EVALUATING THE PERFORMANCE OF THE QUICK CSF METHOD IN DETECTING CSF CHANGES: AN ASSAY CALIBRATION STUDY

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Introduction

Contrast sensitivity function (CSF) provides a comprehensive characterization of spatial vision, has shown promise for monitoring the changes in functional vision that accompany eye disease or its treatment. But long testing times prevent its psychophysical assessment in clinical applications. Recently, Lesmes, et al., (2010) developed the quick CSF method, which uses a Bayesian adaptive procedure (Watson & Pelli 1983) to estimate CSF in a fast and precise way.

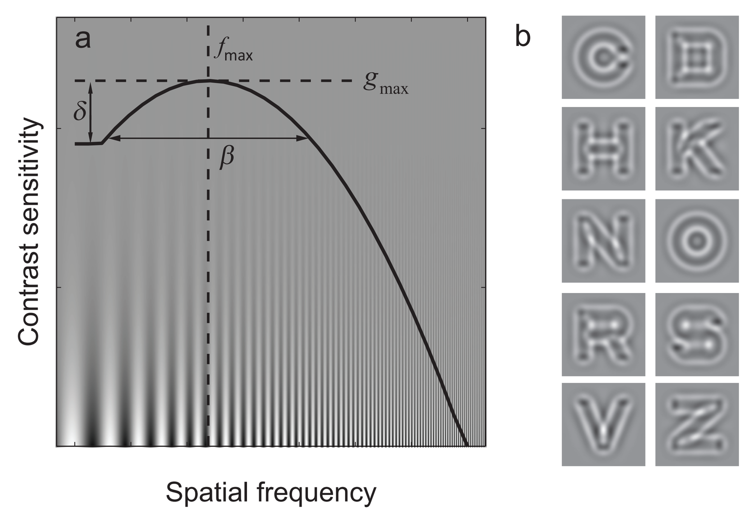

Figure 1: (a) The contrast sensitivity function (CSF) and the parametric model that describes it. (b) The stimuli used in the experiment.

Aims

To develop and evaluate metrics for detecting changes in the CSF using quick CSF method.

Methods

A 10-letter identification task was used to assess CSF in three luminance conditions in 112 naïve observers with self-reported normal vision. The reliability of CSF metrics was calculated. In addition, the sensitivity, specificity and accuracy for detecting CSF changes in individuals were evaluated. Finally, we conducted empirical statistical power analyses for detecting CSF changes in groups of observers.

Results

The standard error of the CSFs obtained with the quick CSF was less than 0.1 log unit after 50 trials. The test-retest reliability reached 0.974 with 50 trials. In 50 trials, the quick CSF method can detect area under log CSF (AULCSF) changes caused by a 7.8 and 36.4 fold luminance change with 94.0% and 98.9% accuracy, respectively. A power analysis showed that a very small change (0.025 log unit or 6%) could be detected with the quick CSF method with 112 observers and 50 trials.

