Ganglion Cell Responsiveness To Perimetric Stimuli: Frequency-doubling Stimuli Are Not Better Than Conventional Stimuli In Separating M-cells From P-cells

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Conflict of Interest: Swanson (Consultant, Zeiss-Meditec)

Sun, Lee, Cao: No Conflict of interest

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BACKGROUND

- The frequency-doubling (FD) illusion was originally thought to be mediated by nonlinear (M_y) ganglion cells
- We showed that nonlinear ganglion cells cannot mediate the frequency-doubling illusion (White, Sun, Swanson, Lee 2002, Invest. Ophthalmol. Vis. Sci. 43: 3590-3599)

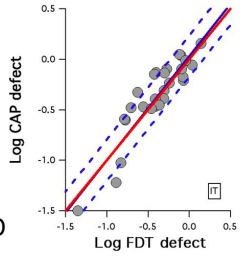
BACKGROUND

- Frequency-doubling perimetry was designed to stimulate magnocellular (M-) ganglion cells more than parvocellular (P-) ganglion cells
- It was proposed that this would "reduce redundancy" compared to the Size III stimulus used in conventional perimetry

FD & III: SIMILAR DEFECTS

FD and size III defects are similar in patients with glaucoma, after accounting for the difference in "dB" scales:

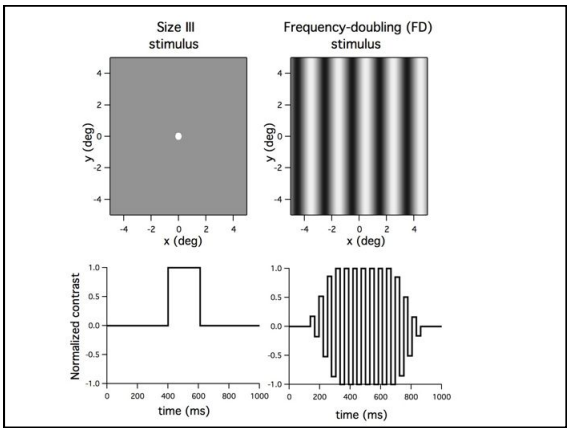
1 log unit = 20 dB for FD
1 log unit = 10 dB for III



Sun, Dul, Swanson 2006, Optom. Vis. Sci. 83: 455-465

PURPOSE

- We compared responses of M and P cells to size III & FD stimuli
- Our results contradict the hypothesis of "reduced redundancy", and help understand why size III and FD defects are similar



MACAQUE GANGLION CELLS

- *in vivo* preparation, at eccentricities of 5°-15°
- 42 M-cells and 28 P-cells
- Stimuli centered on cell's receptive field
- Histograms accumulated over 30 trials per condition, bin width 2.4 msec
- Response amplitude computed with window size of 40 msec

CONTRAST GAIN

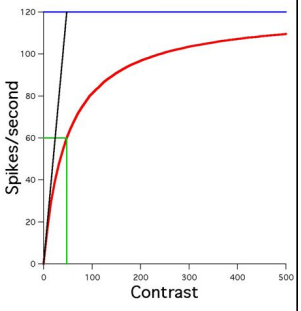
Michaelis-Menton function:

$R(x) = R_{max} * x/(x + C_{sat})$

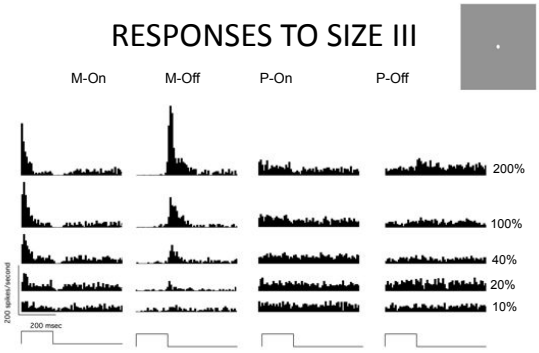
log (impulses/second/ % contrast)

