ADAM MICKIEWICZ UNIVERSITY, POZNAŃ
Faculty of English

Investigating speech rhythm and utterance fluency from a multilingual perspective: insights from production studies on L1 Polish – L2 English – L3 Norwegian learners

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Nordic Speech Research Forum, Apr 11, 2025

Roadmap

- ADIM project introduction
- Study on speech rhythm
- Study on fluency
- Pedagogical implications
- LnNor Corpus
- Podcast: When languages meet

ADIM (GRIEG-1) project

- **Funding**: Norway grants
- **Title**: Across-domain investigations in multilingualism: Modeling L3 acquisition in diverse settings (ADIM)
- **ID nr**: DEC-2019/34/H/HS2/00495
- **Period**: Dec 2021- April 2024 (28 months)
- **PI**: Magdalena Wrembel, Marit Westergaard

Polish-Norwegian project collaboration

ADAM MICKIEWICZ UNIVERSITY POZNAŃ

NTNU
Norwegian University of Science and Technology

UiT The Arctic University of Norway

Project logo and website

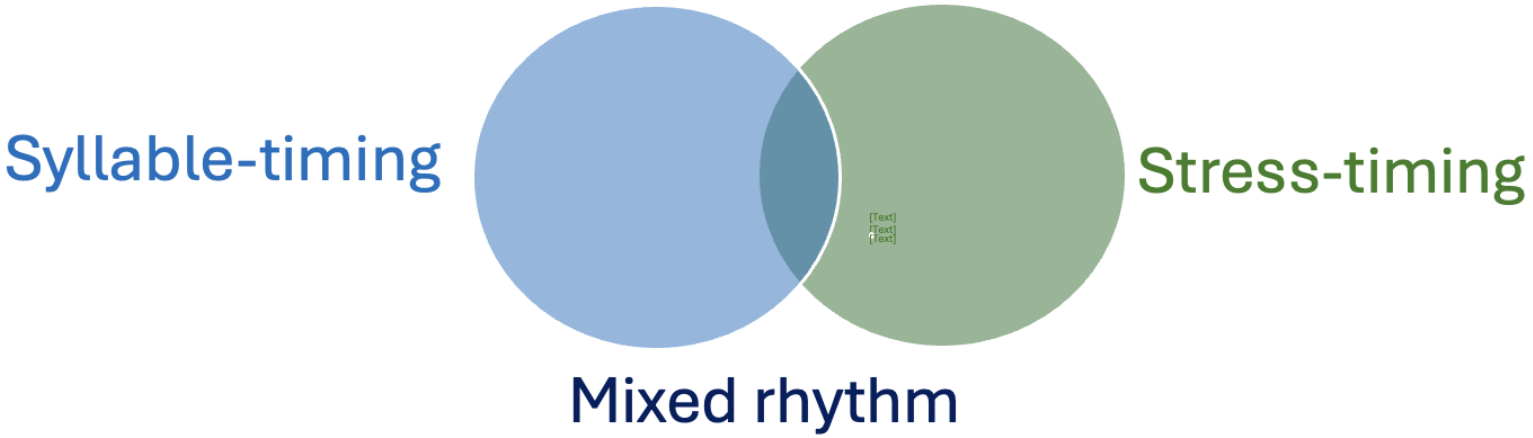
Project scope

- Multilingual perspective: Acquisition of an additional foreign language (L3)
  - after having learned two languages (L1, L2)
- Acquisition across different language domains
  - Phonetics/phonology, syntax, semantics, sociophonetics
  - General patterns vs. language-specific
- Different settings and stages of acquisition
  - Naturalistic vs. formal instructed setting
  - Initial vs. more advanced stages
- A range of methodologies
  - Offline and online tasks

Study 1: Speech rhythm

Speech rhythm

- Classification of languages into rhythmic classes (Pike 1945)
- Rhythm is a perceptual phenomenon (Allen 1975)
- Based on a number of phonological elements (Dauer 1983)



Bilingual speech rhythm

- Identifying differences between native and non-native languages
  - Vowel-based differences (Algethami & Hellmuth 2023)
  - Slower speech rate (Ordin & Polyanskaya 2015)
  - Tempo normalized metrics are better (Ordin & Polyanskaya 2015)

Multilingual speech rhythm

- Establishing sources of cross-linguistic influence in L3
- Gabriel et al. (2015) and Gut (2010)
  - A limited number of participants with different language repertoires
  - Difficult do draw conclusions
  - CLI attested in rhythmic patterns
  - proficiency level – a major influencing factor

Study aims

- To investigate rhythmic patterns in the entire linguistic repertoire of L1 Polish/ L2 English/L3 Norwegian multilinguals
- To analyse cross-linguistic influence (CLI):
  - In the foreign languages L2/L3
  - L1 drift
- Speech mode: text reading

Participants

- L1 Polish, L2 English, L3 Norwegian (N=26)
- 23 F, 2 M and 1 non-disclosed gender
- Mean age 21.16 years old (*SD* = 2.18)
- Students of Norwegian studies at a Polish university

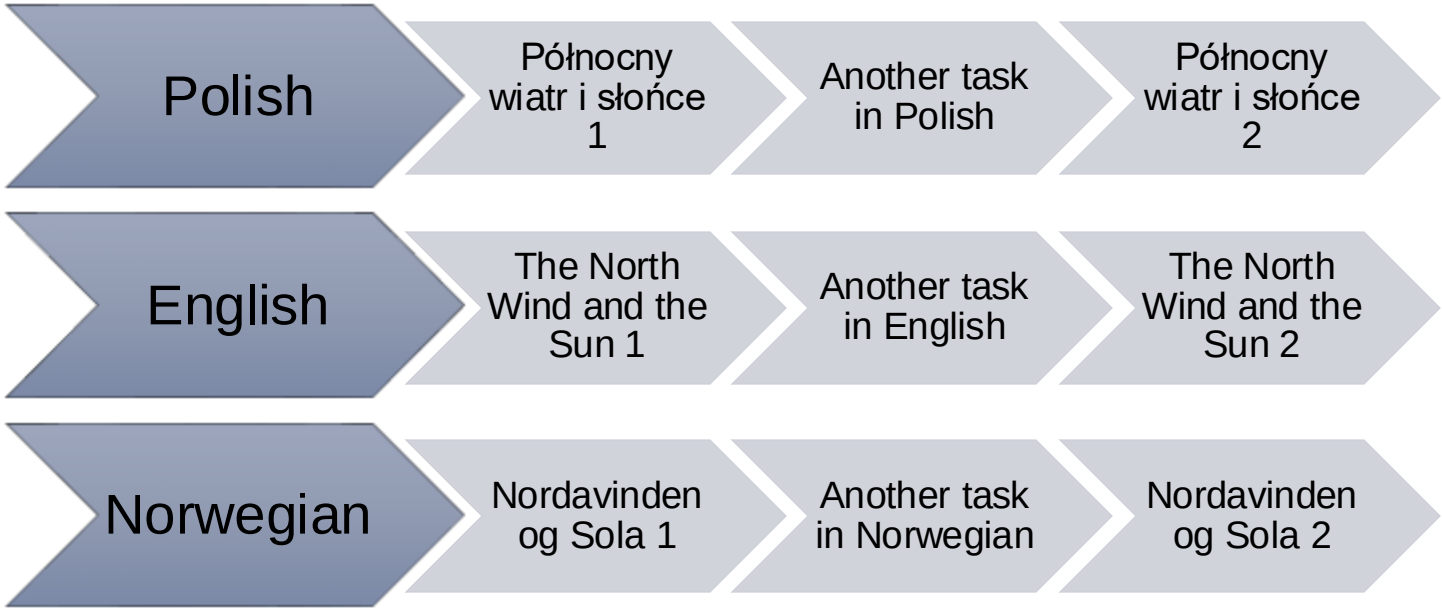
Language	Type of instruction	Age of onset	Level of proficiency
L1 Polish	native acquisition	at birth	native
L2 English	formal	7.88	B1 to C1
L3 Norwegian	formal	19.64	A1 to B1

