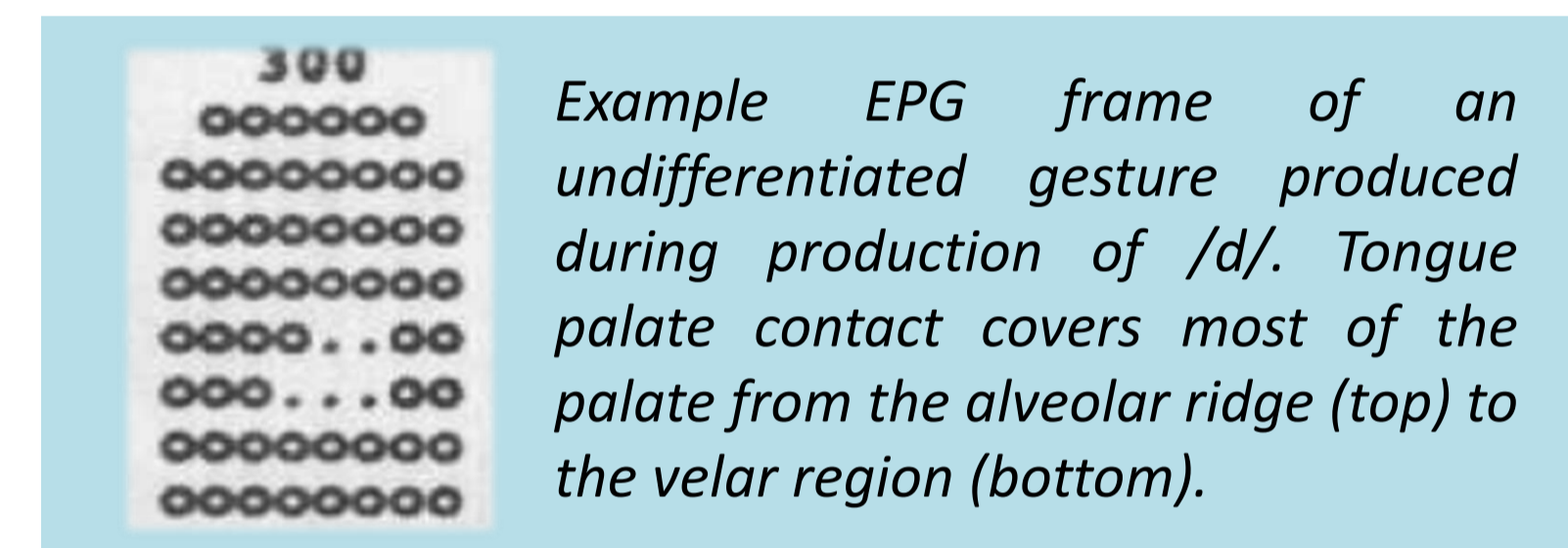## Marie Dokovova and Joanne Cleland
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