

1. Introduction

- Eye movements are a window into the reading process.
- However, if we examine the eye-movement literature, we find that most results come from a small number of countries and involve reading in a limited number of languages.

Illustrating the eye-movement gap

- Data from Scopus: Searching for “eye” and “track(er/ing)” or “movement(s)” and “reading” in the title, abstract, and keywords (Angele & Duñabeitia, 2024)
- Publications from 1974 to 2024
- Counting country affiliations by author (publications can have multiple authors and author affiliations), excluding affiliations with missing country names

Publications over time

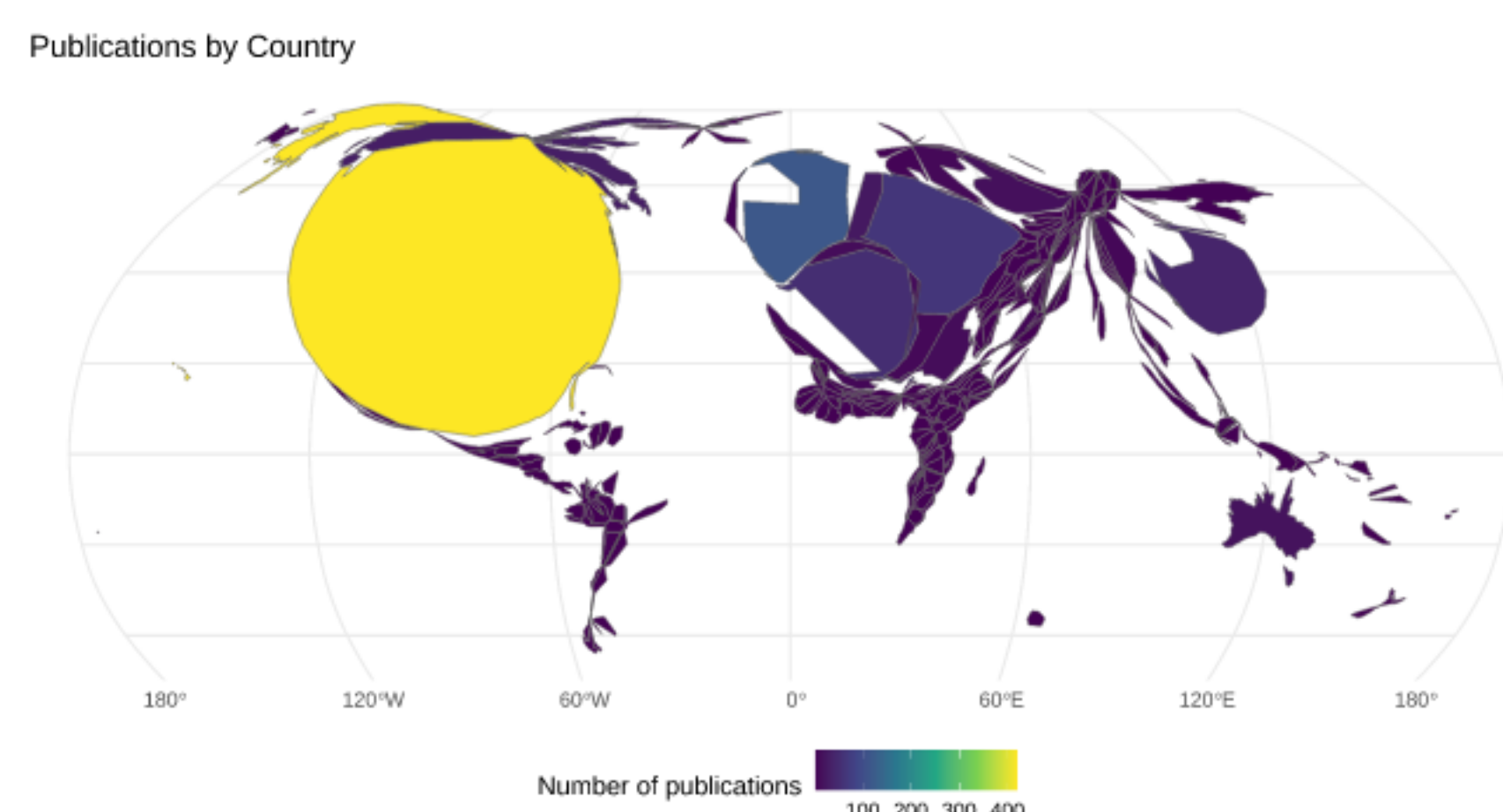


Figure 1: Cartogram of publications from 1974 to 2000

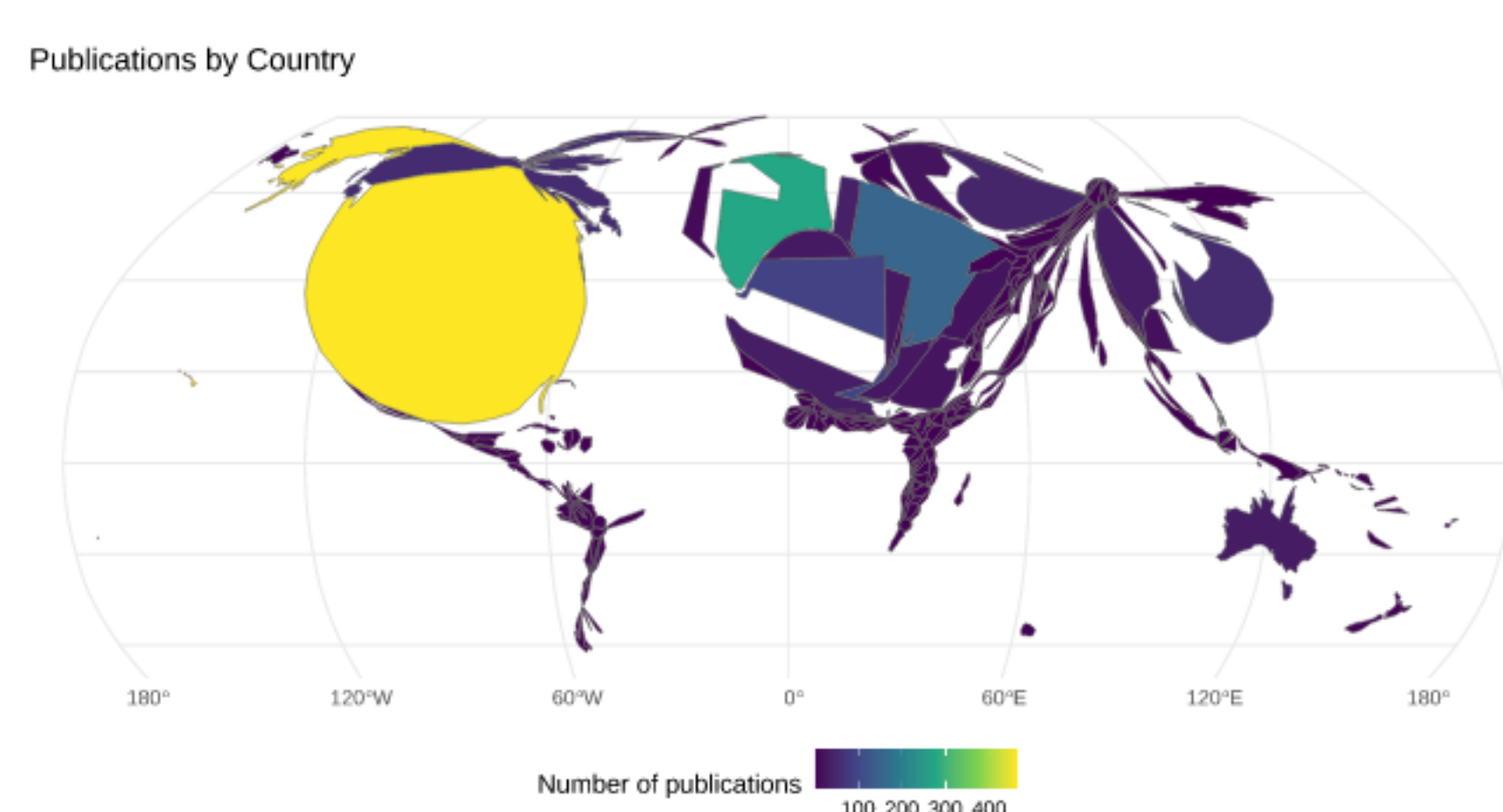


Figure 2: Cartogram of publications from 2001 to 2010

Publications over time: 2011 – 2020

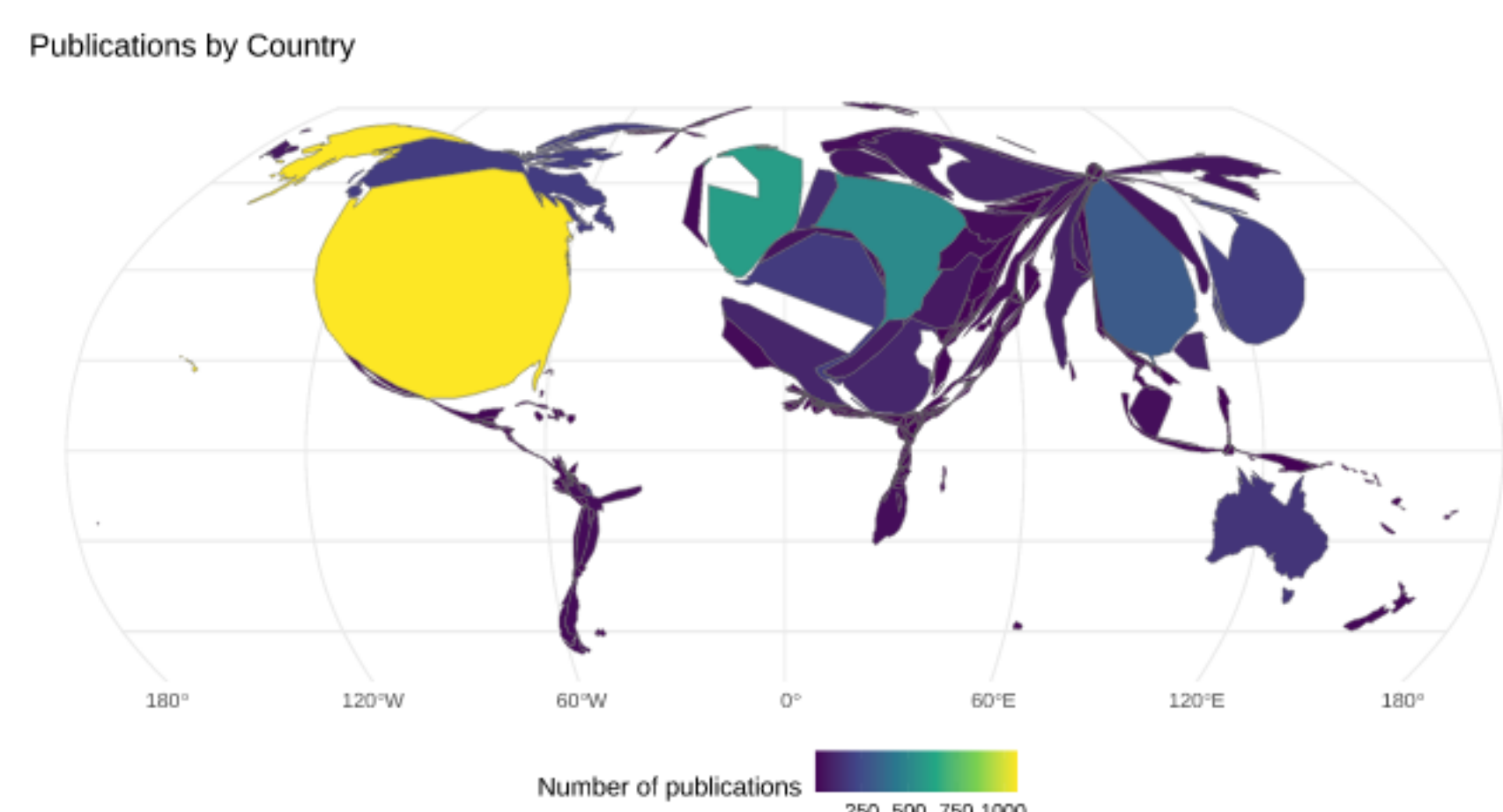


Figure 3: Cartogram of publications from 2011 to 2020

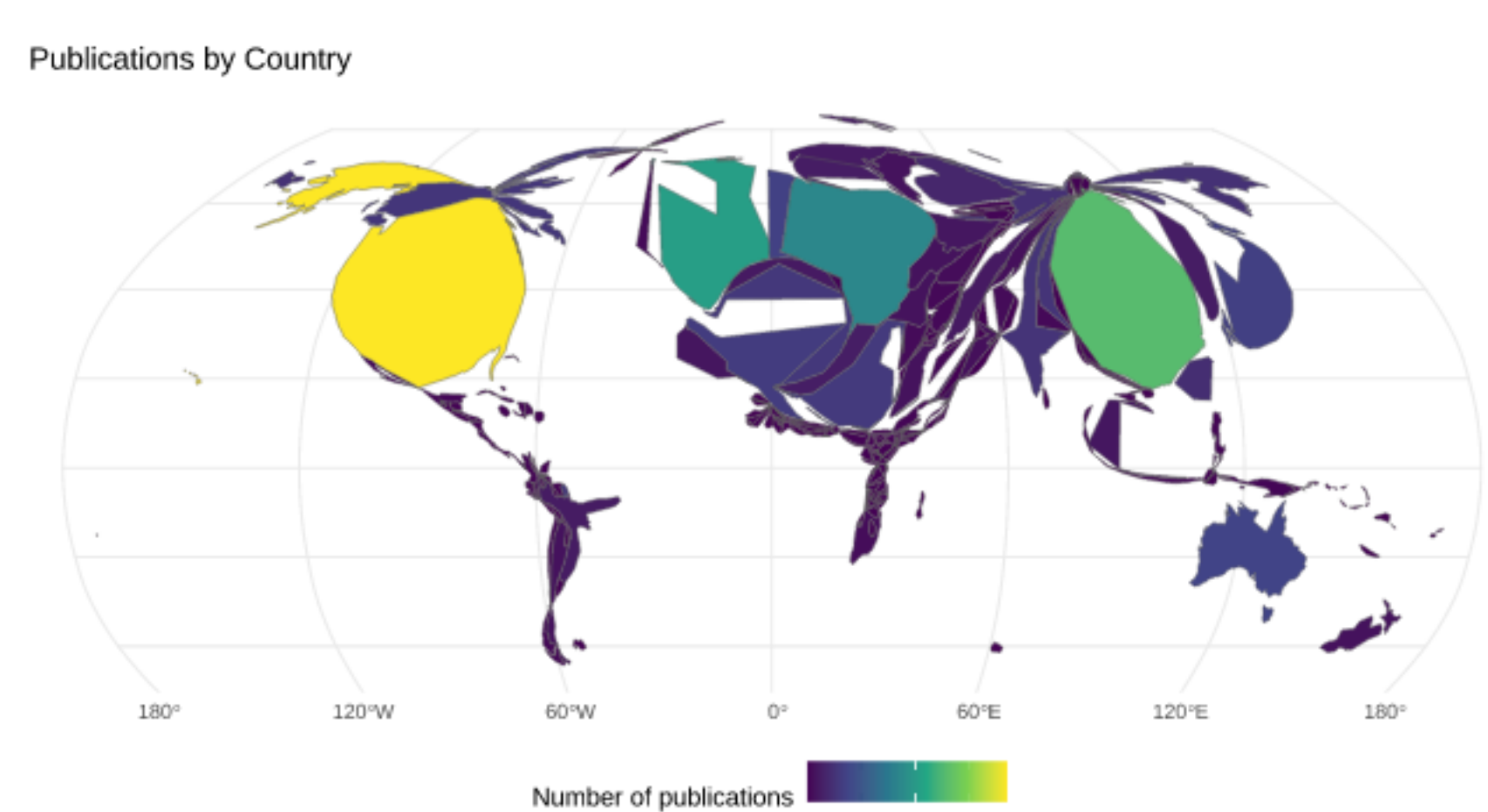


Figure 4: Cartogram of publications from 2021 to 2024

What are we missing?

- General issue of WEIRD research (Henrich et al., 2010): Western participants may not be representative of all readers or even the majority of readers
- English, German, French, Spanish, Italian etc. are similar languages in many respects and all share the same writing system

Why is there so little eye-movement research except in a few countries?

- Most expensive component: High-speed, high-resolution cameras
- Sampling rate is a key bottleneck
- Can we study reading at lower sampling rates?

2. Our study

Our approach

- We take a practical approach: Which is the lowest sampling rate that allows us to find evidence of cognitive processing?
- We need a benchmark effect – a phenomenon that is well-studied and whose existence (and effect size) is clear
- The word frequency effect on fixation duration is ideal for this

Method

- 32 participants read 400 sentences in Spanish
- Eye movements are recorded by an SR Research Eyelink Portable Duo
- Four sampling rates 250 Hz, 500 Hz, 1000 Hz, and 2000 Hz (100 sentences each)
- Frequency manipulation: each sentence has a target word that was manipulated to be either
 - high frequency (mean frequency 47/million)
 - low frequency (mean frequency 2/million)
- The context up to the target word was identical for both versions of the sentence.
 - Context after the target word was allowed to vary.