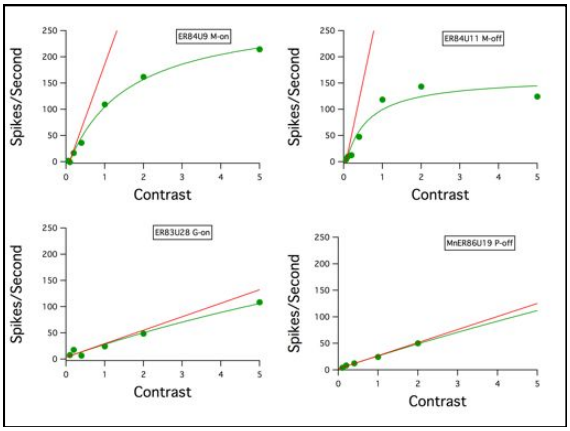
Response linear at low contrasts:

contrast gain = R_{max}/ C_{sat}

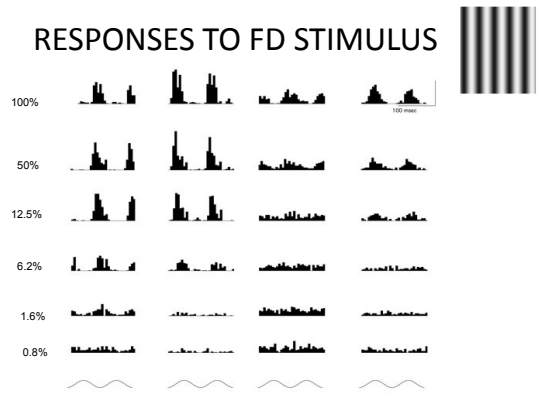


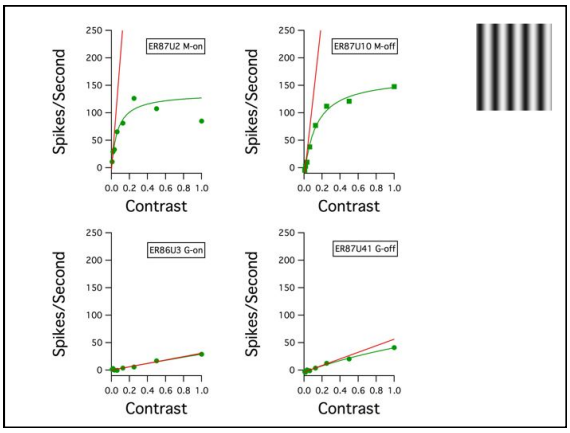
RESPONSES TO SIZE III



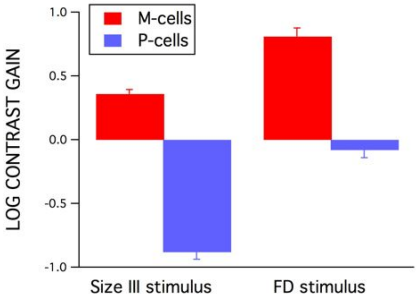


RESPONSES TO FD STIMULUS

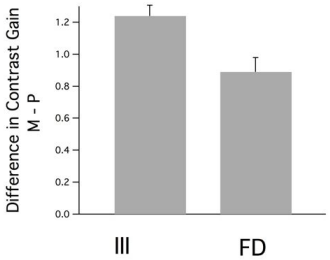




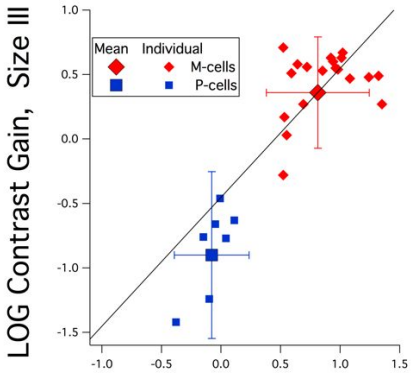
CONTRAST GAIN: SIZE III vs FD



SEPARATING CELLS: M VS P



Size III was superior to FD in separating M and P contrast gain ($t=2.75$, $p < 0.02$)



CONCLUSIONS

- M-cells were very responsive to both size III and FD stimuli, P-cells were less responsive
- Size III stimuli were superior to FD stimuli in differentiating M-cell versus P-cell responses
- These results contradict the assertion that FD perimetry "reduces redundancy" compared to conventional perimetry