Seeing (and) the Brain

Mark S. Cohen
UCLA School of Medicine

UCLA Brain
Mapping Center

Seeing (and) the Brain

- Seeing the organization of the brain.
- How do we see?
- The object stares back.
- Seeing is not just vision.
- We see what we know.

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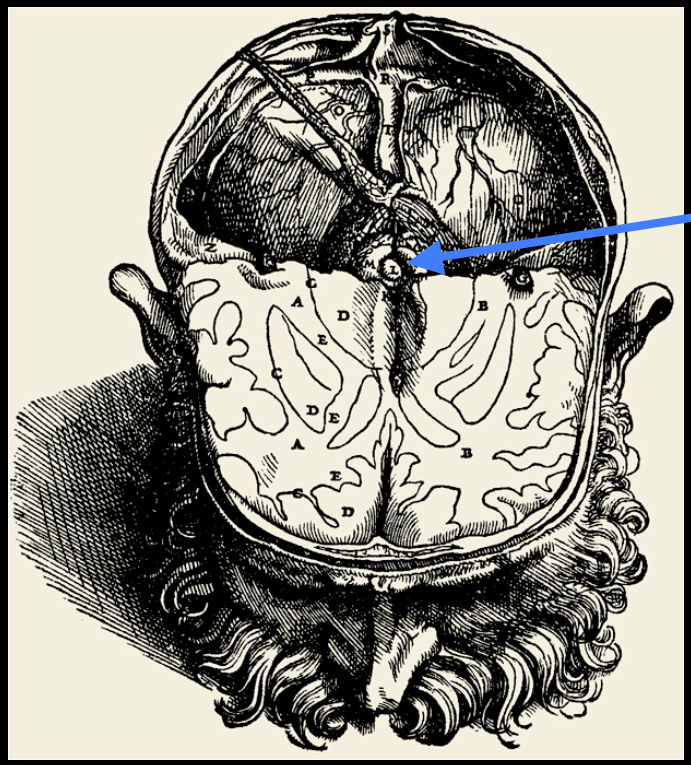
The "Cartesian Theater"*

* After Dennett, "Consciousness Explained", 1991

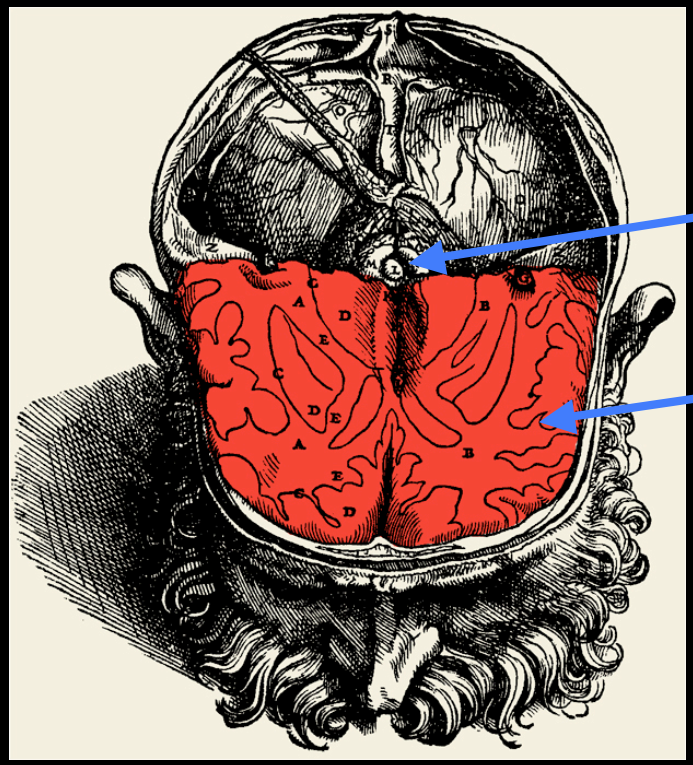


Pineal Gland

Andreas Vesalius c. 1550

The "Cartesian Theater"*

* After Dennett, "Consciousness Explained", 1991



Pineal Gland

Radiator

Andreas Vesalius c. 1550

The "Cartesian Theater"*

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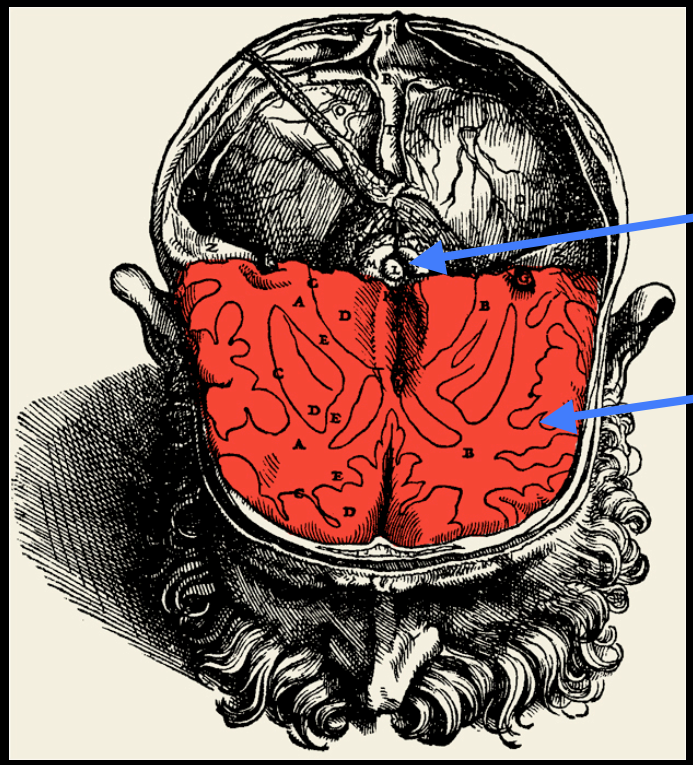
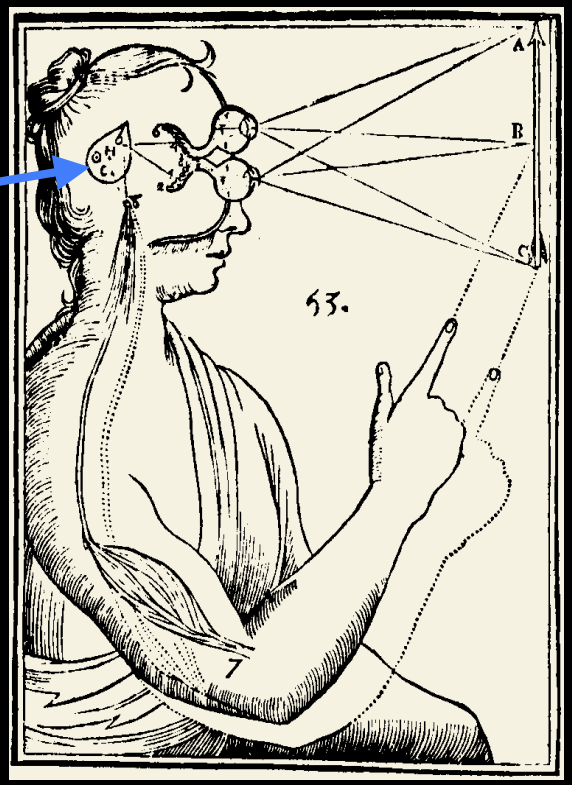


Pineal Gland

Radiator



Andreas Vesalius c. 1550

René Descartes 1637

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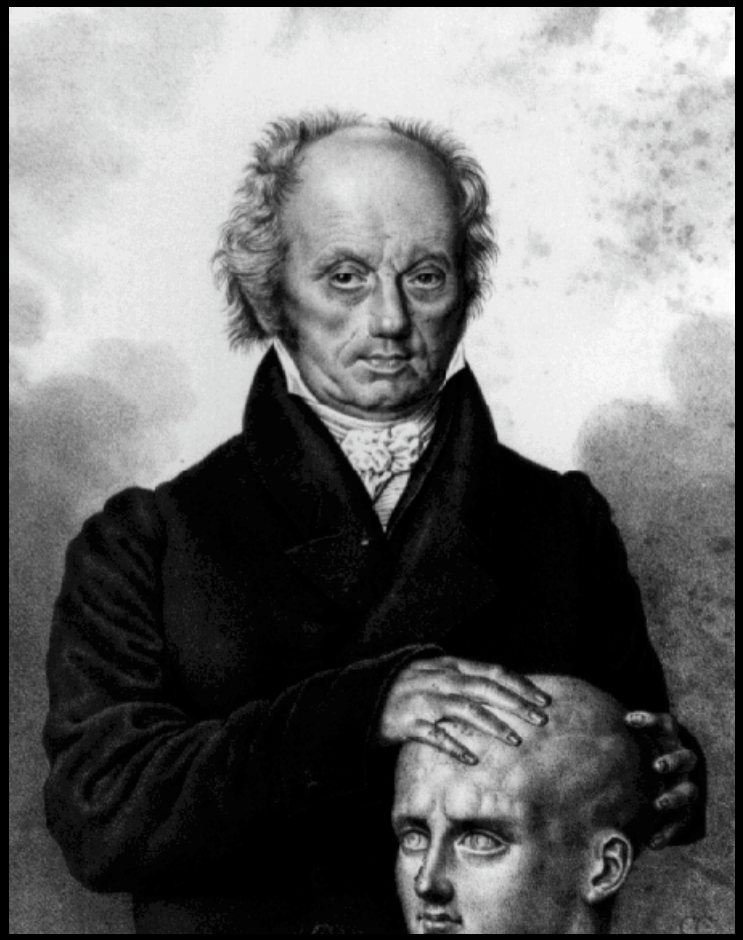
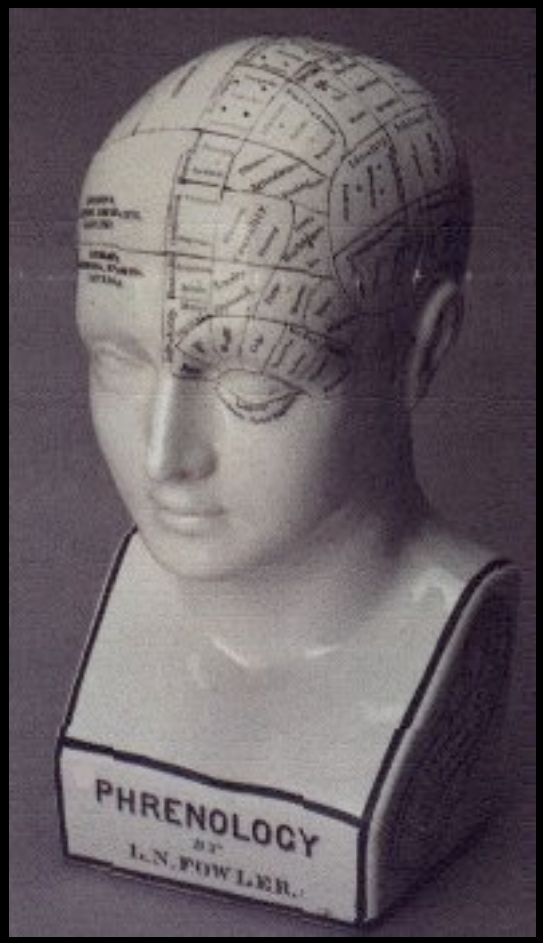
Franz Joseph Gall

1758-1828





The Psychograph

Lavery & White 1929-1937

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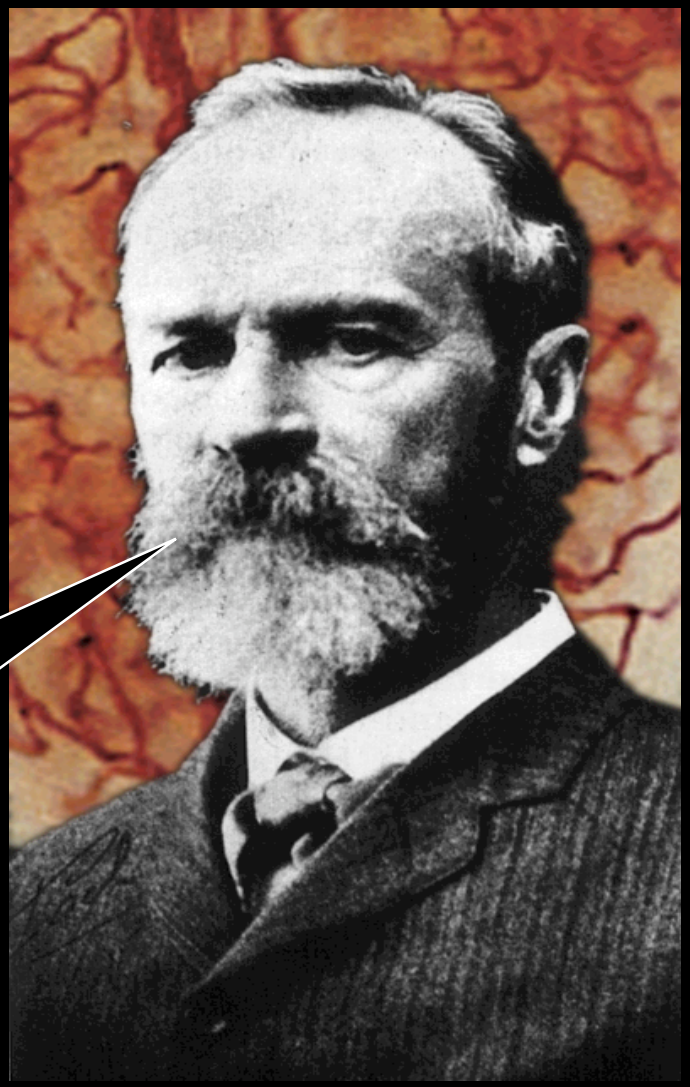
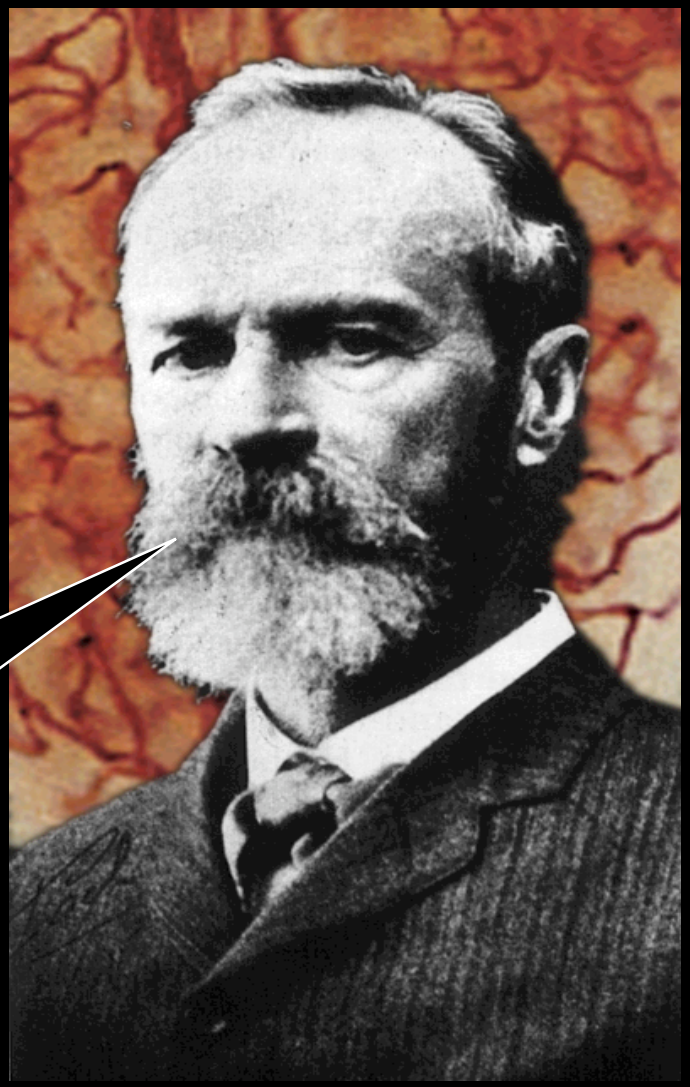


William James, 1890

"We must suppose a very delicate adjustment whereby the circulation follows the needs of the cerebral activity.

Blood very likely may rush to each region of the cortex according as it is most active, but of this we know **nothing.**"



William James, 1890

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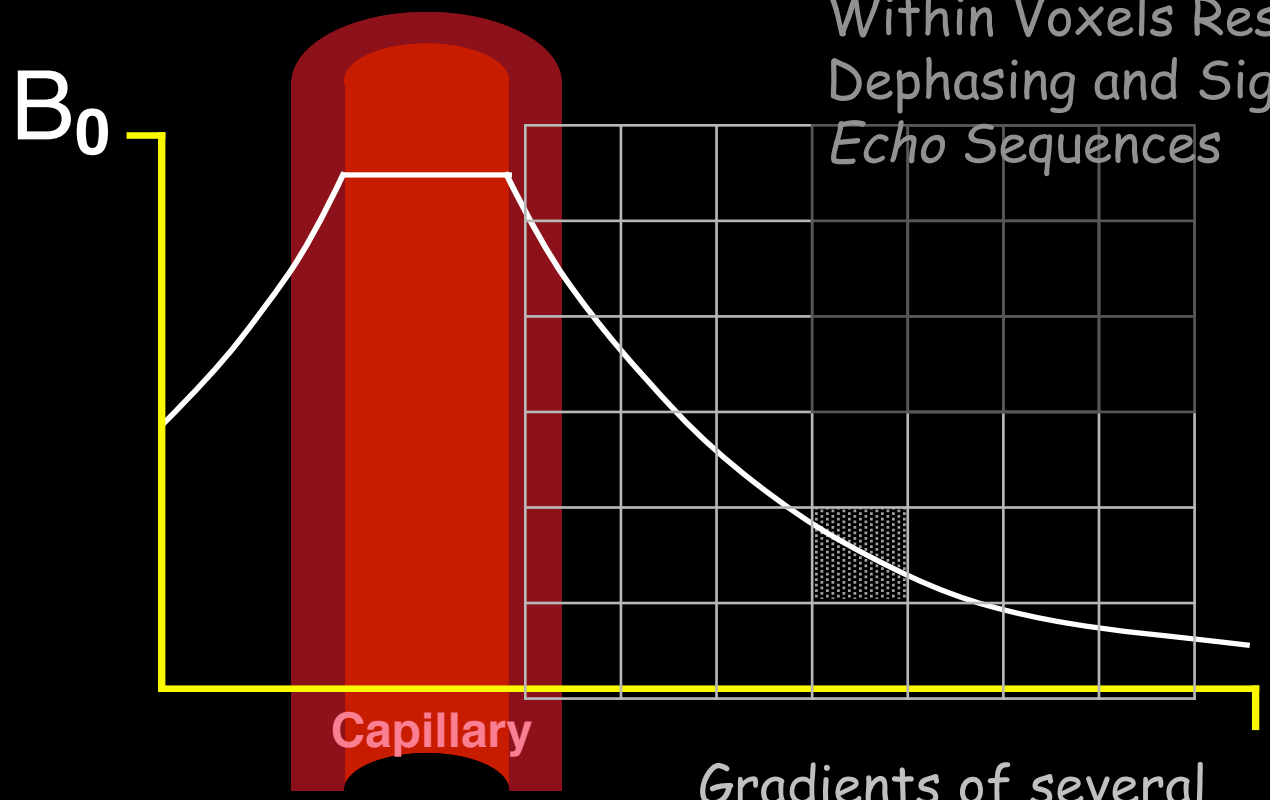
Signal Losses from Spin Dephasing

Inhomogeneous Magnetic Fields Within Voxels Result in Spin Dephasing and Signal Loss in *Gradient Echo* Sequences



Gradients of several Gauss/cm may exist near deoxy-Hb-filled capillaries.

