Towards a computational model of Dyslexia
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Summary

Dyslexics' automatic reference on global context is impaired. This impairment leaves them susceptible to noisy observations. Their usage of recent observations seems intact. Dyslexics' deficient regularity utilization stems from deficient prior representation.

Results

Dyslexics' impaired utilization of experiment's statistics

Continuous trials' statistics is boost performance, and the Dyslexics' benefit gain less from local distribution.

Dyslexics' weighting of previous information is suboptimal

Contexts compare for their internal noise level [a] by optimal weighting of previous representations (q). Grows their high level of internal noise (high-q). Dyslexics underweigh previous representations (low-q).

Dyslexics' automatic representation of prior distribution is impaired

The ERP component P2 (detailed in gray, yellow traces) enlarged for the first time is enhanced in Dyslexics trials among Controls. Not among Dyslexics.

Dissociating prior from regularity

We used a mixed protocol of Reference 1st Trials (odd Trials: first tones repeat across Melodic) and Reference 2nd (even Trials: second tones repeat). Regularity should improve performance in both type of trials. Contrasts towards the mean should improve performance in Reference 1st Trials and harms performance in Reference 2nd Trials.

Dissociating between a local and a global deficit

Prior can be divided to two sources: Global mean of all previous stimuli Local: mean recent stimuli. It subly affects sensor represents the effects of these sources combine in and independent. We used model-based neural-linear regressor to test the discriminant response.

Global representation is impaired in Dyslexia

Dyslexics' utilization of cumulative prior distribution is weaker than Controls, while their short-range utilization is intact.

Using SAD to predict individual responses in the tasks, we found that Dyslexics differ from Controls only in the magnitude of global effect on performance (p < 0.05).

Discussion

Suboptimal weighting of prior representation implies that Dyslexics has an additional noise source (memory instability).

Reading - a highly demanding perceptual task - relies heavily on context and its delayed predictions. Dyslexic's slower and less accurate reading stems from inadequate use of context, which can be a consequence of inadequate representation of priors.

Bayesian account for Anchoring Deficit

In this reference protocol, Control gain from regularity relies on the contribution towards the mean anchoring anchor of the distribution (Anchoring Deficit) leaves them deficient representation of prior distribution.

When the lesion is to the reference and since the mean. Control's performance improves more than Dyslexics. Control's task is to evaluate the reference in a condition (200 ms). Wise et al. (2010). PLoS Comput Bio. At trial.

Representation of the first tone (t1) is degraded compared to the second tone (t2)

Main effect: The fine tone is closer to the mean frequency than the second tone. The anchor effect on the mean decreases the perceived difference between the fine tones and improves performance.

Main effect: The fine tone is farther from the mean frequency than the coarse tone. The anchor effect on the mean decreases the perceived difference between the fine tones and improves performance.

Main effect: Contextual tones have an ambiguous effect on performance.

Implicit Memory Model - heuristic approximation of Bayesian inference

Instead of comparing the two tones, we compare the second tone with the accumulative representation of all previous tones. This linear model is sufficient to yield contrast toward the mean.

* Dependent on the memory component:
    1. lose of memory
    2. weighting of previous representation.