Control groups

- Polish control group
  - L1 Polish (L2 English speakers), N=22
- English control group
  - L1 English speakers (with minimal foreign language exposure), N=18
- Norwegian control group
  - L1 Norwegian (L2 English speakers), N=18

Procedure

- Language blocks: Reading 1, Another task, Reading 2



- Equipment: Shure SM-35 unidirectional cardioid head-worn condenser microphone and a Marantz PMD620 recording device, sampling frequency of 16kHz

Procedure

- Language History Questionnaire (LHQ) (Li et al., 2013)
- Standardized placement tests in English and Norwegian

Procedure: Data

- Reading task
  - Extracted from the second reading
  - Excerpts of 20sec from the beginning of the text

Procedure: Extraction

- Forced alignment by means of BAS WebService (Kisler et al. 2017)
- Manual correction by two trained phoneticians
- Filled and unfilled pauses, hesitations and false starts annotated and excluded from the rhythm analysis
- Duration data extracted by means of PRAAT scripts (Lennes 2002)

Research questions

- RQ1 : Are there differences in speech rhythm patterns produced by multilinguals when compared to controls for each language?
- RQ2: What are the sources and manifestations of cross-linguistic influence in L3 Norwegian?
- RQ3: What are the sources and manifestations of cross-linguistic influence in L2 English?
- RQ4: Do the speakers experience L1 drift?

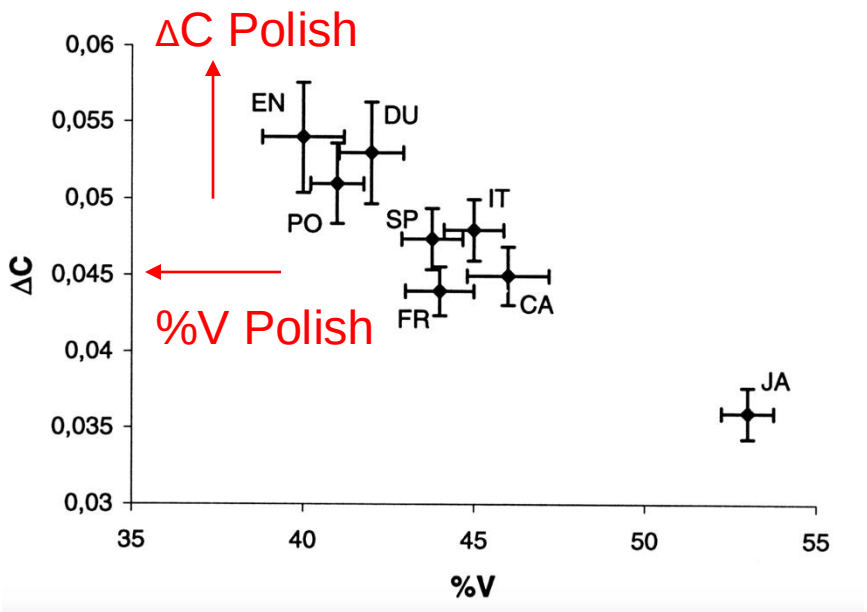
Segmentation protocol

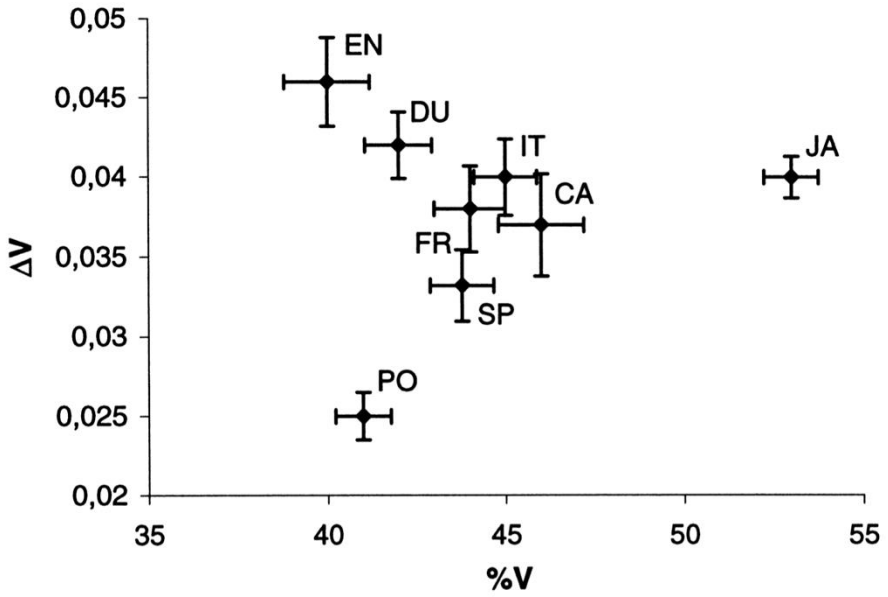
Element	Rationale
Prepausal intervals	Arvaniti (2012)
Word- and utterance-final syllables	Contrary to Algethami & Helmuth (2023); following Grabe & Low (2002), White & Mattys (2007)
Vowel-initial glottal stops included in the CI in utterance- and word-medial contexts	To capture CLI
Creaky voice included in the VI	To capture CLI
Post-vocalic glides included in the CI	To capture CLI
The interval for initial voiceless stops was started at burst in both phrase- and word-initial contexts	To avoid capturing stop occlusion

Rhythm metrics

Rhythm metric	Definition	Reference
%V	Percentage of the total duration of VI	Ramus et al. (1999)
ΔV	SD of the duration of VI	Ramus et al. (1999)
ΔC	SD of the duration of CI	Ramus et al. (1999)
VarcoV	SD of the duration of VI divided by mean duration of VI and multiplied by 100	White and Mattys (2007)
VarcoC	SD of the duration of CI divided by mean duration of CI and multiplied by 100	Dellwo (2006)
RateOfSpeech	Number of actually pronounced phonemes per second	Van Dommelen (2006)

