

Where is the boundary? Perception of voicing distinction in word-initial stops by multilingual learners

Zuzanna Cal



ADAM MICKIEWICZ
UNIVERSITY
POZNAŃ



VOT perception in multilinguals

Liu et al. (2019):

- The effect of the newly learnt language (L3 Spanish) on the previous learnt ones (L1 Mandarin, L2 English)
- Influence of the L1 (or L2) on the L3, but also evidence of regressive cross linguistic influence (L1 drift)
- No evidence of separate perceptual systems in multilingual speakers

Liu & Lin (2021):

- Perception of L3 word-initial stops by L1 Mandarin, L2 English students learning Japanese or Russian as L3
- The bigger the VOT value, the higher the accuracy in perception
-> L3 voiceless stops perceived more accurately
- No significant correlation between learners' accuracy in perceiving voiced stops in L3 and the VOTs of the stimuli

Cal and Wrembel (2023)

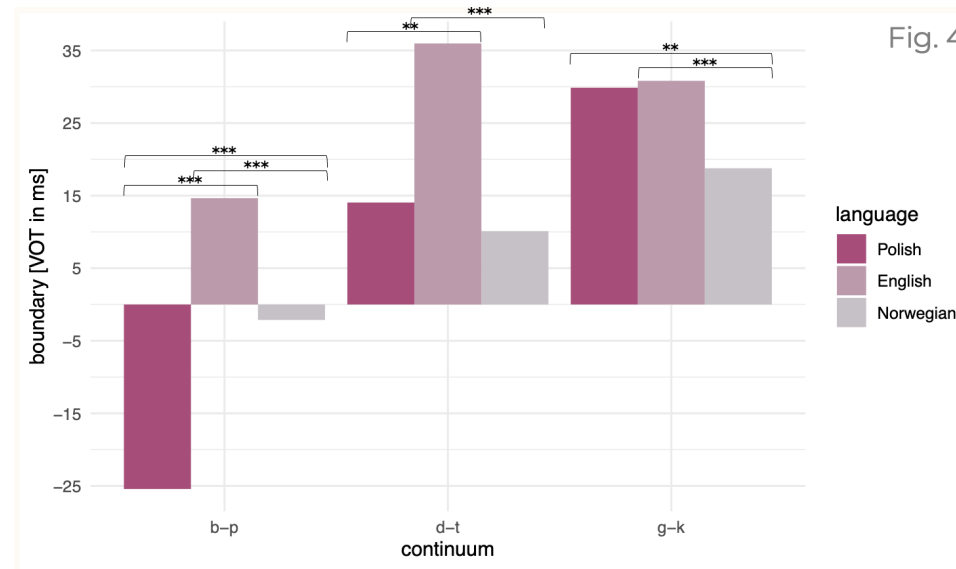
- Presented at ICPHS2023
- Study on the perception of word-initial voiced and voiceless stops by multilingual learners of L1 Polish, L2 English, L3 Norwegian in all the three languages
- We investigated:
 - 1.** The patterns of VOT categorisation in multilinguals - are they language- and PoA-specific?
 - 2.** The perceptual boundary locations for the perception of voiced and voiceless stops in all three languages - do they point to potential sources of cross-linguistic influence (CLI)?

Cal and Wrembel (2023)

- 19 L1 Polish L2 English L3 Norwegian speakers, aged 20, 14 females & 5 males
- After 8 weeks of intense initial exposure to the L3 Norwegian in a formal academic settings
- **Stimuli:** 9 VOT continua – 3 per language and place of articulation, based on minimal pair words with word-initial stop sounds
- Ranges based on the values obtained from native speakers' recordings in all three languages
- Each step differed from the other by 10 ms

	Polish	English	Norwegian
b-p	-90 - 30 ms (13 steps)	0 - 70 ms (8 steps)	-140 - 80 ms (23 steps)
d-t	-130 - 20 ms (16 steps)	0 - 90 ms (10 steps)	-130 - 90 ms (23 steps)
g-k	-80 - 60 ms (15 steps)	0 - 70 ms (8 steps)	-140 - 90 ms (24 steps)

Cal and Wrembel (2023)