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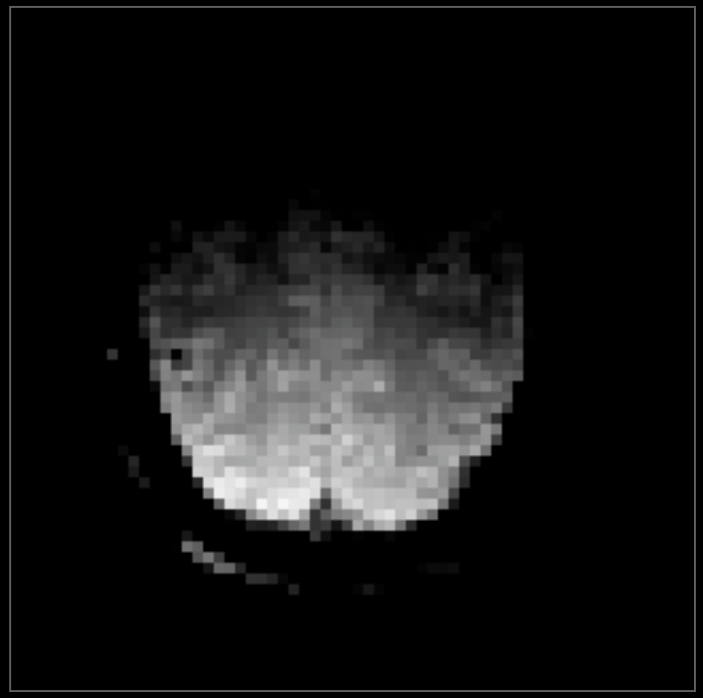
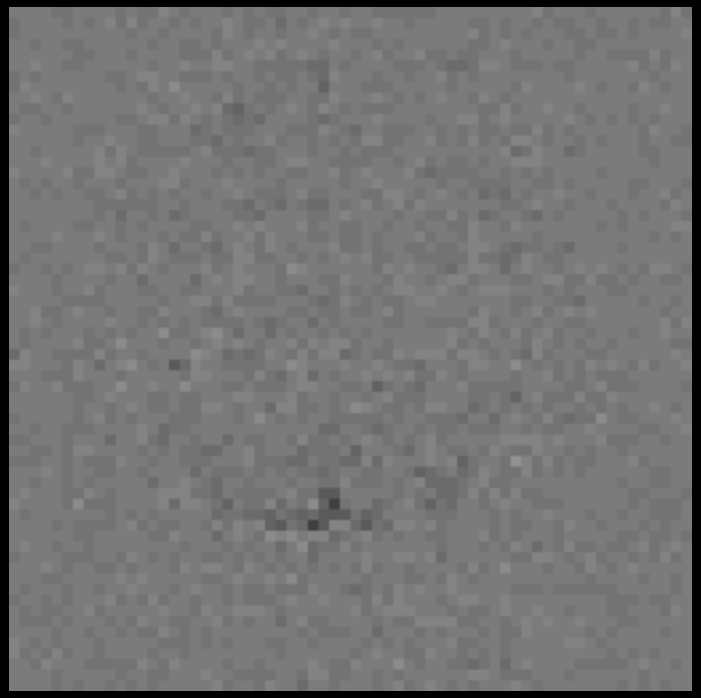
Image series with visual stimulation





Ken Kwong, 1991

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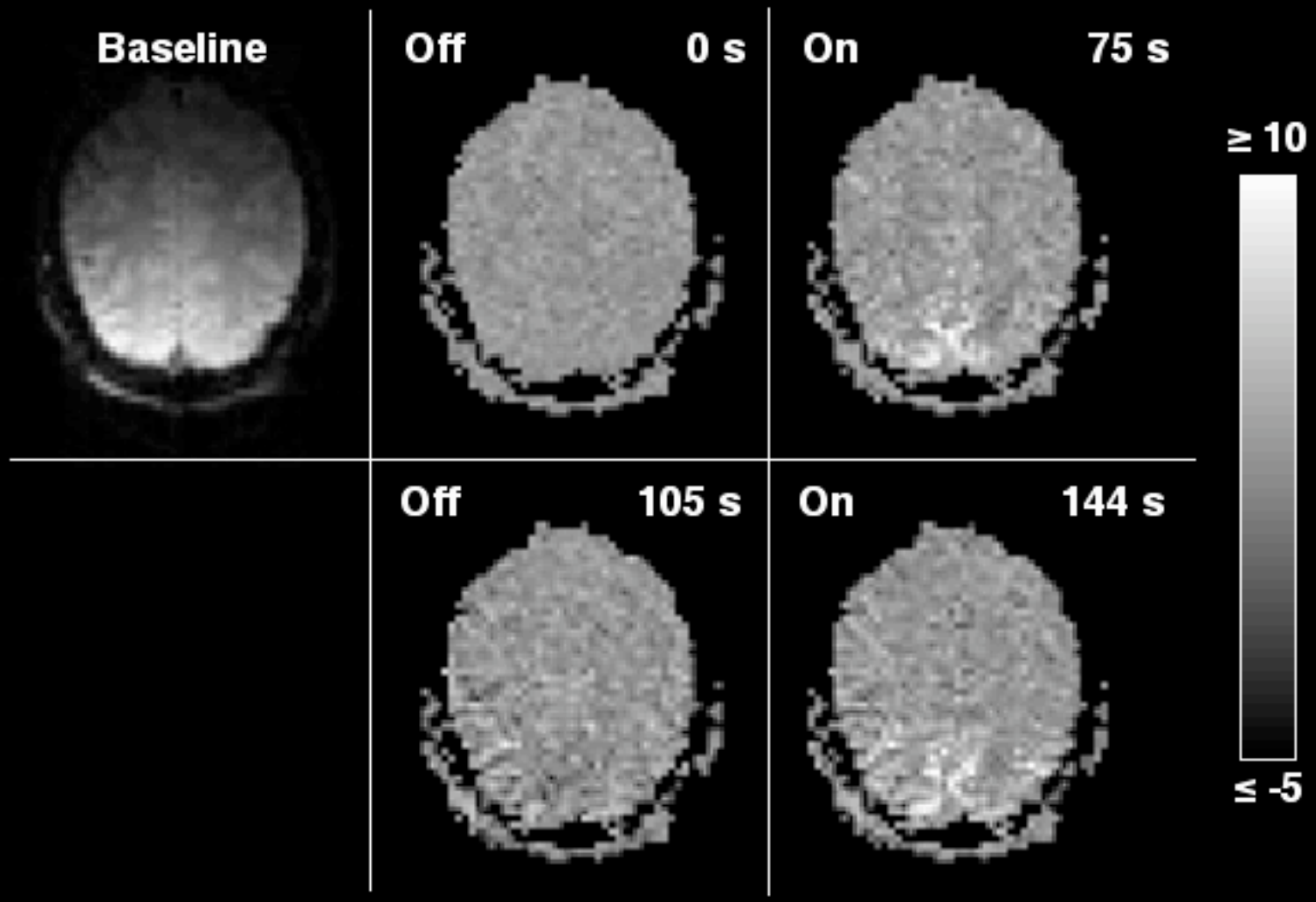
Brain Activity with MRI



Kwong, et al., PNAS 1992

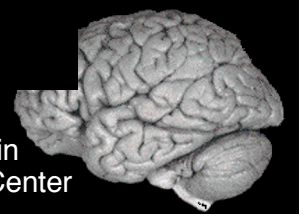


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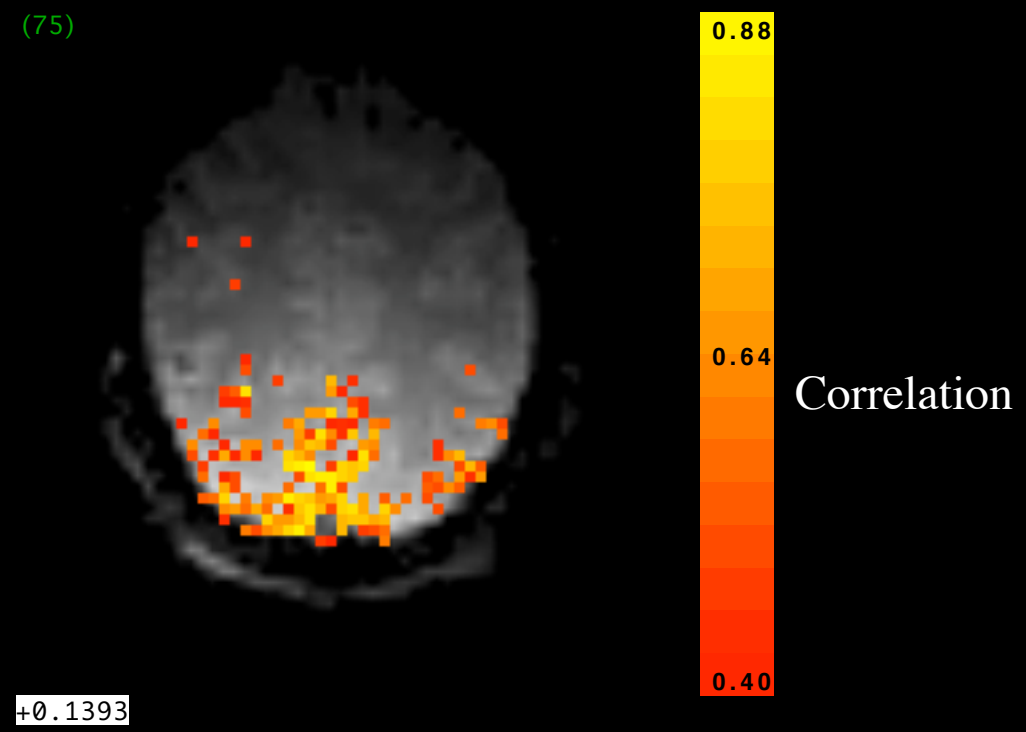
Image series with visual stimulation



Correlation

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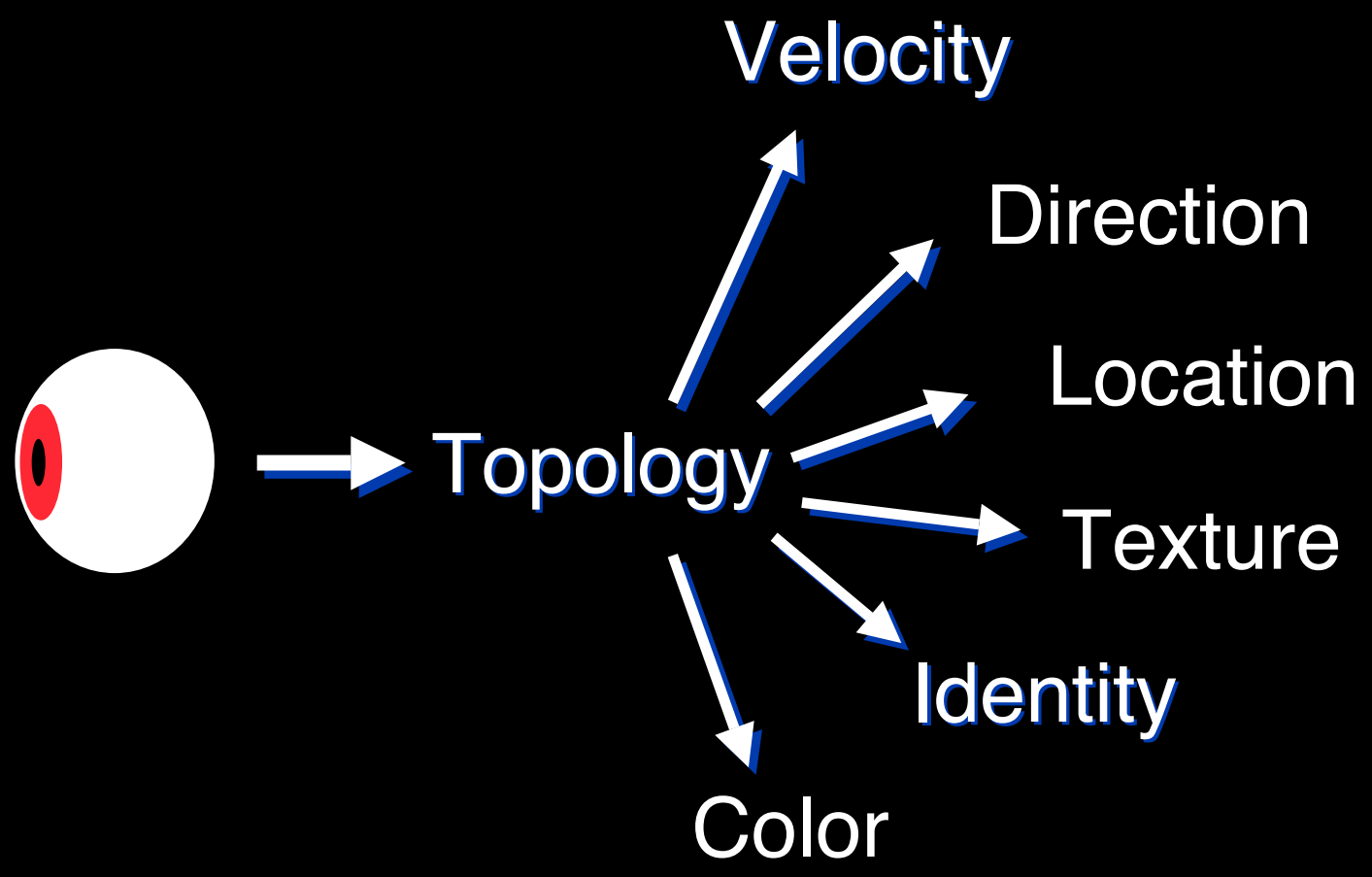
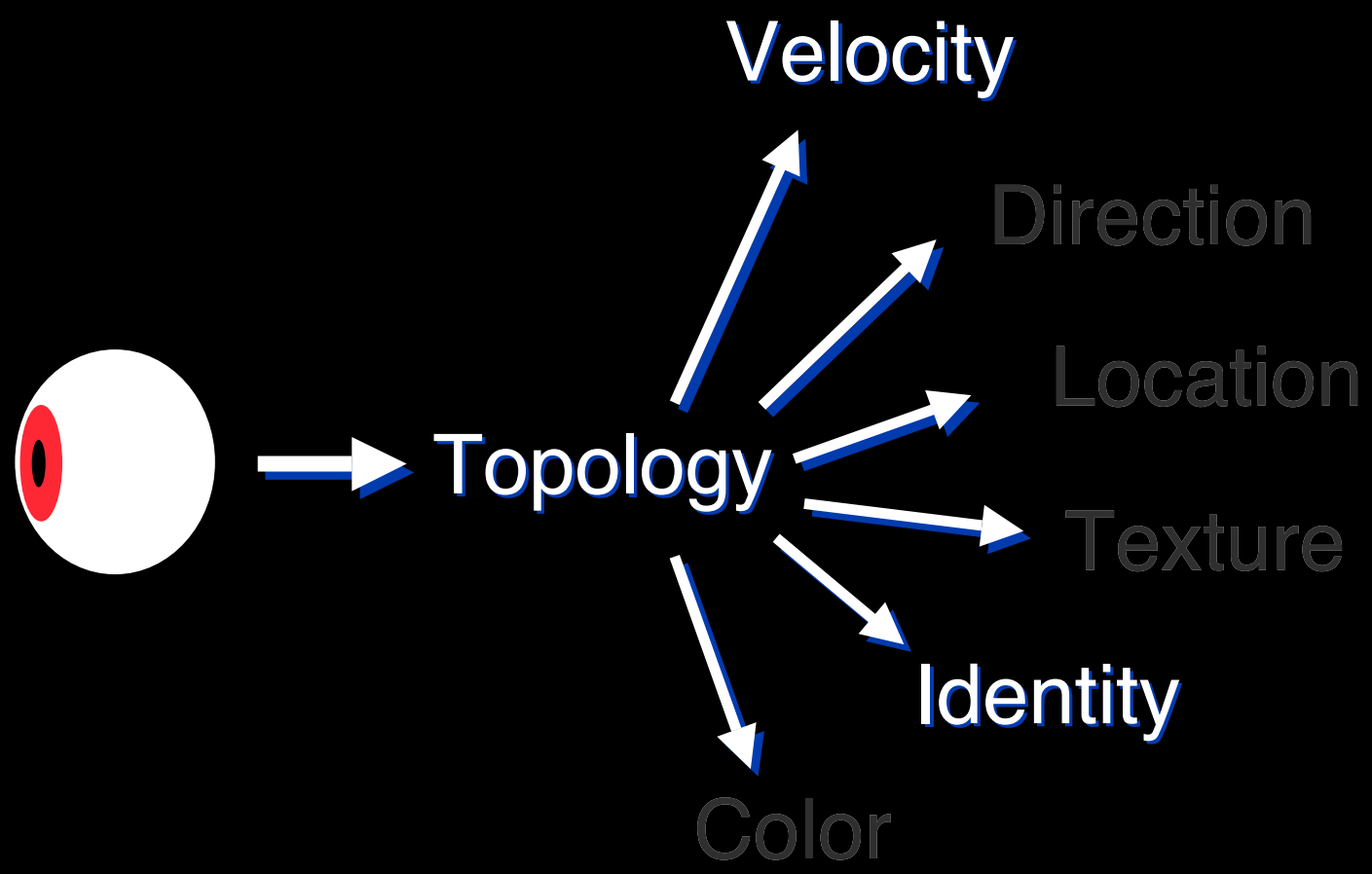
Distinct Visual Pathways



Distinct Visual Pathways



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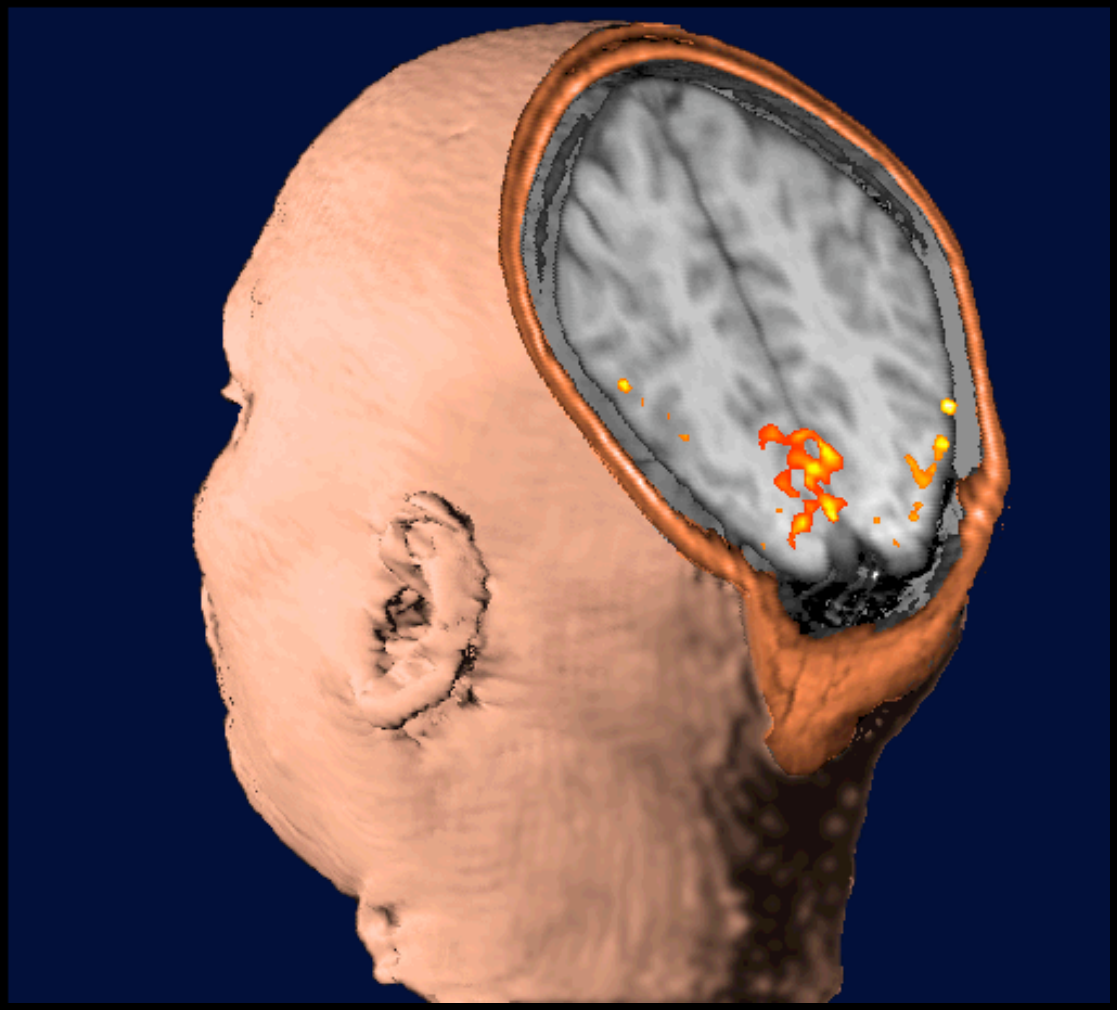
Area 'V1'



