HST.583 Functional Magnetic Resonance Imaging: Data Acquisition and Analysis
Fall 2006

HST.583: Functional Magnetic Resonance Imaging: Data Acquisition and Analysis, Fall 2006
Harvard-MIT Division of Health Sciences and Technology
Course Director: Dr. Randy Gollub.

Laboratory 2: Introduction to fMRI Data and Analysis

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HST.583

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What is functional MRI?

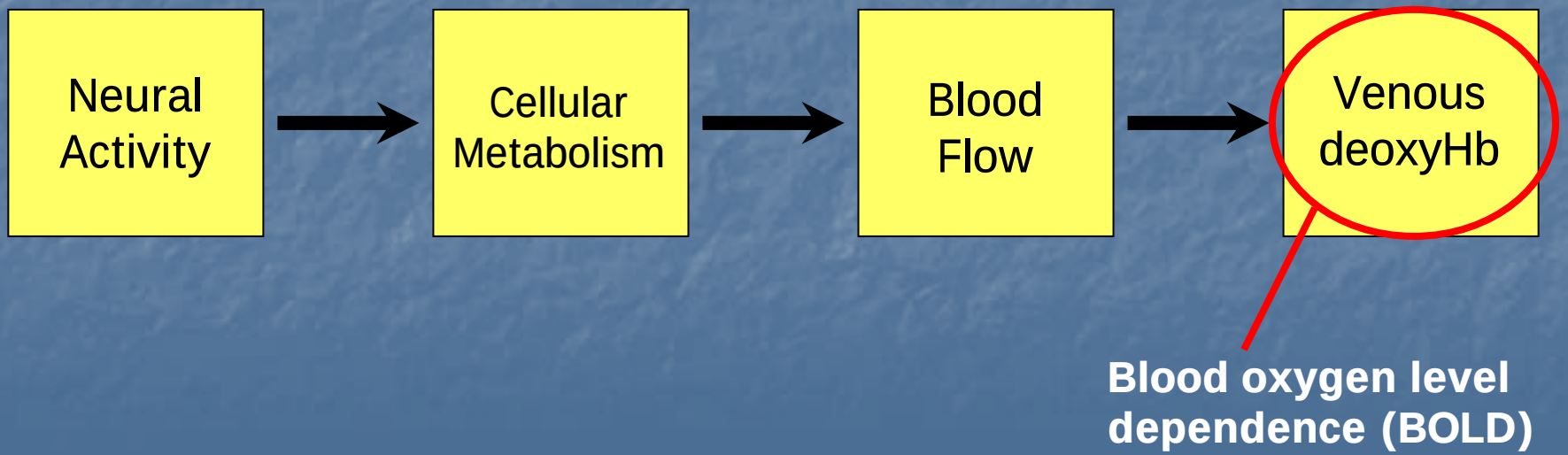
- Broad sense: fMRI refers to any MR technique that goes beyond anatomy to measure aspects of local physiology.
- Specific sense: fMRI refers to MR techniques that investigate changes in brain function over time.
- Brain function/ information processing results from the activity of ensembles of neurons.
- ***Primary goal of fMRI is to detect signal changes corresponding to neuronal activity.***

Buxton RB. Introduction to Functional Magnetic Resonance Imaging, 2002.
Huettel S, Song AW, McCarthy G. Funcitonal Magnetic Resonance Imaging, 2004.

How do we measure neuronal activity with MRI?

- Currently not possible to directly measure neural activity (i.e. firing of action potentials) with MRI
- Can visualize downstream correlates of neural activity