3. Results

Trials

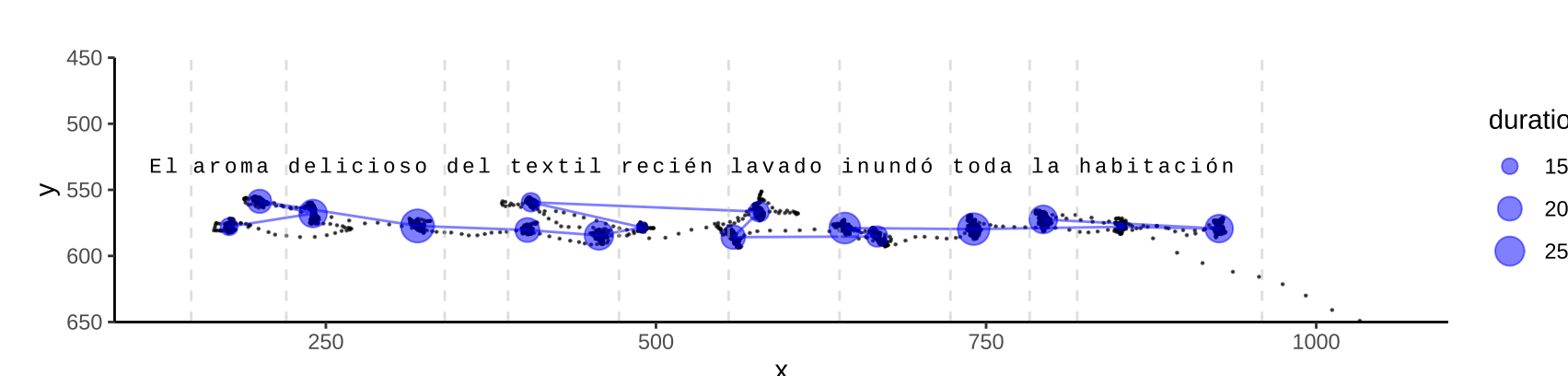


Figure 5: Example trial at 1000 Hz

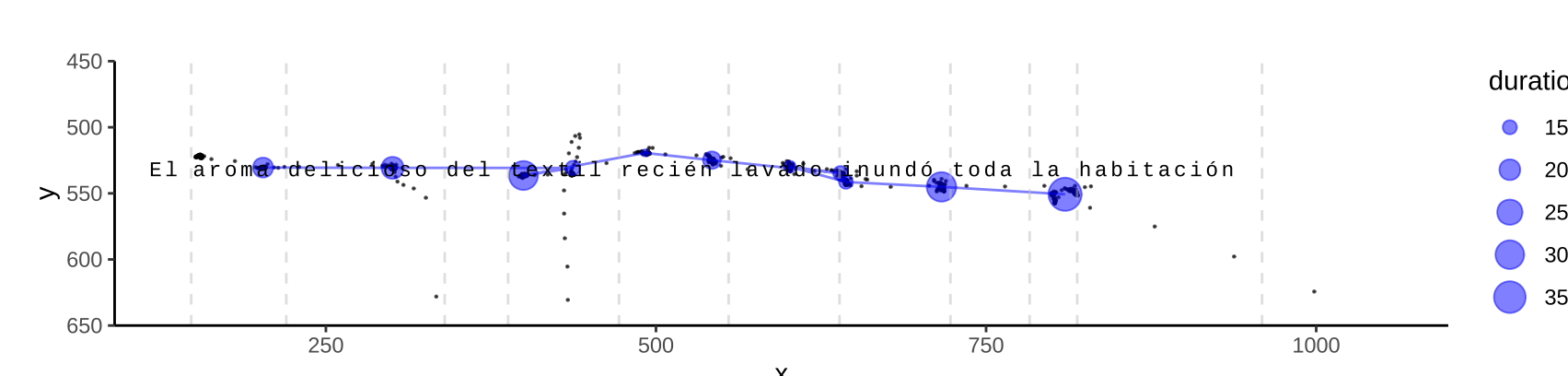


Figure 6: Example trial at 250 Hz

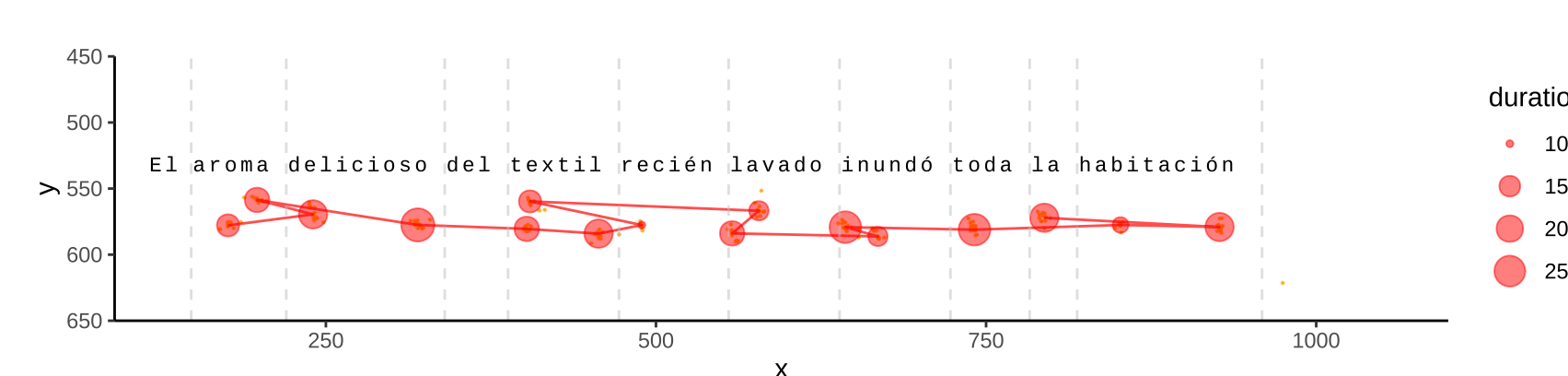


