NEUROCINEMA

and the invention of reality

Sergio Neuenschwander

VISLAB
Brain Institute - UFRN
Natal


O QUE É CINEMA?

Amarcord, 1973

Federico Fellini

DER FILMAMATEUR, 1979
Krzysztof Kieslowski

Kárhozat / Damnation, 1988

Béla Tarr

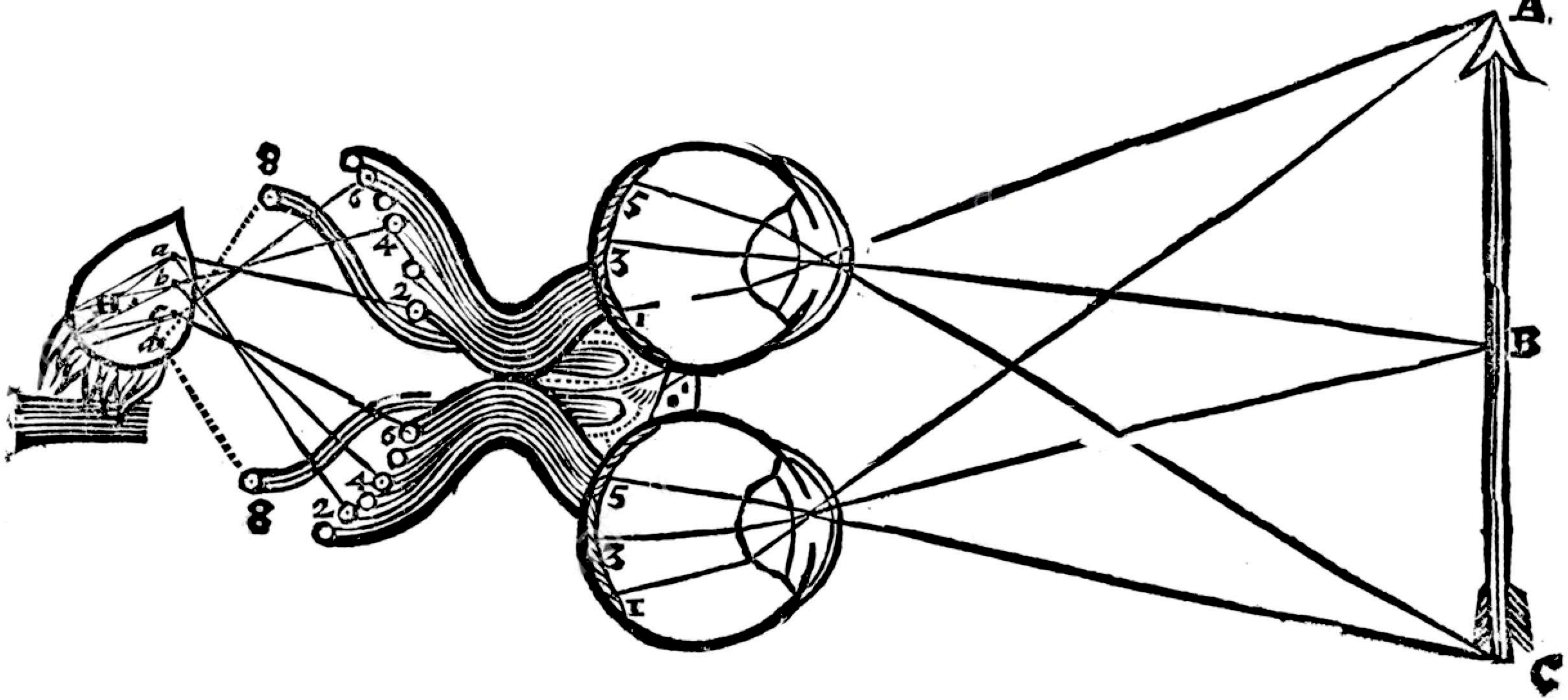

O QUE É VER?

View from a window in Gras, zinc plate, 1826
Joseph Nicéphore Niépce
„heliography“

Image **representation**.

— images of objects are not only produced in the back of the eye, but also sent to the brain.

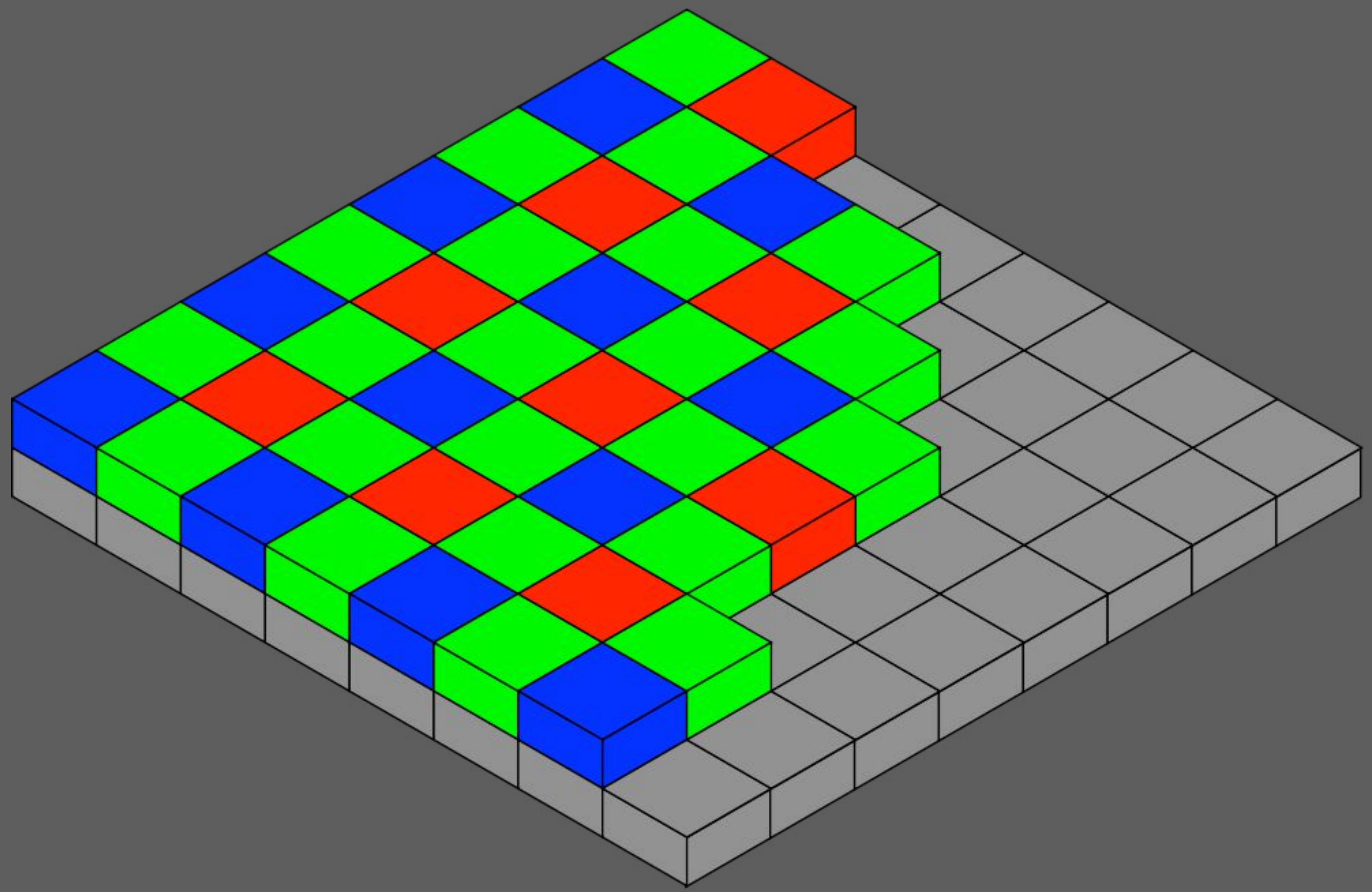
DESCARTES
La Dioptrique, 1637



Cones and rods of a mammalian retina

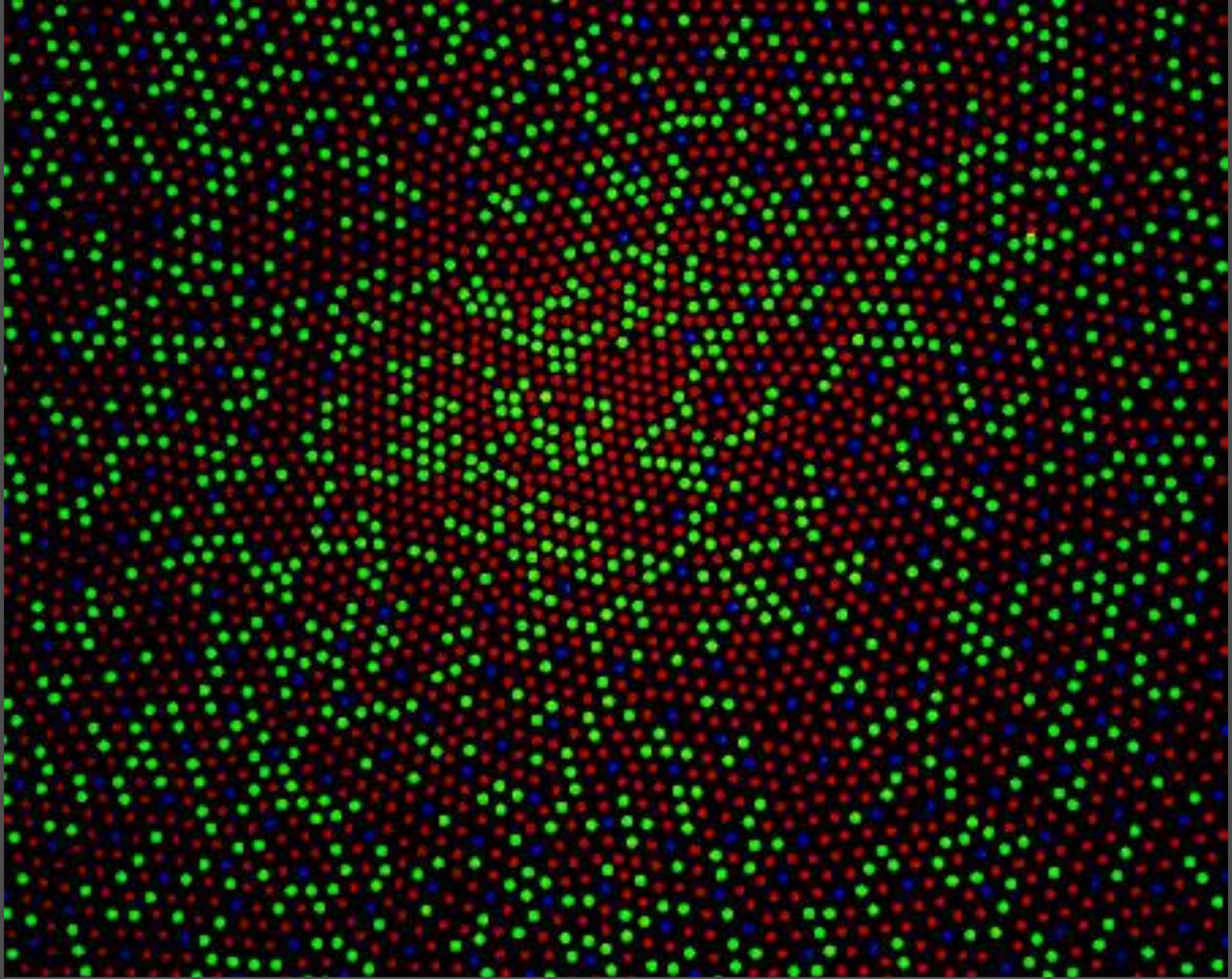
Clouds Hill Imaging, Science Photo Library

Mouse retina
W Ju, K Kim and M Ellisman, 2016.