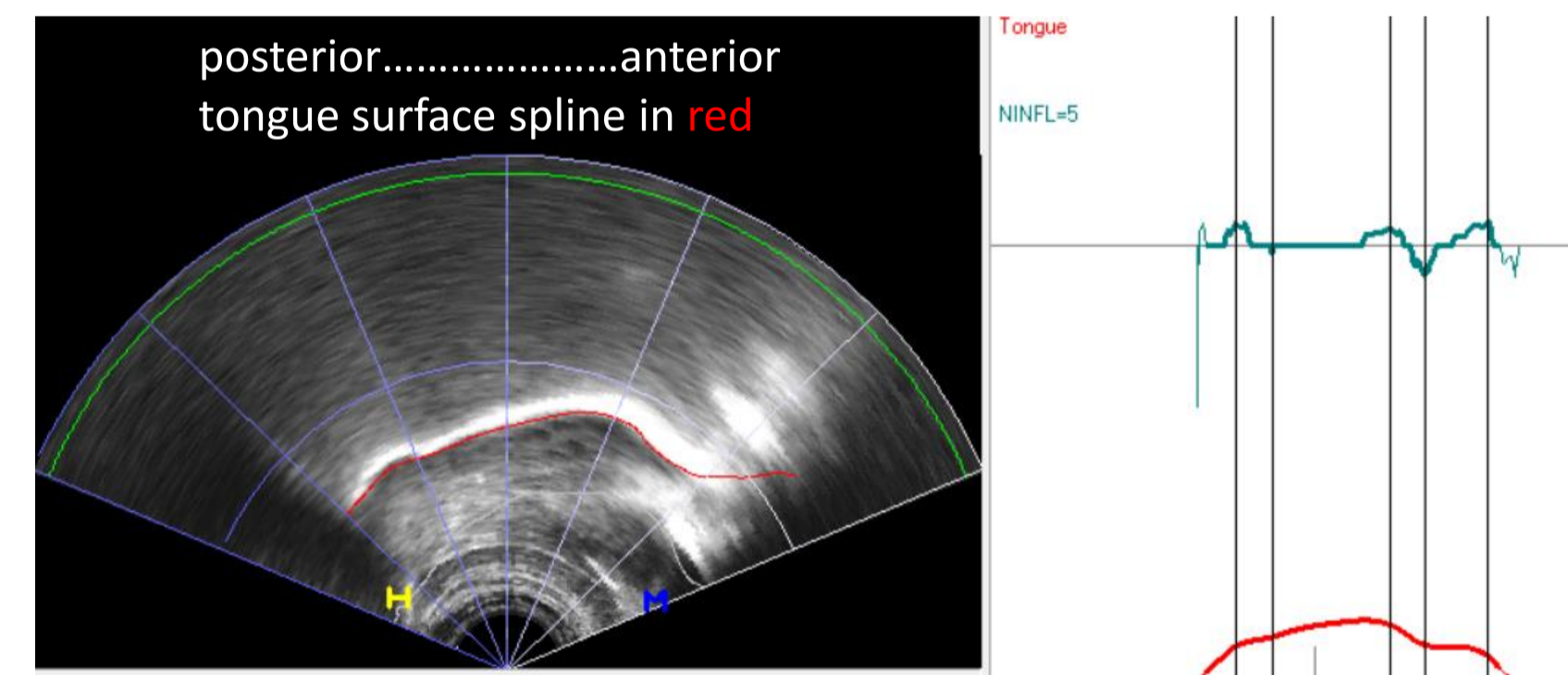
Participants

Group	• Children with Speech Sound Disorders
n	• 29
Age	• 5;0 to 12;11

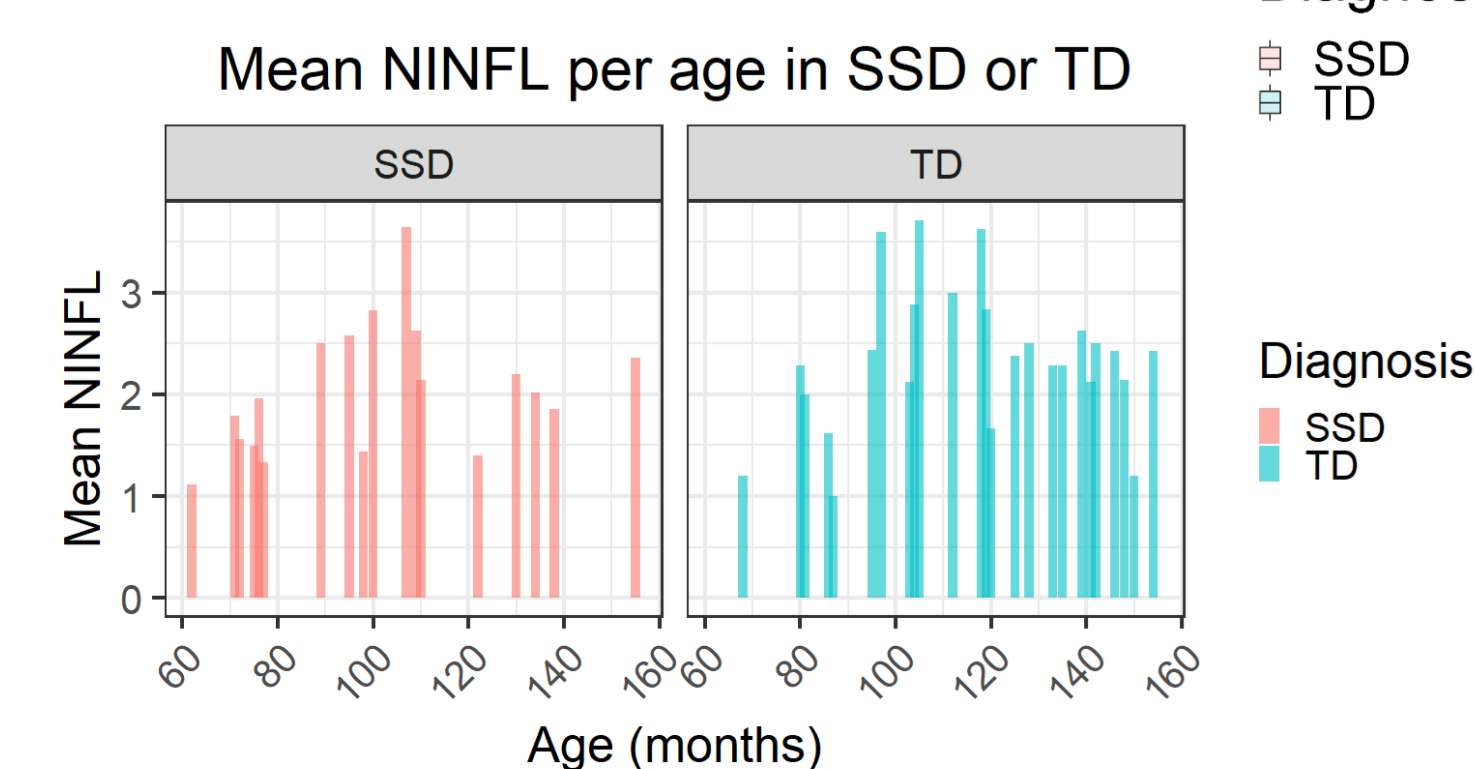