Exploring Locust Looming Detectors

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Exploring Locust Looming Detectors.

- History.
- What does it (DCMD or LGMD) do?
- How does it do it?
  - Critical Image Cues
- Evolved and Engineered Brains.

'Locust DMCD' – 110 papers. Web of Science since 1978

History.

http://blog.twmuseums.org.uk/wp-content/uploads/2013/03/March2013blog2.jpg

Newcastle, 1948

http://3.bp.blogspot.com/-CWolLoGwUeo/TsS9k6O3WuI/AAAAAAAAALM/BVr-EsGT1Y4/s1600/Six+1.jpg

Newcastle, 2017

History.

J. Physiol. (1960), **154**, *pp.* 479–490 479
With 6 *text-figures*
Printed in Great Britain

THE PROPERTIES OF SINGLE-UNIT DISCHARGES IN THE OPTIC LOBE OF THE LOCUST

BY E. T. BURTT AND W. T. CATTON

From the Departments of Zoology and of Physiology, King's College, University of Durham, Newcastle-upon-Tyne, 1

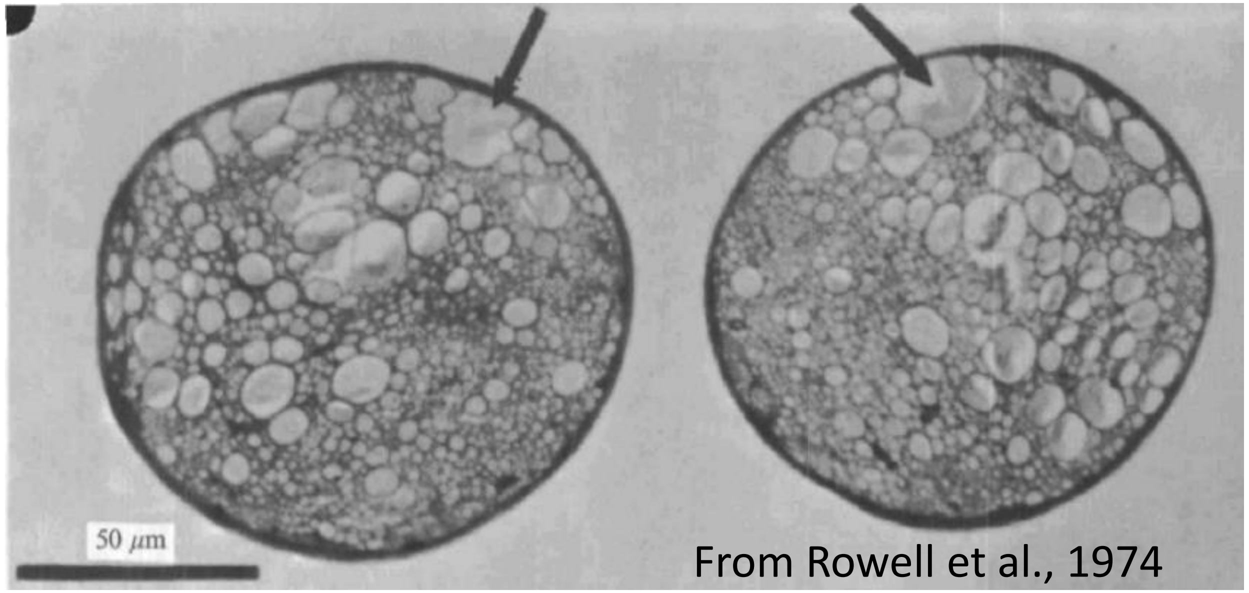
(*Received* 13 *June* 1960)

In the course of previous work in which micro-electrodes have been used to record nervous activity in the locust optic lobe (Burtt & Catton, 1956, 1959*a*), from time to time the activity of single units has been observed, although in general the responses have been multiple in nature. The present paper deals with the collected data from experiments on

History.

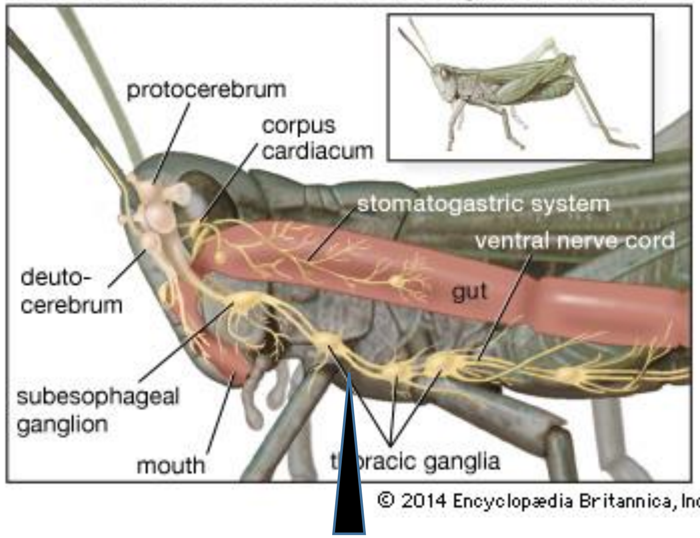
Extracellular recording.

https://c1.staticflickr.com/9/8041/8018448406_8e95a24c8b_b.jpg



From Rowell et al., 1974

Nervous system of the arthropod (grasshopper)



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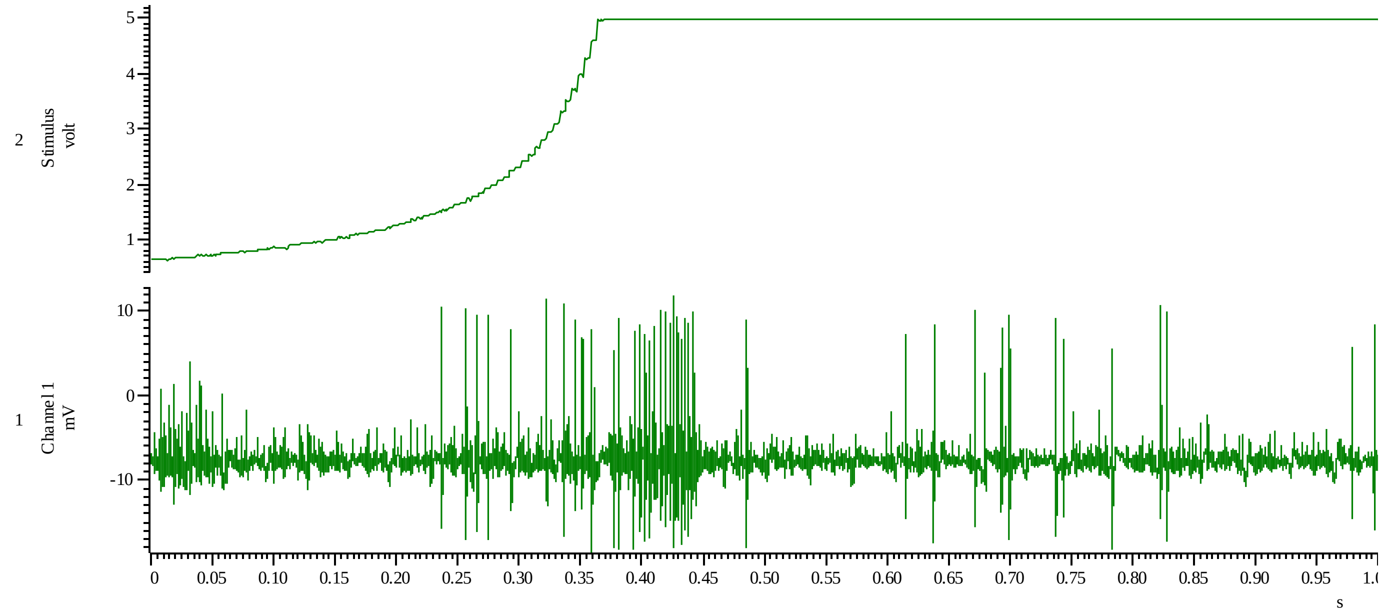


History.

https://i1.rgstatic.net/ii/profile.image/AS%3A278405485481987%401443388448478_xl/Charles_Rowell.png

CHF Rowell

Z. vergl. Physiologie 73, 167—194 (1971)

The Orthopteran Descending Movement Detector (DMD) Neurones: A Characterisation and Review

C. H. Fraser Rowell
Department of Zoology, University of California at Berkeley

descending contralateral movement detector.

