


# Equivalence of firing rates of retinal ganglion cells in magnocellular pathway and "stimulus energy" in Ricco's law

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## Purpose:

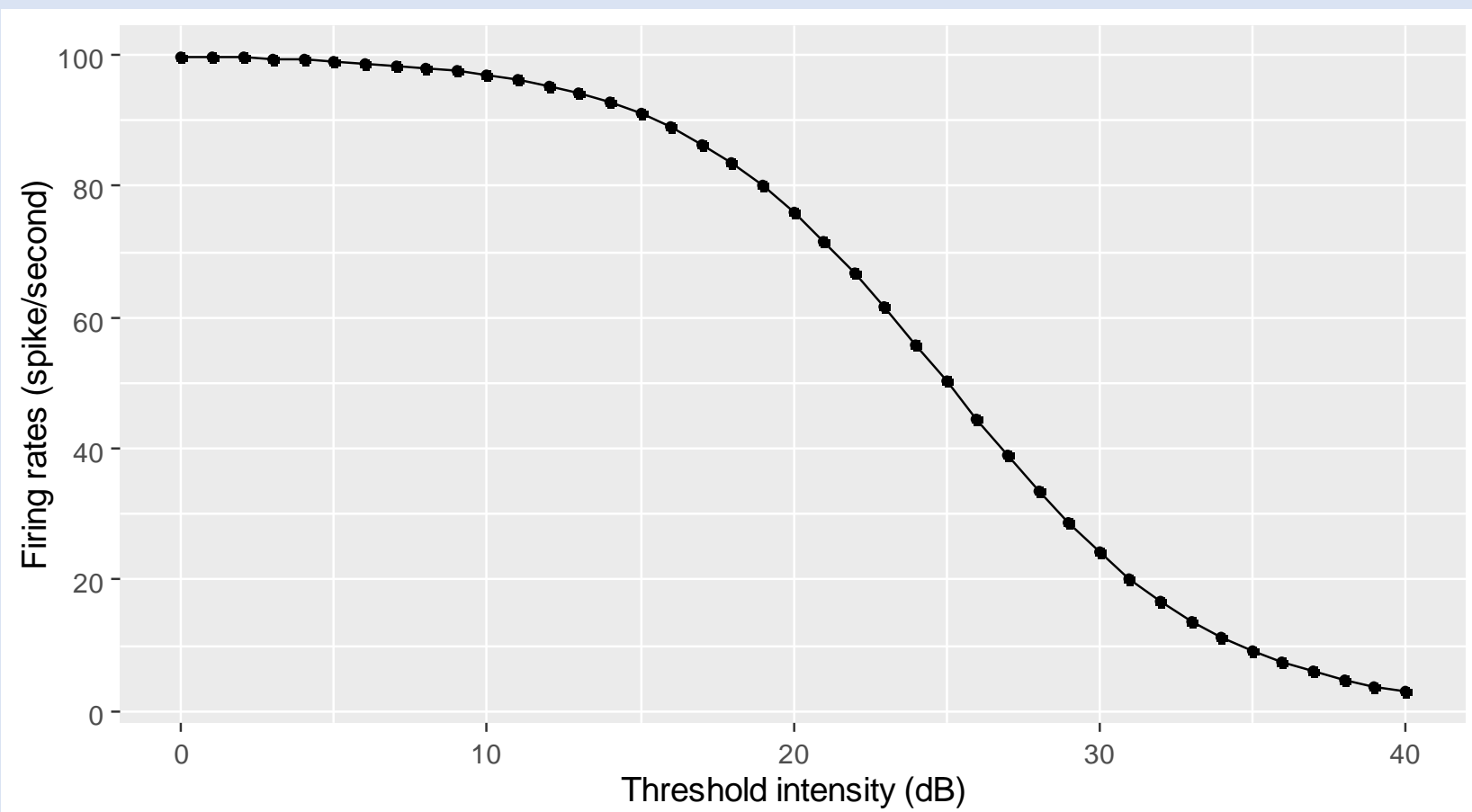
- Conventional perimetric stimuli have been reported to evoke neuronal firing of retinal ganglion cells in magnocellular pathway (M-RGCs). (Swanson *et al.* IOVS 2011;52:764-771)
- The author hypothesized that the firing rates may correspond to the so-called "stimulus energy" in Ricco's law.