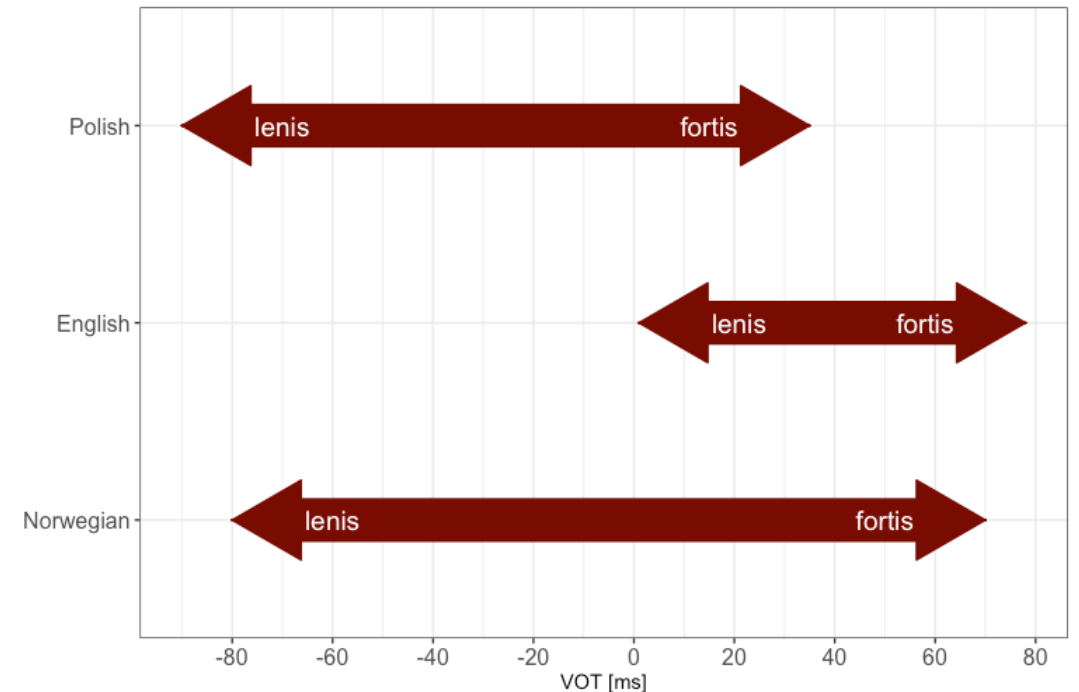
- Language- and PoA-specific patterns of VOT categorisation in most cases – an indication of a multilingual advantage
- But it might also be a range effect... (Keating et al. 1981, Lockhead and Hinson 1986)

Current study

- **Aim:** to explore how L1 Polish, L2 English, L3 Norwegian speakers perceive word-initial voiced and voiceless stops in the three languages
- This time with unified continua across languages and places of articulation (PoAs) and a cross-sectional design

Polish vs. English vs. Norwegian

- **Polish** – true voicing language (prevoicing in /bdg/ and short-lag VOT in /ptk/) (e.g., Keating et al. 1981)
- **English** – aspirating language (partially voiced /bdg/ and aspiration in /ptk/) (e.g., Lisker and Abramson 1964)
- **Norwegian** – prevoicing in /bdg/ (in most cases) and aspiration in /ptk/ (e.g., Ringen and van Dommelen 2013)



RQs and hypotheses

RQ1. Do multilinguals exhibit patterns of VOT categorisation distinct for the language and/or place of articulation?

H1. Perceptual boundary locations for VOT in fortis and lenis stops as perceived by the trilinguals will be separate / distinct with respect to the language and place of articulation rather than merged

Because of:

- multilingual advantage (e.g., Antoniou 2015, Kopečková 2015)
- previous research on VOT perception in multilinguals (Cal and Wrembel 2023)

RQs and hypotheses

RQ2. Can CLI be detected in VOT categorisation patterns across the three languages? If so, what is the directionality of CLI in L1 Polish, L2 English, L3 Norwegian speakers?

H2. Effect on L1: Not much effect on L1, because of the Phonological Permeability Hypothesis (PPH, Cabrelli Amaro & Rothman 2010), and previous research (instructed group in Sypiańska & Cal 2022, Sypiańska & Cal 2023)

Effect on L2: more interactions expected between L2 and L3, due to (psycho-)typology and similar settings of acquisition (i.e. via classroom instruction)

Effect on L3: mostly influenced by L2, because of (psycho-)typology and similar settings of acquisition, and L2 effect (Bardel & Falk 2011); influence from L1 Polish (Ringbom 1987) or a combined CLI (de Angelis 2007, Wrembel 2010) is also expected