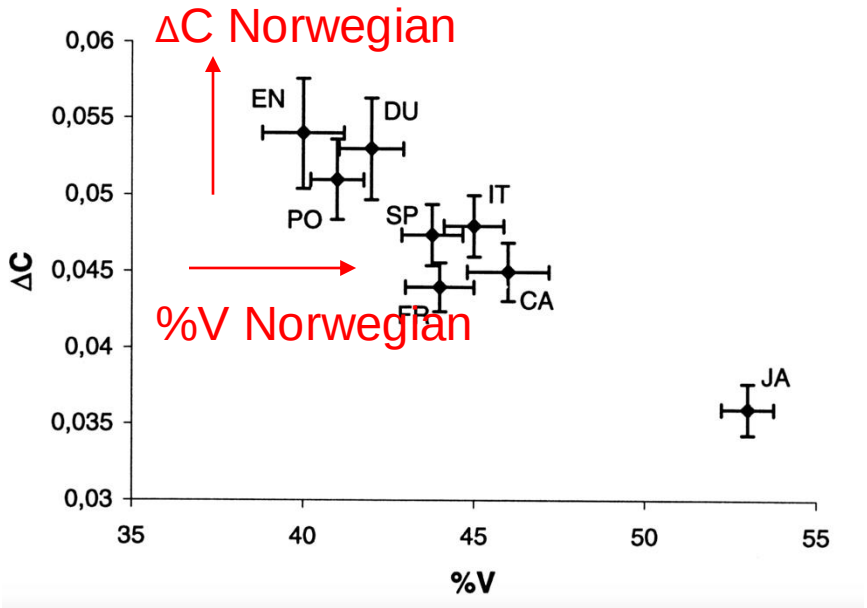
Rhythm in Polish and English

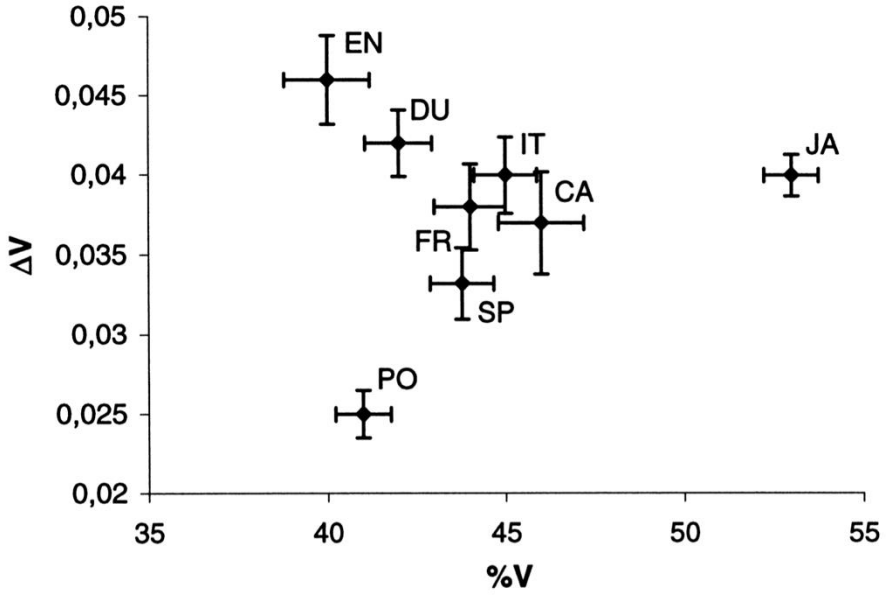




Ramus et al. (1999)
Mairano (2011)

Rhythm in Norwegian



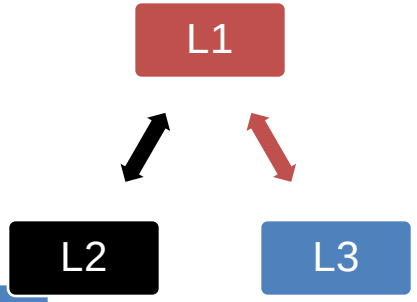


Ramus et al. (1999)

Other Scandinavian languages in Mairano (2011)

Predictions

Cross-linguistic influence



- Compared to controls

Rhythm metric	L1 Polish	L2 English	L3 Norwegian
%V	= ↑	= ↓	= ↓
ΔV	↑	↓	↓
ΔC	= ↓	= ↑	= ↓
VarcoV	↑	= ↓	= ↓
VarcoC	= ↓	= ↑	= ↓
RateOfSpeech	= ↓	↓	↓

Non-rate normalized

Rate normalized

Rhythm metric	Syllable-timed	Stress-timed
ΔV, ΔC, VarcoV, VarcoC	lower	higher
%V	higher	lower

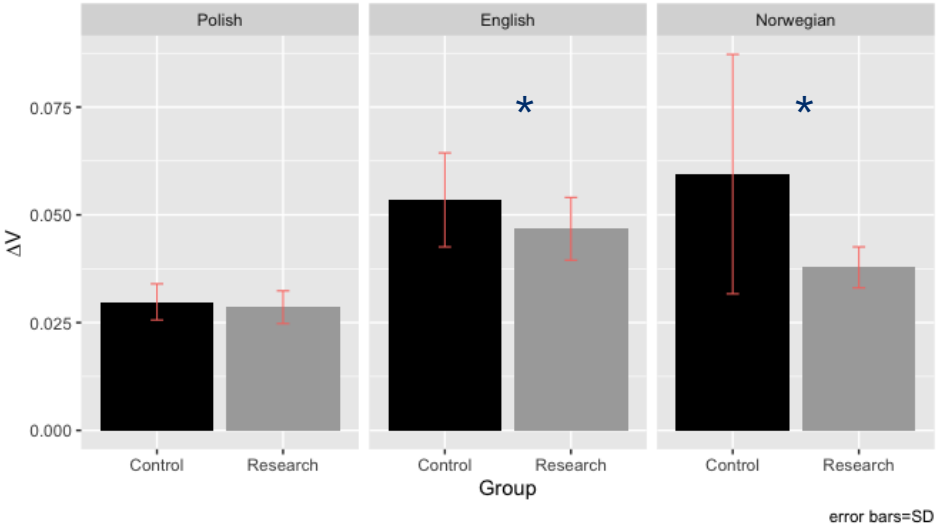
Ramus et al. (1999)
Mairano (2011)

