Slower lexical processing for bilinguals may involve different mechanisms depending on target language age of acquisition

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Competing hypotheses exist to explain why lexical processing is slower for bilinguals compared to monolinguals. The frequency-lag hypothesis (Gollan et al., 2011) holds that lexical processing is slower for bilinguals because of weaker lexical representations, due to bilinguals using each language less than their monolingual peers. This has received support from studies of lexical recognition indicating a moderating effect of word exposure operationalized as lexical frequency, with larger differences between monolinguals and bilinguals for lower versus higher frequency items (Schmidtke, 2016). An alternative hypothesis, rooted in language co-activation (Marian & Spivey, 2003), holds that bilingual lexical processing is slower due to greater lexical competition from more lexical items across a bilingual's languages. This has received support from findings that word exposure operationalized as lexical frequency or participant age did not moderate differences in word production times between monolinguals and bilinguals (Sullivan et al., 2018).

We contend that both hypotheses may be correct but their applicability may depend on age of acquisition (AoA) of the target language. In this study, a large sample of monolingual (n = 3059) and bilingual adults recognized English words presented in background noise at two signal-to-noise ratios (SNR). All bilinguals acquired English either as a second language or as a second first language. Simultaneous bilinguals (n = 462) were those with English AoA before age four; early bilinguals (n = 185) were those with English AoA between ages four and 12; and late bilinguals (n = 97) were those with English AoA after age 12. Each participant heard 40 target words randomly drawn from a list of 274 words. Targets were presented at either -2 or -6 dB SNR. Word frequency was determined by the Zipf value (van Heuven et al., 2014) based on the SUBTLEX-US corpus (Brysbaert & New, 2009). Approximately 43% of the target items were low frequency words (Zipf value < 4), while 57% were high frequency words (Zipf value >= 4).

Log-transformed response time (RT) for correct trials was modeled using linear mixed-effects regression in R. The maximal model included a four-way interaction between target frequency (low/high) x group (monolingual/simultaneous bilingual/early bilingual/late bilingual) x SNR (-2/-6 dB) x listener current age and a non-interacting effect of trial number. The best-fitting model was identified by backwards stepwise elimination of model terms using buildmer (Voeten, 2022). This approach involved two operationalizations of exposure to target words (lexical frequency, participant current age). Differences between the monolingual and bilingual groups in the effect of either factor on RT would provide support for the frequency-lag hypothesis.

In the best-fitting model RTs were slower for words presented at -6 dB SNR (b = 0.037, p < .001). RTs improved across trials (b = -0.020, p < .001) but slowed with increasing current age (b = 0.026, p < .001). The effect of current age did not differ between groups, evidenced by removal of the current age x group term. RTs were slower for bilinguals than monolinguals and slowed across bilingual groups with increasing English AoA (p < .05 all group-wise comparisons). RTs for monolinguals were slower for low versus high frequency words (b = 0.075, p < .001). Crucially, the effect of frequency on RT did not differ between monolinguals and simultaneous bilinguals (b = 0.005, p = 0.34). However, compared to monolinguals, RT increases for low frequency words were exacerbated for early bilinguals (b = 0.021, p = 0.014) and late bilinguals (b = 0.031, p = 0.009). Figure 1 shows model estimates of this interaction. These findings suggest that reduced exposure to English affects lexical processing speed in early and late bilinguals. For simultaneous bilinguals, slower lexical processing may be more consistent with an account based on increased lexical competition.

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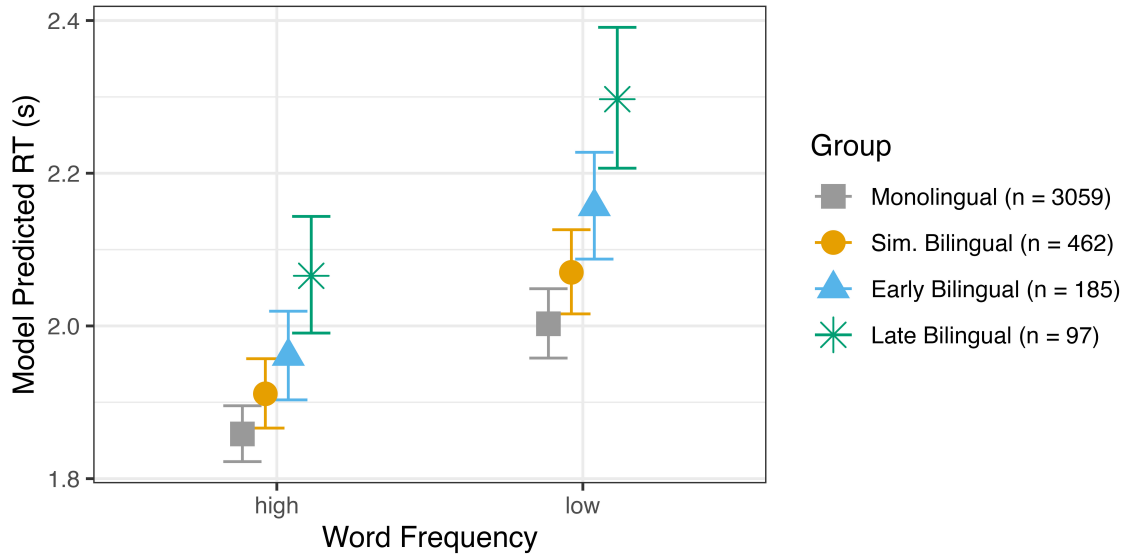
Figures

Figure 1: Model predicted response time by language group and word frequency.



Note: RT = response time; Sim. Bilingual = Simultaneous Bilingual. Error bars = 95% confidence intervals. RT estimates are transformed into seconds to aid interpretation.

References

Brysbaert, M., & New, B. (2009). Moving beyond Kučera and Francis: A critical evaluation of current word frequency norms and the introduction of a new and improved word frequency measure for American English. *Behavior Research Methods*, *41*(4), 977–990.

Gollan, T. H., Slattery, T. J., Goldenberg, D., Van Assche, E., Duyck, W., & Rayner, K. (2011). Frequency drives lexical access in reading but not in speaking: The frequency-lag hypothesis. *Journal of Experimental Psychology: General*, *140*(2), 186.

Marian, V., & Spivey, M. (2003). Bilingual and monolingual processing of competing lexical items. *Applied Psycholinguistics*, *24*(2), 173–193.

Schmidtke, J. (2016). The bilingual disadvantage in speech understanding in noise is likely a frequency effect related to reduced language exposure. *Frontiers in Psychology*, *7*.

Sullivan, M. D., Poarch, G. J., & Bialystok, E. (2018). Why is lexical retrieval slower for bilinguals? Evidence from picture naming. *Bilingualism: Language and Cognition*, *21*(3), 479–488.

van Heuven, W. J. B., Mandera, P., Keuleers, E., & Brysbaert, M. (2014). SUBTLEX-UK: A new and improved word frequency database for British English. *Quarterly Journal of Experimental Psychology*, *67*(6), 1176–1190.

Voeten, C. C. (2022). *buildmer: Stepwise elimination and term reordering for mixed-effects regression* (v. 2.7) [Computer software]. https://CRAN.R-project.org/package=buildmer