

## **The presence of background noise reduces interlingual phonological competition during non-native speech recognition**

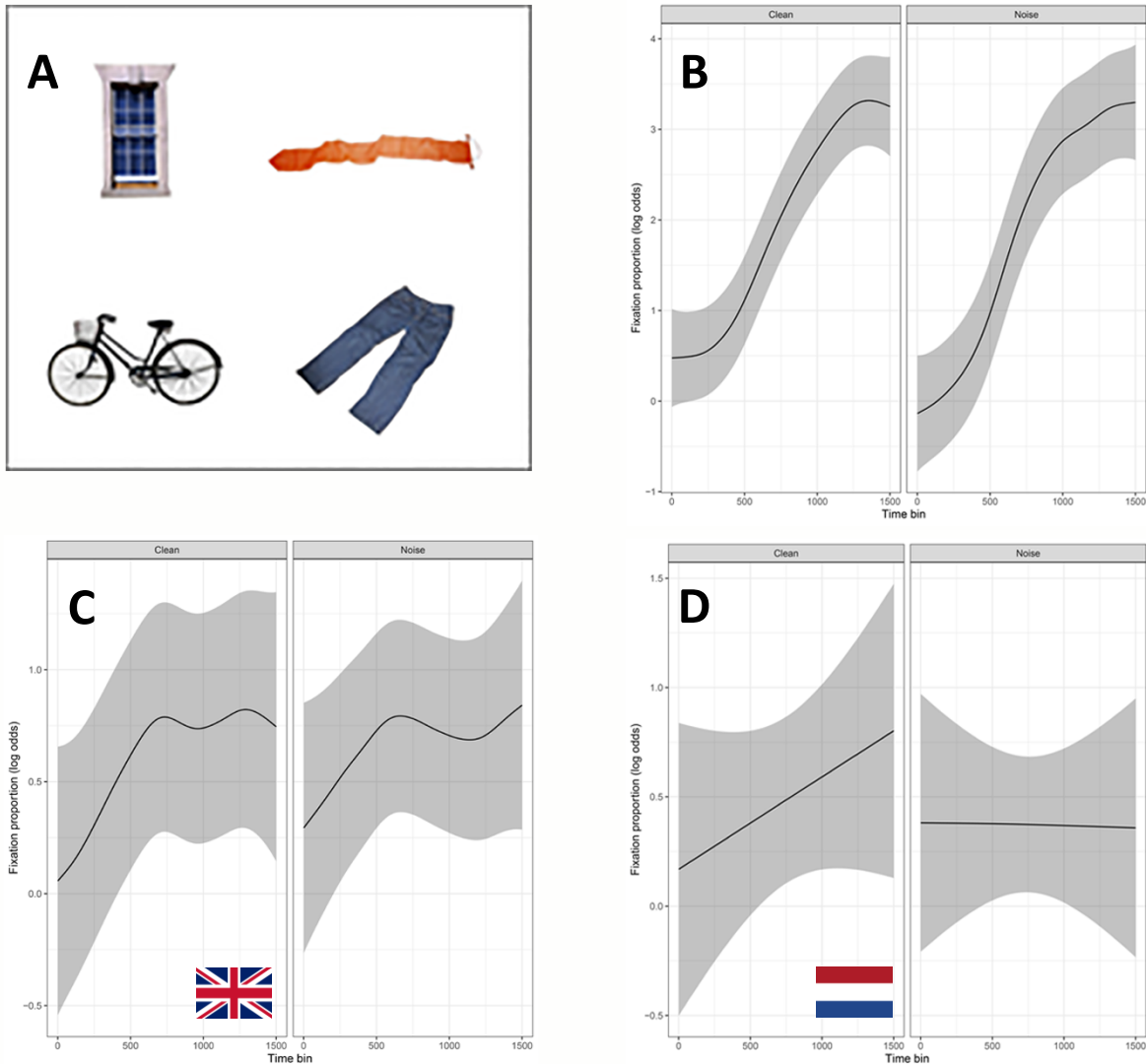
Florian Hintz (Max Planck Institute for Psycholinguistics), Cesko C. Voeten (Leiden University), Odette Scharenborg (TU Delft)

Language users experience interlingual competition when listening to non-native speech. Using the visual world paradigm, listeners have been shown to fixate objects whose word name overlapped phonologically in participants' native language with a simultaneously unfolding non-native target word (e.g., Spivey & Marian, 1999). This finding has been replicated numerous times and contributed to the notion of 'non-selective lexical access' during non-native language processing (Dijkstra et al., 2019). To the best of our knowledge, all previous experiments studied interlingual phonological competition under 'ideal' circumstances, involving carefully produced speech and high-quality audio recordings. In the real world, speech comprehension rarely takes place under ideal circumstances. Moreover, previous research has shown that noise has more dramatic effects on non-native than on native speech recognition (Scharenborg & van Os, 2019). The reasons for this asymmetry are not well understood.