Simplified Flowchart



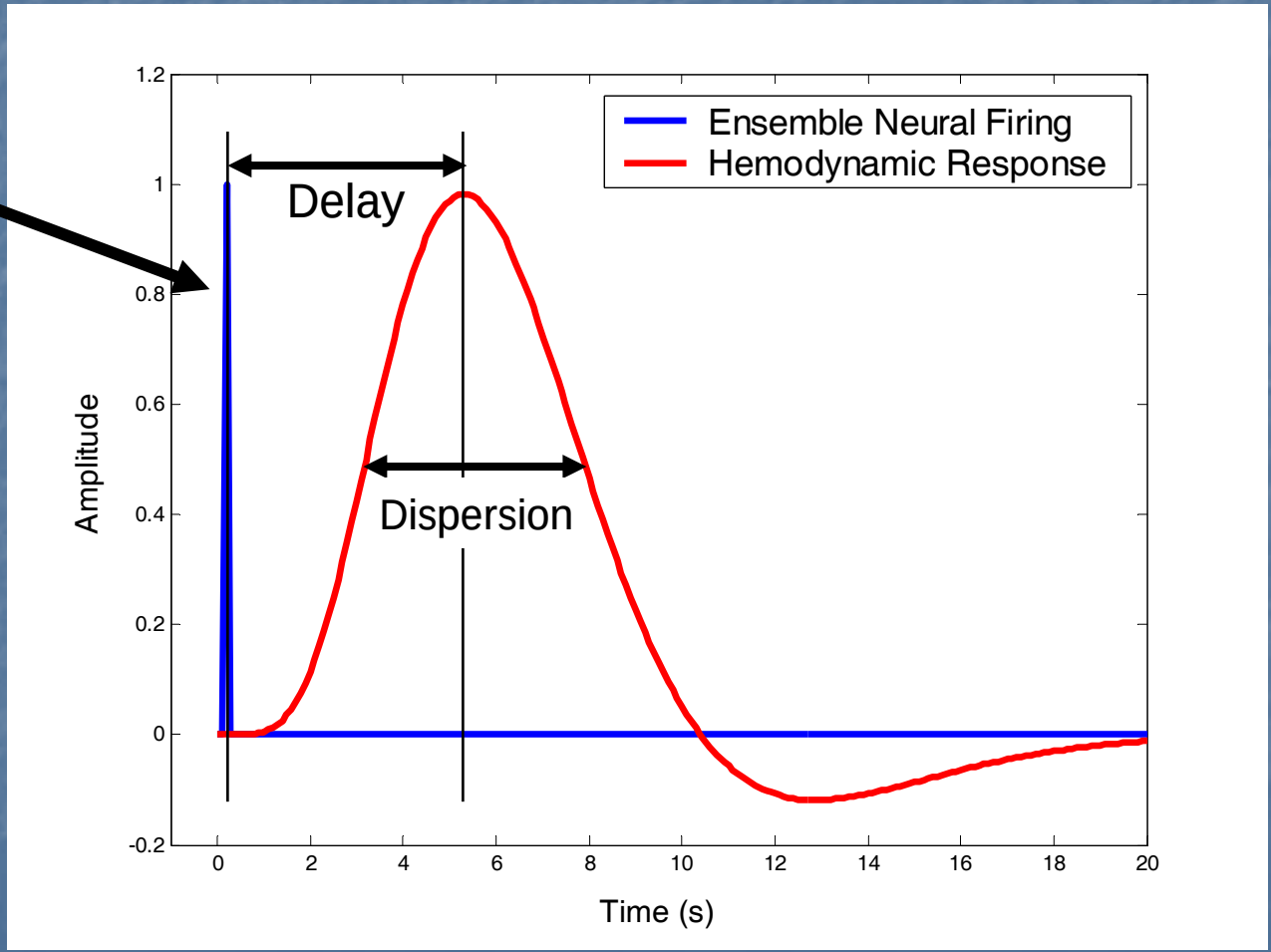
BOLD Imaging

- Neural activation increases local blood flow
- Increased blood flow delivers fresh, oxygenated hemoglobin, and washes out deoxygenated hemoglobin (dHb)
- Venous dHb content *decreases*, leading to an *increase* in MRI signal (dHb attenuates MRI signal)
- *MRI signal thus increases with increased brain activity**

BOLD Imaging: Timing

- BOLD effect is dependent on so-called "hemodynamic response"
- Hemodynamic response describes how blood flow changes over time, in response to neural activation
- Hemodynamic response does not instantaneously follow neural activity; it occurs with delay and dispersion

Example Hemodynamic Response (impulse response)