RQs and hypotheses

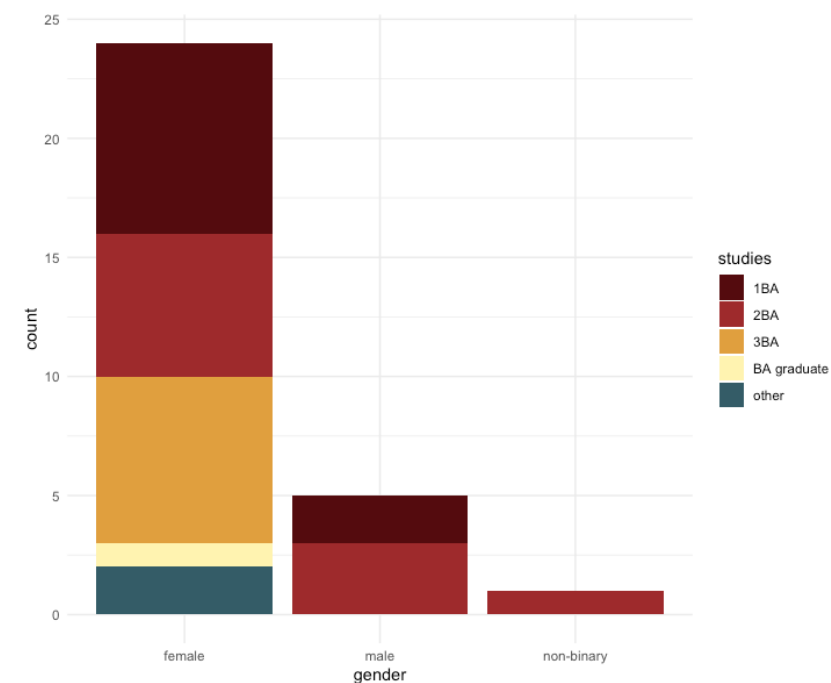
RQ3. How is perceptual boundary location mediated by proficiency levels in L3?

H3. Low level of L3 proficiency will bring about greater CLI from L2 to L3
(e.g., Williams and Hammarberg, 1998, Gut 2010, Sánchez 2014)

With the increase in L3 proficiency, there will be more CLI stemming from L1 to L3
(Williams and Hammarberg 1998, Tremblay 2006, Wrembel 2010)

Participants

- 30 speakers of L1 Polish L2 English L3 Norwegian
- 24 females, 5 males and 1 non-binary person
- Mean age = 21.4 (SD=2.1)
- Students/graduates of Norwegian Studies at Polish universities
- 10 1BA students, 10 2BA students, 7 3BA students, 1 graduate, 2 other learners of Norwegian
- Language History Questionnaire (Li et al. 2006)
- Placement tests in L2 and L3:
 - L2 English proficiency: A2-C2
 - L3 Norwegian proficiency: A1-B1+



Current study - design

- Continua ranged from -100–100ms – the same across three languages and three PoAs
- Prepared using a Praat script (Winn 2022)
- 21 steps, each of 10ms
- F0 manipulated according to Winn 2020's description

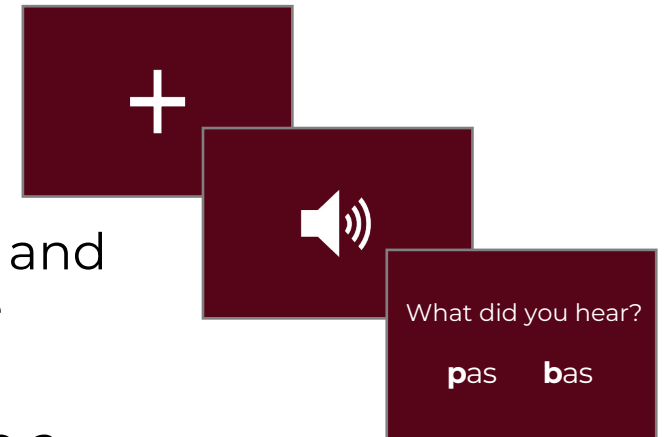
Norwegian: *bar-par* 

English: *done-ton* 

Polish: *gaz-kas* 

Experiment in PsychoPy (Peirce et al. 2019):