Belliveau, et al., Science 1991

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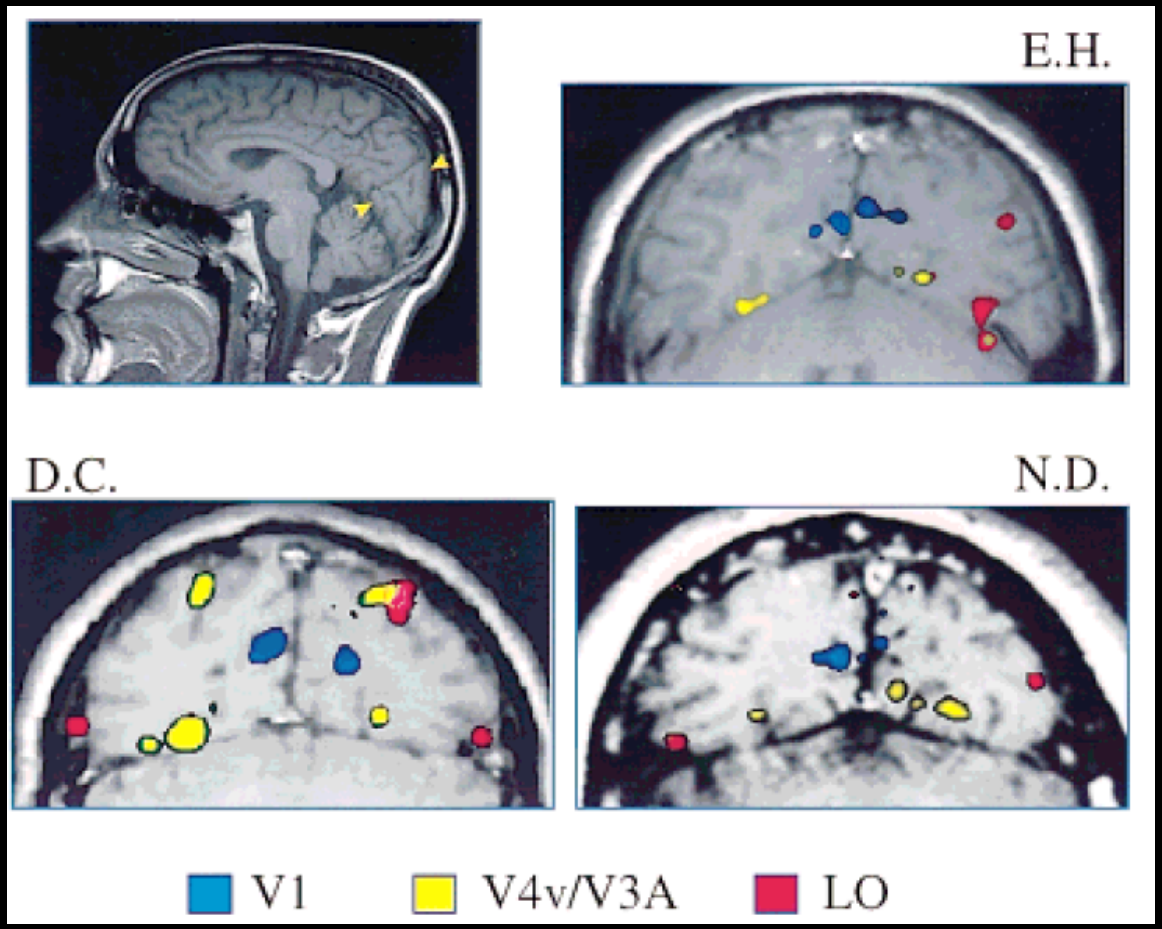
Area 'LO'



Grill-Spector, *et al.*, Human Brain Mapping 6:316–328(1998)

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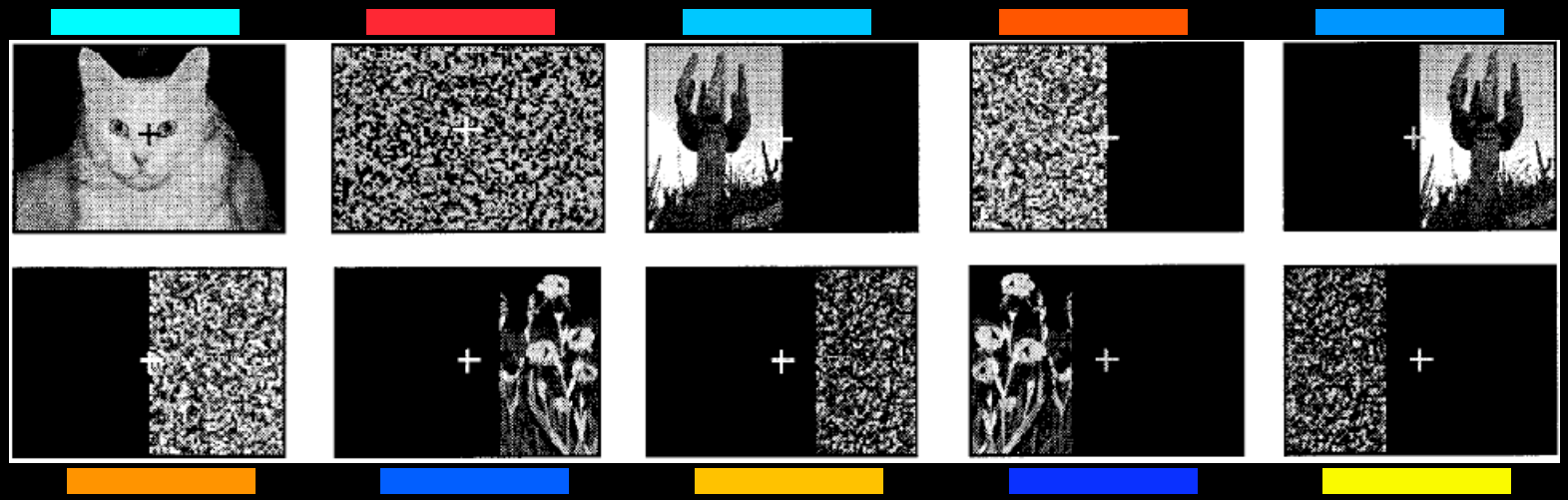
Area 'LO'



Grill-Spector, *et al.*, Human Brain Mapping 6:316–328(1998)

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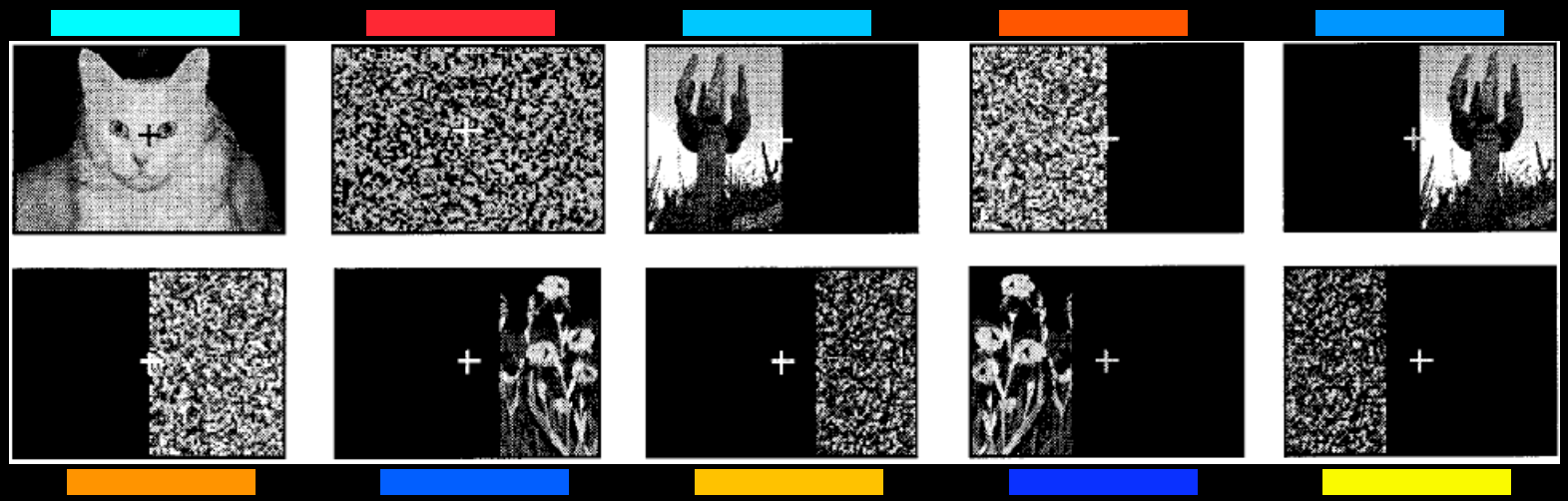
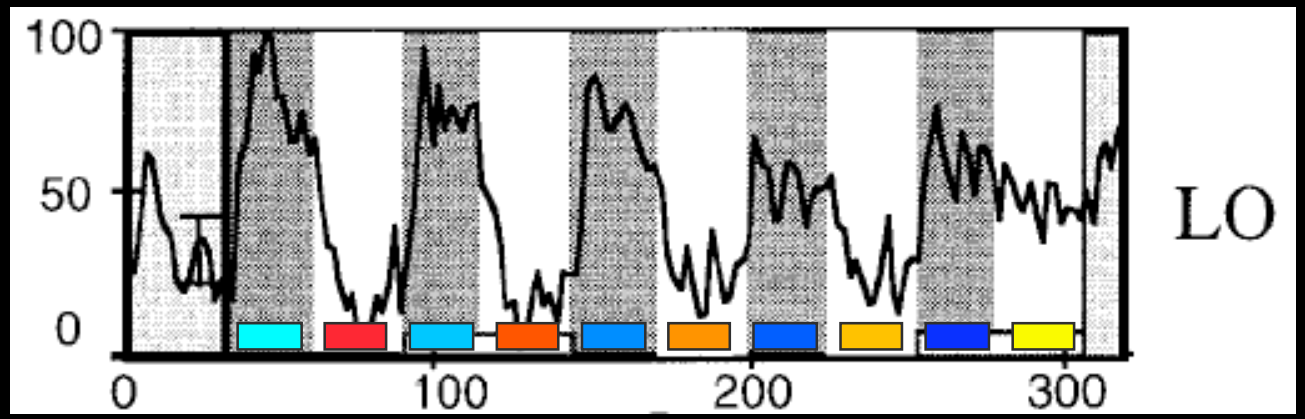
Area 'LO'





Grill-Spector, *et al.*, Human Brain Mapping 6:316–328(1998)

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Area 'LO'

Rafael Malach

Grill-Spector, *et al.*, Human Brain Mapping 6:316–328(1998)

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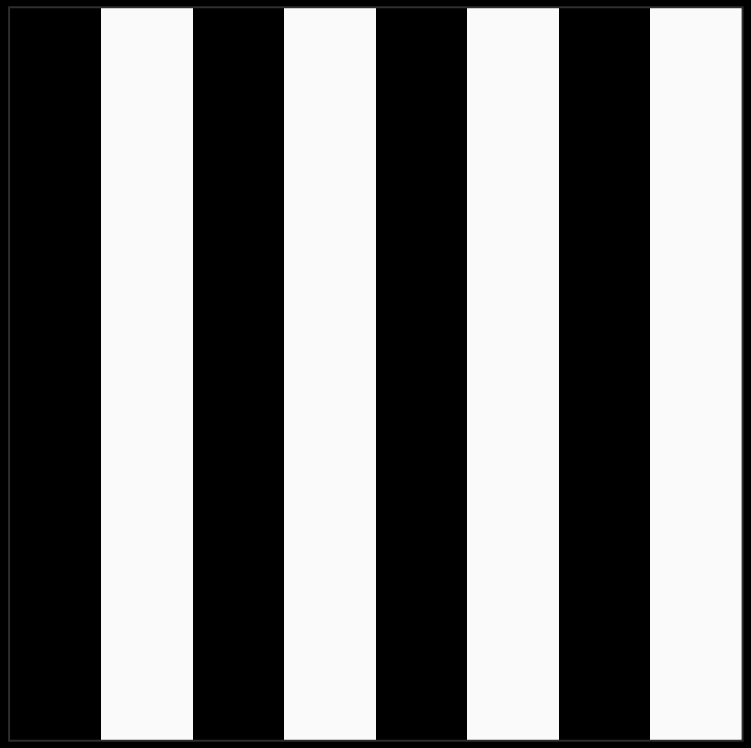
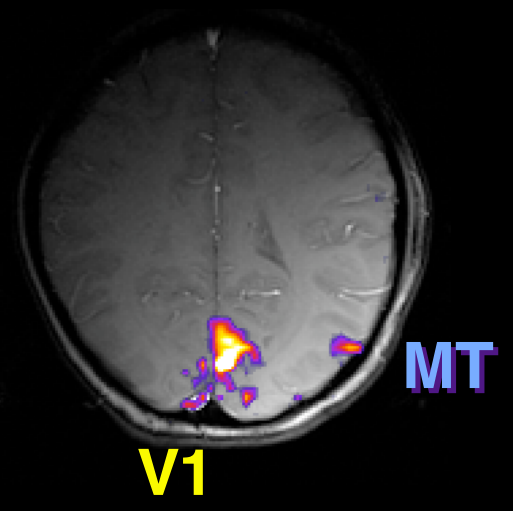
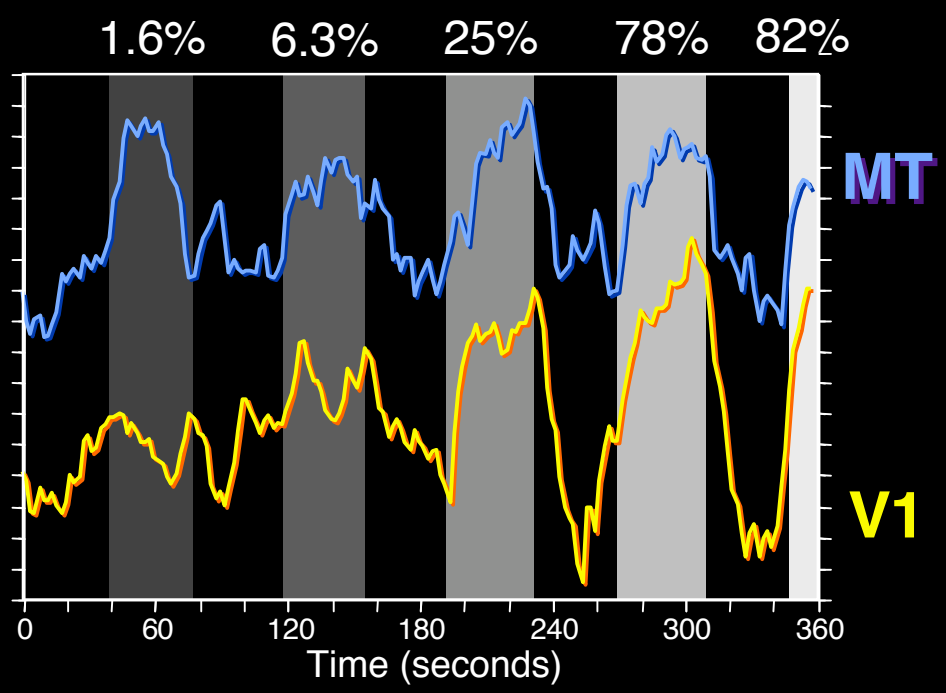
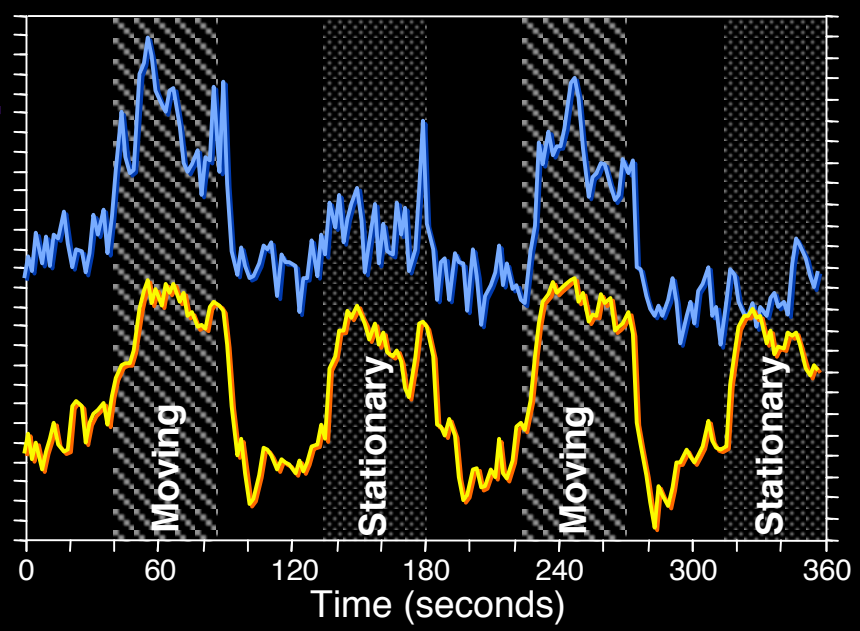
Moving/Stationary stimuli