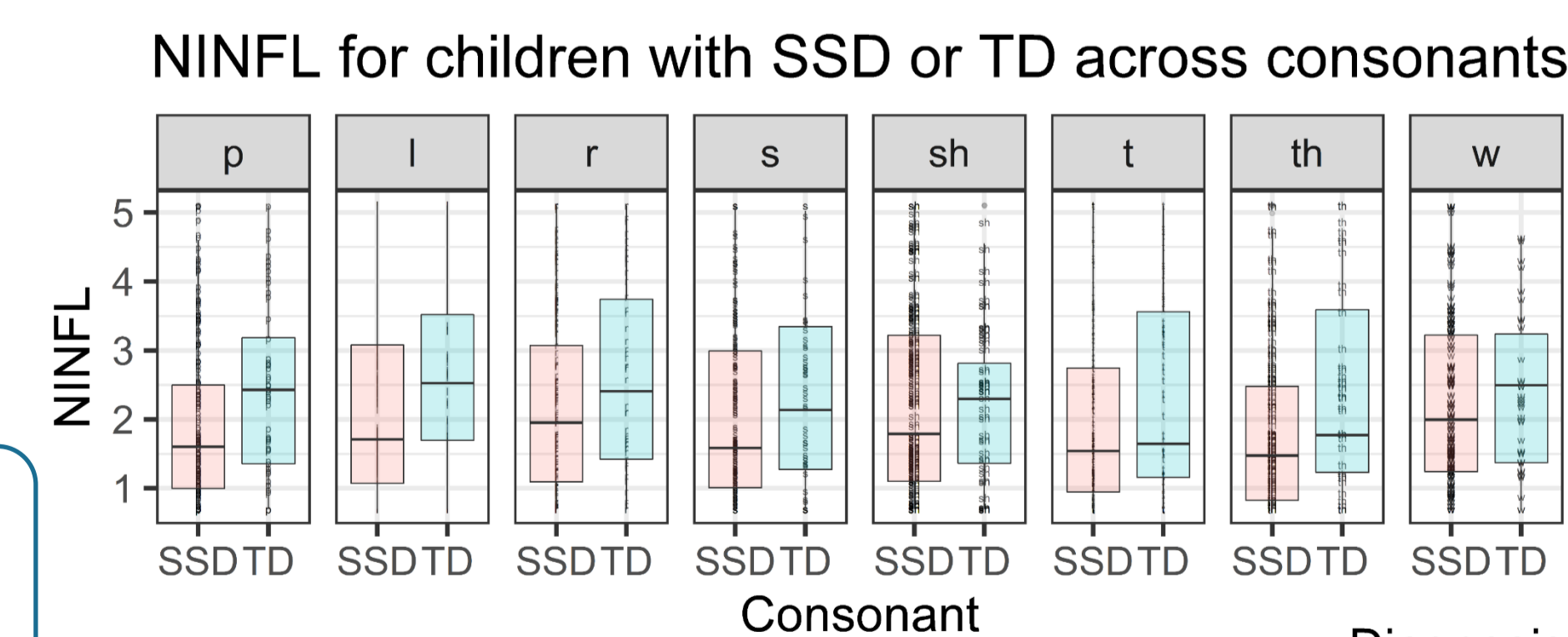| **Group**	• Typically developing children
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