Figure 7: 1000 Hz trial downsampled to 50 Hz

Bayesian LMMs

Original data:

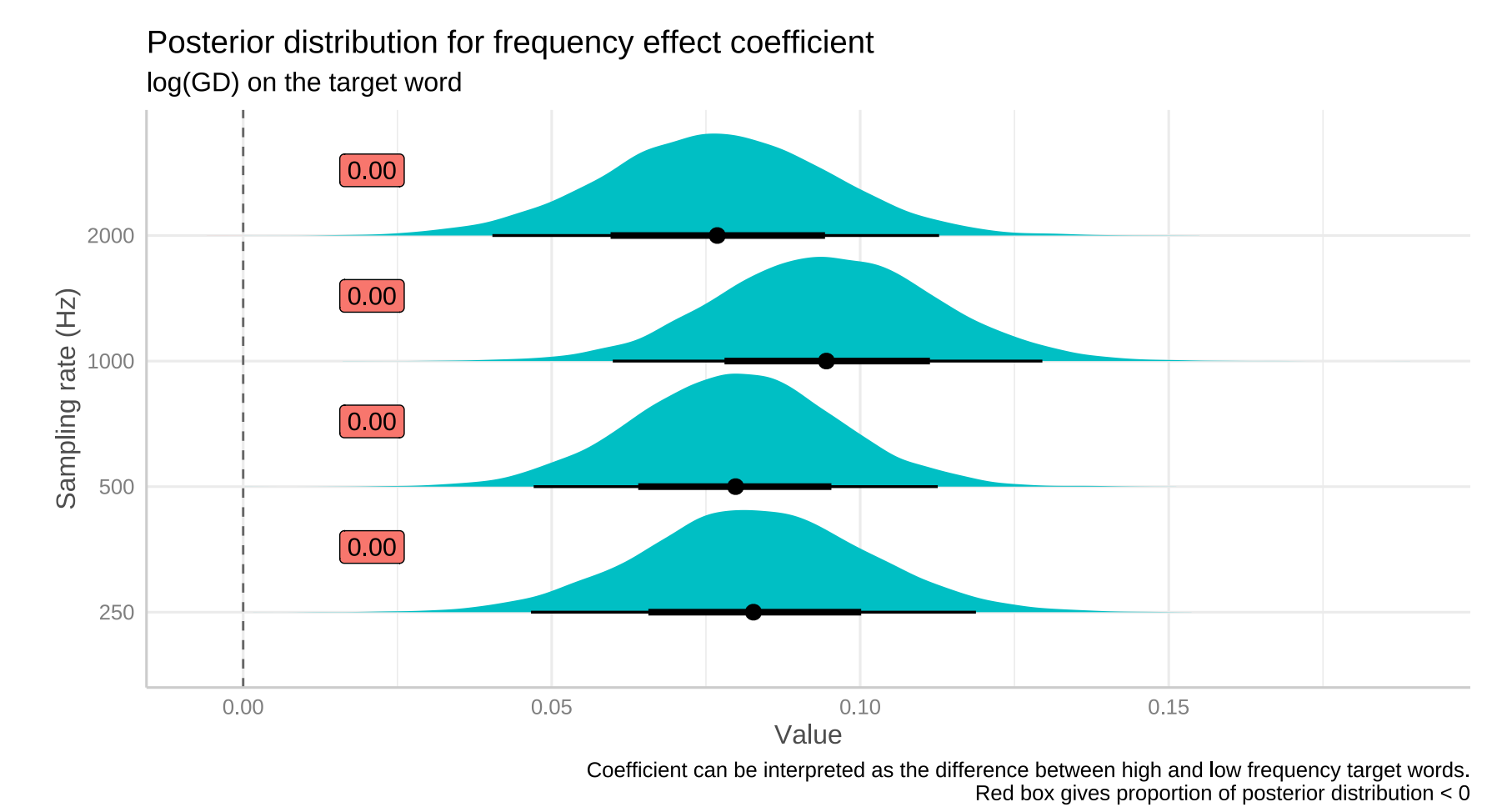


Figure 8: Evidence for frequency effect in GD on the target word by sampling rate (Eyelink)

