

Frequency, predictability & lexical quality effects: individual differences in reading & proofreading

Sara Milligan & Elizabeth R. Schotter (University of South Florida)
smilliga@mail.usf.edu

Plenty of evidence suggests that low frequency and unpredictable words receive increased reading times (e.g., gaze durations, GD), but it is less clear how the underlying processes that give rise to these effects contribute to reading skill across individuals (Rayner & Duffy, 1986; Kretzschmar, Schlesewsky & Staub, 2015). When predictability and frequency are experimentally crossed, the effects are additive (i.e., no interaction; Ashby, Rayner, & Clifton, 2005; see Staub, 2015), suggesting that processing a word's contextual fit is independent from processing its surface form. Both effects vary across individuals, potentially as a function of linguistic skill (Ashby, Rayner, & Clifton, 2005). For example, older individuals exhibit both larger frequency effects and predictability effects (Rayner, Reichle, Stroud, Williams & Pollatsek, 2006). Although low frequency and low predictability have additive effects overall, the relative roles of contextual fit in the sentence and lexical form across individuals are not necessarily equivalent. Readers with impoverished lexical representations may use context more than stronger readers as a compensatory strategy to facilitate comprehension (Frith, 2017).

To further investigate the relationships between an individual's sensitivity to frequency and predictability, we turned to a manipulation of reading goals, which should modify sensitivity to these word properties. Past comparisons of eye movements during reading for comprehension and checking surface-form of words in sentences suggest that word frequency effects on gaze duration are eliminated during visual search (Rayner & Raney, 1996) but are more pronounced during proofreading for spelling errors. (Kaakinen & Hyönä, 2010). However, pronounced predictability effects during proofreading only occur when processing sentence context is necessary for error detection (i.e., when spelling errors produce real, but contextually anomalous words; Schotter, Bicknell, Howard, Levy, & Rayner, 2014).

In a reanalysis of Schotter et al. (2014), we investigated correlations between frequency and predictability effects for individual readers across tasks. Sentences with frequency and predictability manipulations (separate stimuli) had no errors; another set served as fillers in the reading task and contained spelling errors in the proofreading tasks (pronounceable & unpronounceable nonwords in Exp 1, contextual anomaly words in Exp 2). We expected better readers to show smaller frequency effects in reading and smaller slowdowns for low frequency words in proofreading due to superior lexical knowledge. We also expected worse readers to show larger predictability effects in reading because of compensatory reliance on context, but not in proofreading that did not depend on context.

During reading, there was a negative correlation between frequency and predictability effects on GD among all individuals ($N = 96$; $r = -0.277$, $p < 0.01$; Figure 1). In proofreading in Exp 1 ($N = 48$), which did not require contextual processing, there was a positive correlation between frequency and predictability effects ($r = 0.299$, $p = 0.04$; Figure 2). This supports the idea that worse surface-form processing leads to more reliance on sentence context when the task requires high-level comprehension (Frith, 2017), but suggests that it does not extend to a scenario involving checking for surface-level errors.

We also investigated the relationship between reading speed during comprehension (i.e., GD in on target words in filler sentences) and the ability to detect errors of different types. Reading speed was negatively correlated with both sensitivity to orthographic and phonological lexicality during proofreading (i.e. the ratio of GD on pronounceable/unpronounceable nonwords in Exp 1; $r = -0.354$, $p = 0.01$; Figure 3) and sensitivity to word frequency when detecting semantic anomalies (i.e., the ratio of GD on error words that are lower/higher frequency than the correct word in Exp 2; $r = -0.347$, $p = 0.02$; Figure 4). These patterns suggest that worse

readers rely more on context because they are less sensitive to not only orthographic and phonological anomalies, but also semantic anomalies.

Figure 1. Correlation between the frequency effect (low – high frequency) and predictability effect (low – high predictability) on gaze duration during reading for comprehension in both experiments (96 subjects).

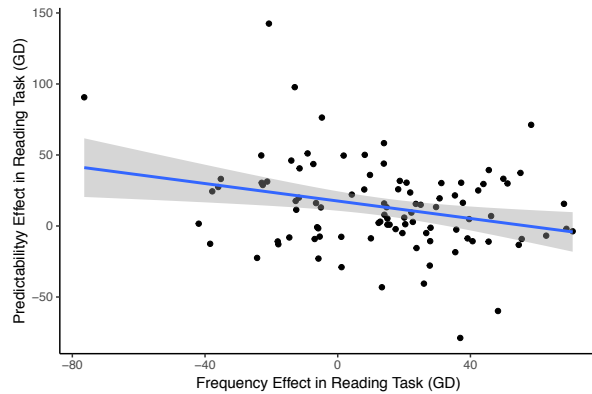


Figure 2. Correlation between the frequency effect (low – high frequency) and predictability effect (low – high predictability) on gaze duration during proofreading in Experiment 1 (48 subjects).

