

Form prediction and competitor suppression in sentence reading:
Evidence from German

Katja Haeuser, Saarland University
khaeuser@coli.uni-saarland.de

People leverage linguistic context to predict upcoming words during reading [1]. But do readers predict form-related aspects of language (e.g., a word's orthography) as readily as they predict semantic features? Some studies have suggested time-equivalent prediction of form and meaning [2,3], even in conditions where comprehenders are pressed for time [4]. Another line of research has called these findings into question, by showing that form prediction disappears under speeded processing conditions [5,6] and is subject to large individual differences [7,8]. A possible reason for the conflicting findings could be that previous studies did not differentiate between conditions when target and orthographic neighbor share onset similarity (e.g., “cat”-“car”, head relationship) and conditions when they share offset similarity (e.g., “cat”-“mat”, rhyme relationship). We know that word onsets are more critical to language processing [9,10], especially in paradigms that promote serial processing of language, such as reading [11]. In addition, most previous studies on predictive processing have assumed that form prediction will *facilitate* processing of form-related neighbors – for example, expecting “ice” will facilitate processing “dice”. However, orthographic priming studies have shown *inhibitory*, not *facilitatory* effects for form-related words, in particular for head-related neighbors [12].

In this study, we investigated prediction of form and meaning by using a sentence reading-lexical decision task. We compared two types of form relationship: Rhyme-related words, which share global similarity with predictable targets (e.g., “cat”-“fat”), and head-related targets, which share onset similarity with predictable words (e.g., “cat”-“can”). We expected to more readily form prediction effects for head-compared to rhyme-related targets [9,10,13].

One-hundred native speakers of German (62m, 37f, 1n-b, *Mean Age* = 28 years, *Range* = 18-40) read constraining unpredictable sentences (e.g., “In der Stille des Nachmittags hörte man laut und deutlich das Ticken der Heizung.”, “In the quiet of the afternoon one could clearly hear the ticking of the heater.”) that disconfirmed their predictions for a specific noun (e.g., “Uhr”, “clock”). At sentence offset, participants indicated as quickly as possible whether a visually presented letter string was a German word or not. Targets were previously predictable but not presented words (e.g. “Uhr”, “clock”, PRED), close semantic associates (e.g., “Zeit”, “time”, SEM), or form-related words that either shared a head relationship (e.g., “Uhu”, “owl”, HEAD) or a rhyme relationship (e.g. “Kur”, “spa”, RHYME) with predictable targets. Unrelated control nouns were also presented (e.g., “Tisch”, “desk”, UR). We quantified prediction of semantic and orthographic features by comparing reaction times of form- and meaning-related targets to unrelated control words. PRED/SEM/UR words had no form similarity with the presented word.

We found that lexical decision times to PRED and SEM were facilitated, compared to UR (see Table 1 and Figure 1 for model and graph), suggesting that PRED targets were likely predicted during reading, and pre-activation of semantic features also activated semantically related words. No facilitation difference emerged between PRED and SEM (i.e., no graded effect for semantic targets). HEAD targets showed *slower* lexical decision times compared to UR, possibly reflecting competitor suppression of orthographic neighbors that shared onset similarity. No effects emerged for RHYME targets, maybe because of the temporal delay with which offset-related words become available during processing.

Our results indicate that language users activate both semantic and form-related aspects of likely upcoming words. Compared to earlier studies that quantified form prediction as *facilitation* for words with global similarity (i.e., rhymes), our results showed *slowing* for words with onset similarity (i.e. heads). Thus, prediction of orthographic features may involve active suppression of onset competitors. Our results are in line with psycholinguistic models that postulate competition between a word and its orthographic neighbors [14,15], and with prediction-by-production models of predictive processing [16,17].

Figure 1

Partial effects plot of model-estimated lexical decision times (de-logged here) across the five experimental conditions.

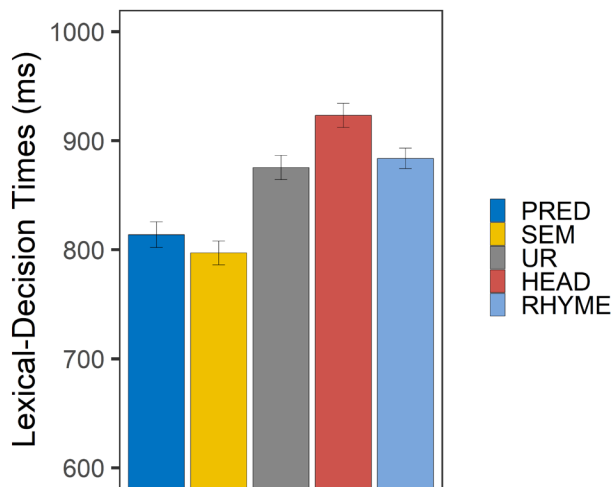


Table 1

Output of LMER model estimating the differences in log-transformed lexical decision times between PRED, SEM, RHYME, HEAD vs UR.