BAYER MOSAIC
(CMOS sensor)

BAYER IMAGE



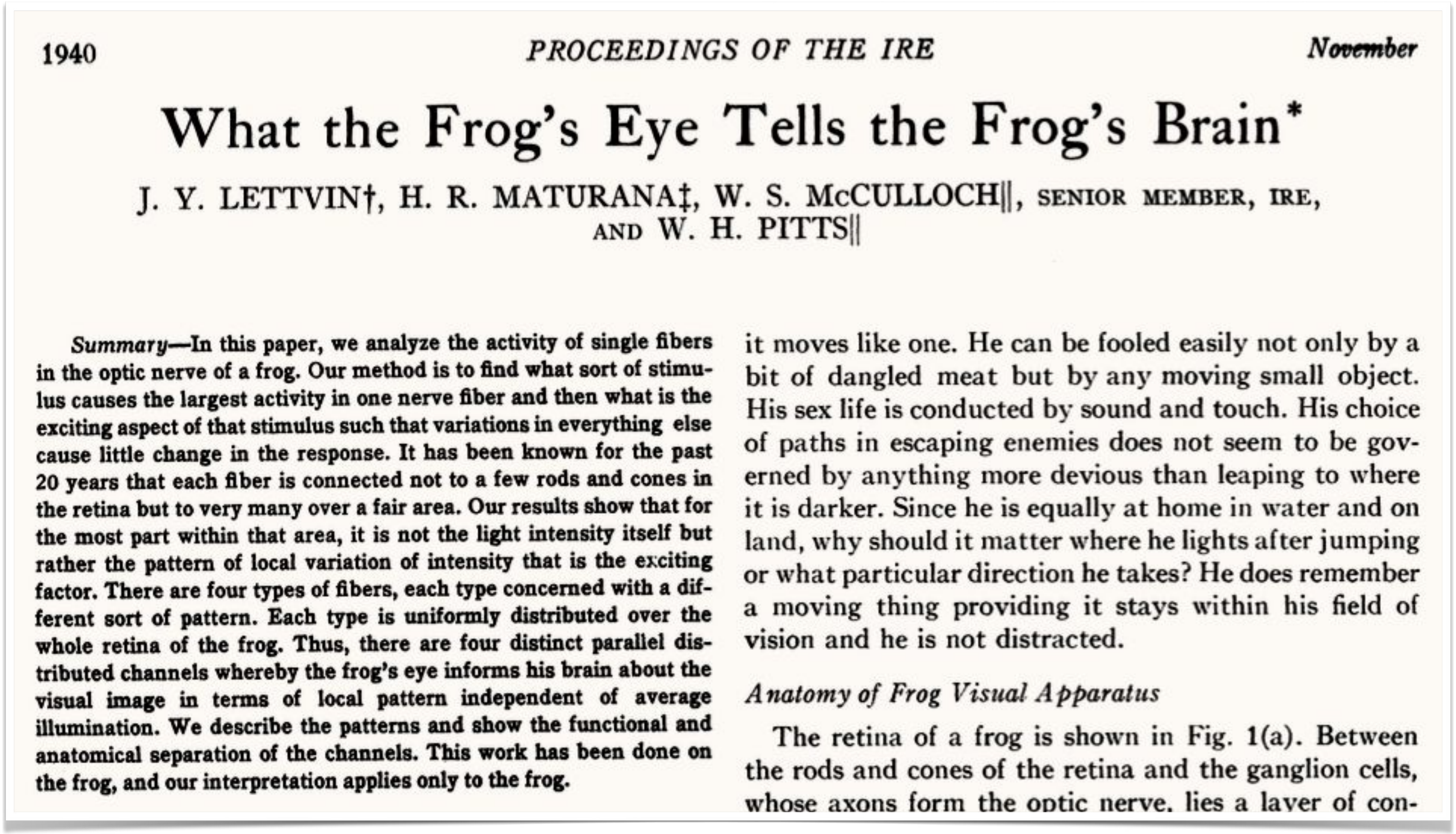
Cones in the human fovea

Mark Fairchild, 2010

— What the frog's eye tells the frog's brain?

Quarta-feira de Cinzas, 2006

Rivane Neuenschwander & Cao Guimarães, TATE MODERN


1940 *PROCEEDINGS OF THE IRE* November

What the Frog's Eye Tells the Frog's Brain*

J. Y. LETTVIN†, H. R. MATURANA‡, W. S. McCULLOCH||, SENIOR MEMBER, IRE, AND W. H. PITTS||

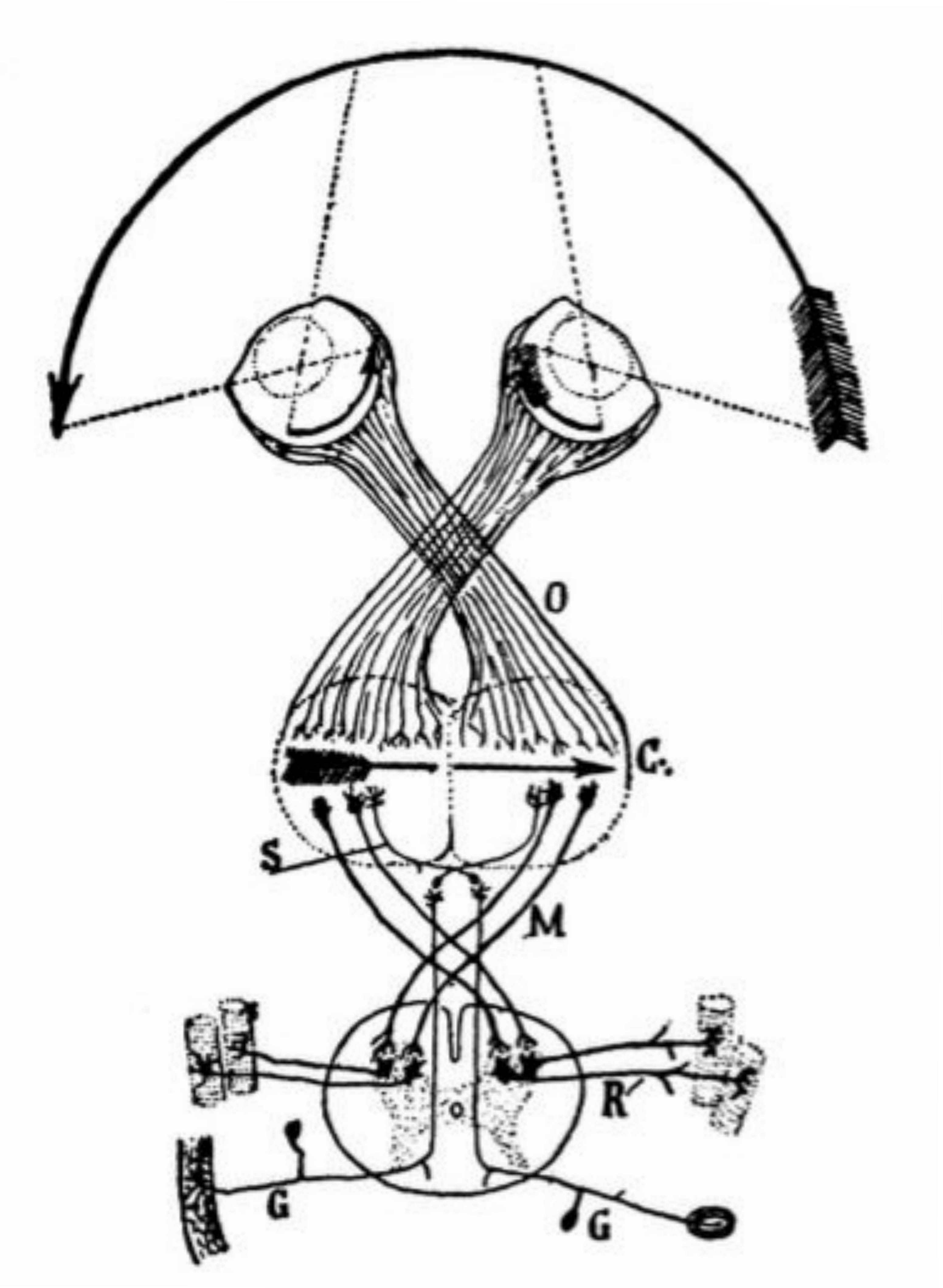
Summary—In this paper, we analyze the activity of single fibers in the optic nerve of a frog. Our method is to find what sort of stimulus causes the largest activity in one nerve fiber and then what is the exciting aspect of that stimulus such that variations in everything else cause little change in the response. It has been known for the past 20 years that each fiber is connected not to a few rods and cones in the retina but to very many over a fair area. Our results show that for the most part within that area, it is not the light intensity itself but rather the pattern of local variation of intensity that is the exciting factor. There are four types of fibers, each type concerned with a different sort of pattern. Each type is uniformly distributed over the whole retina of the frog. Thus, there are four distinct parallel distributed channels whereby the frog's eye informs his brain about the visual image in terms of local pattern independent of average illumination. We describe the patterns and show the functional and anatomical separation of the channels. This work has been done on the frog, and our interpretation applies only to the frog.

it moves like one. He can be fooled easily not only by a bit of dangled meat but by any moving small object. His sex life is conducted by sound and touch. His choice of paths in escaping enemies does not seem to be governed by anything more devious than leaping to where it is darker. Since he is equally at home in water and on land, why should it matter where he lights after jumping or what particular direction he takes? He does remember a moving thing providing it stays within his field of vision and he is not distracted.

Anatomy of Frog Visual Apparatus

The retina of a frog is shown in Fig. 1(a). Between the rods and cones of the retina and the ganglion cells, whose axons form the optic nerve, lies a layer of con-

Our method consists of finding in the frog's optic nerve which **type of stimulus causes the greatest activity in a cell** and then identifying which are the **most effective aspects of this stimulus**, so that variations in everything else cause little change in the response.

