Morphological effects on the acoustics of word-final /s/
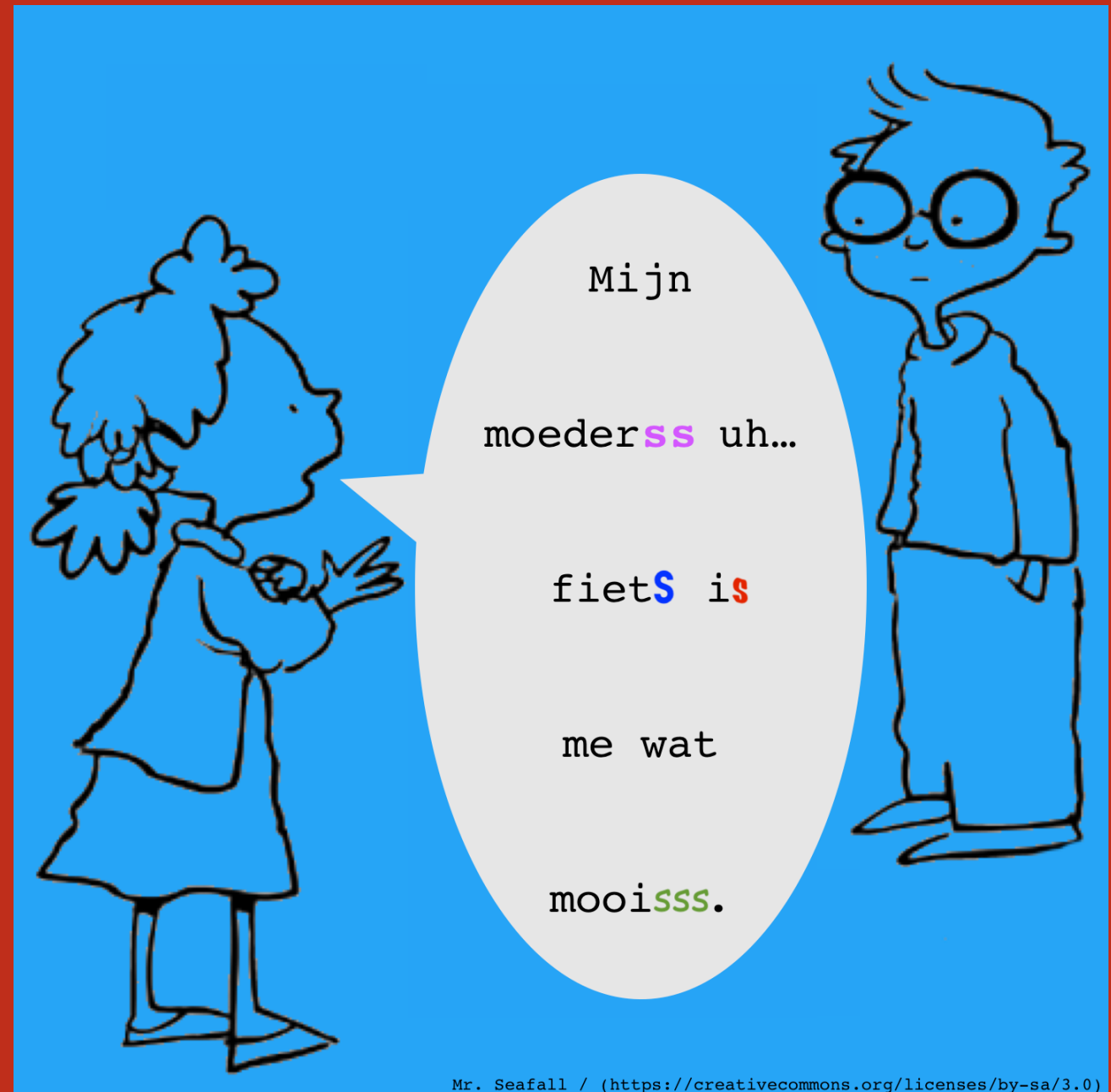
Tim Zee,