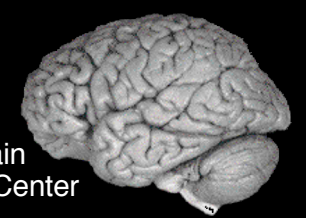
Dissociation of Contrast and Motion







From R. Tootell



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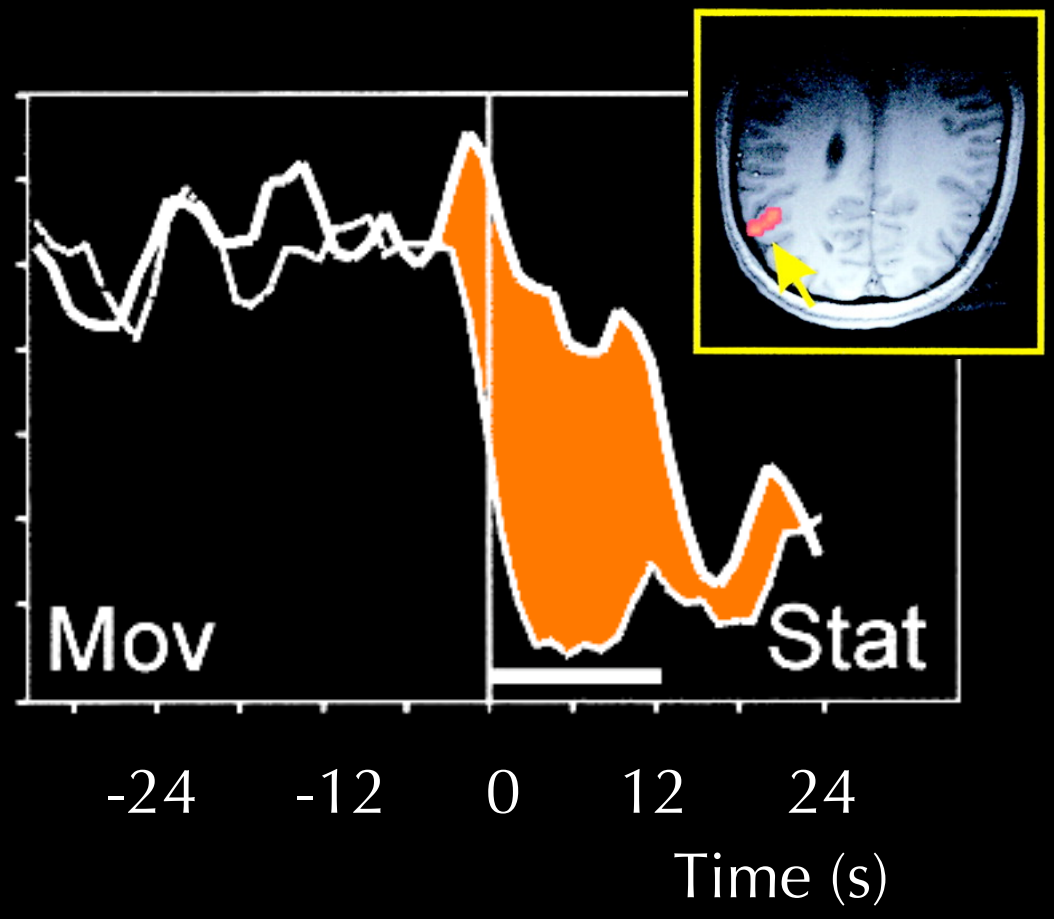
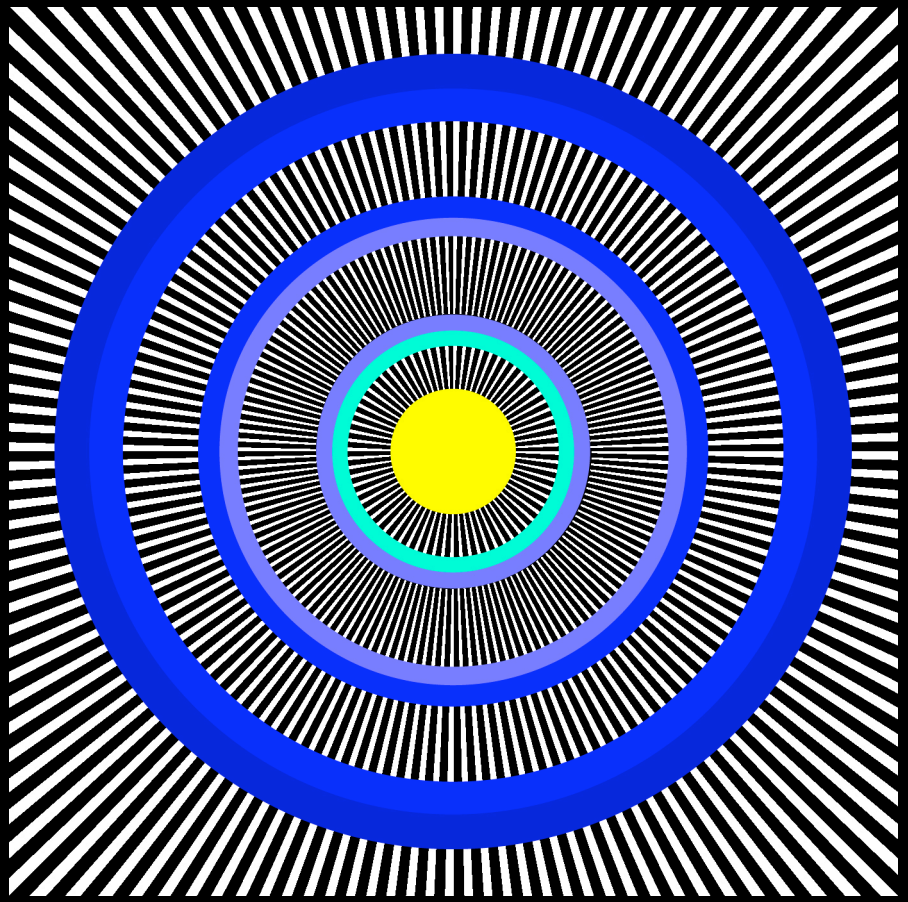
MAE

Motion After Effect



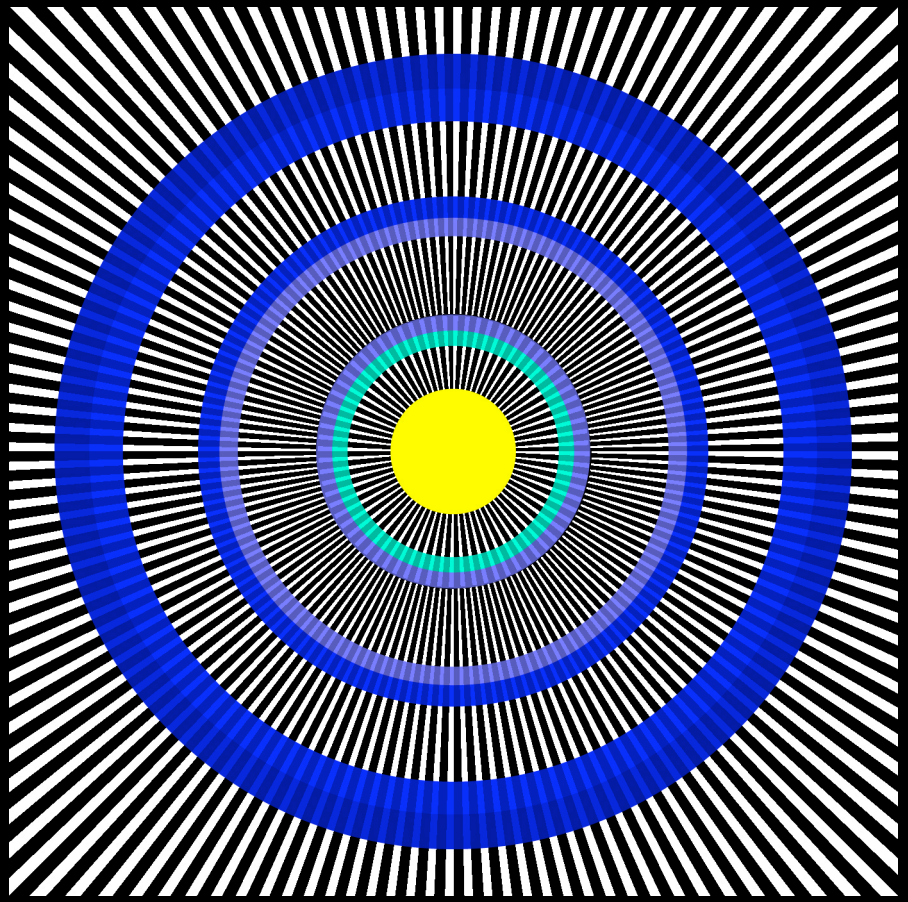
Culham, et al., *J Neurophysiol* 81: 388-393, 1999

Enigma



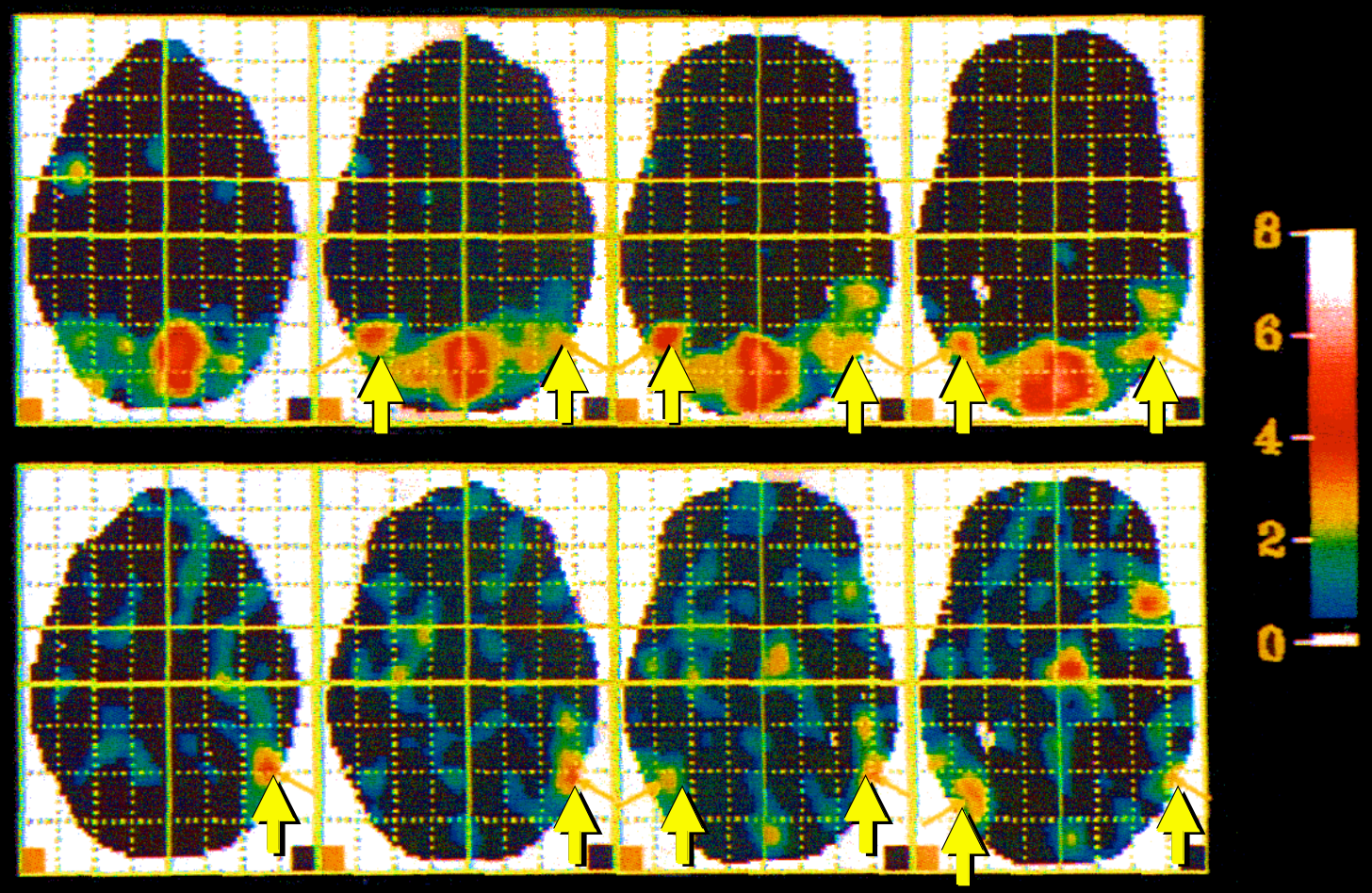
Isia Levant

Enigma



Isia Levant

Illusory Motion - Imaging Results



Zeki, Watson and Frackowiak. Proc R Soc Lond B Biol Sci 252:215, 1993

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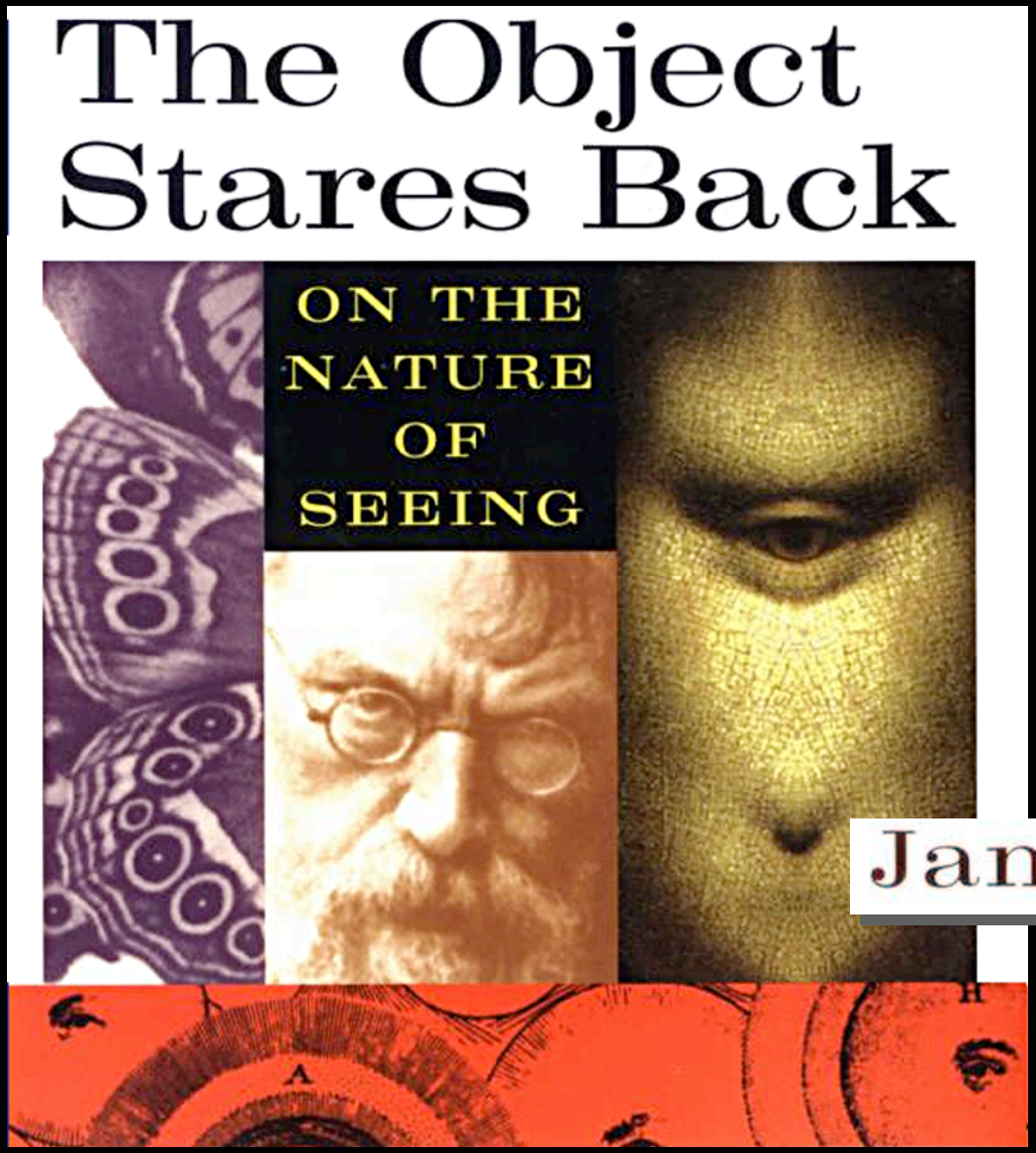

James Elkins

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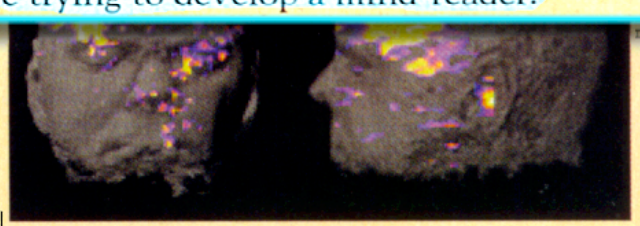
Echo-Planar MRI: Learning to Read Minds

innovation IN IMAGING

Magnetic resonance imaging (MRI) is a prized weapon in the armamentarium of basic researchers and clinicians, used for everything from studying changes in the brains of schizophrenic patients to diagnosing torn knee ligaments in professional athletes. Yet speed has not been the technique's strong point. Far from it. In fact, because it is slow, during its 20-yea
biologica

But M
high-perf
technique
needed t
images fr
little as 3
echo-planar MRI (EPI)—the collective name for the new techniques—is providing high-resolution images of functional activity in brain, heart, liver, and other tissues. "We've broken the speed barrier (of MRI), and the implications for both basic research and diagnostics is tremendous," says Robert Turne
ticians alike
instruments. From a utilitarian point of view, the new devices should reduce the overall cost of MRI because patient throughput will be greater. But beyond that, demand for EPI is fueled by the fact that the method eliminates the motion artifacts that plague its conventional counterpart. Conventional MRI is so slow that even images of the brain are blurred as the brain shifts with the cardiac and respiratory cycles. The heart obviously moves much more, and, as a result, cardiac imaging has been virtually impossible.

Now, says Turner, it is possible to evaluate cardiac function in real time using EPI. For example, Mansfield and Michael K.
h Israel Hospital, have mea-
the heart and through heart
to diagnose valvular heart
by detecting blood flow
leaky or stenosed valves.
k S. Cohen and his colleagues
sachusetts General Hospital
) have used EPI to study muscle activity as it occurs. "We've been able to see muscle recruitment patterns during complex exercise. This has clear implications for both basic science research and clinical use," said Cohen, director of MGH's High-Speed Imagi



Madness in his method. Echo-planar MRI im

Cohen said he has "absolutely no doubt that echo-planar MRI will make a major impact as a clinical tool, simply through imaging speed." But, he added, "what we're tying to do here is optimize the system so we can use it as a neuroscience research tool. In effect, we're trying to develop a mind-reader."

–J.A.

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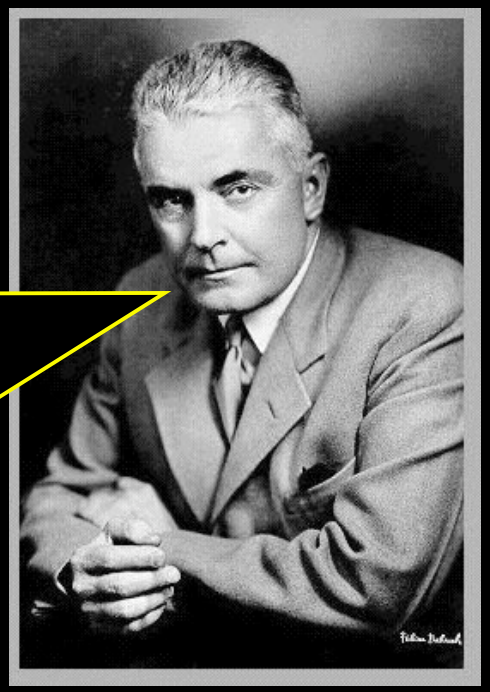
Imagery Controversy

"I believe we can write a psychology, and … never use the terms consciousness, mental states, mind, content, introspectively verifiable, imagery, and the like. … It can be done in terms of stimulus and response, in terms of habit formation, (and) habit integrations."



John B. Watson 1878-1958

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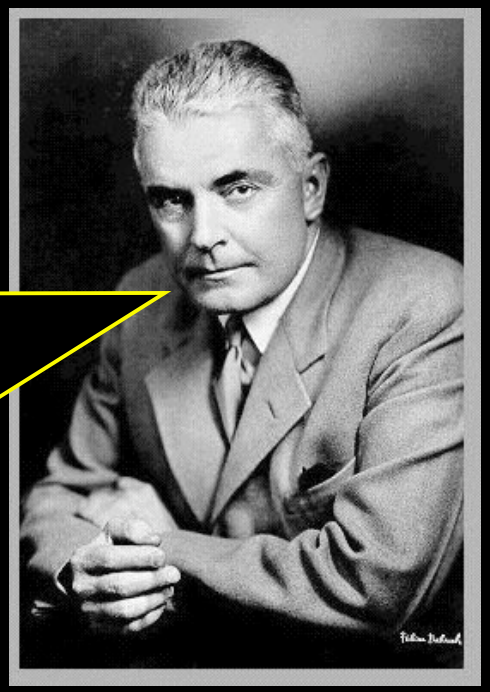

John B. Watson 1878-1958

- Unscientific
- Medieval
- Old Wives' Tale
- Sheer Bunk

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Imagery Controversy

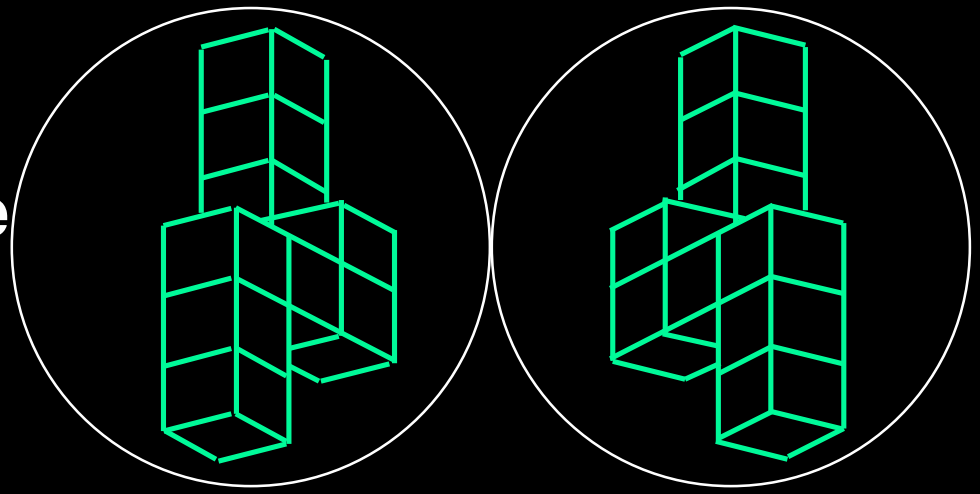
Zenon Pylyshyn

"We are now continuing … studies in order to show that **the visual system is not involved in mental imagery** and, in fact, that "imagery", in the pictorial sense in which it is understood by many psychologists, is not involved in vision either."