History.

Rowell's paper and review, 1971.

- Whole field of eye on other side to axon
- Abrupt movement of contrasting object
- Dimming (or brightening) small area
- Decrement to repeated stimulus
- Wide-field stimuli, or animal's own movement, reduce responses
- No directional preference
- No direct correlation with specific motor behaviour

1970s:

- Series of papers: O'Shea, Rowell, Williams
- Output to fast extensor tibiae motor neuron (Rowell & Burrows)

History.

What does it do?

Schlotterer (1977) – approaching *versus* receding disks. Quite slow.

Rind & Simmons (1992) – selective responses to approaching objects

How does it do it?

Simmons & Rind (1992) – critical image cues

What does it do? Selective responses to approaching objects

https://www.sciencephoto.com/image/213631/225

- ❖ Movie
- ❖ Real disks
- ❖ Computer images

- More vigorous and long-lasting responses to approaching objects than to receding, or translating ones.
- During approach, over a variety of speeds, spikes increase in rate until just after movement stops.
- Dark or light objects.
- Background movement reduces vigour.

➢ Several other neurons excited by approaching objects; but DCMD discriminates and tracks.

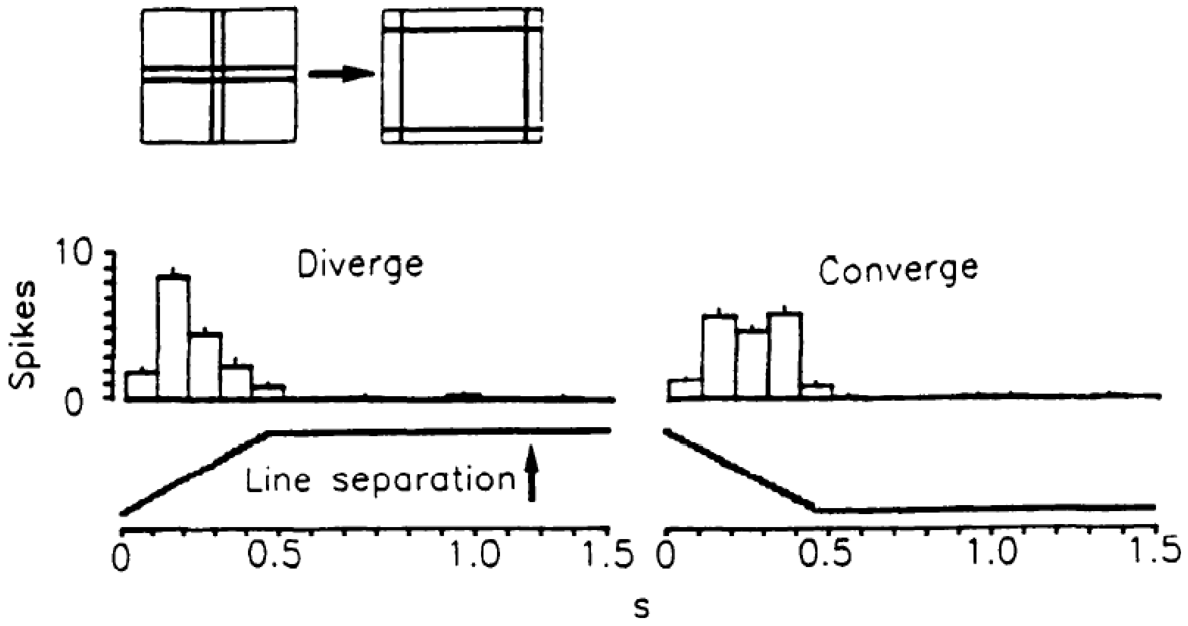
How does it do it?   Critical Image Cues.

Vision in depth with one eye.

Image expansion:

Edges must move – change in luminance insufficient.

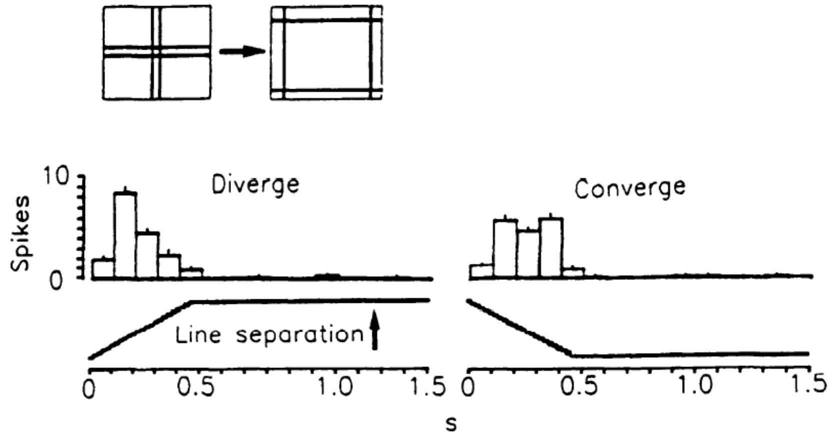
Edges increase in extent & speed.

