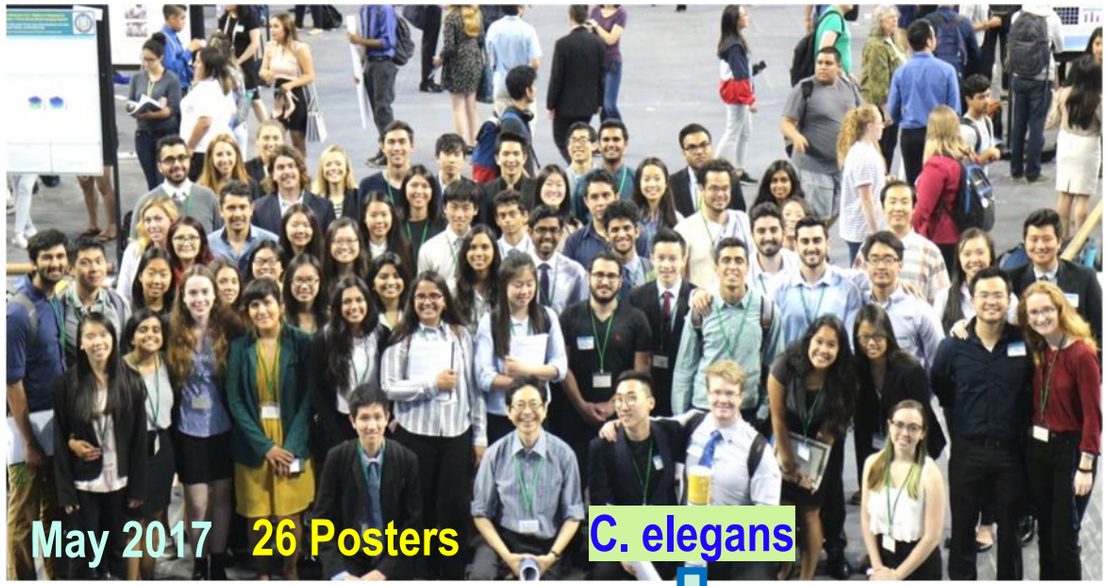
Grand Unified Theory of Mind and Brain

Space-Time Approach to 3D Vision

Katsushi Arisaka

University of California, Los Angeles
Department of Physics and Astronomy

Elegant Mind Club (2013 – Now) ~500 undergrads



Division	Major	Fall 2020	Fall 2021	Winter 2022	
		Remote	In-person	Senior	New
Life Sciences		**56**	**61**	**44**	**83**
	Neuroscience	16	11	9	24
	Biology	11	18	10	15
	Psychobiology	2	11	1	16
	Psychology	10	2	9	3
	Molecular, Cell, and Developmental Biology (MCDB)	7	7	6	6
	Microbiology, Immunology, and Molecular Genetics (MIMG)	4	5	3	7
	Physiological Science	2	4	2	6
	Cognitive Science	2	2	2	3
	Computational and Systems Biology	2	1	2	3
Physical Sciences		**22**	**26**	**19**	**23**
	Physics	11	12	8	8
	Biochemistry	4	7	6	8
	Biophysics	1	3	2	3
	Astrophysics	4	2	1	2
	Chemistry	0	1	1	2
	Mathematics	1	0	0	0
	Applied Math	1	1	1	0
Engineering		**27**	**11**	**6**	**11**
	Mechanical Engineering	9	4	2	4
	Electical and Computer Engineering	2	4	3	6
	Chemical Engineering	4	0	0	0
	Computer Science	5	1	0	1
	Aerospace Engineering	2	1	1	0
	Bioengineering	4	1	0	0
	Civil Engineering	1	0	0	0
Social Sciences		**4**	**1**	**3**	**5**
	Anthropology	3	0	1	0
	Sociology	0	1	1	0
	History	1	0	0	1
	Gender Studies	0	0	0	1
	Human Biology and Society	0	0	1	3
Total		**109**	**99**	**72**	**122**
				194	

Talk Outline

- Three Mysteries of Vision
- The Origin of the Brains – MePMoS
- Experimental Evidence – Reaction Time
- Neural Holographic Tomography – NHT and HAL
- Grand Unification of Five Senses

Mystery of Vison

A fundamental first step in exploring the nature of mind, from a scientific point of view, is to reject the premise that the mind appeared suddenly as a result of spectacular intervention. The nature of mind must be understood on the basis of its origin, the process of its becoming, by the biological mechanism of trial and error endlessly at work. The mind, or what I shall refer to as the "mindness state," is the product of evolutionary processes that have occurred in the brain as actively moving creatures developed from the primitive to the highly evolved. Therefore, a true examination of the scientific basis for mindness requires a rigorous evolutionary perspective, as it is through this process that mindness came to be. How the mind came to us (or we to it, as we shall see) is a rich and beautiful story that is over 700 million years old—and, like all things biological, is still being written.

How do we sense the locations, shapes, colors?

How do we know the distances?


#GOBRUINS
UCLA VOLLEYBALL
22
@UCLAMVB
UCLA BASKETBALL

Saccadic eye movement while driving a car

https://www.youtube.com/watch?v=thGrRNKVhXA

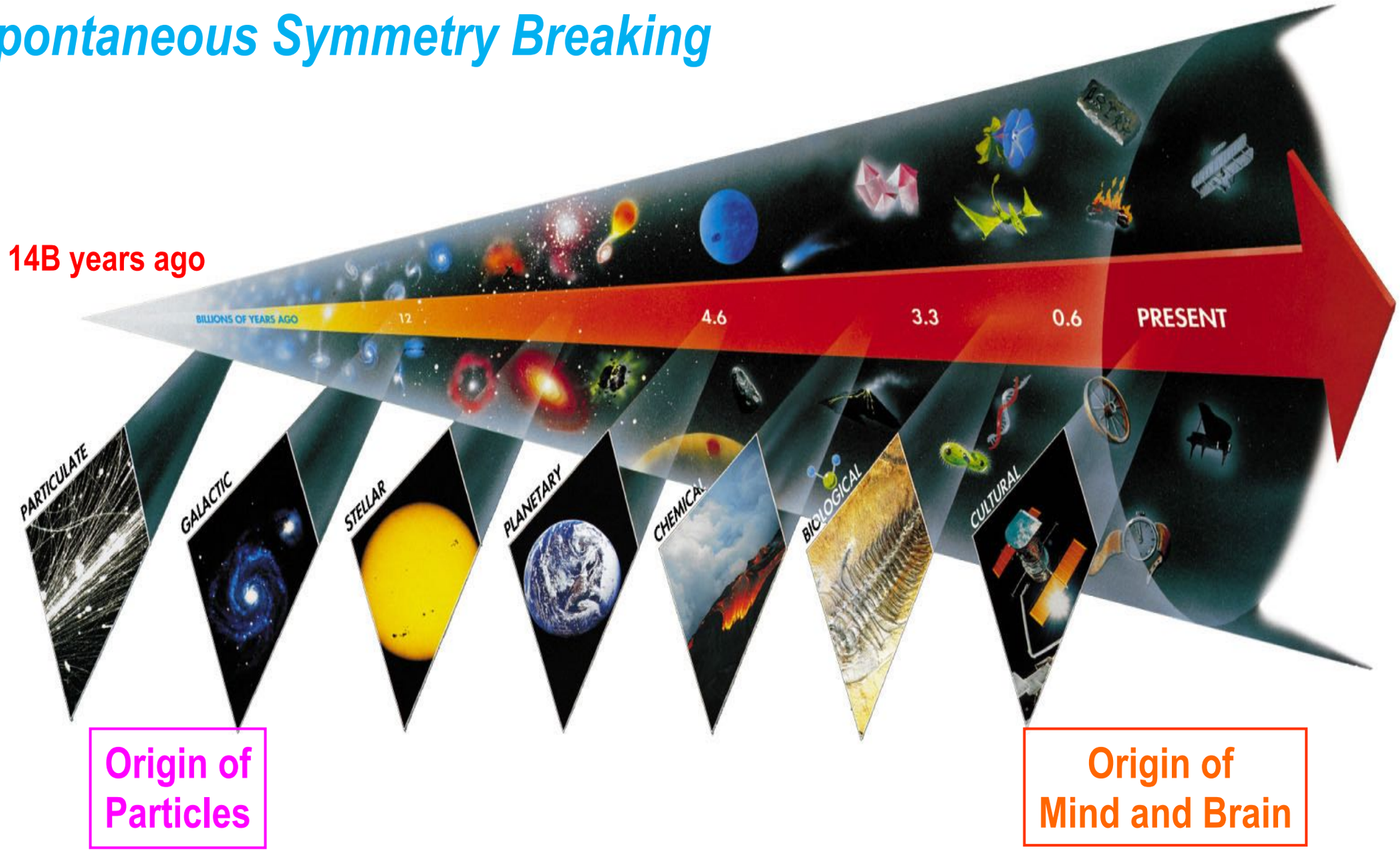
Three Major Mysteries of Vision

- Why nothing moves even if we move our eyes/head?
  - Why do we constantly move our eyes unconsciously?
- Why can we perceive the 3D space with depth?
  - Even with monocular view.
- How can we recognize the 3D shape?
  - at any 3D location with different apparent size and different 3D orientation?