## Methods:

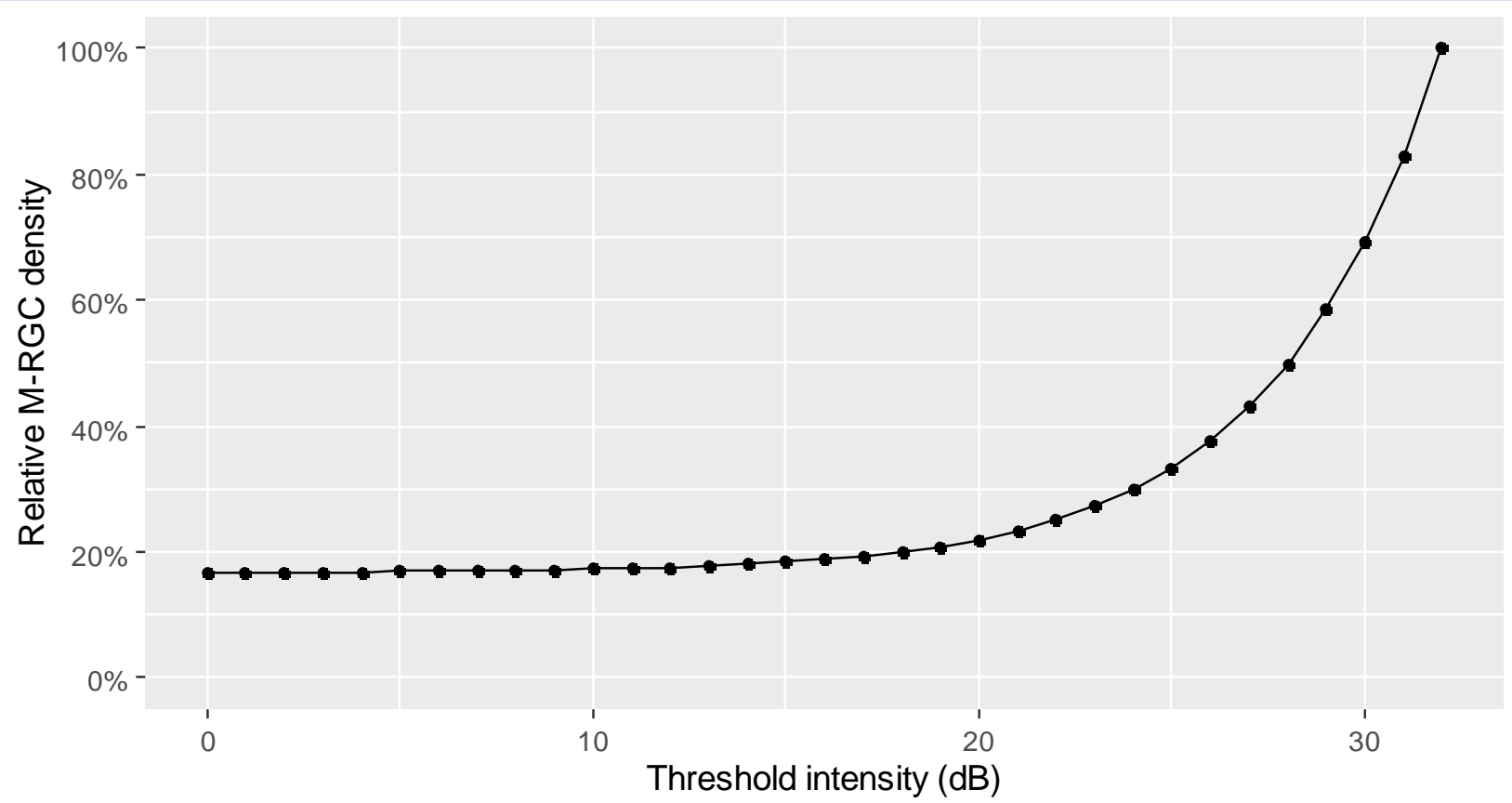
- To test this hypothesis, the author calculated the reciprocal of firing rates at detection threshold as estimates of local M-RGC density.
- The firing rates to threshold intensity were simulated by a Michaelis-Menten equation.
- Validation of estimates was done by predicting the mean M-RGC density in regions with glaucomatous damage as a weighted average of local density estimates.
- The weights, representing the spatial irregularity of surviving M-RGCs, were derived from the slope of empirical frequency-of-seeing curves (ARVO2021 E-abstract #3532912, URL  ).