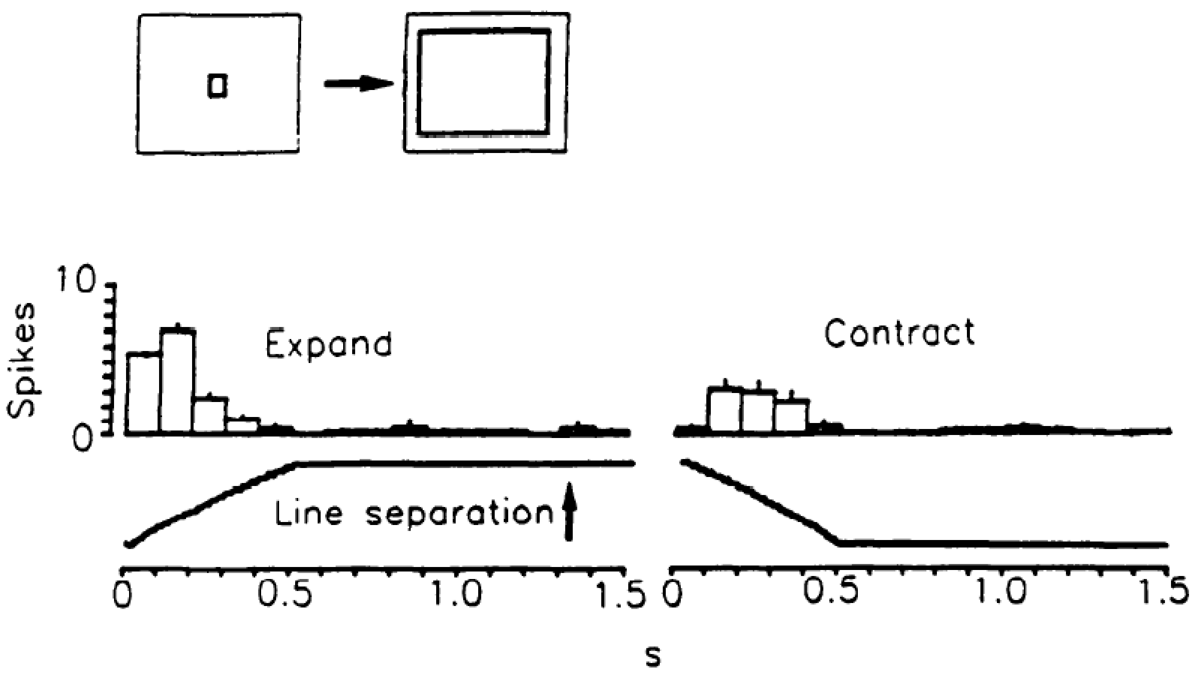


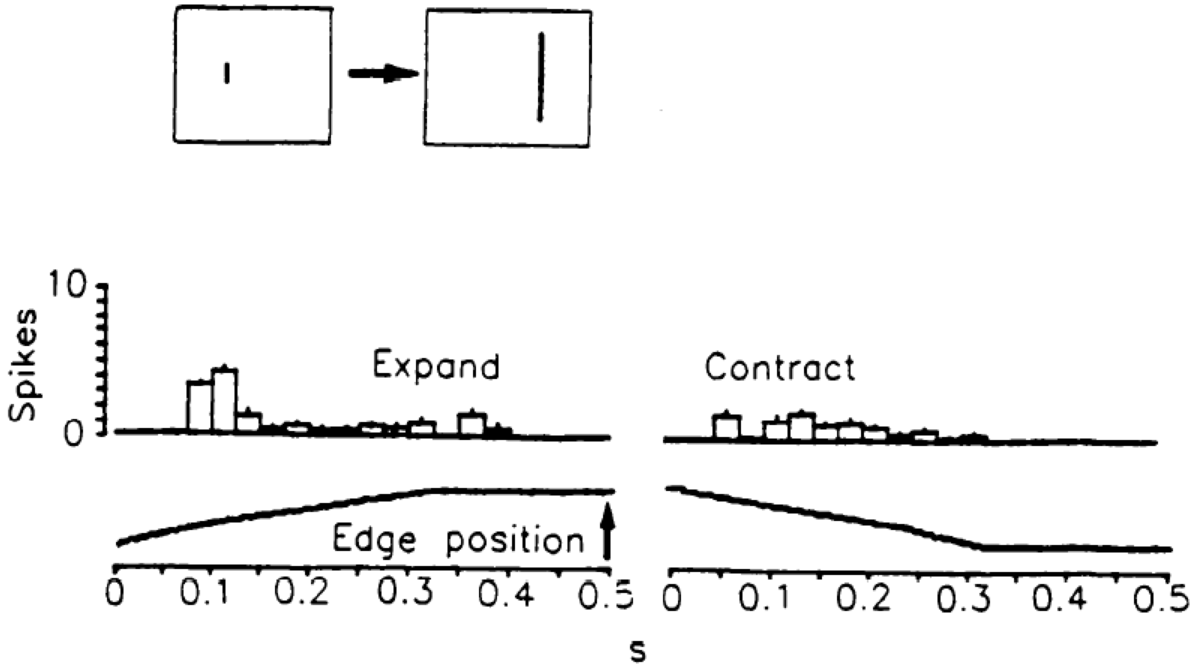
How does it do it?   Critical Image Cues.

(Simmons & Rind, 1992)

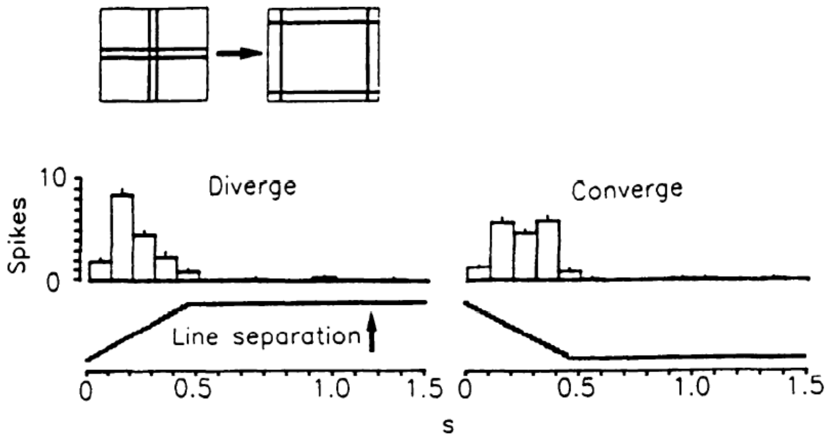
Edges must increase in extent



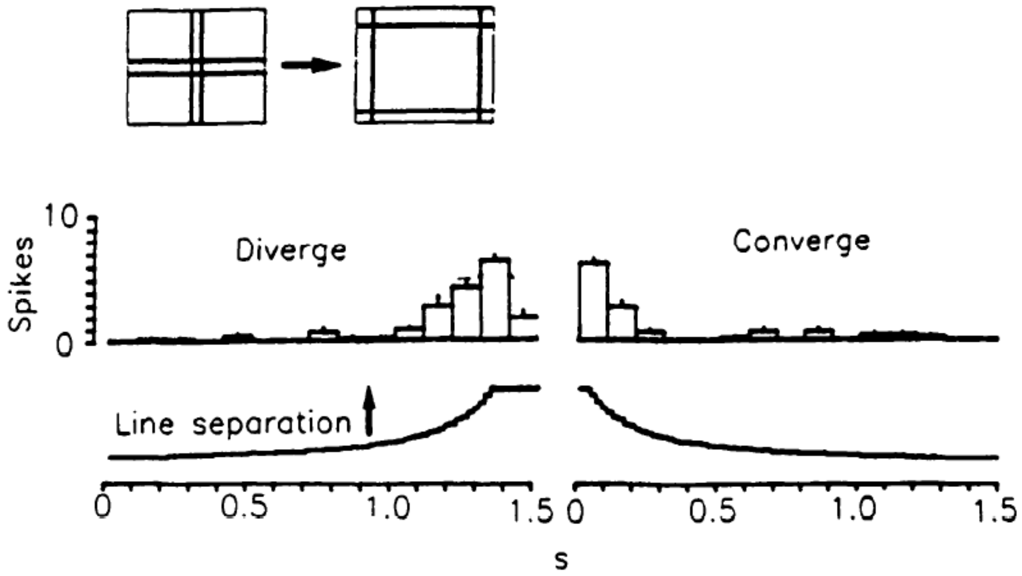




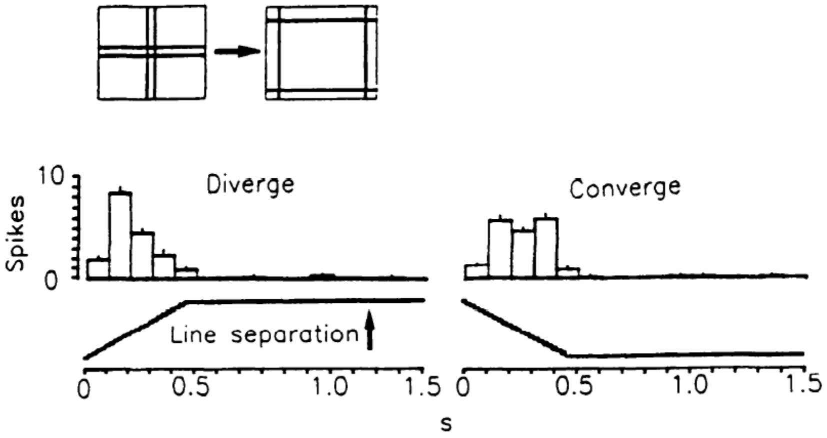
How does it do it?   Critical Image Cues.