The Origin of the Brains

Seven steps of cosmic evolution

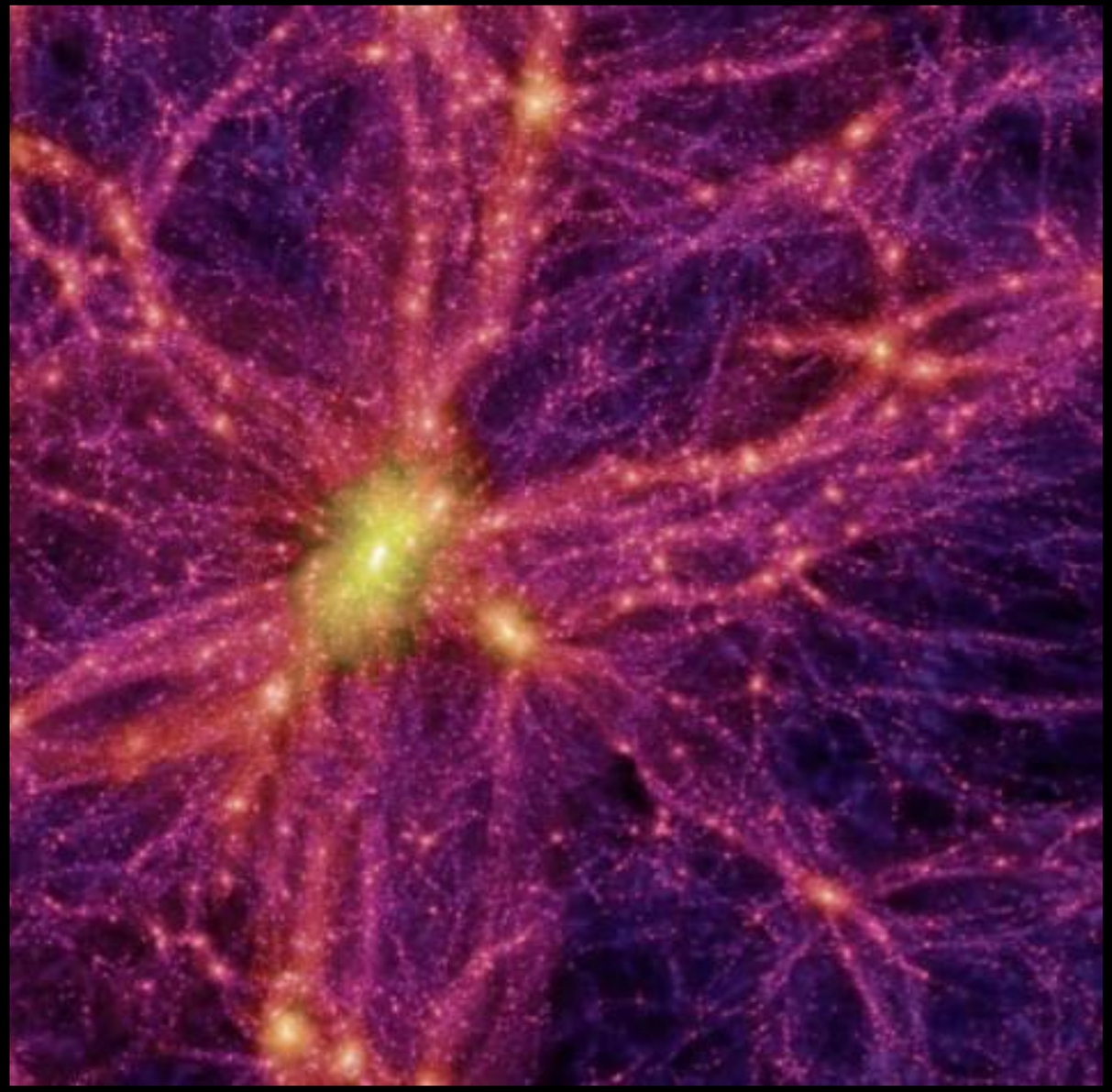
Spontaneous Symmetry Breaking



Origin of Particles

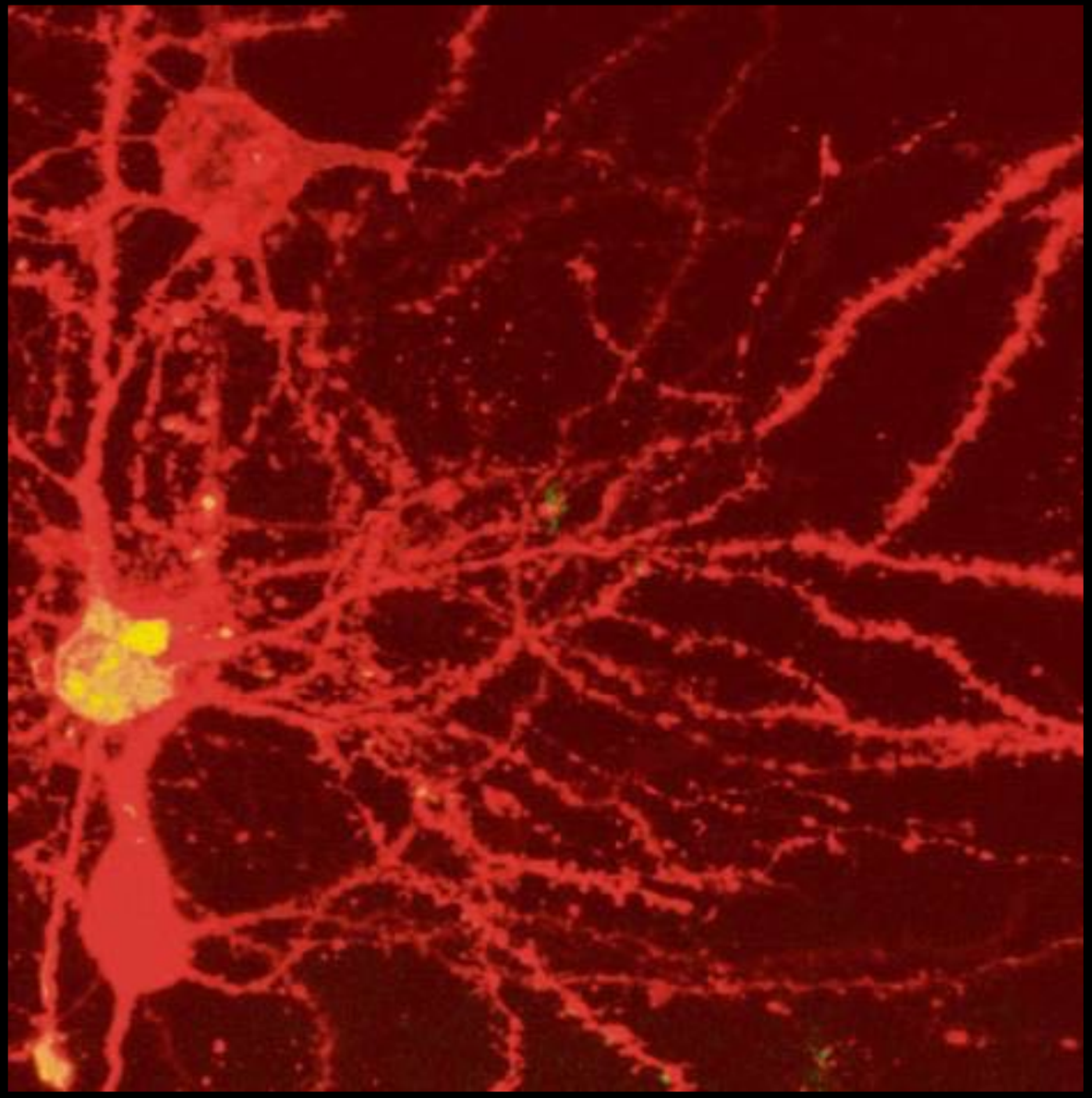
Origin of Mind and Brain

Universe



100 Billions Galaxies

Brain



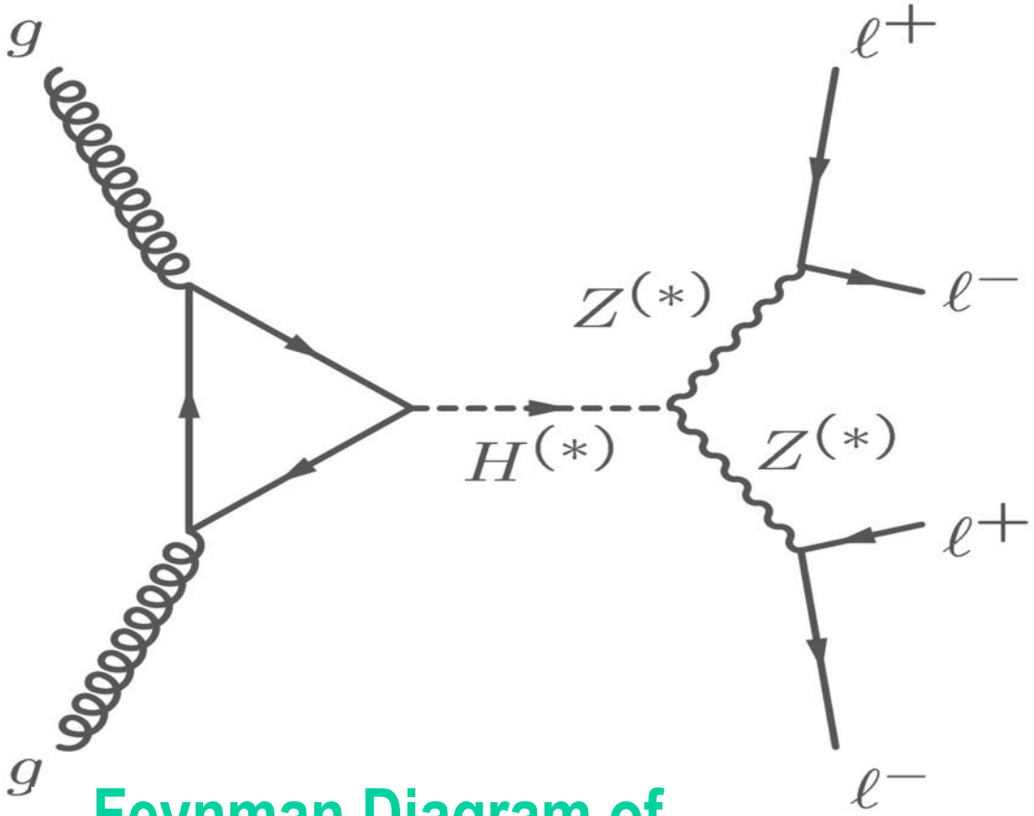
100 Billions Neurons

New York Times 8/21/2006

Particle Physics vs. Neurophysics

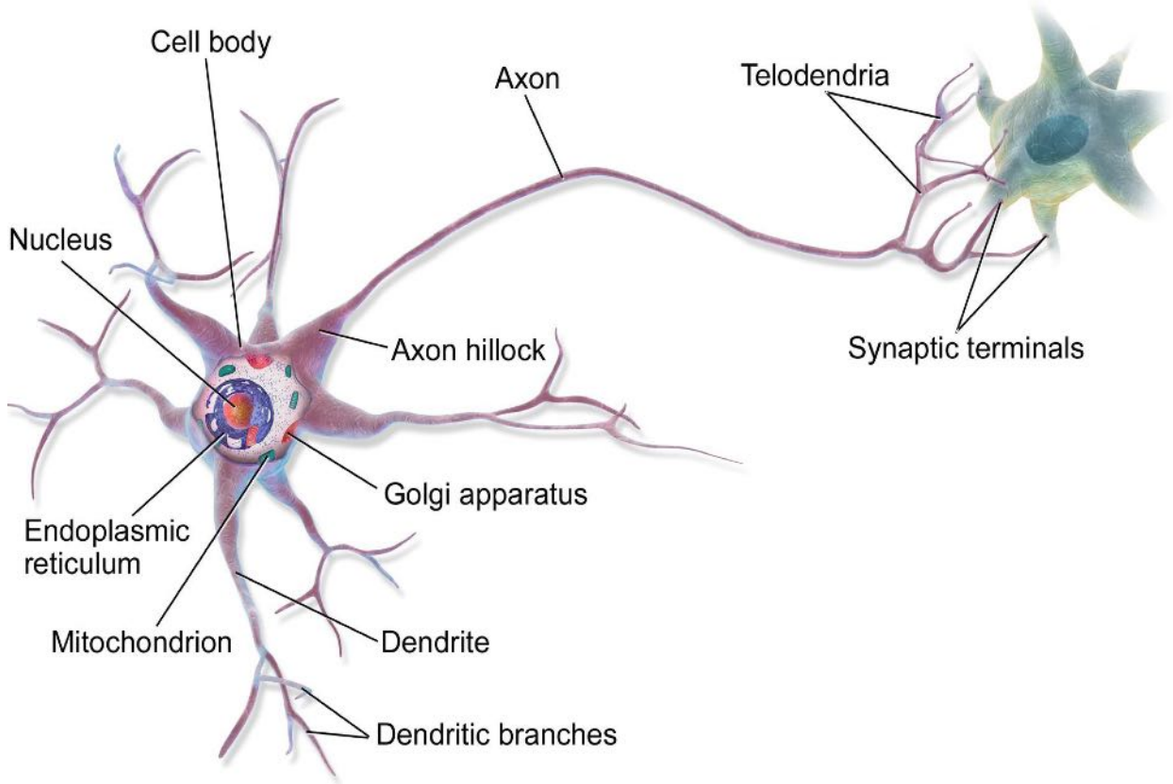
Space

Particle Interaction



Feynman Diagram of
Higgs → 4 Leptons

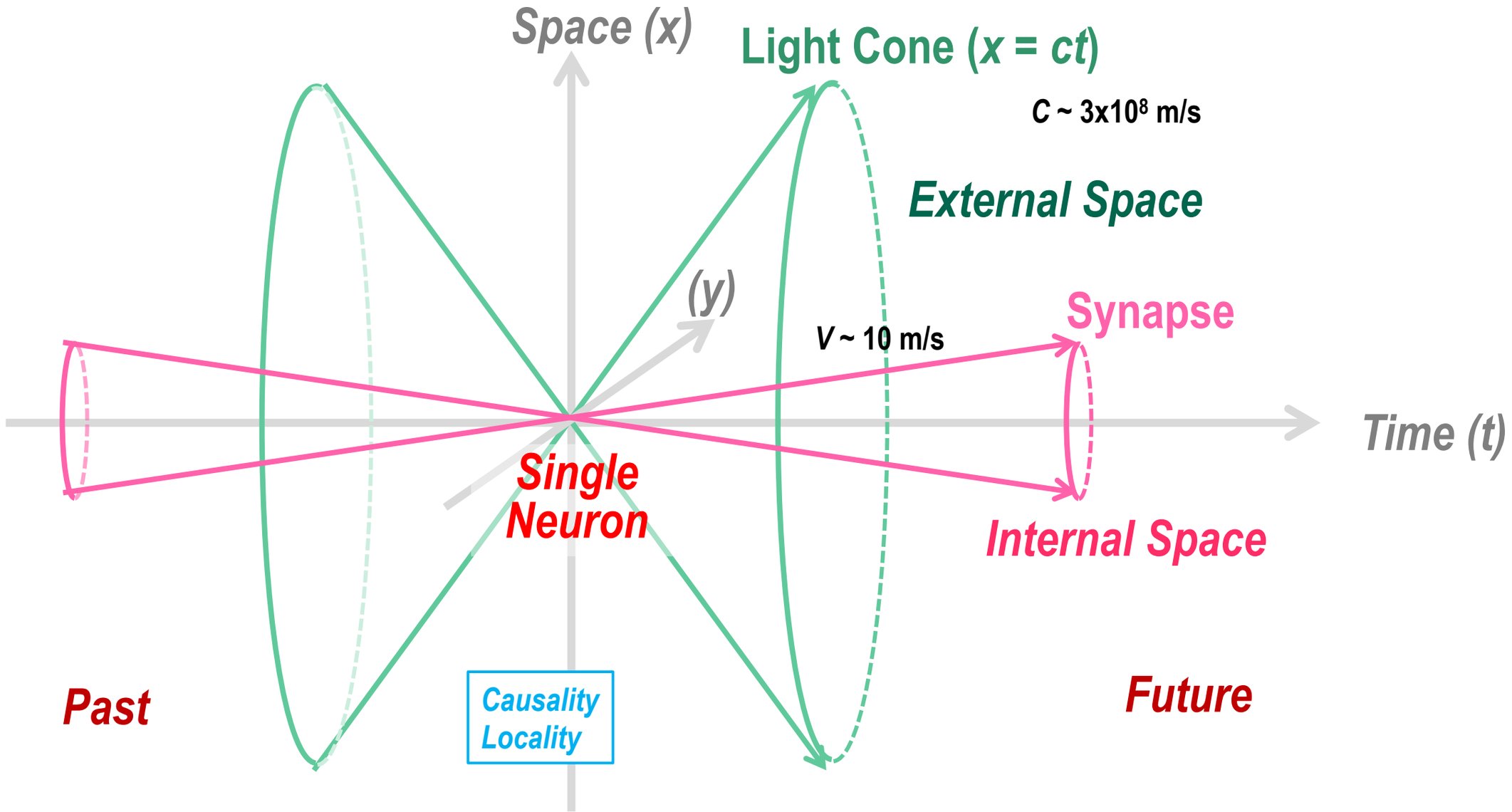
Neuronal Connection



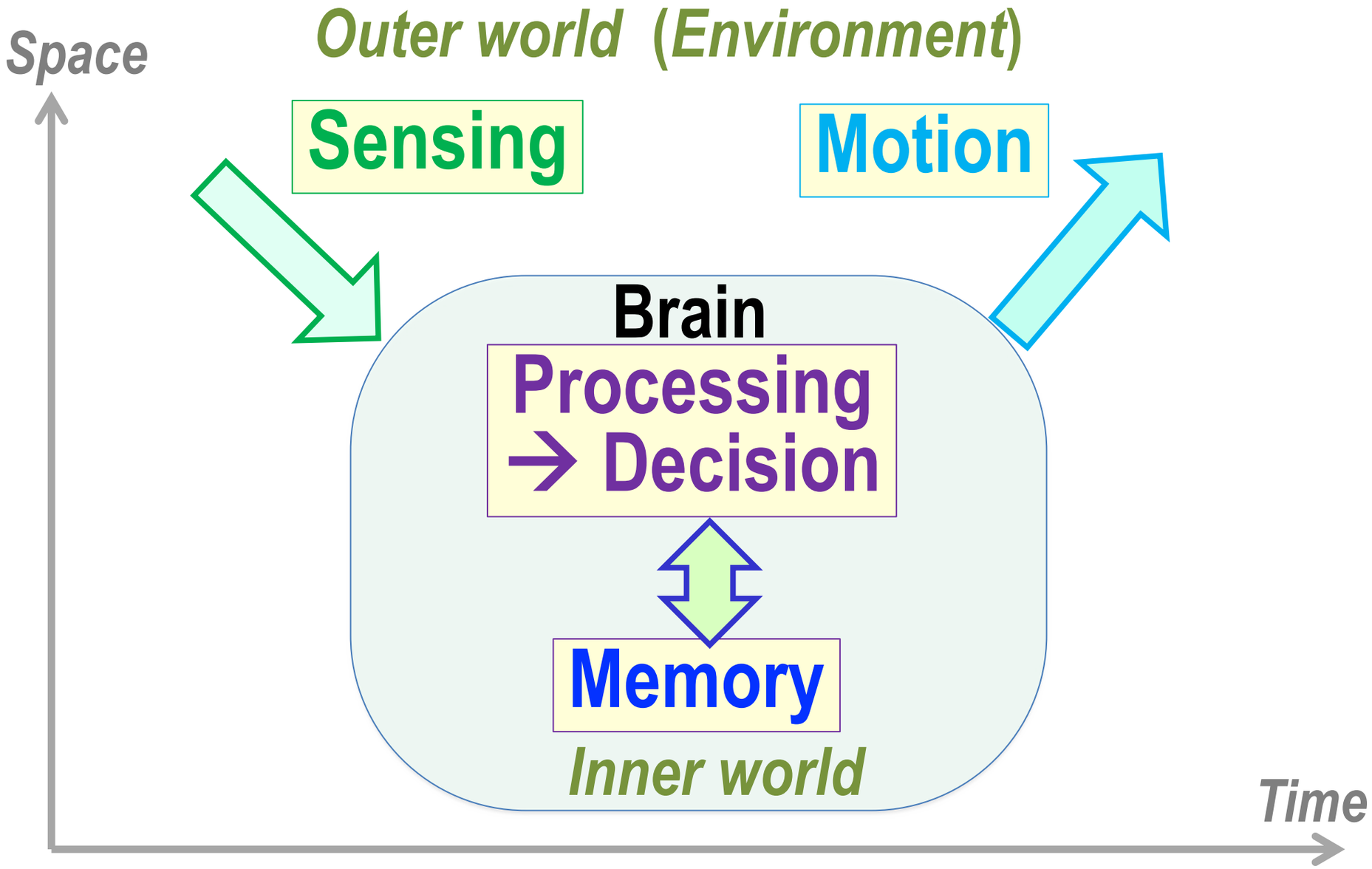
Signal propagation
In Synapse

Time

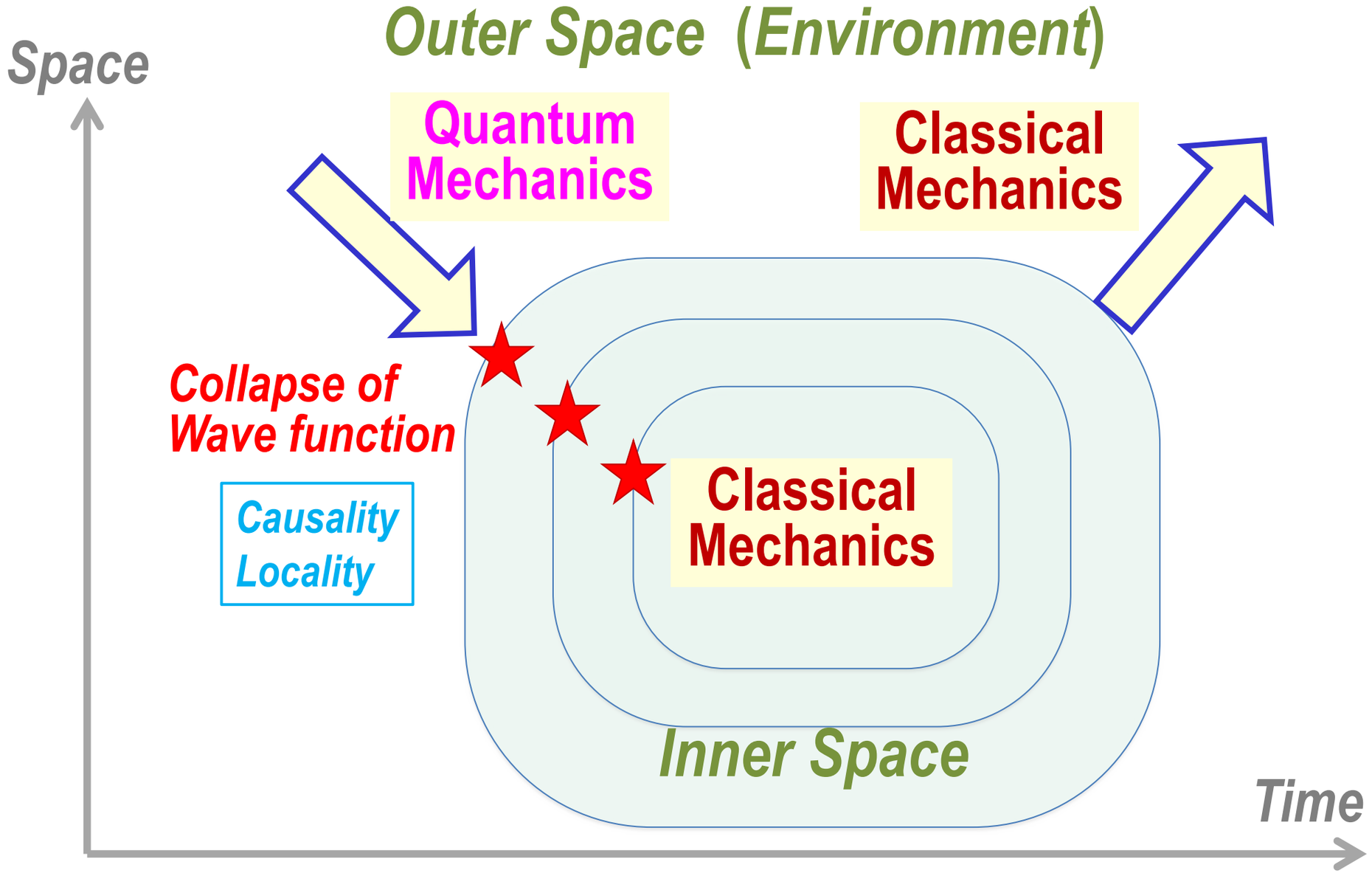
Causality and Locality



Conventional Space-Time Diagram of Sensorimotor Integration



Conventional Space-Time Diagram of Sensorimotor Integration

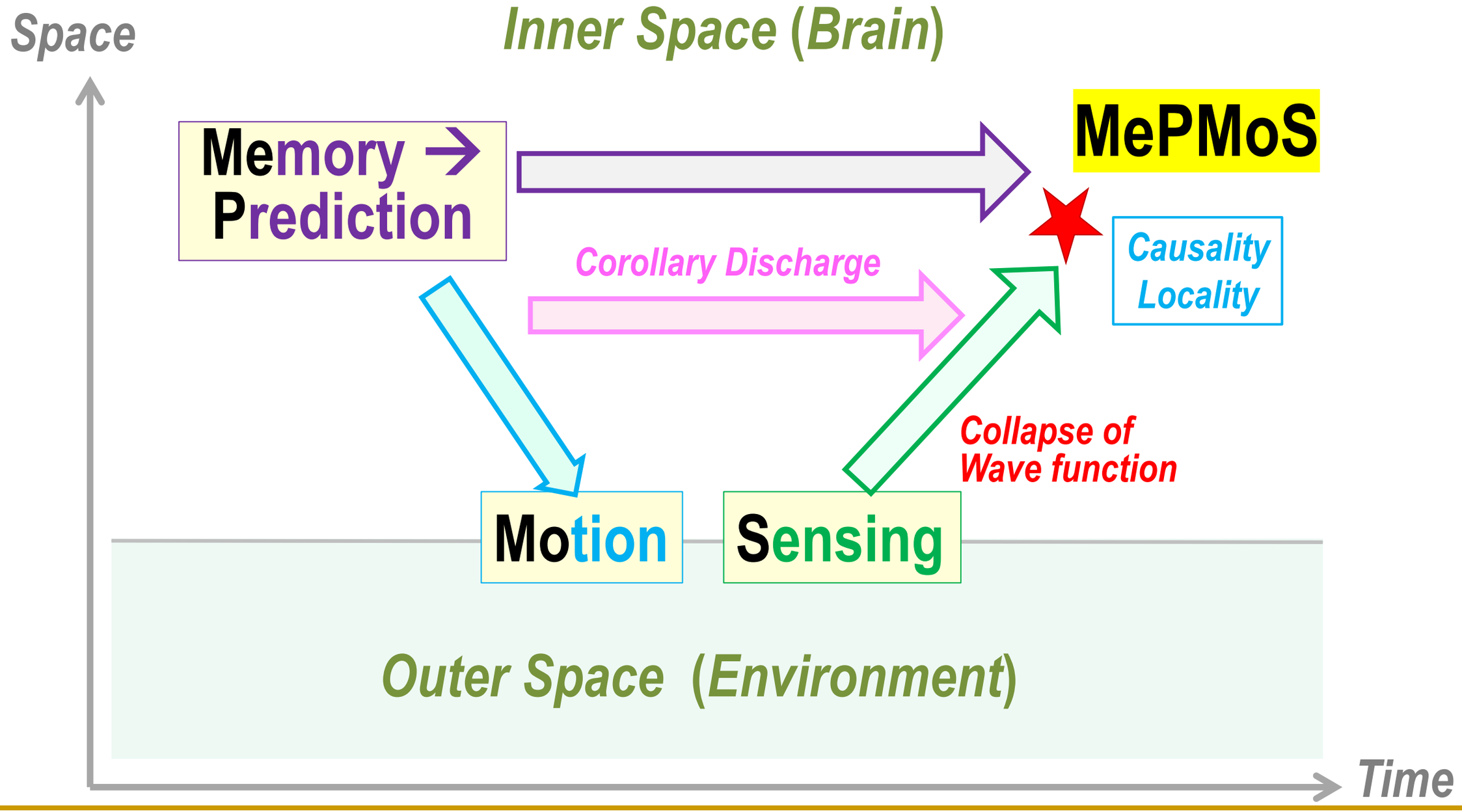


How do we know the locations?

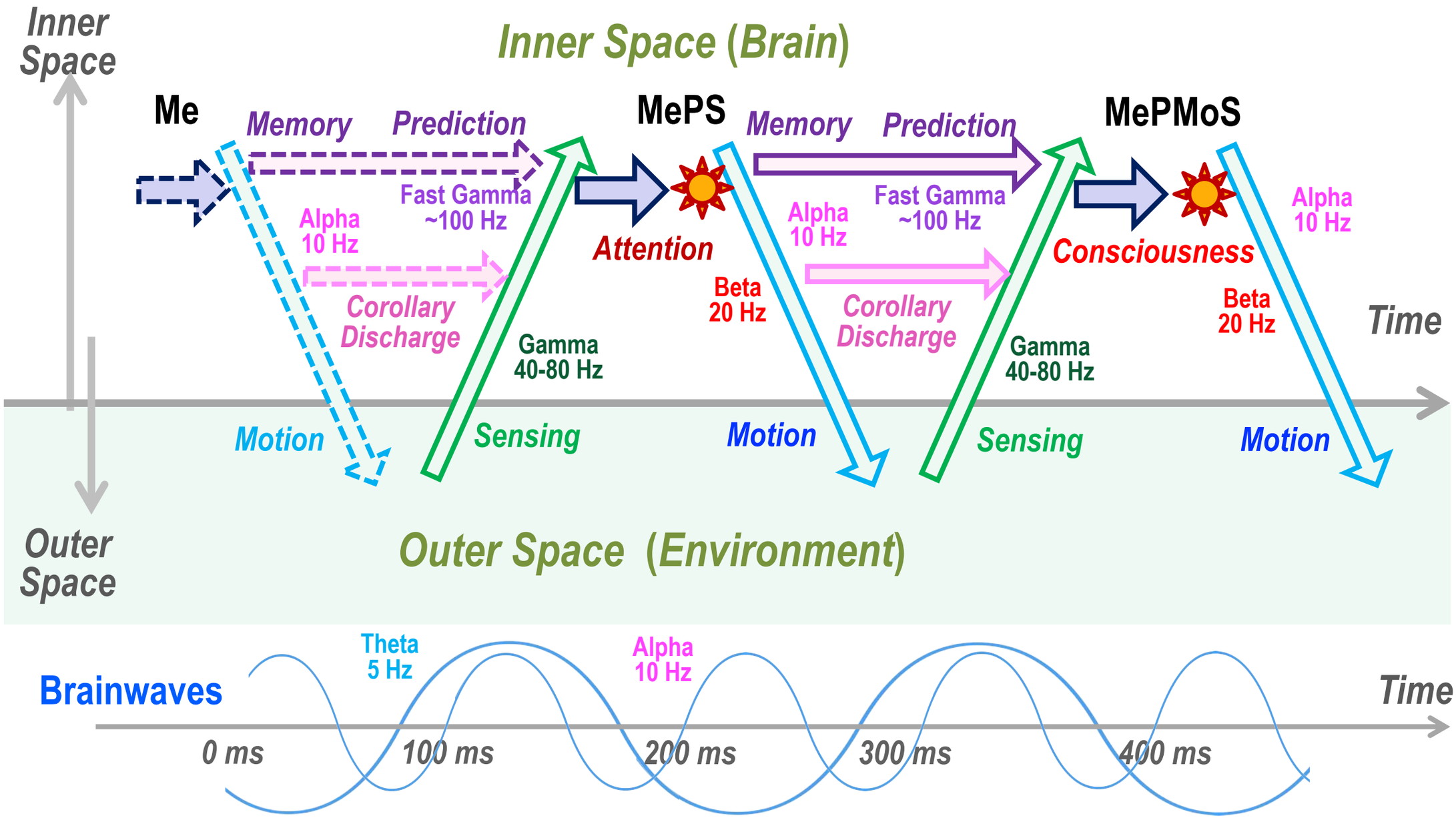
Overt Attention = Saccadic Eye Movement

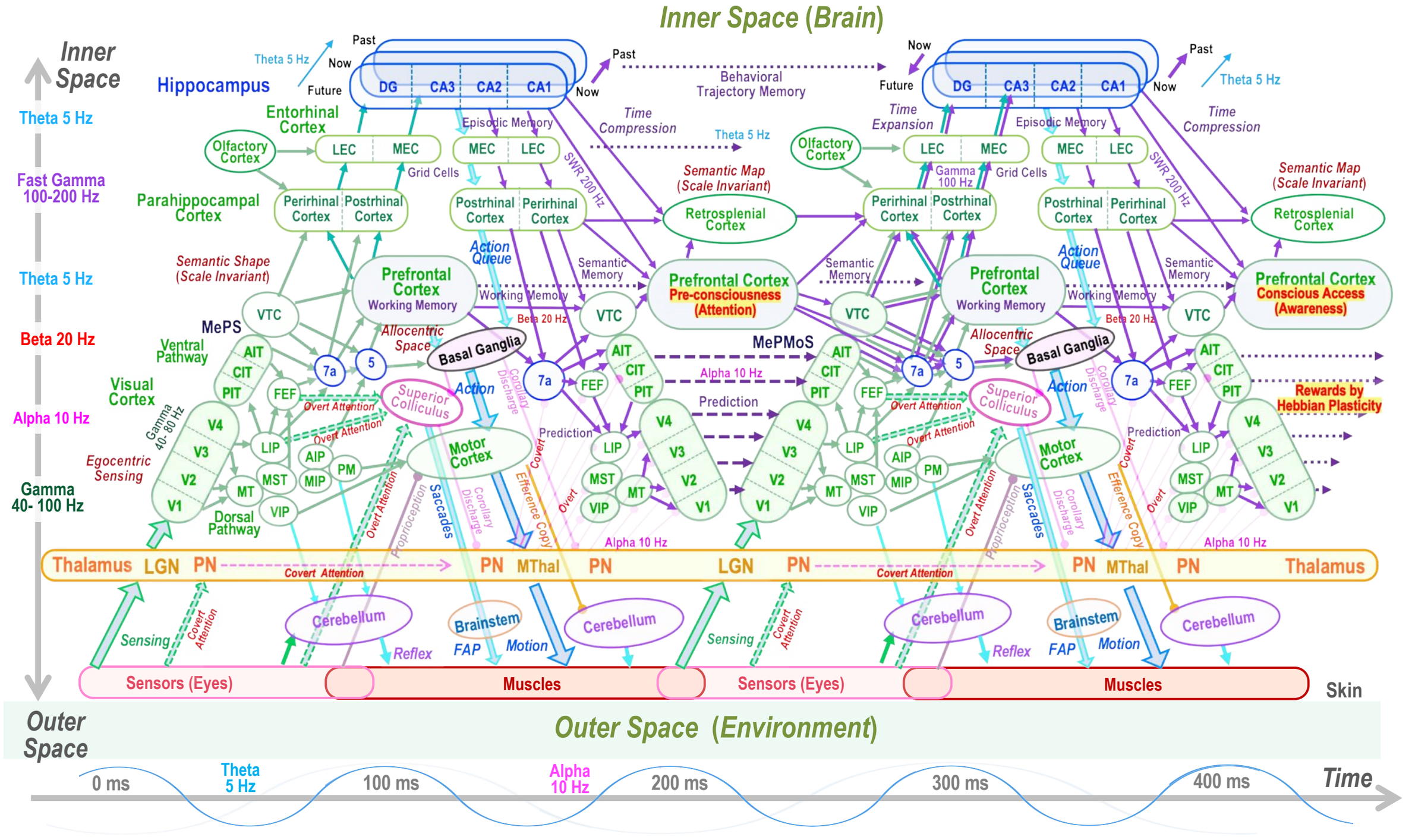
Covert Attention = Alpha Brainwave

New Space-Time Diagram of Sensorimotor Integration



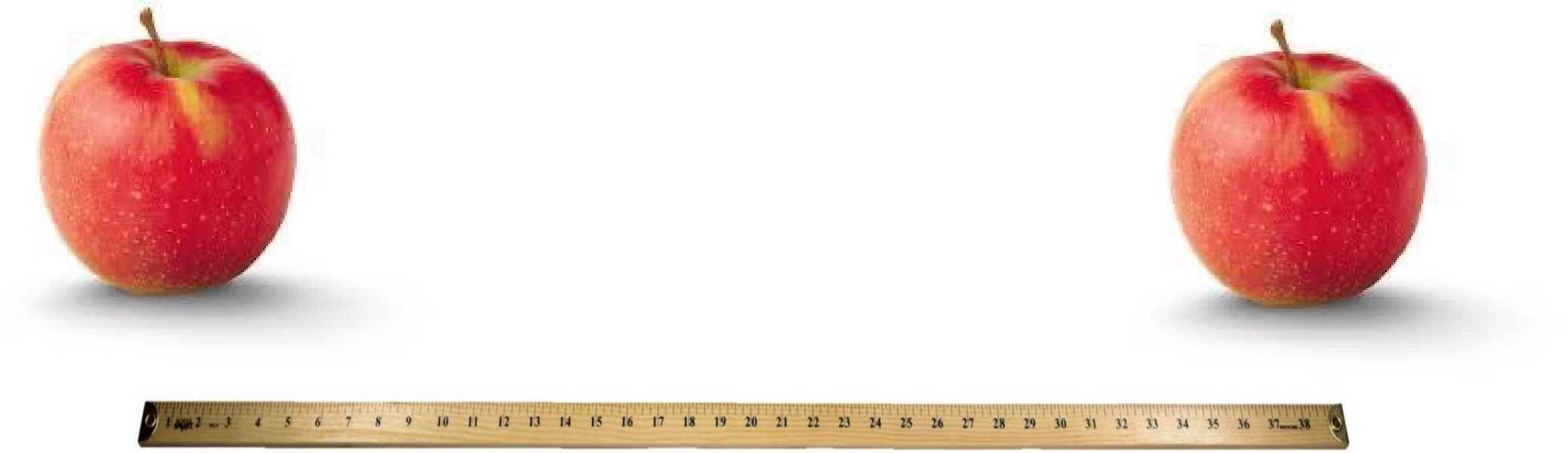
New Space-Time Diagram of Sensorimotor Integration




Inner Space (Brain)
Inner Space
Theta 5 Hz
Fast Gamma 100-200 Hz
Theta 5 Hz
Beta 20 Hz
Alpha 10 Hz
Gamma 40- 100 Hz
Hippocampus
Past
Now
Future
DG
CA3
CA2
CA1
Theta 5 Hz
Behavioral Trajectory Memory
Time Compression
Time Expansion
Episodic Memory
Entorhinal Cortex
Olfactory Cortex
LEC
MEC
Grid Cells
Gamma 100 Hz
SWR 200 Hz
Parahippocampal Cortex
Perirhinal Cortex
Postrhinal Cortex
Semantic Map (Scale Invariant)
Retrosplenial Cortex
Semantic Shape (Scale Invariant)
Prefrontal Cortex
Working Memory
Action Queue
Semantic Memory
Prefrontal Cortex
Pre-consciousness (Attention)
Prefrontal Cortex
Conscious Access (Awareness)
Beta 20 Hz
Allocentric Space
Basal Ganglia
MePS
MePMoS
Ventral Pathway
Visual Cortex
VTC
AIT
CIT
PIT
FEF
7a
5
Alpha 10 Hz
Prediction
Action
Superior Colliculus
Overt Attention
Gamma 40- 80 Hz
Egocentric Sensing
V4
V3
V2
V1
LIP
AIP
MIP
PM
MST
MT
VIP
Motor Cortex
Dorsal Pathway
Corollary Discharge
Covert
Efference Copy
Overt
Proprioception
Saccades
Rewards by Hebbian Plasticity
Thalamus
LGN
PN
MThal
Covert Attention
Sensing
Cerebellum
Brainstem
FAP
Motion
Reflex
Sensors (Eyes)
Muscles
Skin
Outer Space
Outer Space (Environment)
Time
0 ms
Theta 5 Hz
100 ms
Alpha 10 Hz
200 ms
300 ms
400 ms

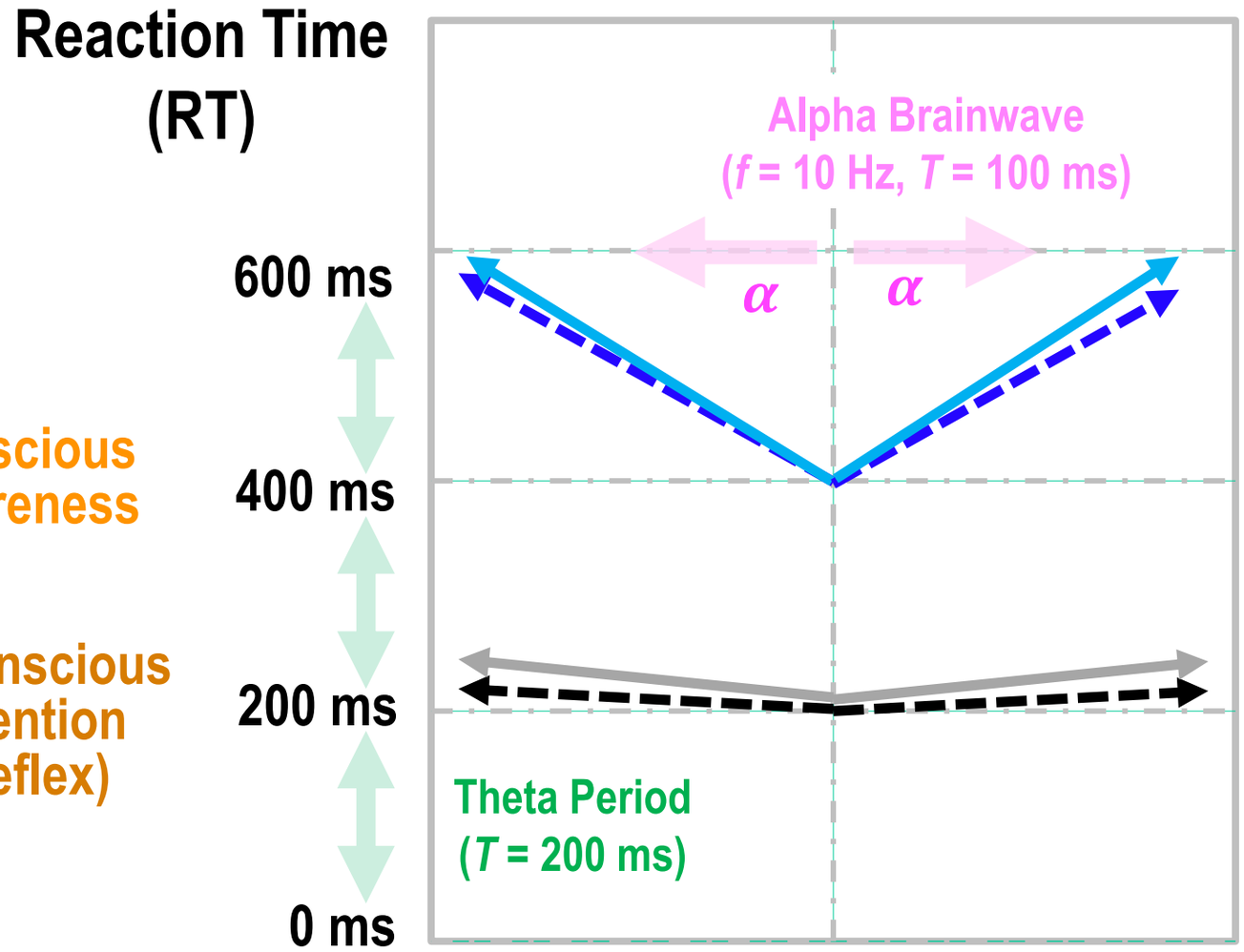
Experimental Evidence: Reaction Time

How do we know the locations?



How do we know the locations?

Prediction of Reaction Time (RT) in 7D



Covert
Overt
} Choice Reaction Time

Covert
Overt
} Simple Reaction Time

- 3D Translation (H, V, Depth)
- 1D Scaling (Smaller/Larger)
- 3D Rotation (Yaw, Pitch, Roll)

Visual Perception of 3D Space and Shape in Time

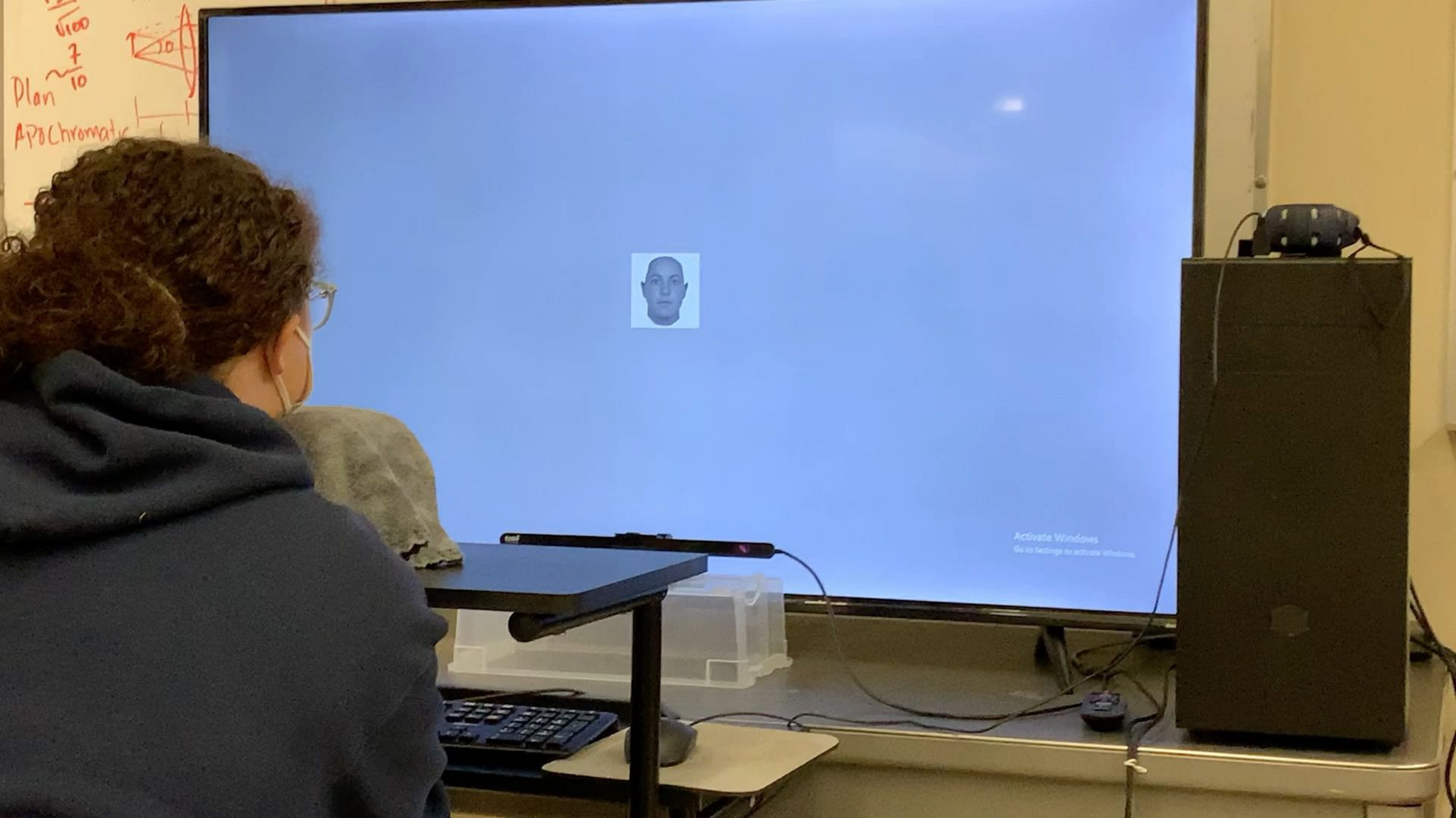
Part I

2D Space Perception by 2D Linear Translation

52 EMC members

Umaima Afifa, Javier Carmona, Amy Dinh, Trevor McCarthy, Brian Ta, Patrick Wilson, Benjamin Asdell, Jinwoo Baik, Archana Biju, Sonia Chung, Christopher Dao, Mark Diamond, Saba Doust, Angela East, Diego Espino, Kailey Fleiszig-Evans, Adrian Franco, Anthony Garibay-Gutierrez, Aparajeeta Guha, Roshan Gunturu, Luke Handley, Christina Honore, Abinav Kannan, Jared Khoo, Mira Khosla, Chandan Kittur, Alexandra Kwon, Jessica Lee, Nicholas Lwe, Mylan Mayer, Elizabeth Mills, Delilah Pineda, Pasha Pourebrahim, Jacob Rajacich, Shan Rizvi, Liliana Rosales, Leonard Schummer, Conor Sefkow, Alexander Stangel, Cindy Ta, Ivy Ta, Natalie Tong, Kyle Tsujimoto, Alyssa Vu, Henry Wang, Amanda Yares, Natsuko Yamaguchi, Ki Woong Yoon, Shuyi Yu, Aaron P. Blaisdell*, and Katsushi Arisaka