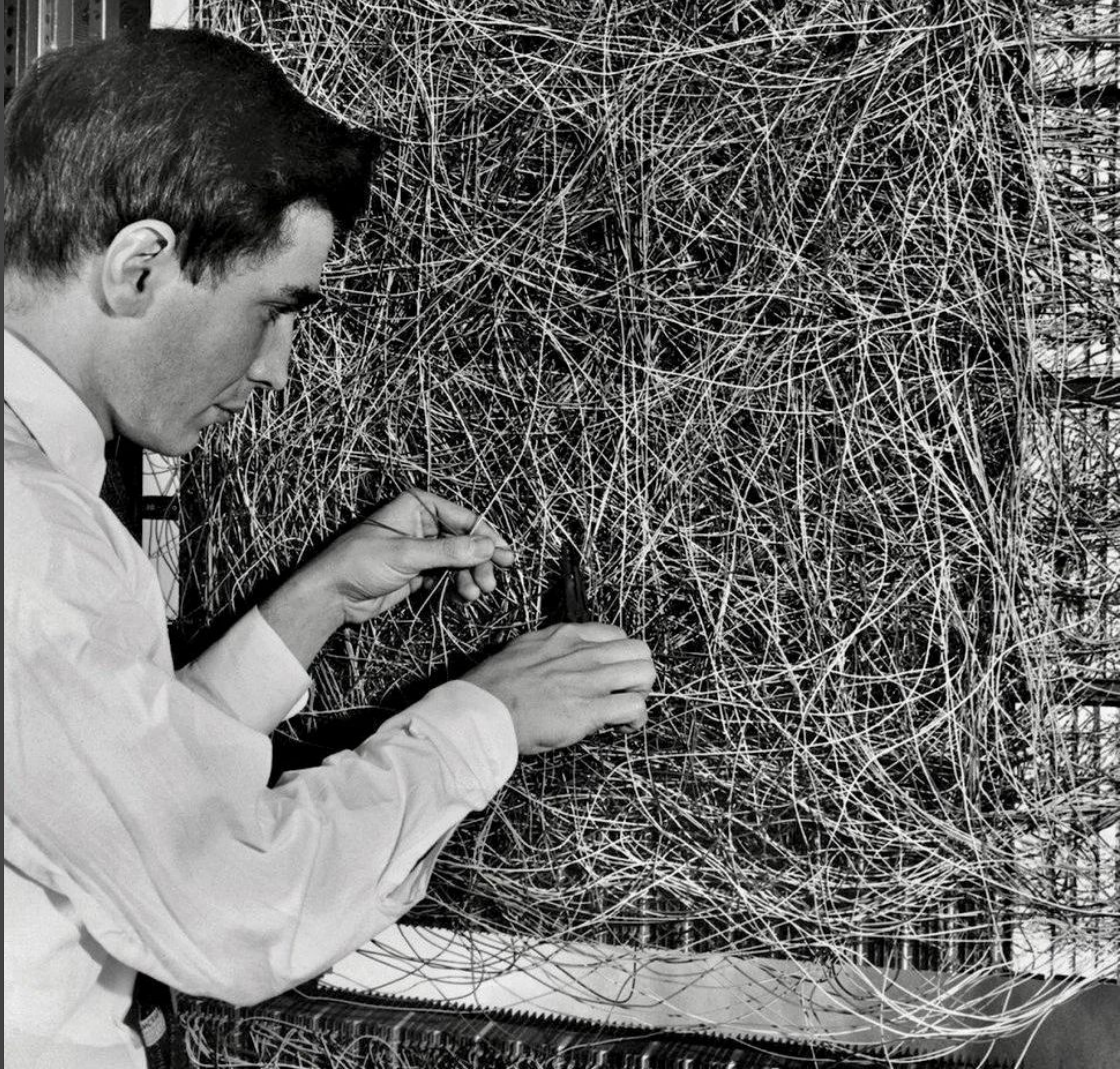


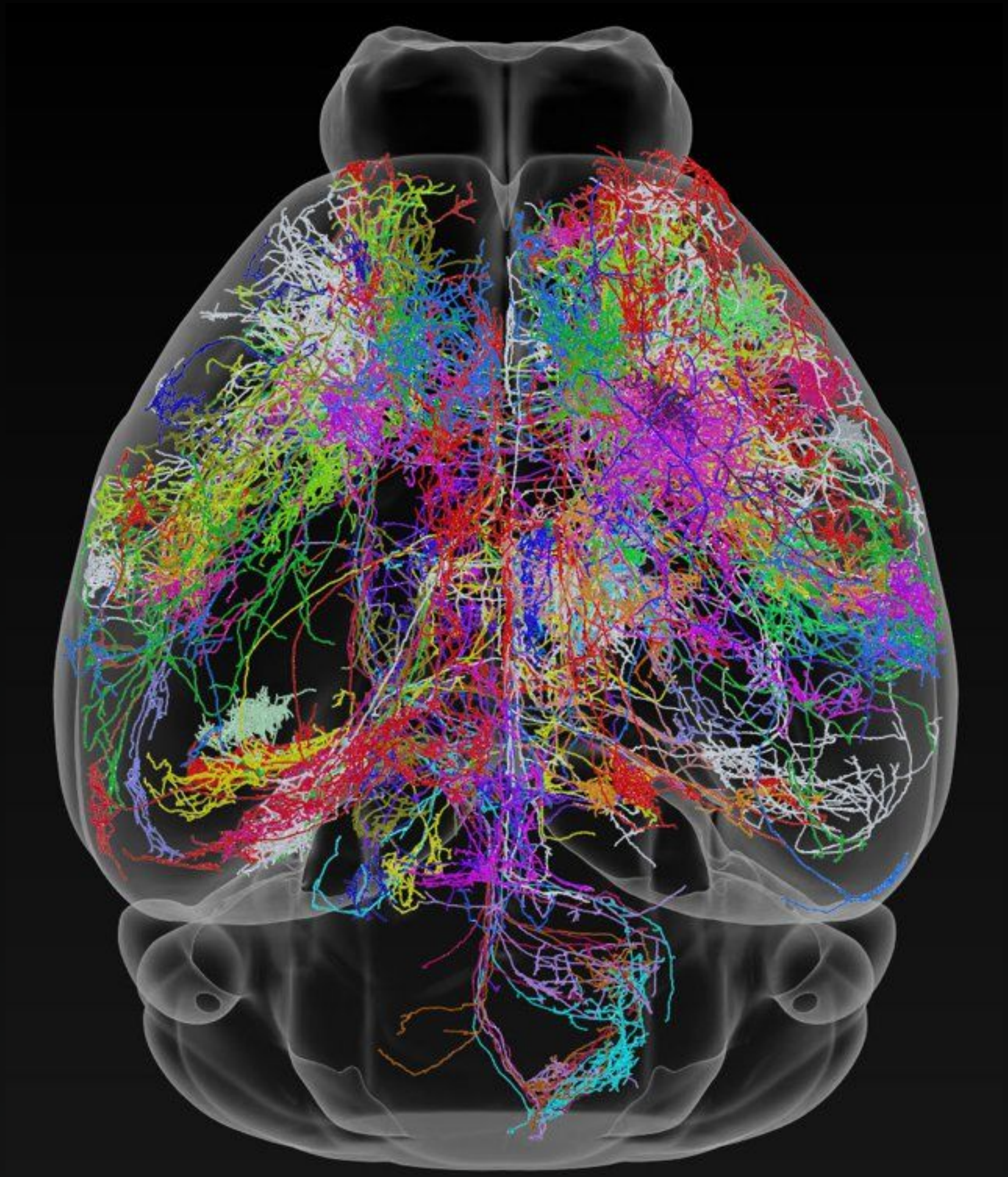
Lettvin… Pitts, Proc. Inst. Radio Engr 1959.

In the basic version, a **Perceptron** consisted of a single artificial neuron with adjustable weights and a threshold.

Perceptron networks convert an input vector into an output vector, functioning as a simple associative memory.

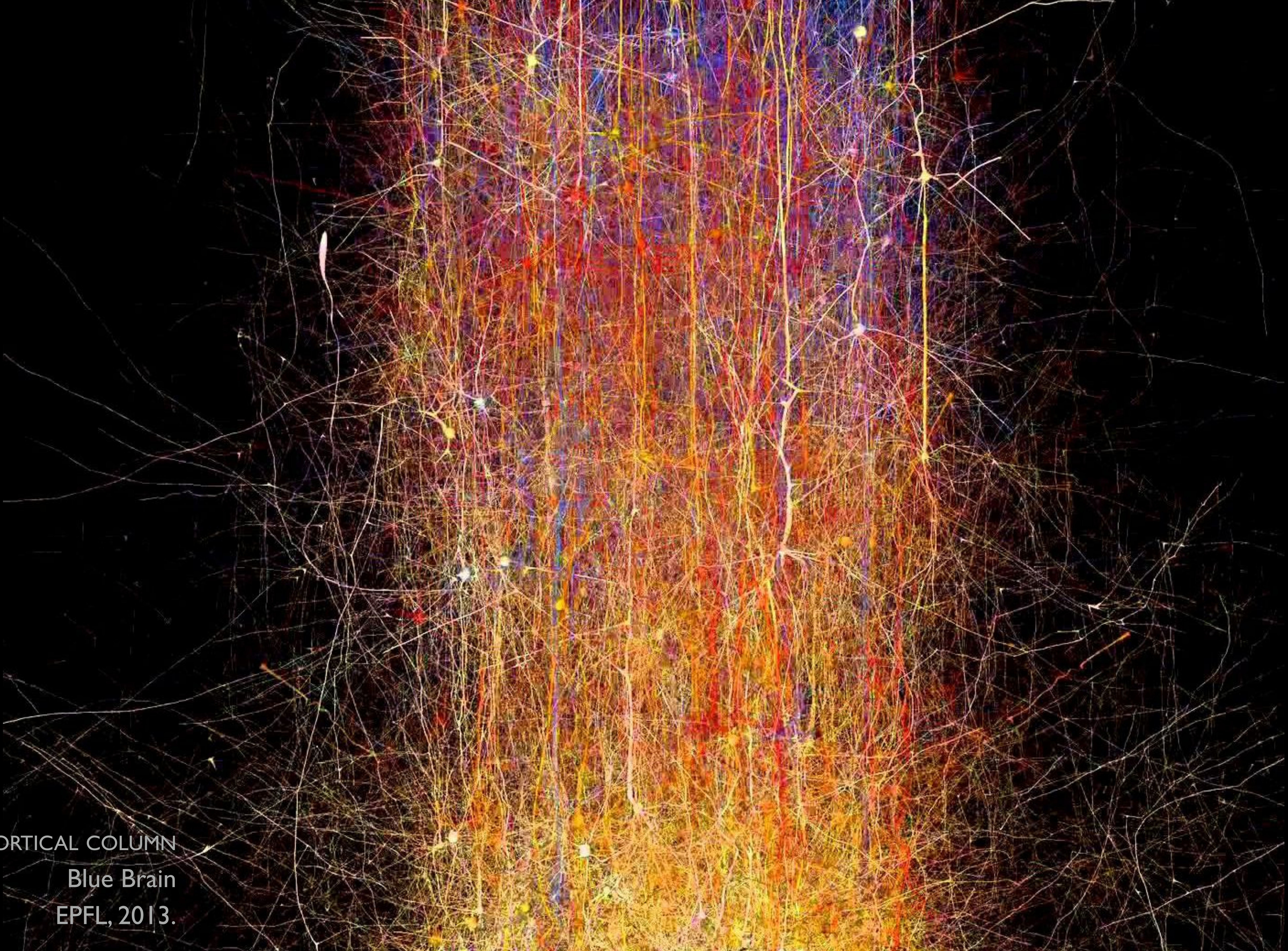
PERCEPTRON de Frank Rosenblatt
(MARK I, Cornell, 1960.





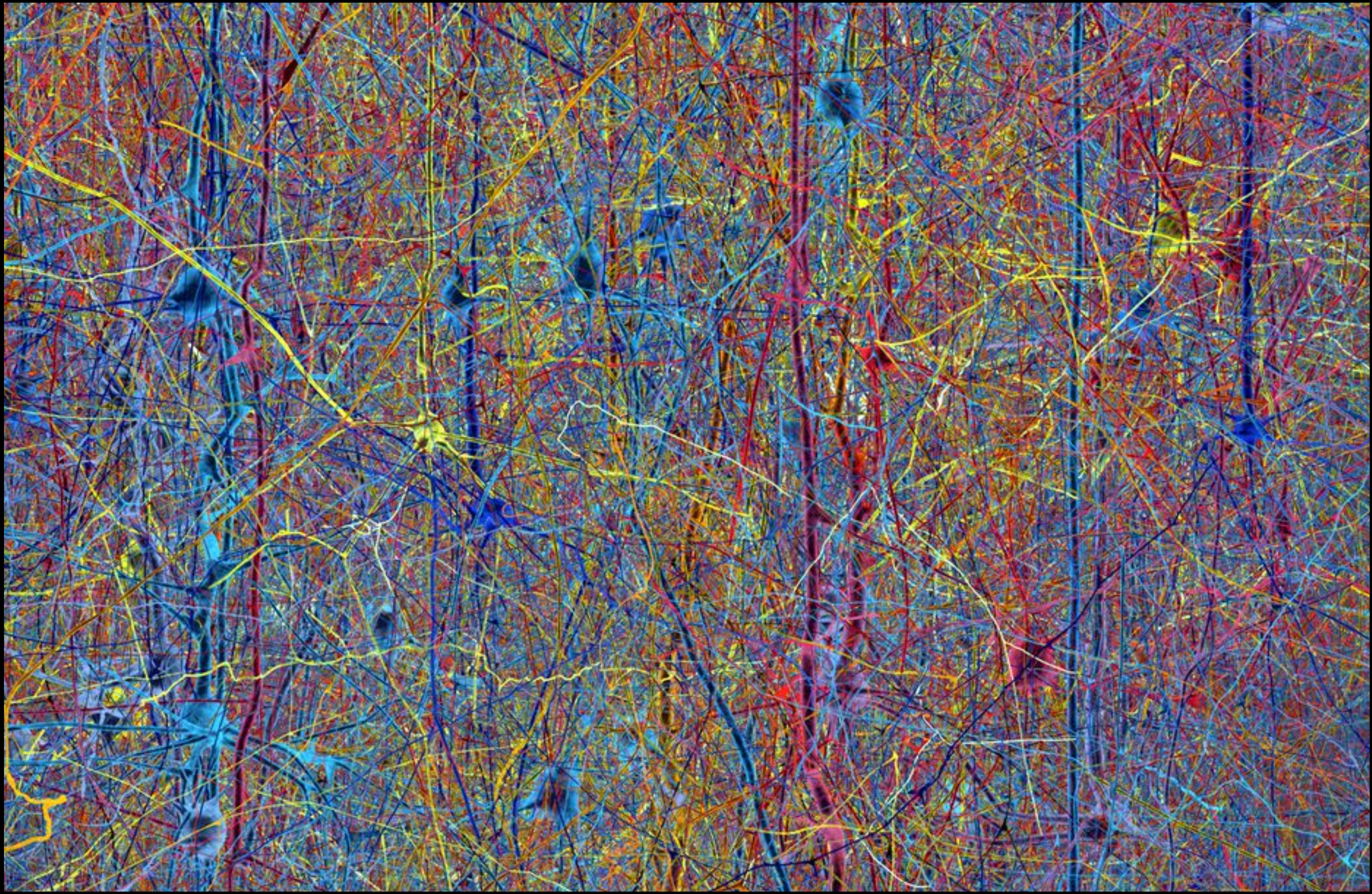
THE SIZE OF THE BRAIN

300 neurons
In a mouse brain

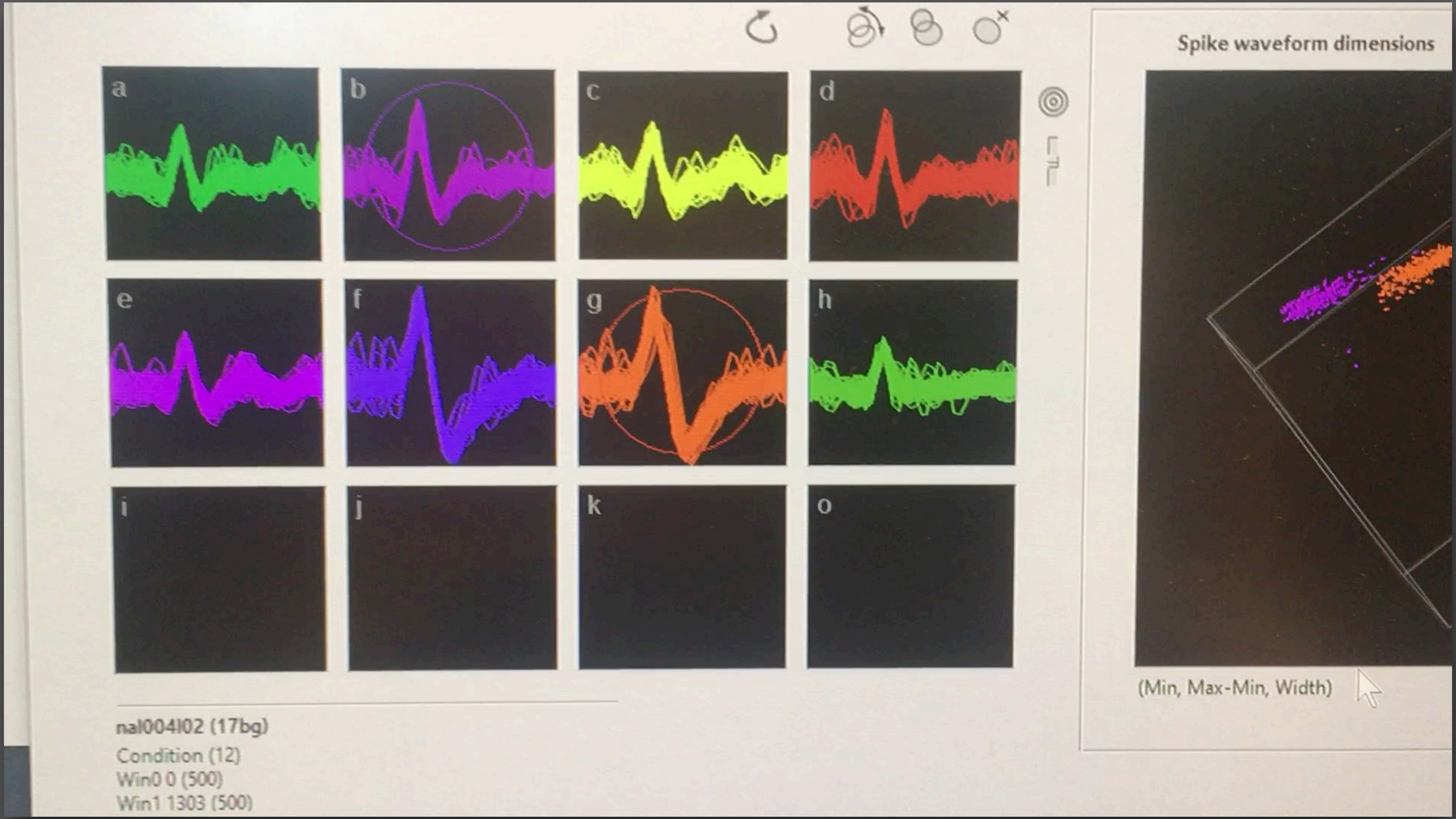


Cortical column
Blue Brain
EPFL, 2013.