Edges must increase in movement speed



How does it do it?   Critical Image Cues.



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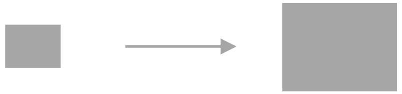
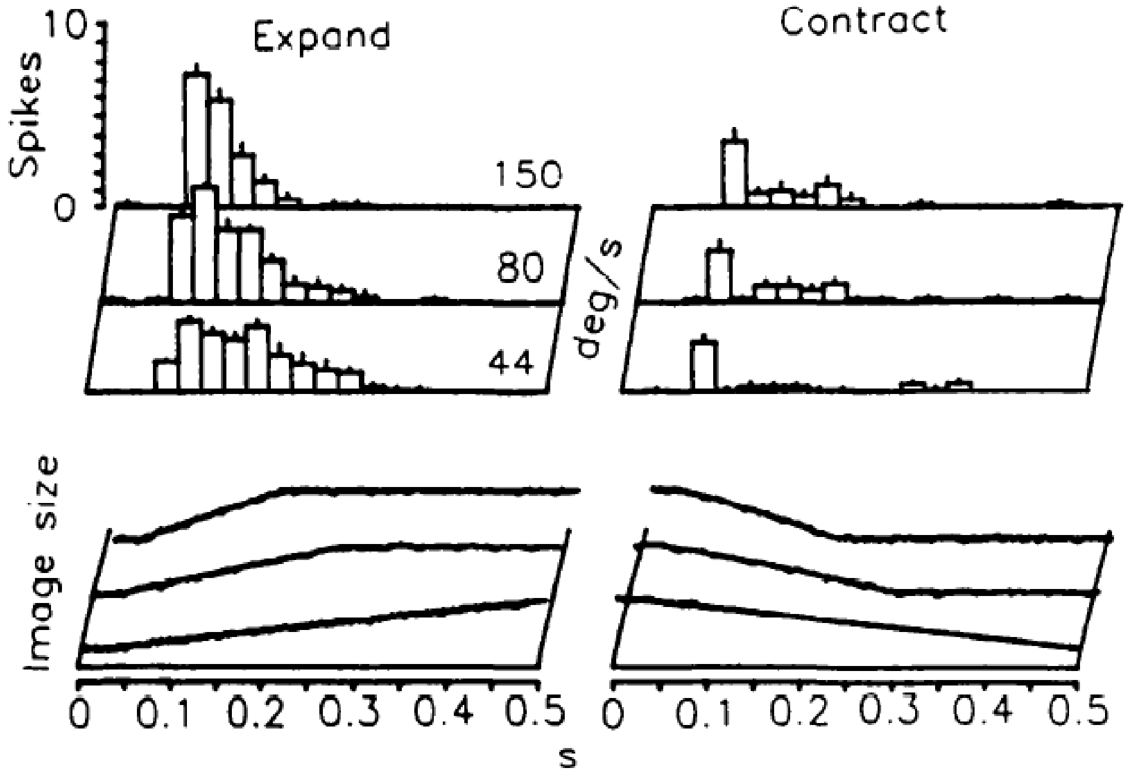
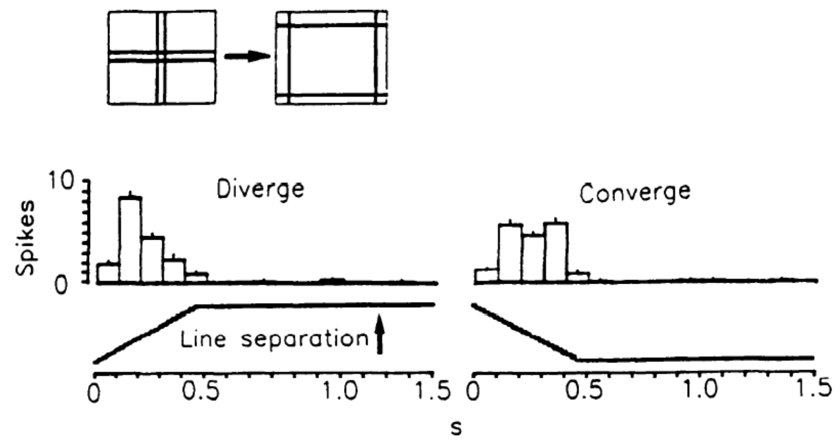




How does it do it?   Critical Image Cues.