Louis ten Bosch,

Ingo Plag,

Mirjam Ernestus
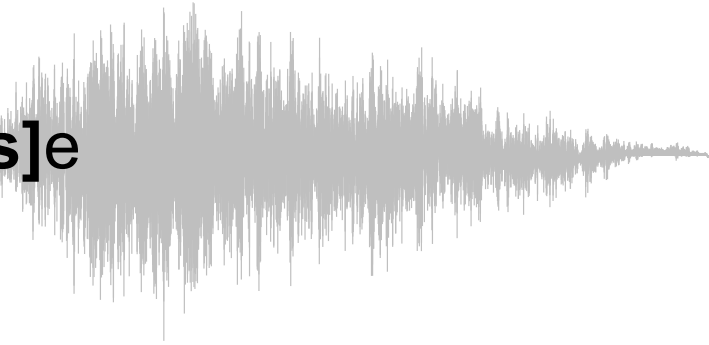

Mr. Seafall / (https://creativecommons.org/licenses/by-sa/3.0)

Heinrich Heine
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Background

- What is it?

- Why does it occur?

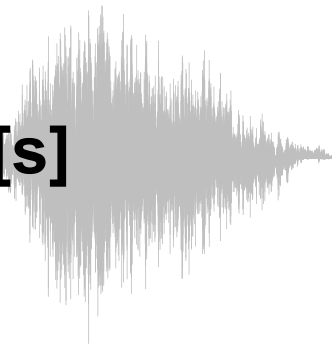- When does it occur?

Background: What is it?

- Conversational English:

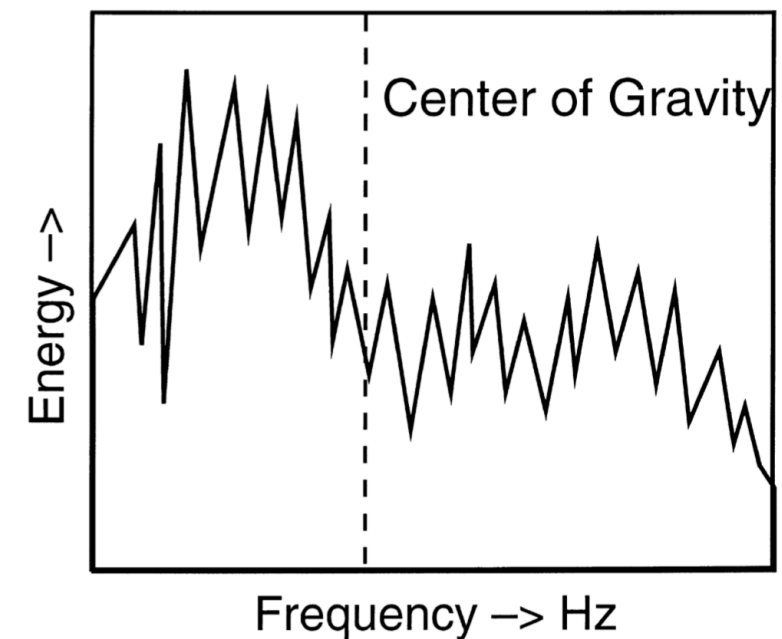 – Non-suffixal (S):   elap**[s]**e

  – Plural (PL):   cap**[s]**

    → Expectation: The same difference should exist in Dutch

Plag, Homann & Kunter, 2017; Zimmerman et al., 2016; Tomaschek et al., n.d.

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Background: What is it?

- Part of phonetic reduction?

    - Reduction of [s]:

        - Shorter duration

        - Lower Center of Gravity (CoG)

→ Expectation: Non-suffixal [s] should have a higher CoG than Plural [s].

van Son & Pols (1999)

Background: Why does it occur?

> **Paradigmatic Signal Enhancement Hypothesis:**
> "Whenever selection of an element from alternatives is probabilistic, the element's duration is predicted by the amount of paradigmatic support for the element"

Kuperman, Pluymaekers, Ernestus & Baayen (2007)

Background: Why does it occur?