— A complex and seemingly impenetrable world of interacting cells.

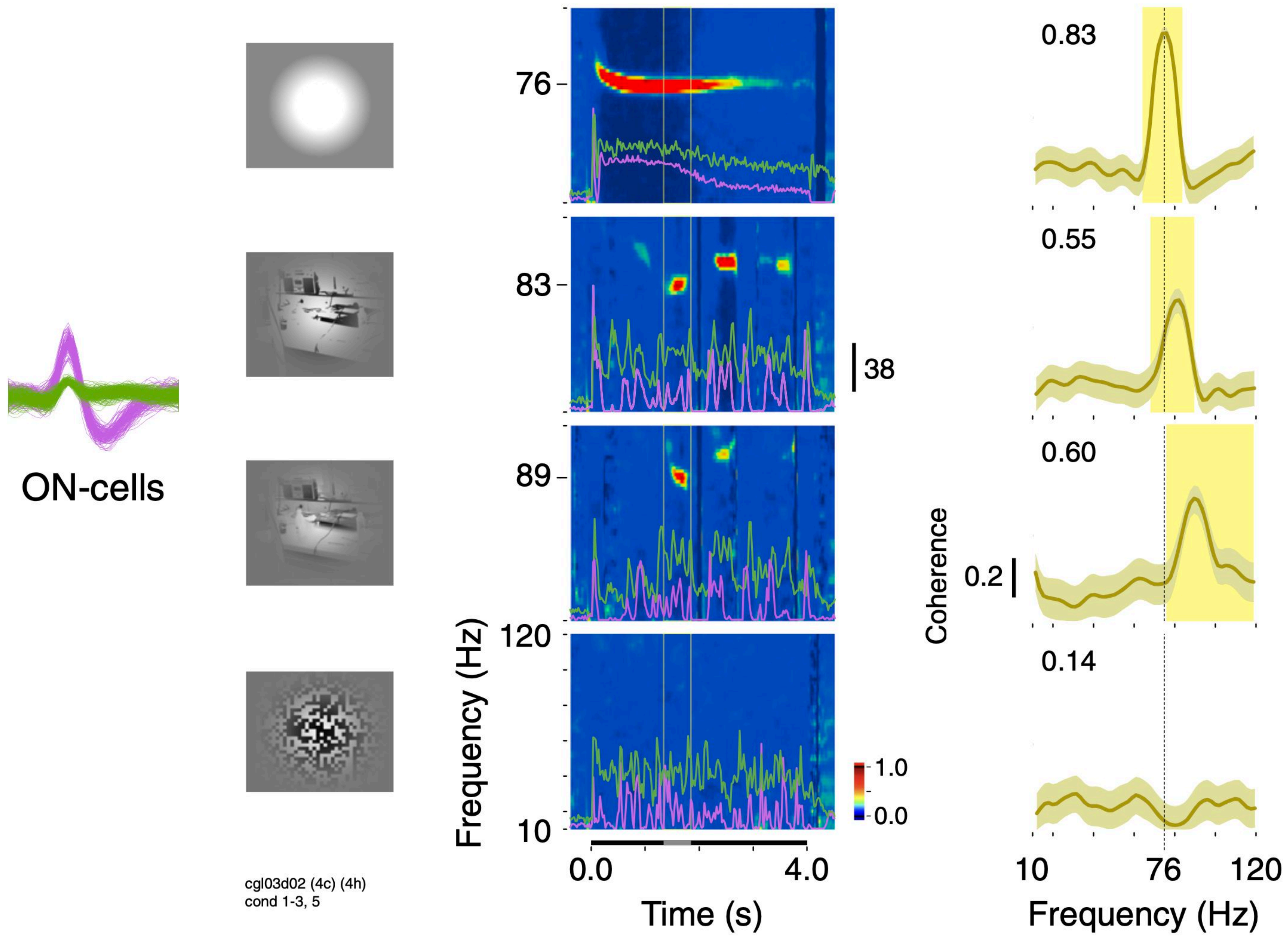


JAVIER DEFELIPE
Blue Brain Project
EPFL, 2005 – 2017

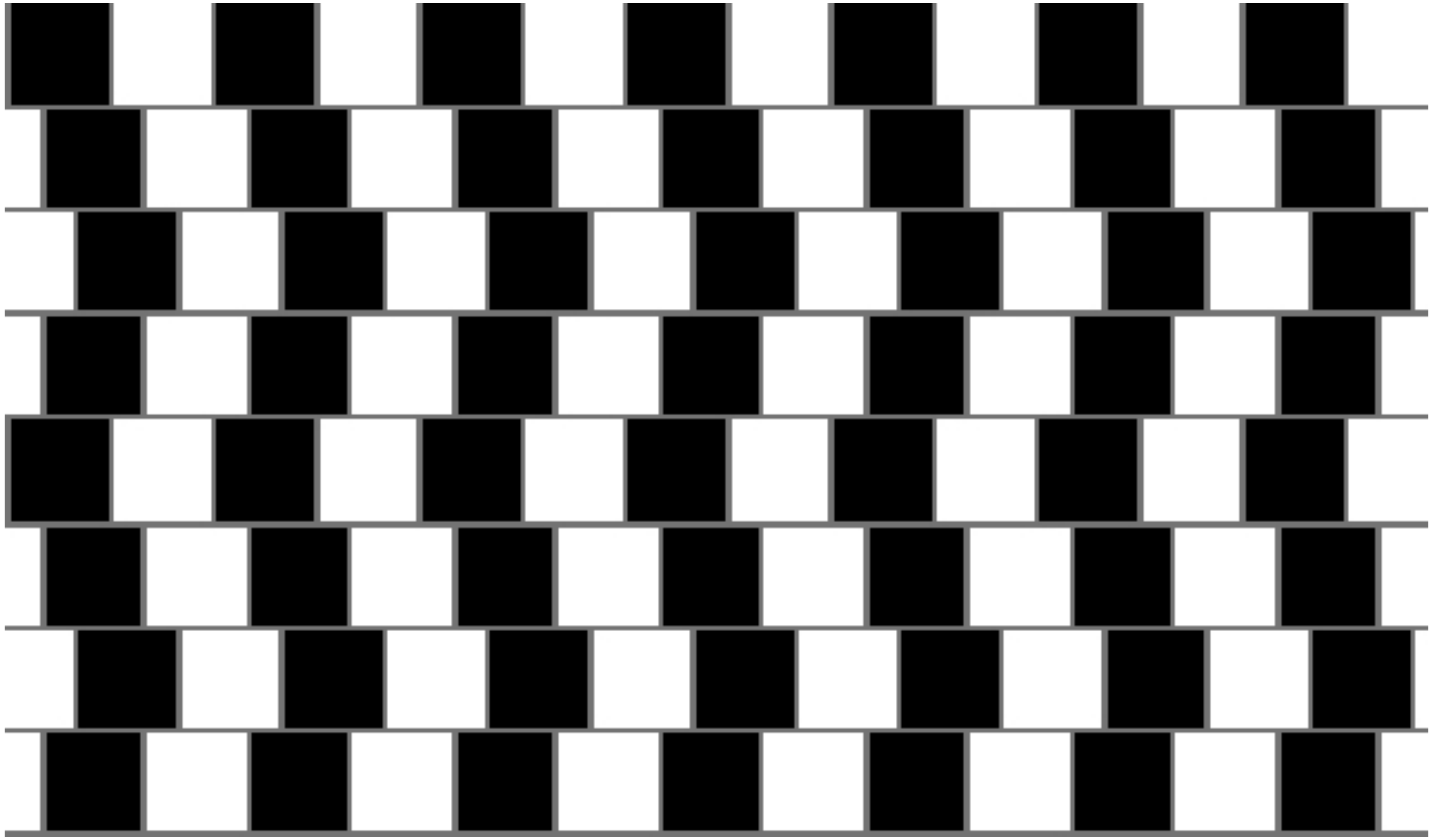

Spike waveform dimensions
a
b
c
d
e
f
g
h
i
j
k
o
(Min, Max-Min, Width)
nal004l02 (17bg)
Condition (12)
Win0 0 (500)
Win1 1303 (500)

Retina

stimulus → response



Neuenschwander, Rosso … Baron,
J NEUROSCI 2023



Is it real?

FRANCISCO VARELA,
1989.

Love lettering
2002
Rivane & Sergio
Neuenschwander
The Walker Center

Color **constancy**.

The real.

Motion **illusion**.

Motion studies, 1883
Étienne-Jules Marey

— persistence of vision?

Zoetrop
William George Horner, 1834

Blow
Rivane Neuenschwander
Cao Guimarães
2000
GUGGENHEIM MUSEUM

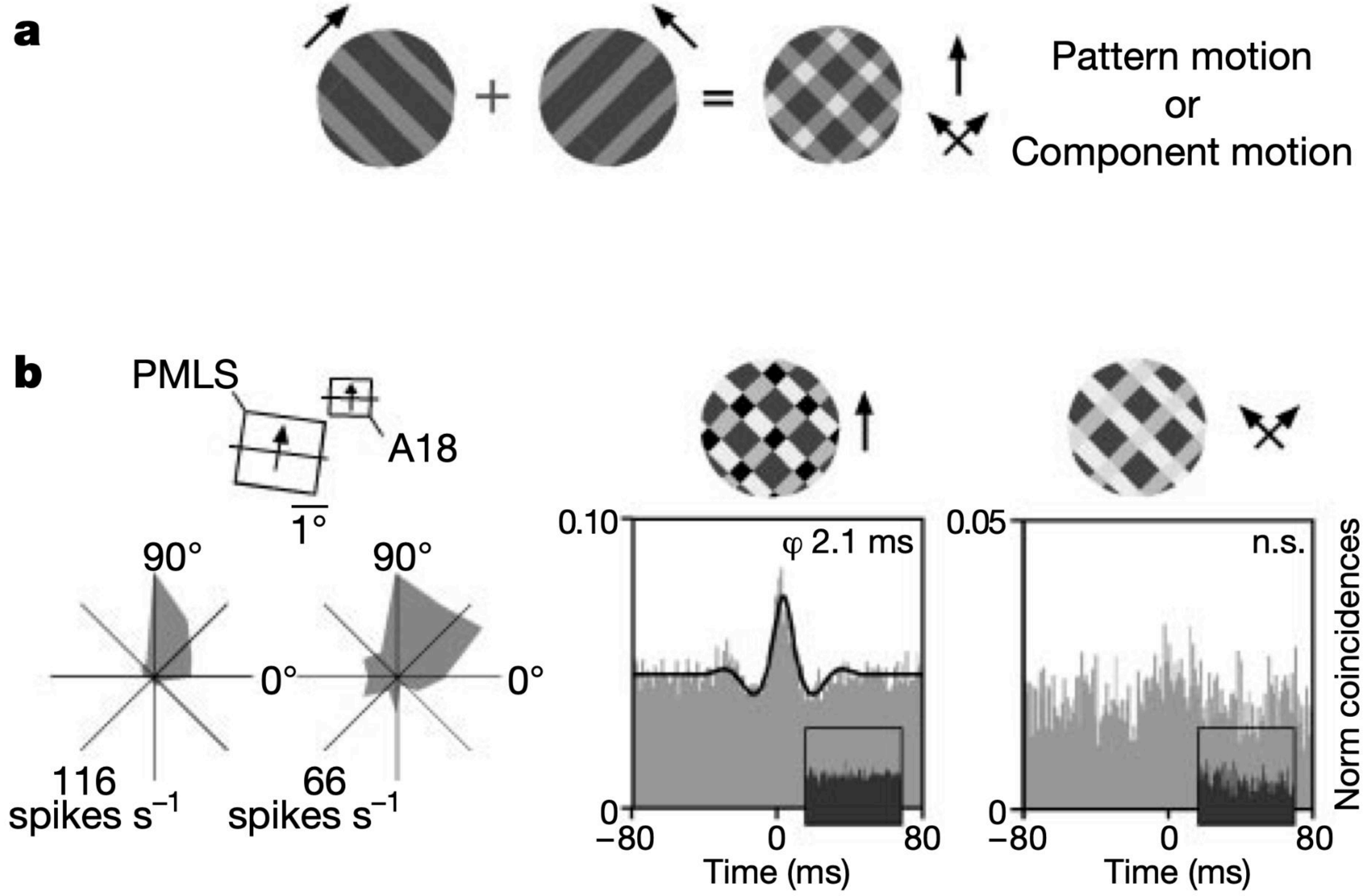
Inventing **reality**.

NORMAN MACLAREN, 1950.

Pangaea's Diaries, 2008
Rivane Neuenschwander

Contingent, 2008
Rivane Neuenschwander

BBS in cortex.



CASTELO-BRANCO, GOEBEL, NEUENSCHWANDER & SINGER, Nature 2000

Controversies.