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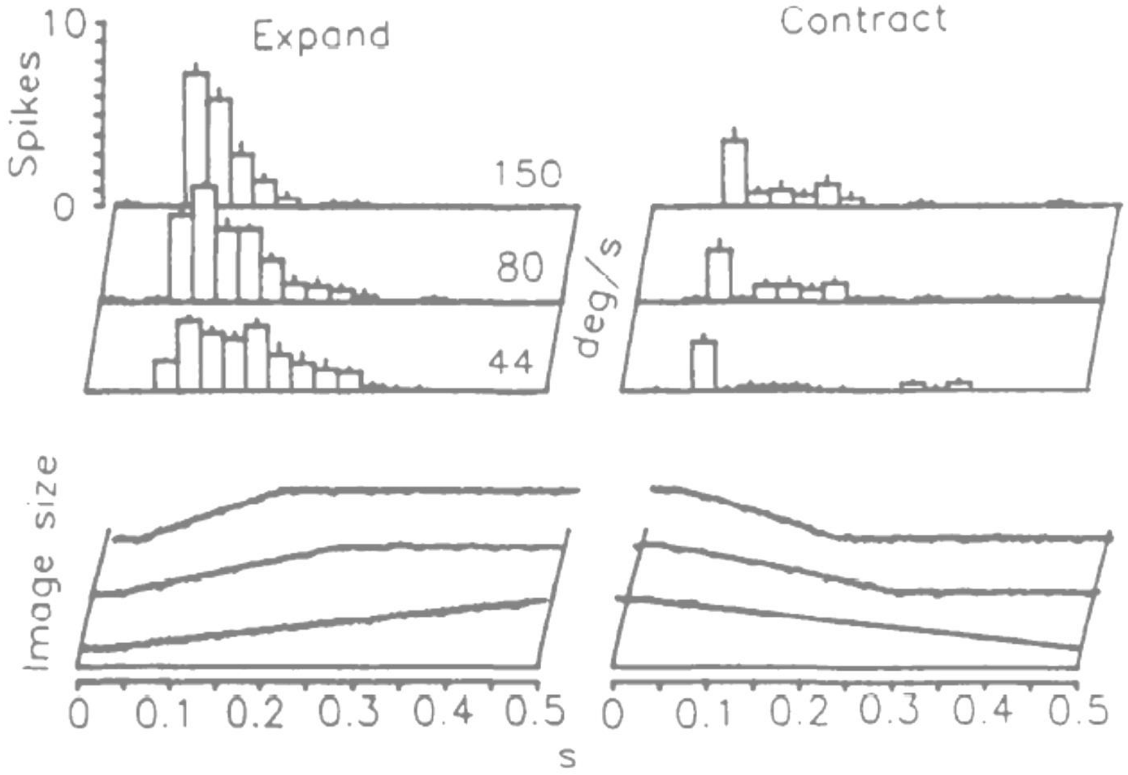
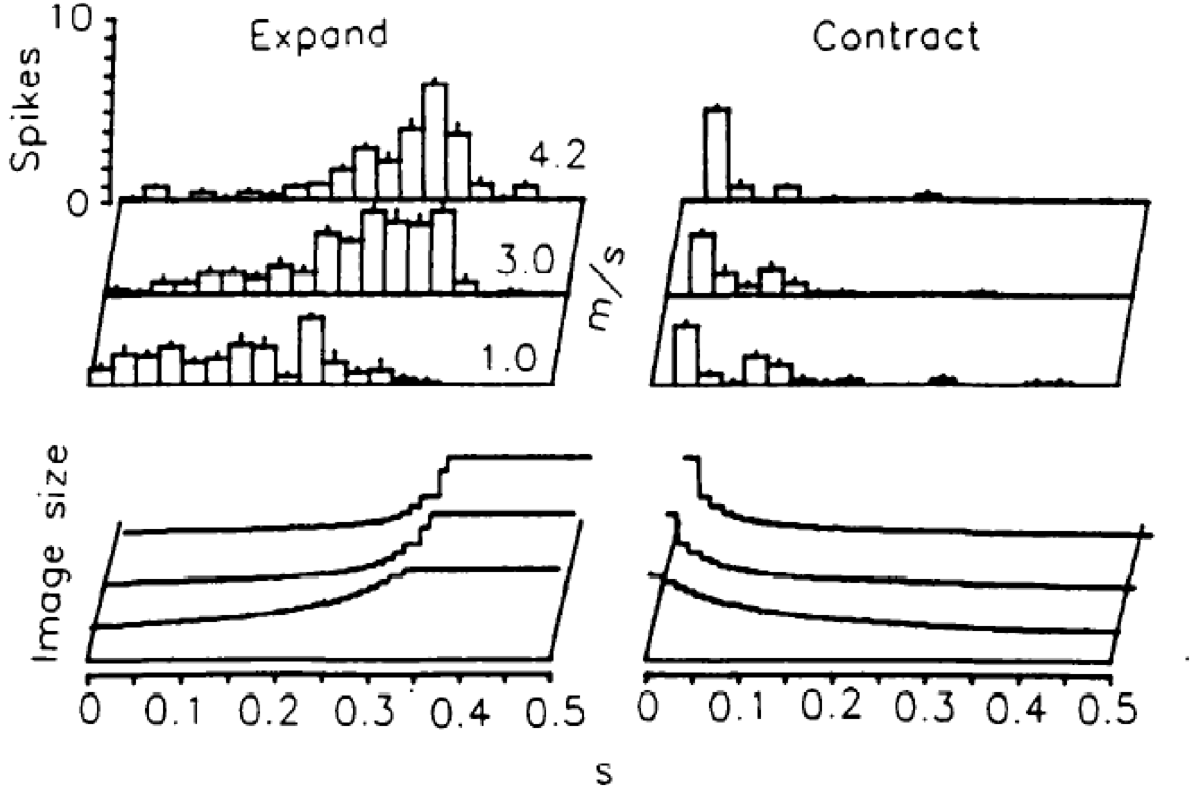
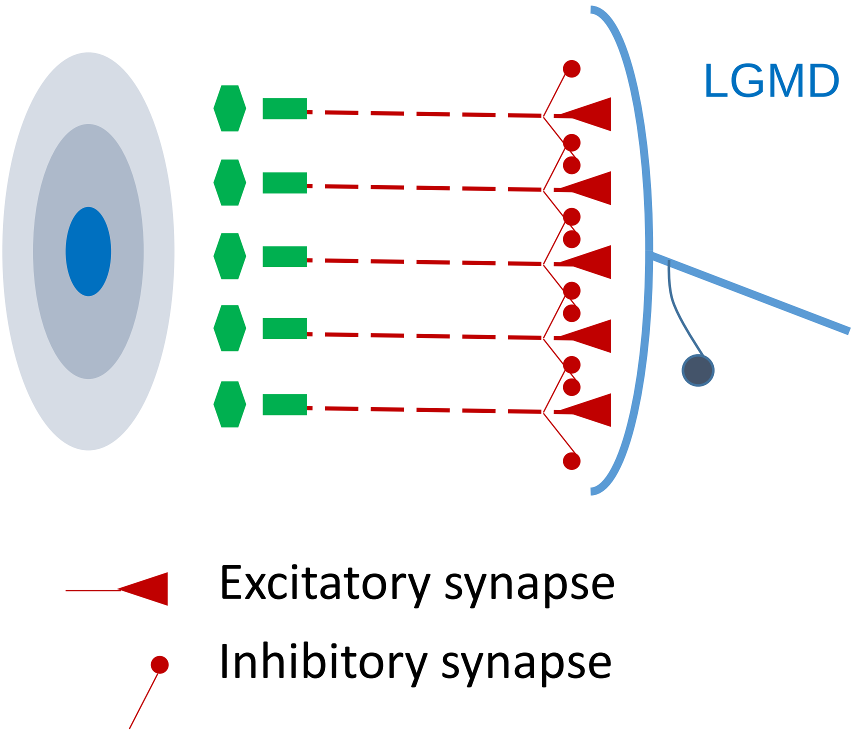


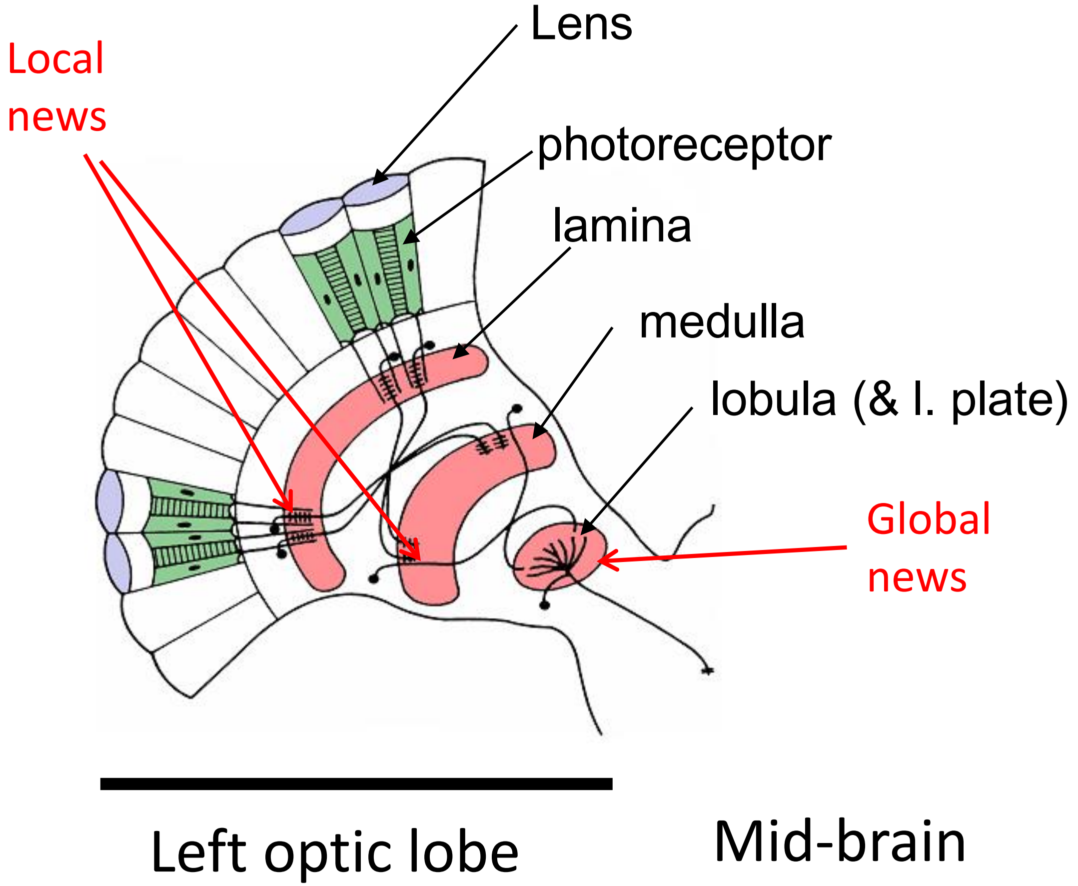


How does it do it? Critical Image Cues.

