The interplay between syllable-based predictability and voicing during closure in intersonorant German stops

Omnia Ibrahim, Ivan Yuen, Bistra Andreeva, Bernd Möbius

Background

- Contextual predictability affects the acoustic realization of speech [1], e.g., short syllable duration in predictable contexts.
- However, it is not clear if predictability effect spreads to other linguistic level.
- In German, syllable-based predictability affects closure duration (CD) in both voiced and voiceless stops but only voiceless stops in VOT [2], likely due to German being an aspirating language.
- Could such differences be related to the nature of the acoustic cues to German voicing?
- We re-examined the downstream effect of predictability by measuring the degree of residual voicing during stop closure (VDC) in intersonorant context.
- **Hypothesis:** predictability will have a uniform effect on phonetic voicing of voiced and voiceless stops, since [spread glottis] is associated with aspiration, not voicing.

Method

- A subset of a read corpus [3].
- 60 sentences from 26 German female speakers.
- 20 CV syllables = **/p, k, b, d/ + /a:, e:, i:, o:, u:/** in **2 predictability contexts** (HS & LS).
- **Predictability**: Surprisal($unit_i$)= $-\log_2 P(unit_i \mid context)$.
- VDC/CD ~ Surprisal + Consonant voicing + (1 | Speaker) + (1 | Syllable) + (1 | PrevManner)+ (1 | Sentence)

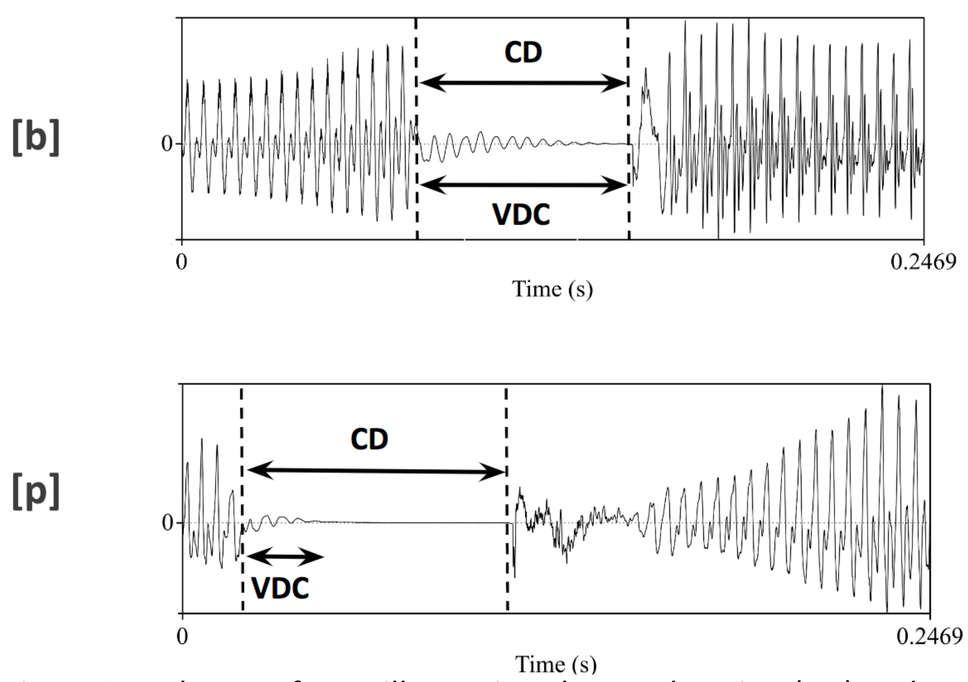
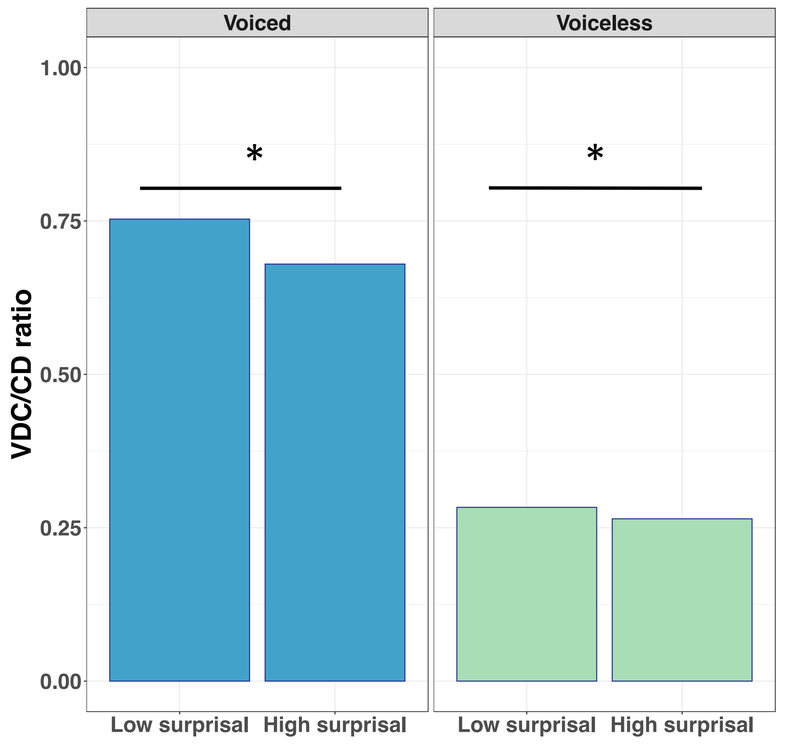


Fig. 1: Sample waveforms illustrating closure duration (CD) and voicing during closure (VDC) of [b] and [p].

Results

The results yielded significant main effects of:

- **Voicing: Smaller** VDC/CD ratio for voiceless than voiced stops (Fig. 2).
- **Surprisal: Larger** VDC/CD ratio in low than high surprisal syllable, irrespective of the voicing status of the target stops (Fig. 2).
- No interaction between voicing and surprisal.



Discussion & Conclusion

- The impact of syllable-based surprisal has extended to the temporal cues of the German voicing contrast, and this influence is consistent for both voiceless and voiced stops.
- Surprisal affects acoustic cues that are not directly associated with a phonological feature in German voicing, such as [spread glottis].

References

[1] Aylett, M., and Turk, A. (2004). The smooth signal redundancy hypothesis: A functional explanation for relationships between redundancy, prosodic prominence, and duration in spontaneous speech, Language and Speech, vol. 47, no. 1, pp. 31–56.
[2] Ibrahim, O.; Yuen, I.; Andreeva, B.; Möbius, B. (2022) The effect of predictability on German stop voicing is phonologically selective ,Proc. Speech Prosody 2022 Lisbon, Portugal.
[3] Ibrahim, O.; Yuen, I.; van Os, M.; Andreeva, B.; Möbius, B. (2022) The combined effects of contextual predictability and noise on the acoustic realisation of German syllables, JASA.