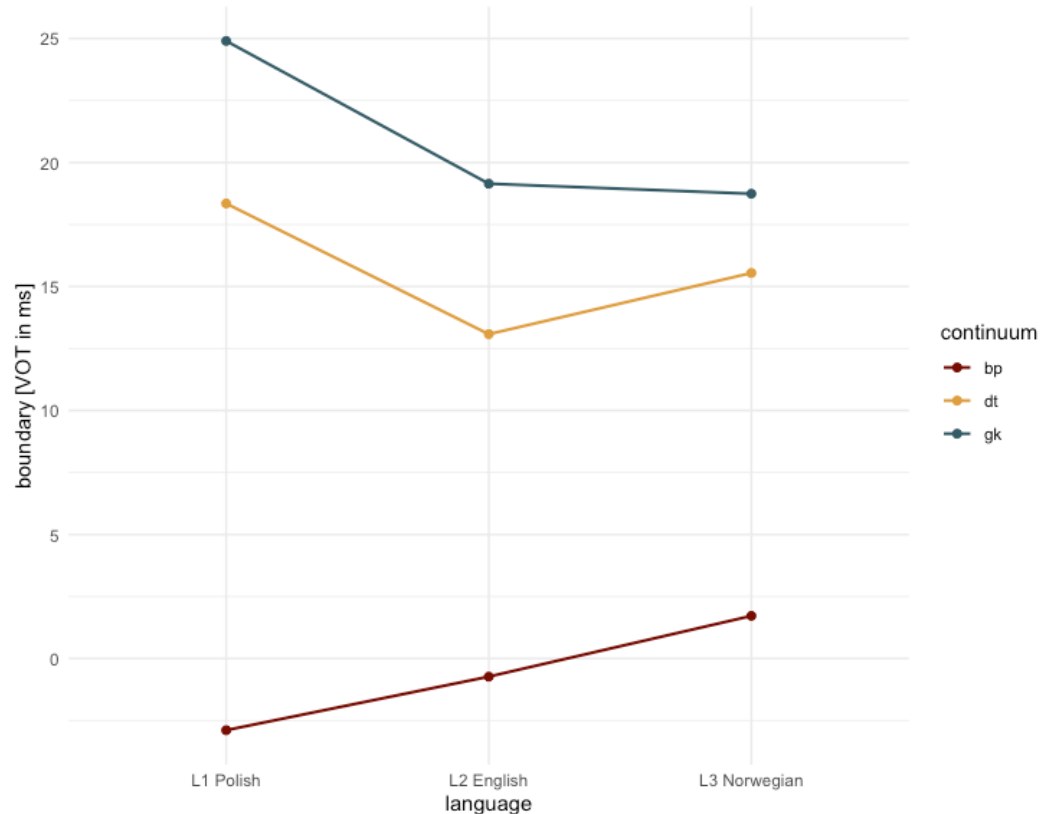
- a two-alternative forced-choice task
- participants were presented with one word from the continuum and asked whether they heard a voiced or voiceless consonant at the beginning
- three separate language blocks preceded by an introduction into a respective language mode (short film)



Analysis

- **Accuracy scores** (%) converted using logistic regression
- Obtained constant (b_0) and slope (b_1) values were used to calculate the perceptual boundary locations with the following formula: $-LN(b_0)/LN(b_1)$
(Aliaga-García & Mora 2009)

Results - boundary



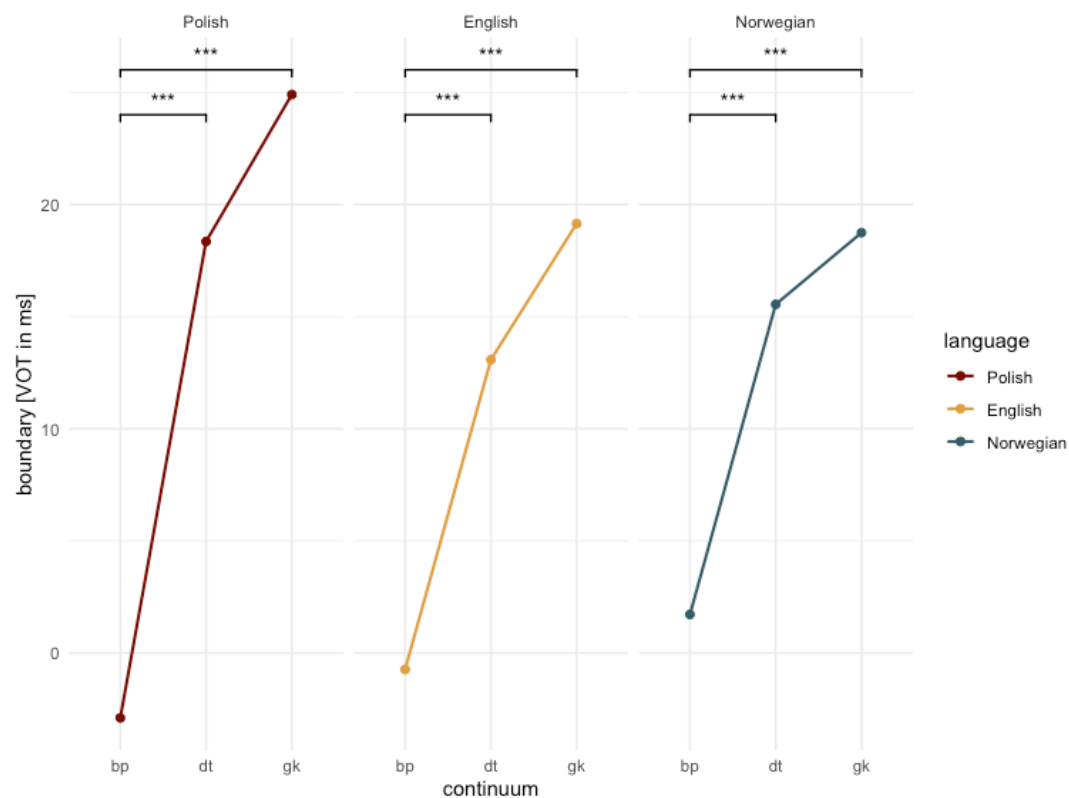
- **bp continuum:** values around 0 ms, the lowest for Polish
- **dt & gk continua:** boundaries higher in the continua, the highest boundary locations found in Polish