increasing velocity over the retina. The spread of inhibition is rapid and extensive, and we propose that there is a "critical race" in which an edge must move more rapidly over the ommatidia at the eye surface than the speed with which inhibition spreads through the retinotopic network. Such a

Retina-lamina-medulla - lobula



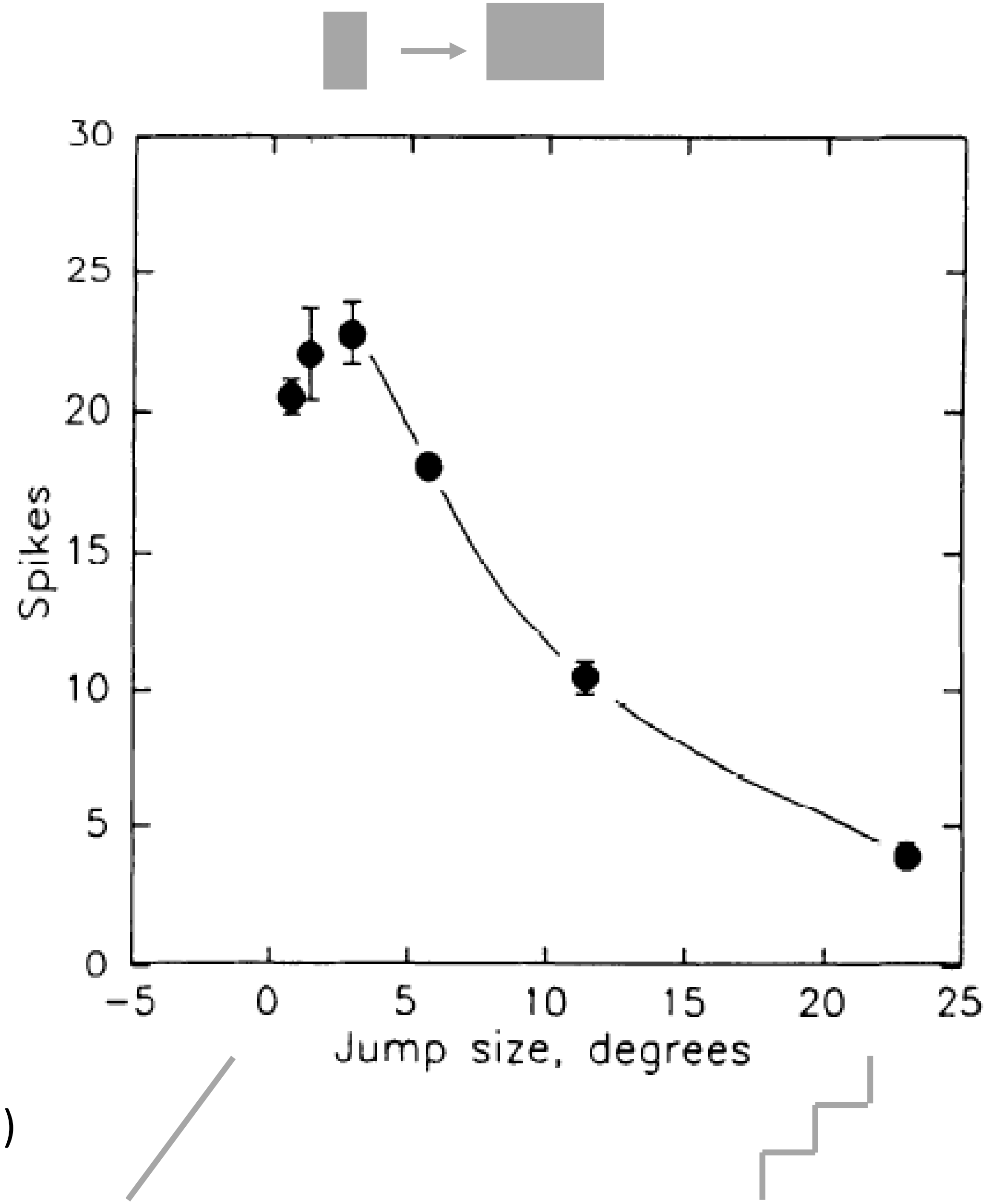


How does it do it?

Four more points:

1, smooth movements are better than jumps

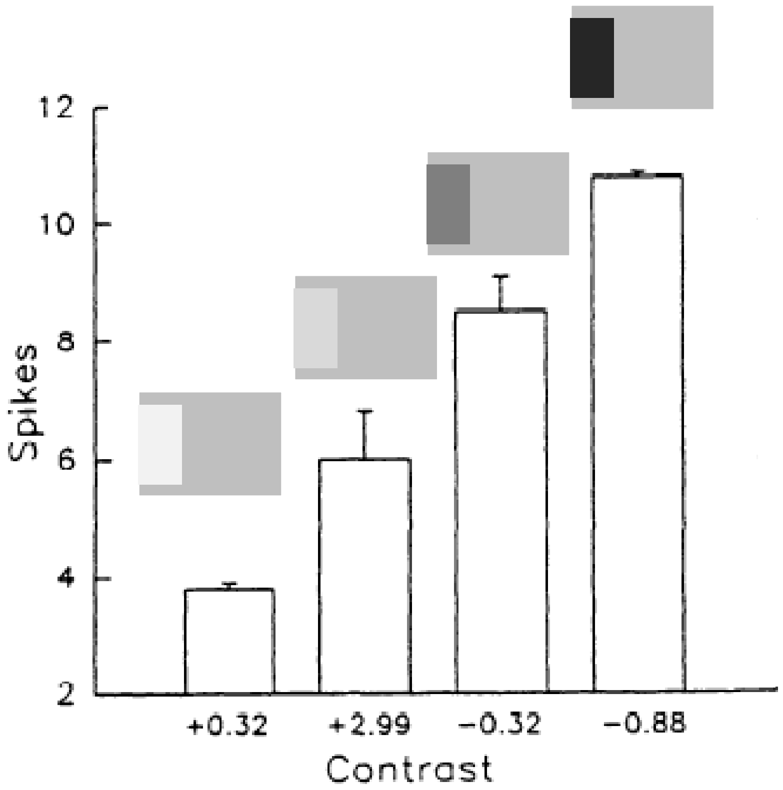
(Simmons & Rind, 1992)