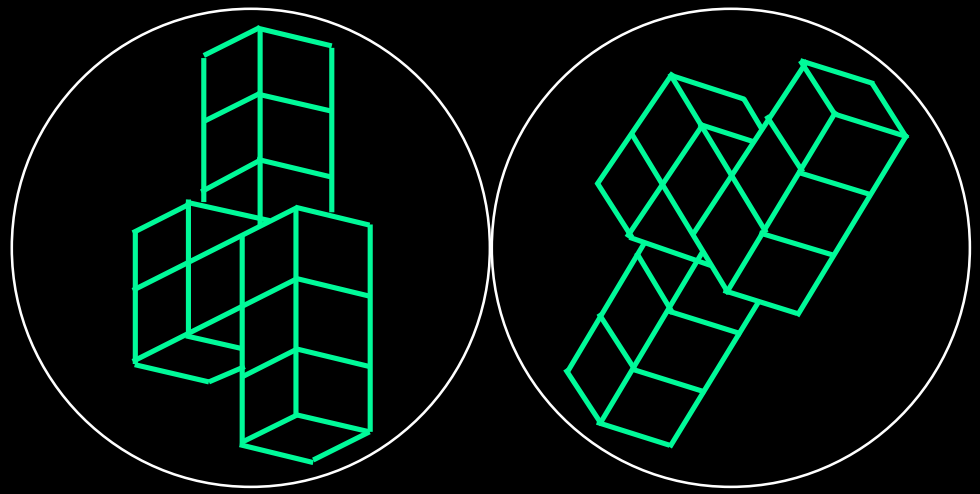
http://ruccs.rutgers.edu/faculty/pylyshyn.html, 2004

Mental Rotation - Stimuli

Compare (Control)

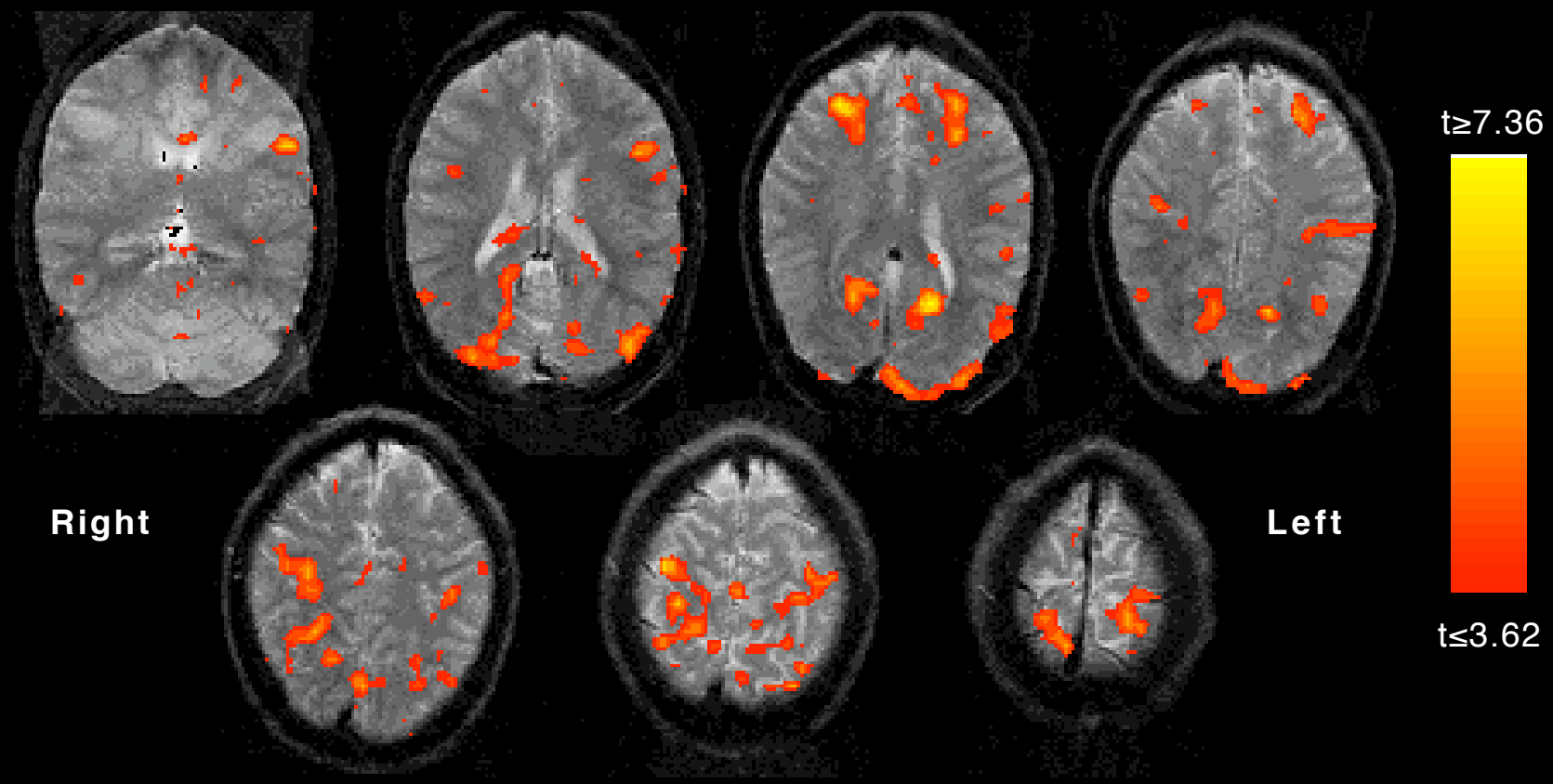


Rotate



Mental Rotation vs. Control

- localization



Cohen, *et al.*, Brain 199:89, 1996

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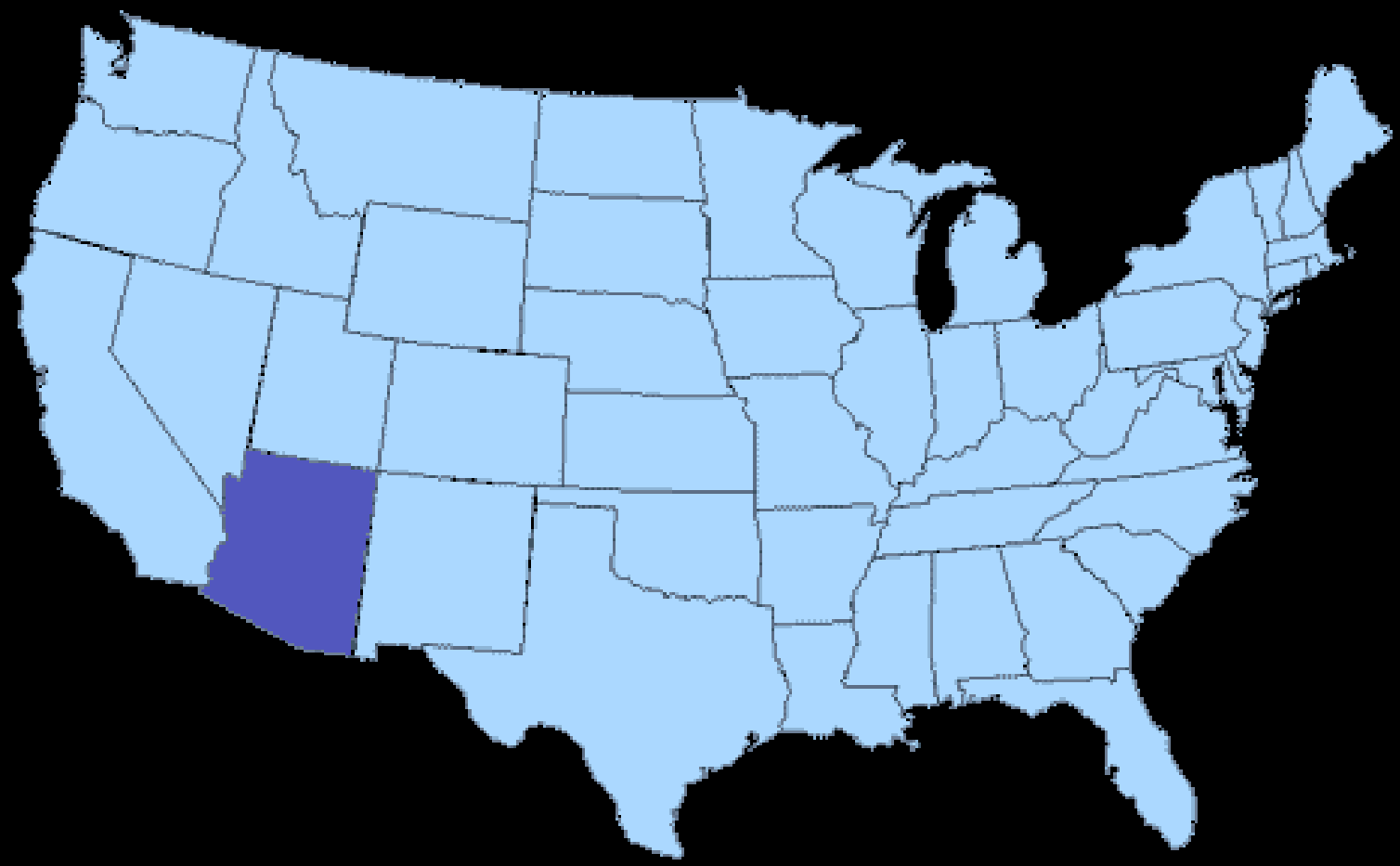
States Task



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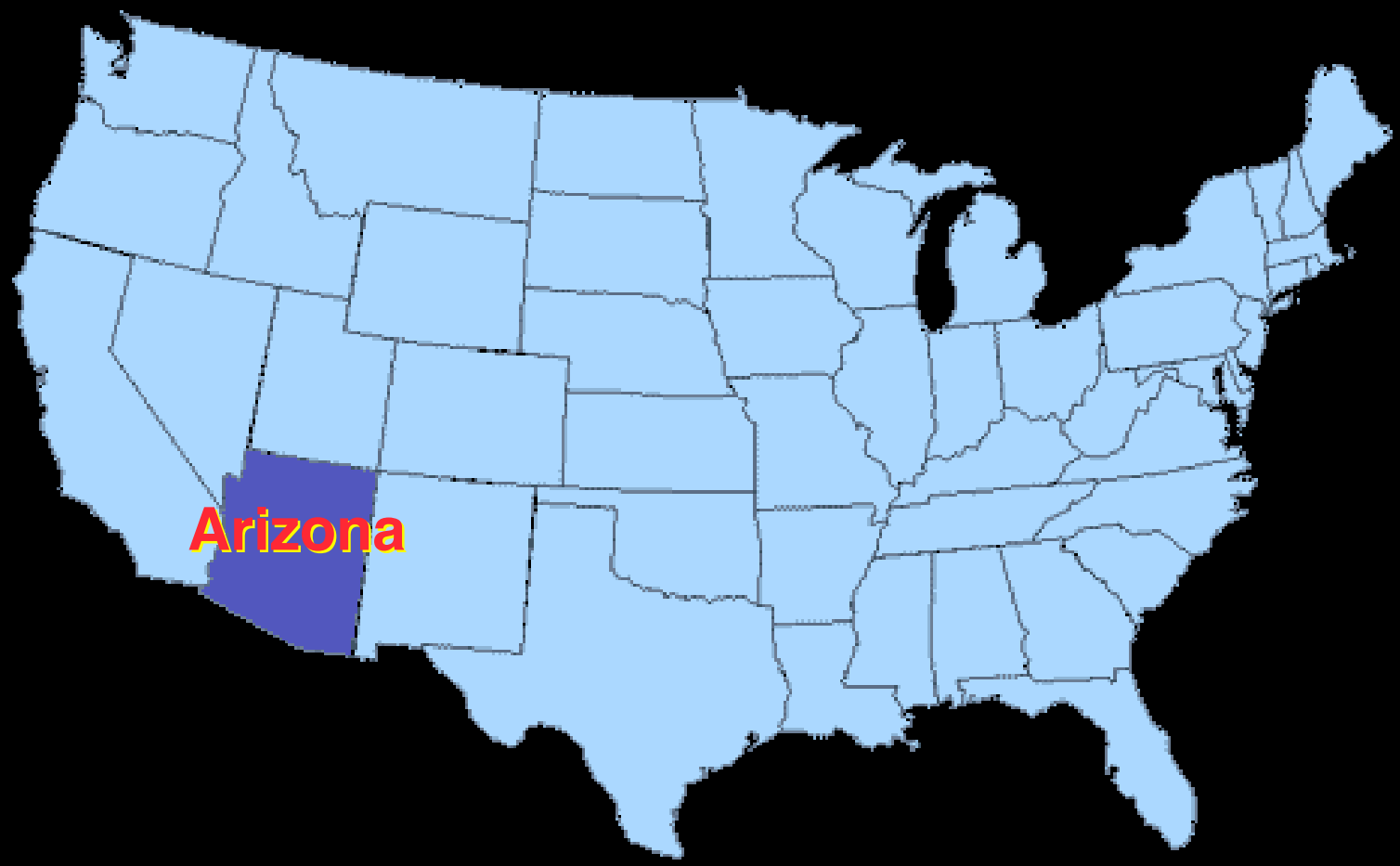
States Task



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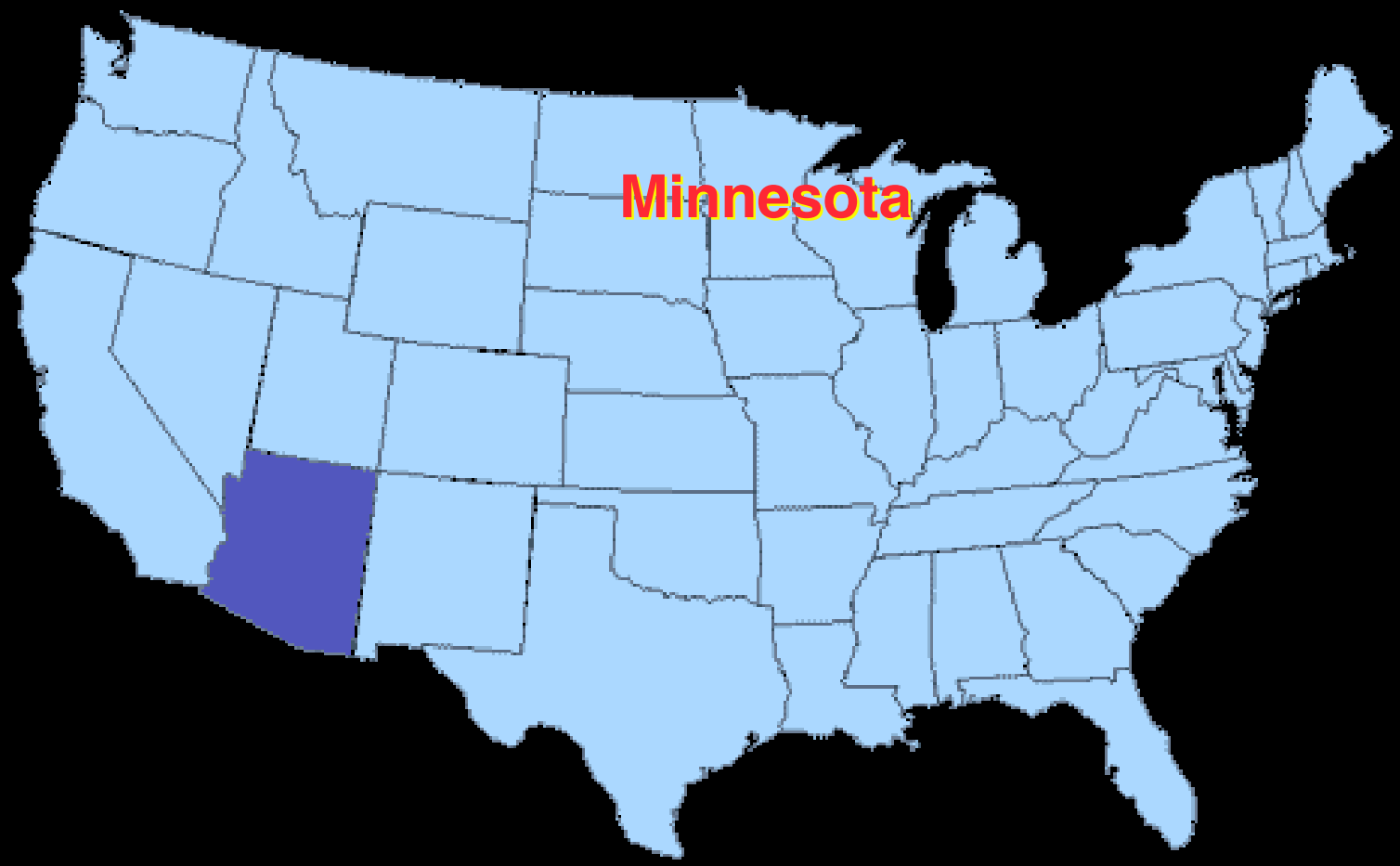

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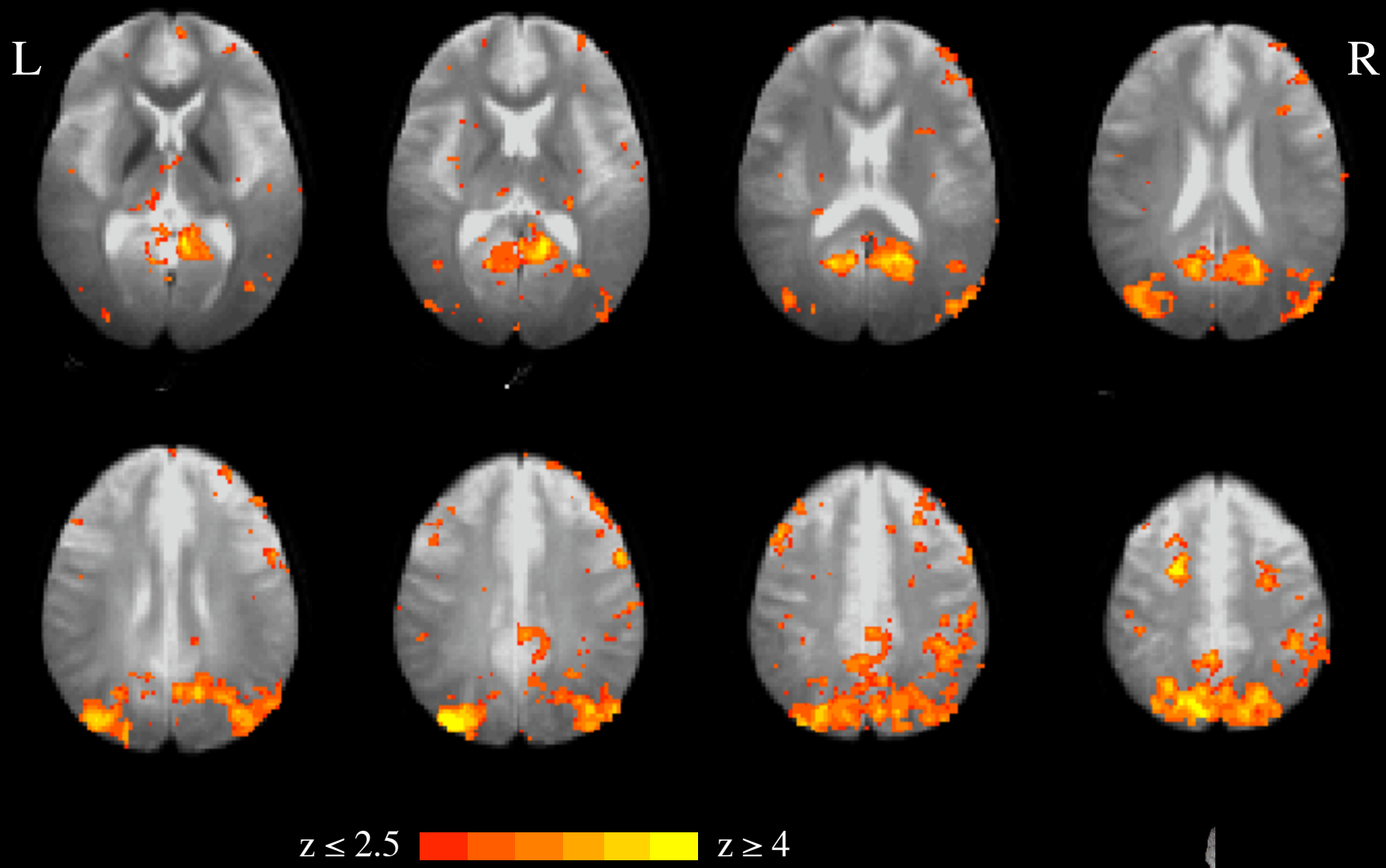
Why not try it?