Results

- Linear mixed effects model in R:
(boundary~continuum*language+(1|participant))
- Statistically significant main effect of **continuum** ($F=127.304$, $p<.0001$):
 - dt ($t=5.658$, $p<.0001$)
 - gk ($t=8.145$, $p<.0001$)
- No effect of **language**

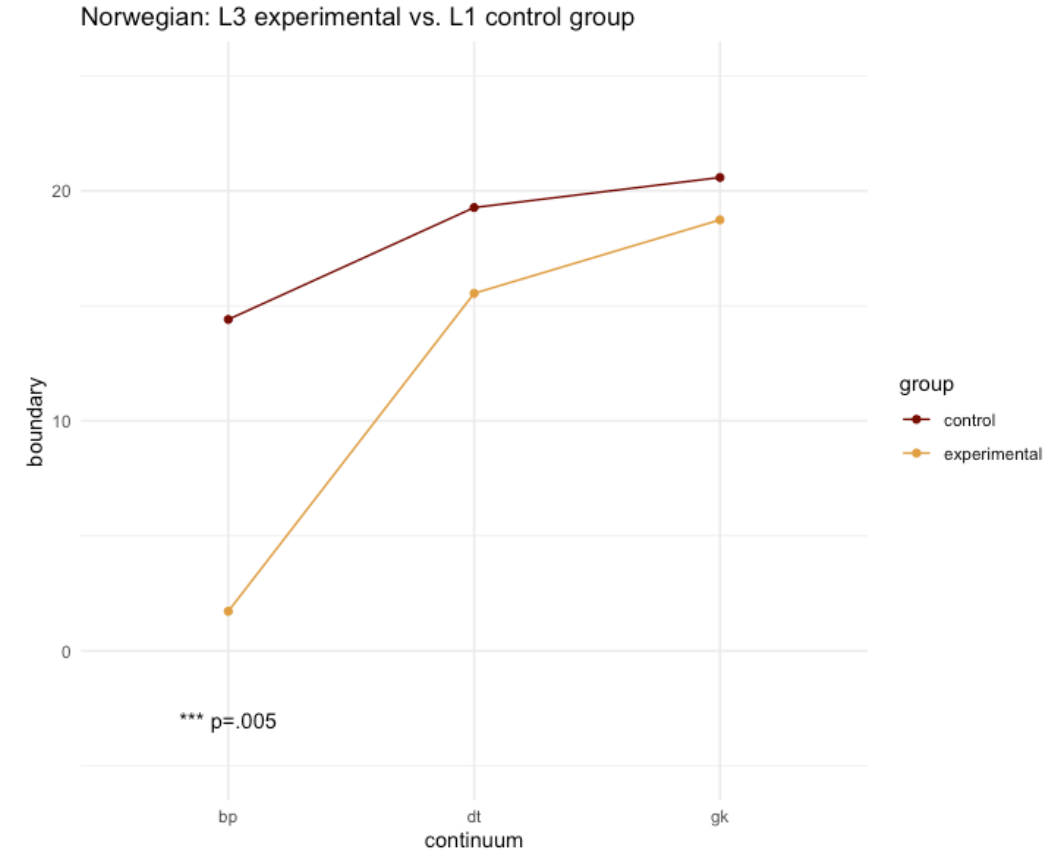
Results

- **Post hoc analysis** – significant differences between bp and dt, as well as bp and gk continua in the three languages