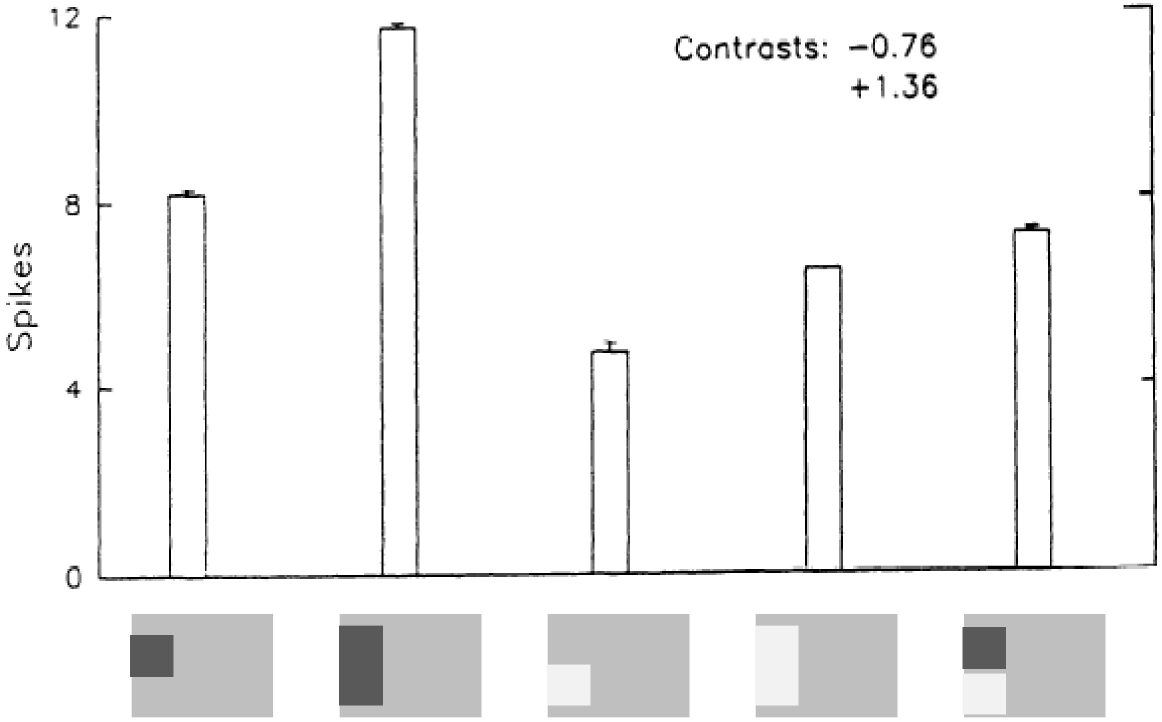


How does it do it?

Four more points:

2, dark and light edges interact





(Simmons & Rind, 1992)

How does it do it?

Four more points:

3, LGMD2 and LGMD1

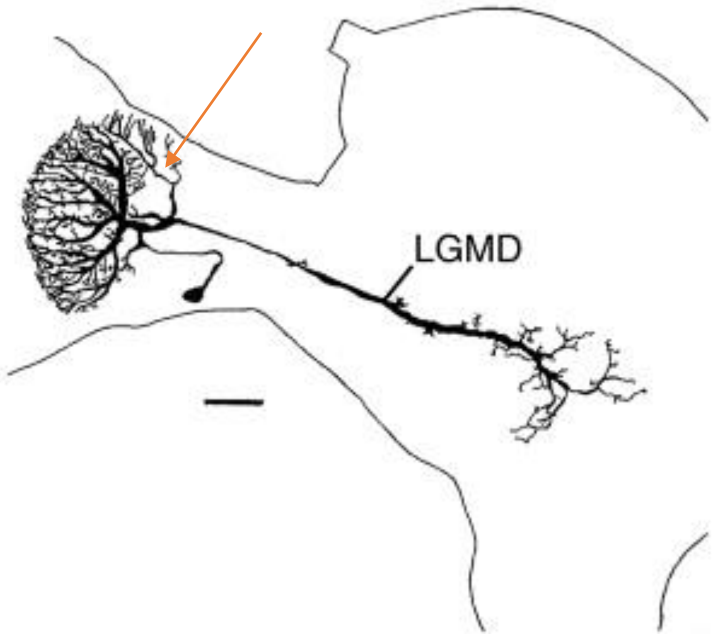
- One of each in each optic lobe
- Both select approaching, dark objects
- There are differences

    Spontaneous spikes

    LGMD1 -> DCMD -> flight and jumping

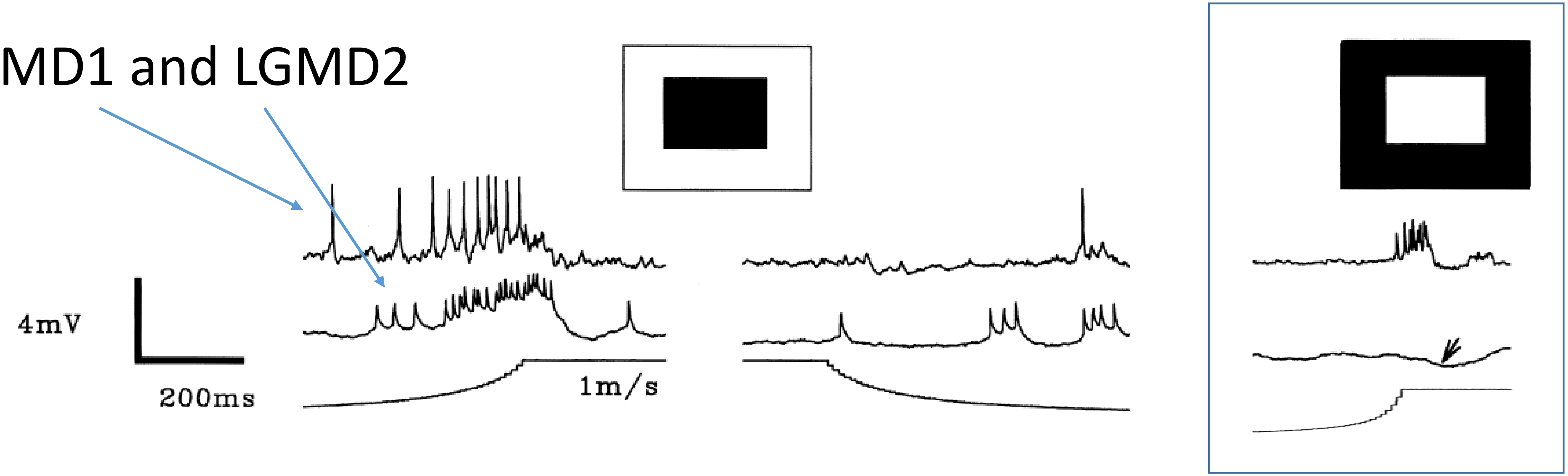
    LGMD2 -> ?

(Simmons & Rind, 1997)



How does it do it?