University of California, Los Angeles


Plan
Activate Windows

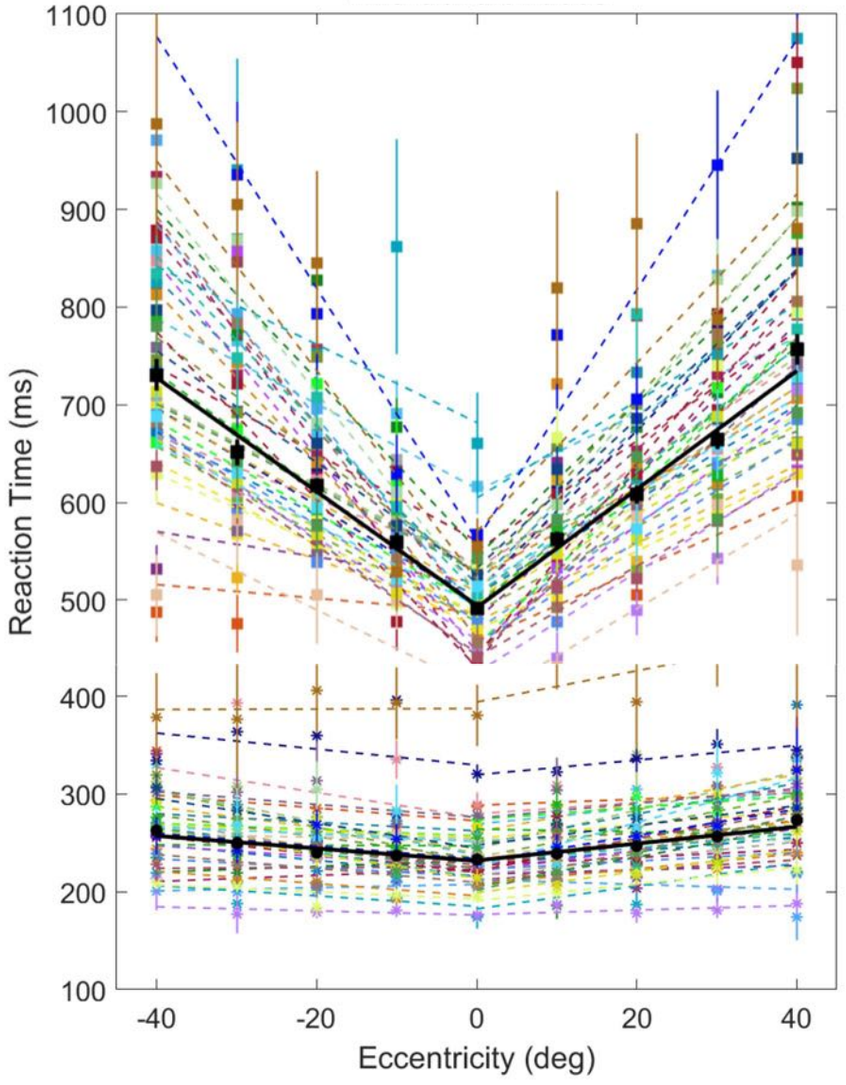
Eccentricity RT W2022 New Members

Covert

Raw Data

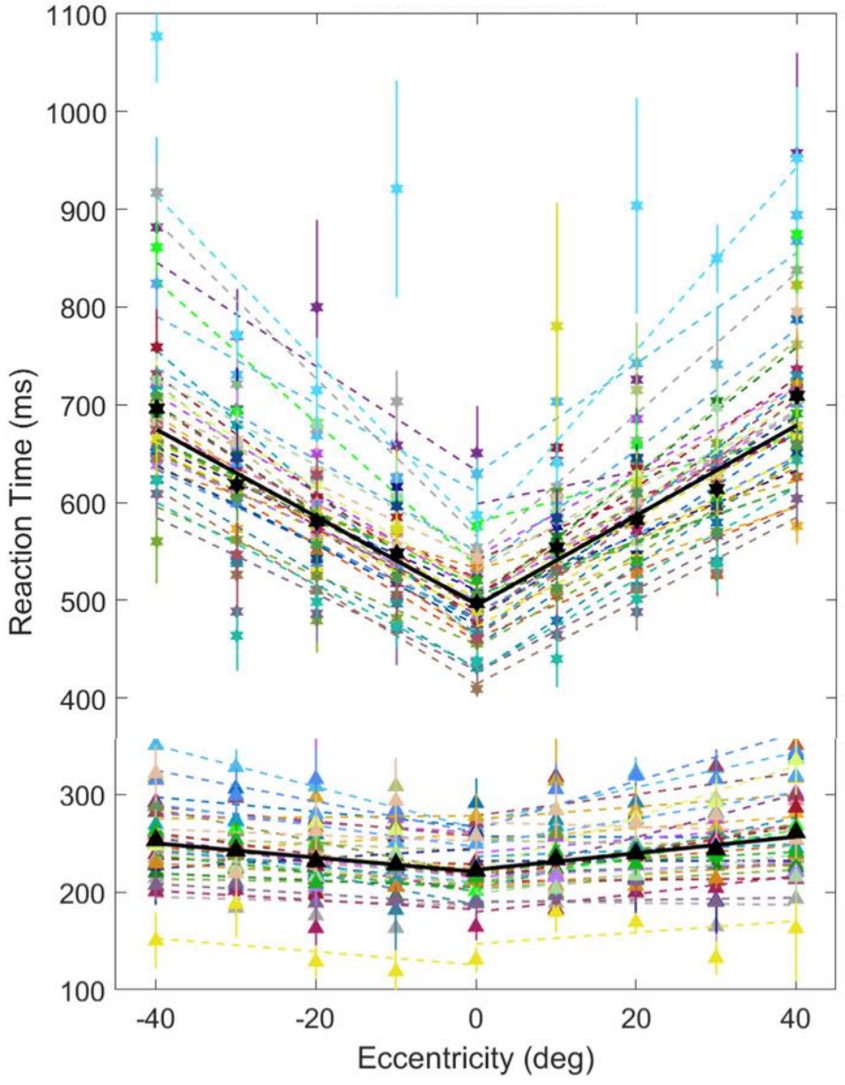
Overt

N = 40



Choice Reaction Time (CRT) for Two Faces

Simple Reaction Time (SRT) for One Face



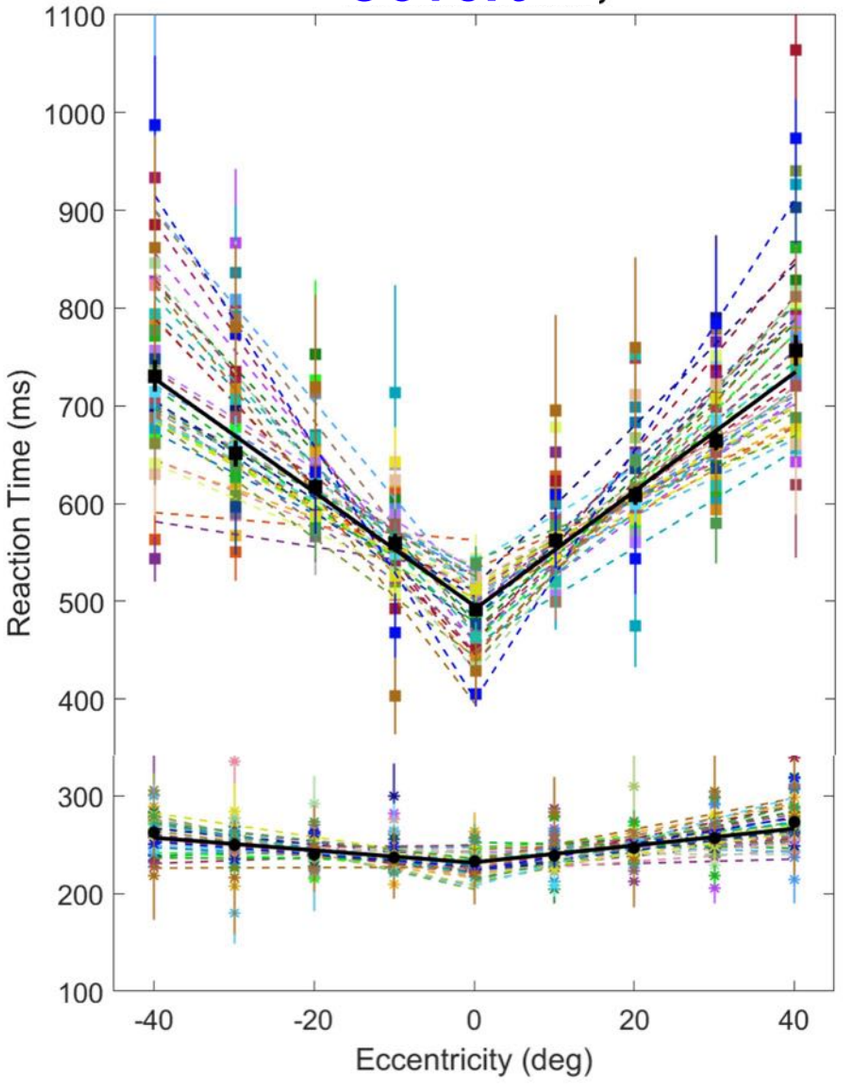
Eccentricity RT W2022 New Members

Covert

Renormalized

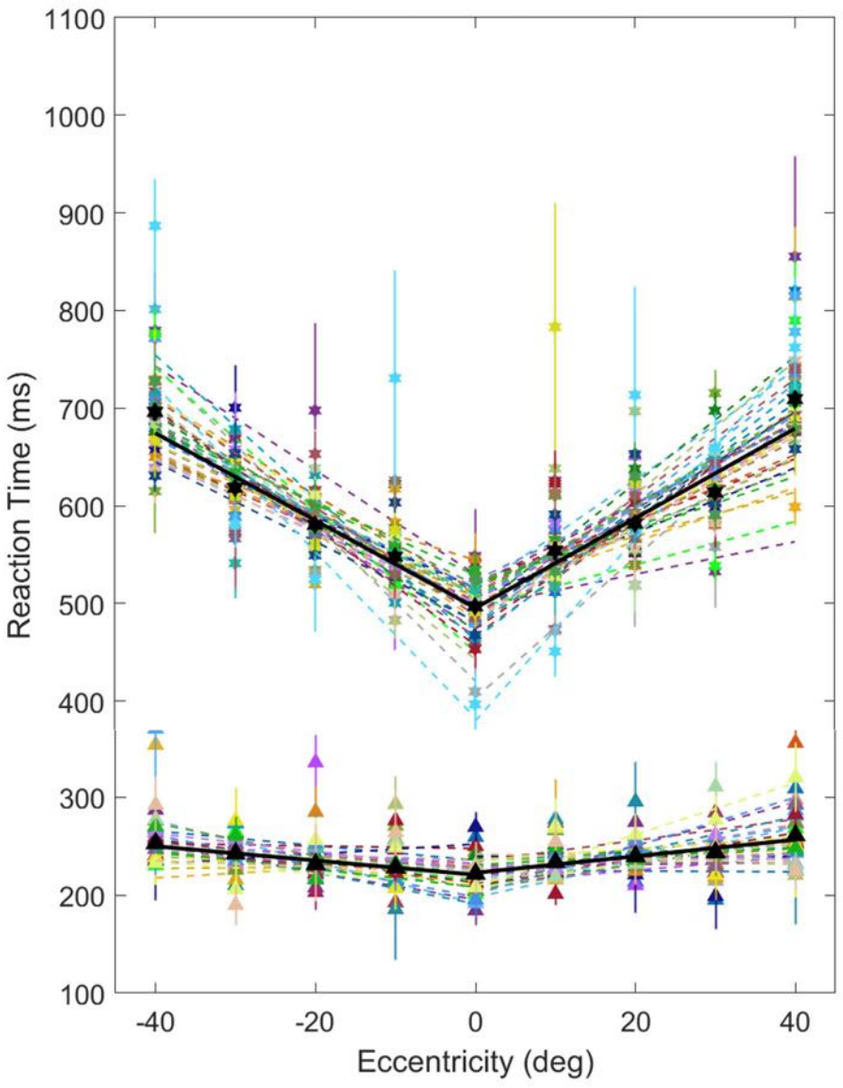
Overt

N = 40



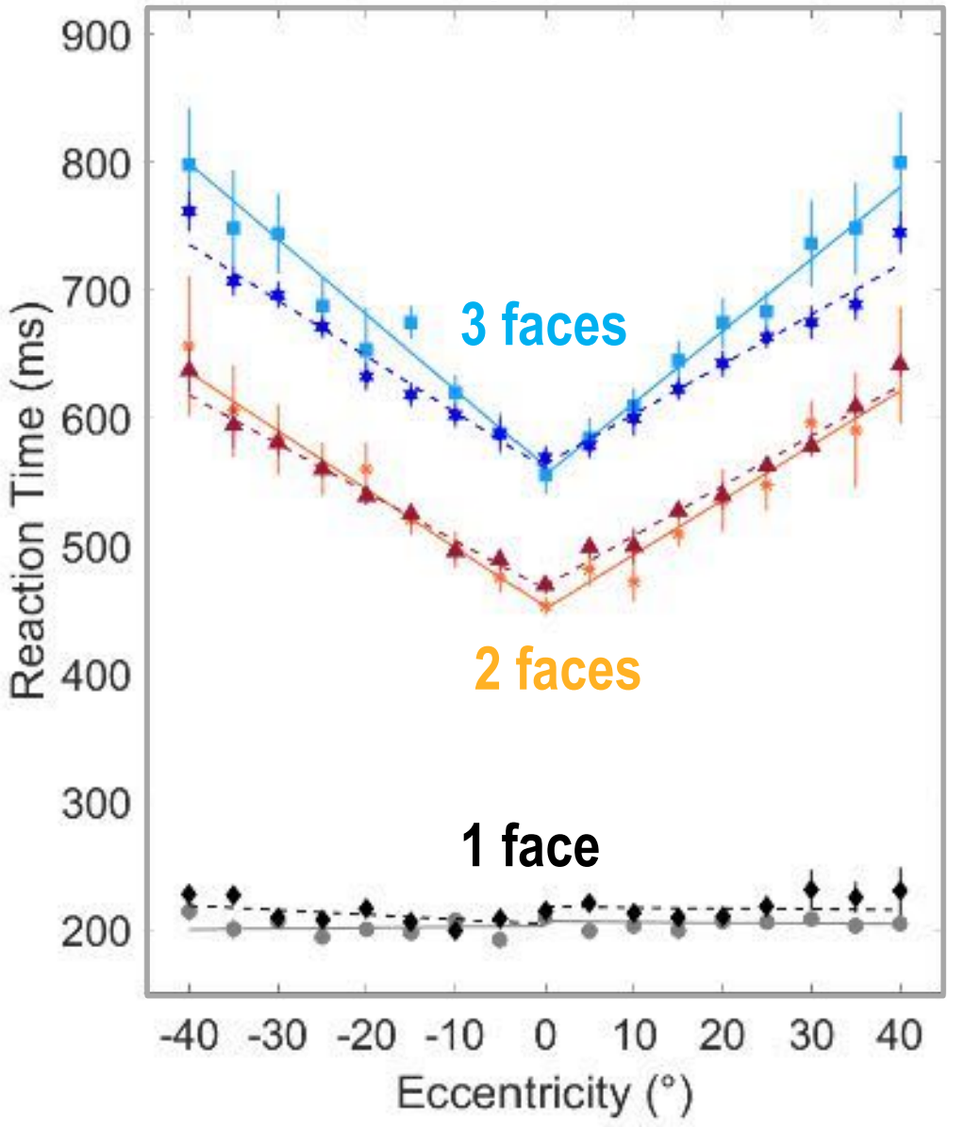
Choice Reaction Time (CRT) for Two Faces

Simple Reaction Time (SRT) for One Face



Face Eccentricity RT

Winter 2021 (Remote) N = 13

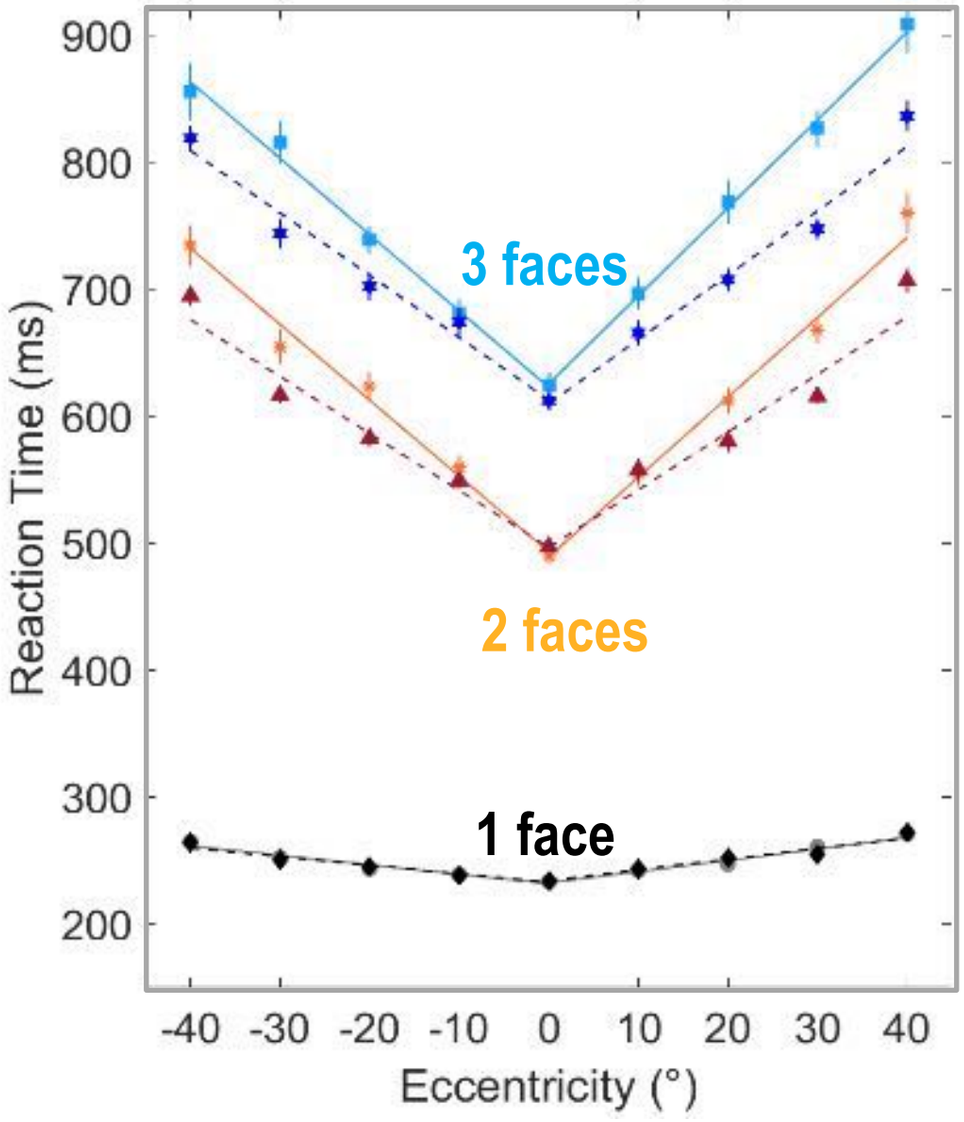


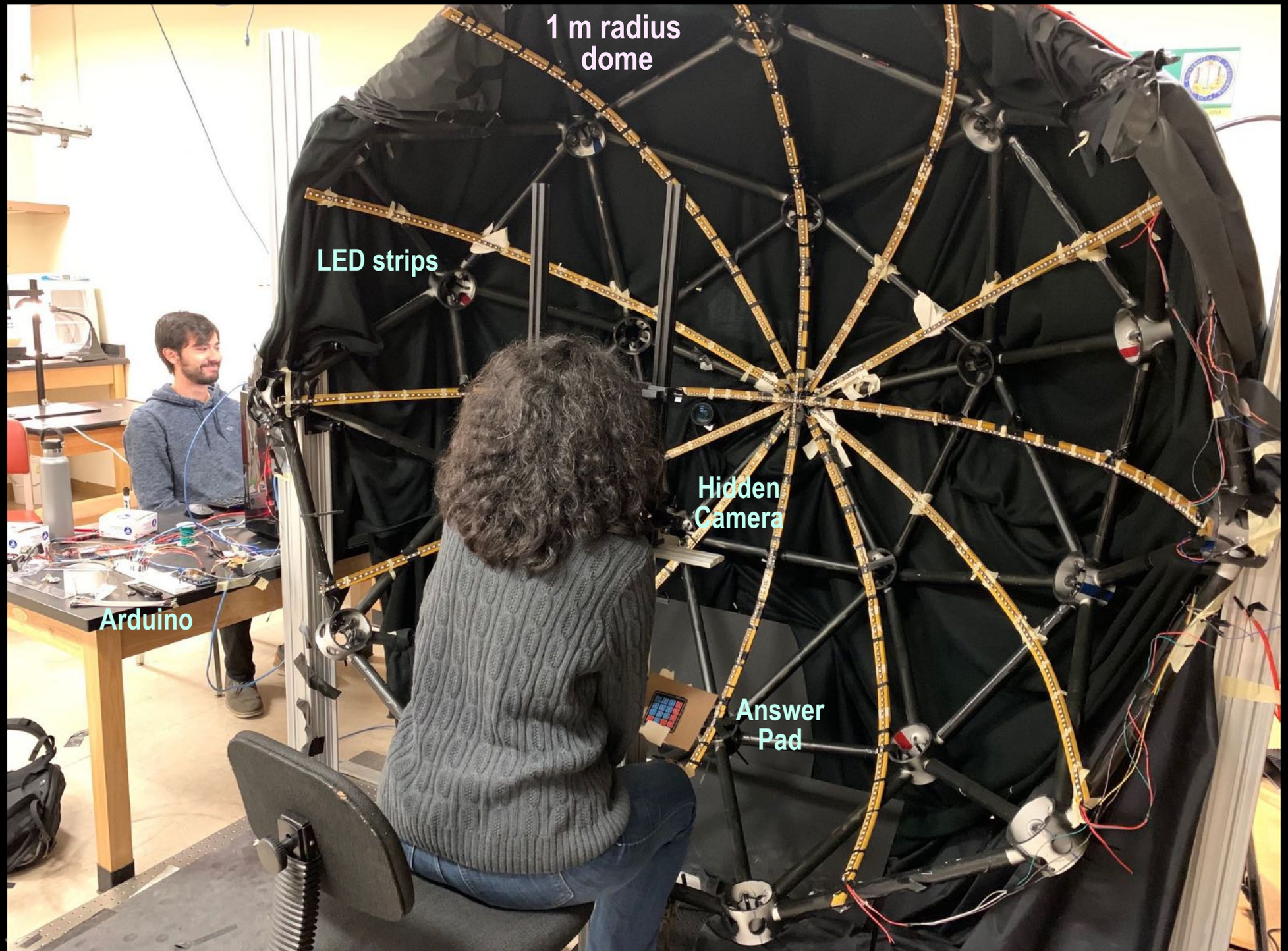
Covert
Overt

Covert
Overt

Covert
Overt

Winter 2022 N = 40





Zipdome Setup

Free Parameters:

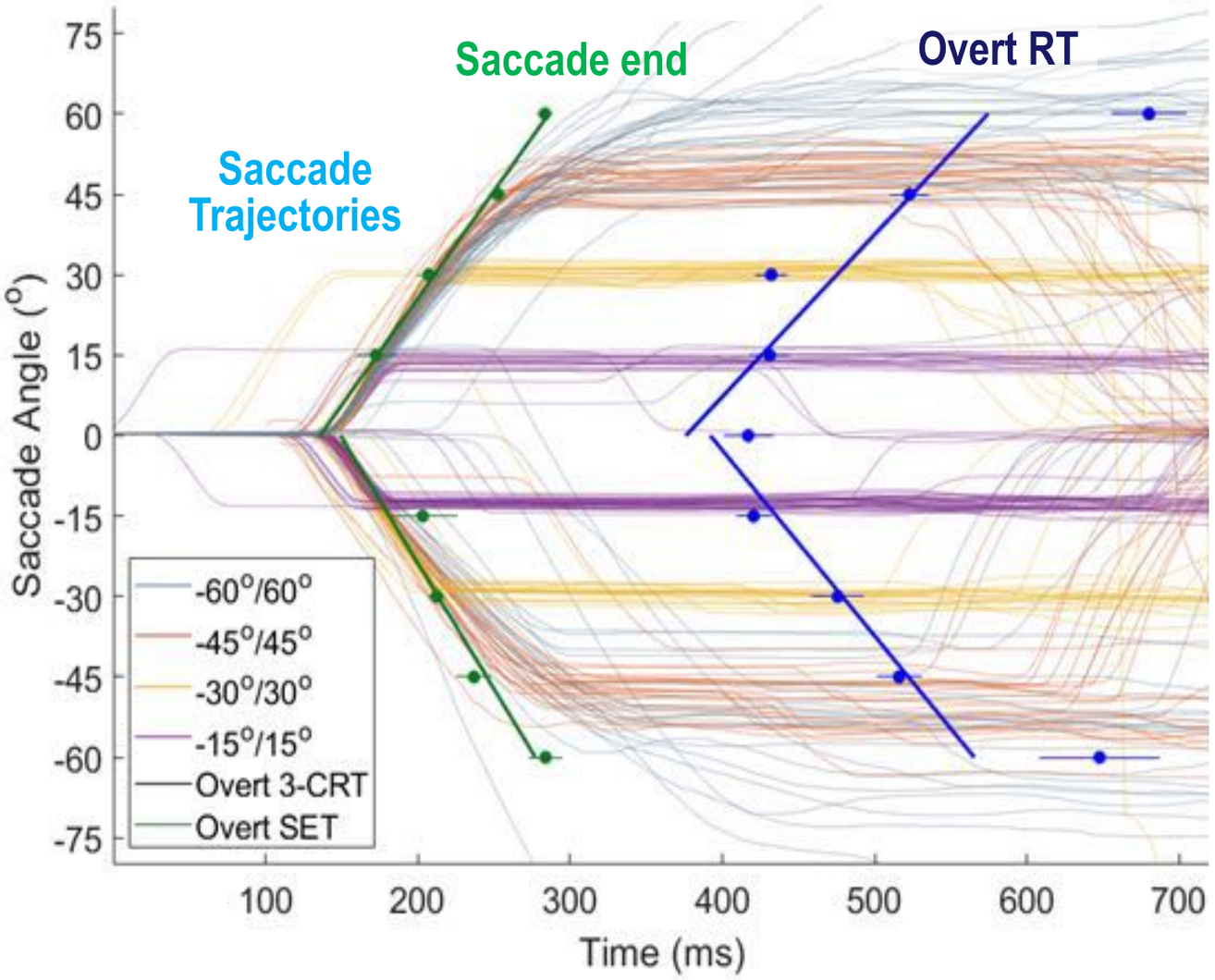
- Location
- Color
- Intensity
- Timing
- Duration

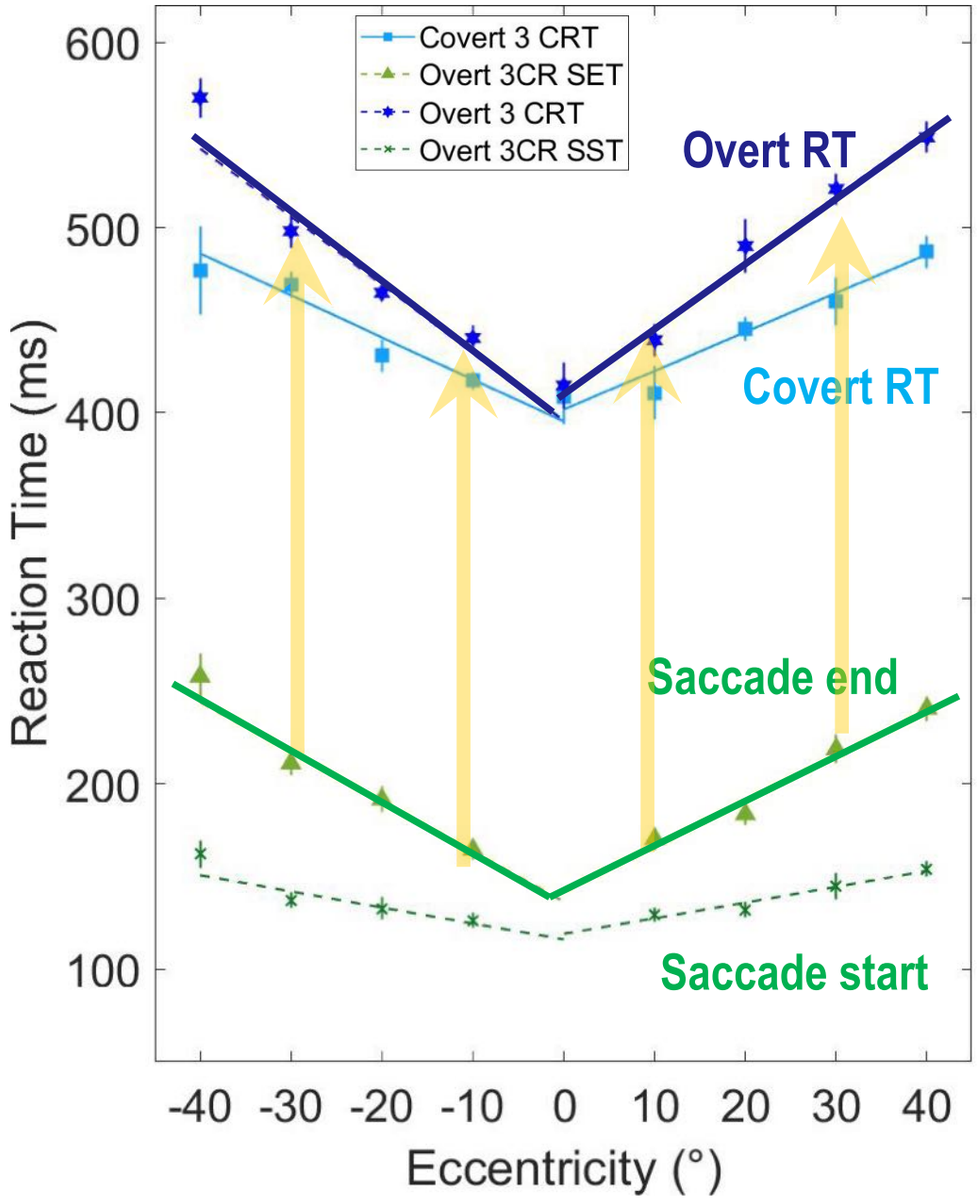
Observables:

- Reaction Time
- Eye Motion
- Brainwaves

Spin-off of Physics 4BL

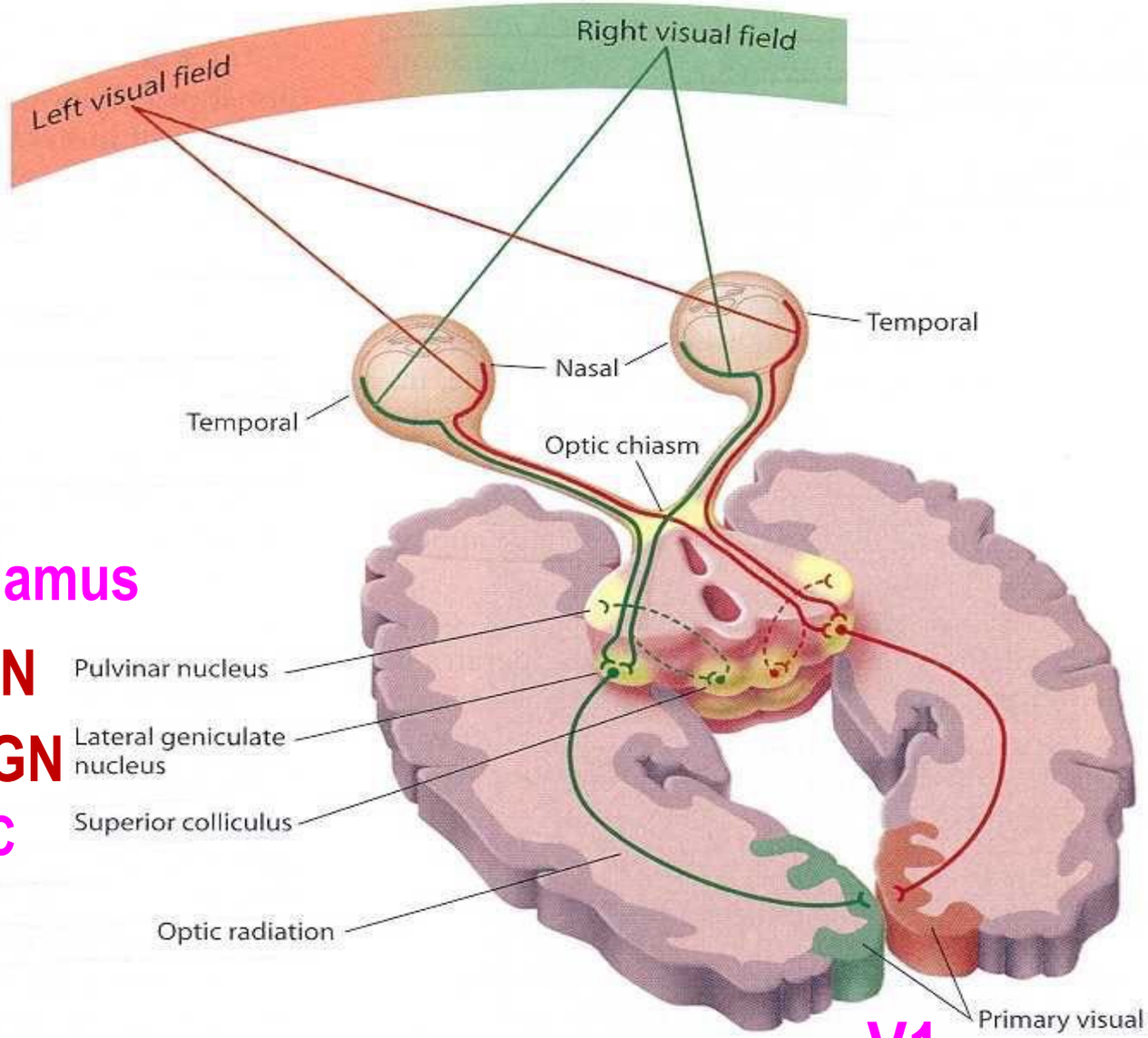
Eye Motion Tracking

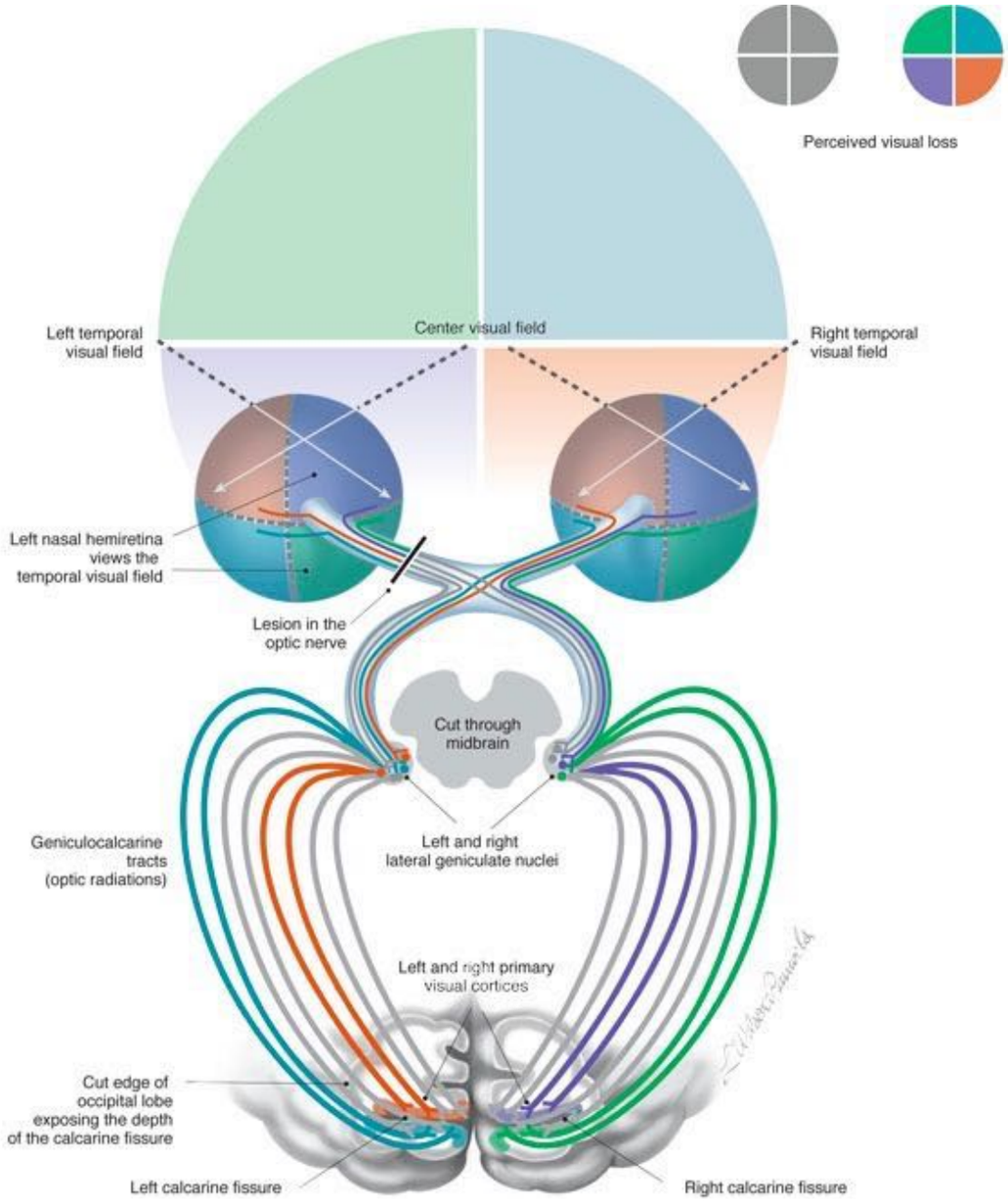




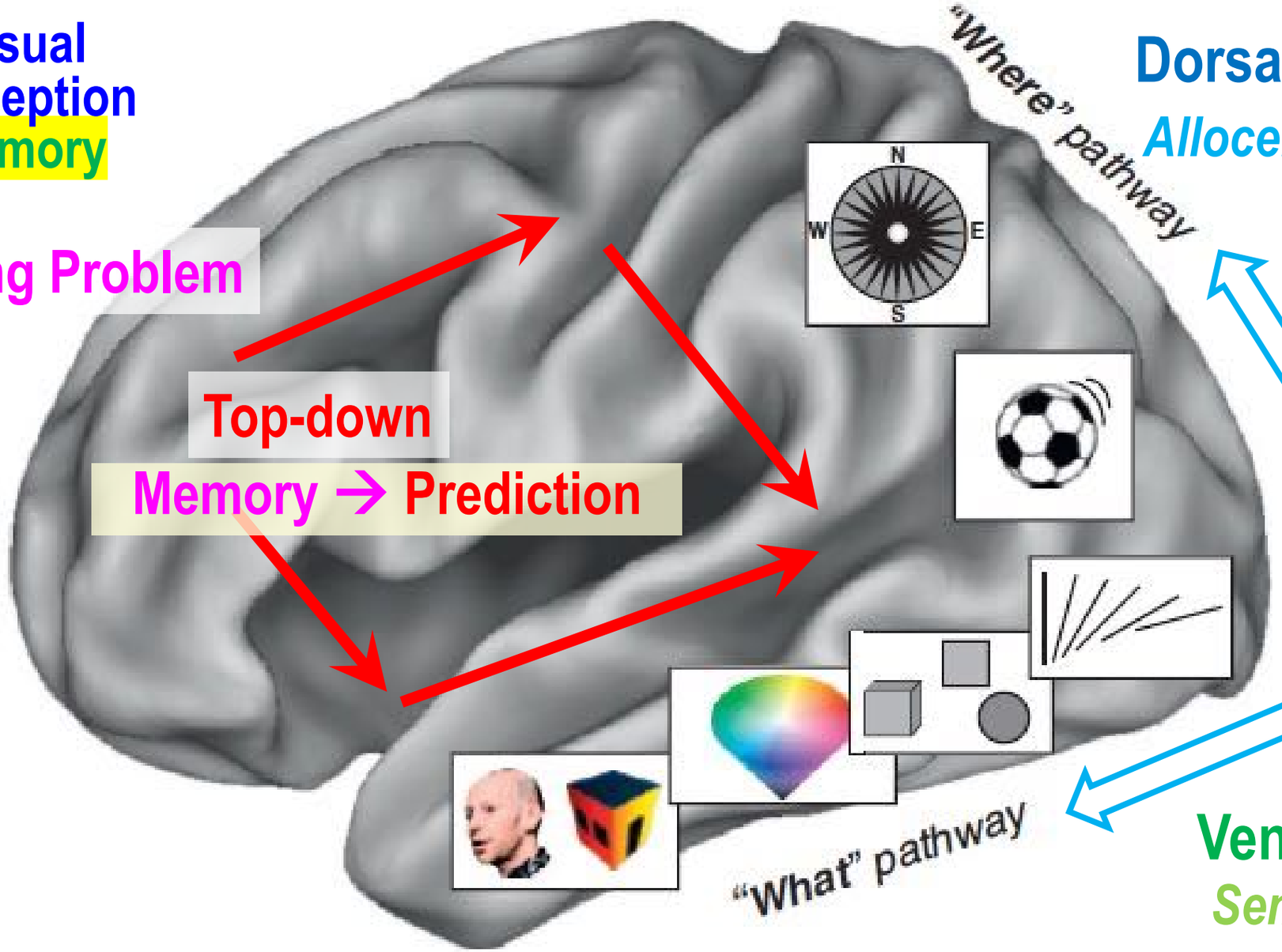
N = 12

Human Eyes → LGN (Lateral Geniculate Nucleus) → V1





Two Visual Pathways



Visual Perception Memory

Binding Problem

Top-down

Memory → Prediction

Dorsal Pathway

Allocentric Frame

Bottom up

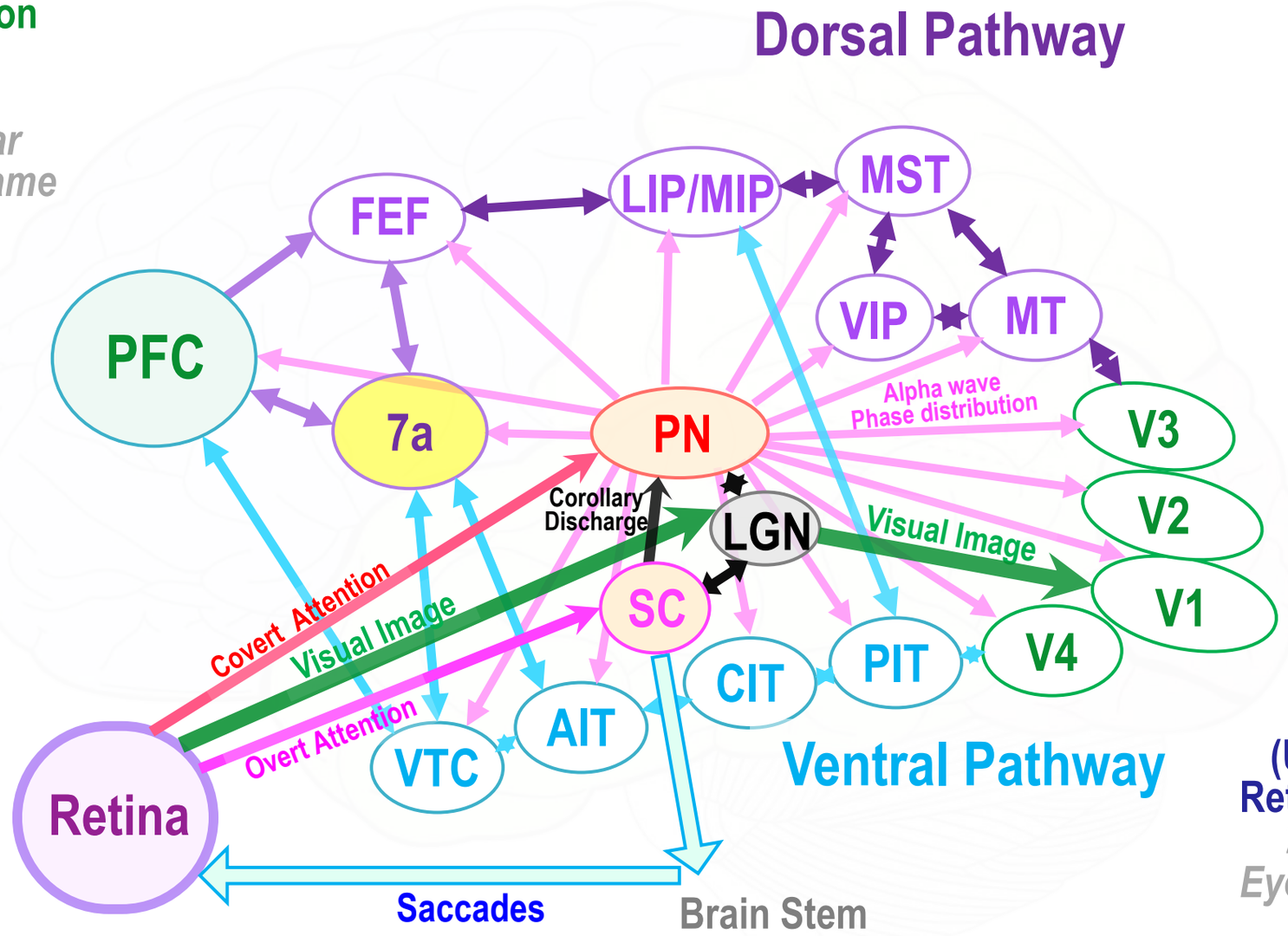
V1

Ventral Pathway

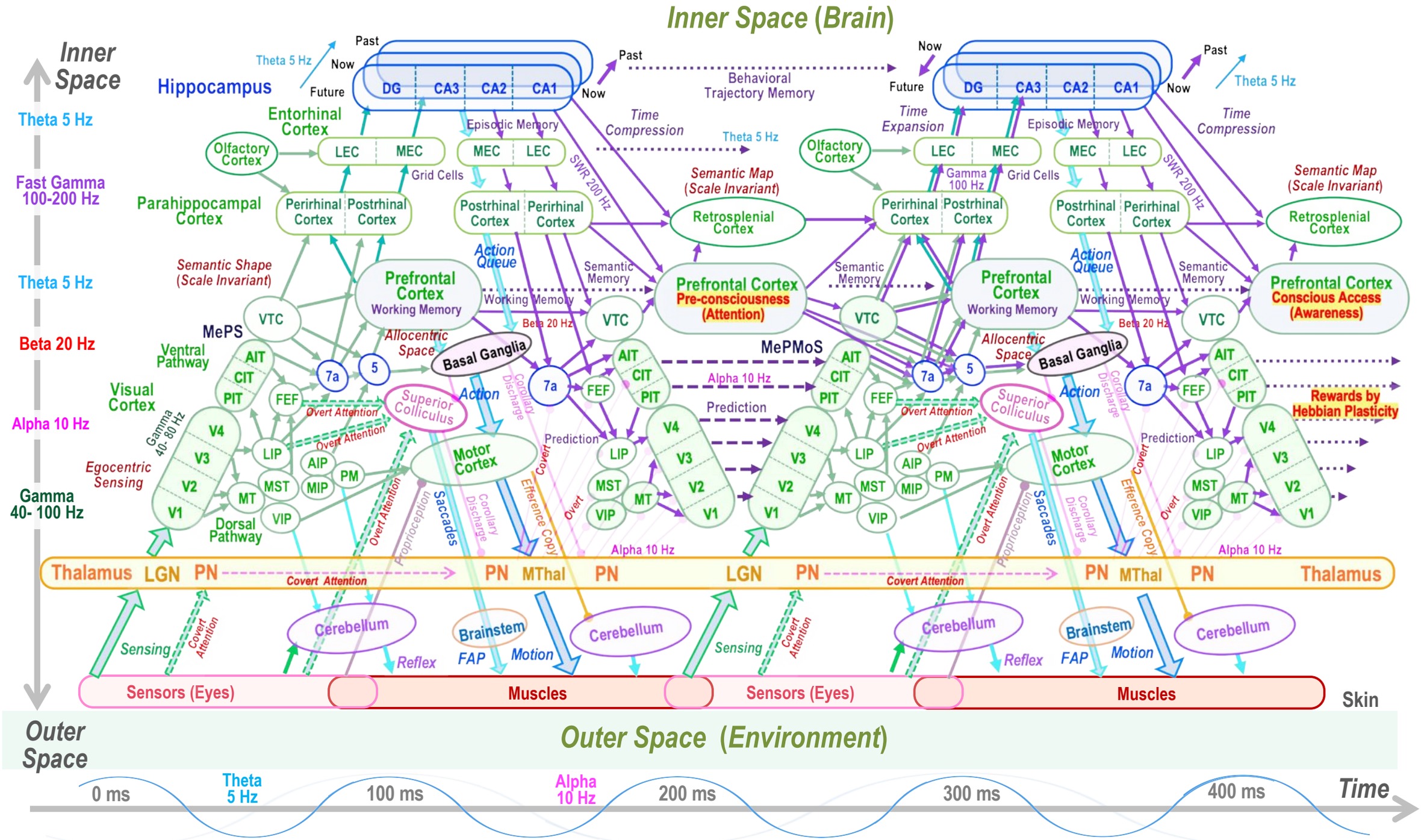
Semantic Shape

Two Visual Pathways with Attention

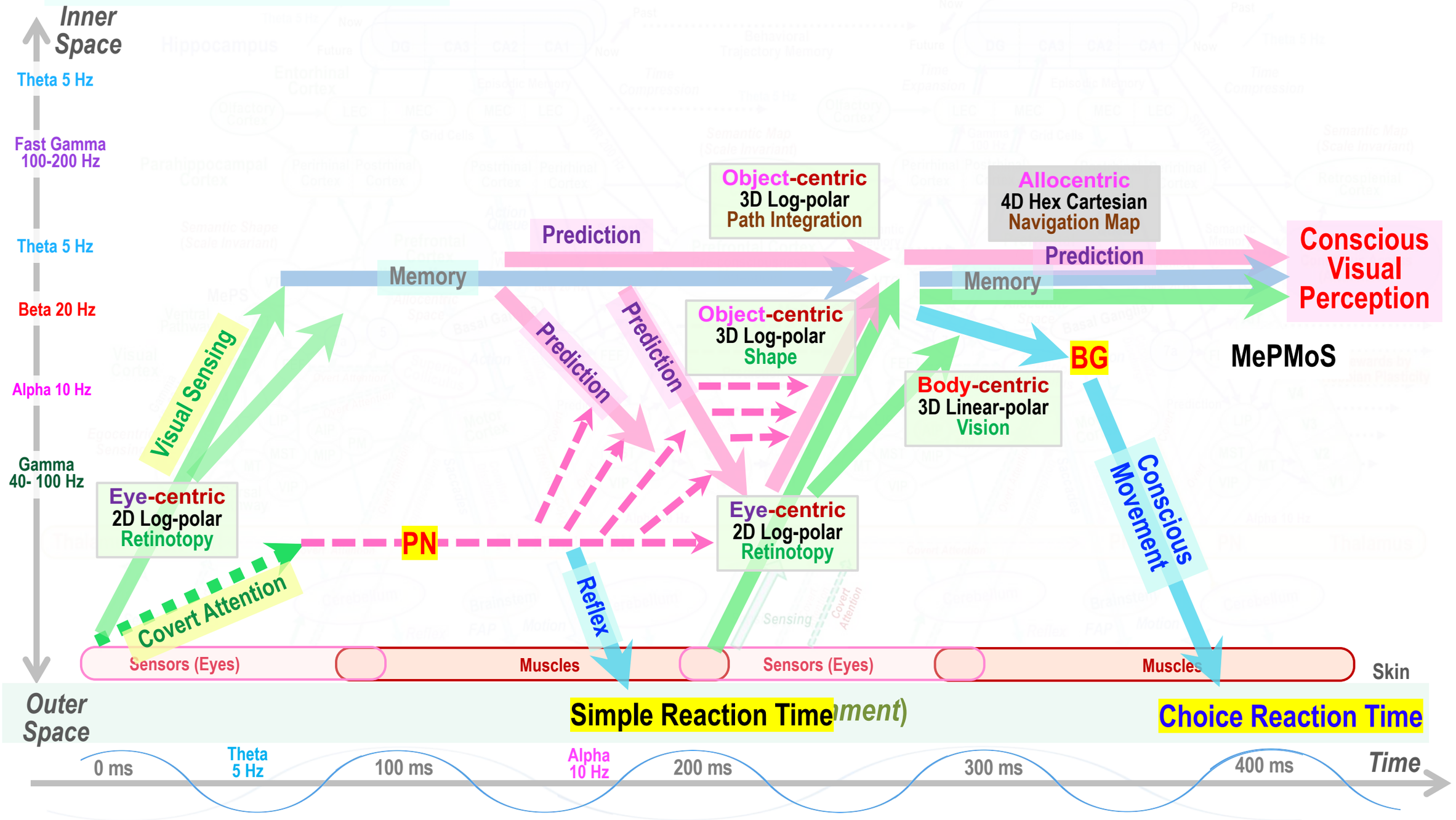
Conscious
Visual Perception
(Awareness)
3D Cartesian
3D Linear-Polar
Body-centric Frame

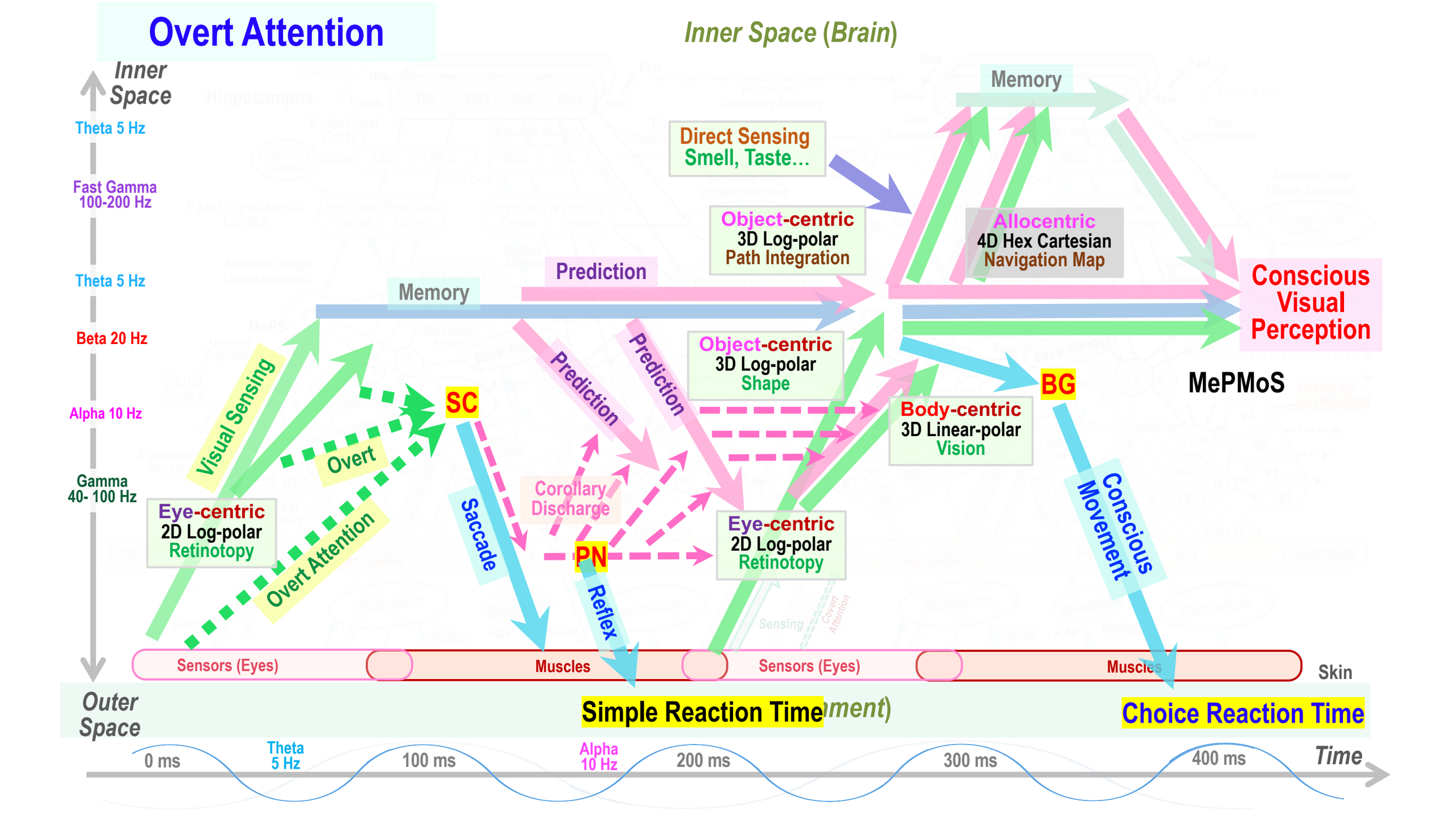


Invisible
(Unconscious)
Retinotopic Image
2D Log-polar
Eye-centric Frame

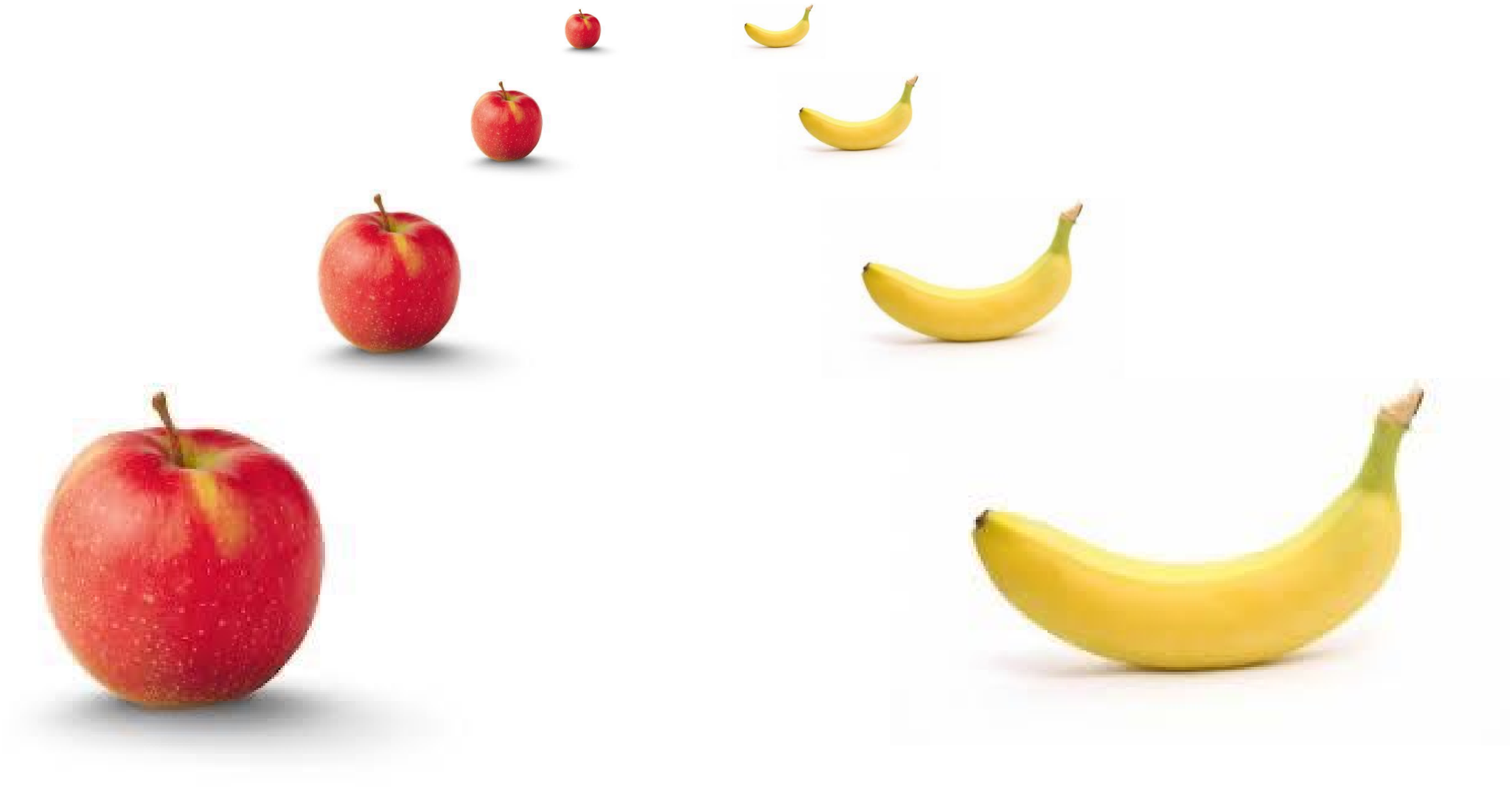

Inner Space (Brain)
Inner Space
Theta 5 Hz
Fast Gamma 100-200 Hz
Theta 5 Hz
Beta 20 Hz
Alpha 10 Hz
Gamma 40- 100 Hz
Hippocampus
Past
Now
Future
DG
CA3
CA2
CA1
Theta 5 Hz
Entorhinal Cortex
Olfactory Cortex
LEC
MEC
Episodic Memory
Grid Cells
SWR 200 Hz
Parahippocampal Cortex
Perirhinal Cortex
Postrhinal Cortex
Behavioral Trajectory Memory
Time Compression
Time Expansion
Semantic Map (Scale Invariant)
Retrosplenial Cortex
Gamma 100 Hz
Semantic Shape (Scale Invariant)
Prefrontal Cortex
Working Memory
Action Queue
Semantic Memory
Prefrontal Cortex
Pre-consciousness (Attention)
Prefrontal Cortex
Conscious Access (Awareness)
Beta 20 Hz
MePS
MePMoS
Ventral Pathway
Visual Cortex
VTC
AIT
CIT
PIT
FEF
7a
5
Allocentric Space
Basal Ganglia
Alpha 10 Hz
Action
Prediction
Rewards by Hebbian Plasticity
Gamma 40- 80 Hz
Egocentric Sensing
V4
V3
V2
V1
LIP
AIP
MIP
PM
MST
MT
VIP
Dorsal Pathway
Overt Attention
Superior Colliculus
Motor Cortex
Corollary Discharge
Covert
Efference Copy
Overt
Proprioception
Saccades
Thalamus
LGN
PN
MThal
Covert Attention
Cerebellum
Brainstem
FAP
Motion
Reflex
Sensing
Sensors (Eyes)
Muscles
Skin
Outer Space
Outer Space (Environment)
Theta 5 Hz
Alpha 10 Hz
0 ms
100 ms
200 ms
300 ms
400 ms
Time

Covert Attention




Overt Attention
Inner Space (Brain)
Inner Space
Theta 5 Hz
Fast Gamma 100-200 Hz
Theta 5 Hz
Beta 20 Hz
Alpha 10 Hz
Gamma 40- 100 Hz
Memory
Direct Sensing Smell, Taste…
Object-centric 3D Log-polar Path Integration
Allocentric 4D Hex Cartesian Navigation Map
Conscious Visual Perception
Prediction
Memory
Object-centric 3D Log-polar Shape
MePMoS
Visual Sensing
SC
Prediction
Prediction
BG
Body-centric 3D Linear-polar Vision
Overt
Corollary Discharge
Saccade
Conscious Movement
Eye-centric 2D Log-polar Retinotopy
PN
Eye-centric 2D Log-polar Retinotopy
Overt Attention
Reflex
Sensors (Eyes)
Muscles
Sensors (Eyes)
Muscles
Skin
Outer Space
Simple Reaction Time
Choice Reaction Time
Theta 5 Hz
Alpha 10 Hz
0 ms
100 ms
200 ms
300 ms
400 ms
Time

How do we know the distances?