Neural synchrony correlates with surface segregation rules

Miguel Castelo-Branco, Rainer Goebel, Sergio Neuenschwander & Wolf Singer

Max-Planck-Institut für Hirnforschung, Deutschordenstraße 46, 60528 - Frankfurt am Main, Germany

To analyse an image, the visual system must decompo
into its relevant parts. Identifying distinct surface
operation in such analysis, and is believed to pr
recognition[1,2]. Two superimposed gratings moving
directions (plaid stimuli) may be perceived either a
one being transparent and sliding on top of the oth
motion) or as a single pattern whose directio
intermediate to the component vectors (pattern
degree of transparency, and hence the perception
lated by changing only the luminance of t
sections[7–12]. Here we show that neurons in t
areas—A18 and PMLS—synchronize their
responding to contours of the same surf
responding to contours belonging to diff
amplitudes of responses correspond to pre
predictions[3,13–16] for component and pat
contrast to synchrony, failed to reflect th
ponent to pattern motion induced by ma
transparency. Thus, dynamic changes in
encode, in a context-dependent way, relation
taneous responses to spatially superimposed contours
thereby bias their association with distinct surfaces.

Neuronal synchrony does not correlate with motion coherence in cortical area MT

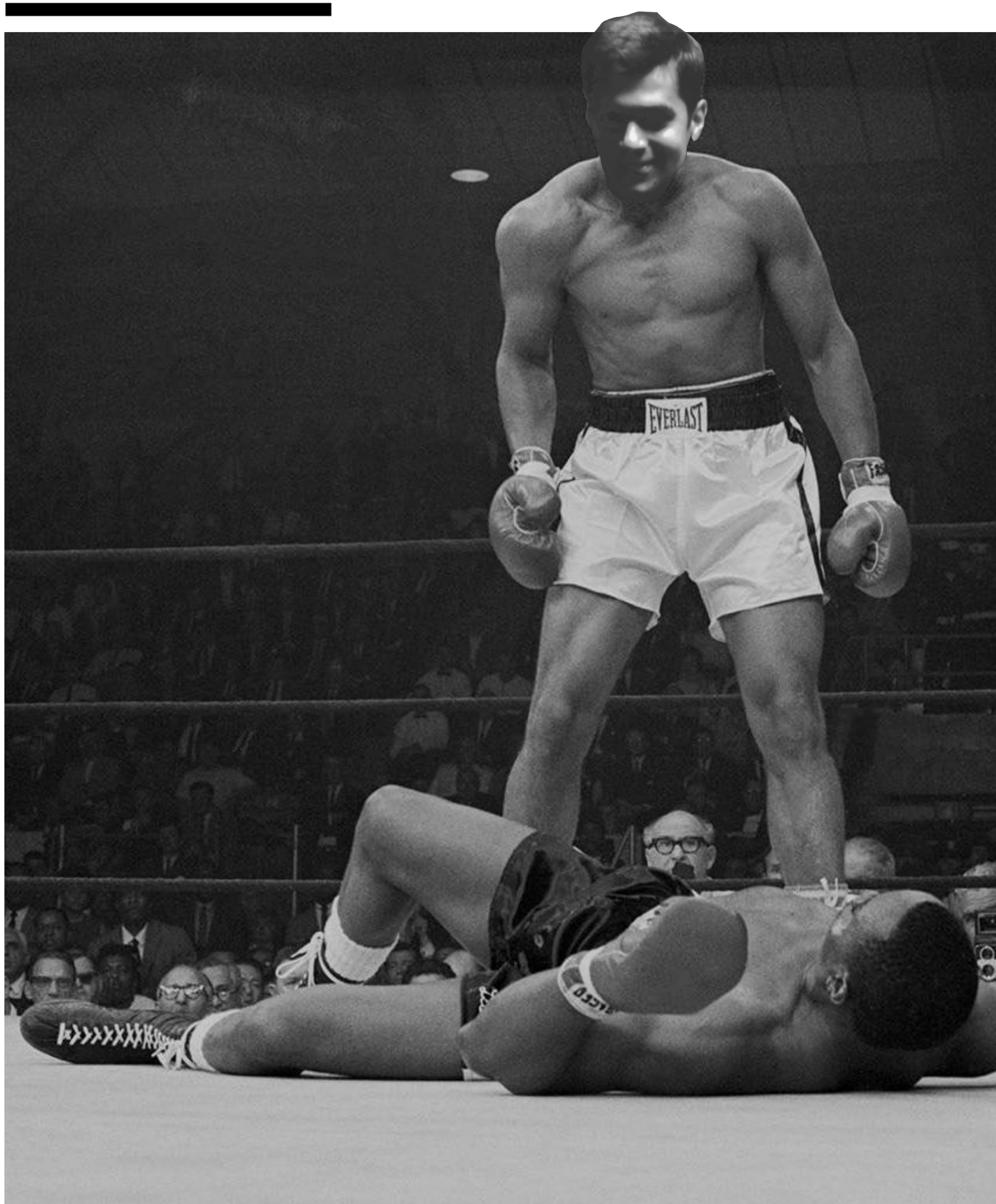
Alexander Thiele*† & Gene Stoner*

* *Salk Institute for Biological Studies, La Jolla, California 92037, USA*

Natural visual scenes are cluttered with multiple objects whose individual features must somehow be selectively linked ('bound') if perception is to coincide with reality. Recent neurophysiological evidence[1,2] supports a 'binding-by-synchrony' hypothesis[3]: neurons excited by features of the same object fire synchronously, while neurons excited by features of different objects do not. Moving plaid patterns offer a straightforward means to test this idea. By appropriate manipulations of apparent transparency, the component gratings of a plaid pattern can be seen as parts of a single coherently moving surface or as two non-coherently moving surfaces. We examined directional tuning and synchrony of area-MT neurons in awake, fixating primates in response to perceptually coherent and non-coherent plaid patterns. Here we show that directional tuning correlated highly with perceptual coherence, which is consistent with an earlier study[4]. Although we found stimulus-dependent synchrony, coherent plaids elicited significantly less synchrony than did non-coherent plaids. Our data therefore do not support the binding-by-synchrony hypothesis as applied to this class of motion stimuli in area MT.

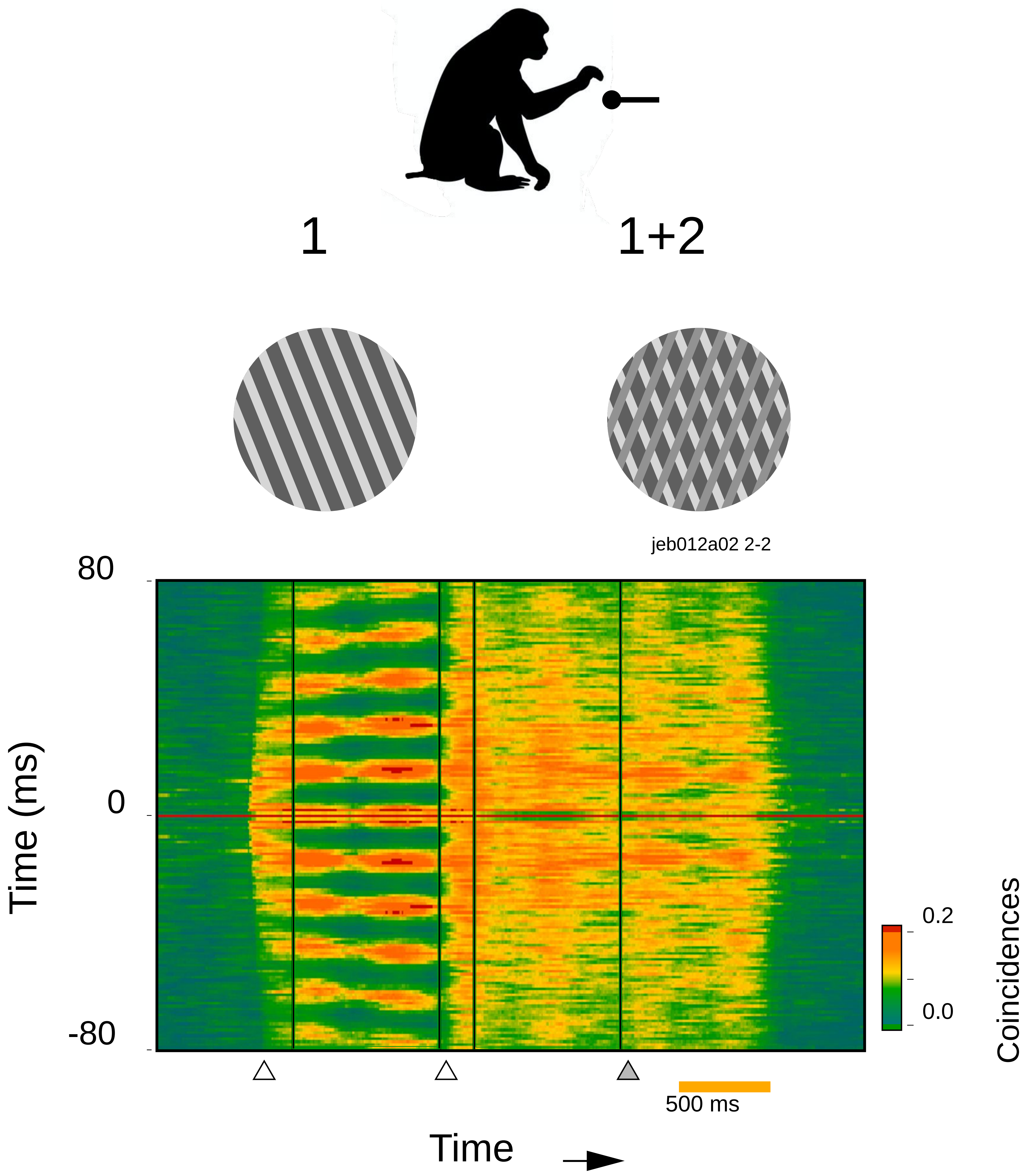
To confirm that monkeys' perception is influenced by transparency manipulations[5–8], we trained one monkey to distinguish coherent from non-coherent motion. After training, perceptual reports were obtained for nine probe plaids. For eight of these

letters to nature



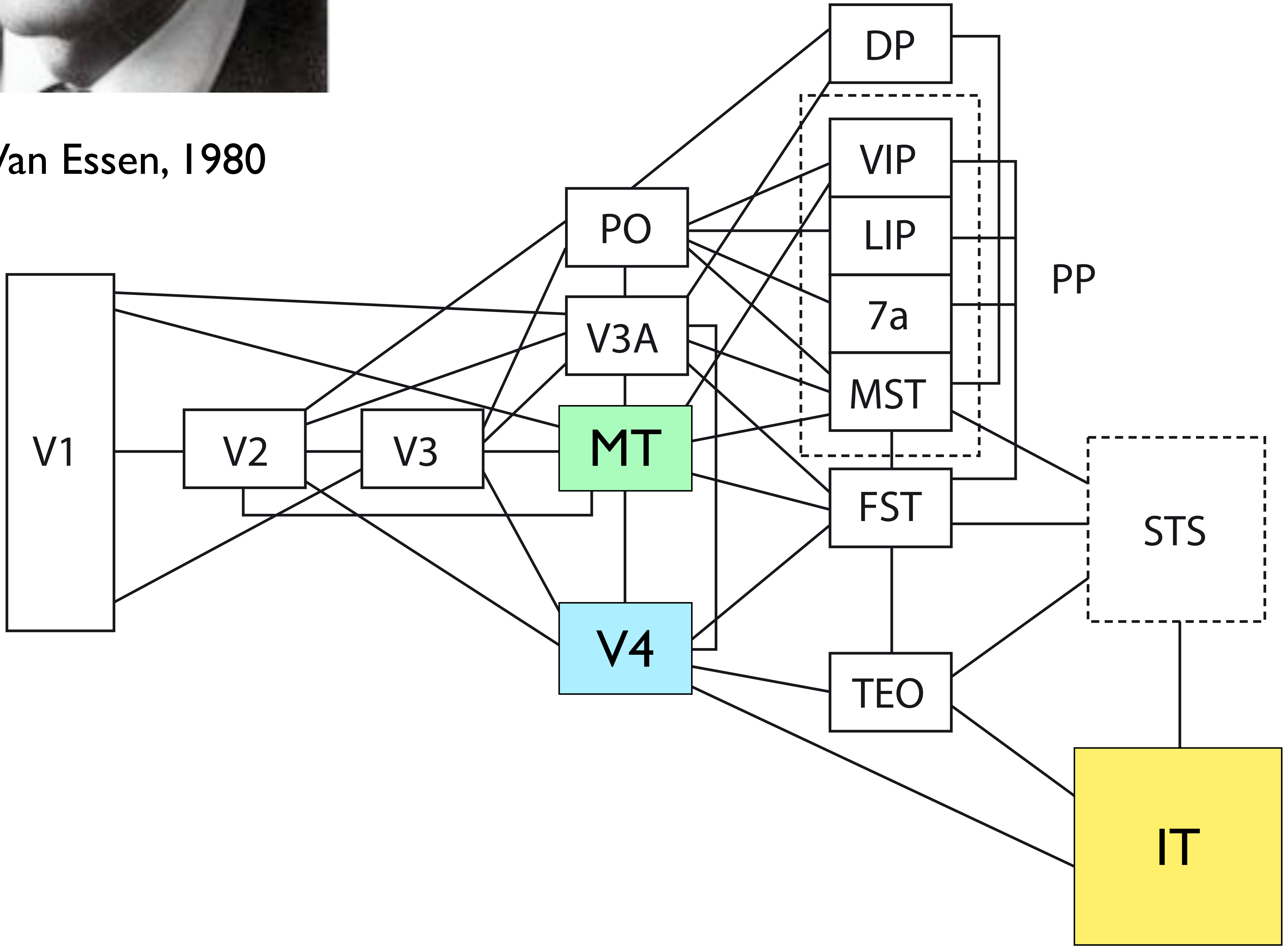
From the window of my room
Cao Guimarães
2004
CANNES