	<i>b</i>	SE	<i>t</i>	<i>p</i>
(Intercept)	6.71	0.02	333	< .001
PRED	-0.04	0.01	-2.67	.01
SEM	-0.04	0.01	-2.69	.01
HEAD	0.03	0.01	2.29	.02
RHYME	0.01	0.01	0.53	.59
Scaled Trial	-0.03	0.01	-6.85	< .001
Scaled Length	0.004	0.01	0.85	0.39
Scal. Frequency	-0.05	0.01	-9.02	< .001

Note. The intercept reflects log-transformed lexical decision times for UR. Negative *b*-coefficients reflect facilitation compared to UR, positive *b*-coefficients reflect slowing. Frequency values were taken from the SUBTLEX-DE database.

References

- [1] Kuperberg, G. R., & Jaeger, T. F. (2016). What do we mean by prediction in language comprehension?. *Language, Cognition and Neuroscience*, 31(1), 32-59.
- [2] DeLong, K. A., Chan, W. H., & Kutas, M. (2019). Similar time courses for word form and meaning preactivation during sentence comprehension. *Psychophysiology*, 56(4), e13312.
- [3] Laszlo, S., & Federmeier, K. D. (2009). A beautiful day in the neighborhood: An event-related potential study of lexical relationships and prediction in context. *Journal of Memory and Language*, 61(3), 326-338.
- [4] DeLong, K. A., Chan, W. H., & Kutas, M. (2021). Testing limits: ERP evidence for word form preactivation during speeded sentence reading. *Psychophysiology*, 58(2), e13720.
- [5] Huettig, F., & Guerra, E. (2019). Effects of speech rate, preview time of visual context, and participant instructions reveal strong limits on prediction in language processing. *Brain Research*, 1706, 196-208.
- [6] Ito, A., Corley, M., Pickering, M. J., Martin, A. E., & Nieuwland, M. S. (2016). Predicting form and meaning: Evidence from brain potentials. *Journal of Memory and Language*, 86, 157-171.
- [7] Martin, C. D., Thierry, G., Kuipers, J. R., Boutonnet, B., Foucart, A., & Costa, A. (2013). Bilinguals reading in their second language do not predict upcoming words as native readers do. *Journal of Memory and Language*, 69(4), 574-588.
- [8] DeLong, K. A., Groppe, D. M., Urbach, T. P., & Kutas, M. (2012). Thinking ahead or not? Natural aging and anticipation during reading. *Brain and Language*, 121(3), 226-239.
- [9] Allopenna, P. D., Magnuson, J. S., & Tanenhaus, M. K. (1998). Tracking the time course of spoken word recognition using eye movements: Evidence for continuous mapping models. *Journal of Memory and Language*, 38, 419-439.
- [10] Magnuson, J. S., Dixon, J. A., Tanenhaus, M. K., & Aslin, R. N. (2007). The dynamics of lexical competition during spoken word recognition. *Cognitive Science*, 31(1), 133-156.
- [11] Barton, J. J., Hanif, H. M., Eklinder Björnström, L., & Hills, C. (2014). The word-length effect in reading: A review. *Cognitive Neuropsychology*, 31(5-6), 378-412.
- [12] Frisson, S., Bélanger, N. N., & Rayner, K. (2014). Phonological and orthographic overlap effects in fast and masked priming. *Quarterly Journal of Experimental Psychology*, 67(9), 1742-1767.
- [13] Sommers, M. S., & Lewis, B. P. (1999). Who really lives next door: Creating false memories with phonological neighbors. *Journal of Memory and Language*, 40(1), 83-108.
- [14] Marslen-Wilson, W., & Zwitserlood, P. (1989). Accessing spoken words: The importance of word onsets. *Journal of Experimental Psychology: Human Perception and Performance*, 15, 576-585.
- [15] McClelland, J. L., & Elman, J. L. (1986). The TRACE model of speech perception. *Cognitive Psychology*, 18, 1-86.
- [16] Pickering, M. J., & Garrod, S. (2007). Do people use language production to make predictions during comprehension? *Trends in Cognitive Sciences*, 11(3), 105-110.
- [17] Martin, C. D., Branzi, F. M., & Bar, M. (2018). Prediction is Production: The missing link between language production and comprehension. *Scientific Reports*, 8(1), 1079.