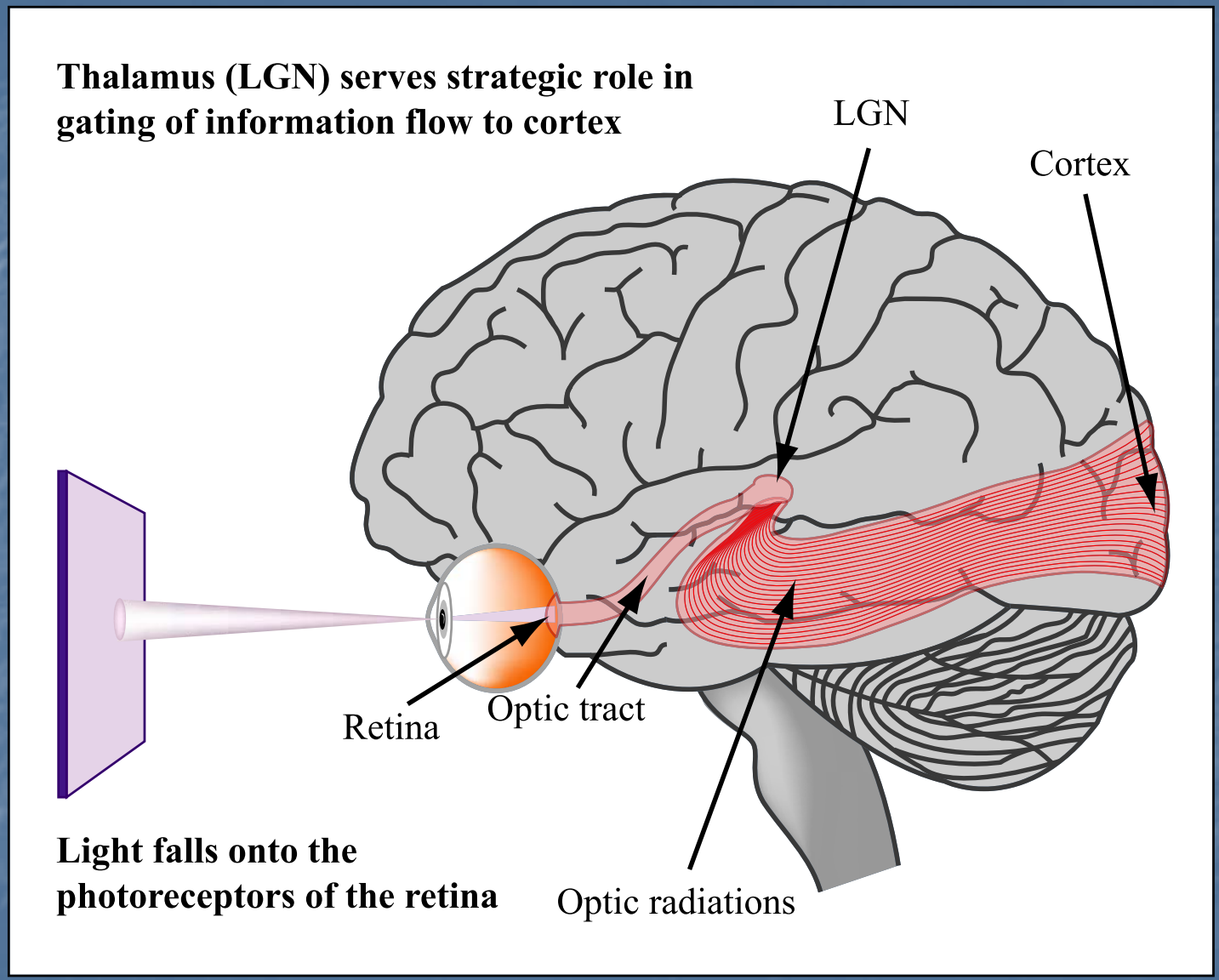


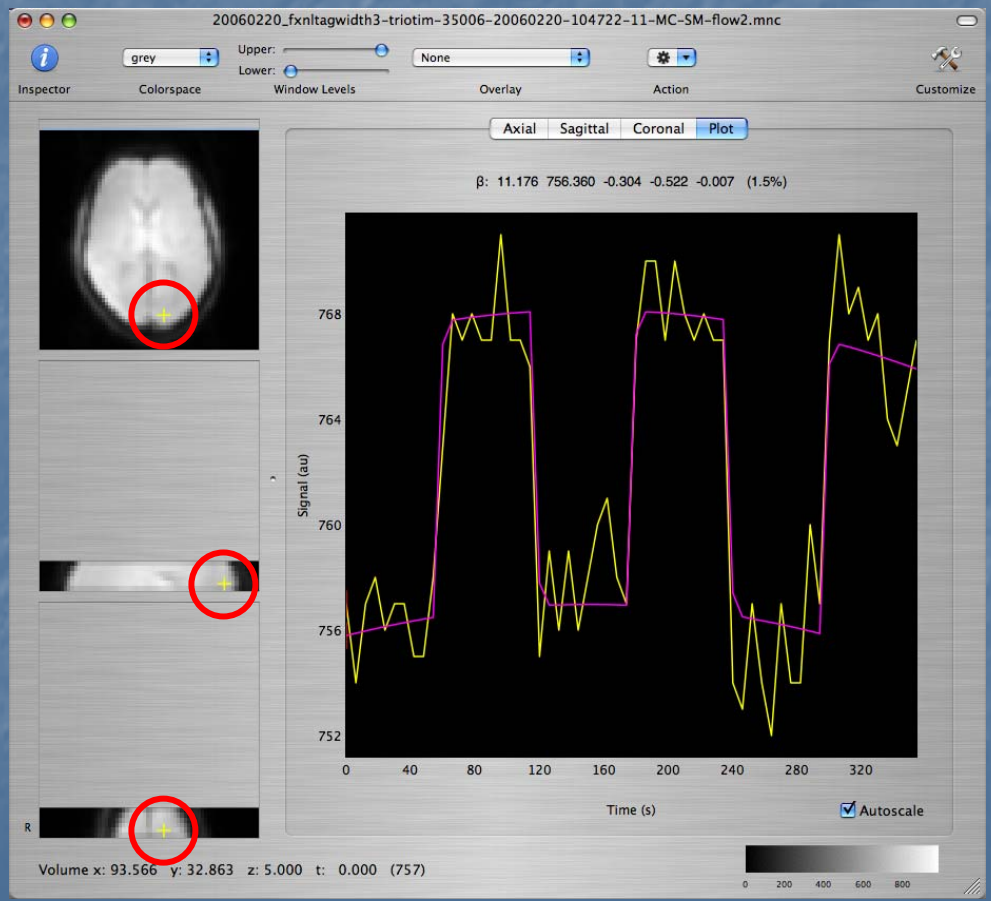
Figure by MIT OpenCourseWare. After Hubel, 1995.

Unregistered HyperCam 2

Sample fMRI paradigm:

Simple visual task; flashing circle checkerboard (8 Hz)

See supplemental video clip #1



- Time series fMRI data of visual cortex voxel matches paradigm
- Indicates a positive BOLD effect; i.e. decreased dHb content as a result of neural activation
- This is fMRI!

Screenshots courtesy of NeuroLens.org. Used with permission.