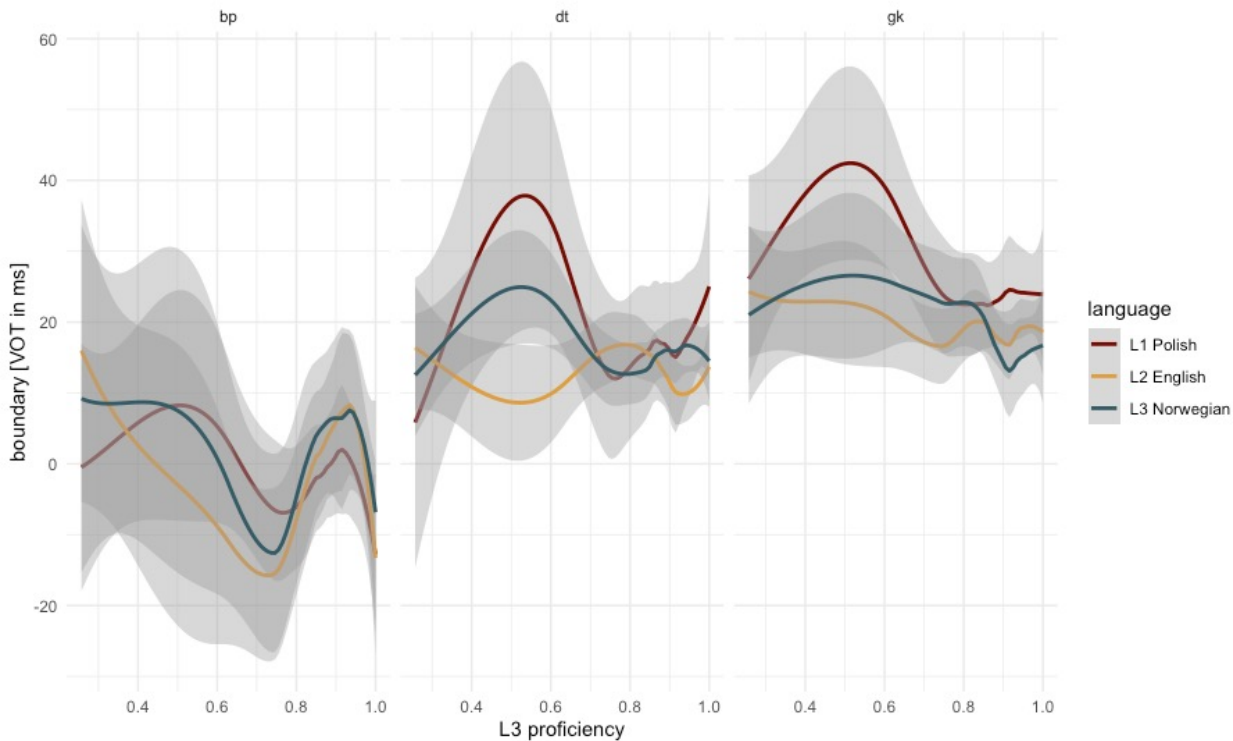


Results – Norwegian controls

- 12 L1 Norwegian controls, 9 females, 3 males
- Comparison of L3 data with L1 Norwegian control using Linear mixed effects model in R: (boundary~group*language+(1|participant))
- Statistically significant main effect of **group** ($F=4.086$, $p=.05$)
- **Post hoc analysis:** significant difference between boundaries in bp continuum across the two groups ($F=8.311$, $p=.005$)