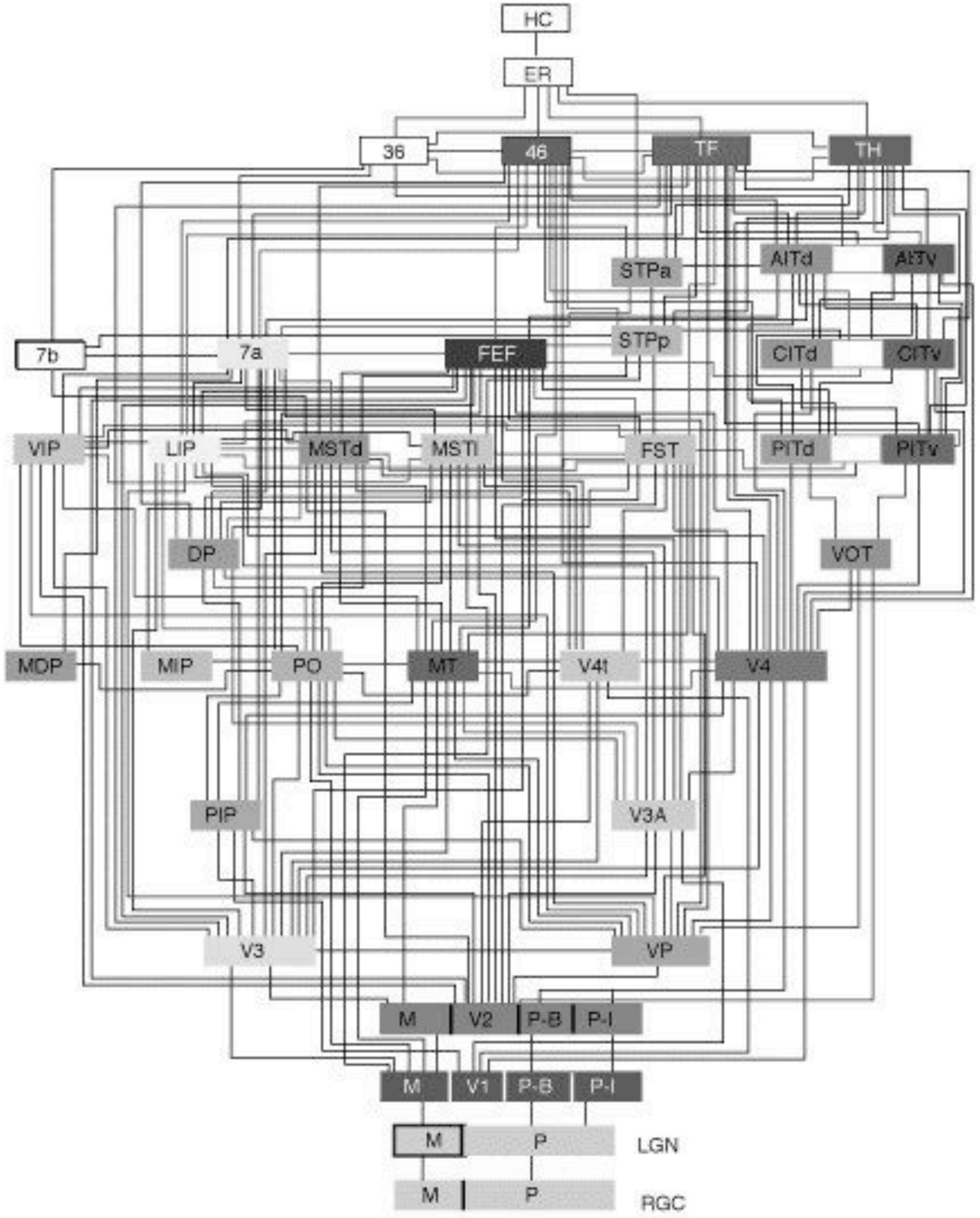
Gamma coherence.



LIMA,... SINGER, NEUENSCHWANDER
Cereb Cortex, 2010

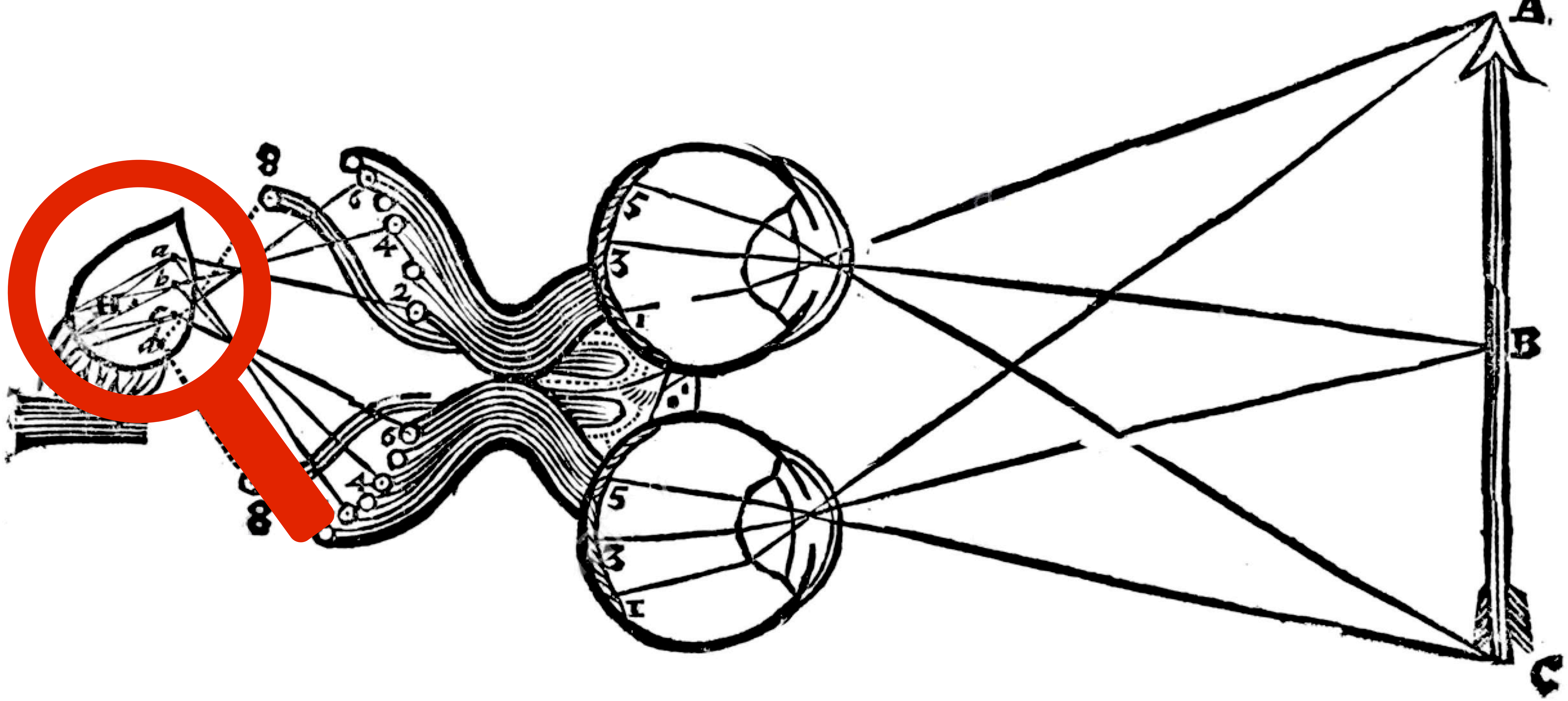
David Van Essen, 1980





A gambiarra cartesiana.

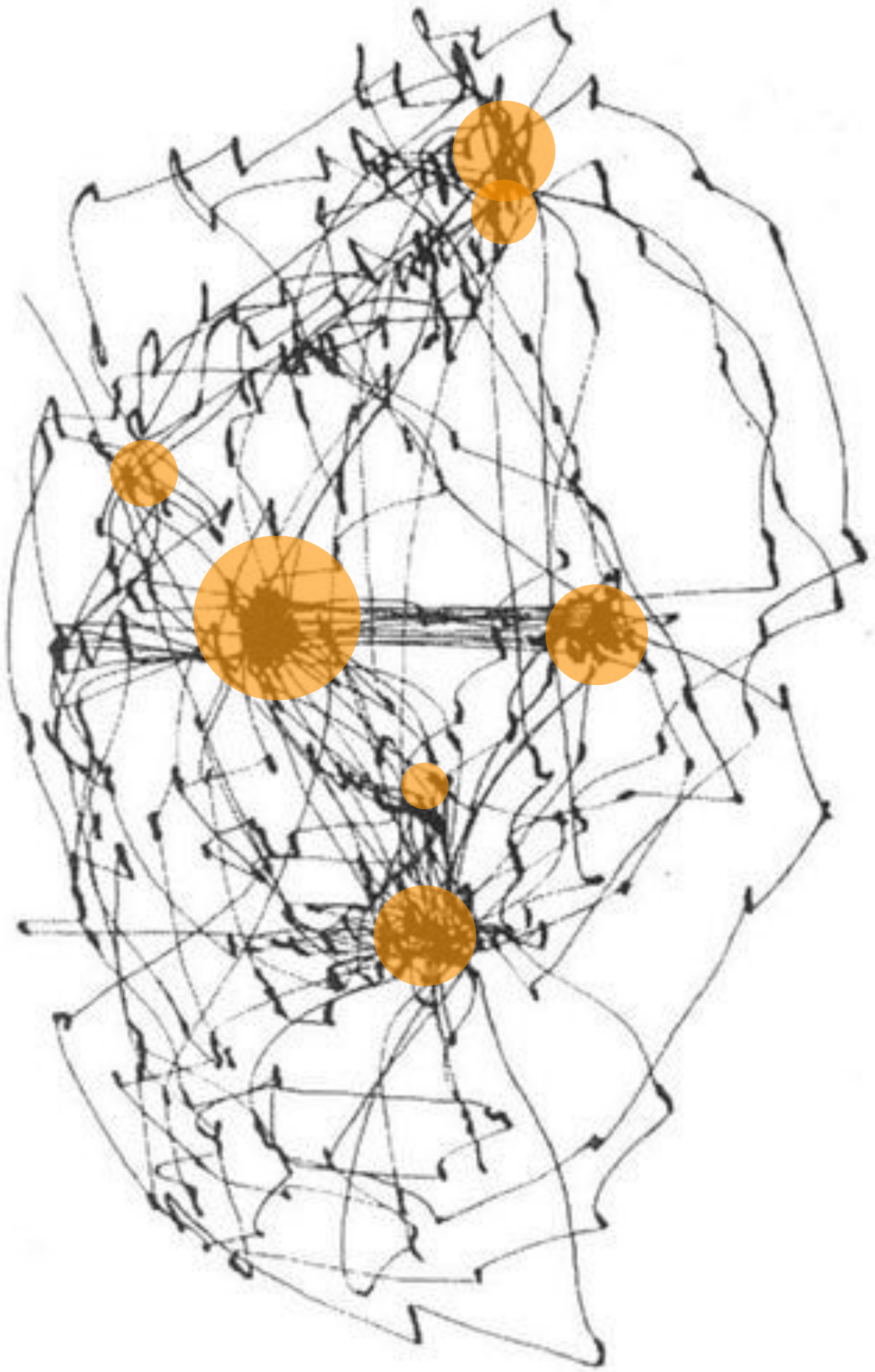
Convergence to a POV.



It is through our faces that we can be recognized as individuals.

On our face we carry the seal of our experiences.

Oliver Sacks, Face-Blind, 2010.

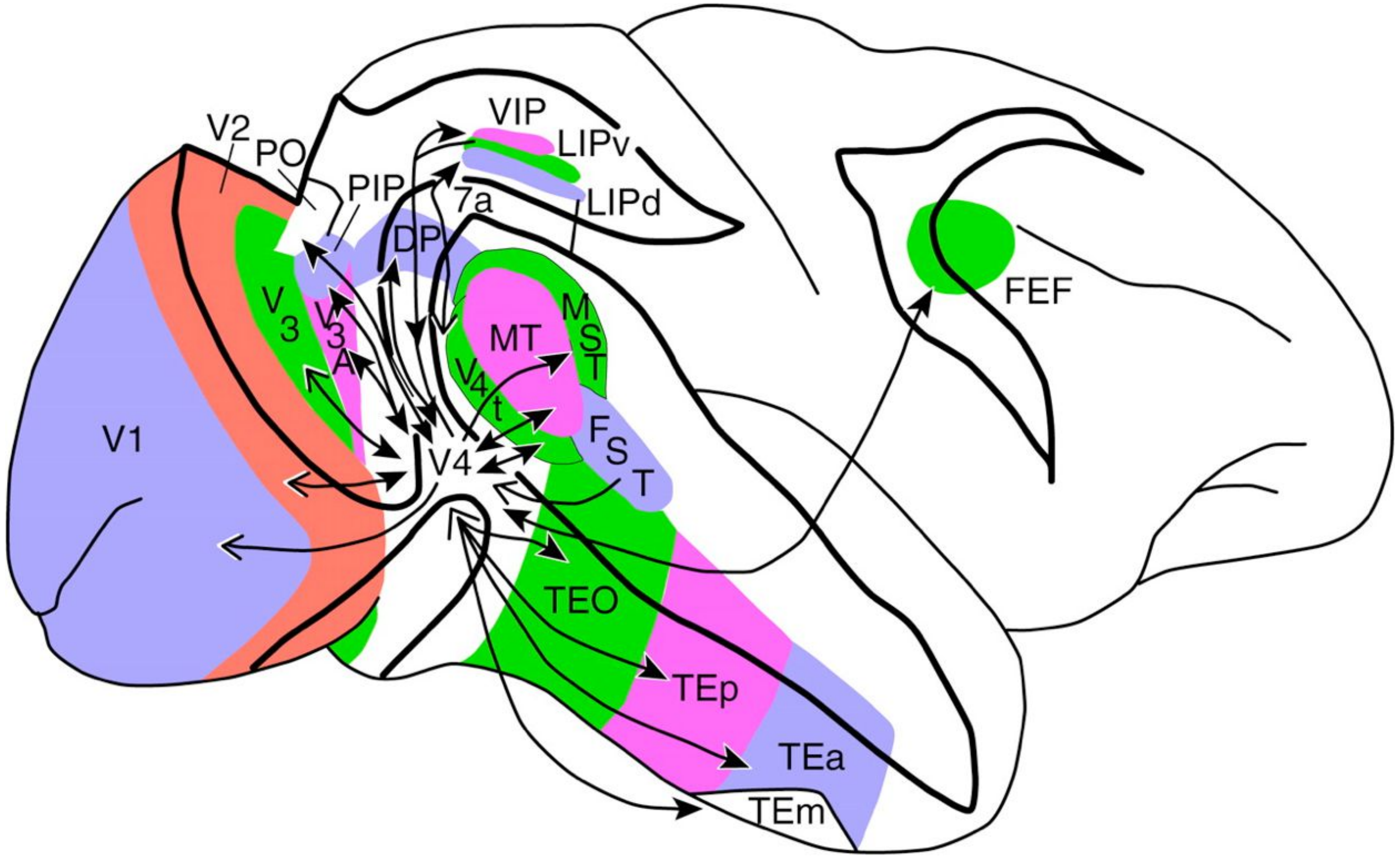


Alfred Yarbus,
Eye Movements and Vision, 1965.