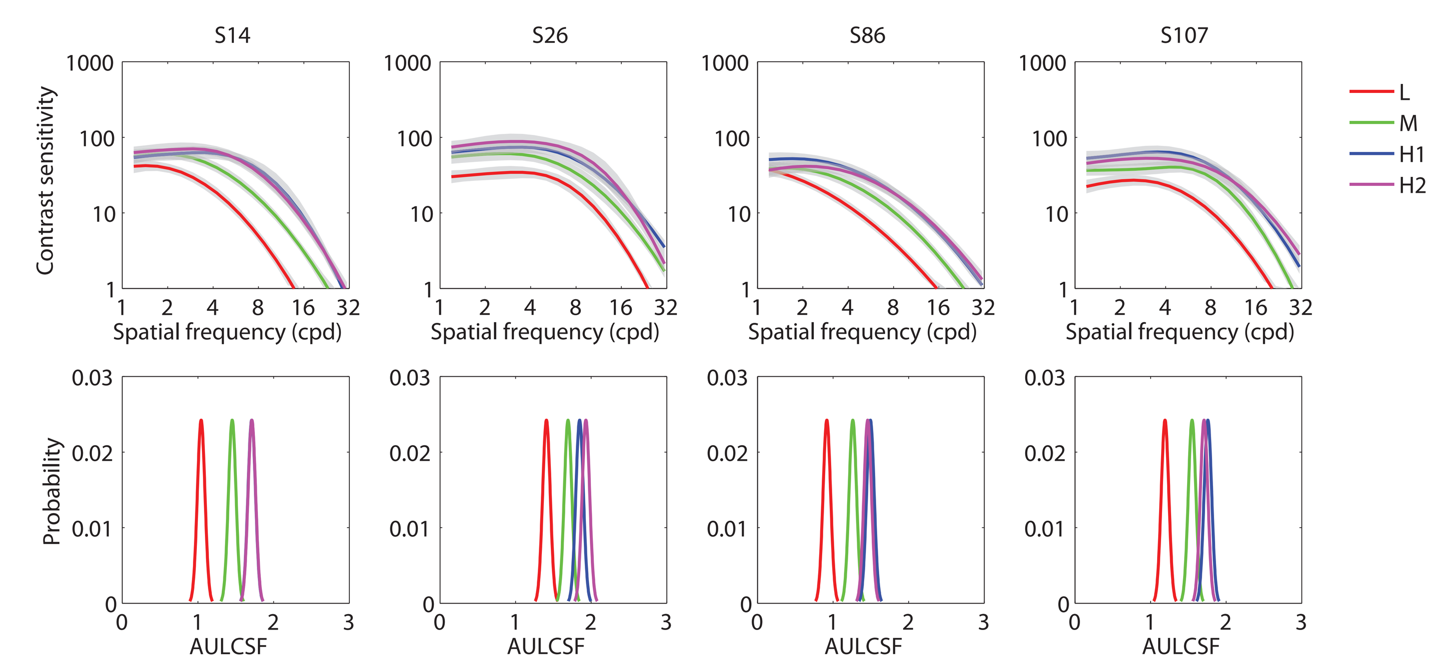

Figure 2: Top row: Estimated CSFs in the L, M, H1, and H2 conditions of S14, S26, S86 and S107. Shaded regions indicate the 68.2% HWCI. Bottom row: Posterior distributions of estimated AULCSF in the L, M, H1, and H2 conditions of the four observers.