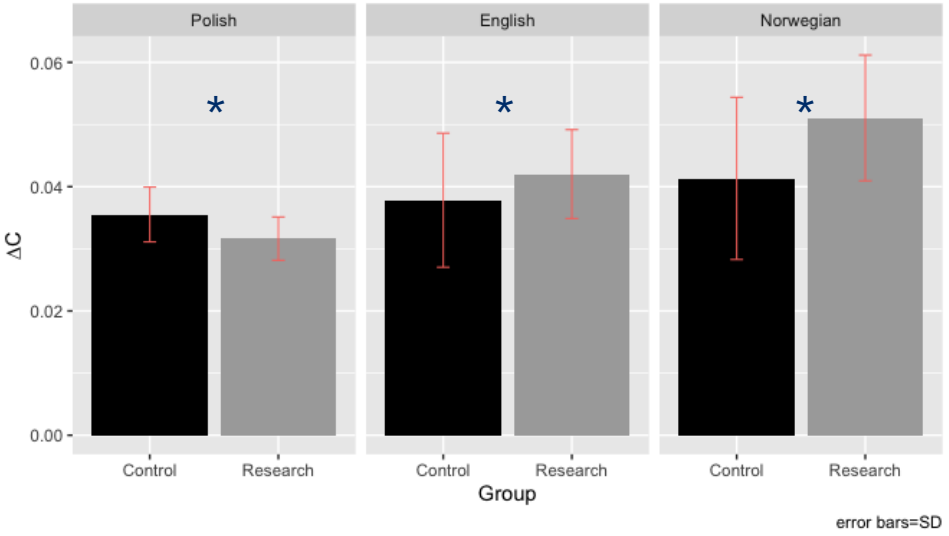
Statistical analysis

- Non-normally distributed data
- Mann-Whitney U tests

Results: ΔV and ΔC

Rhythm metric	L1 Polish		L2 English		L3 Norwegian	
	Prediction	Result	Prediction	Result	Prediction	Result
ΔV	↑	=	↓	↓	↓	↓
ΔC	= ↓	↓	= ↑	↑	= ↓	↑

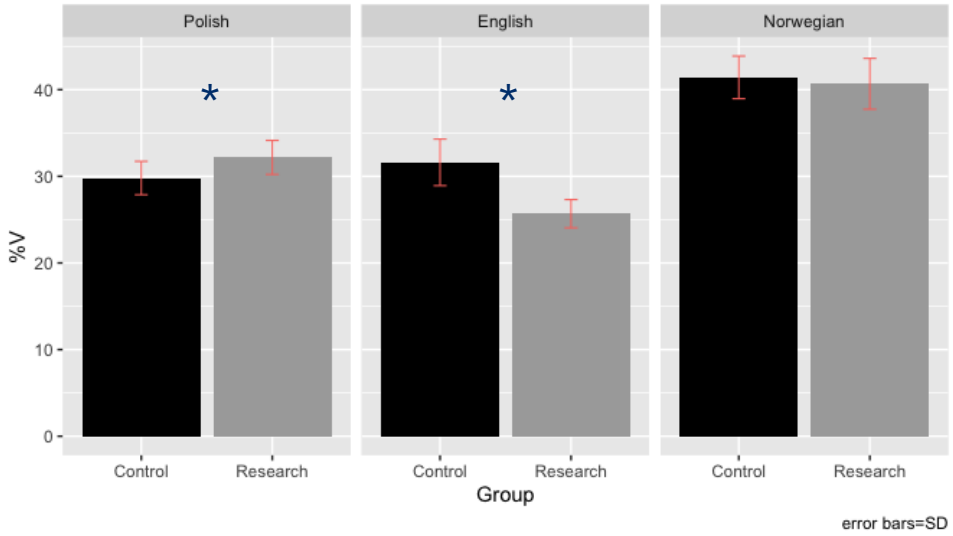




* <0.001

Results: %V

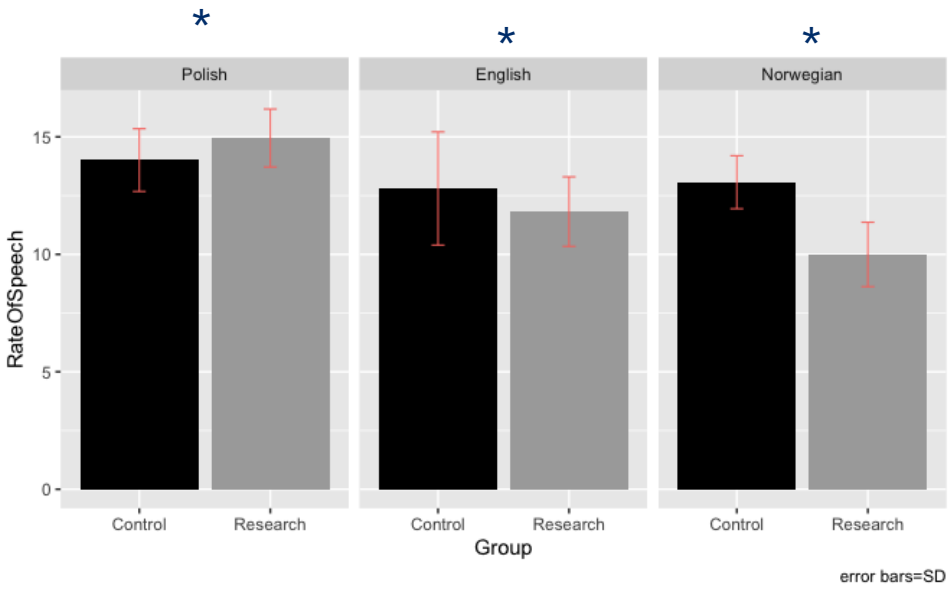
Rhythm metric	L1 Polish		L2 English		L3 Norwegian	
	Prediction	Result	Prediction	Result	Prediction	Result
%V	= ↑	↑	= ↓	↓	= ↓	=



* <0.001

Results: rate of speech

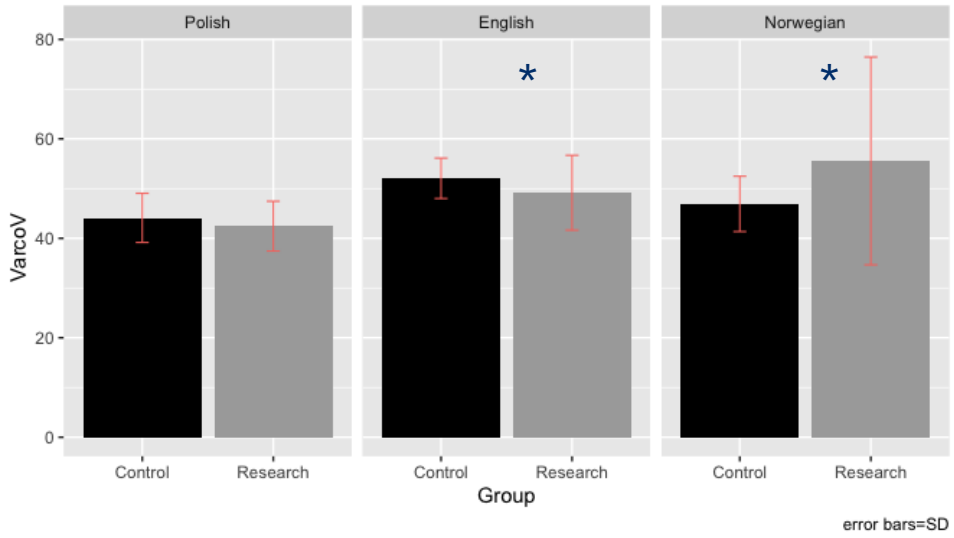
Rhythm metric	L1 Polish		L2 English		L3 Norwegian	
	Prediction	Result	Prediction	Result	Prediction	Result
RateOfSpeech	=	↓	↑	↓	↓	↓