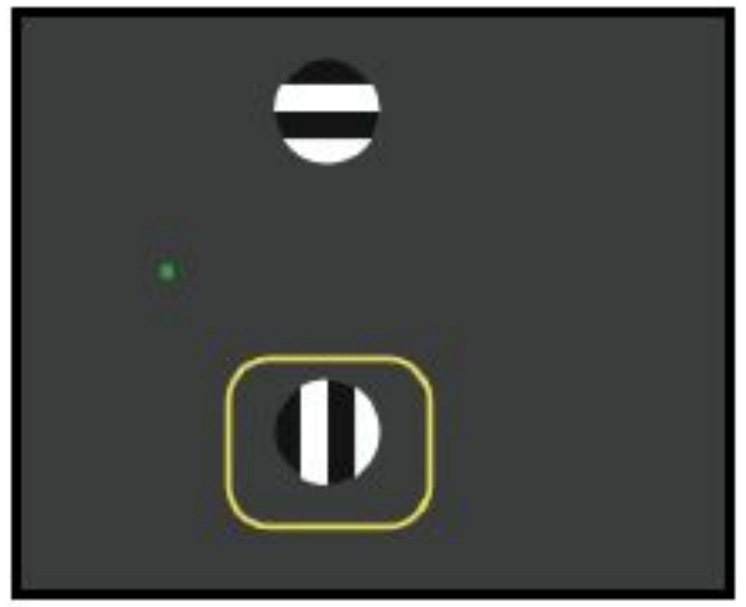
Accattone, 1961
Pier Paolo Pasolini

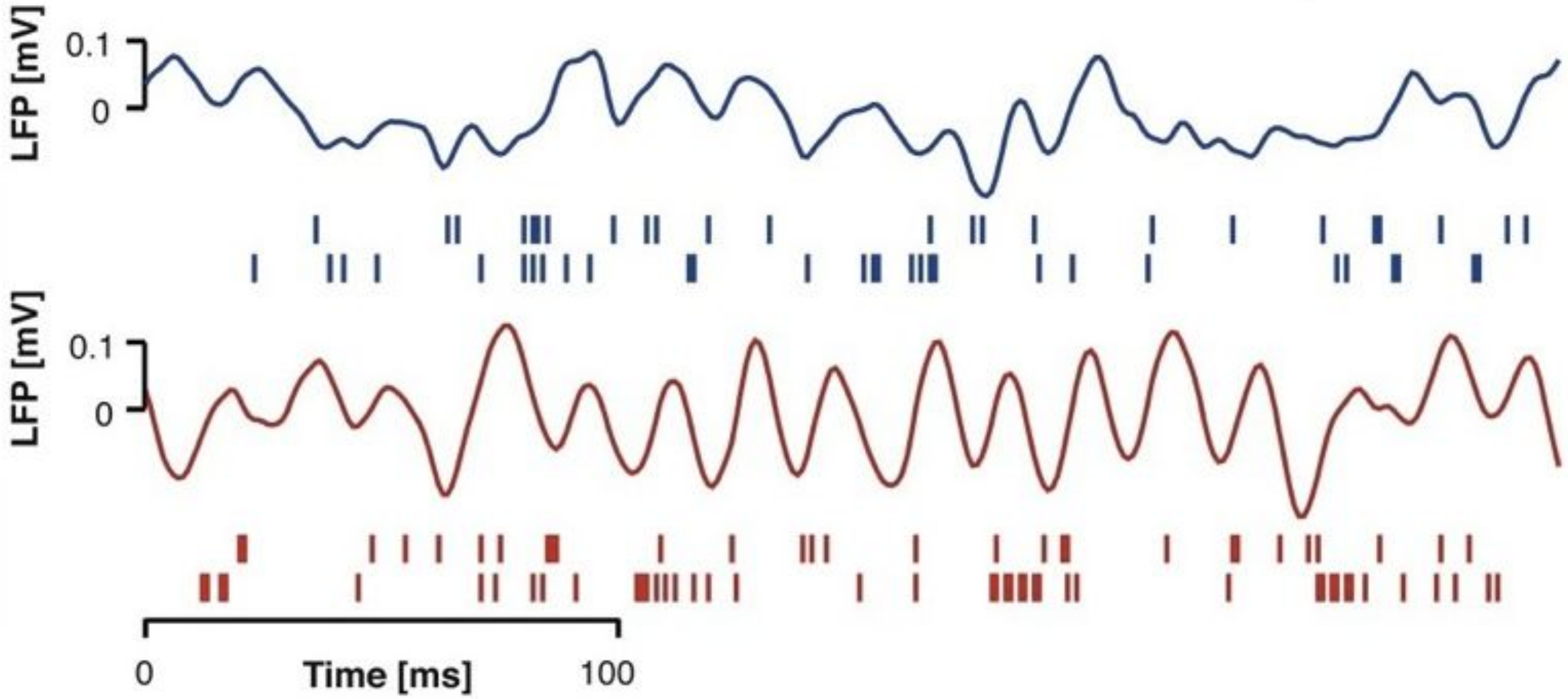
V4
VISUAL CONNECTIONS

Ricardo Gattass, 2004

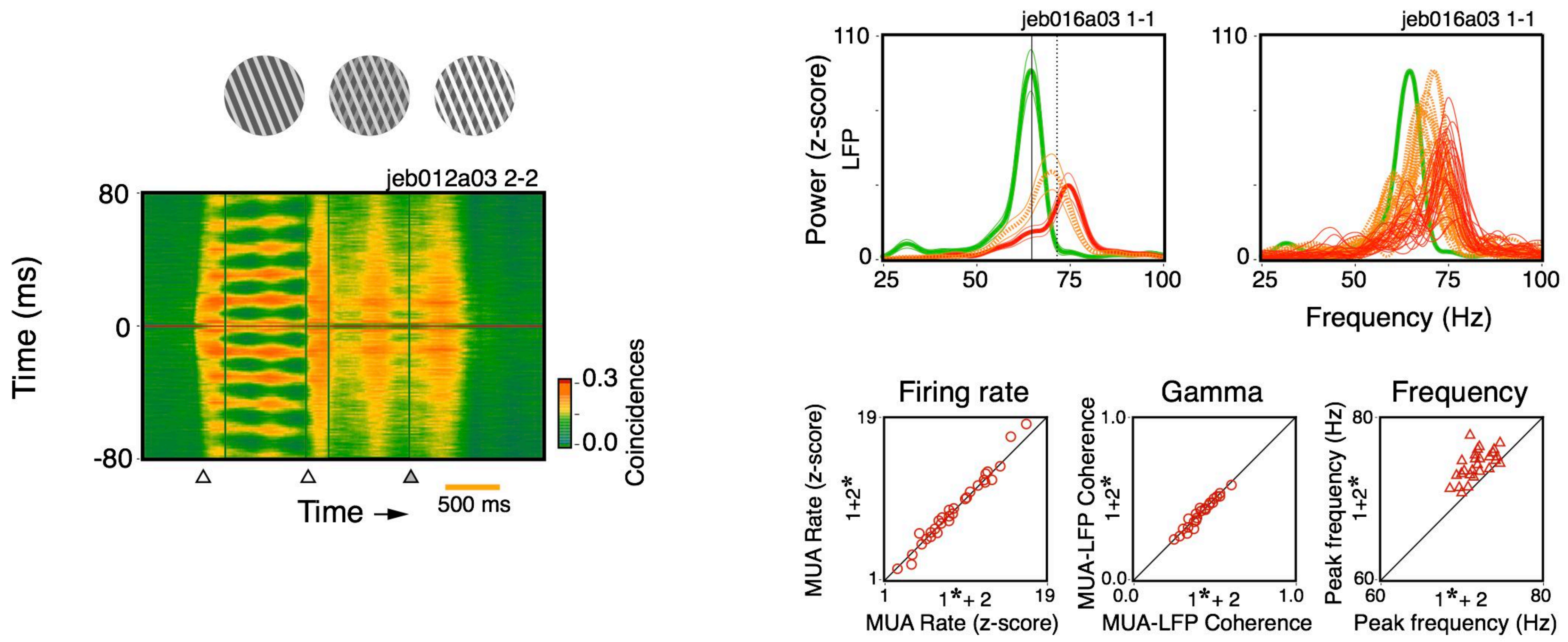


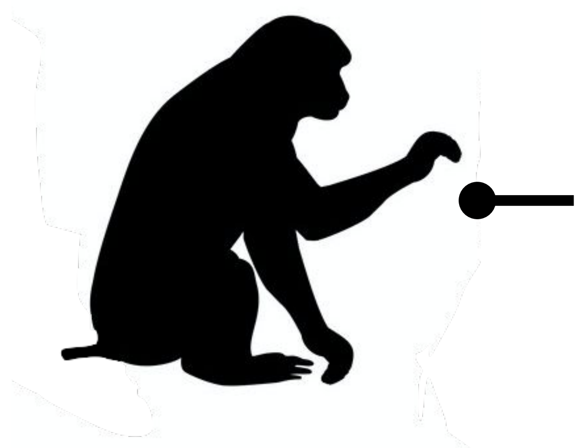
Pascal Fries, 2015



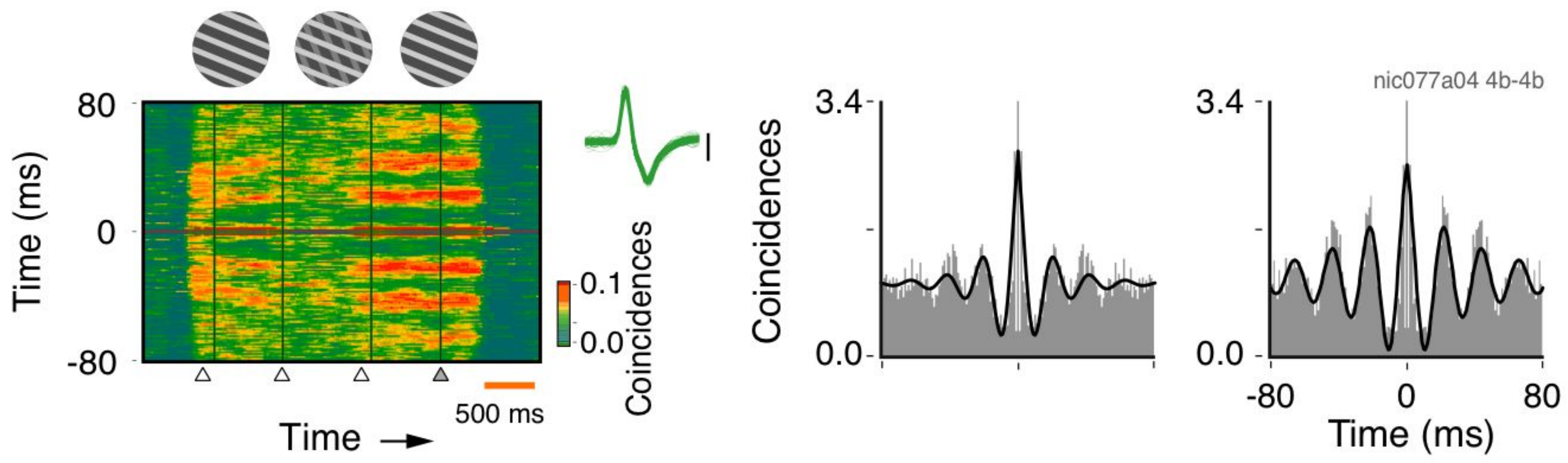


FRIES ET AL., Science, 2001.