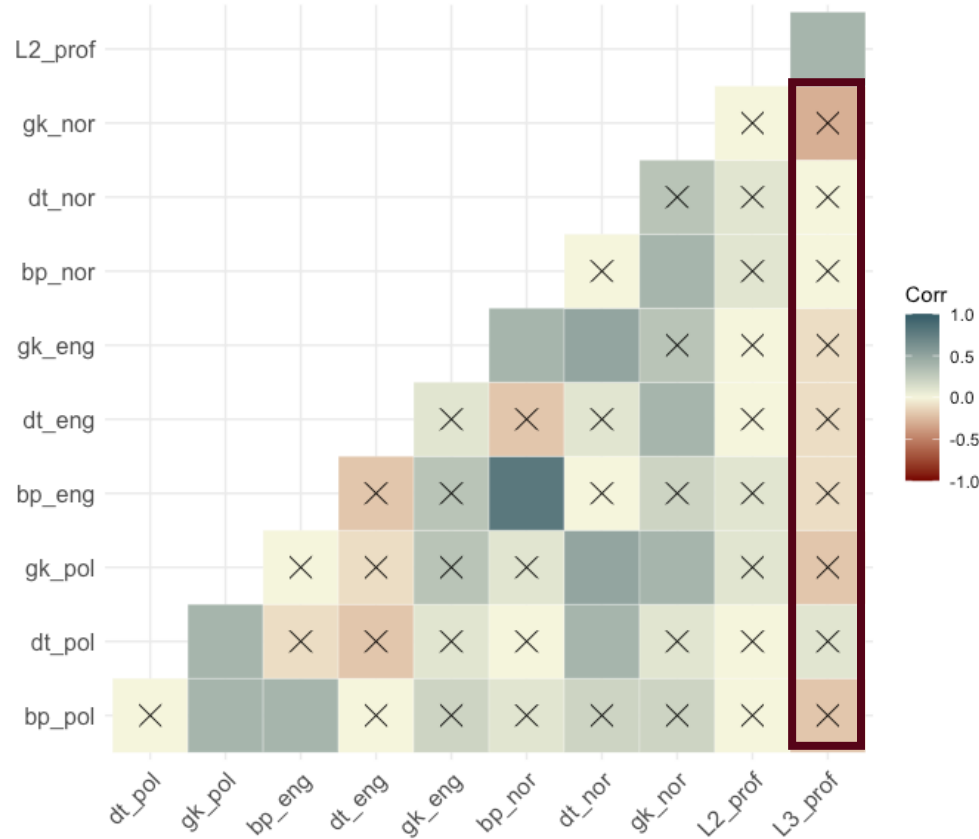


Results – L3 proficiency effect



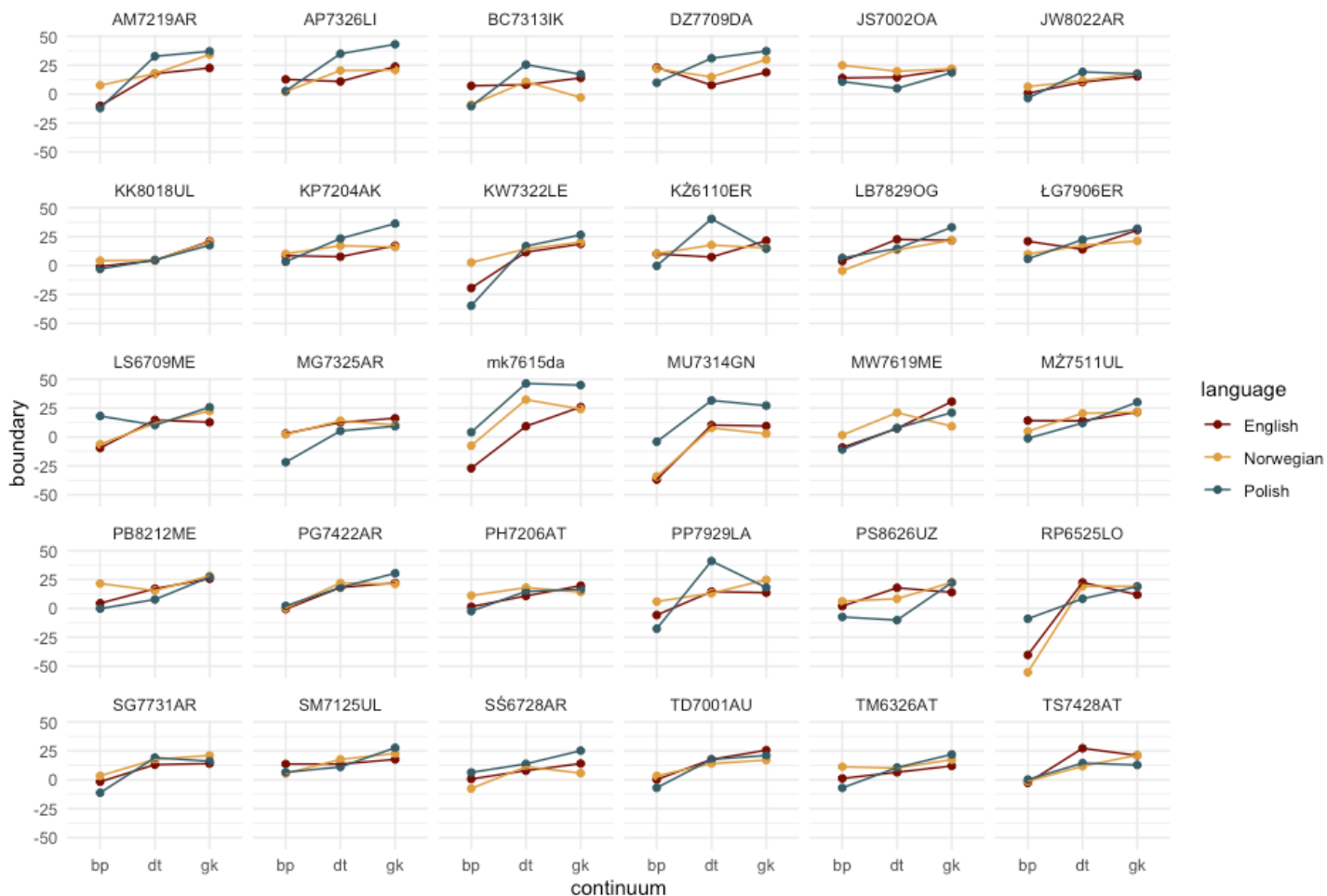
- **bp continuum:** similar (merged) trajectories across languages, irrespective of proficiency level
- **dt continuum:** Polish peaks at around 0.5, learners start to exhibit more sensitivity to VOT differences across languages; for higher proficiency they are getting more aligned
- **gk continuum:** boundary locations getting a bit lower in the continuum with the increase in L3 proficiency, Polish peaks at around 0.5 (mid proficiency level)