In the present study, we tested the effects of background noise on interlingual competition, i.e. co-activation of listeners' native language when listening to non-native speech. We conducted a visual world experiment and recorded the eye movements of 35 native Dutch participants (all proficient users of English) as they listened to English sentences while looking at displays featuring four objects. Each sentence contained a target word. On filler trials ( $n = 22$ ), the visual referent depicting the target word was present, along with three unrelated distractors. On experimental trials ( $n = 22$ ), the picture of the spoken target (e.g., 'wizard') was absent. Instead, the display featured an English competitor, overlapping with the spoken English target in phonological onset (e.g., 'window'), a Dutch competitor, whose Dutch (but not English) word name overlapped with the English target in phonological onset (e.g., Dutch 'wimpel', English: 'pennant'), and two unrelated distractors (e.g., 'bike', 'jeans'). Half of the sentences was masked by speech-shaped noise at a signal-to-noise ratio (SNR) of +3 dB. This SNR was chosen based on an earlier Dutch study (Scharenborg et al., 2018) such that intelligibility was reduced but floor effects were avoided. The other half of the sentences were presented in the clear. Participants previewed the displays for three seconds before target word onset. Eye movements were analyzed using logistic GAMMs (generalized additive mixed models).

Our analyses showed that participants fixated the target objects on filler trials shortly after they were mentioned. Target fixations occurred later when the signal was masked by background noise. On experimental trials, we observed fixation biases for English onset competitors (relative to the distractors) in the clear and in noise demonstrating that participants engaged in non-native phonological onset competition. In contrast, the likelihood of increased looks to the Dutch onset competitors varied across listening conditions: Replicating earlier research (Spivey & Marian, 1999), participants looked at the Dutch competitors in the clear condition when hearing the English target word, reflecting the (partial) activation of their native lexicon (i.e., interlingual competition). However, the likelihood of looks to the same objects was substantially reduced when speech was masked by background noise (Panel D in Figure 1).

Our data thus demonstrate that the presence of background noise reduces the likelihood of interlingual competition during non-native listening, casting new light on the situational influences on non-selective lexical access. Interestingly, while earlier research showed that noise enhances *intralingual* phonological competition (in both native and non-native listeners, e.g., Scharenborg et al., 2018), the present data suggest the opposite for the involvement of one's native language during non-native speech recognition. We believe that our results are most compatible with the notion that hearing non-native speech in noise enforces a re-allocation of cognitive resources in the service of achieving the present task goal. This happens at the expense of the task-irrelevant co-activation of one's native language.



**Figure 1.** *Panel A:* Example of a visual stimulus used on experimental trials. English target was ‘wizard’; ‘window’ was English phonological competitor; ‘pennant’ (Dutch: ‘wimpel’) was Dutch phonological competitor; ‘bike’ and ‘jeans’ were unrelated distractors. *Panel B:* Results of logistic additive mixed-model for filler items (left: clear trials, right: noise trials). *Panels C and D:* Results of logistic additive mixed-models for English and Dutch phonological competitors (experimental items; left: clear trials, right: noise trials). As a shorthand, fixation biases can be considered meaningful when confidence intervals (gray ribbons) do not cross zero.

## References

- Dijkstra, T., Wahl, A., Buytenhuijs, F., Van Halem, N., Al-Jibouri, Z., De Korte, M., & Rekké, S. (2019). Multilink: a computational model for bilingual word recognition and word translation. *Bilingualism: Language and Cognition*, 22(4), 657-679.
- Scharenborg, O., & Os, M. (2019). Why listening in background noise is harder in a non-native language than in a native language: A review. *Speech Communication*, 108, 53-64.
- Scharenborg, O., Coumans, J. M., & van Hout, R. (2018). The effect of background noise on the word activation process in nonnative spoken-word recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 44(2), 233.
- Spivey, M. J., & Marian, V. (1999). Cross talk between native and second languages: Partial activation of an irrelevant lexicon. *Psychological science*, 10(3), 281-284.