

The effect of predictability on the duration of phrase-final syllables and pause

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There is a growing body of evidence suggesting that speakers and listeners have access to probability distributions over linguistic units (e.g., Jaeger 2010). This entails that speakers' linguistic choices and listeners' preference are affected by the probability and frequency of occurrence of realizations of such units in a variety of contexts. According to the Smooth Signal Redundancy (SSR) hypothesis (Aylett and Turk 2004, 2006), there is an inverse relationship between predictability and acoustic realization of phonetic structures because speakers tend to maintain a steady flow of information, and this relationship is mediated through prosodic structure such as prosodic prominence. Another aspect of prosodic structure is pre-boundary lengthening.

The present study extends previous work on information density to examine its impact on pre-boundary lengthening or pause duration in a subset of the DIRNDL Radio News Database in German (Eckart et al., 2012). DIRNDL is manually annotated for pitch accents and prosodic boundaries following the autosegmental intonation model (Mayer, 1995). Each data point in our analysis is the last syllable before an intermediate phrase boundary (ip) or an intonational phrase boundary (IP). Information density (ID) is defined as contextual predictability or surprisal of a unit and estimated from language models based on DeWaC (Baroni et al., 2009). Surprisal is calculated as the inverse log probability of a syllable to occur in the context of two preceding syllables, that is, in a syllable trigram context. Our prediction is that (a) at final boundaries of prosodic constituents of the same type, the syllables with higher surprisal values will have longer duration compared to syllables with lower surprisal; (b) since the magnitude of phrase-final lengthening varies systematically with the level of the constituent in the prosodic hierarchy, the increase in duration due to surprisal will be significantly greater before IP than before ip boundaries; and (c) similar effects will be observed on pause duration (if present) because it is used to convey prosodic structure like pre-boundary lengthening.

Regarding the first hypothesis, results from the linear mixed effects model revealed an interaction of surprisal with prosodic boundaries. As expected, syllable duration and surprisal were positively correlated with final syllable durations. Regarding the second hypothesis, the slope of correlation was steeper before an intermediate phrase (ip) boundary counter to the expectation. Regarding the third hypothesis, pause duration was not subject to surprisal, but prosodic boundaries and syntactic complexity. These results raise further questions about where, when and how these information density effects might arise during speech production planning.

References

- Aylett, Matthew and Alice Turk. 2004. "The smooth signal redundancy hypothesis: A functional explanation for relationships between redundancy, prosodic prominence, and duration in spontaneous speech." *Language and Speech*, 47(1): 31-56.
- Aylett, Matthew and Alice Turk. 2006. "Language redundancy predicts syllabic duration and the spectral characteristics of vocalic syllable nuclei." *Journal of the Acoustical Society of America*, 119(5): 3048-3058.
- Baroni, M., Bernardini, S., Ferraresi, A., Zanchetta, E. 2009. The WaCky Wide Web: A collection of very large linguistically processed web-crawled corpora, *Language Resources and Evaluation*, 43, 209-226.
- Eckart, K., Riester, A., Schweitzer, K. 2012. A discourse information radio news database for linguistic analysis. In C. Chiarcos, S. Nordhoff and S. Hellman (Eds.) *Linked Data in Linguistics: Representing and Connecting Language Data and Language Metadata*, Springer. pp. 65-75.
- Jaeger, Florian T. 2010. "Redundancy and reduction: speakers manage syntactic information density." *Cognitive psychology*, 61 (1): 23-62.

Mayer, J. 1995. Transcription of German Intonation – the Stuggart system. Institute of Natural Language Processing. University of Stuggart Tech. Report. doi: <https://www.ims.uni-stuttgart.de/documents/arbeitsgruppen/ehemalig/ep-377dogil/STGTsystem.pdf>