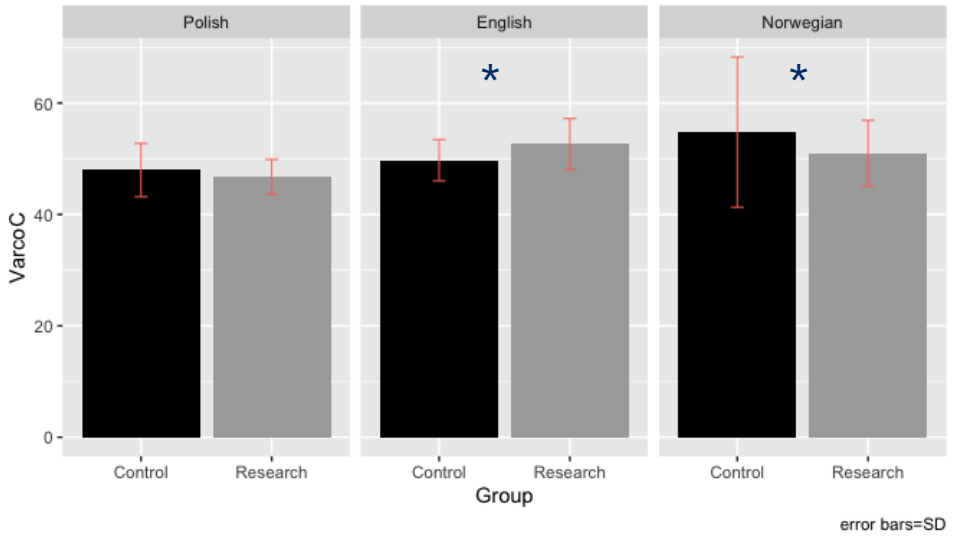


* <0.001

Results: VarcoV and VarcoC

Rhythm metric	L1 Polish		L2 English		L3 Norwegian	
	Prediction	Result	Prediction	Result	Prediction	Result
VarcoV	↑	=	= ↓	↓	= ↓	↓
VarcoC	=	=	= ↑	↑	= ↓	↓





* <0.001

Discussion

- RQ1 : Are there differences in speech rhythm patterns produced by multilinguals when compared to controls for each language?

YES but only for the foreign languages

RQ2: What are the sources and manifestations of cross-linguistic influence in L3 Norwegian?

- **L3 Norwegian**
  - ΔV is lower and ΔC is higher than in the controls
  - slower rate
  - VarcoV and VarcoC are lower
  - %V is similar to the controls

  } Different from L2 English
- Multilinguals do not vary vowel length as much as the controls
- Multilinguals may have problems with pronouncing some consonantal intervals -> sound-letter correspondences
- Although rate is slower, there are other reasons for different results.

RQ3: What are the sources and manifestations of cross-linguistic influence in L2 English?

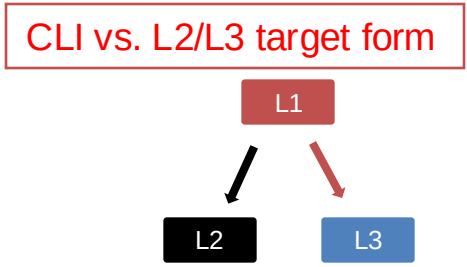
- **L2 English**
  - ΔV is lower and ΔC is higher than in the controls
  - %V is lower than in the controls
  - slower rate
  - VarcoV is lower and VarcoC is higher
- Multilinguals do not vary vowel length as much as the controls
- They take more time to produce consonantal intervals -> %V is lower
- Although rate is slower, there are other reasons for different results.

RQ4: Do the speakers experience L1 drift?

- **L1 Polish**
  - no differences in ΔV
  - ΔC is lower than for the controls
  - %V is higher than for the controls
  - faster rate
  - rate normalized metrics don't show differences
- A lot of the differences are due to rate
- Consonantal clusters are articulated in a shorter time frame because of the faster rate -> greater %V
- No signs of L1 drift.

Study 1: Conclusions

- Differences in the speech rhythm patterns of each foreign language of the multilinguals when compared to the controls
  - less variation in vowel length
  - slower speech rate
  - L2 English more time to pronounce consonantal intervals
  - L3 Norwegian problems with sound-letter correspondences
- L3 Norwegian
  - L1 Polish influence in vowel length variations
- L2 English
  - L1 Polish influence in vowel length variations
- No L1 drift



Study 2: Fluency

Previous research

- Body of research on similarities between L1 and L2 fluency (see Gao & Sun, 2024)

- Peltonen and Lintunen (2022) the only investigation into fluency in multilingual speakers
  - Pausing and speed fluency in L1 Finnish, L2 English speakers and Finnish-Swedish bilinguals speaking L3 English
- No statistically significant differences between the groups in their L1 Finnish and English
- The bilingual group produced more repetitions in L1 Finnish than the trilinguals
- Variability in Swedish in speech rate, articulation rate, silent pauses -> due to difference in proficiency level

Fluency study design

- The same group of multilingual speakers
- The same recording procedure
- Two tasks:
  - text reading
    - 20 sec of *The North Wind and The Sun*
  - extemporaneous speech
    - 20 seconds of impromptu speech

Aims

- To investigate utterance fluency across three languages of multilingual speakers in terms of breakdowns and speed
  - find correlations across languages
  - compare to native speakers of the languages

- To analyse the effects of language (L1, L2, L3) and task (text reading and extemporaneous speech)
  - focus on characterising (dis)fluency in the two foreign languages of the multilinguals

Extraction

- Pauses included filled and unfilled pausal elements
- Cut-off point for the pause duration established at 100ms (Goldman-Eisler 1961; Riazantseva 2001)
- Segment and pause durations extracted with the use of PRAAT scripts

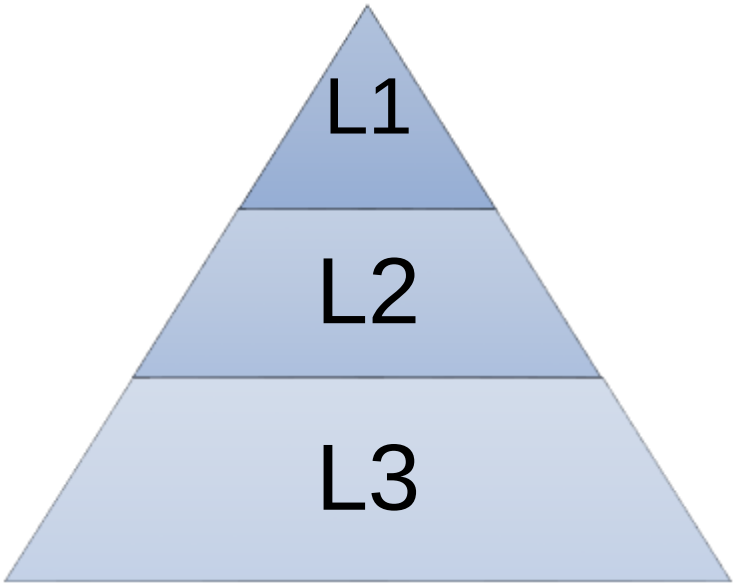
Fluency measures

Fluency measure	Operationalization
Mean length of run	Mean duration of speech measured from pause to pause
Rate of speech	Number of actually pronounced phonemes per second
Mean duration of pauses	Mean duration of pauses from the speech sample
Pause to speech ratio	Duration of pauses divided by the total duration of speech sample
Number of pauses per second	Number of pauses divided by the total duration of speech sample

Research questions and predictions

RQ 1: Are there differences in fluency across the languages of multilingual speakers?

language status (L1>L2>L3)



Fluency measure	Prediction
Mean length of run	L1>L2>L3
Rate of speech	L1>L2>L3
Mean duration of pauses	L1<L2<L3
Pause to speech ratio	L1<L2<L3
Number of pauses per sec	L1<L2<L3

Research questions and predictions

RQ 2: Are there differences in fluency across speaking tasks in multilingual speakers?

