An optimal estimator for edge contrast explains perceived contrast of sine wave gratings

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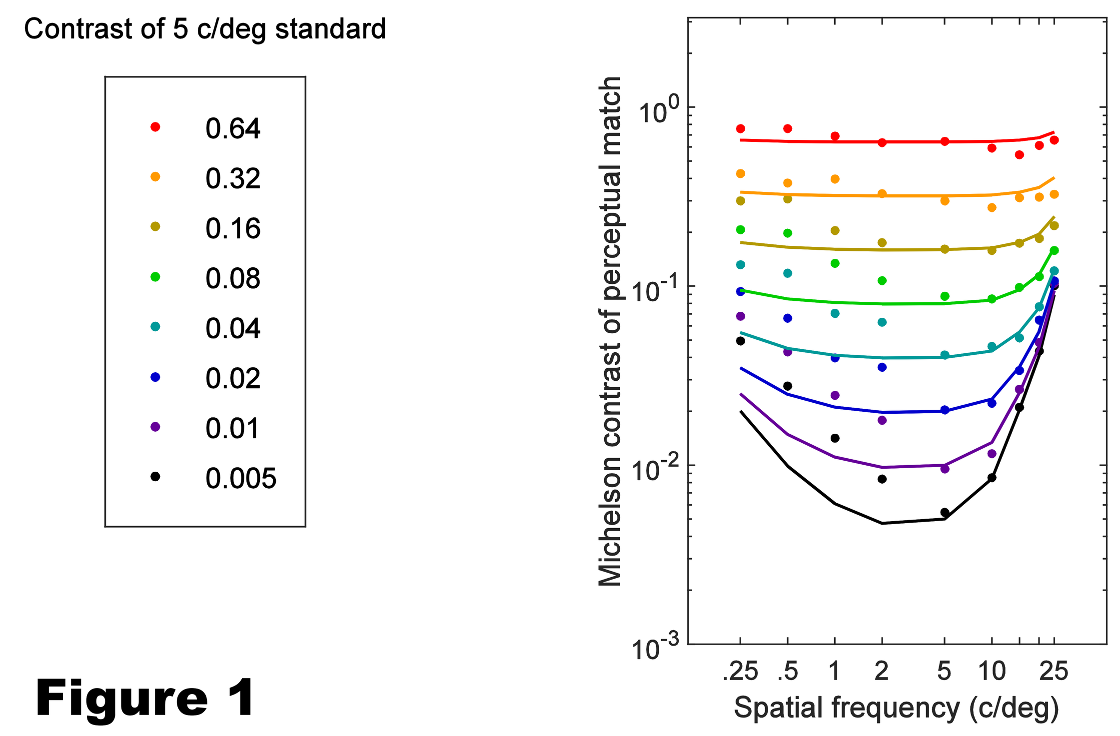

Figure 1

Background

- Georgeson and Sullivan (1975) adjusted sine wave grating contrast to perceptually match a 5 c/deg standard (Figure 1, symbols)
- Kulikowski (1976) showed data fit quite well by assuming *perceived contrast = actual contrast – contrast threshold*
- McIlhagga (2004) showed Kulikowski's subtractive rule arises from contrast estimator that minimises error while rejecting noise
- But this rule overestimates perceived contrast of low spatial frequency gratings (Figure 1, lines)

