The role of bias in a letter acuity identification task: a noisy template model

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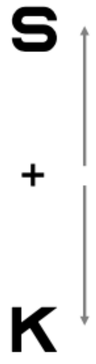
BACKGROUND

- Previous studies suggest biases towards certain letters in acuity measurements [1-4]
- Here we measured letter identification performance against letter size, spanning the resolution threshold, for 10 Sloan letters at central and paracentral (±3˚ eccentricity) visual field locations
- The aim of the current study was to develop a model to quantify such biases

METHODS

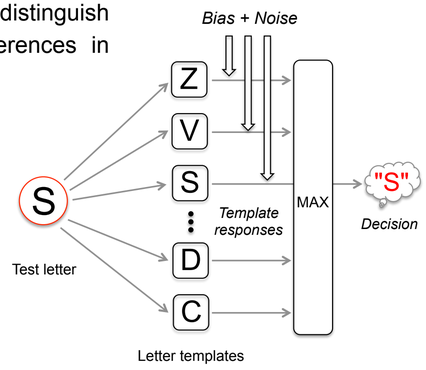
- N=10 (naïve subjects)
- Visual acuity measurements for Sloan letters
- Central and 3˚ eccentricity in upper and lower visual field (vertical meridian).

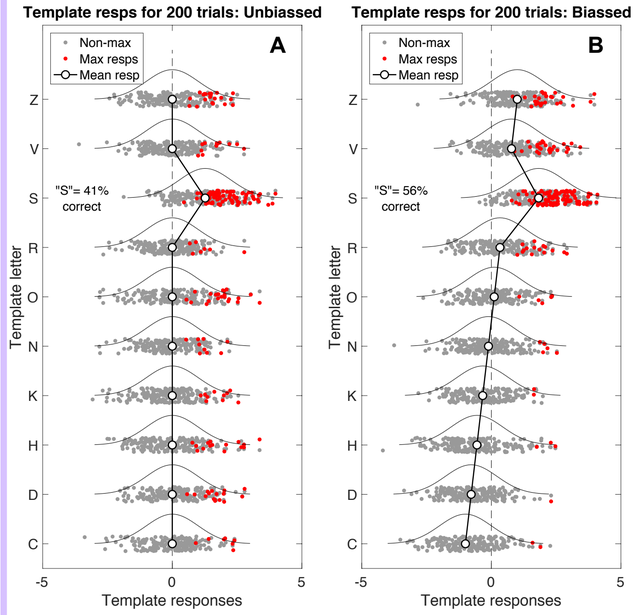


- Data of the psychometric functions were split into three groups:
  - The top 2 (most used) letters
  - The bottom 2 (least used)
  - The 6 letters with intermediate usage

MODEL

- A “noisy template” model was derived to distinguish biases from differences in visibility

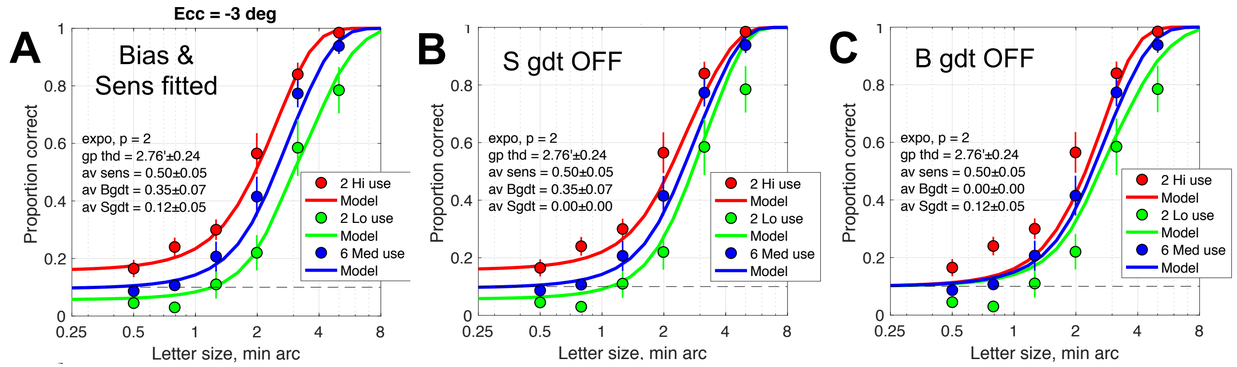




- The Noisy Template Model:
  - **A** without biases
  - **B** with biases
- Biases (or sensitivity) are ordered from negative to positive with a mean of zero.
- Free model parameters are: Baseline sensitivity, Bias gradient (Bgdt), Sensitivity gradient (Sgdt)

RESULTS

- Results show that observers had different individual letter biases consistent across the whole range of sizes.
- Preferred letters were called more frequently and others less frequently than expected (group averages from 4% to 20% across letters, where the unbiased rate was 10%)
- The over- and under-calling decreased at larger letter sizes, but was well-predicted by templates having fixed additive response bias: with stronger inputs (larger letters) there is less opportunity for bias to influence which template gives the biggest response



- **A** fit of the two-factor (bias and sensitivity) model
- **B** the model was re-computed with Sgdt = 0.
- **C** the model was re-computed with Bgdt = 0.
- Comparison of row **B** with **C** strongly suggests that:
  - Bias (in row **B**) was the major contributing factor to the variation in letter usage
  - Variation in sensitivity across letters (row **C**) played a much smaller role, mainly at the larger letter sizes at the periphery .

CONCLUSION

- Results show that biases are responsible for the observed differences in letter usage in the letter acuity measurements with Sloan letters
- In the future, it will be important to investigate whether the observed response biases are likely to have a meaningful effect on clinical measures of visual performance

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