

Estimating prosodic prominences in verb–particle constructions from the Nordic Word Order Database with continuous wavelet transform

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Previous studies on verb–particle constructions in Scandinavian languages have highlighted variation both in syntactic ordering and prosodic realisation, particularly regarding stress and accent placement. While perceptual analyses have traditionally dominated prosodic research, these approaches face challenges in pitch-accent languages like Norwegian and Swedish, where dialectal diversity and complex prosodic hierarchies introduce subjectivity and interrater inconsistencies.

Prosodic variation in Norwegian particle verbs is well documented and dialect-sensitive (e.g., Tengesdal et al., 2024). Four main impressionistic patterns occur: (i) **particle accent**, where the particle carries the main stress (e.g., *skjelt ÚT* ‘scolded’); (ii) **compound accent**, with a single main stress on the verb (e.g., *SKJÉLT út* ‘scolded’); (iii) **double accent**, where both verb and particle are accented (e.g., *SKJÉLT ÚT* ‘scolded’); and (iv) **no accent**, where neither verb nor particle are accented. These patterns vary across dialects. Such variation interacts with syntax and information structure but is not fully predictable from word order alone.

This study is a work in progress with two main aims: (i) to explore the feasibility and applicability of Continuous Wavelet Transform (CWT) as a more objective method for prosodic analysis of Norwegian speech, and (ii) to analyse verb–particle constructions in experimentally elicited speech data from the Nordic Word Order Database (NWD; Lundquist et al., 2019). The current dataset focuses on Trøndelag varieties, with Oslo data planned for inclusion in subsequent analyses.

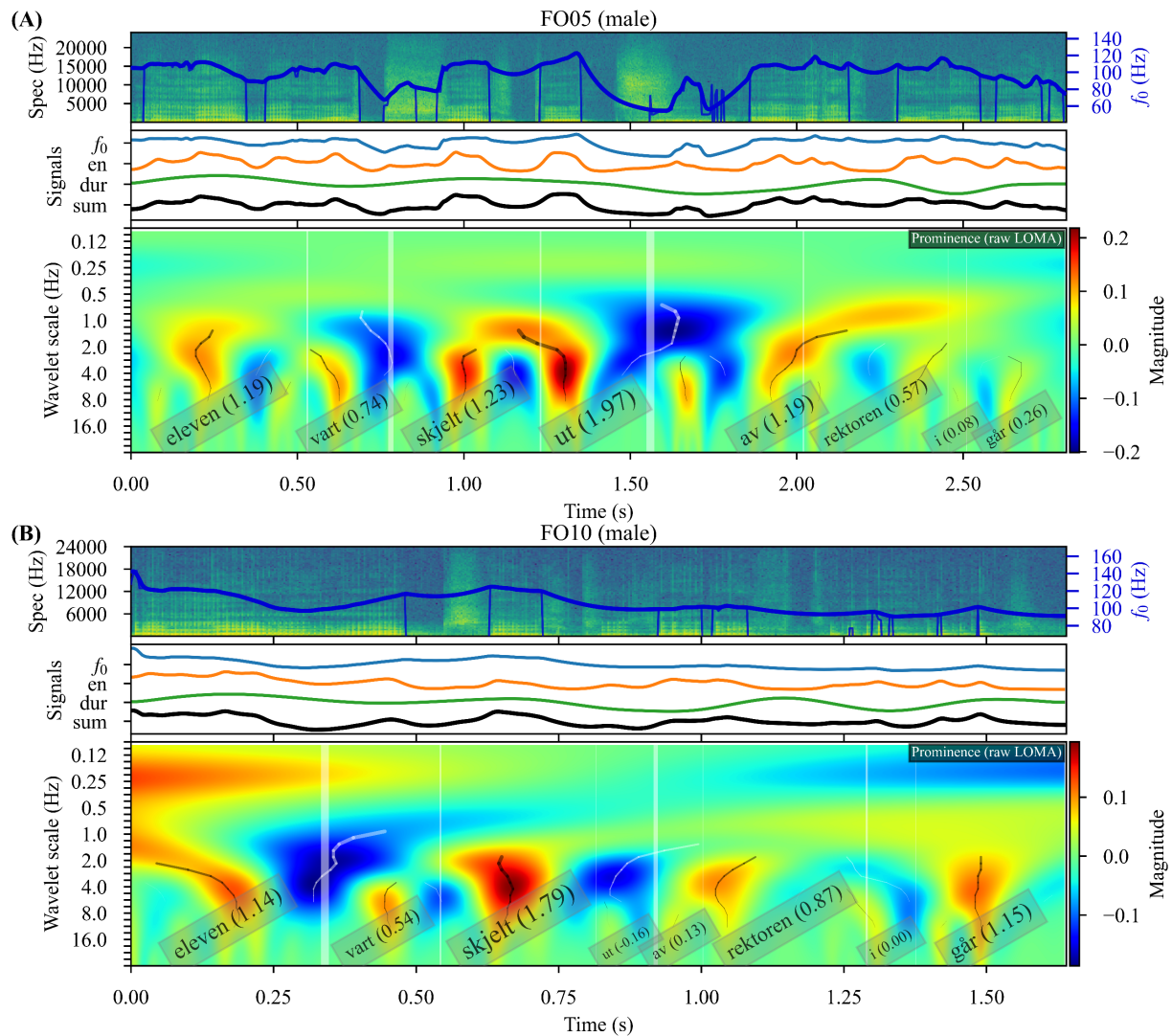
The motivation for adopting CWT lies in the methodological limitations of perceptual categorisation, which might be influenced by researchers’ dialectal background, theoretical assumptions, and potential mismatches between intended and perceived prosodic structures. While reliability checks such as interrater agreement can mitigate some issues, they remain subject to similar biases. Objective, signal-based methods like CWT offer a triangulating approach that reduces rater influence and captures gradient prominence patterns. Unlike categorical annotation systems, CWT does not presuppose discrete tonal event types; rather, it estimates gradient degrees of prominence, making it more analogous to crowdsourced magnitude-based approaches such as rapid prosody transcription (RPT; Cole et al., 2017).