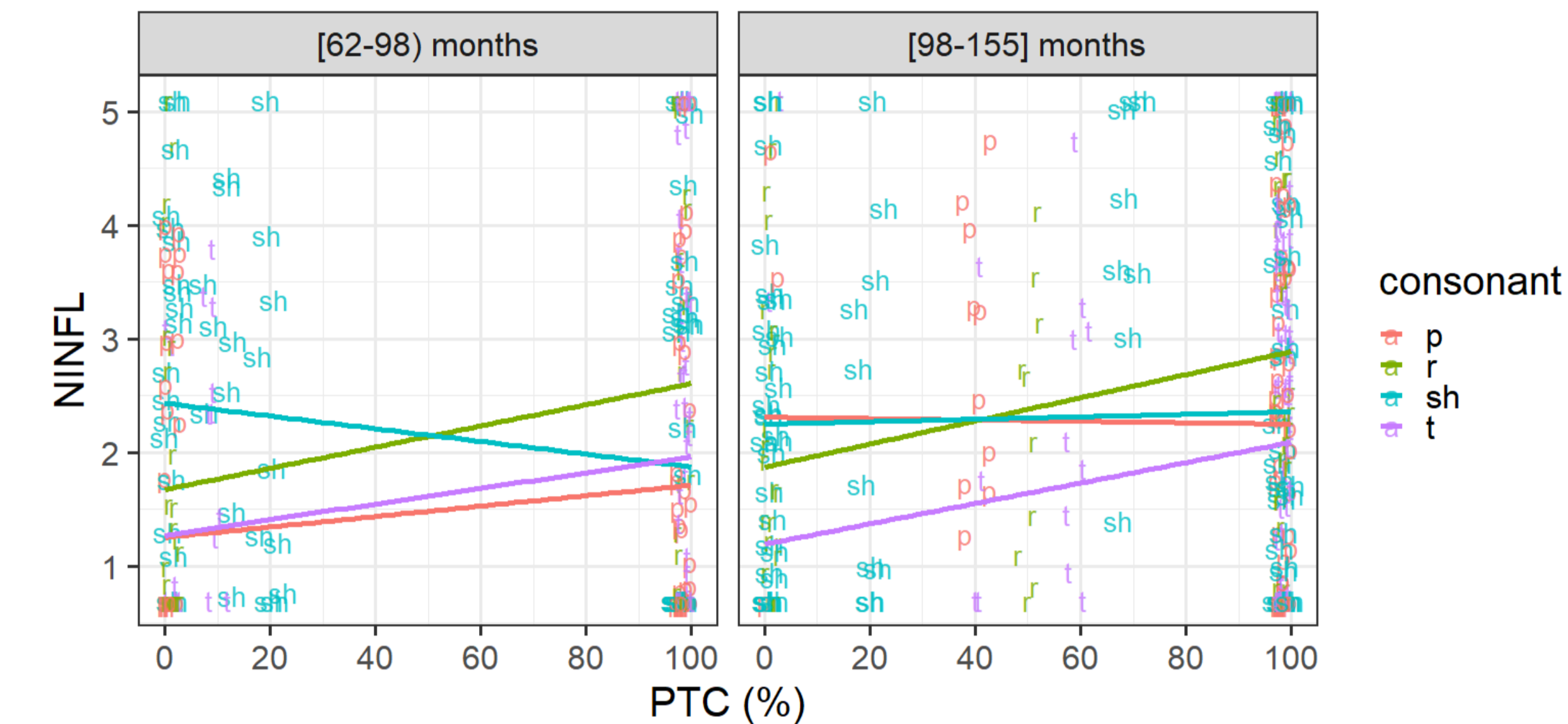- Export of NINFL (values between 1 and 5)

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