Visual Perception of 3D Space and Shape in Time

Part II

3D Space Perception with Holographic Depth

30 EMC members

Isabella Bustanoby, Andrew Krupien, Umaima Afifa, Benjamin Asdell, Michaela Bacani, James Boudreau, Javier Carmona, Pranav Chandrashekar, Mark Diamond, Diego Espino, Arnav Gangal, Chandan Kittur, Yaochi Li, Tanvir Mann, Christian Matamoros, Trevor McCarthy, Elizabeth Mills, Stephen Nazareth, Justin Nguyen, Kenya Ochoa, Sophie Robbins, Despoina Sparakis, Brian Ta, Kian Trengove, Tyler Xu, Natsuko Yamaguchi, Christine Yang, Eden Zafran, Aaron P. Blaisdell*, and Katsushi Arisaka

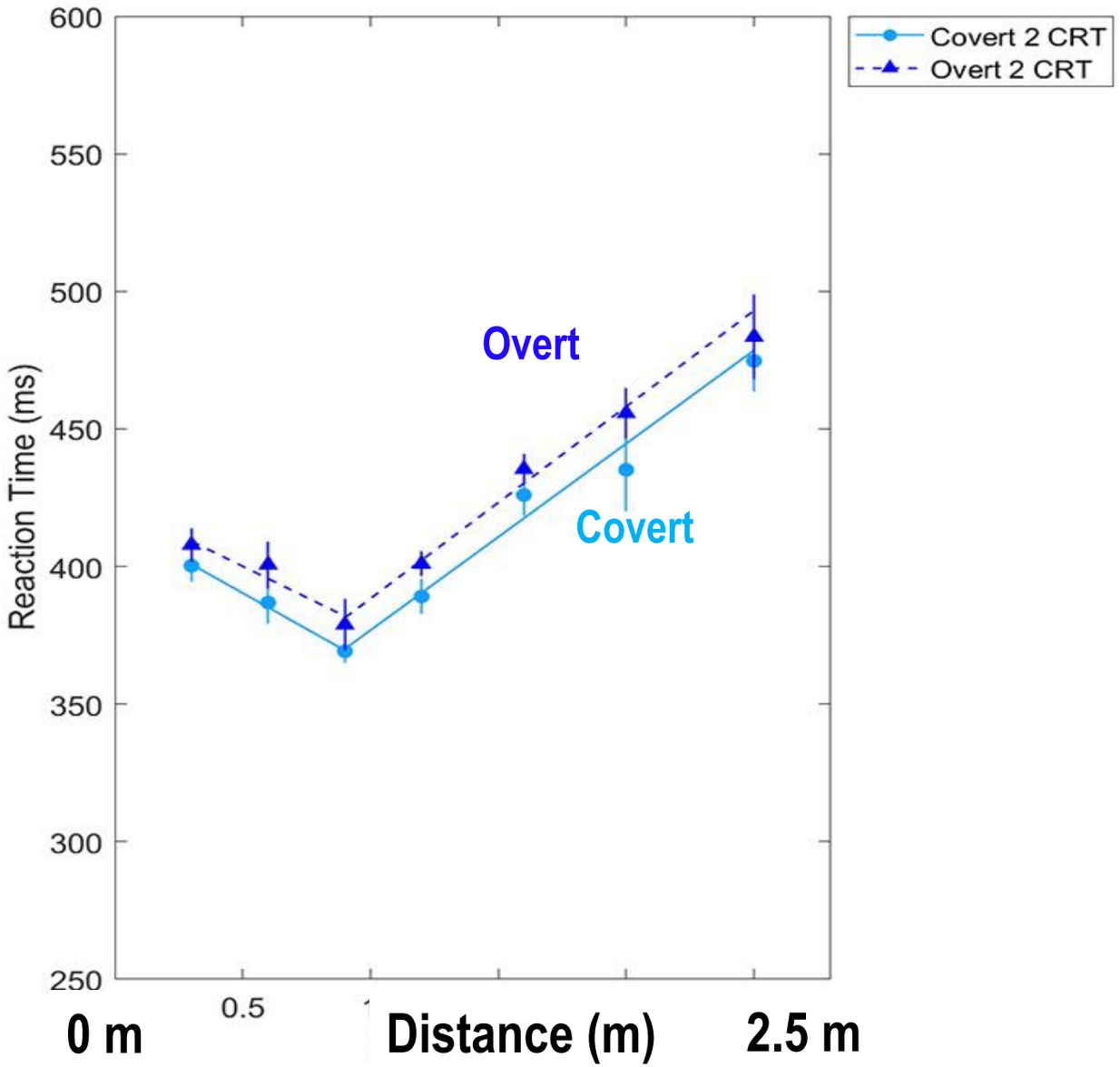
University of California, Los Angeles

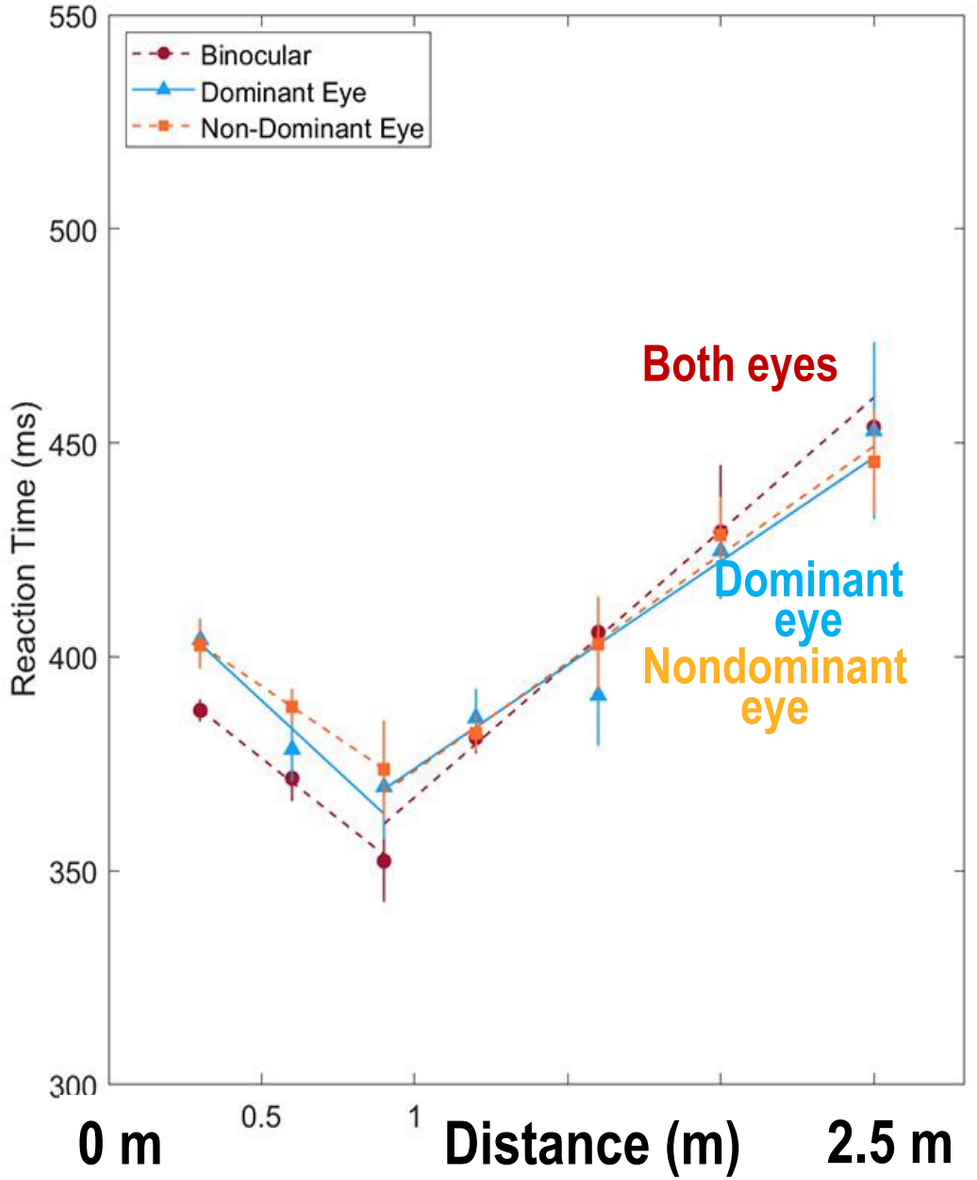
Reaction Time Setup for Depth Perception

Spin-off of Physics 4BL

RT vs. Depth by Remote Members

N = 7





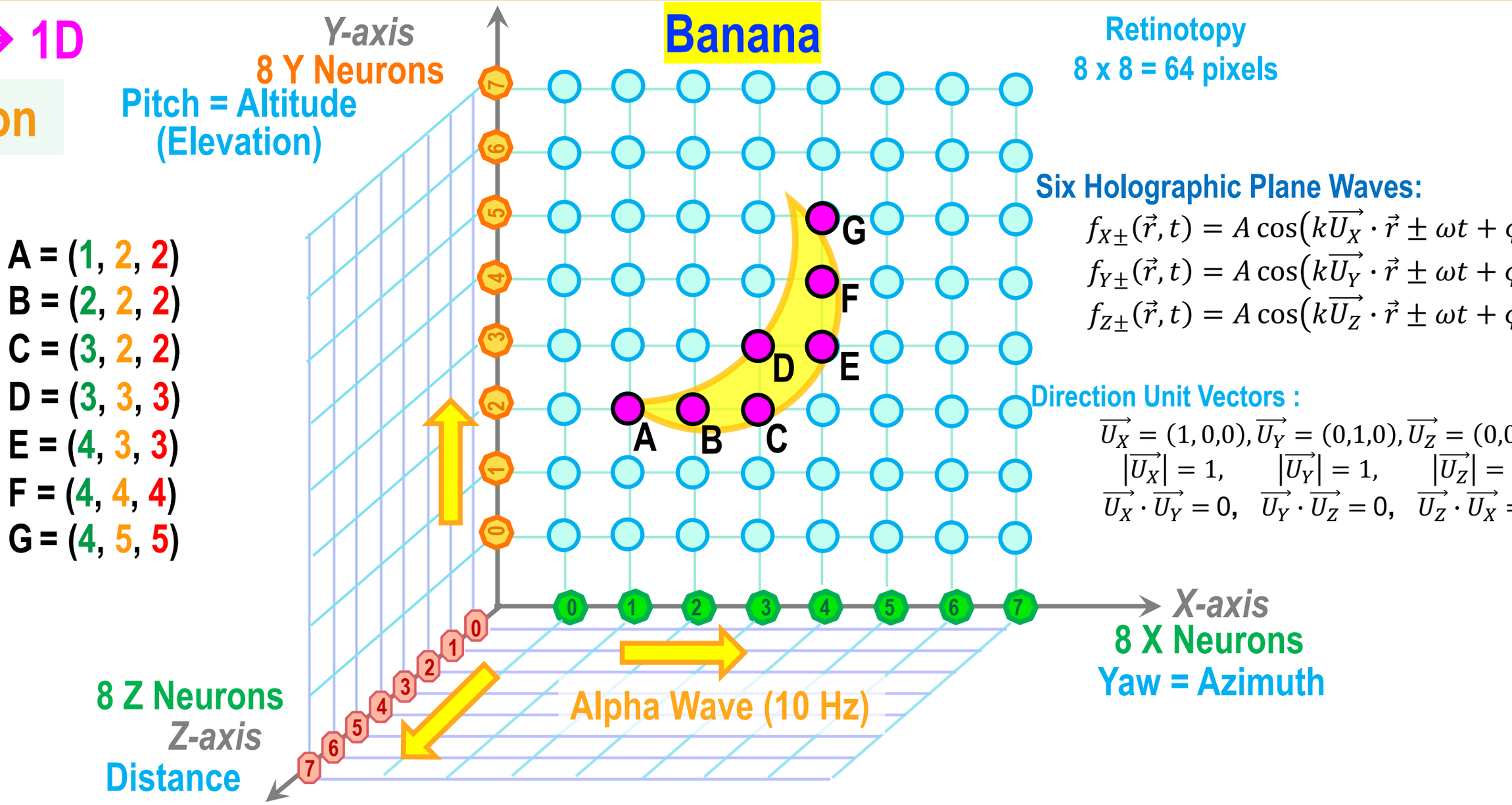

-40°
-20°
2.4 m
0°
20°
40°
1.8 m
1.2 m
0.6 m
Arduino
Flat 2D Lattice RT

Neural Holographic Tomography (NHT)
by
Holographic Ring Attractor Lattice (HAL)

Principle of Neural Holographic Tomography (NHT)

3D → 1D

Vision



Retinotopy
8 x 8 = 64 pixels

Six Holographic Plane Waves:

$$f_{X\pm}(\vec{r},t) = A\cos\left(k\overrightarrow{U_X}\cdot\vec{r} \pm \omega t + \phi_X\right)$$
$$f_{Y\pm}(\vec{r},t) = A\cos\left(k\overrightarrow{U_Y}\cdot\vec{r} \pm \omega t + \phi_Y\right)$$
$$f_{Z\pm}(\vec{r},t) = A\cos\left(k\overrightarrow{U_Z}\cdot\vec{r} \pm \omega t + \phi_Z\right)$$

Direction Unit Vectors :

$$\overrightarrow{U_X} = (1,0,0), \overrightarrow{U_Y} = (0,1,0), \overrightarrow{U_Z} = (0,0,1)$$
$$\left|\overrightarrow{U_X}\right| = 1, \quad \left|\overrightarrow{U_Y}\right| = 1, \quad \left|\overrightarrow{U_Z}\right| = 1$$
$$\overrightarrow{U_X}\cdot\overrightarrow{U_Y} = 0, \quad \overrightarrow{U_Y}\cdot\overrightarrow{U_Z} = 0, \quad \overrightarrow{U_Z}\cdot\overrightarrow{U_X} = 0$$

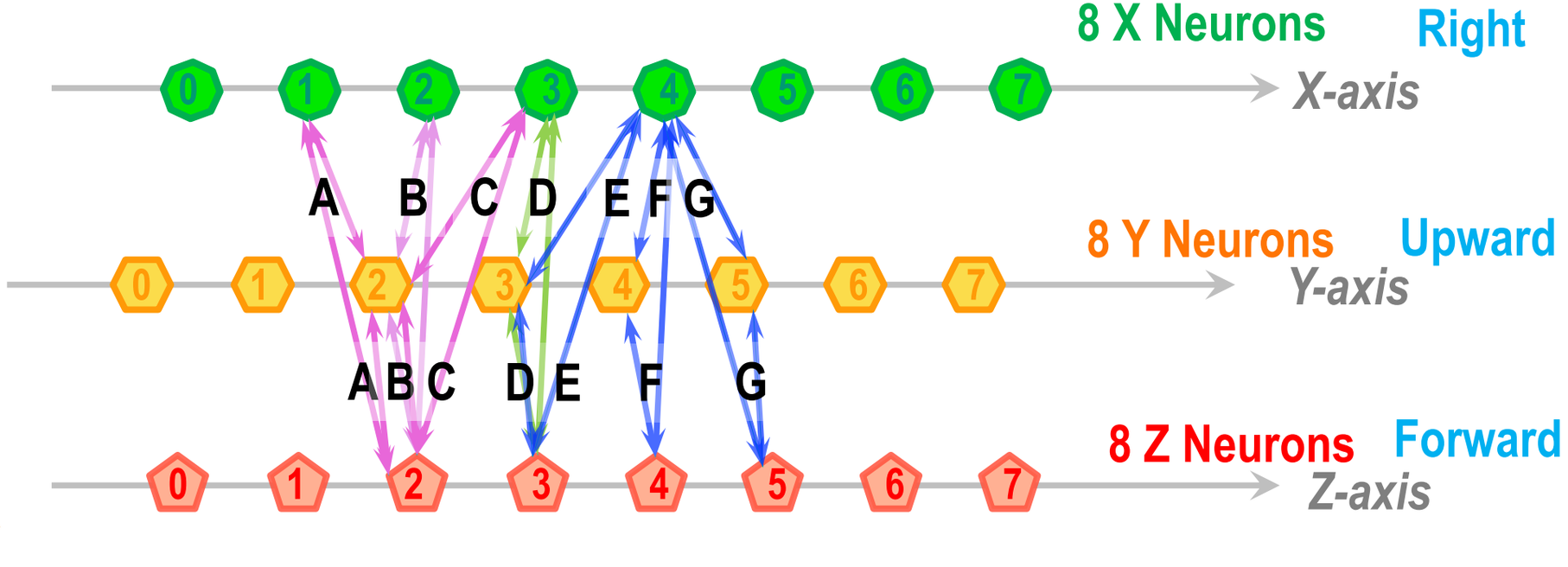
3D → 1D Hologram for Perception and Memory of 3D Banana Shape and Location

3D → 1D

8 x 3 = 24 Neurons
8^2 x 3 = 192 Synapses
8^3 = 512 Voxels (in 3D)

Banana

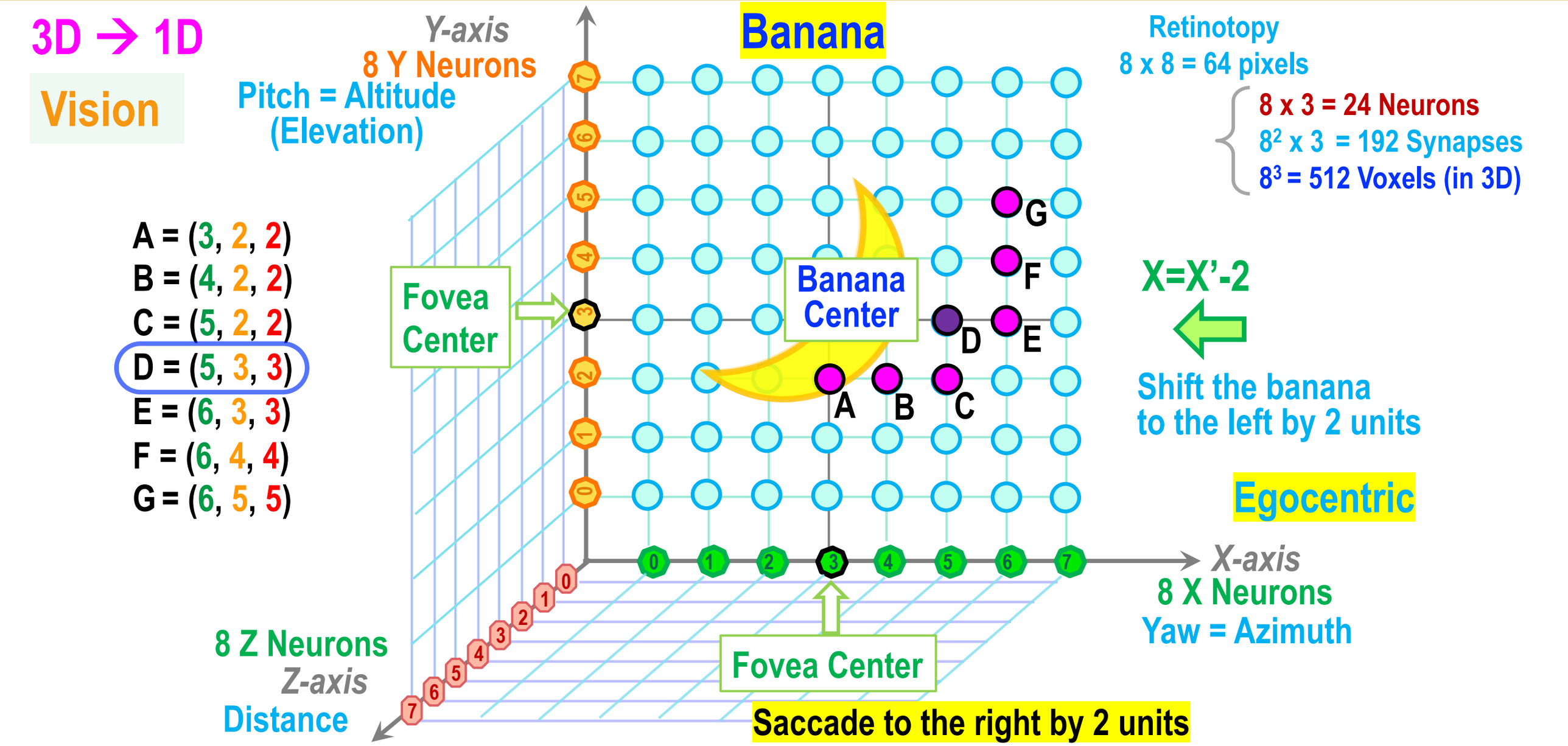
A = (1, 2, 2)
B = (2, 2, 2)
C = (3, 2, 2)
D = (3, 3, 3)
E = (4, 3, 3)
F = (4, 4, 4)
G = (4, 5, 5)



Alpha Wave (10 Hz)

Memory and Prediction of the 3D Banana
→ Visual Awareness (Consciousness)

Banana shifted to the Right



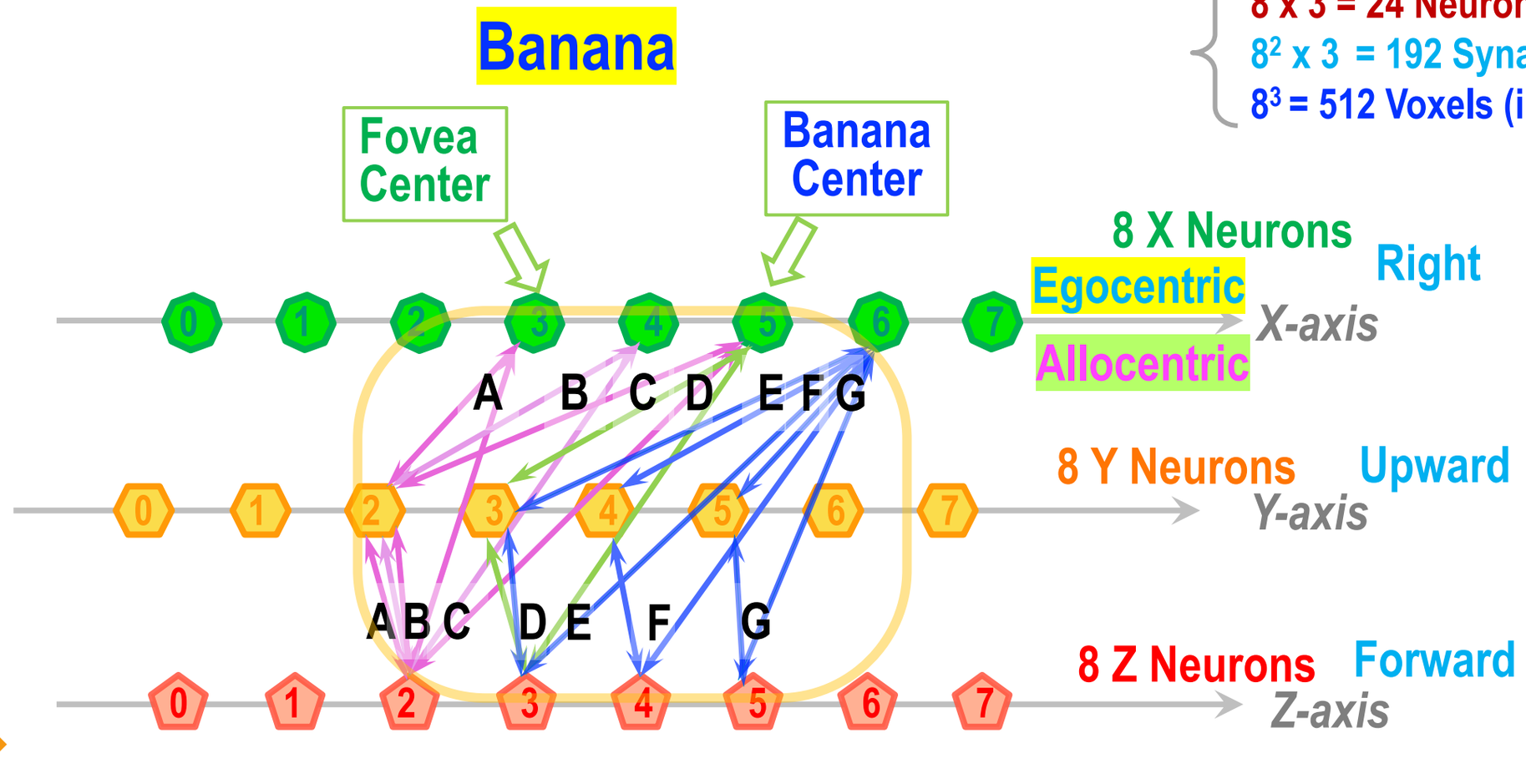
Banana shifted to the Right

1D

8 x 3 = 24 Neurons
8^2 x 3 = 192 Synapses
8^3 = 512 Voxels (in 3D)

X' = X+2

A = (3, 2, 2)
B = (4, 2, 2)
C = (5, 2, 2)
D = (5, 3, 3)
E = (6, 3, 3)
F = (6, 4, 4)
G = (6, 5, 5)

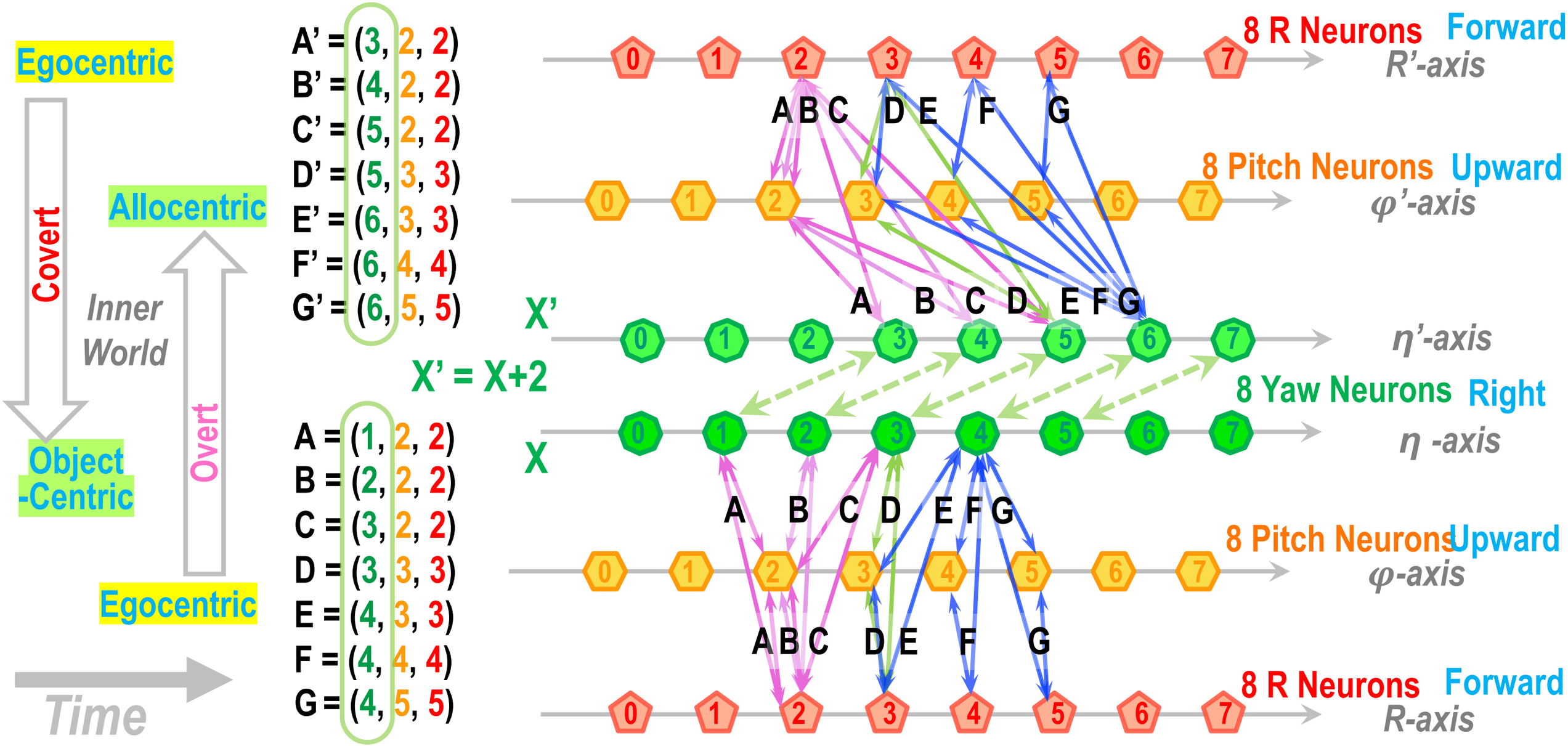


Alpha Wave (10 Hz)

3D Visual Perception of Banana

Covert → Overt Attention

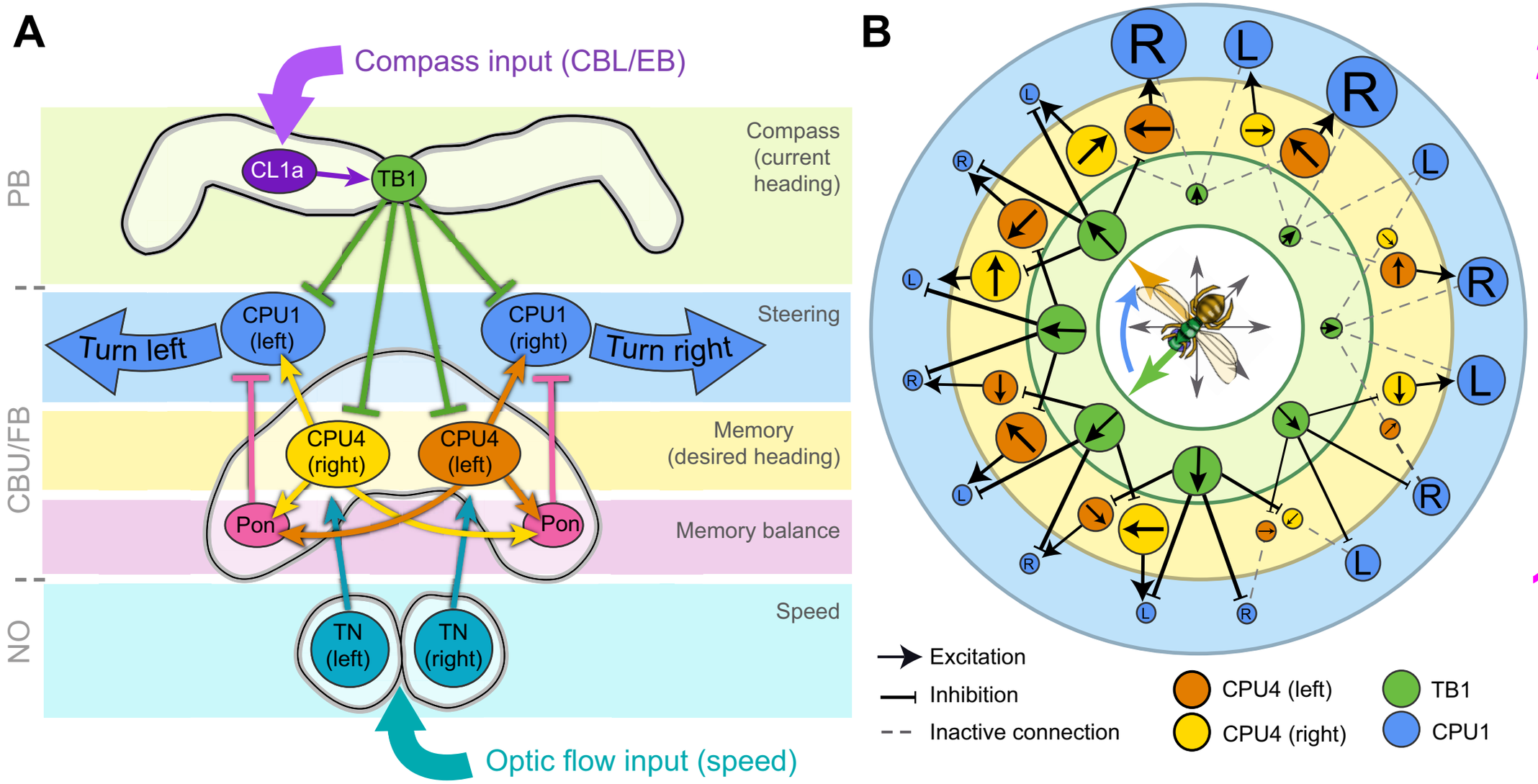
1D→ 1D'