CWT has been successfully applied to prosodic analysis in other languages (e.g., English and Finnish; Suni et al., 2017), but its application to Norwegian remains underexplored. Verb–particle constructions provide an ideal test case due to their variability in stress and accentuation, which interacts with information structure and dialectal prosody. Preliminary results shown in Figure 1, panel (A) and (B), suggest that CWT-derived measures such as Lines of Maximal Amplitude (LOMA) correspond well to impressionistic categorisations, while revealing gradient differences between speakers. For instance, NWD item 1317 shows contrasting prominence patterns on the particle *ut* across two speakers, aligning with accentual differences.

The broader theoretical context involves Scandinavian tone-accent typology (Riad, 2006) and hierarchical prosodic models (e.g., Kristoffersen, 2000; Myrberg & Riad, 2015), which posit multiple levels above the foot (prosodic word, phrase, intonation phrase). While these frameworks capture abstract generalisations, applying them to diverse varieties remains challenging due to surface variation and potential categorisation biases. Signal-based approaches like CWT may complement these models by providing empirical evidence for prominence patterns without presupposing categorical boundaries.

Future work will expand the dataset to include Oslo speakers in the NWD, compare CWT-based measures with perceptual judgments, and evaluate the method’s potential for large-scale prosodic analysis in Nordic languages. This triangulation may contribute to refining prosodic theory and improving empirical robustness in studies of dialectal variation.

Figure 1: Two NWD participants uttering NWD ID 1317: *Elven vart skjelt ut av rektoren i går* ‘The pupil was scolded (*lit.* ‘yelled out’) by the headmaster yesterday’. **Panel (A):** FO05. The higher LOMA value on the particle *ut* (1.97) than on the verb *skjelt* (1.23) is consistent with an analysis of accented particle. The non-negligible verb value may additionally support a double accent reading; CWT’s gradient output makes such borderline cases explicit rather than forcing a categorical decision. **Panel (B):** FO10. The high prominence on the verb *skjelt* (1.79) and strongly suppressed particle *ut* (−0.16) indicate that prominence is concentrated on the verb. The tonal contour supports a compound accent or verb accent analysis; the presence of a pause makes these alternatives difficult to fully exclude on acoustic grounds alone, illustrating how CWT gradient measures can make competing analyses explicit. The figure was generated using an adapted version of the *Wavelet Prosody Toolkit* (https://github.com/asuni/wavelet_prosody_toolkit).



References:

- Albert, A. (2023). *A model of sonority based on pitch intelligibility* (Studies in Laboratory Phonology 13). Language Science Press. <https://doi.org/10.5281/zenodo.7837176>
- Cole, J., Mahrt, T., & Roy, J. (2017). Crowd-sourcing prosodic annotation. *Computer Speech & Language*, 45, 300–325. <https://doi.org/10.1016/j.csl.2017.02.008>
- Kristoffersen, G. (2000). *The Phonology of Norwegian*. Oxford University Press.
- Lundquist, B., Larsson, I., Westendorp, M., Tengesdal, E., & Nøklestad, A. (2019). Nordic Word Order Database: Motivations, methods, material and infrastructure. *Nordic Atlas of Language Structures (NALS) Journal*, 4(1), 1–33. <https://doi.org/10.5617/nals.7529>
- Myrberg, S., & Riad, T. (2015). The prosodic hierarchy of Swedish. *Nordic Journal of Linguistics*, 38(2), 115–147. <https://doi.org/10.1017/S0332586515000177>
- Riad, T. (2006). Scandinavian accent typology. *STUF – Language Typology and Universals*, 59(1), 36–55. <https://doi.org/10.1524/stuf.2006.59.1.36>
- Suni, A., Šimko, J., Aalto, D., & Vainio, M. (2017). Hierarchical representation and estimation of prosody using continuous wavelet transform. *Computer Speech & Language*, 45, 123–136. <https://doi.org/10.1016/j.csl.2016.11.001>
- Tengesdal, E., Larsson, I., & Lundquist, B. (2024). Prosodic Variation in Particle Constructions in Three Norwegian Dialect Areas. *Maal og Minne*, 116(2), 295–344. <https://doi.org/10.52145/mom.v116i2.2316>