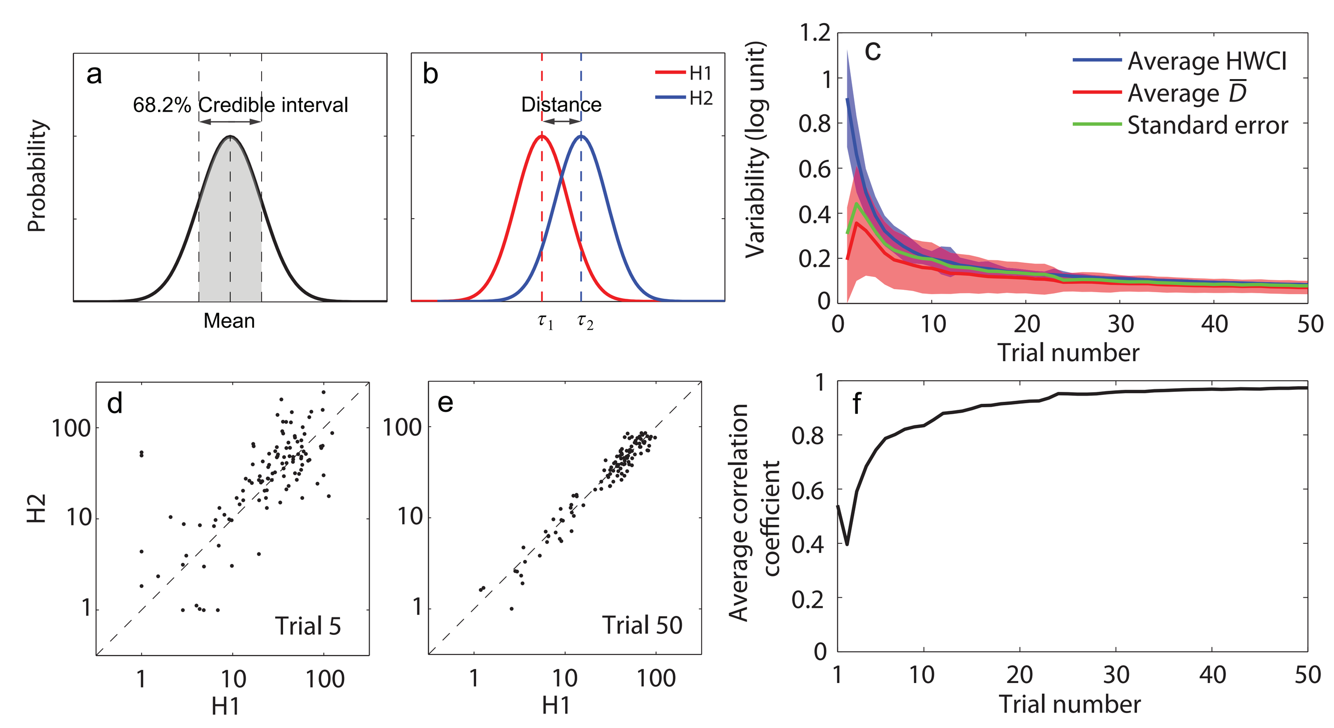

Figure 3: (a) Half width of 68.2% credible interval (HWCI). (b) Distance between two CSF measures. (c) The HWCI, mean distance and standard error are plotted as functions of the number of trials. (d) and (e) are scatter plots of the CSFs measured in the H1 and H2 conditions after 5 and 50 trials. (f) Average Pearson correlation coefficient as a function of trial number.