Results – correlation with L3 proficiency



- No correlation between L3 proficiency and the boundaries across languages and PoAs
- Analysis of the interaction between L2 and L3 proficiency on perceptual boundary locations might be more insightful (stay tuned for Sypiańska and Cal's presentation)

Results – individual variation



Language-specific patterns of VOT

categorisation: AP7326LI, BC7313IK, DZ7709DA, MK7615DA

Overlap of the three languages

(“equivalents”): JW8022AR, KK8018UL, PG7422AR, SG7731AR, SM7125UL, TD7001AU

L1-L2 overlap: MW7619ME

L1-L3 overlap: TS7428AT

L2-L3 overlap: MG7325AR, MU7314GN, RP6525LO

L1 drift (reverse CLI): AM7219AR, AP7326LI, BC7313IK, DZ7709DA, KP7204AK, LB7829OG, MK7615DA, MU7314GN, SŚ6728AR

Non-aligned behaviour of the three continua:

KW7322LE, KŻ6110ER, LS6709ME, PS8626UZ, RP6525LO

Discussion

- No effect of language - participants perceived the continua similarly across languages
- No evidence of separate perceptual systems in multilingual speakers (in line with Liu et al. 2019, unlike previous findings in Cal & Wrembel 2023)
- bp continuum significantly different from the other two
- The participants might not have noticed the difference between bp continua in the three languages and, therefore, perceive them as “equivalents” to L1 Polish (as the values are around 0 ms, and there is no L1 drift) (see equivalence classification (Flege 1995))
- It is also confirmed in the comparison to Norwegian controls’ boundaries (there is a significant group effect for the bp continuum)

Discussion

- L1 Polish boundaries were significantly higher and more similar to L2 and L3 in dt and gk continua – evidence for L1 drift (either from L2 English or L3 Norwegian)
- Similar boundary locations for L2 English and L3 Norwegian suggesting possible interactions between the two in dt and gk continua (no significant differences between the languages)

Individual variation:

- Great individual variation, various scenarios attested for individual participants
- Might be because L2/L3 proficiency, frequency of use or auditory sensitivity which may differ across individuals

Discussion

L3 proficiency effect:

- bp continuum more aligned in the three languages, showing again that participants perceive this continuum closely to L1 Polish
- dt and gk continua are more perceptually salient, thus exhibit greater fluctuation as a function of L3 proficiency
- L1 drift especially visible at moderate levels of proficiency (around 50%) in dt and gk continua – it is possible that participants start to notice the differences between the languages at around this point

Conclusions

- Trilingual learners exhibit separate perceptual systems for word initial stops
- It is the most difficult for participants to notice the difference between bp continua in the three languages
- Evidence for L1 drift in dt and gk continua that peaks at moderate levels of proficiency – to be confirmed with control data

Future steps

- Control data collection in progress (in Poland and in the UK)
- Comparisons with production data to see how participants produce stops in the three languages

Dziękuję! Thank you! Takkk!

e-mail me for references:
zuzanna.cal@amu.edu.pl





Acknowledgements

This research has been supported financially by:

- a grant of the Polish National Science Centre (NCN) OPUS-19-HS (UMO-2020/37/B/HS2/00617) CLIMAD “Cross-linguistic influence in multilingualism across domains: Phonology and syntax”
- a Norway funds/NCN grant GRIEG-1 (UMO-2019/34/H/HS2/00495) ADIM “Across-domain investigations in multilingualism: Modeling L3 acquisition in diverse settings”

PIs: Magdalena Wrembel, Marit Westergaard

Follow us