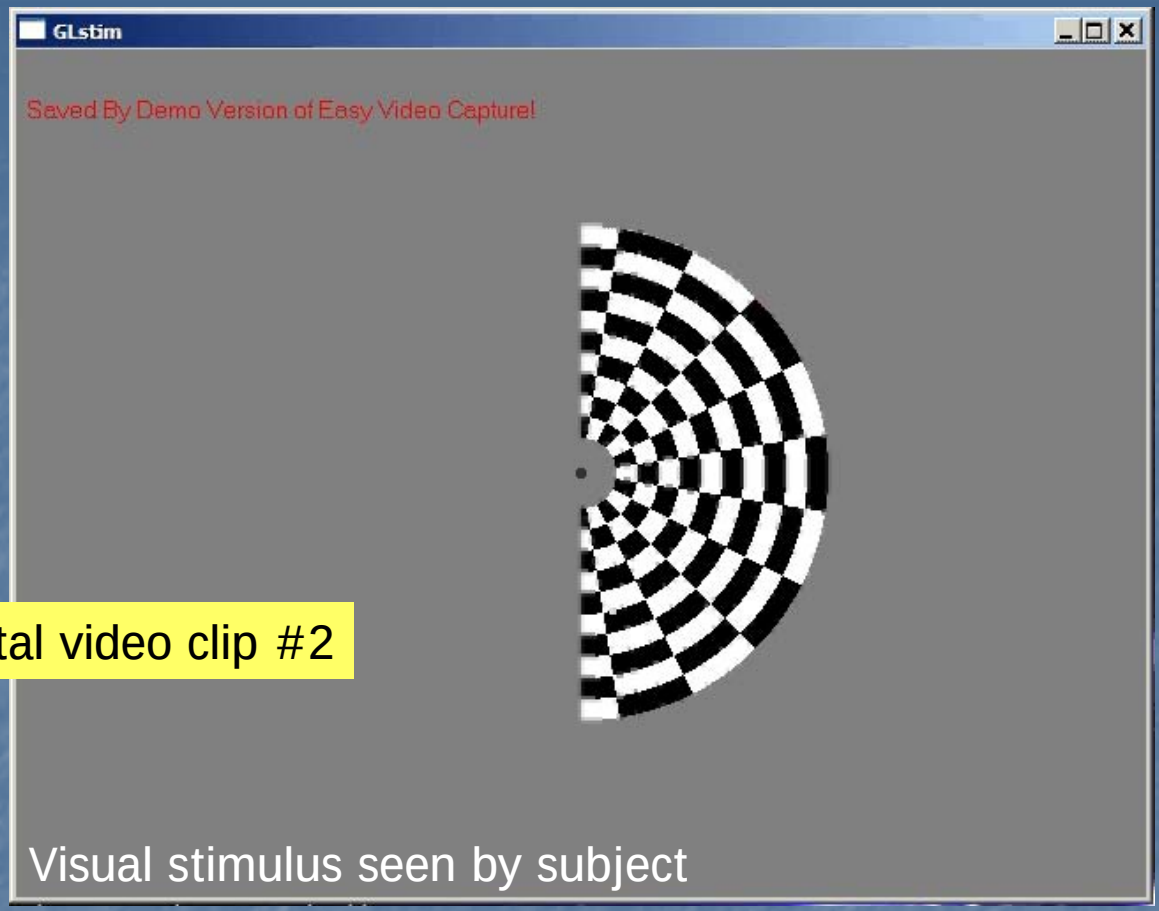
Goals of laboratory 2:

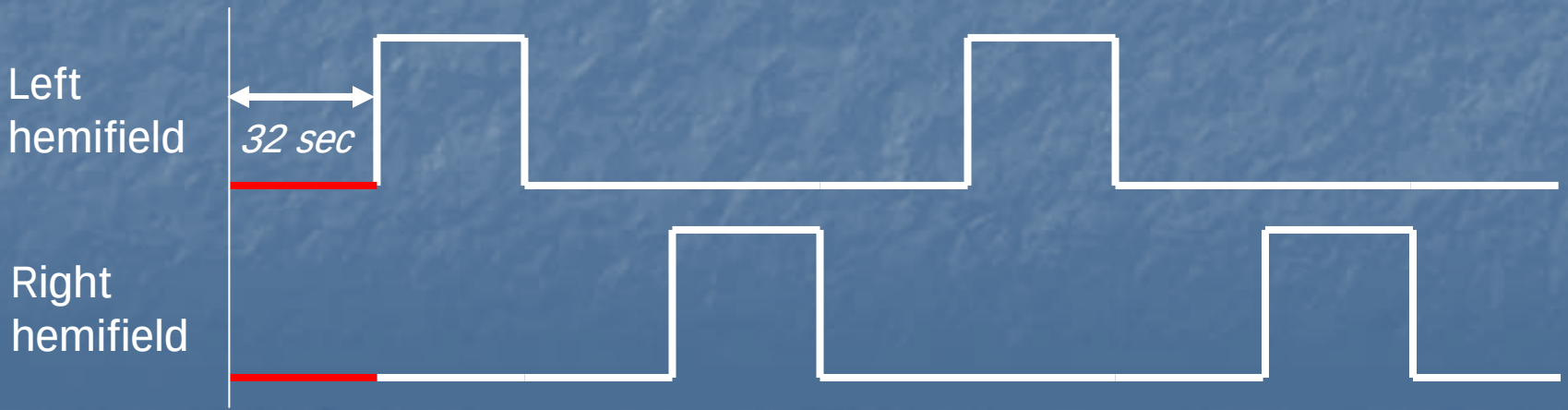
- Goal 1: Get familiar with sample fMRI data set from visual hemifield stimulation task (*Neurolens*[1] *tutorial, exercises 1 and 2)*
- Goal 2: Successfully analyze data set and show appropriate activations *(Neurolens tutorial, exercises 3 and 4)*
- Goal 3: Answer laboratory questions and do exercises on handout (*graded)*
- Bonus: Neurolens tutorial, exercises 5 and 6