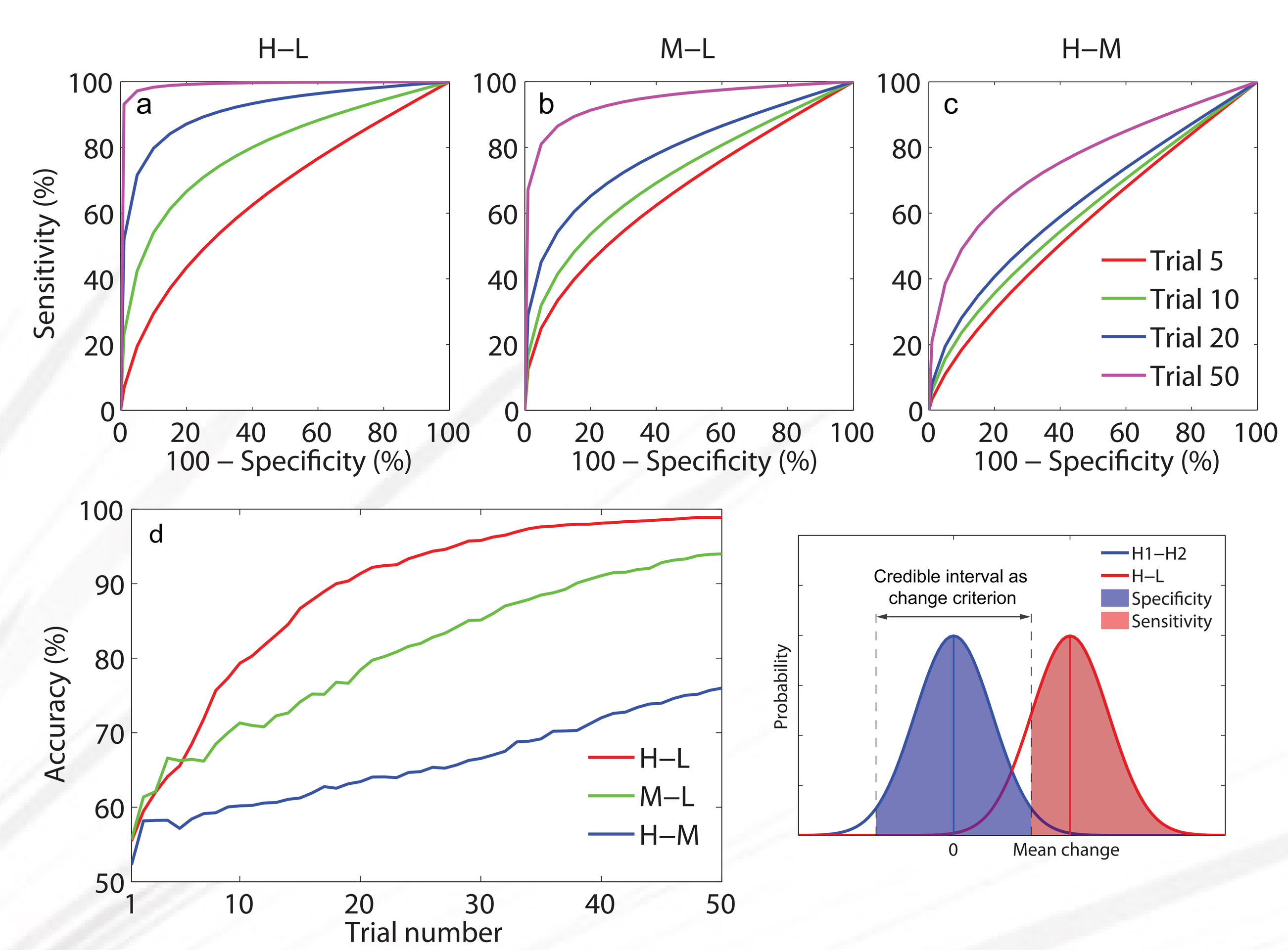

Figure 4: (a), (b) and (c), the receiver operating characteristic (ROC) for the CSF changes between H and L, between M and L, and between H and M. (d) Accuracy of the quick CSF method in detecting different AULCSF change. The additional panel shows how sensitivity and specificity are calculated.

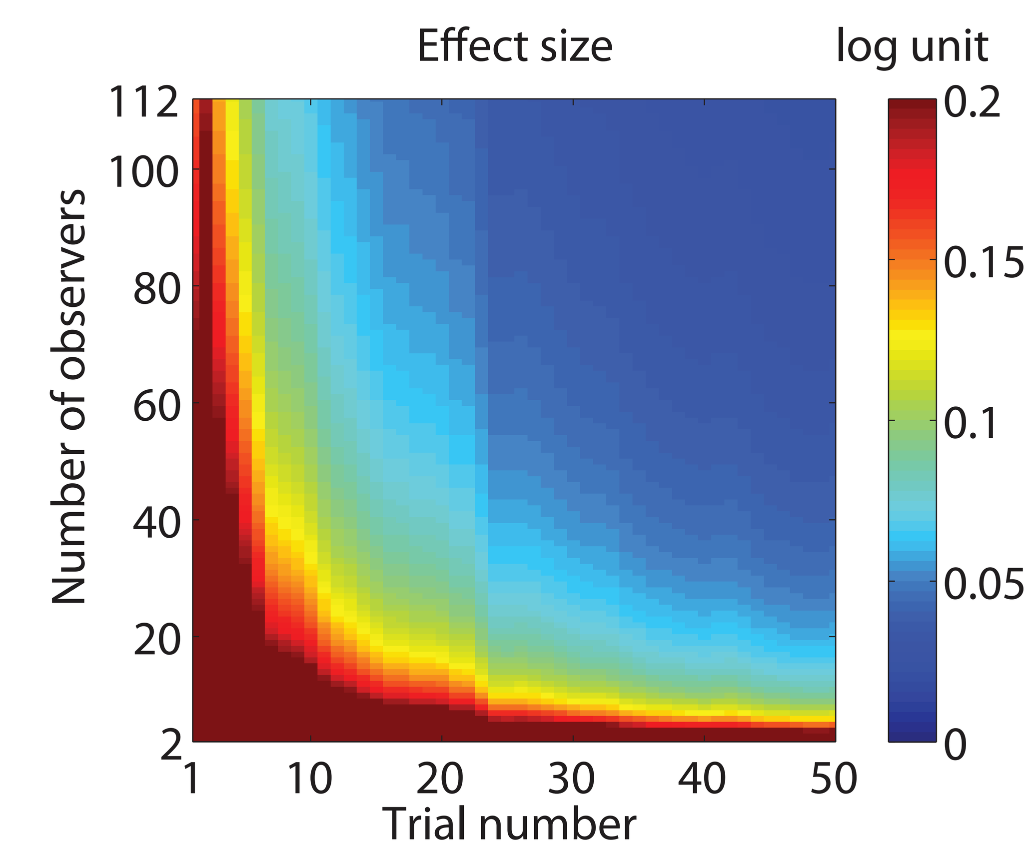

Figure 5: The effect size that can be detected by the quick CSF method with a = .05 and power = .95 as a joint function of observer and trial numbers.

Conclusion

The quick CSF is very precise, highly reliable and extremely sensitive in detecting CSF changes at both individual and group levels. These advantages make it plausible to apply the method to monitor the progression of visual diseases or treatment effects on individual patients, and greatly reduce the time, sample size and costs in clinical trials.

Bibliography

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