- *Paradigmatic Signal Enhancement Hypothesis* applied to sub-lexical units

			kaar**s**en	
Kan	jij	de	kaar**s**	aansteken?
			kaar**s**jes	

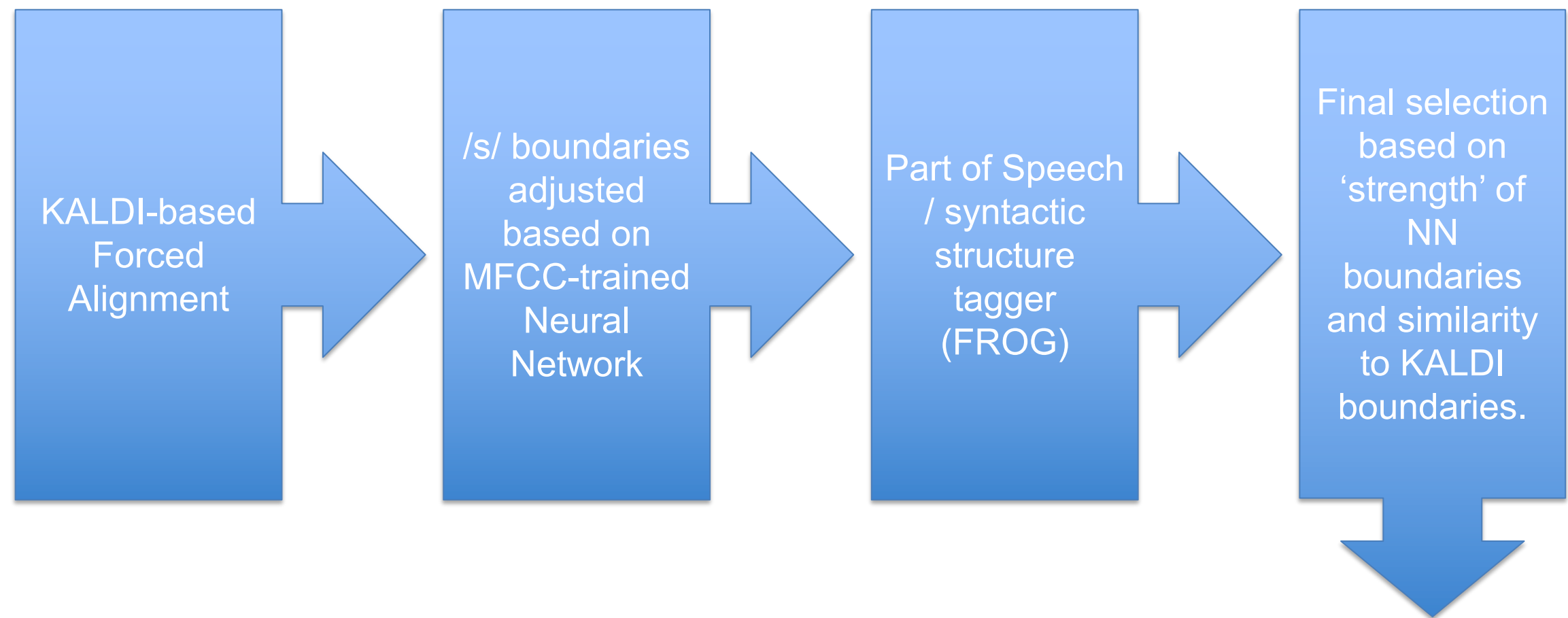|			cadeau	
Kan	jij	de	cadeau**s**	inpakken?
			cadeautjes	

→ Expectation: /s/ with more support in paradigm should be 'enhanced', i.e., have longer duration and higher CoG

Background: When does it occur?