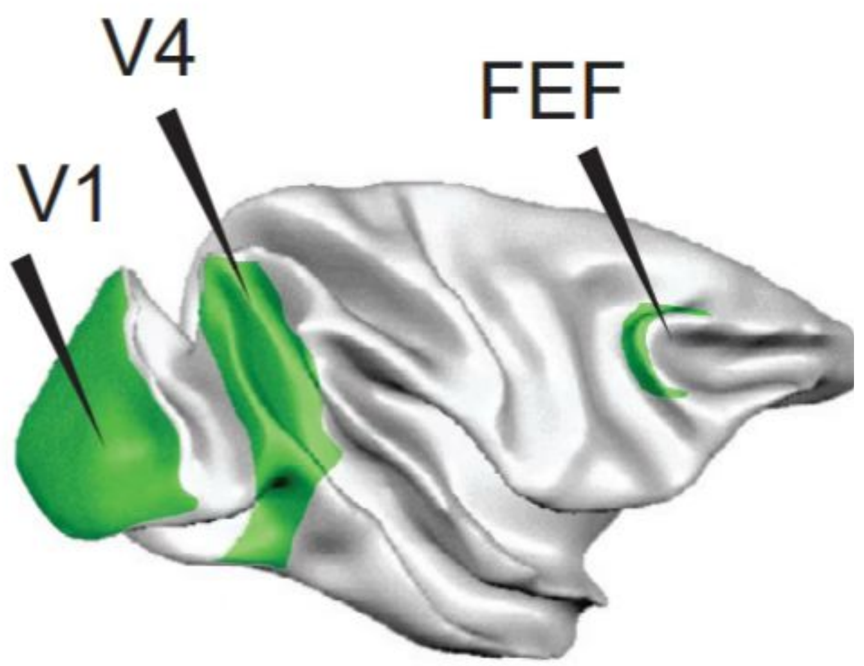


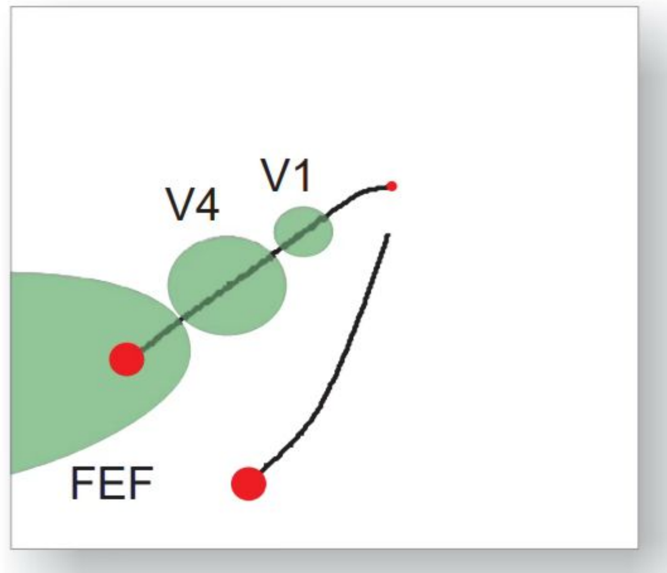
Gamma frequency changes as function of attention.



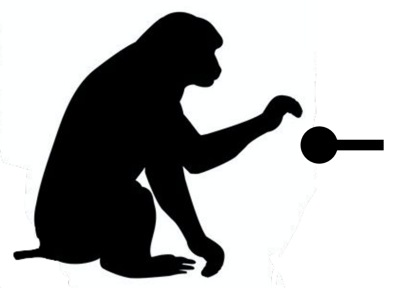
Gamma oscillations increase when the monkeys expected an event in time.

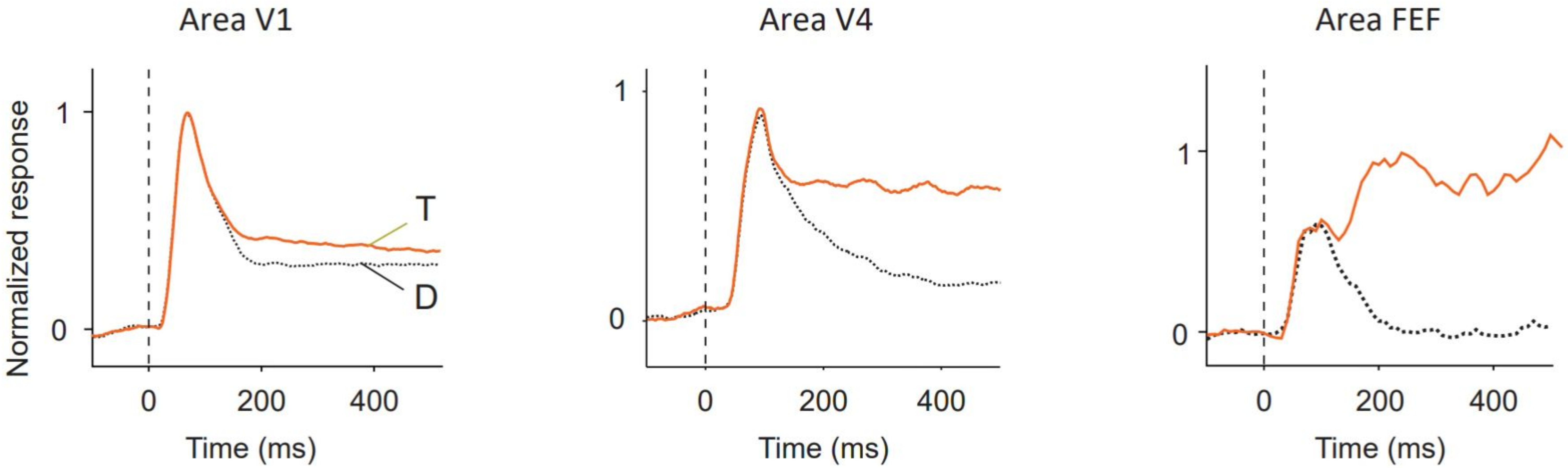
LIMA,... SINGER, NEUENSCHWANDER
Cereb Cortex, 2010





Pieter Roelfsema, 2007

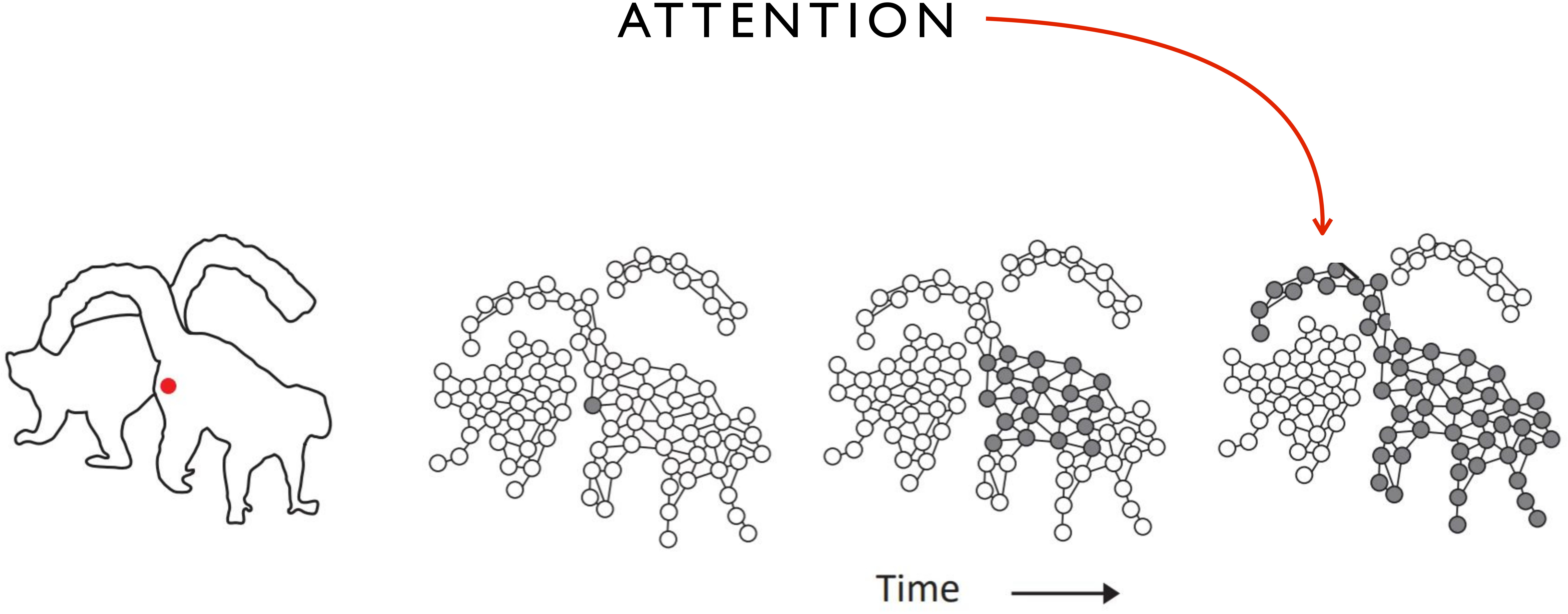




Incremental **grouping**.

ROELSFSEMA, Neuron, 2023.

ATTENTION



R O E L S F S E M A , N e u r o n , 2 0 2 3 .


Sunday
Rivane Neuenschwander
Sergio Neuenschwander
2010
Centre Pompidou


The Fall
Rivane Neuenschwander
Sergio Neuenschwander
2009

— Visual worlds?

Enredo, 2017
Rivane Neuenschwander
Sergio Neuenschwander
Stephen Friedman, London

WORD/ WORLD

Word/ World, 2001
Rivane Neuenschwander
Cao Guimarães
MOMA

Neurocinema as a technological process?

Balloon man, 2024
Sora, OpenAI

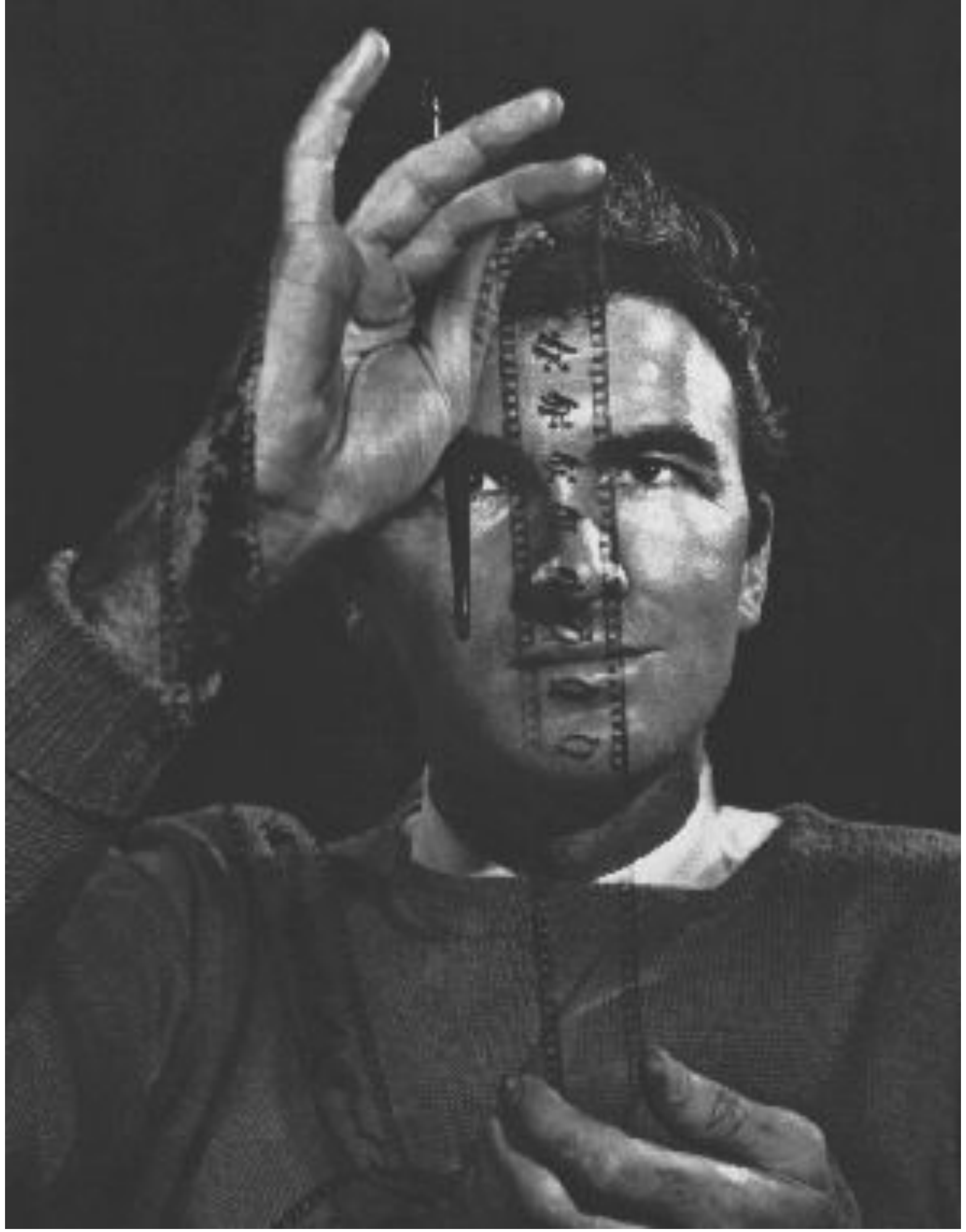
It is through our **faces** that we can be recognized as individuals.

On our face we carry the seal of our experiences.

Oliver Sacks, Face-Blind, 2010.

Jungfrukällan / La Source, 1960

Ingmar Bergman



Norman MacLaren

It is not important what goes on each frame of film, it is the **spaces between** the frames that are important.