1. *Hoge RD, www.neurolens.org, 2006.*

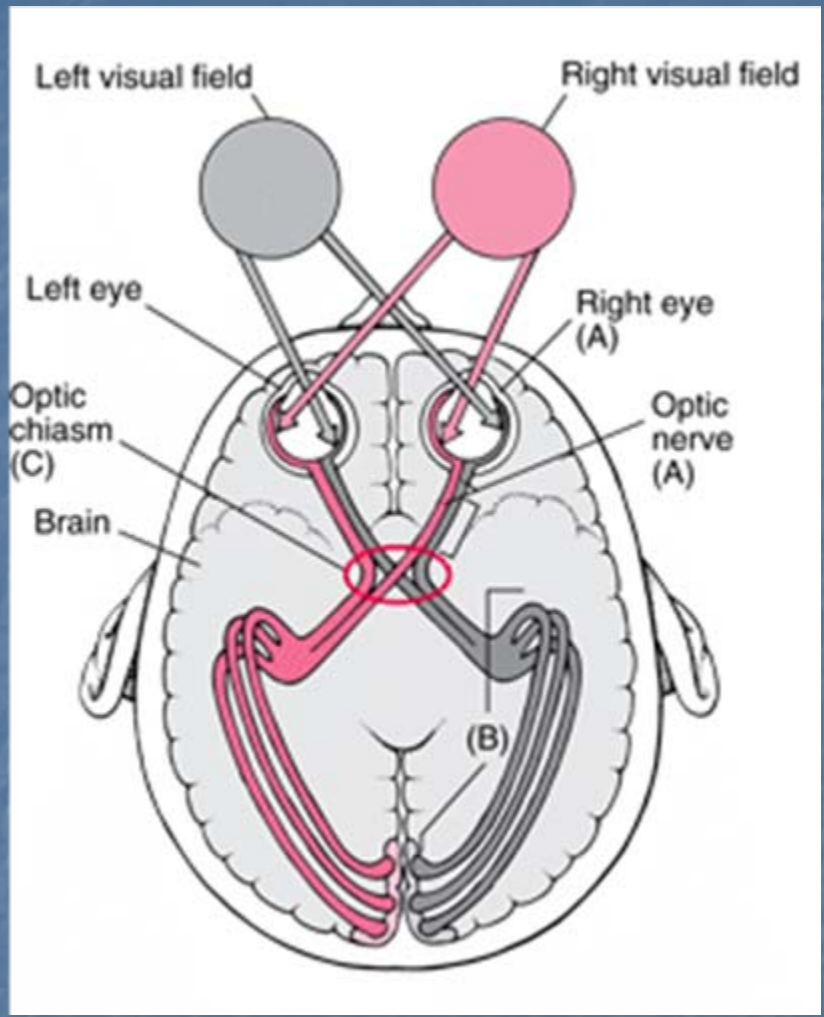
Visual Task:
Interleaved left and right visual field stimulation (8 Hz flashing checkerboard)

See supplemental video clip #2





Visual Field Pathway



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So where should we expect activation??

So where should we expect activation?

- Primary activation should be in *contralateral* visual cortex
- Will be *slight* activation in *ipsilateral* visual cortex, due to some crosstalk. In other words, the flashing checkerboard stiumulus does not completely isolate L/R visual fields

Image removed due to copyright restrictions.

"Visual Pathways." Images #202 & 203 from Hanaway, Woolsey, Gado and Roberts. *The Brain Atlas: A Visual Guide to the Human Central Nervous System*. Fitzgerald Science Press, 1998.