Why not try it?

Louisiana

really?

Group Result - Geographic Imagery



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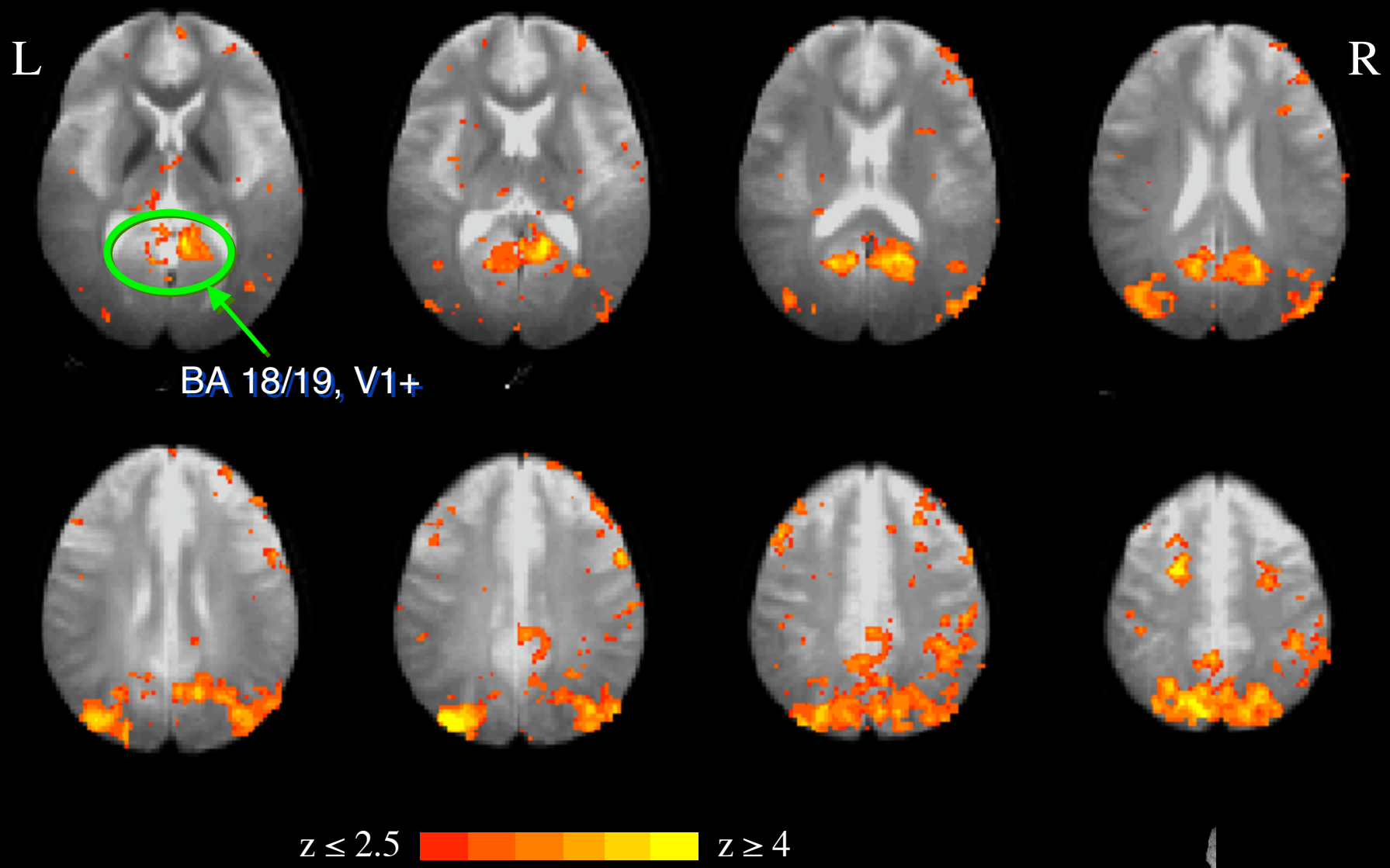
Group Result - Geographic Imagery



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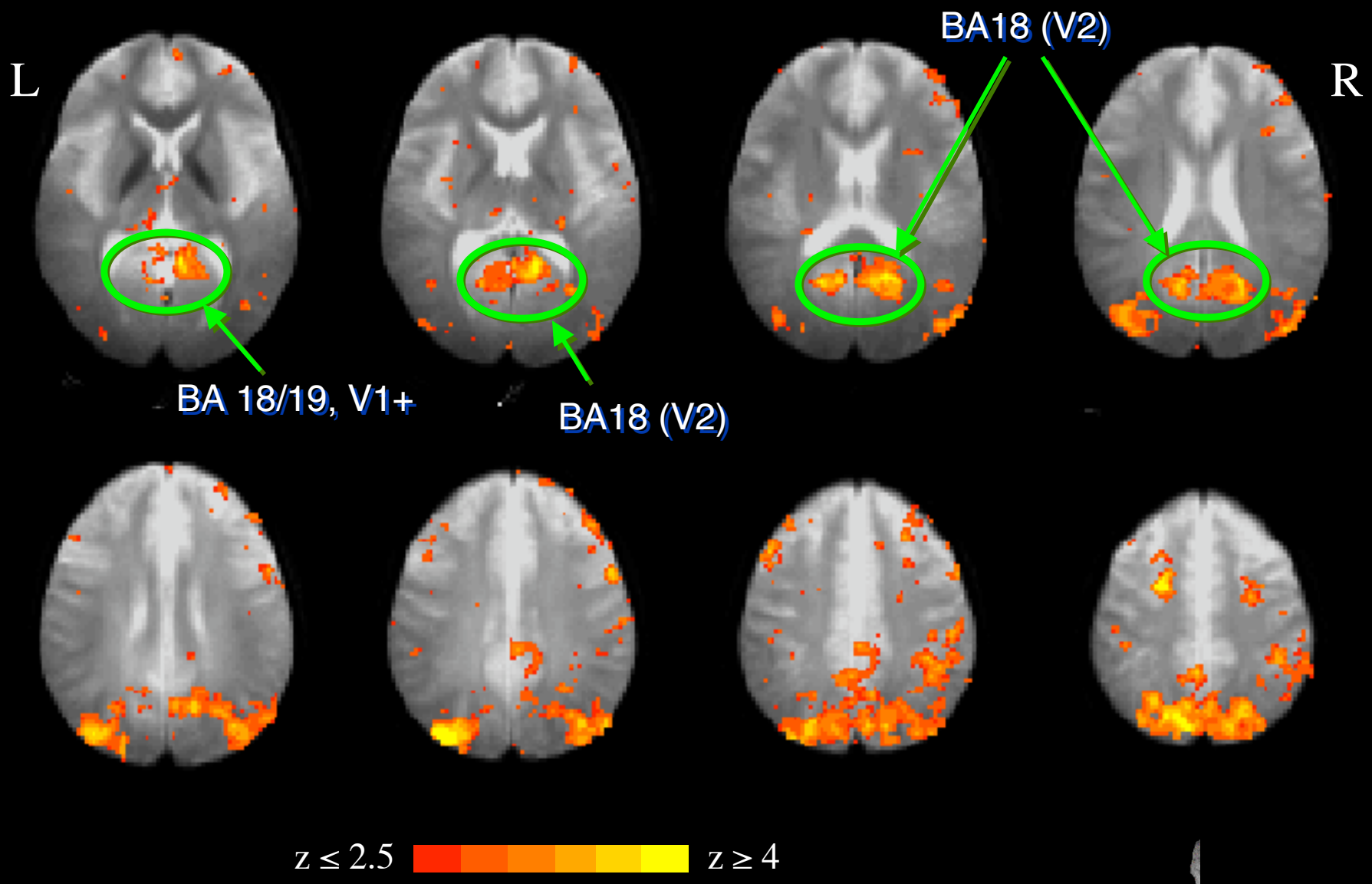
Group Result - Geographic Imagery



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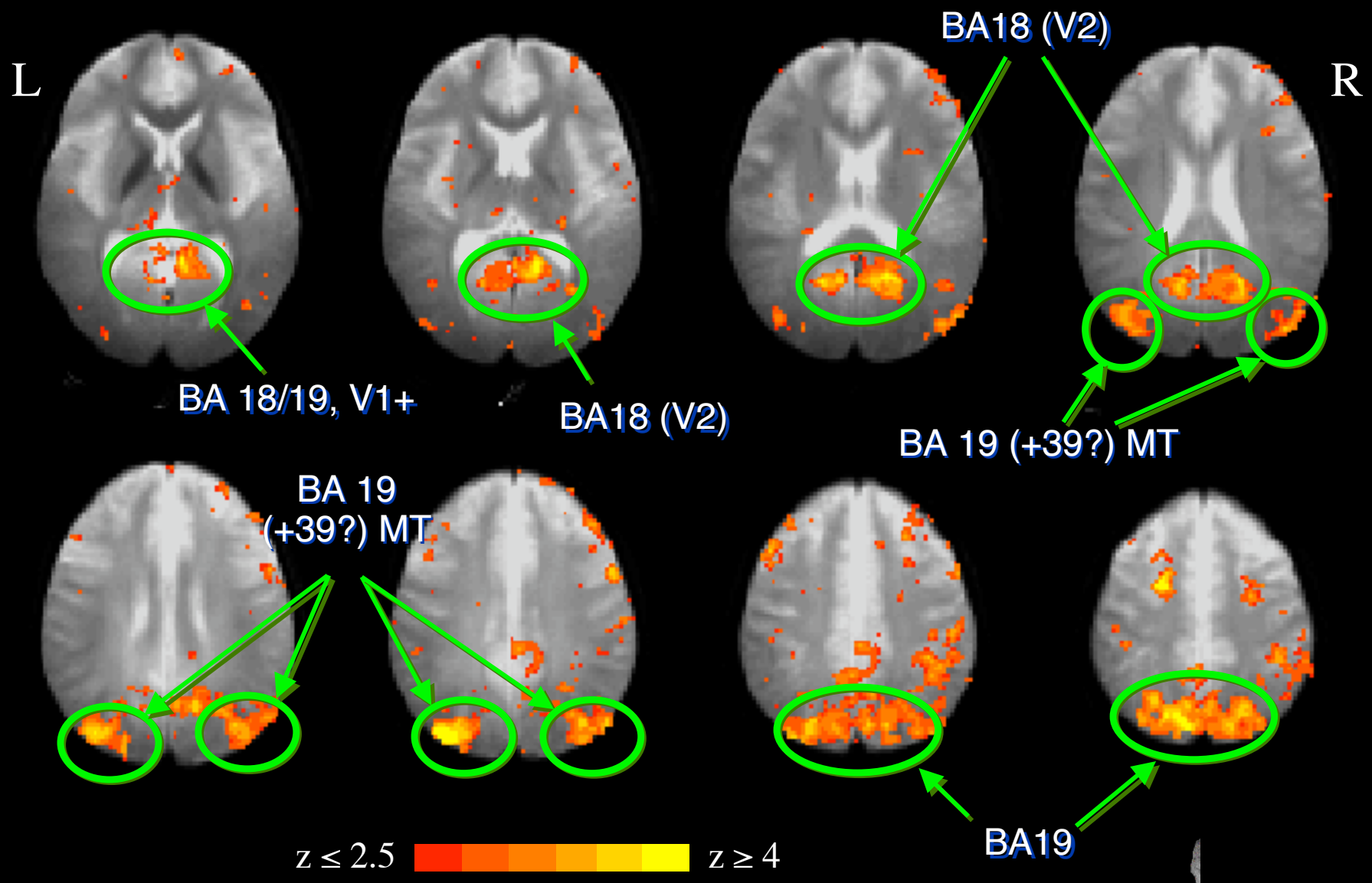
Group Result - Geographic Imagery



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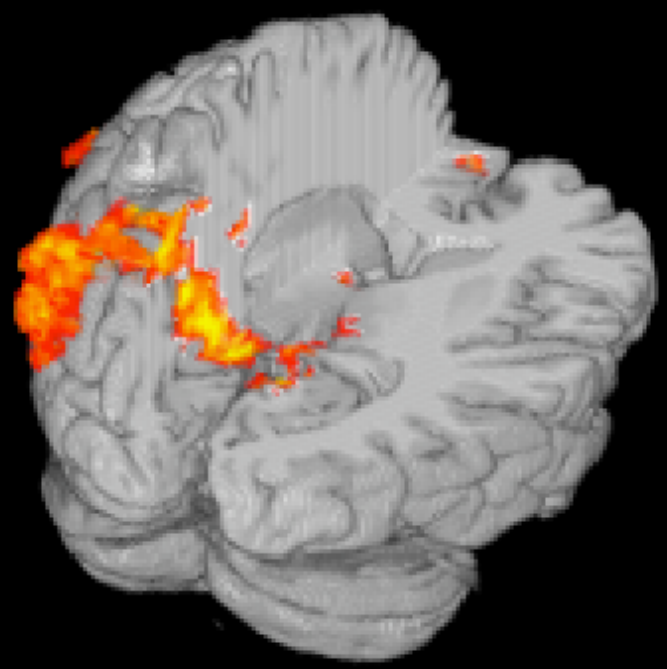
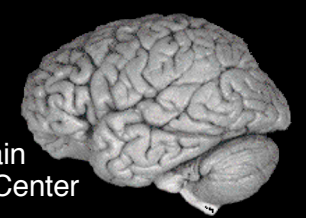
Geographic Imagery



$z \leq 2.5$ $z \geq 4$



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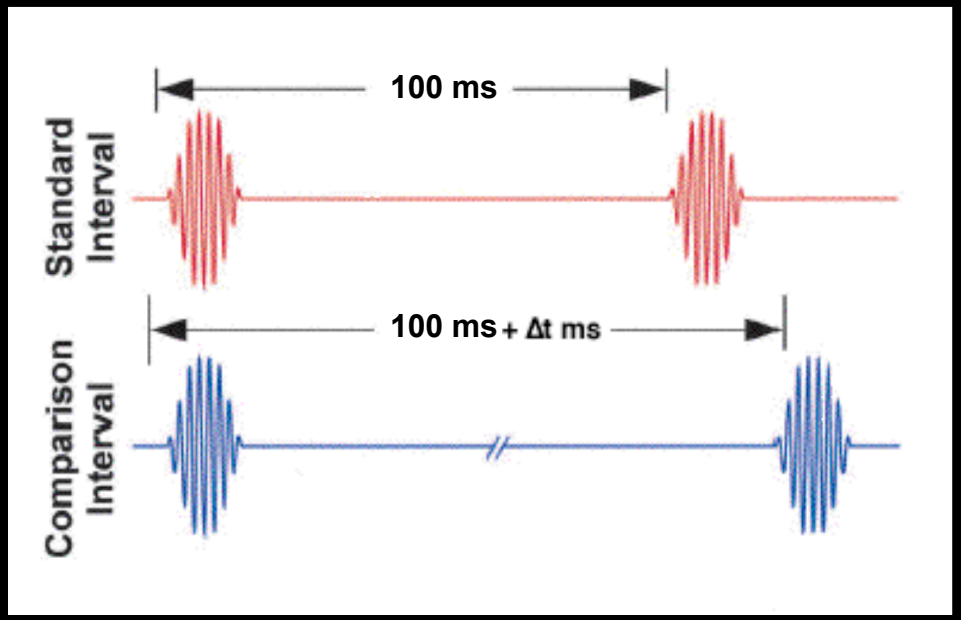
100 ms Interval Task

- Hear Paired Pulse
  - 100 ms standard
  - Comparison
- Respond:
  "Longer" or "Shorter"
- Staircasing
  - 80% correct

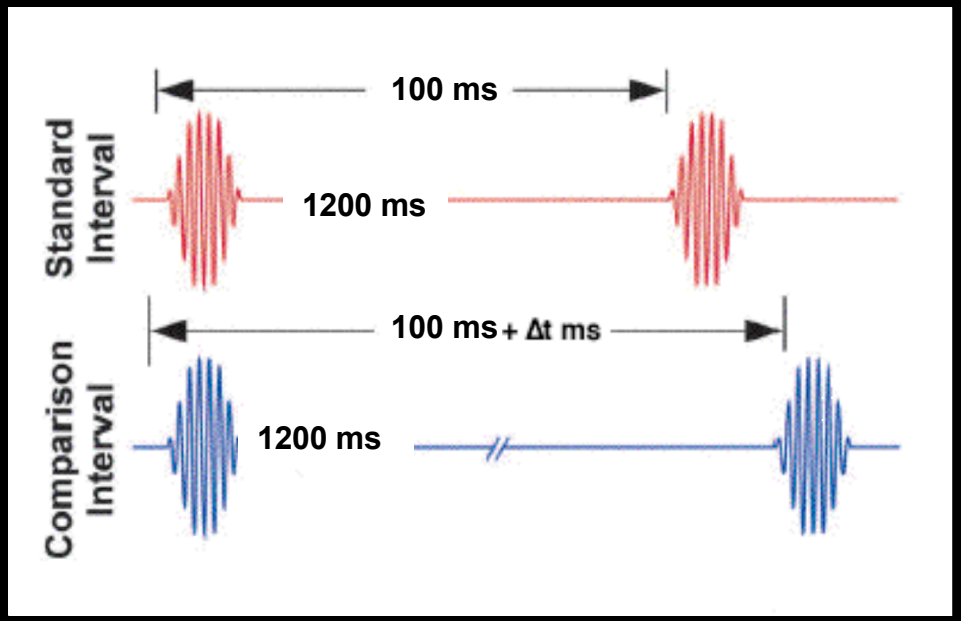


What you see is what you hear.