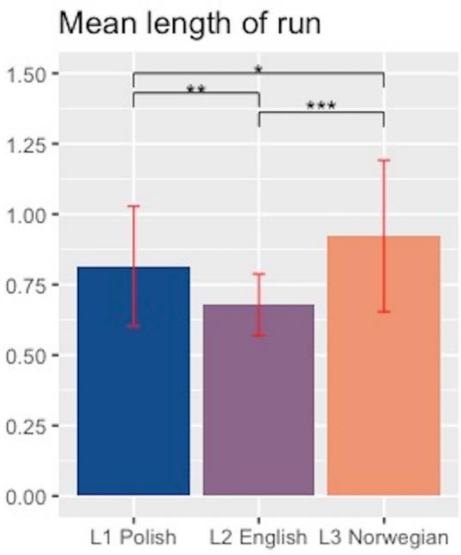
Fluency measure	Prediction
Mean length of run	TR>E
Rate of speech	TR>E
Mean duration of pauses	TR<E
Pause to speech ratio	TR<E
Number of pauses per sec	TR<E

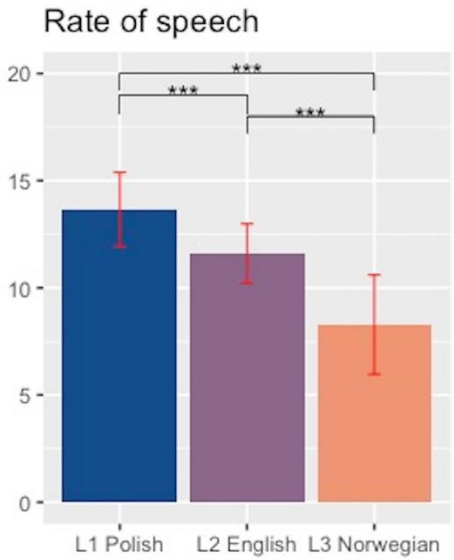
TR - text reading; E - Extemporaneous

Statistical analysis

- Linear regressions
- Independent variables: task, language
- Dependent variable: fluency measure
- R Studio (2023) version 2023.6.1.524
- Post-hoc tests using the emmeans package (Lenth 2023)
- Effect sizes η_p^2
- Correlations
- Comparisons to controls

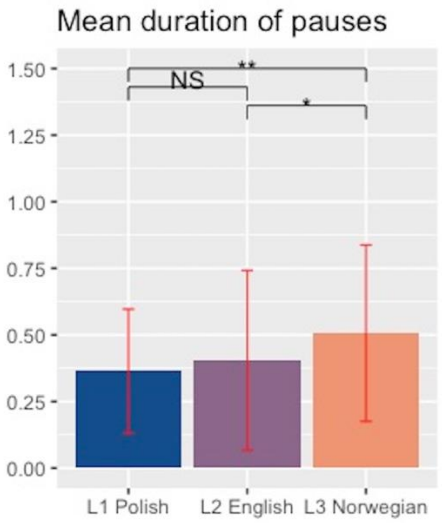
Results: Language effect

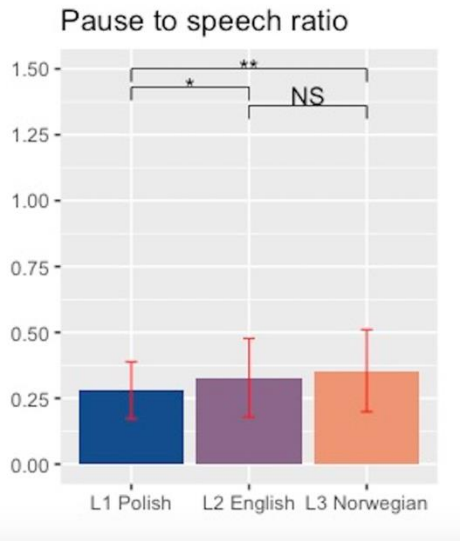


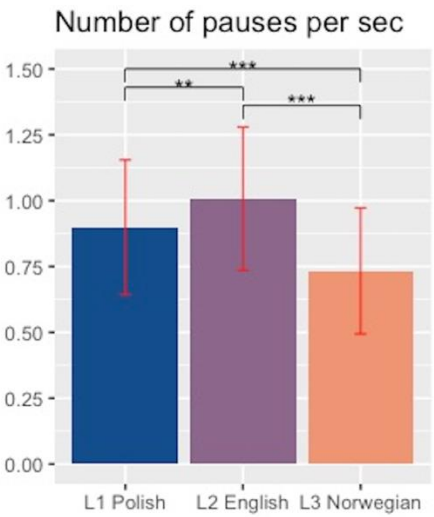


Fluency measure	Prediction	Result
Mean length of run	L1>L2>L3	**L3>L1>L2**
Rate of speech	L1>L2>L3	✓

Results: Language effect

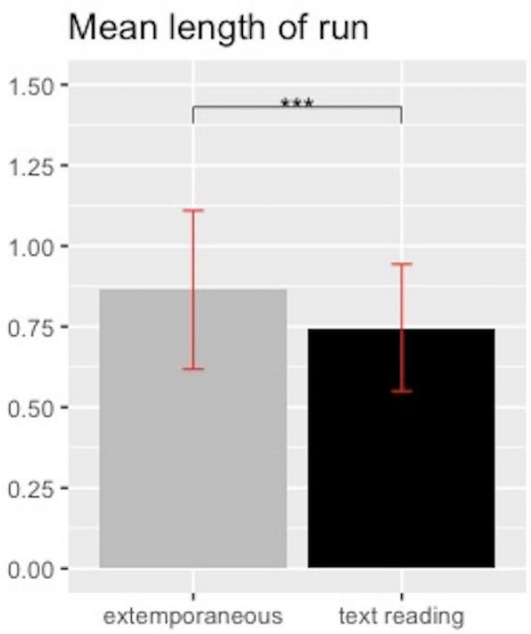


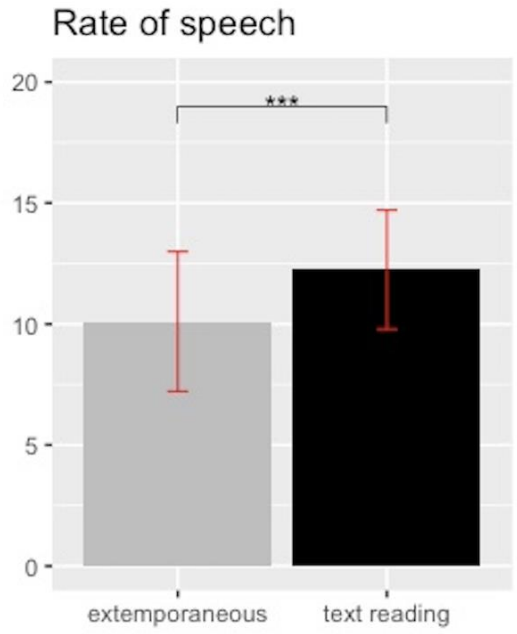




Fluency measure	Prediction	Result
Mean duration of pauses	L1<L2<L3	✓
Pause to speech ratio	L1<L2<L3	✓
Number of pauses per sec	L1<L2<L3	L3<L1<L2