LGMD1 and LGMD2

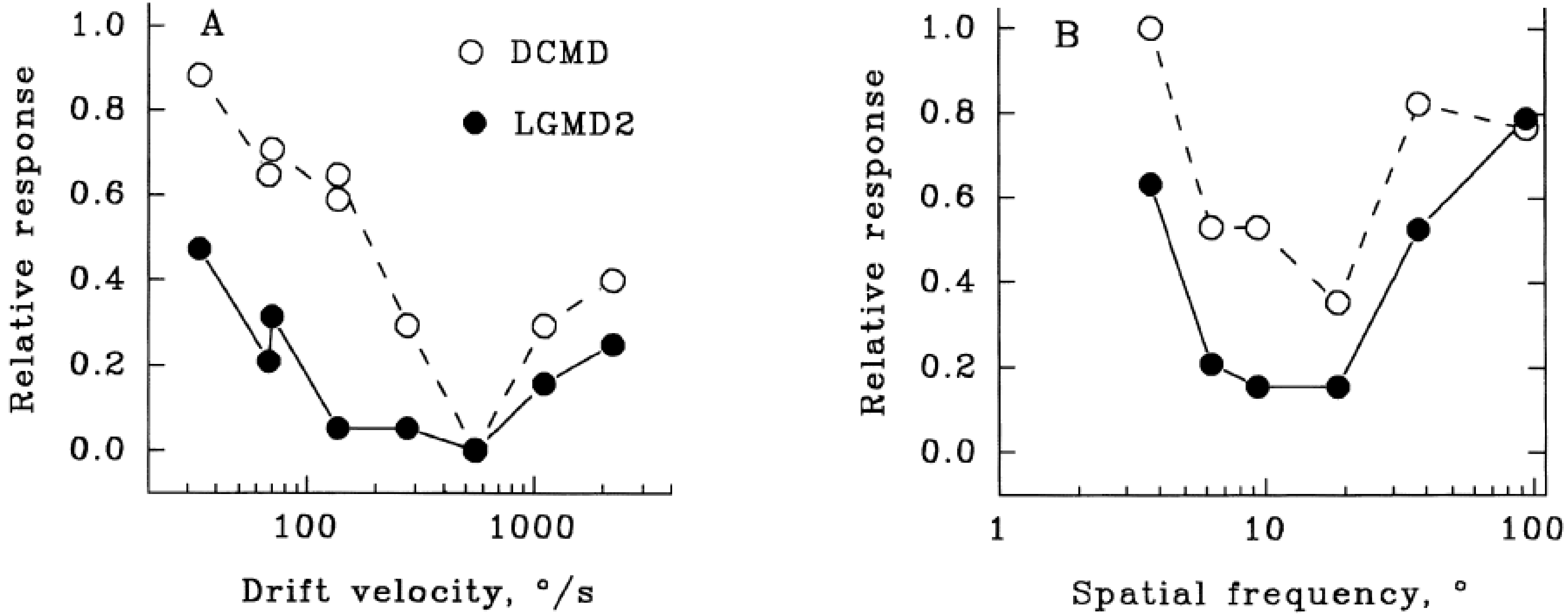


(Simmons & Rind, 1997)

How does it do it?

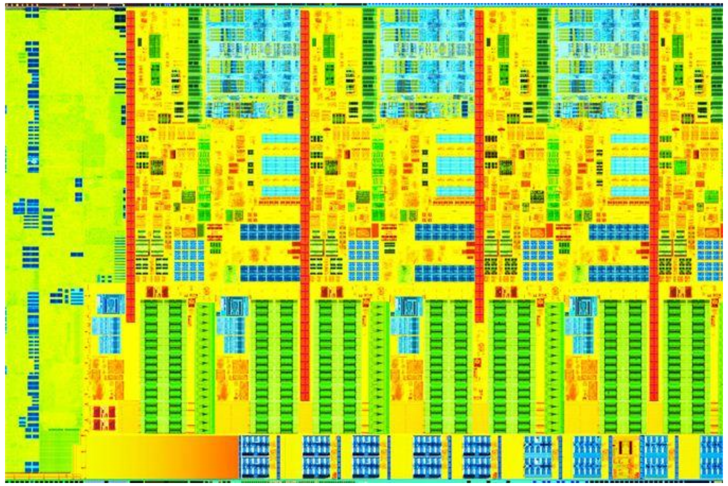
Four more points:

4, Background movement suppresses response vigour.

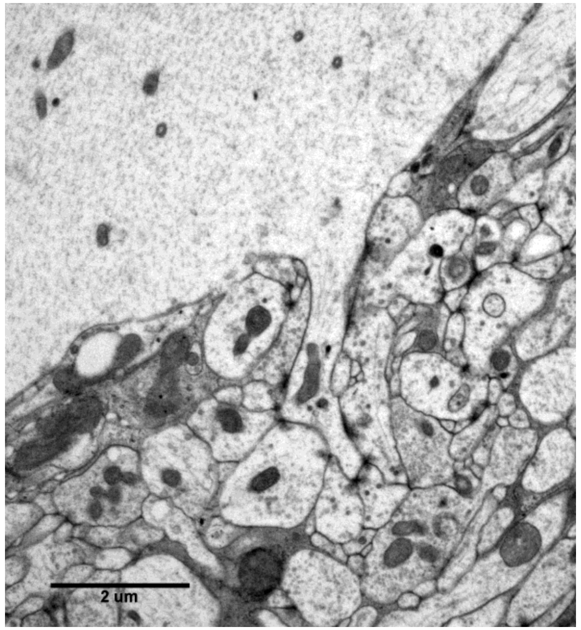


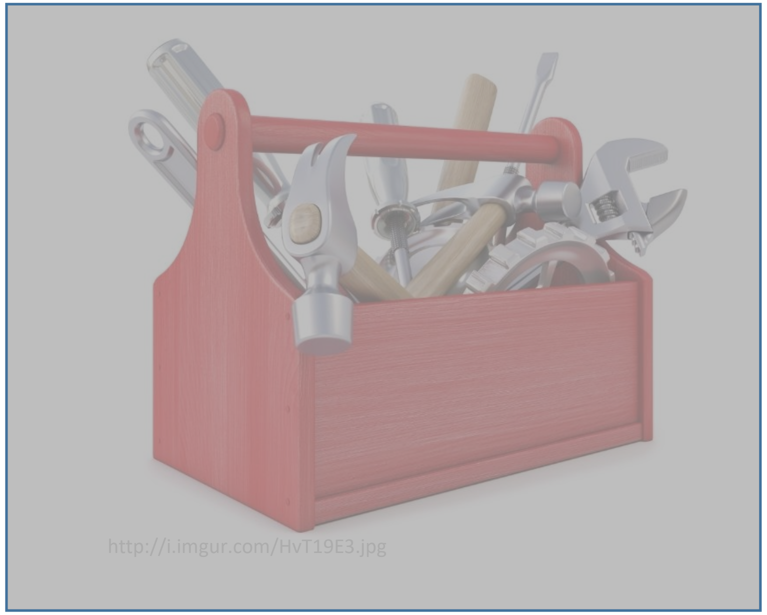
(Simmons & Rind, 1997)

Evolved and Designed Brains.



https://images.anandtech.com/doci/7003/Haswell_Quad_Core_Hero_HR_678x452.jpg





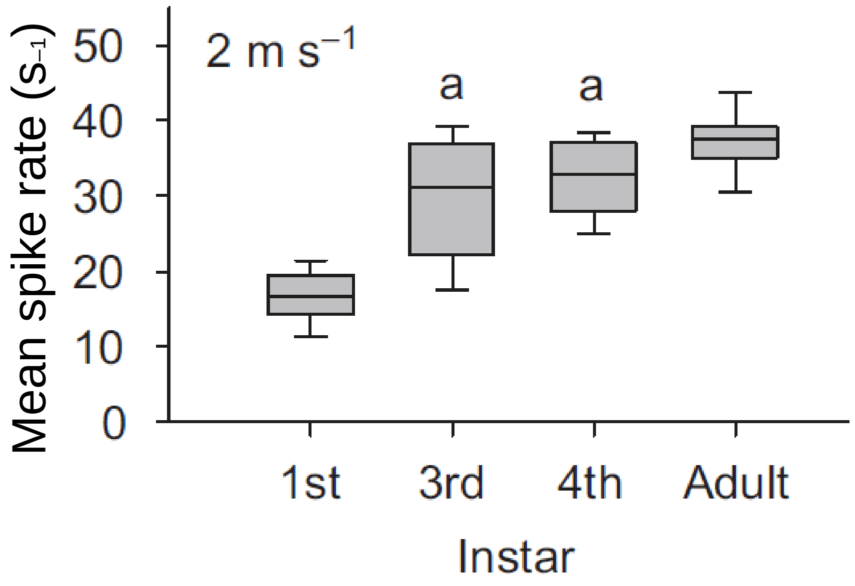
http://i.imgur.com/HvT19E3.jpg

Evolved and Designed Brains.

Transistor density about same as synapse density – but brains are much larger.
Brains and microprocessors are energy hungry.

Compared with electronic devices, neuronal networks:

- Not so neatly arranged.
- Slow.
- Unreliable.
- Change through lifetime.
- Less dedicated – multiple mechanisms work alongside each other.



Simmons, Sztarker, Rind (2013)

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