- In conversation:

  - the form is selected to best match the intended meaning

  - selection is presumably influenced by syntagmatic and paradigmatic structure

- In read-aloud speech:

  - the 'correct' form is (also) given by the text

  → Expectation: morphological effect in read-aloud registers should be smaller or non-existent
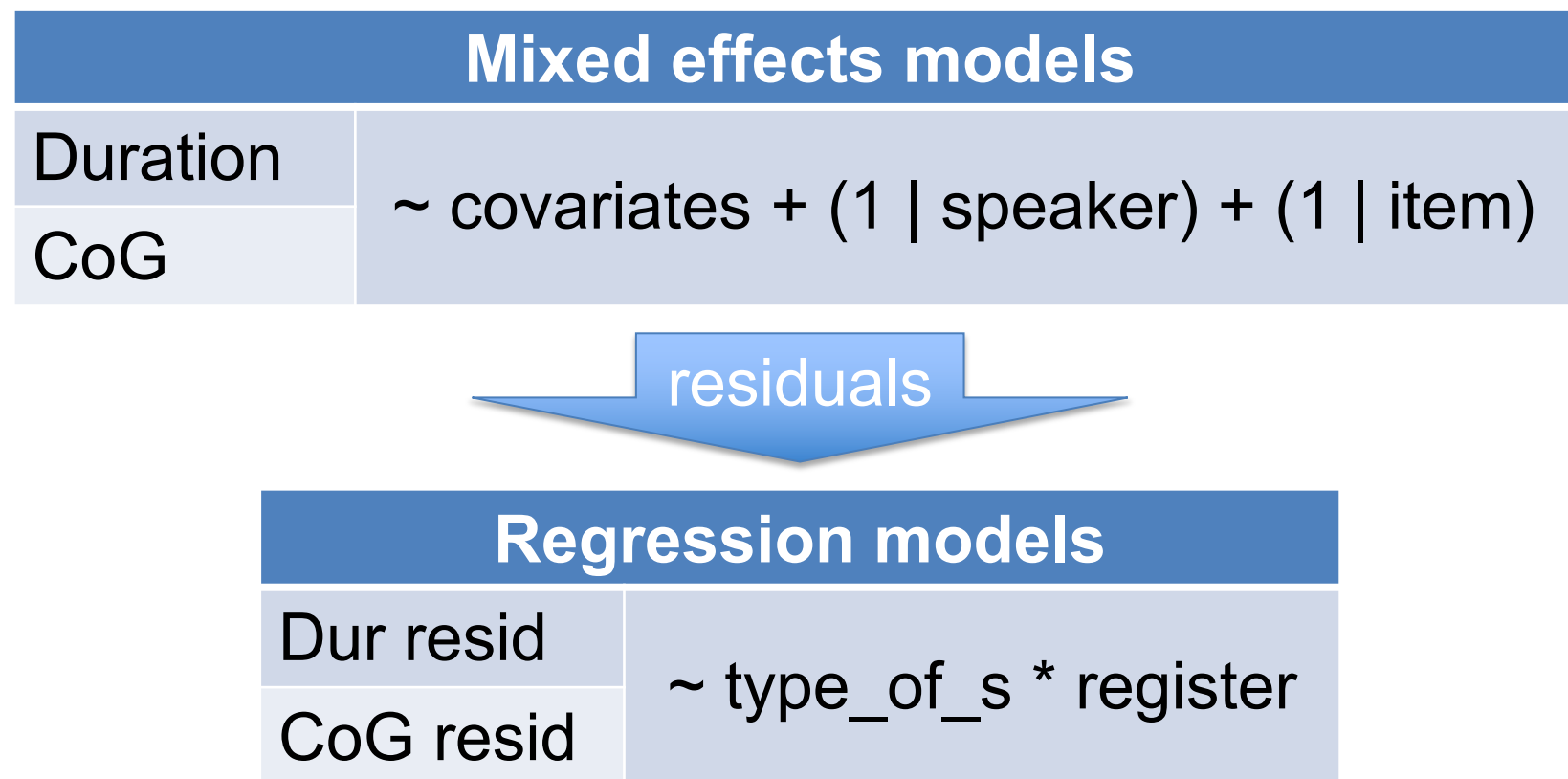
Data analysis

KALDI-based Forced Alignment → /s/ boundaries adjusted based on MFCC-trained Neural Network → Part of Speech / syntactic structure tagger (FROG) → Final selection based on 'strength' of NN boundaries and similarity to KALDI boundaries.