The insect central complex and the neural basis of navigational strategies

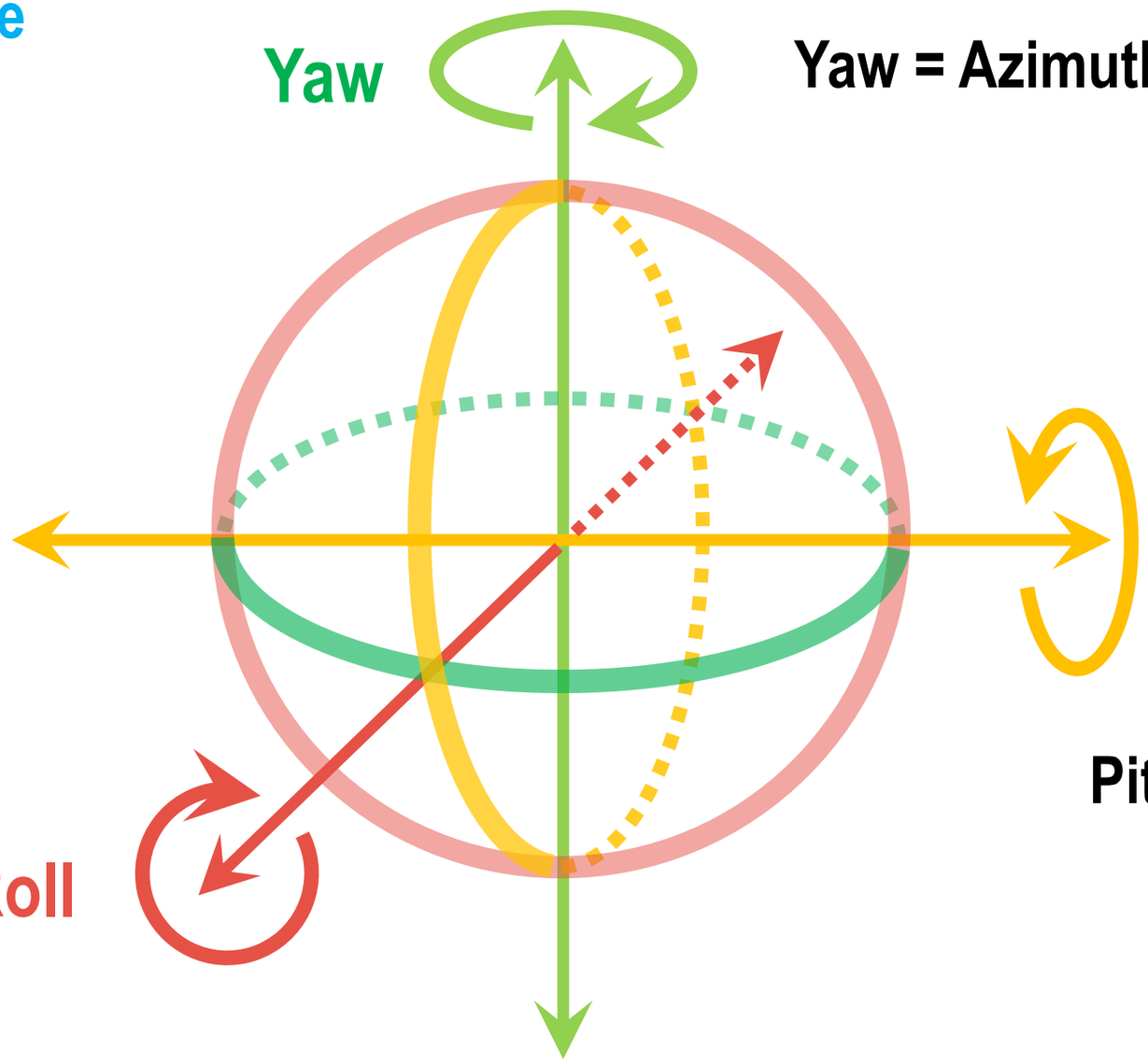
Ring Attractor

Honkanen 2019



3D Rotation – Yaw, Pitch and Roll

3D Linear Polar Coordinate
Allocentric Direction
Egocentric Center



Yaw = Azimuth

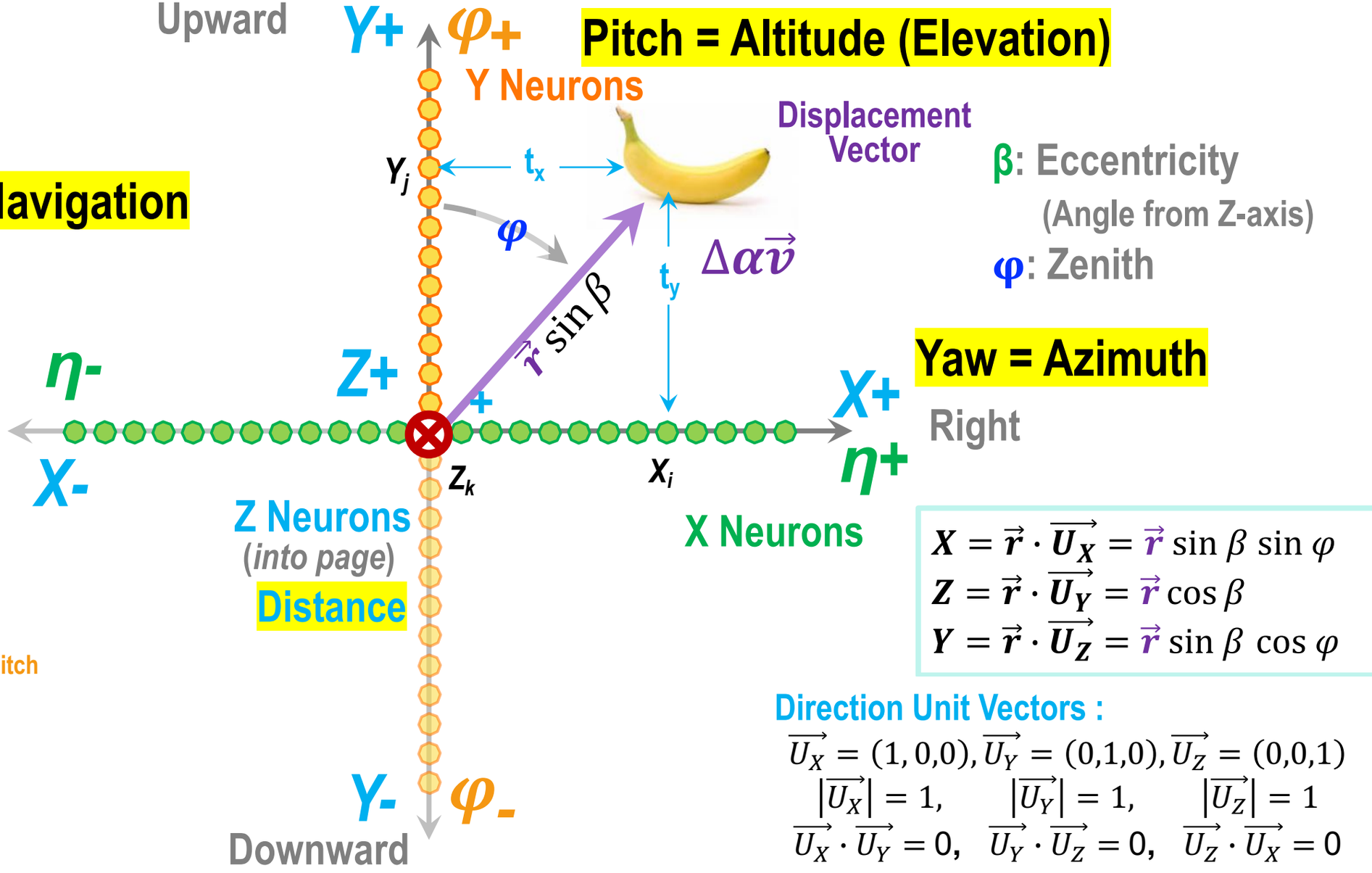
Pitch = Altitude
= Elevation

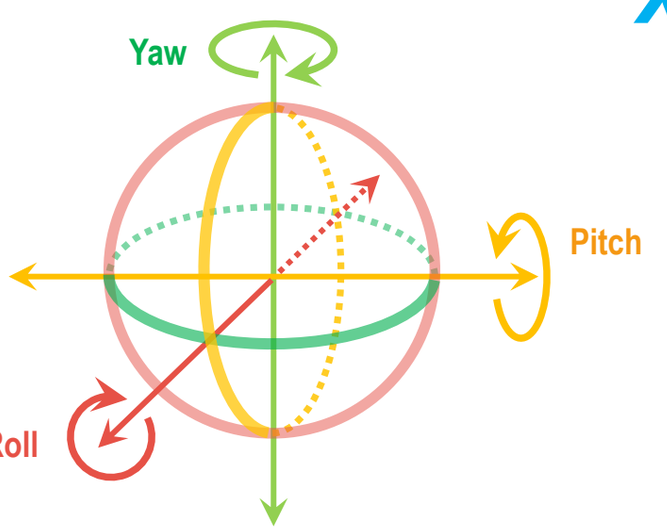
3D Polar Coordinate for Vision

Body-centric

Upward

Saccade = Insect's Navigation





$$X = \vec{r} \cdot \overrightarrow{U_X} = \vec{r} \sin\beta \sin\varphi$$
$$Z = \vec{r} \cdot \overrightarrow{U_Y} = \vec{r} \cos\beta$$
$$Y = \vec{r} \cdot \overrightarrow{U_Z} = \vec{r} \sin\beta \cos\varphi$$

Direction Unit Vectors :

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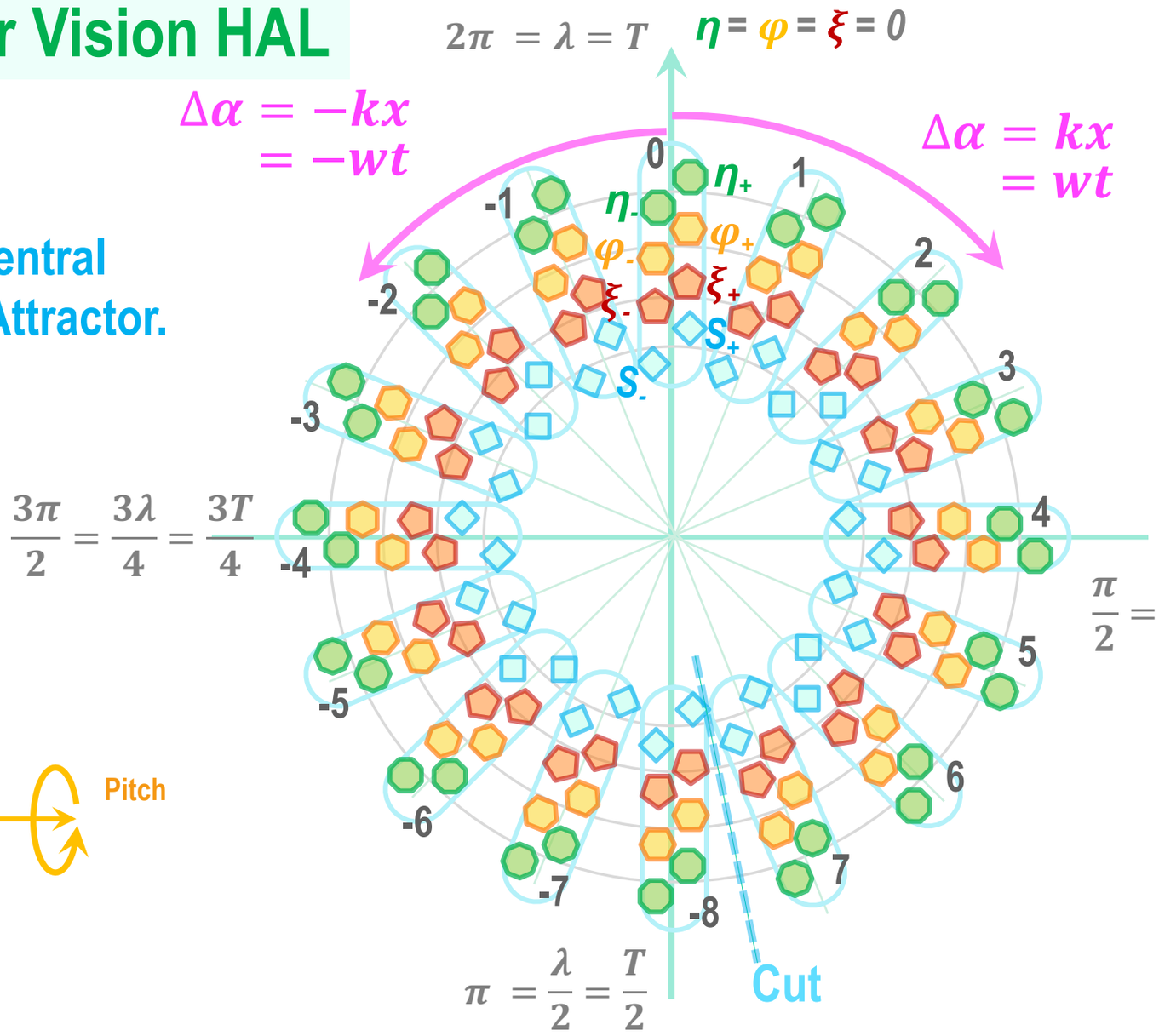
3D Polar Coordinate for Vision

3D Linear-polar Vision HAL

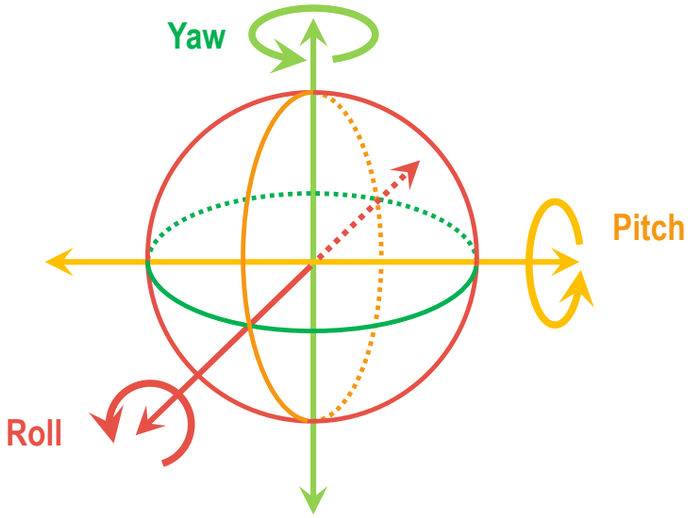
Identical to Insect Central Complex as a Ring Attractor.



η Yaw Cells
φ Pitch Cells
ξ Roll Cells
S Distance Cells

Log(Distance)

Log(Eccentricity)

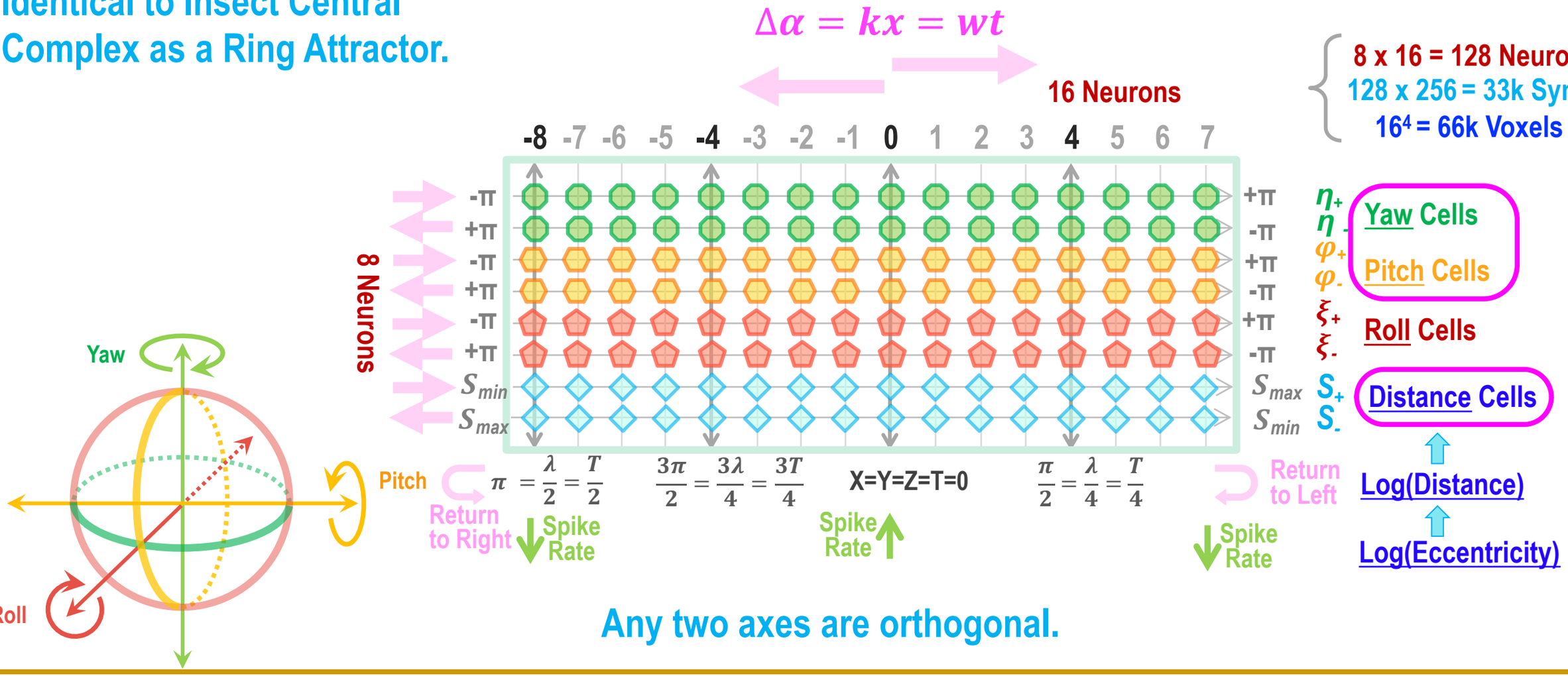


Holographic Ring Attractor Lattice (HAL)

3D Linear-polar Vision HAL

Three independent
Head Direction Cells:
(Yaw, Pitch, Roll)

Identical to Insect Central
Complex as a Ring Attractor.



Any two axes are orthogonal.

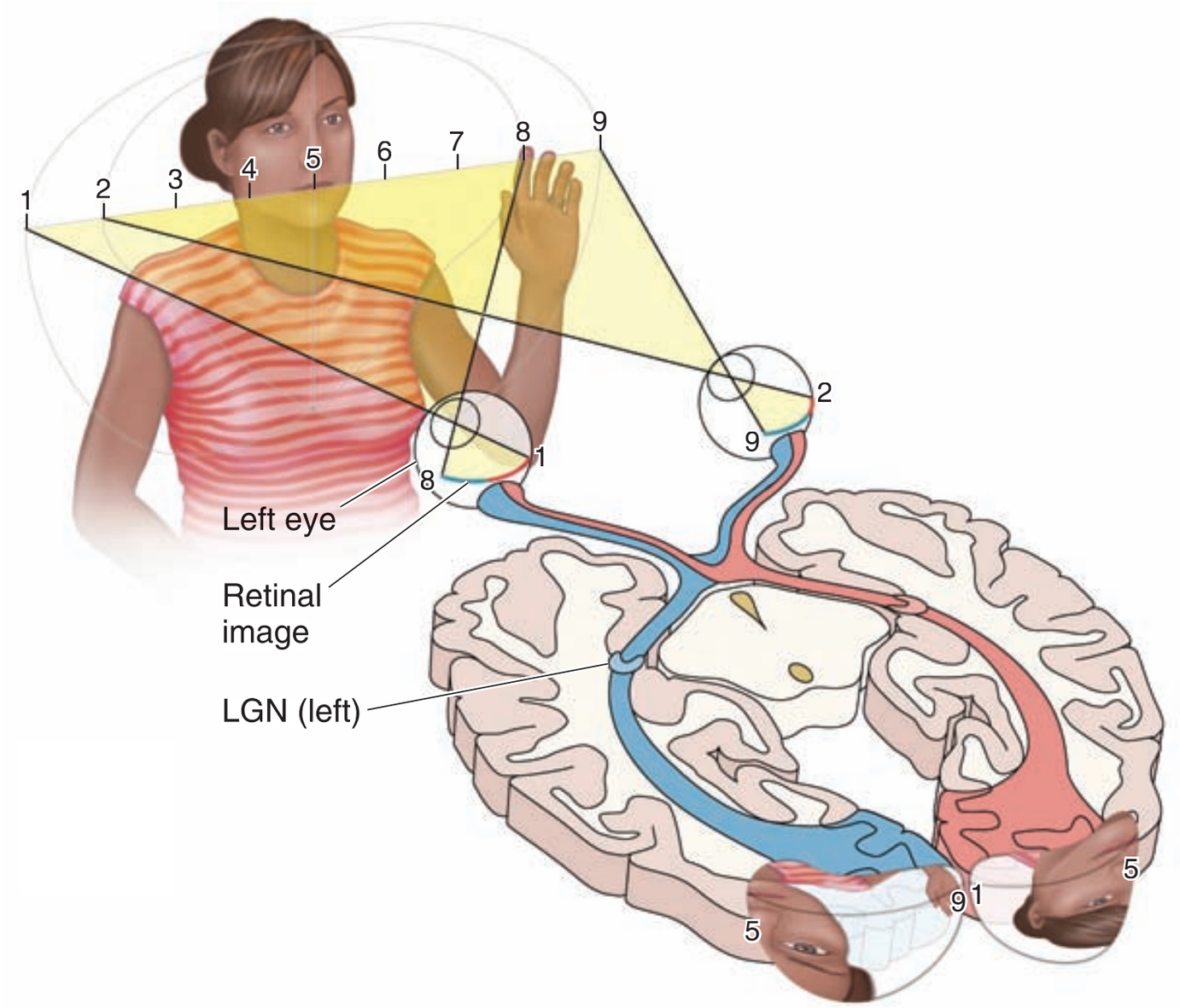
Visual Perception of 3D Shape by Log-polar HAL

Three Major Mysteries of Vision

- Why nothing moves even if we move our eyes/head?
  - Why do we constantly move our eyes unconsciously?
- Why can we perceive the 3D space with depth?
  - Even with monocular view.
- **How can we recognize the 3D shape?**
  - **at any 3D location with different apparent size and different 3D orientation?**

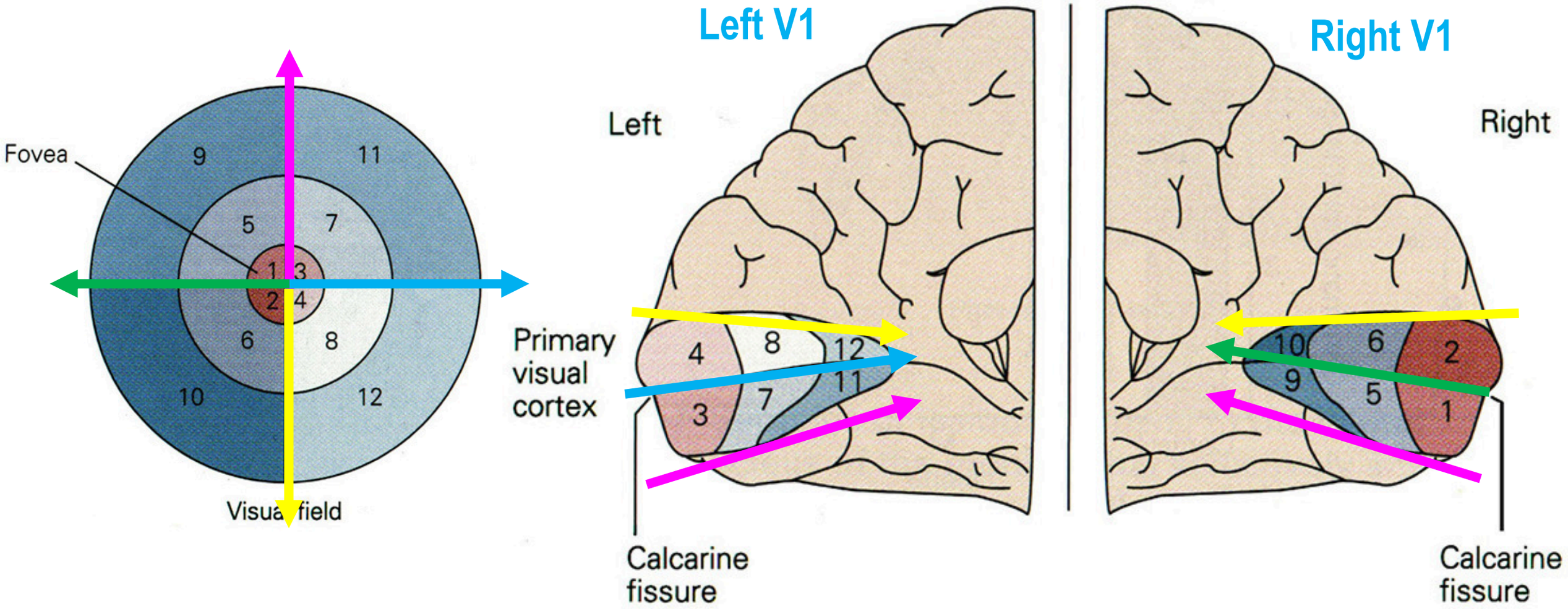
Neuroscience Exploring the Brain: Chapter 9 – The Eye

Bear 4th edition



Primary Visual Cortex V1

Paulun 2018

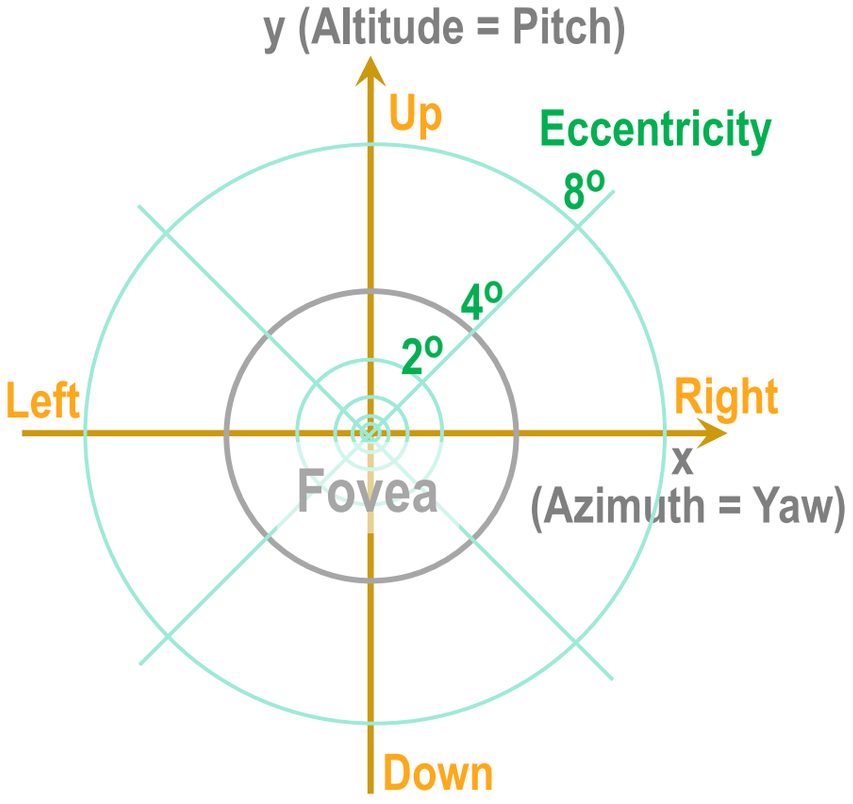


Jaygandhi786 (2015). *Visual Cortex*. Available online at: https://commons.wikimedia.org/wiki/User:OgreBot/Uploads_by_new_users/2015_May_02_15:00