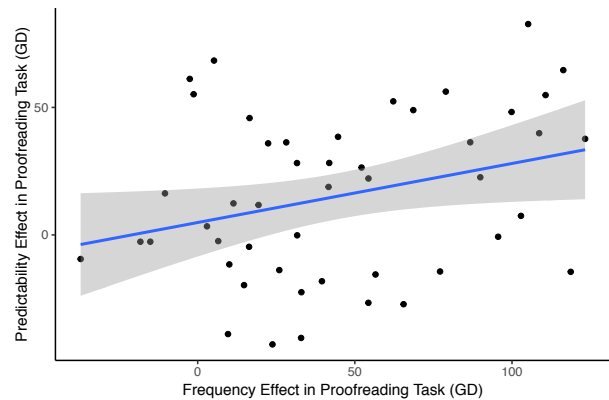


Figure 3. Correlation between gaze duration on fillers during reading and the ratio of gaze duration on nonword errors that are pronounceable and unpronounceable during proofreading in Experiment 1 (48 subjects).

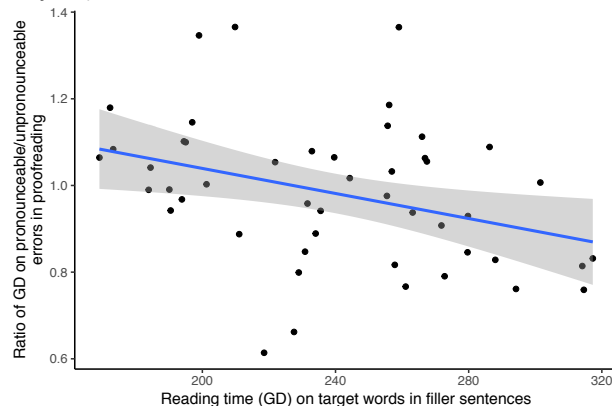
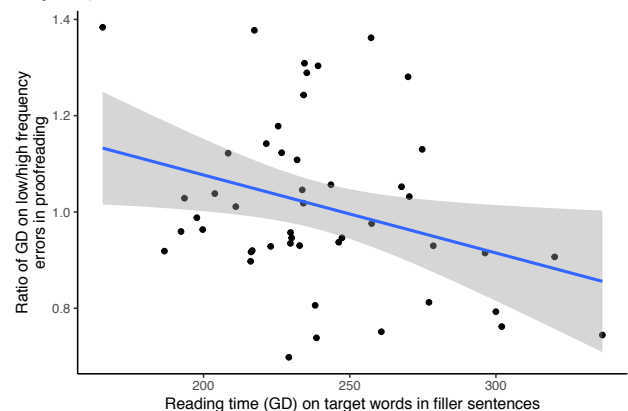


Figure 4. Correlation between gaze duration on fillers during reading and the ratio of gaze duration on error words that are lower/higher frequency than the correct word during proofreading in Experiment 2 (48 subjects).



References

- Ashby, J., Rayner, K., & Clifton, C. (2005). Eye movements of highly skilled and average readers: Differential effects of frequency and predictability. *Q J Exp Psychol A*, 58(6), 1065-1086.
- Frith, U. (2017). Beneath the surface of developmental dyslexia. In *Surface dyslexia* (pp. 301-330). Routledge.
- Kaakinen, J. K., & Hyönä, J. (2010). Task effects on eye movements during reading. *J Exp Psychol Learn Mem Cogn*, 36(6), 1561.
- Kretzschmar, F., Schlesewsky, M., & Staub, A. (2015). Dissociating word frequency and predictability effects in reading: Evidence from coregistration of eye movements and EEG. *J Exp Psychol Learn Mem Cogn*, 41(6), 1648.
- Rayner, K., & Duffy, S. A. (1986). Lexical complexity and fixation times in reading: Effects of word frequency, verb complexity, and lexical ambiguity. *Memory & cognition*, 14(3), 191-201.
- Rayner, K., & Raney, G. E. (1996). Eye movement control in reading and visual search: Effects of word frequency. *Psychonomic Bulletin & Review*, 3(2), 245-248.
- Rayner, K., Reichle, E. D., Stroud, M. J., Williams, C. C., & Pollatsek, A. (2006). The effect of word frequency, word predictability, and font difficulty on the eye movements of young and older readers. *Psychology and aging*, 21(3), 448.
- Schotter, E. R., Bicknell, K., Howard, I., Levy, R., & Rayner, K. (2014). Task effects reveal cognitive flexibility responding to frequency and predictability: Evidence from eye movements in reading and proofreading. *Cognition*, 131(1), 1-27. Downloaded from the Keith Rayner Eye Movements in Reading Data Collection: <http://dx.doi.org/10.6075/J0X63JTD>