	Conversations					Stories	News
	CGN-A	CGN-C	CGN-D	IFADV	ECSD	CGN-O	CGN-K
S	24360	10011	6977	1607	1874	13966	6151
PL	1635	641	456	110	157	2047	1448

Data analysis

- Covariates

  - ➢ Syntagmatic probability
  - ➢ Prosody
  - ➢ Phonetic context
  - ➢ Lexical features

- High correlations with each other

- Principle component analysis

  - – Threshold of 0.9 cumulative proportion of variance
  - – Included PCs 1-9

Data analysis

- **Principle Component 1** associated with predictor of interest **Type of S**

- Modelling strategy

| Mixed effects models	
Duration	~ covariates + (1 | speaker) + (1 | item)
CoG	

residuals

Regression models	
Dur resid	~ type_of_s * register
CoG resid	

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Data analysis

Test for significance of interaction (ANOVA)

		Df	Sum Sq	Mean Sq	F value	Pr(>F)
Dur	type_of_s	1	1.39	1.39	21.70	**<0.001**
	register	2	2.09	1.05	16.32	**<0.001**
	type_of_s : register	2	1.20	0.60	9.36	**<0.001**
	Residuals	69978	4480.73	0.06		
CoG	type_of_s	1	250409	250409	2.16	0.141
	register	2	13107797	6553899	56.64	**<0.001**
	type_of_s : register	2	1337220	668610	5.78	**0.003**
	Residuals	70205	8123101426	115705		