3D Log-polar HAL for 3D Scale-invariant Shape

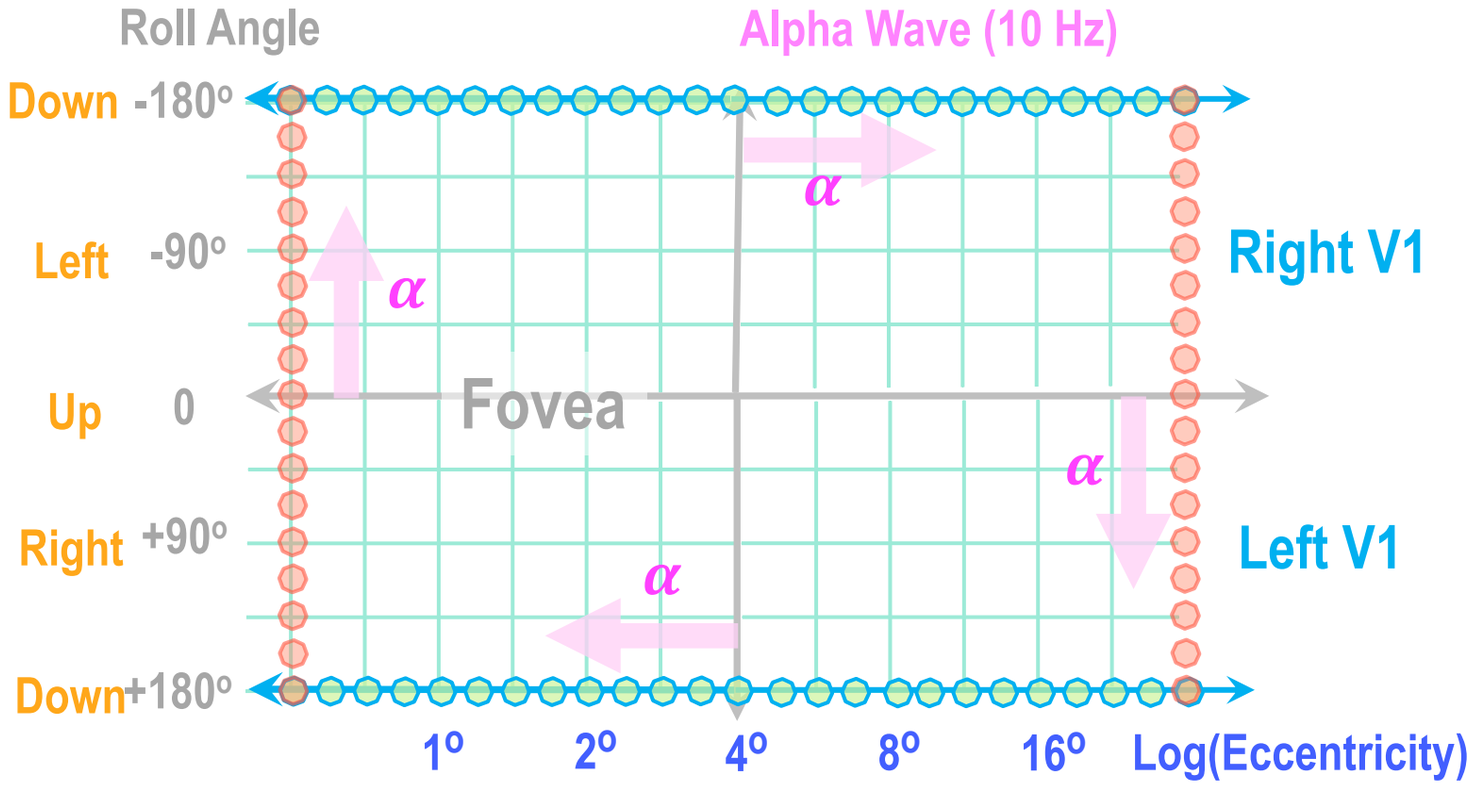
2D Linear

Space Invariant



2D Log-Polar

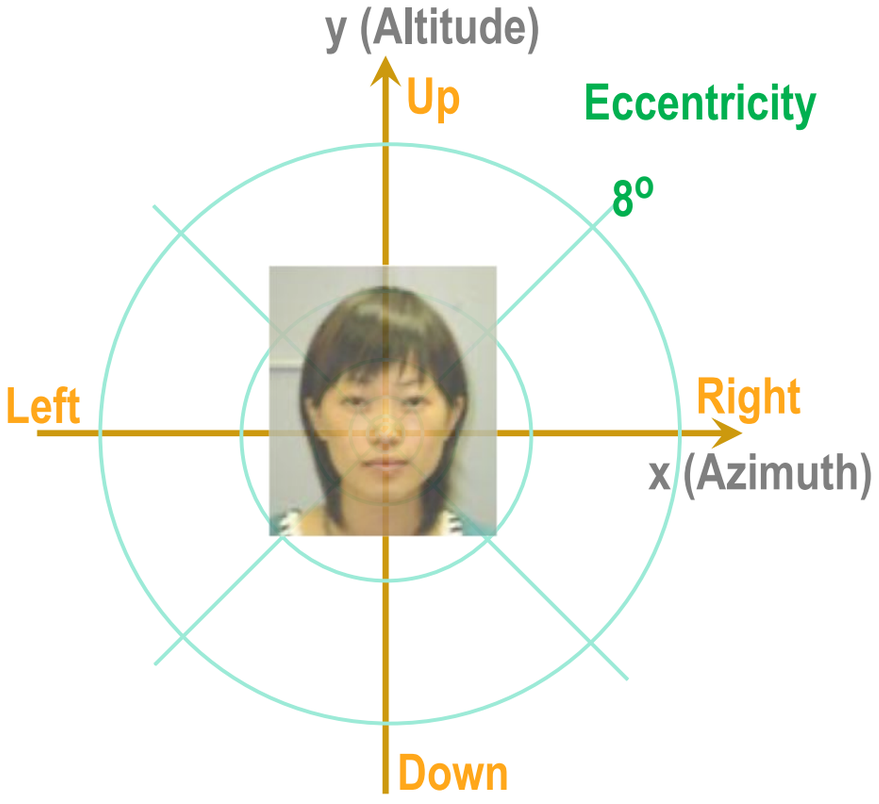
Scale Invariant



3D Log-polar HAL for 3D Scale-invariant Shape

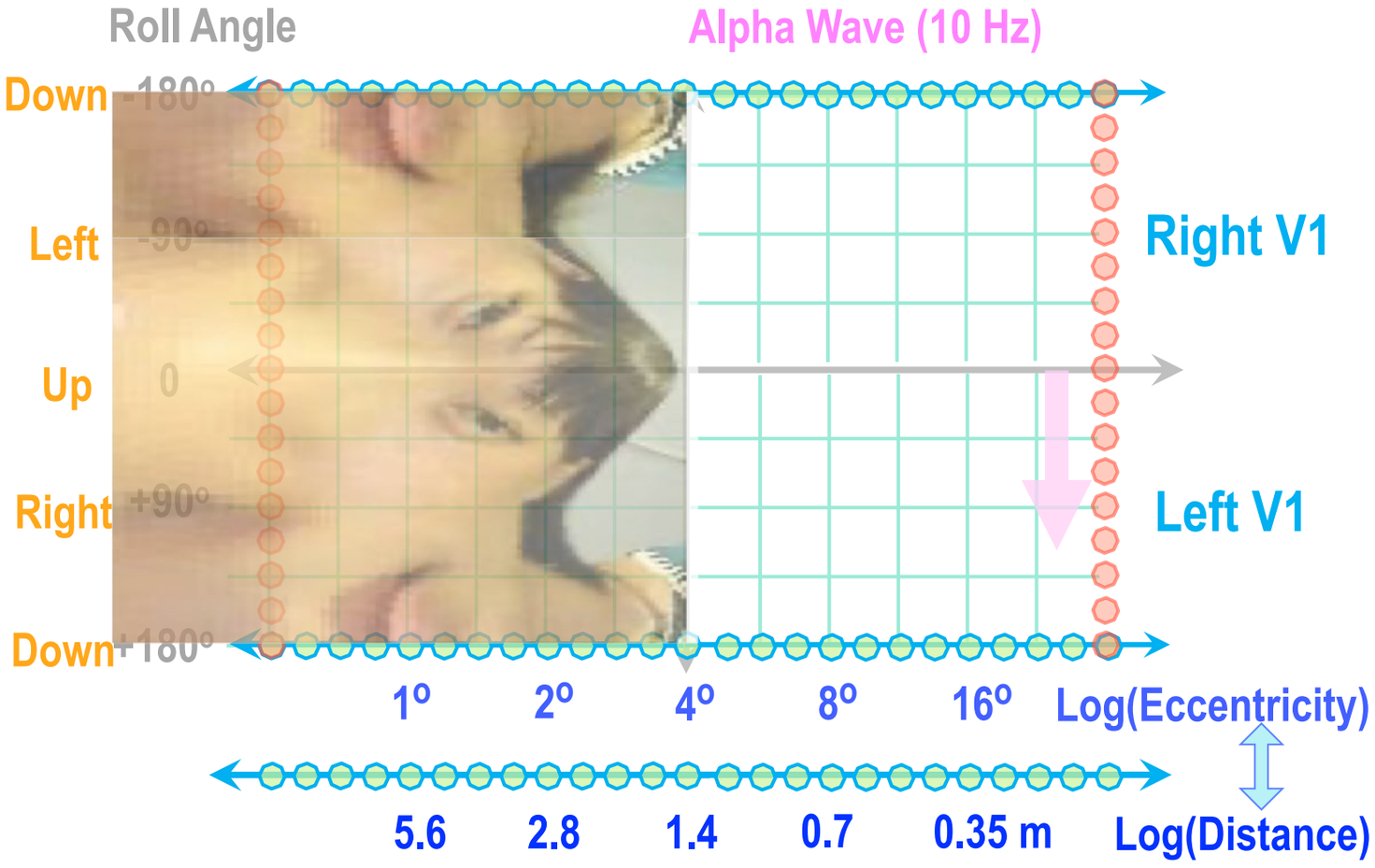
2D Linear

Space Invariant



2D Log-Polar

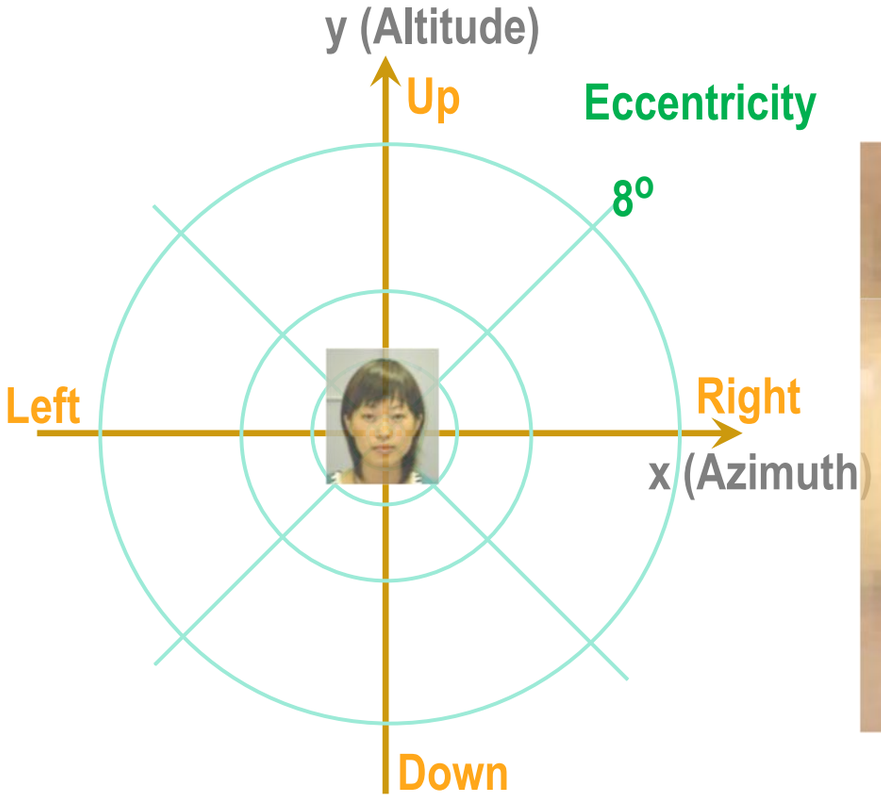
Scale Invariant



3D Log-polar HAL for 3D Scale-invariant Shape

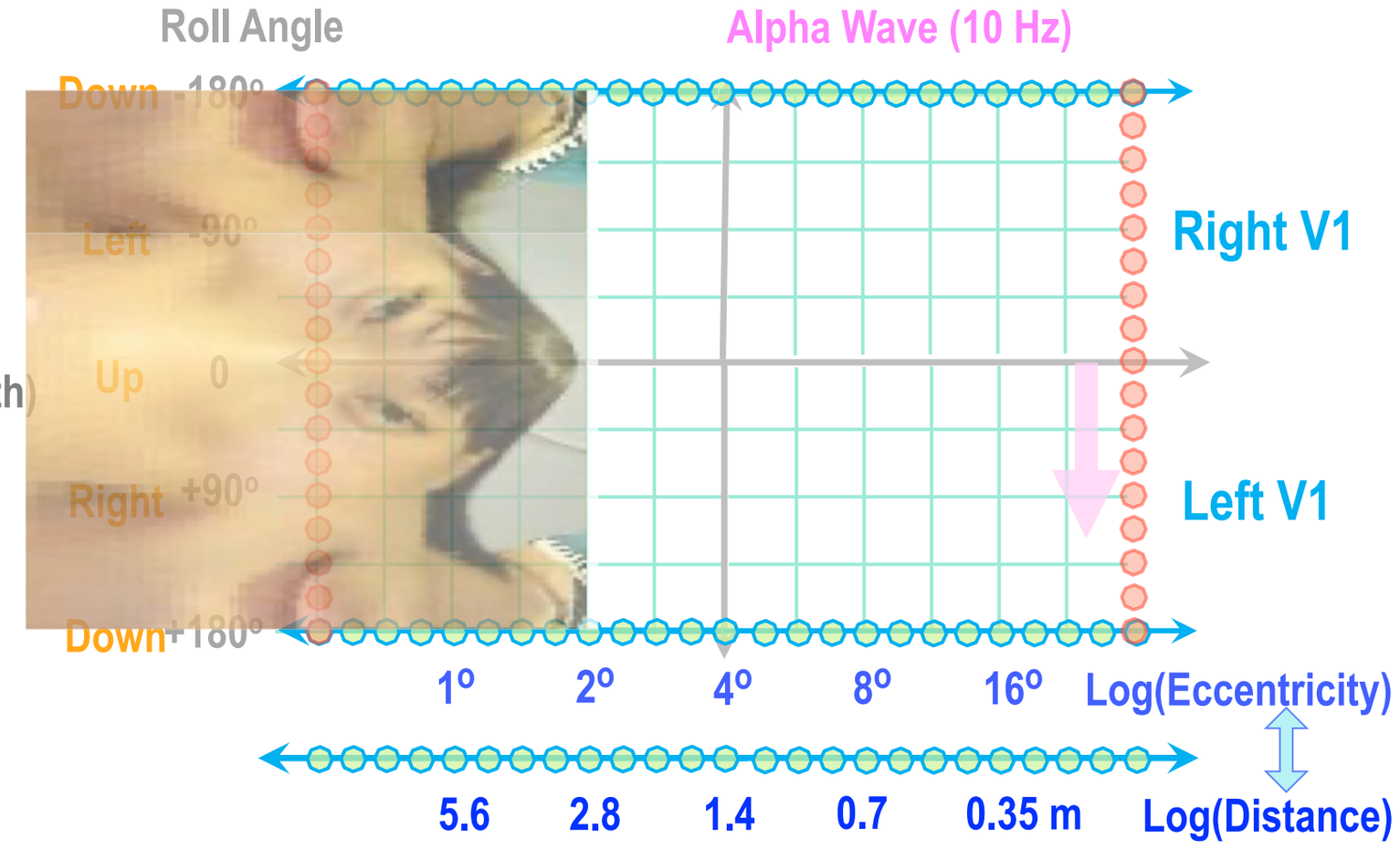
2D Linear

Space Invariant



2D Log-Polar

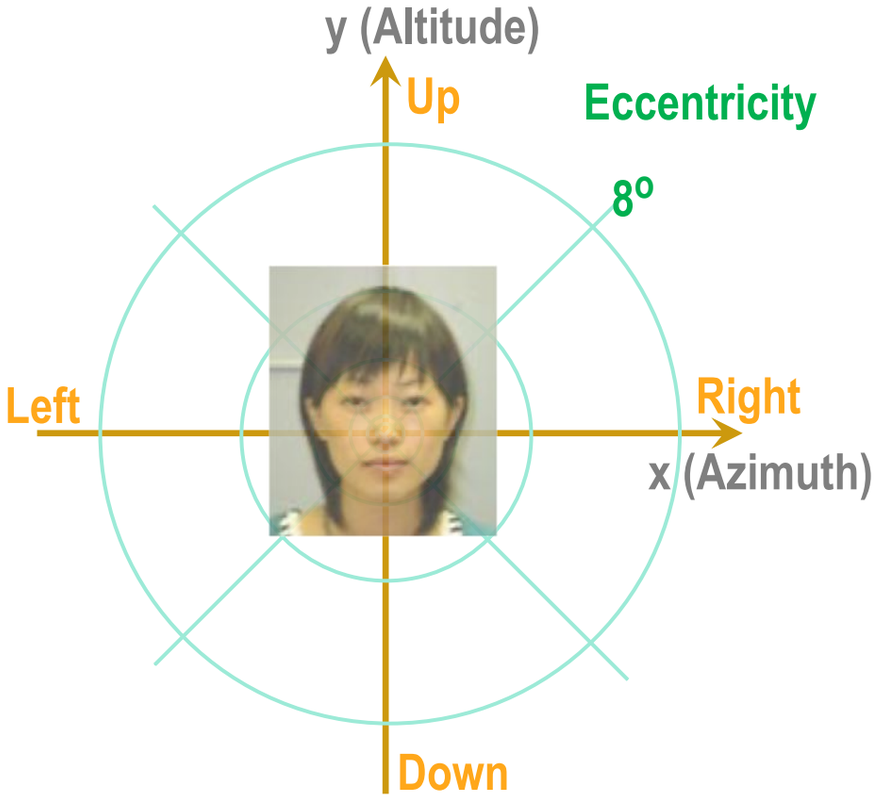
Scale Invariant



3D Log-polar HAL for 3D Scale-invariant Shape

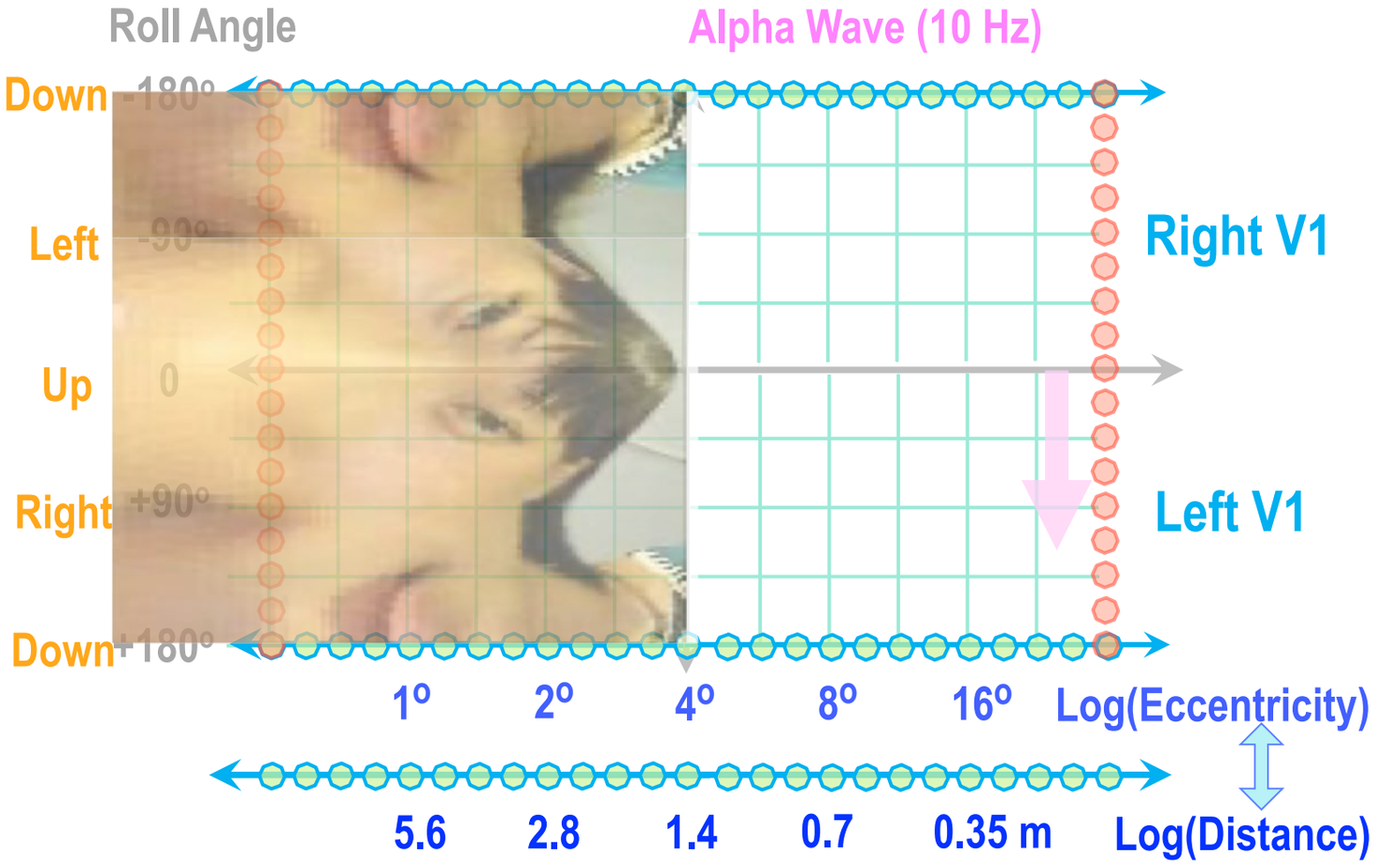
2D Linear

Space Invariant



2D Log-Polar

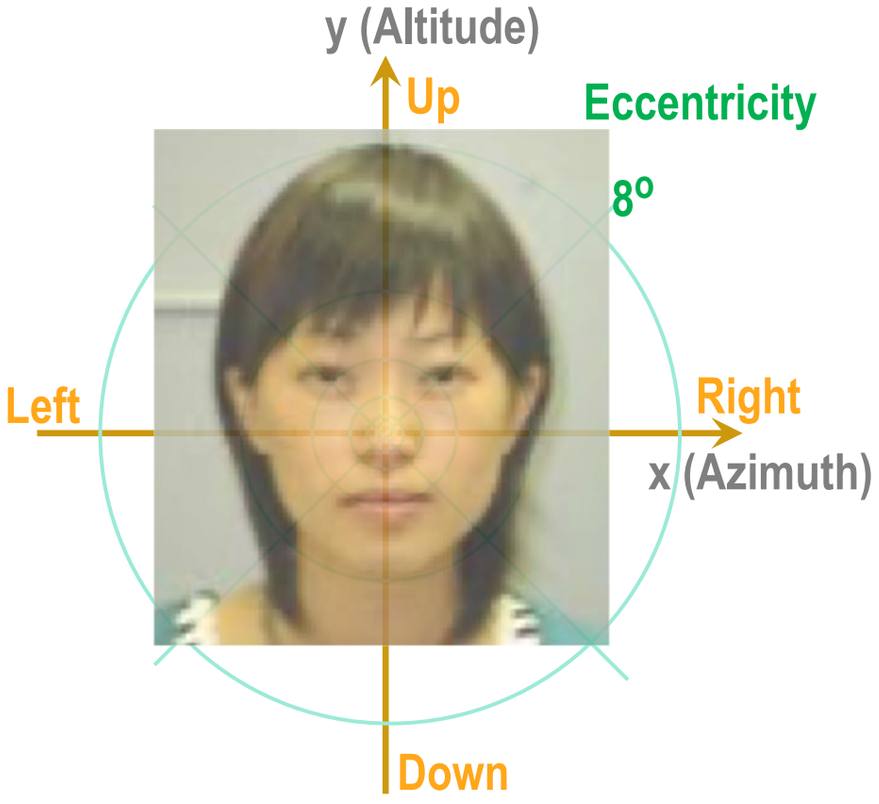
Scale Invariant



3D Log-polar HAL for 3D Scale-invariant Shape

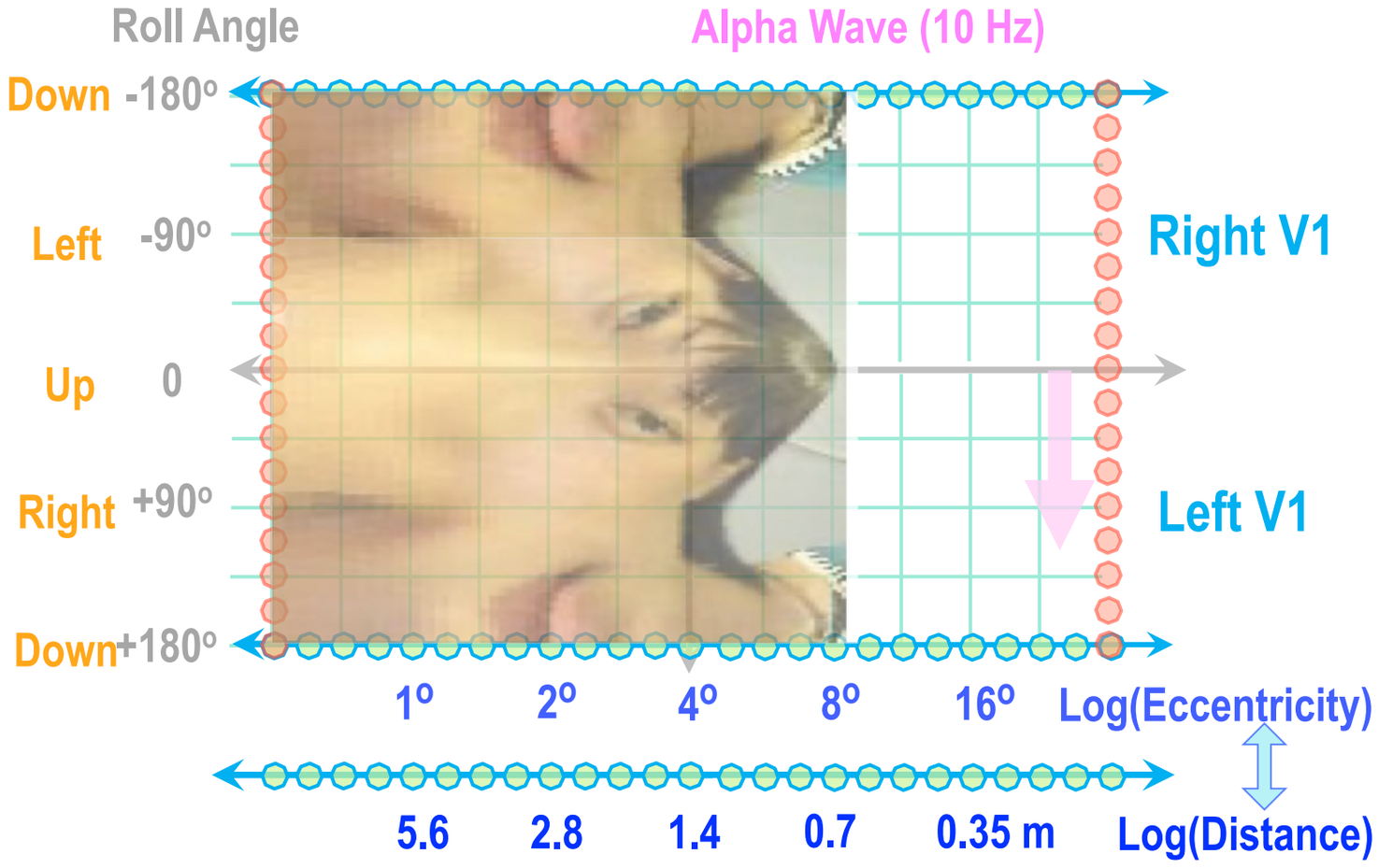
2D Linear

Space Invariant



2D Log-Polar

Scale Invariant



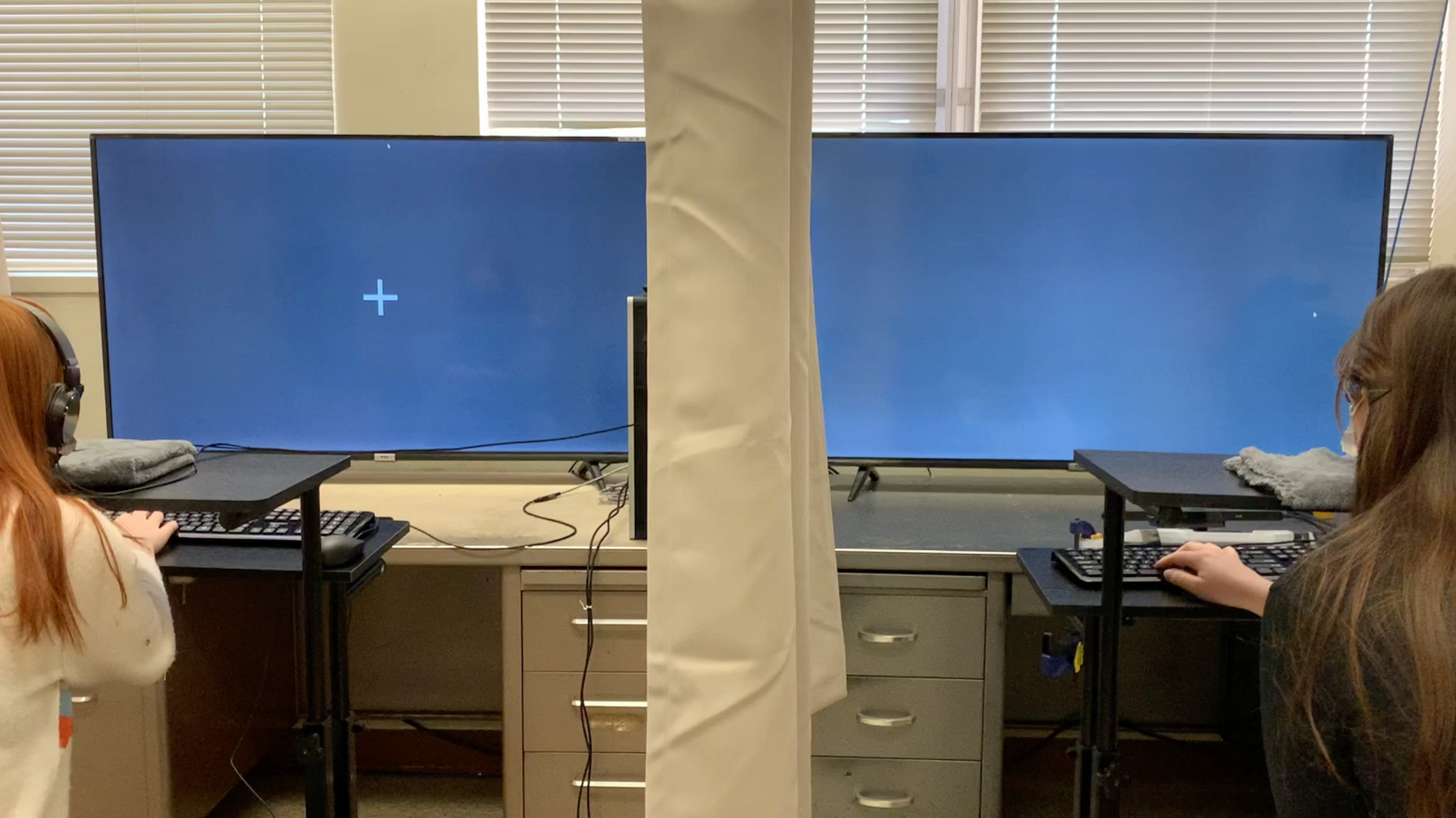
Visual Perception of 3D Space and Shape in Time

Part III
2D Shape Recognition by Log-Scaling

44 EMC members

Brian Ta, Maria E. M. M. Silva, Kelly Bartlett, Umaima Afifa, Ricardo Canela, Javier Carmona, Emmanuel John L. De Leon, Alyssa Drost, Diego Espino, Kyleigh Follis, Paul Gan, Lauren Ho, Christina Honoré, Emily Huang, Luis Ibarra, Mira Khosla, Victor Li, Trevor McCarthy, Elizabeth Mills, Sukanya Mohapatra, Yuuki Morishige, Nancy Nguyen, Ziyan Peng, Kimya Peyvan, Michael Phipps, Isabella Poschl, Jagannathan Rangarajan, Charÿsa Santos, Leonard Schummer, Sky Shi, Natalie Smale, April Smith, Divya Sood, Cindy Ta, Anna Tran, Michelle Tran, Rui Wang, Patrick Wilson, Nicole L. Yang, Megan Yu, Selena Yu, Aaron P. Blaisdell*, Katsushi Arisaka