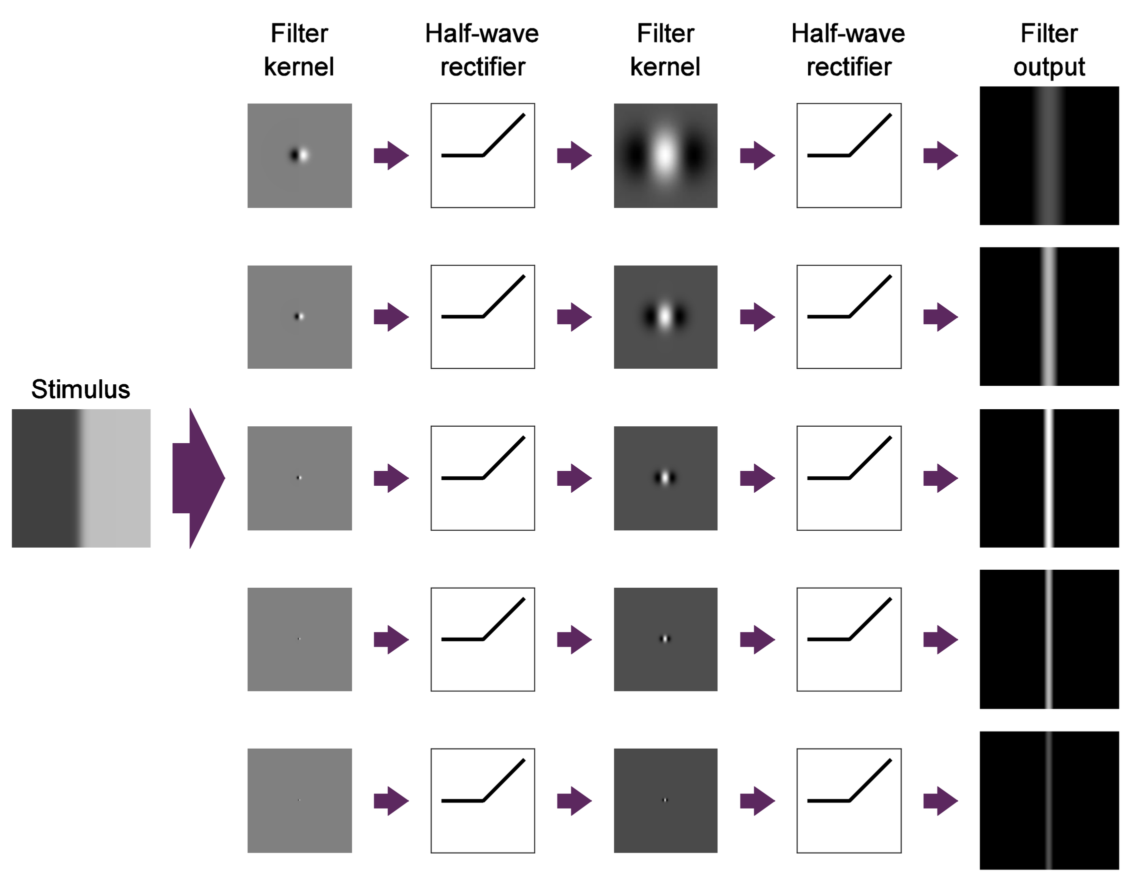

Figure 2

Edge detection

- Georgeson and Sullivan's full data set can be explained by applying McIlhagga's optimal estimator to the output of a general-purpose edge detection mechanism devised by Georgeson et al (2007)
- The edge detection model has channels for edge blur and orientation
- Peak across blur (i.e. spatial frequency) channel indicates blur of edge
- Edge contrast estimate, E, derived from height of peak
- May and Georgeson (2007) modified model to account for misperceptions of contrast and blur: "Blurred edges look faint, and faint edges look sharp"
- Half-wave rectifier replaced with smooth transducer with 2 parameters
- Causes blurred edges to look lower in contrast

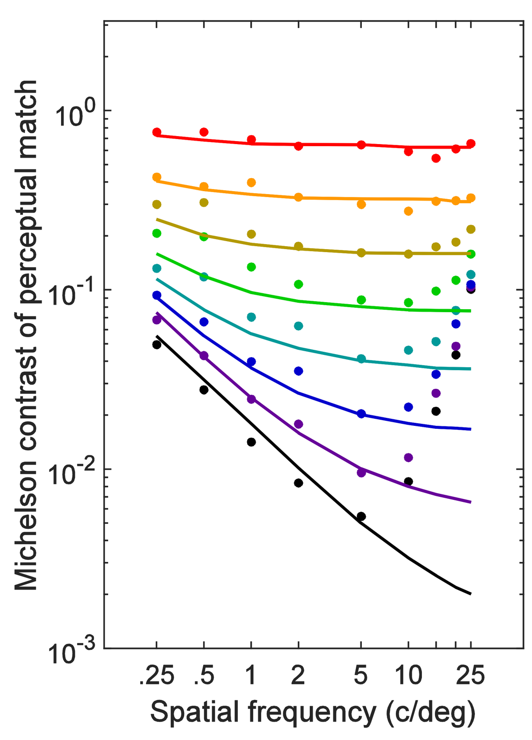

Figure 3

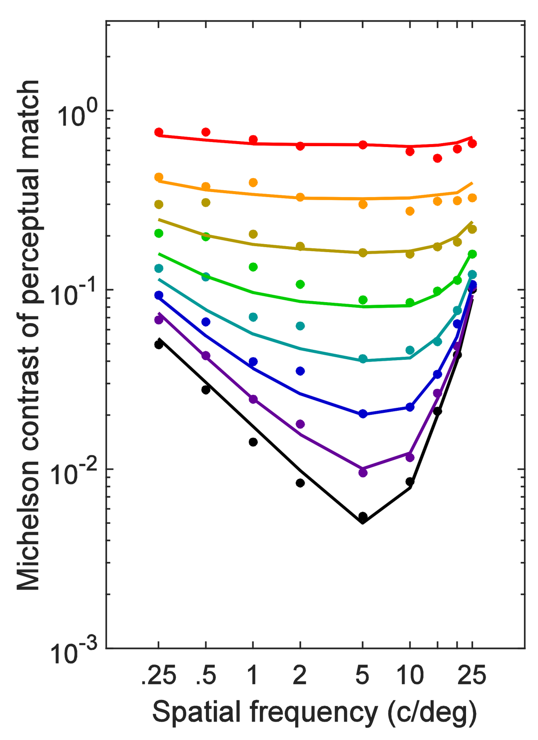

Figure 4

Perceived contrast of low-frequency gratings

- Model with parameters fitted to May & Georgeson's data for subject MAG predicts Georgeson & Sullivan's low SF data for same subject (Figure 3)

Perceived contrast of high-frequency gratings

- Using McIlhagga's (2004) reasoning, we modified the contrast estimator to reject noise
- If E is edge contrast estimate assuming no noise, the modified contrast estimate, $\hat{C}$, is given by $\hat{C} = \max(0, E - M)$, where M is the expected maximum value of the noise across all the channels being monitored
- Following McIlhagga's reasoning, M is the noise-free edge contrast estimate, E, when the stimulus contrast is at detection threshold
- We calculated M for each spatial frequency by applying the model to the stimulus at MAG's detection threshold
- Very good parameter-free prediction of contrast matches (Figure 4)

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Georgeson et al (2007) *J Vis*, *7*(13):7, 1–21
Kulikowski (1976) *Vis Res*, *16*, 1419–1431
May & Georgeson (2007) *Vis Res*, *47*,1705–1720
McIlhagga (2004) *Vis Res*, *44*, 2659–2666