Data analysis
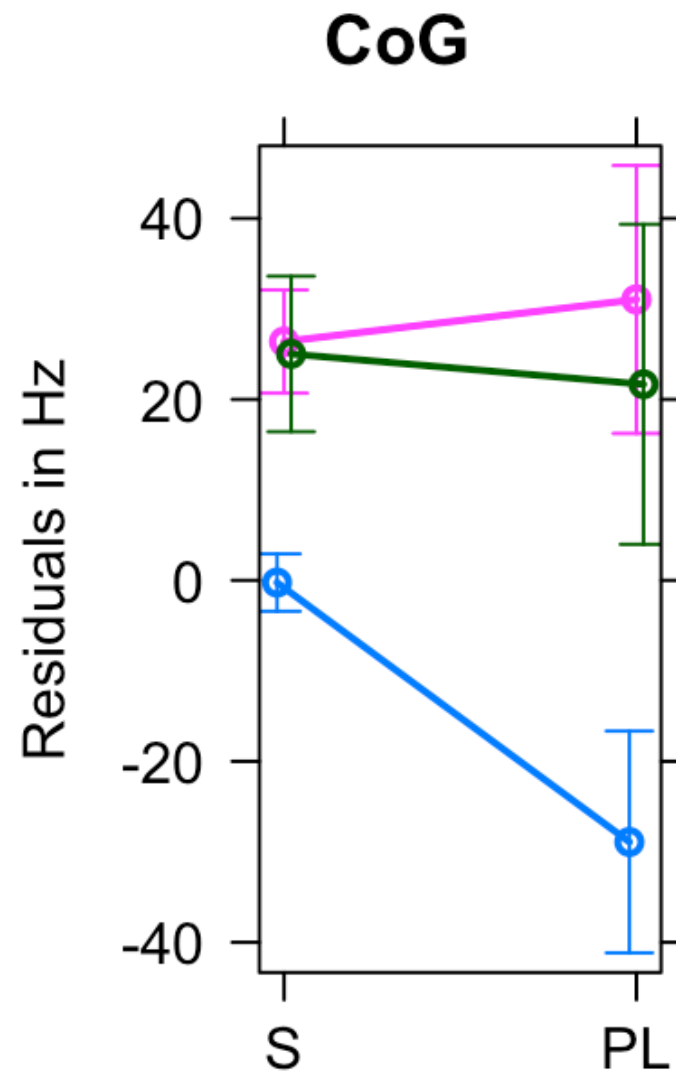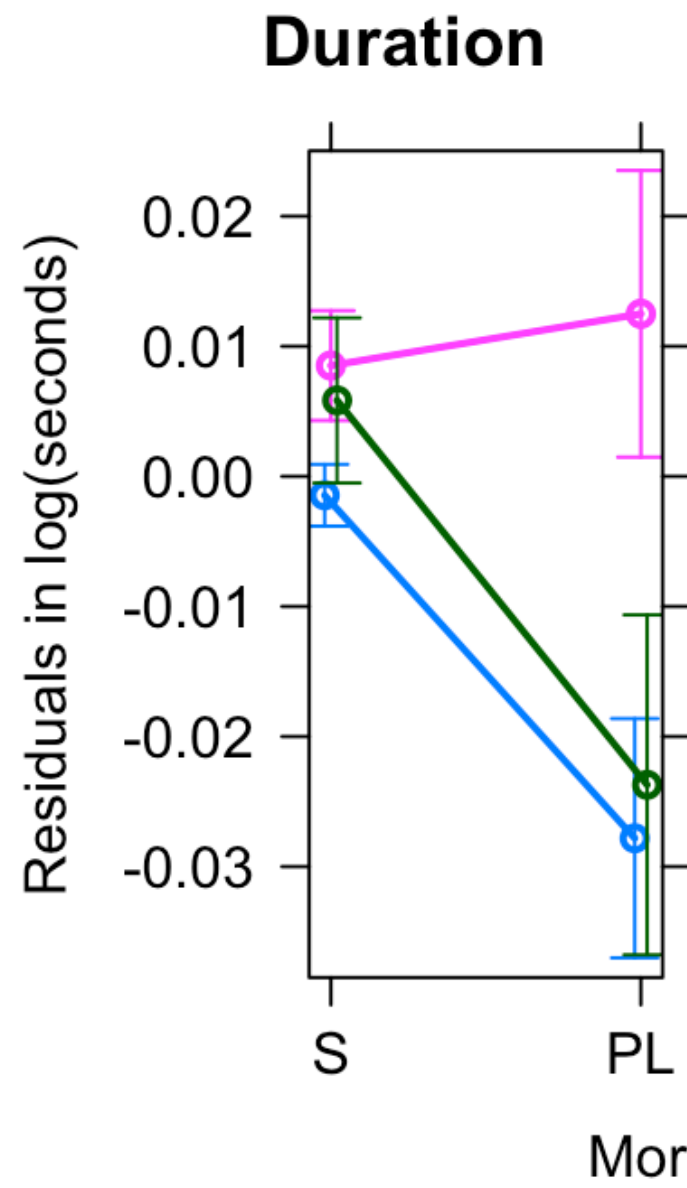
Data analysis

- **Conversation:**

  – Duration — **S** 2.16 ms longer than **PL** ✔

  – Centre of Gravity — **S** 28.67 Hz higher than **PL** ✔

- **News:**

  – Duration — **S** 2.23 ms longer than **PL** ✔

  – Centre of Gravity — **S** 3.35 Hz higher than **PL** ✘

- **Stories:**

  – Duration — **S** 0.50 ms shorter than **PL** ✘

  – Centre of Gravity — **S** 4.65 Hz lower than **PL** ✘

Conclusion

- Effects do exist in Dutch

- Direction of duration and CoG effects consistent with reduction

- Clear effects in conversation but inconsistent in read speech

  - Differences in speech planning between News and Stories?

- Small effects

  - Residualization

  - Perceptual relevance?

Open questions

- How should paradigmatic support be formalised?

    – Relative frequency, inflectional entropy   Cohen (2014)

    – Discriminative learning models (NDL, LDL)   Tomaschek et al. (nd)

- How do these effects generalize to other suffixes?

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Questions / Comments?