Downsampled data:

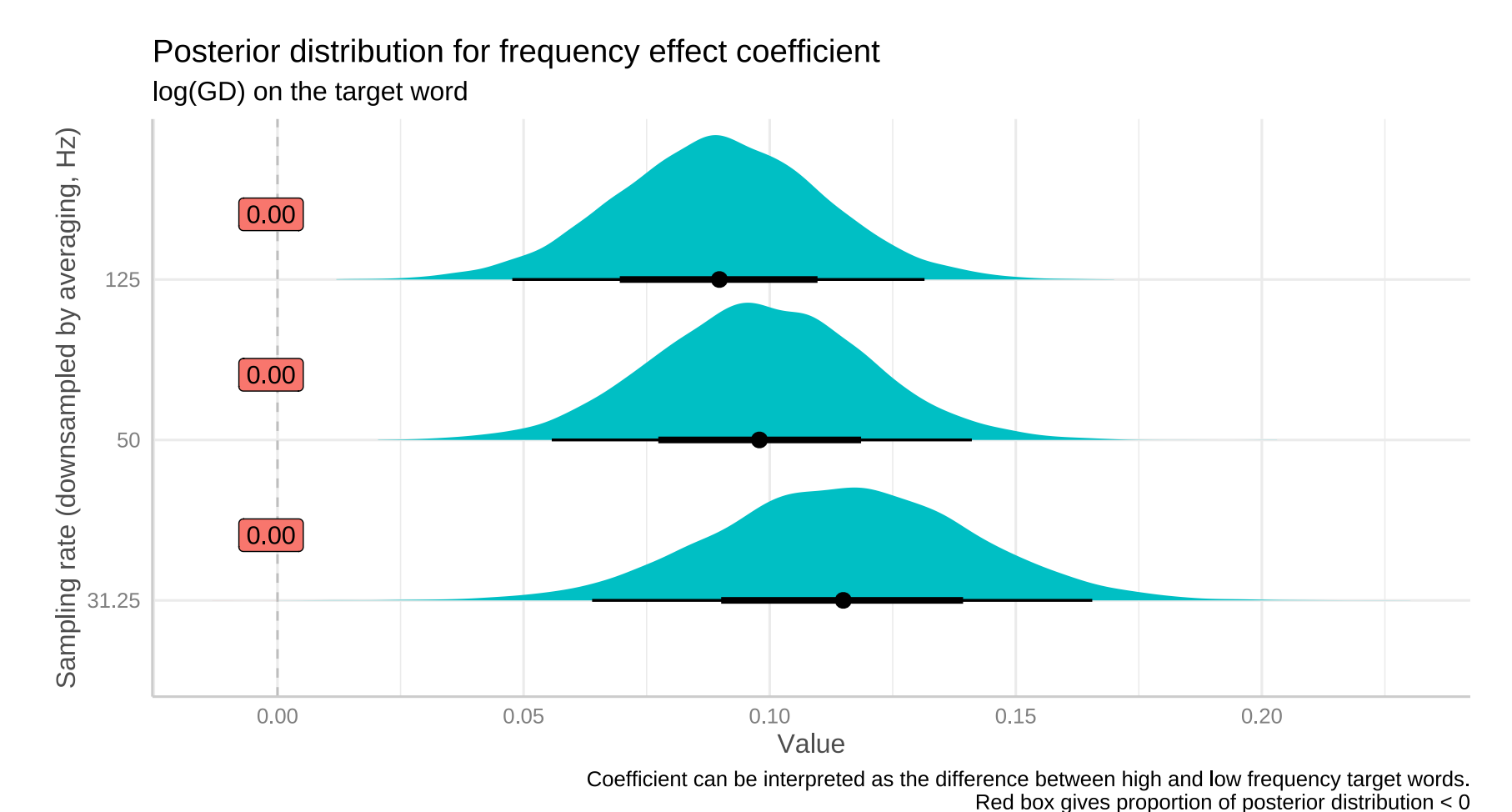


Figure 9: Evidence for frequency effect in GD on the target word by sampling rate (downsampled data, 100 sentences per participant)