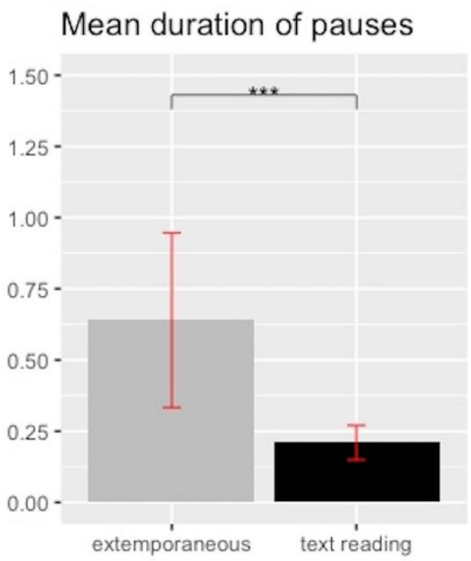
Results: Task effect

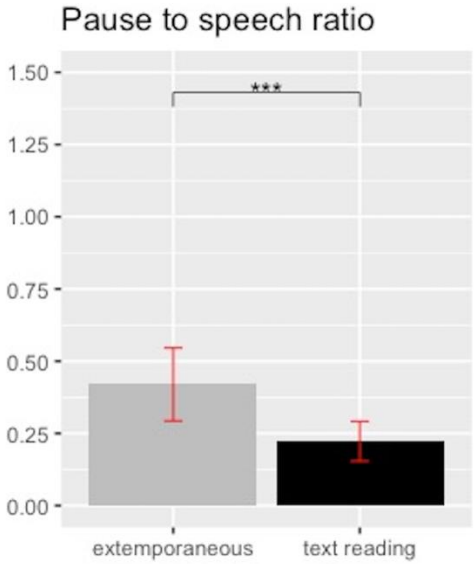


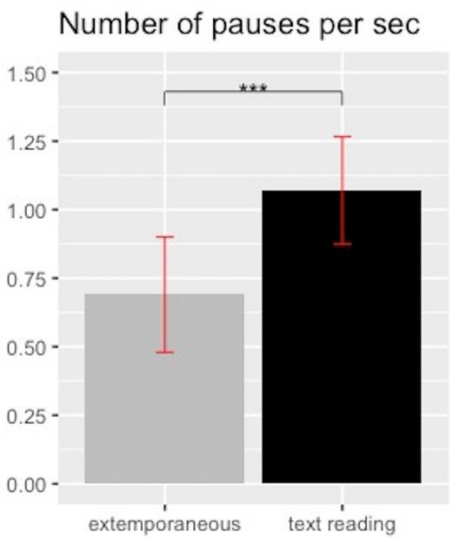


Fluency measure	Prediction	Result
Mean length of run	TR>E	E>TR
Rate of speech	TR>E	✓

Results: Task effect





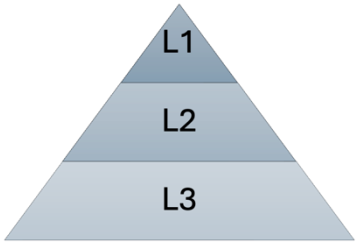


Fluency measure	Prediction	Result
Mean duration of pauses	TR<E	✓
Pause to speech ratio	TR<E	✓
Number of pauses per sec	TR<E	E<TR

Discussion: Language effect

- Mean duration of pauses and pause to speech ratio increased with language status (L1<L2<L3)
  - the shortest pauses in L1 and the longest pauses in L3
  - more speech in the same time frame in L1 than in both foreign languages
- Rate of speech decreased with language status (L1>L2>L3)
  - the fastest speech in L1, the slowest in L3
- Mean length of run L3>L1>L2
  - the longest stretch of speech before making a pause in L3 and the shortest in L2
- Number of pauses per sec L2>L1>L3
  - fewer pauses in L3 than in L1 and L2

Discussion: Language effect



- Multilingual speakers demonstrate different patterns of fluency performance in their three languages
- Special status of L1
  - Multilinguals had the shortest pauses, produced the most speech in the given time frame and spoke the fastest in their native language when compared to their two non-native language
  - The shortest conceptualization and formulation stages in L1 and the speech production process is the most efficient
- Different configurations of fluency measures for the two foreign languages
  - An indirect relationship between fluency measures and language status for the foreign languages

Discussion: (Dis)fluency profiles

- (Dis)fluency profile for L3 Norwegian
  - a very long mean length of run and fewer but longer pauses
  - more preparation time and production of longer chunks prepared ahead or because they spoke slowlier
  - the lowest rate of speech and pause to speech ratio
  - the formulation and encoding of the preverbal message was difficult and less efficient in L3 Norwegian compared to the other two languages
  - low efficiency of the entire speech production process in the L3

- (Dis)fluency profile for L2 English
  - shorter mean length of run with many shorter pauses
  - the rate of speech was greater and the pause to speech ratio was lower in comparison to L3 Norwegian
  - shorter preparation time and shorter chunks of speech produced at a faster rate than L3 Norwegian

Discussion: Task effect

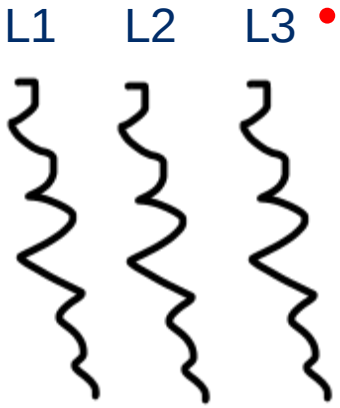
- Mean duration of pauses and pause to speech ratio were lower in TR than in E
  - shorter pauses while reading
  - more speech in the same time frame while reading
- Rate of speech was greater in TR than in E
  - reading was faster than the impromptu speech
- Shorter mean length of run with longer pauses for TR compared to E which is contrary to previous reports (e.g. Gut 2009)
  - Choice of text
  - Fable with short verses