Shams, Nature, 2000

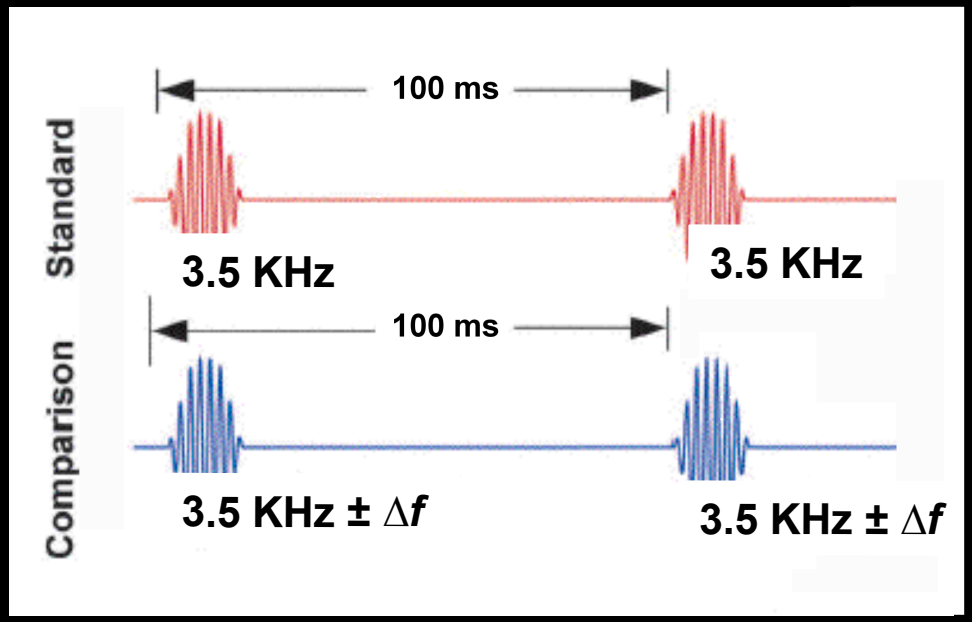
1200 ms Interval Task

- Hear Paired Pulse
  - 1200 ms standard
  - Comparison
- Respond:
- "Longer" or "Shorter"
- Staircasing
  - 80% correct
- Same Stimuli!

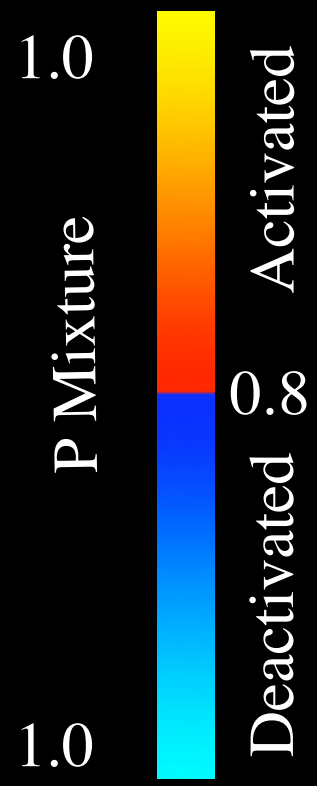


Frequency Control Task

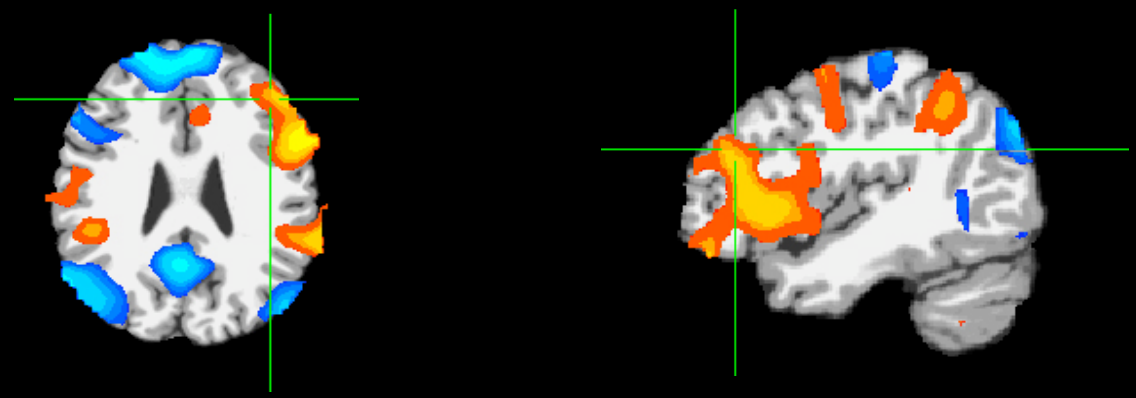
- Hear Paired Pulse
  - 3.5 KHz standard
  - Comparison
- Respond: "Higher" or "Lower"
- Staircasing
  - 80% correct
- Same Stimuli!



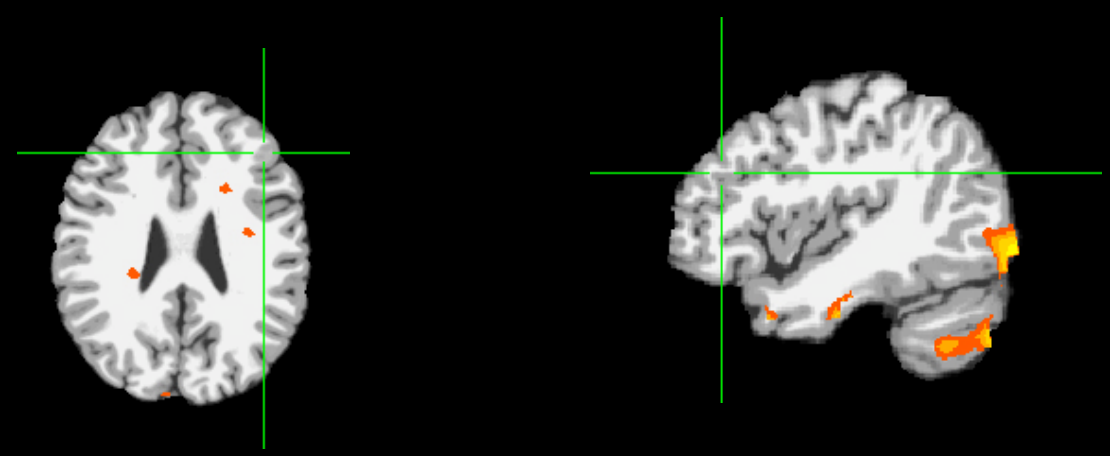
Results:



1200 ms > Frequency



100 ms > Frequency



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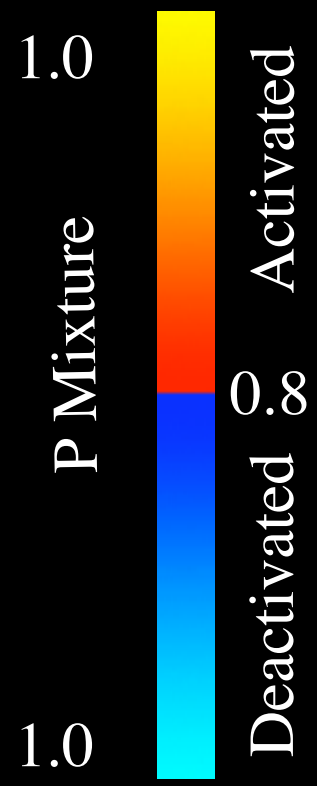
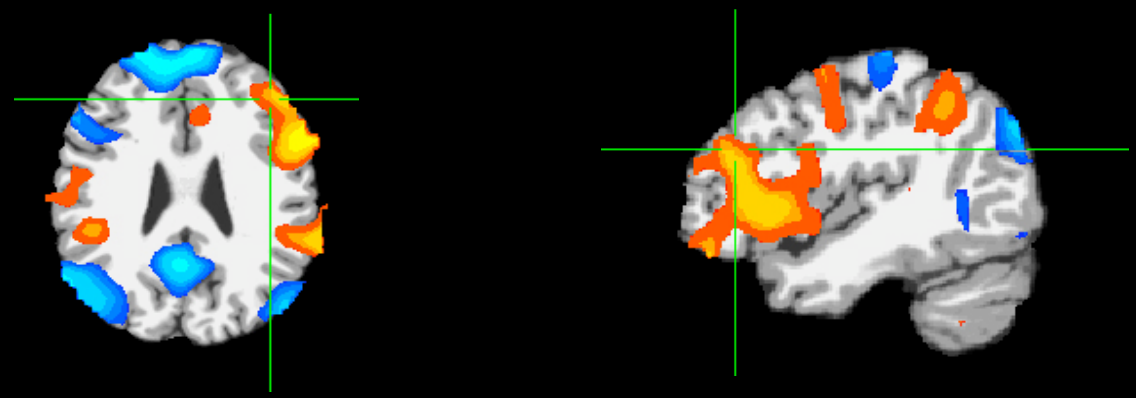
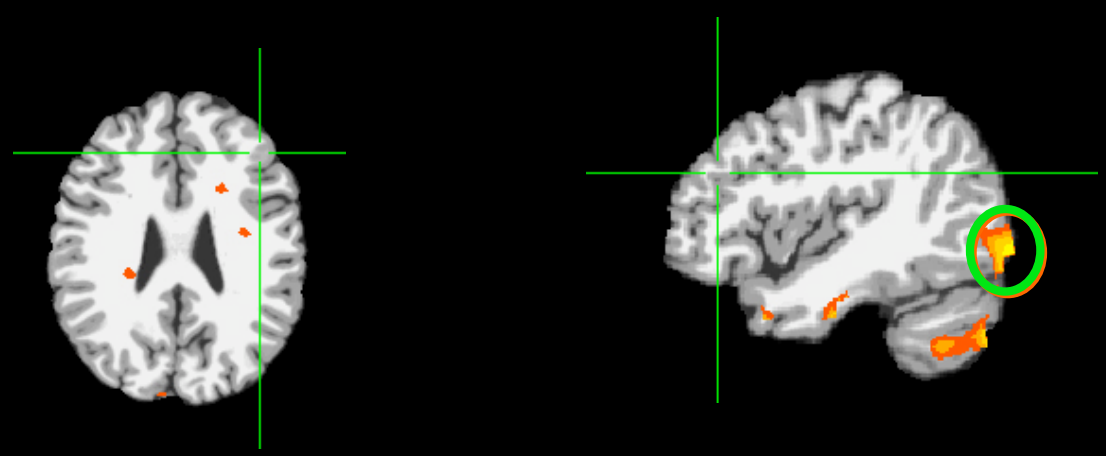
Results:



1200 ms > Frequency



100 ms > Frequency



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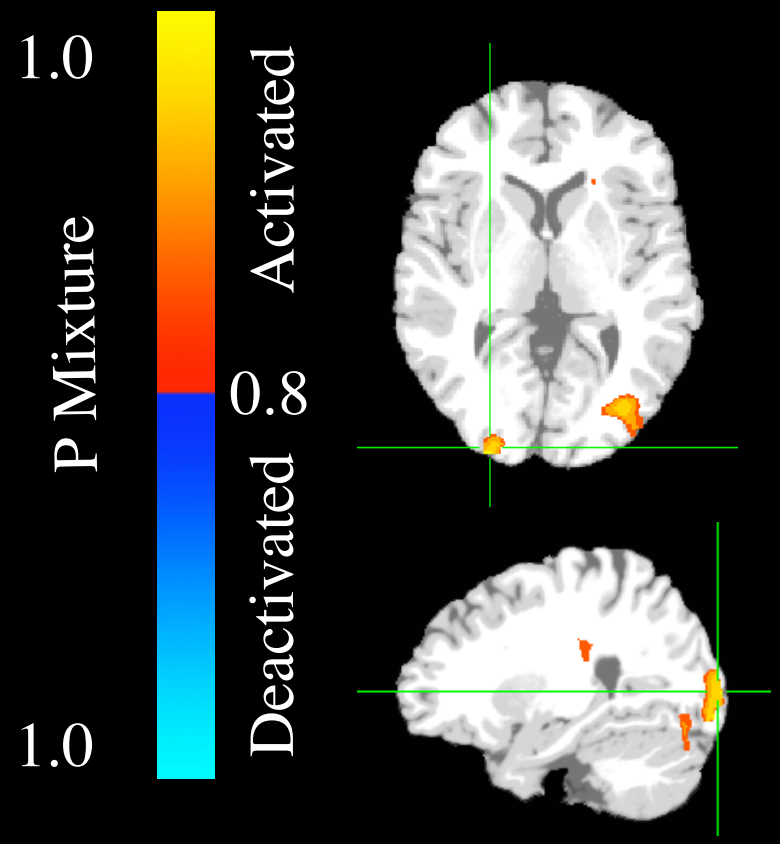
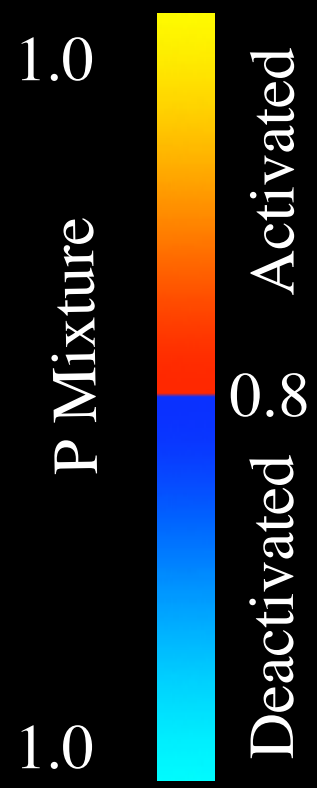
Results:

100 ms > Frequency



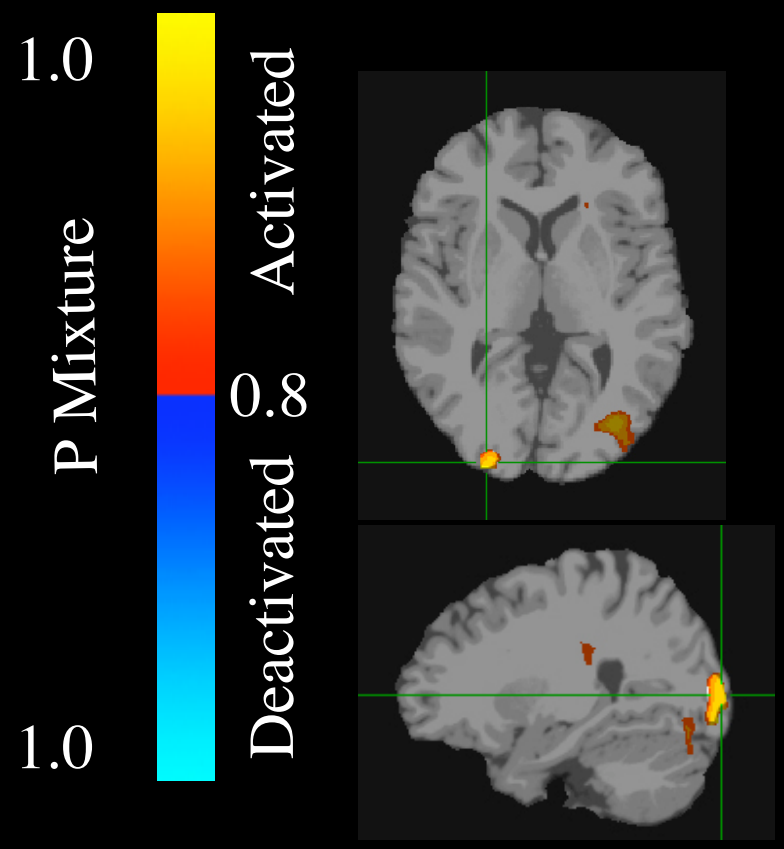
Results:

100 ms > Frequency



Results:

100 ms > Frequency



L Cuneus

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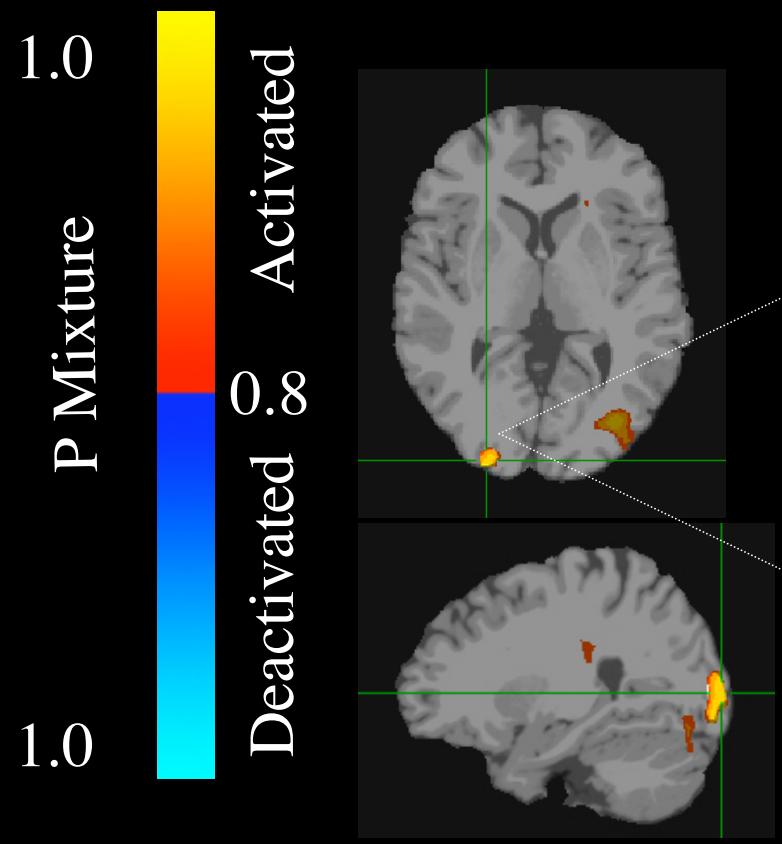
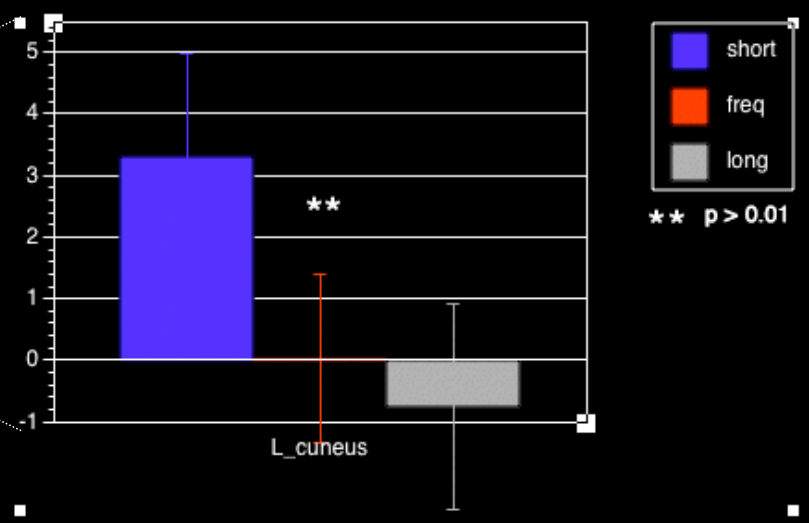
Results:

100 ms > Frequency



L Cuneus



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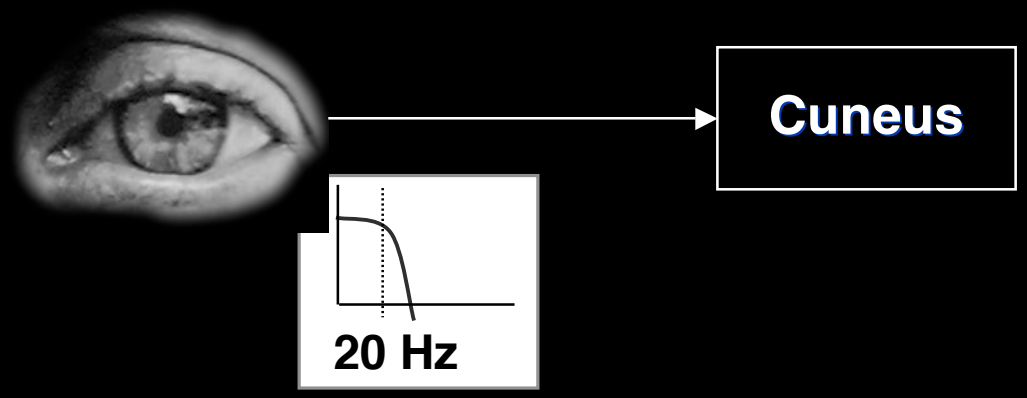
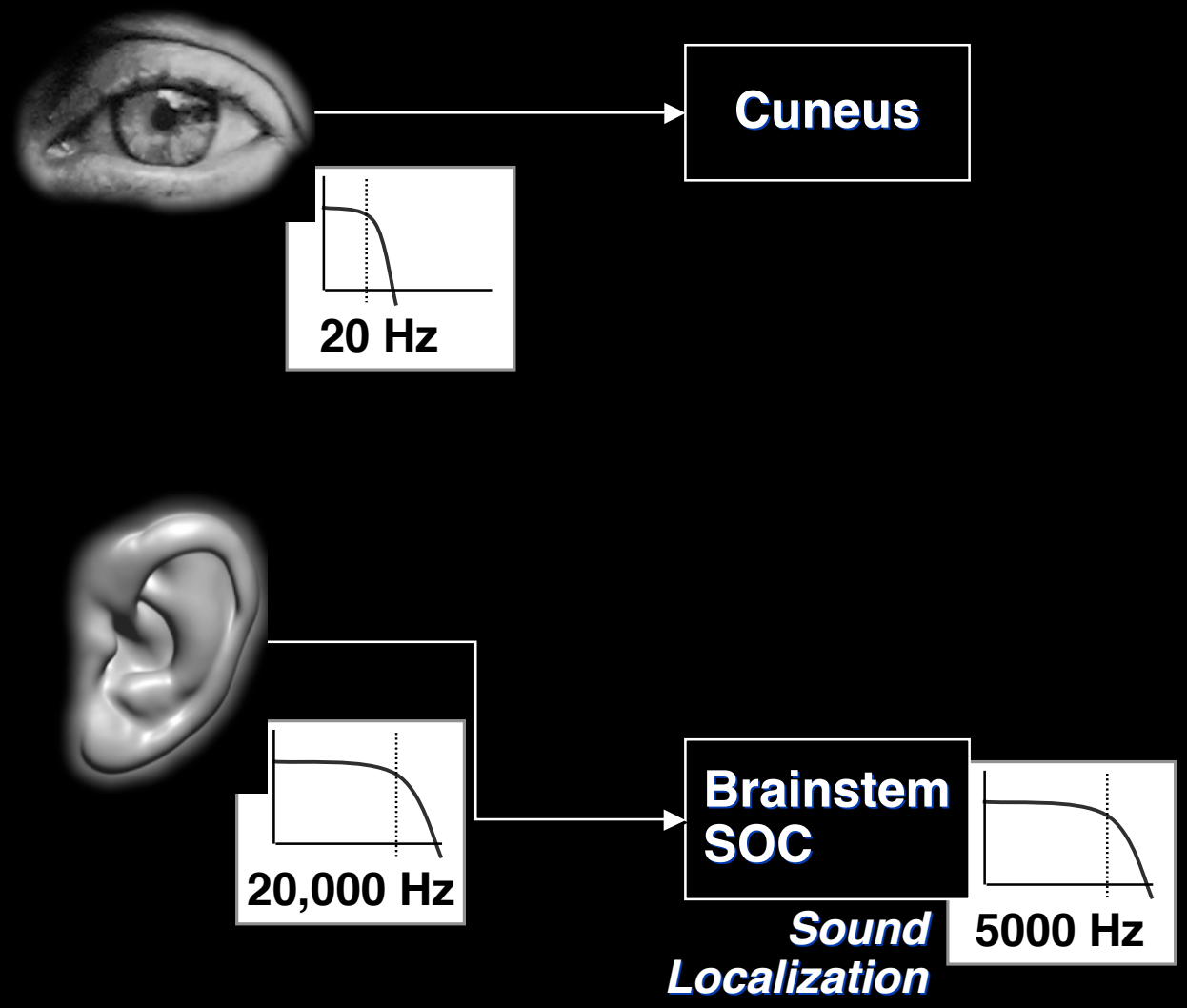
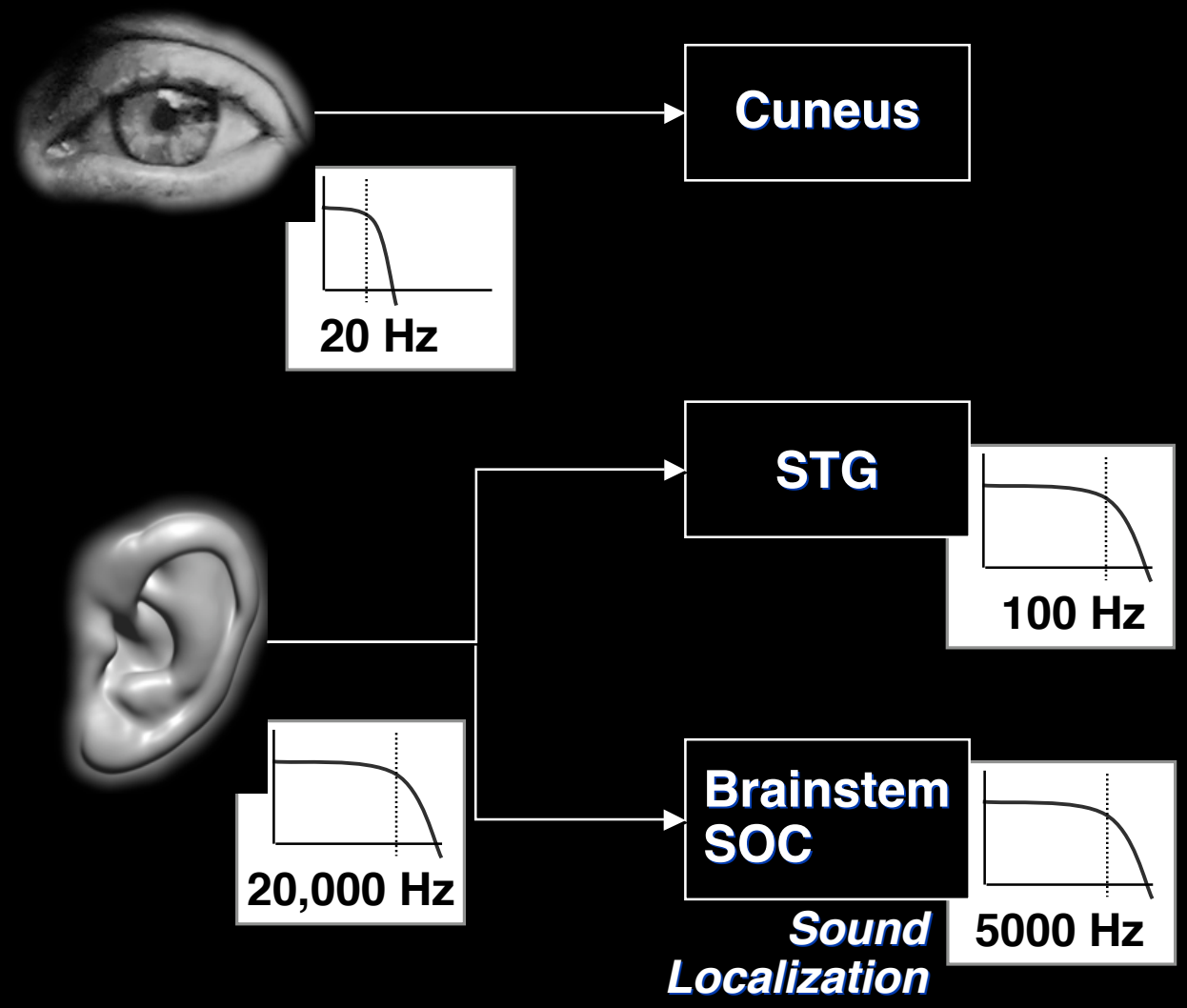
Short Interval Processing



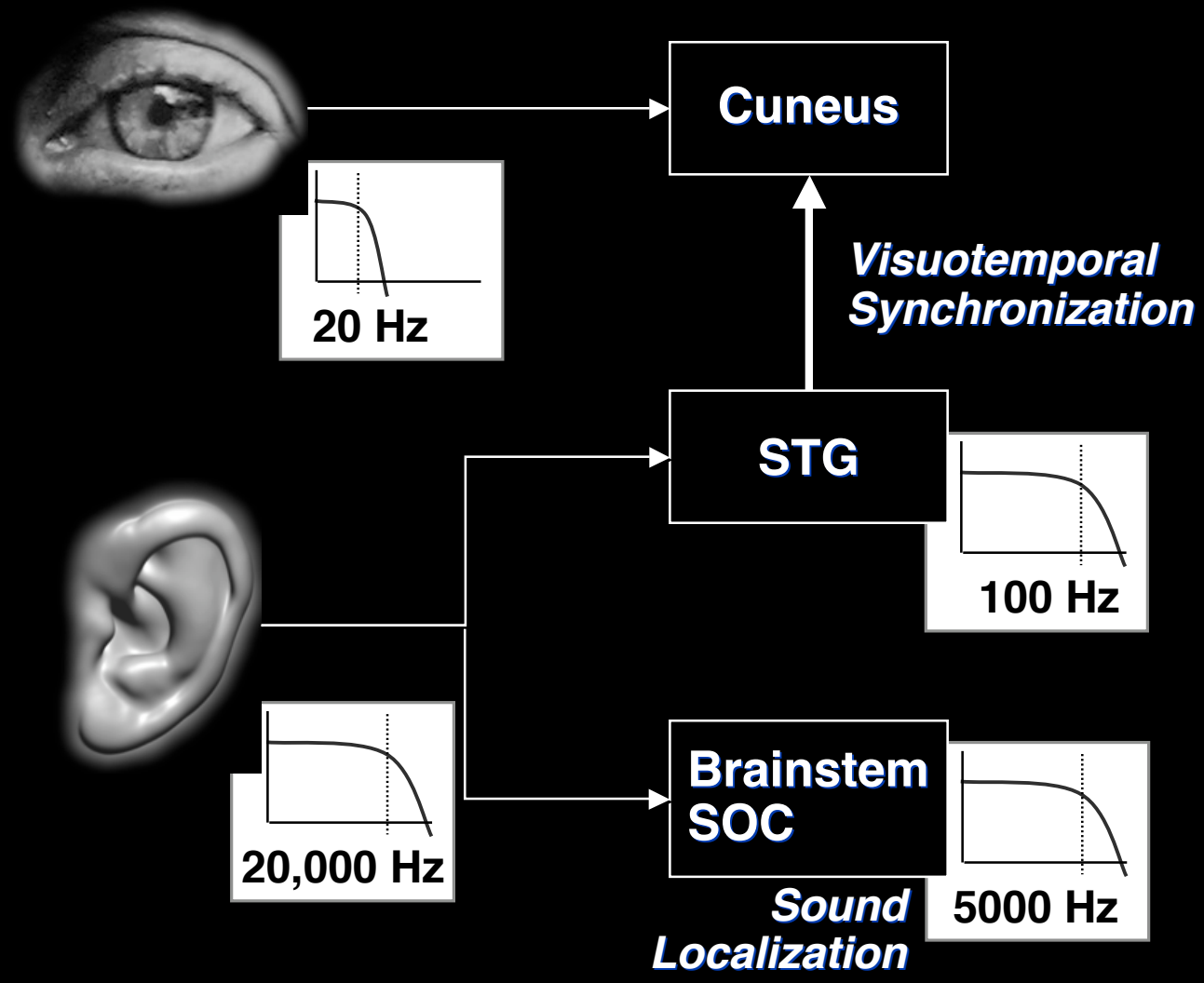
Short Interval Processing



Short Interval Processing



Short Interval Processing



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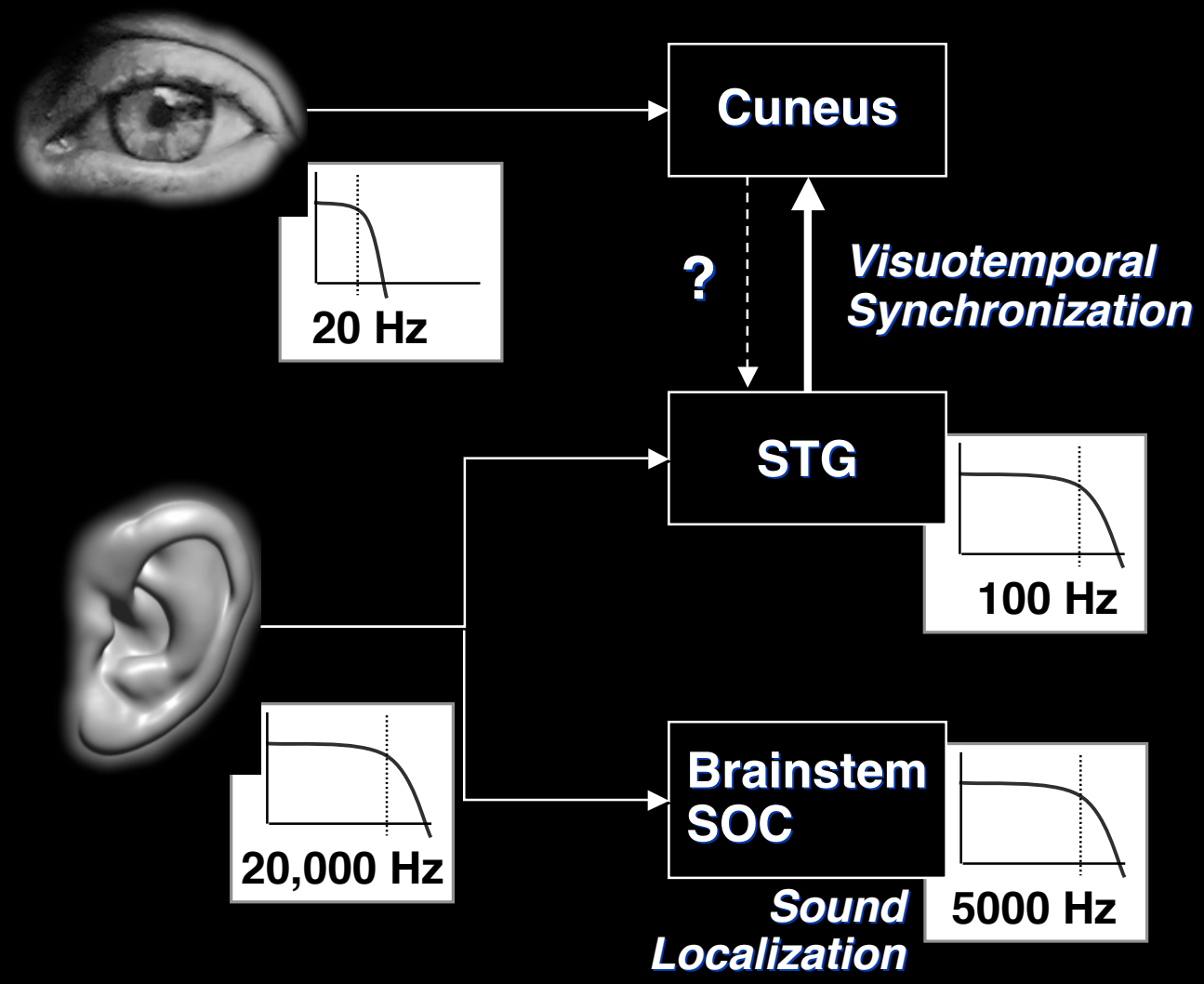
Short Interval Processing



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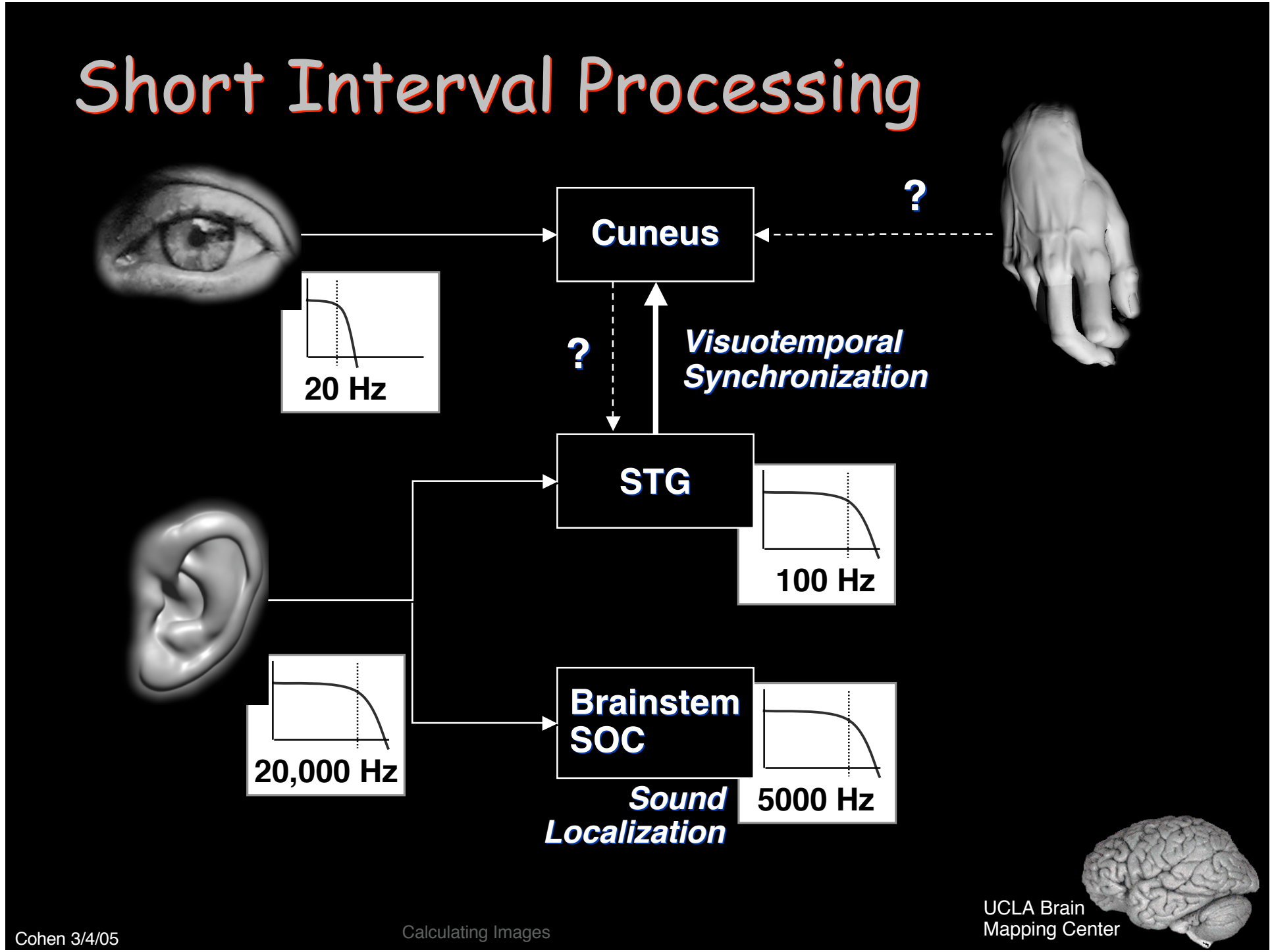
Short Interval Processing



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Seeing (and) the Brain

- Seeing the organization of the brain.
- How do we see?
- The object stares back.
- Seeing is not just vision.
- We see what we know.

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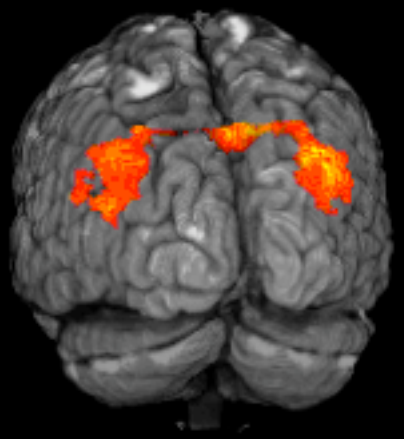
Implications & Speculation

- Imagery Tasks May Represent ***Obligate*** rather than ***Automatic*** Areal Recruitment
- Significance of 39/19 area (a.k.a., 'V5') in Imagery is Unclear and May Suggest Functions beyond Motion Analysis (time?)
- ***IF*** Mental Imagery Requires Activity in Early Sensory Areas, the Neurology of Sensation May Limit our Ability for Image Ideation.



www.brainmapping.org/MarkCohen/

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Where is the image?

VISION

Stimulus	Detection	Perception
light	eye	the brain
sound, chemistry, motion, vibration, electricity	other sense organs	the mind

The psychophysical border of observing can be placed … "unrestrcitedly into the interior of the observers body."

John von Neumann

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Thanks to the Gang

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