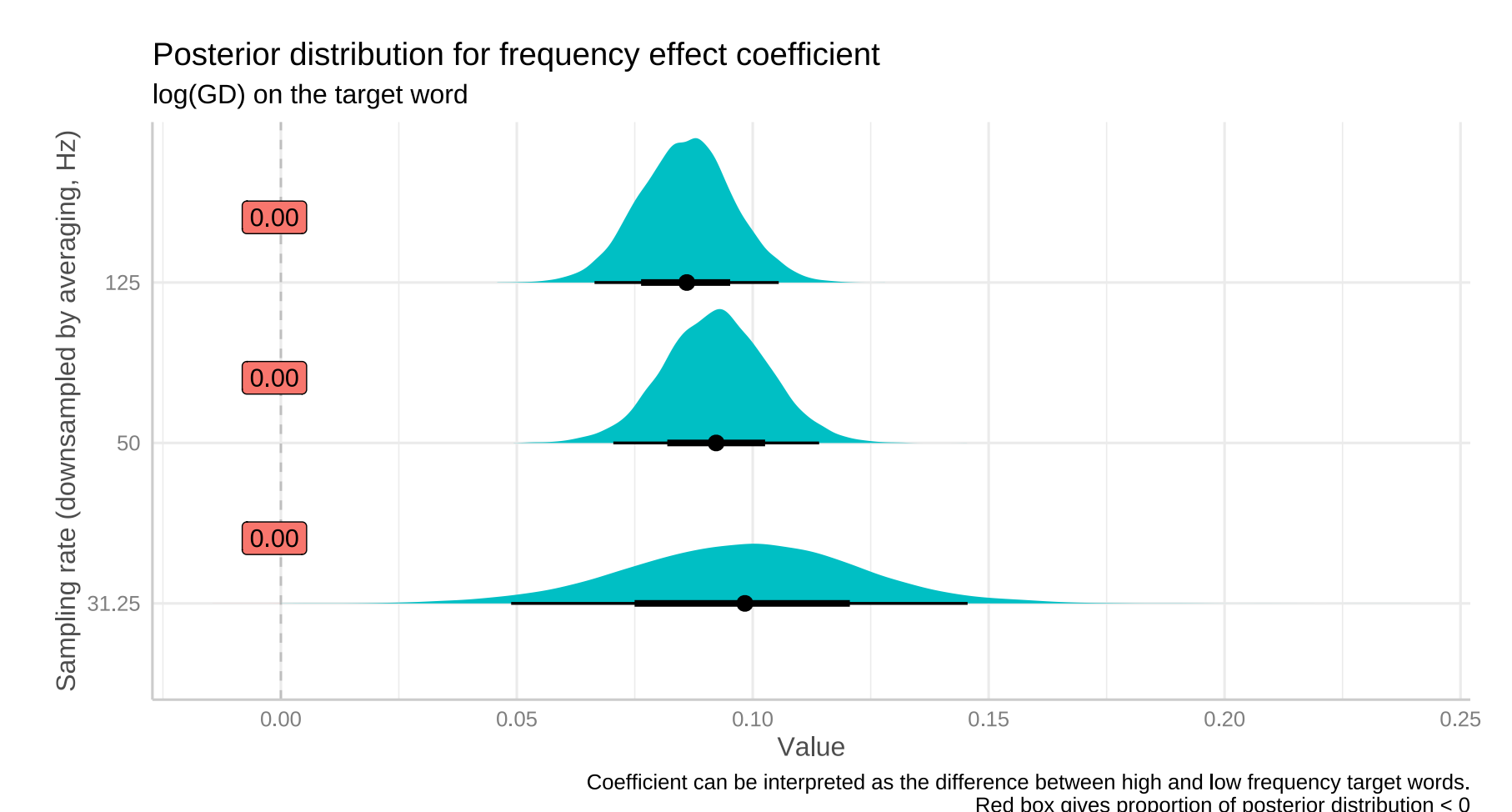


Figure 10: Evidence for frequency effect in GD on the target word by sampling rate (downsampled data, 400 sentences per participant)

4. Discussion

- Apparently, not even 30 Hz is too low to detect word frequency effects.
- If you want to use affordable eye-trackers to study reading:
 - target effects that are large enough
 - choose aggregate measures (GD, TVT, go-past time, etc.)
 - plan to use a large sample
 - consider running a pilot study with a known effect (word frequency) and do a power analysis based on the results

Bibliography

Angele, B., & Duñabeitia, J. A. (2024). Closing the eye-tracking gap in reading research. *Frontiers in Psychology*, 15. <https://doi.org/10.3389/fpsyg.2024.1425219>

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). Most people are not WEIRD. *Nature*, 466(7302), 29–30. <https://doi.org/10.1038/466029a>