- **TR** – text reading; **E** – extemporaneous speech

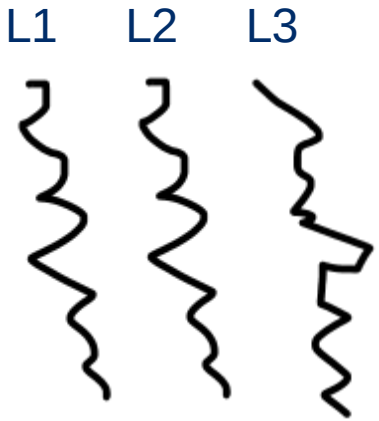
Discussion: Task effect

- Pausing has different purposes depending on the mode of speech
  - syntactic pausing in reading that reflects punctuation (Campione et al., 2002)
- Pausing behaviour reflects differences in the nature of speech production for different modes of speech
  - E requires time for conceptualization and formulation of the speech content than TR thus lower speech rate, longer pauses and higher pause to speech ratio (Eren et al. 2020)

Fluency: relationship across all languages in a repertoire



- Text reading:
  - a correlation for *pause to speech ratio* and *rate of speech* across all three languages
  - **reading speed** is universal regardless of language (**speaker-specific)**



- Extemporaneous speech:
  - correlations across L1 & L2: *number of pauses* and *mean length of run*
  - correlations across L2 & L3: *pause to speech ratio* and *mean duration of pauses*
  - **fluency** in extemporaneous speech is more **language-dependent**

Fluency: influence of L3 Norwegian on L1/L2

- Comparison to native speakers of Polish, English, Norwegians

  - In L1 Polish and L2 English most measures for multilinguals are different than for controls
  - In L3 Norwegian there is more similarity between multilinguals and controls
  - L1 Polish and L2 English reveal influence of L3 Norwegian
    - apart from *rate of speech* and *pause to speech ratio*
    - but these two are more speaker-specific
    - they are less likely to undergo cross-linguistic influence

Pedagogical implications

Implications from fluency research

1. Implications for teachers/caretakers/learners:

- **foreign languages may have different disfluencies**
- **speaker-specific elements of fluency:** pause to speech ratio and speech rate are **universal** across languages in reading regardless of language
- reading is a speaker-specific ability -> boost reading skills

a) children

a) all languages starting with the native language

b) positive outcomes in the future and for all languages

Implications from fluency research

2. Implications for teachers and learners:

- **extemporaneous speech is overall less fluent** than reading in foreign languages and is more dependent on the language (less speaker-specific)
  - focus on extemporaneous speech in class
  - make space/room, provide conditions for students' own productions
  - also in classes of other languages than English

Implications from rhythm study

1. multilinguals with a syllable-timed L1 have a **difficult time with L2/L3 vocalic interval durations**
   - **incorporate phonological elements into curricula,** bearing in mind particular features of the foreign language and the native language
     - long/short vowel distinctions
     - unstressed vowel reductions

2. multilinguals have problems with sound-letter correspondences
   - **practice reading consonantal clusters**

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LnNOR Corpus

LnNor Corpus

A spoken multilingual corpus of non-native and native Norwegian, English and Polish



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Repositories
AMUReD repository
WA server

DOI
http://dx.doi.org/10.60629/pmrh-p471
http://dx.doi.org/10.60629/bvw4-dd31

LnNor Corpus: Statistics

Part 1
2021-2022

1056
annotated files

78
speakers

34
hours of speech

Part 2
2023-2024

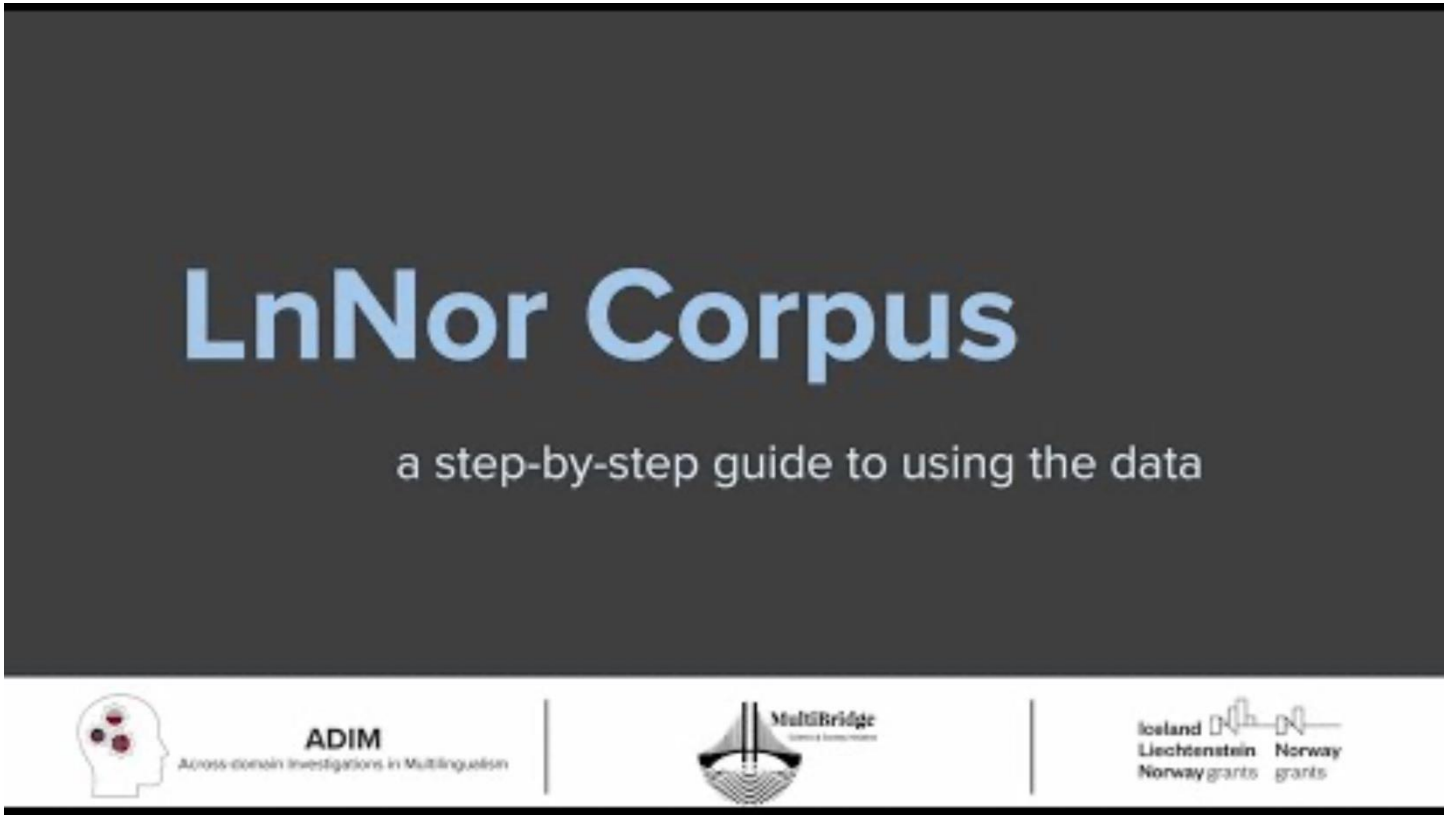
1727
annotated files

164
speakers

67
hours of speech

Tutorial

https://www.youtube.com/watch?v=4KpfrliuKeg



Dziękuję! Thank you!
Tusen takk!

Norway
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