## Results:

### 1) Estimation of local M-RGC density around the center of stimulus



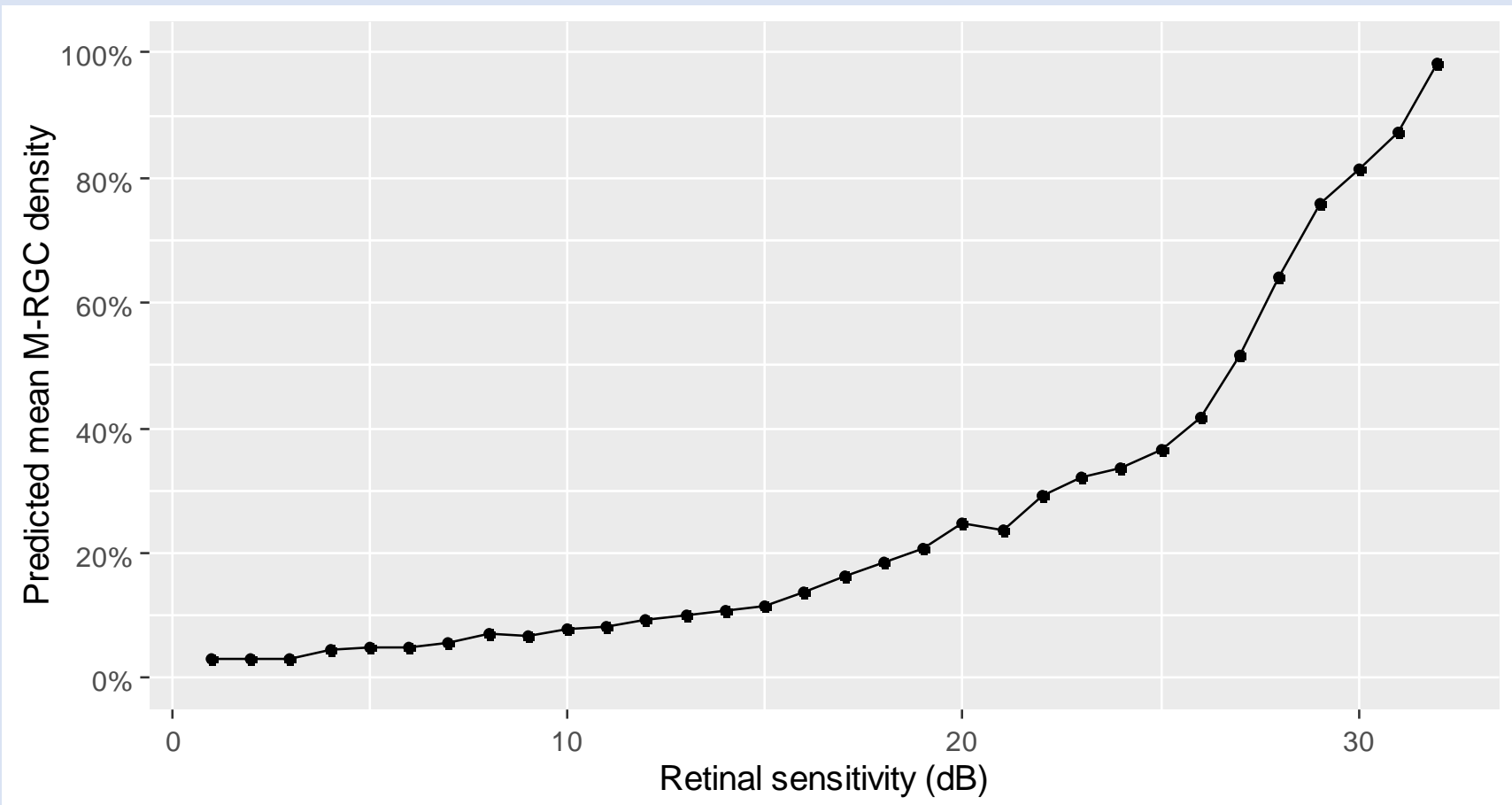
threshold (dB)	firing rates (spike/second)	local density estimate	relative density (%)
32	16.7	1/16.7	100
⋮	⋮	⋮	⋮
27	38.8	1/38.8	16.7/38.8*100 = 43.1
⋮	⋮	⋮	⋮
22	66.8	1/66.8	16.7/66.8*100 = 25.1
⋮	⋮	⋮	⋮
0	99.7	1/99.7	16.7/99.7*100 = 16.8



- In simulations, the firing rates of M-RGCs increased with threshold intensity until they reached an asymptote.
- The reciprocal of the firing rate was used as estimates of local M-RGC density. The density was also presented as a percent of the normal region, where the threshold intensity was 32dB.
- As threshold intensity increases, the corresponding estimates of local M-RGC density decreased and eventually plateaued at approximately 17% of normal.

### 2) Prediction of mean RGC density at regions with glaucomatous damage

threshold (dB)	[A] relative density (%)	[B] weight	[A] x [B]
32	100	0.00000428	0.000428
⋮	⋮	⋮	⋮
21	23.3	0.0638	1.49
20	22.0	0.0707	1.55
19	20.9	0.0689	1.44
⋮	⋮	⋮	⋮
<0	0	0.503	0
sum		1	11.3 (%)



- This table shows an example calculation of mean M-RGC density at retinal sensitivity 15dB.
- The predicted mean M-RGC density in regions with glaucomatous damage decreased with retinal sensitivity from 98.4% at 32dB to 3.0% at 1dB.

## Conclusions:

- The reciprocal of firing rates yielded reasonable estimates of M-RGC density, supporting the equivalence of firing rates of M-RGCs and "stimulus energy".

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The author have no conflict of interest to disclose.