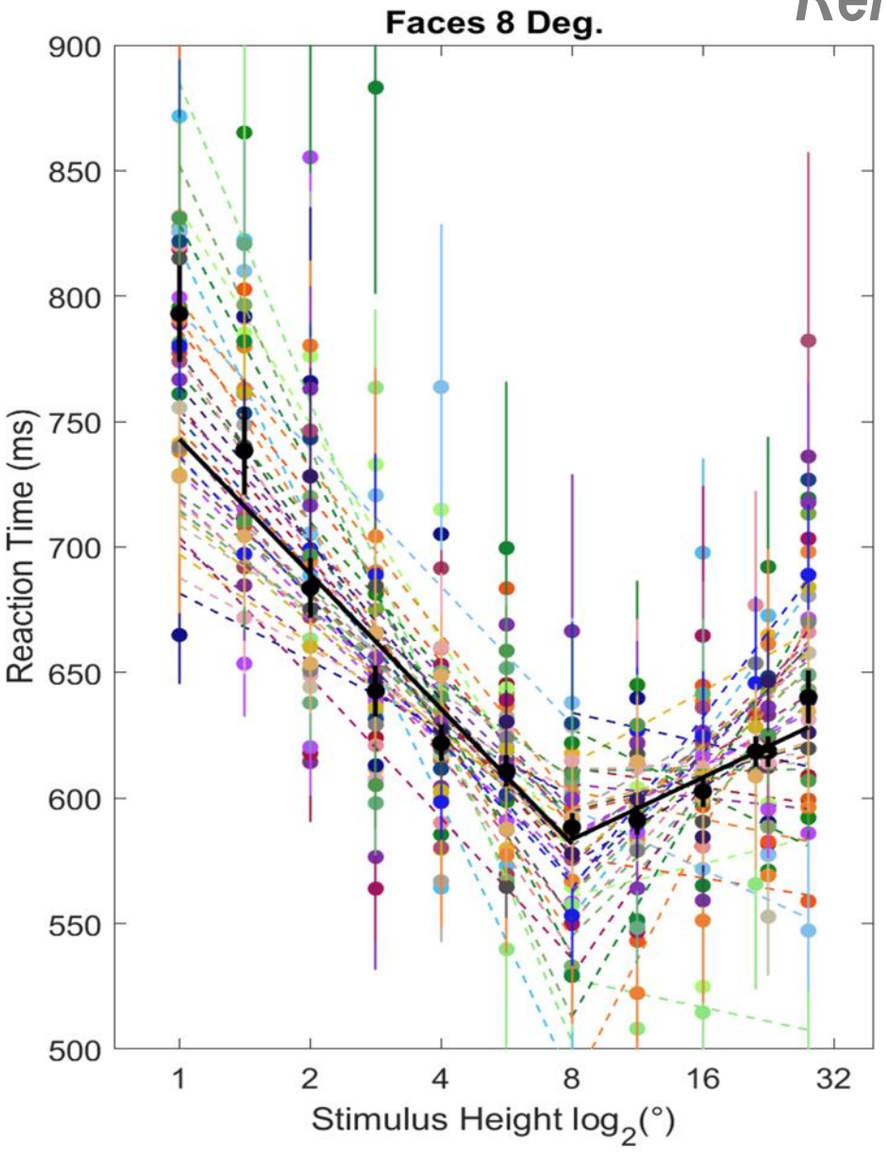
University of California, Los Angeles

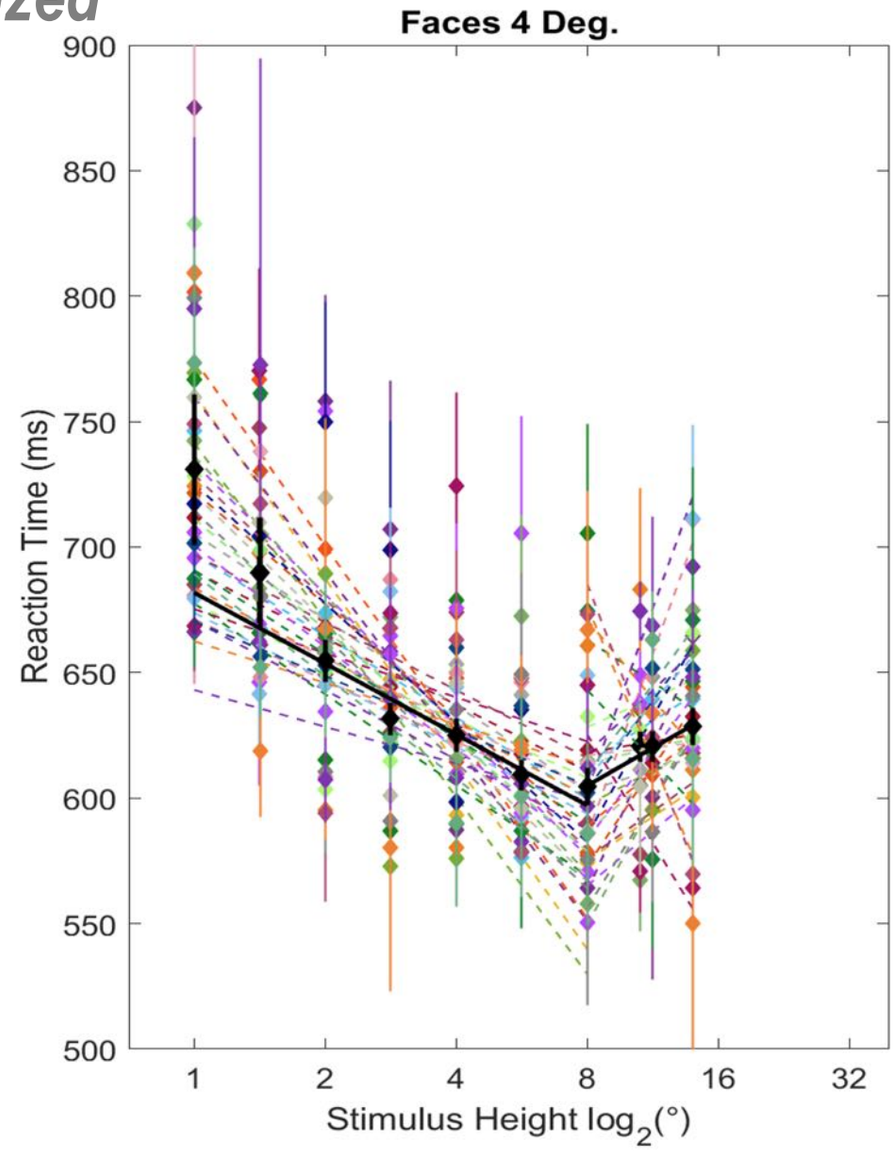


Face Scaling RT

Renormalized

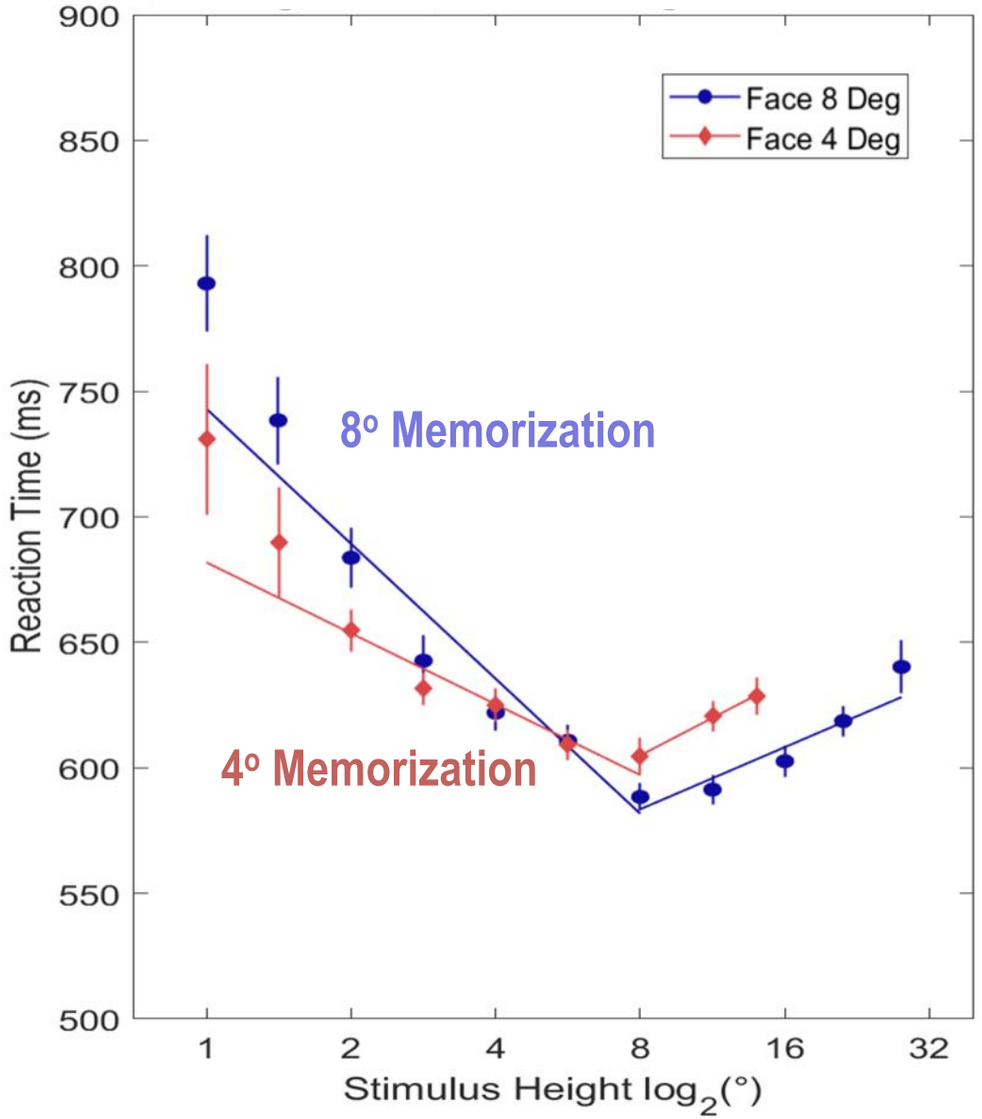
N = 40



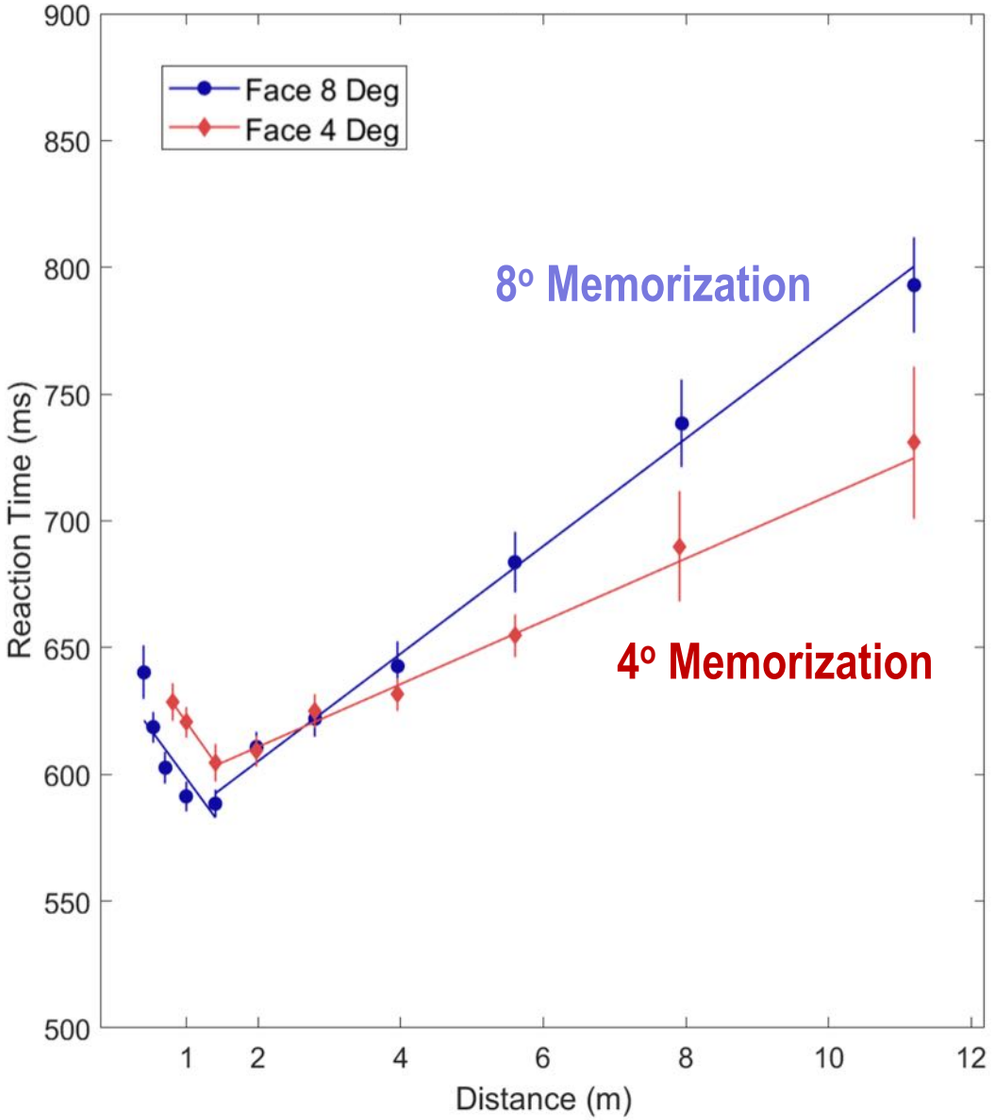


Face Scaling RT

Scaling with Log (Height)



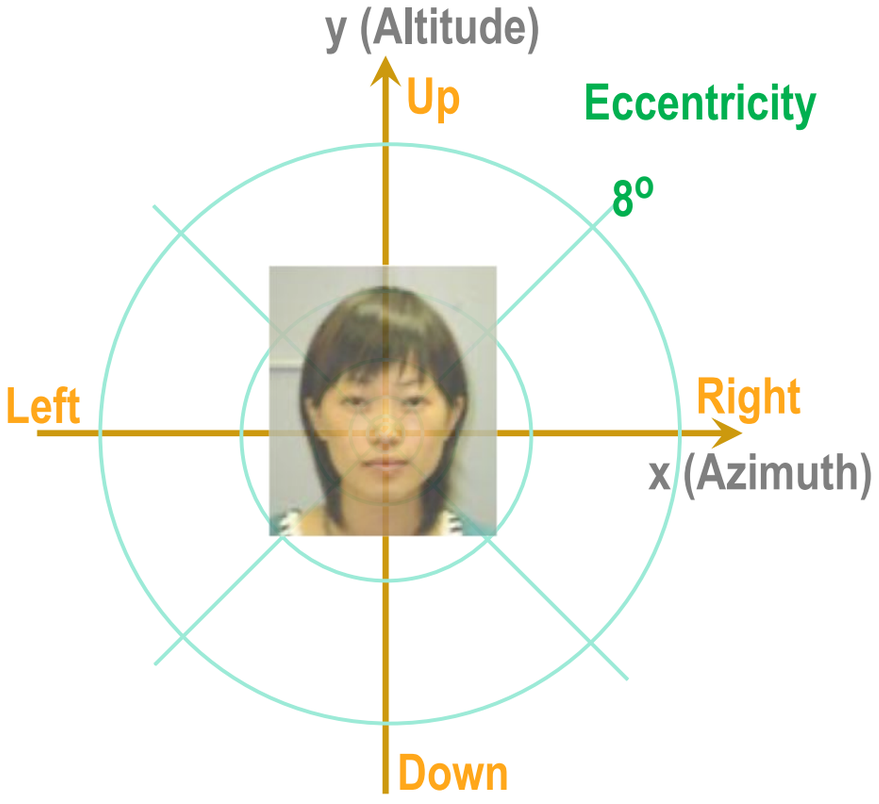
Scaling with Virtual Distance



3D Log-polar HAL for 3D Scale-invariant Shape

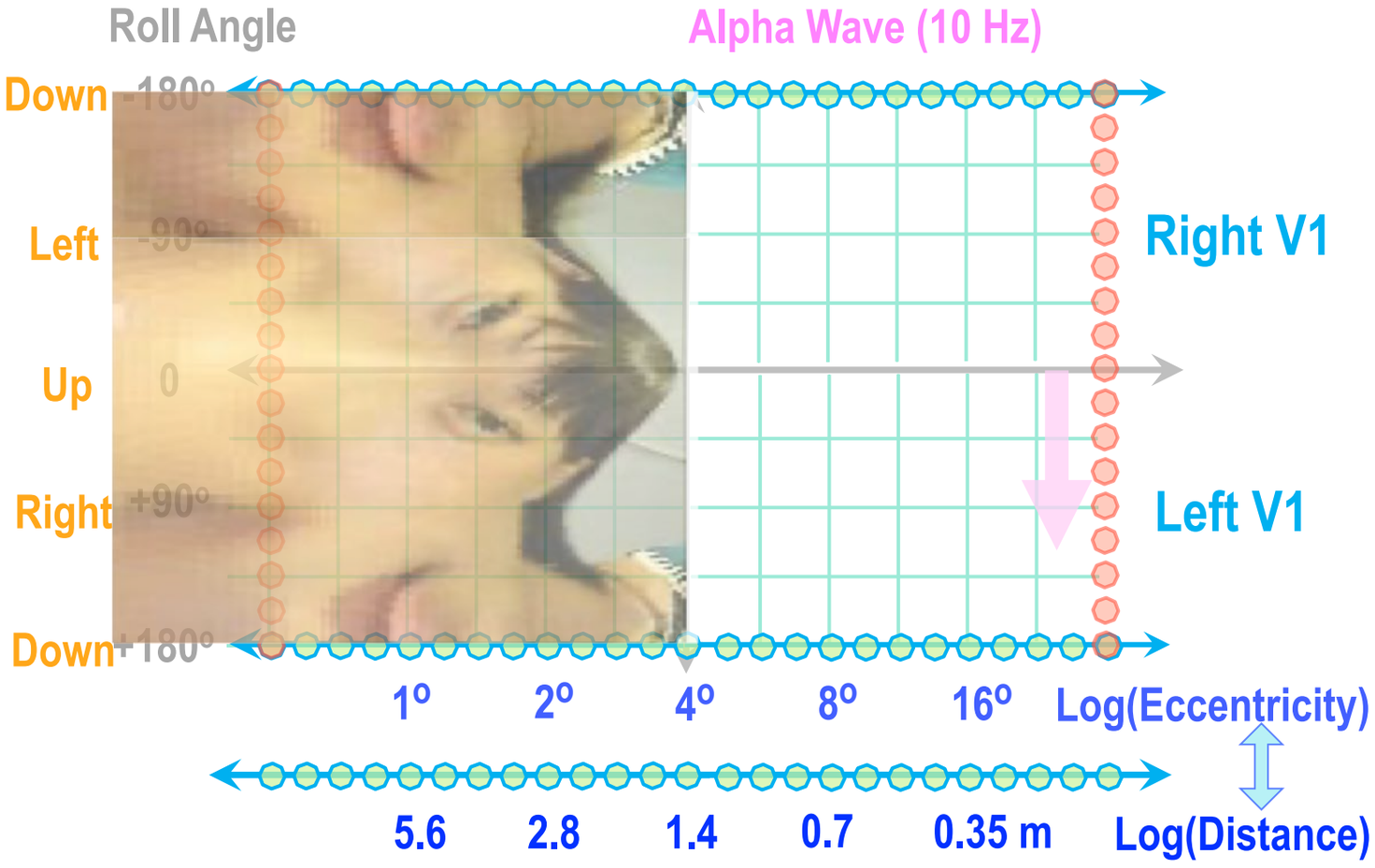
2D Linear

Space Invariant



2D Log-Polar

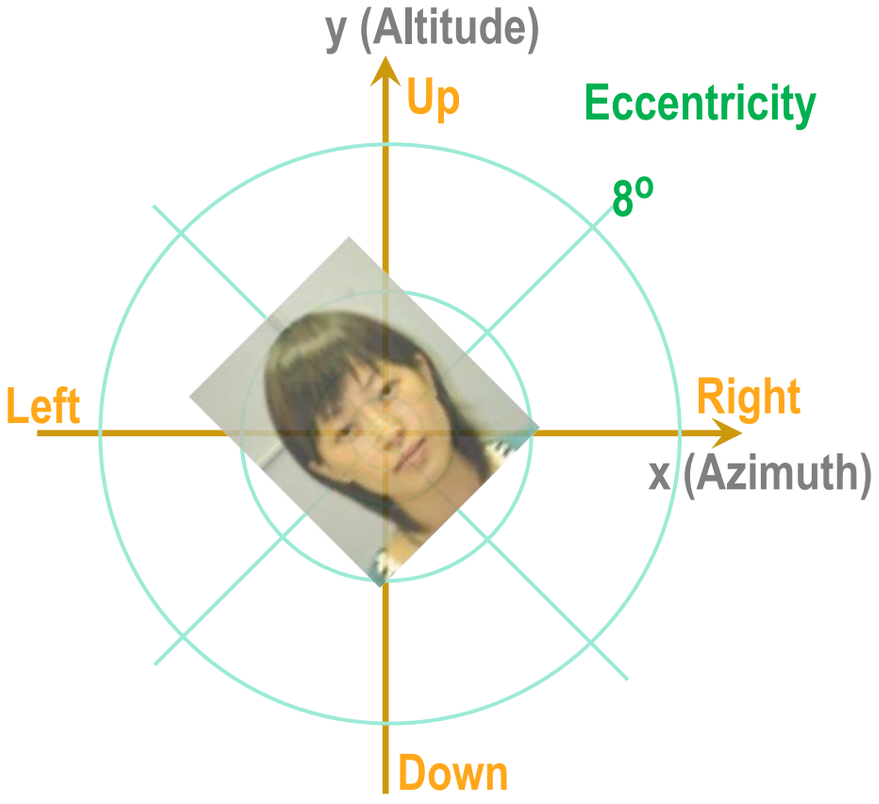
Scale Invariant



3D Log-polar HAL for 3D Scale-invariant Shape

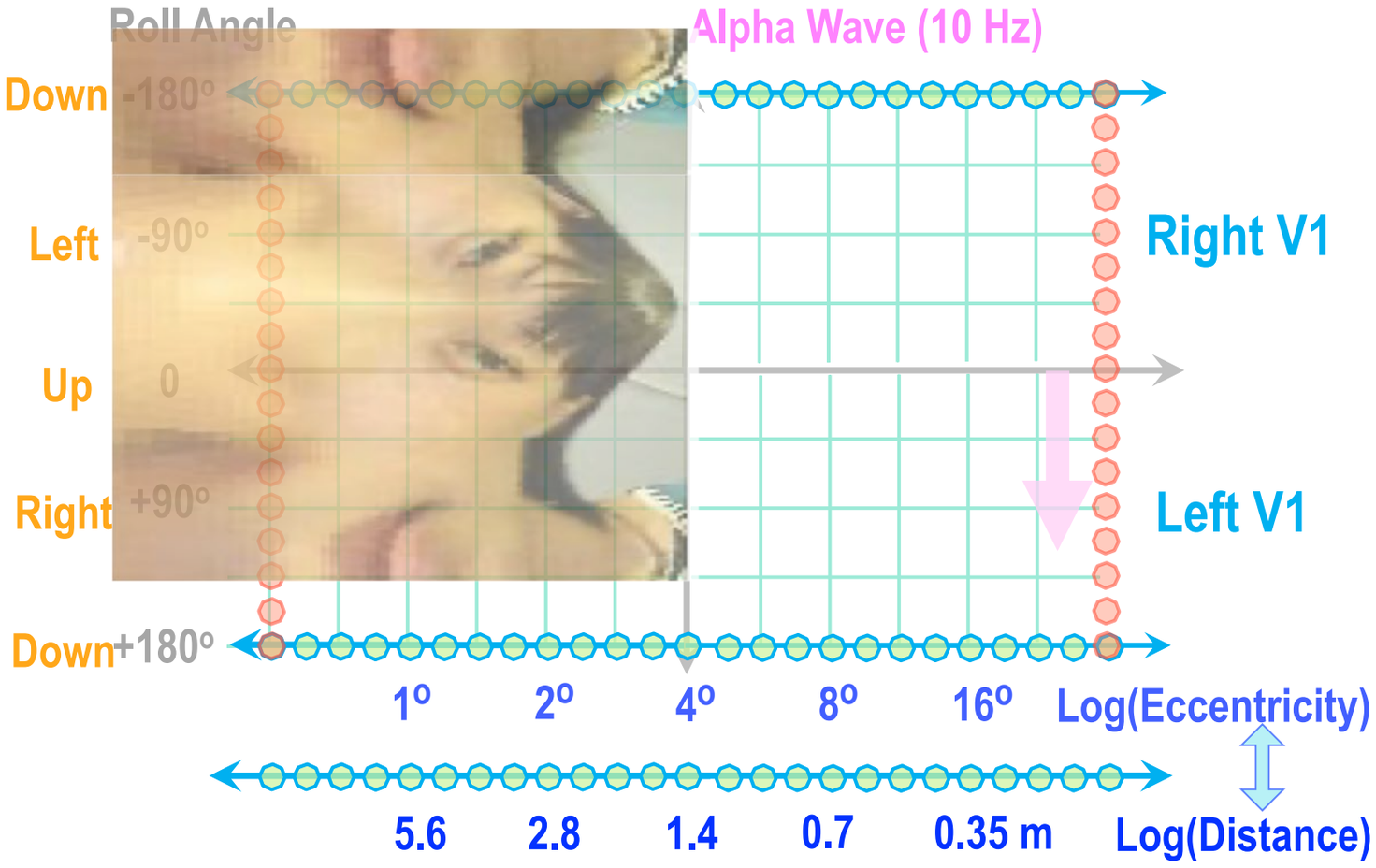
2D Linear

Space Invariant



2D Log-Polar

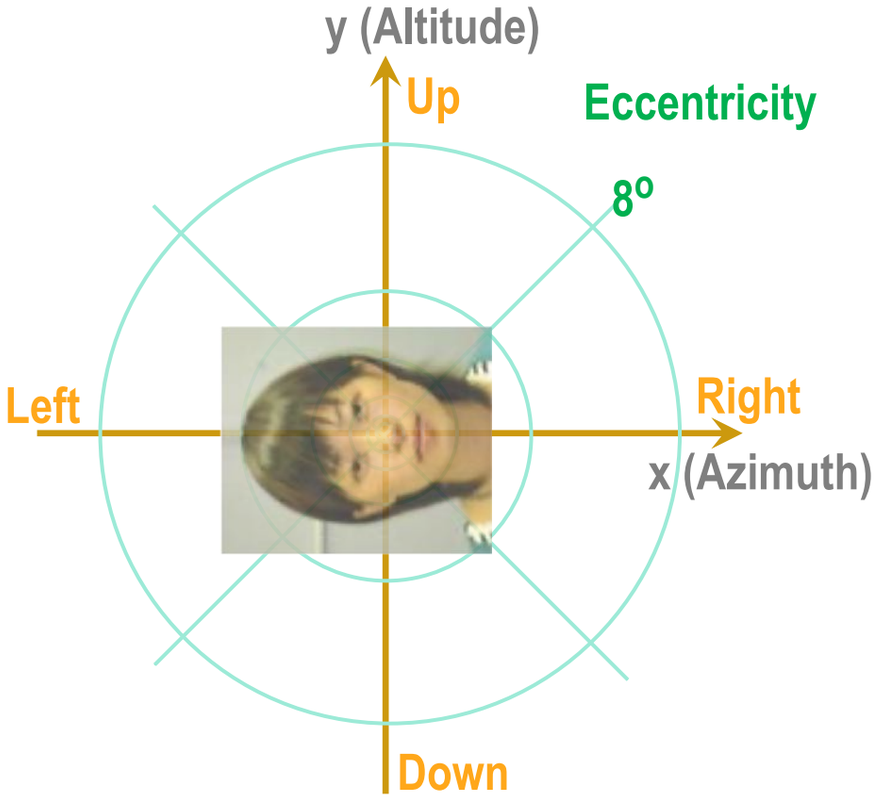
Scale Invariant



3D Log-polar HAL for 3D Scale-invariant Shape

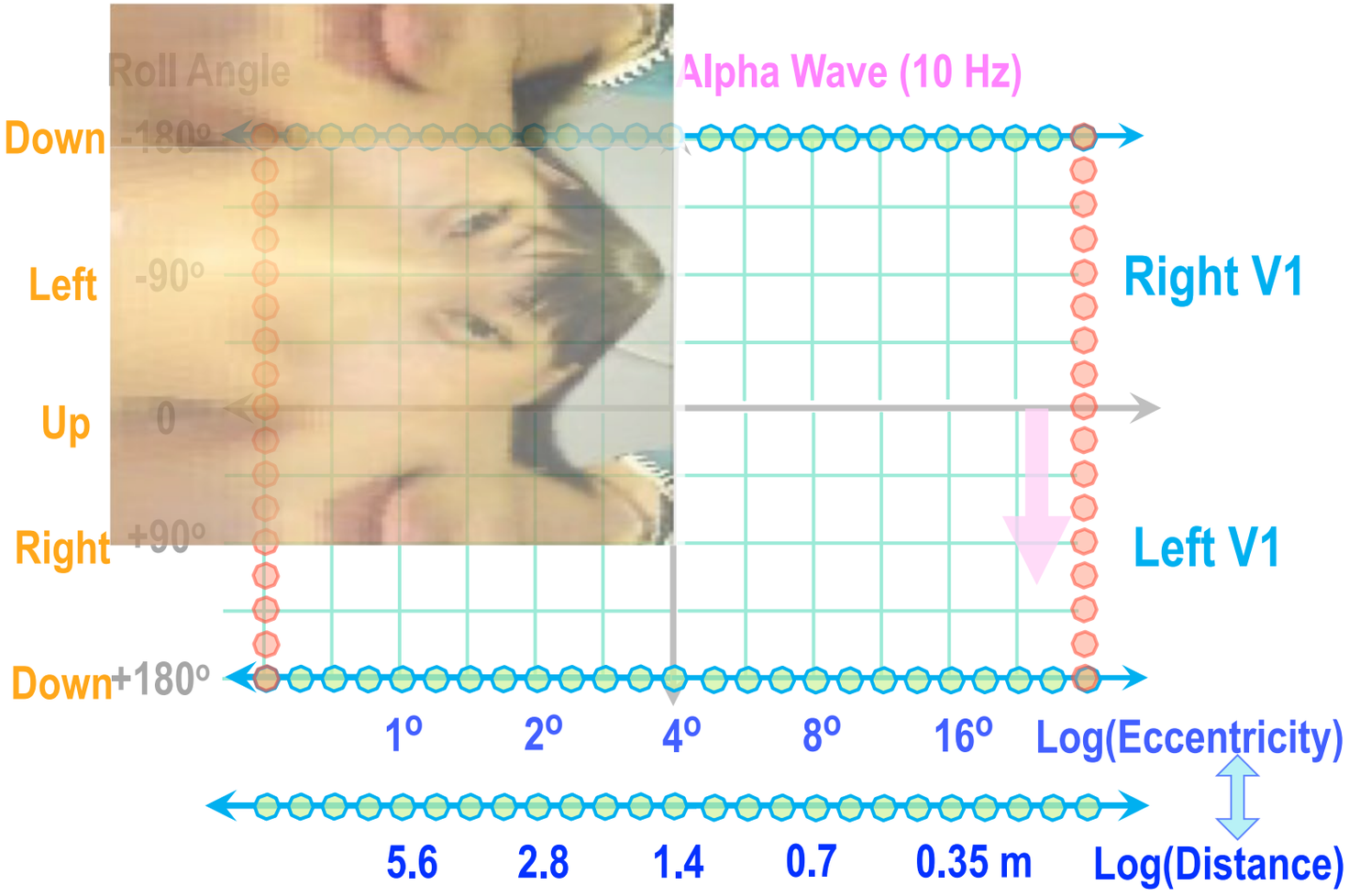
2D Linear

Space Invariant



2D Log-Polar

Scale Invariant



Visual Perception of 3D Space and Shape in Time

Part IV - 3D Shape Recognition by 3D Rotation

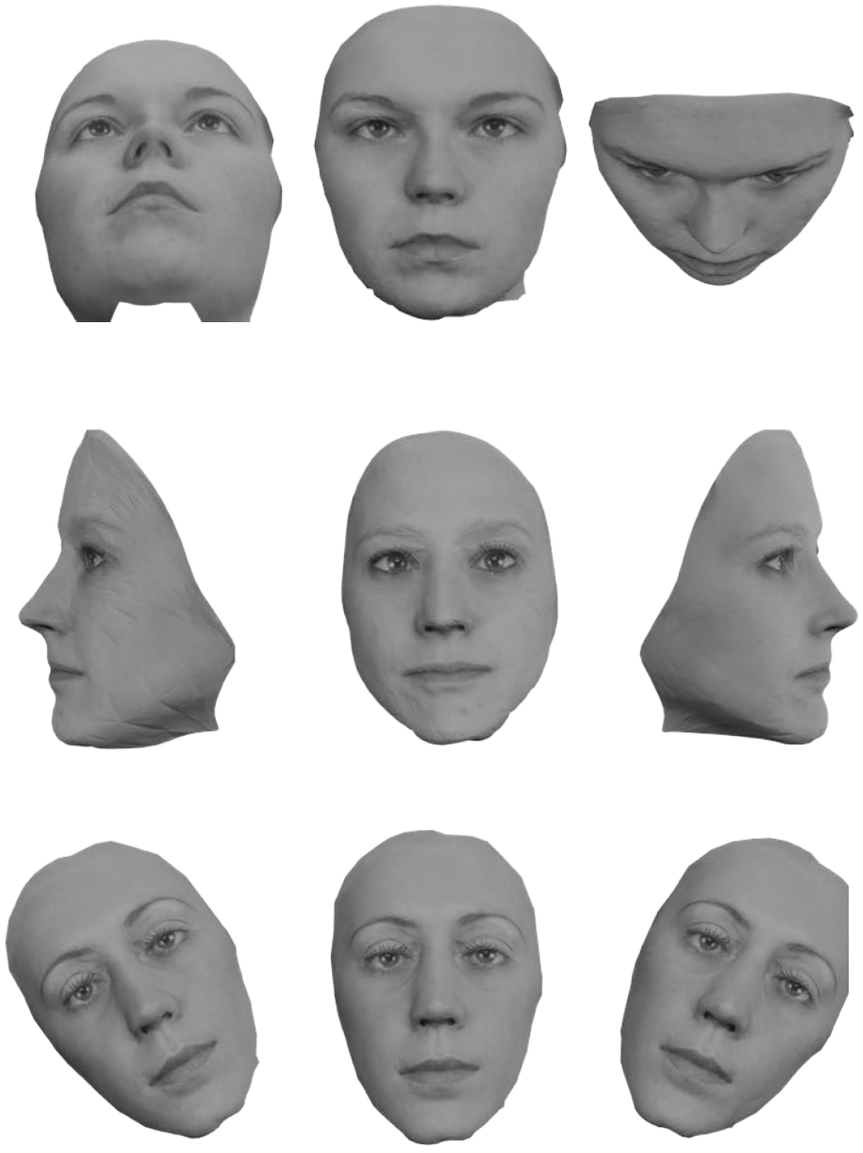
32 EMC members

Caominh Le, Samantha Pedersen, Nathaniel Chen, Jonathan Chan, Brian Ta,
Patrick Wilson, Trevor McCarthy, Emma Barseghyan, Anushka Chauhan, Hind Saif,
Jonathan Tu, Darren Wijaya, Annika Zhang, Erica Li, Camille Marangi, Setayesh Nekarae,
Felicia Wang, Alice Yanovsky, Umaima Afifa, Javier Carmona, Diego Espino,
Leonard Schummer, Phillip Gudijanto, Gurleen Kaur, Andrew Lam, Matthew Mar,
Elizabeth Mills, Alexandra Nevins, Elijah Ortiz, Kyle Wheeler,
Aaron Blaisdell*, and Katsushi Arisaka

University of California, Los Angeles

Face 3D Rotation RT

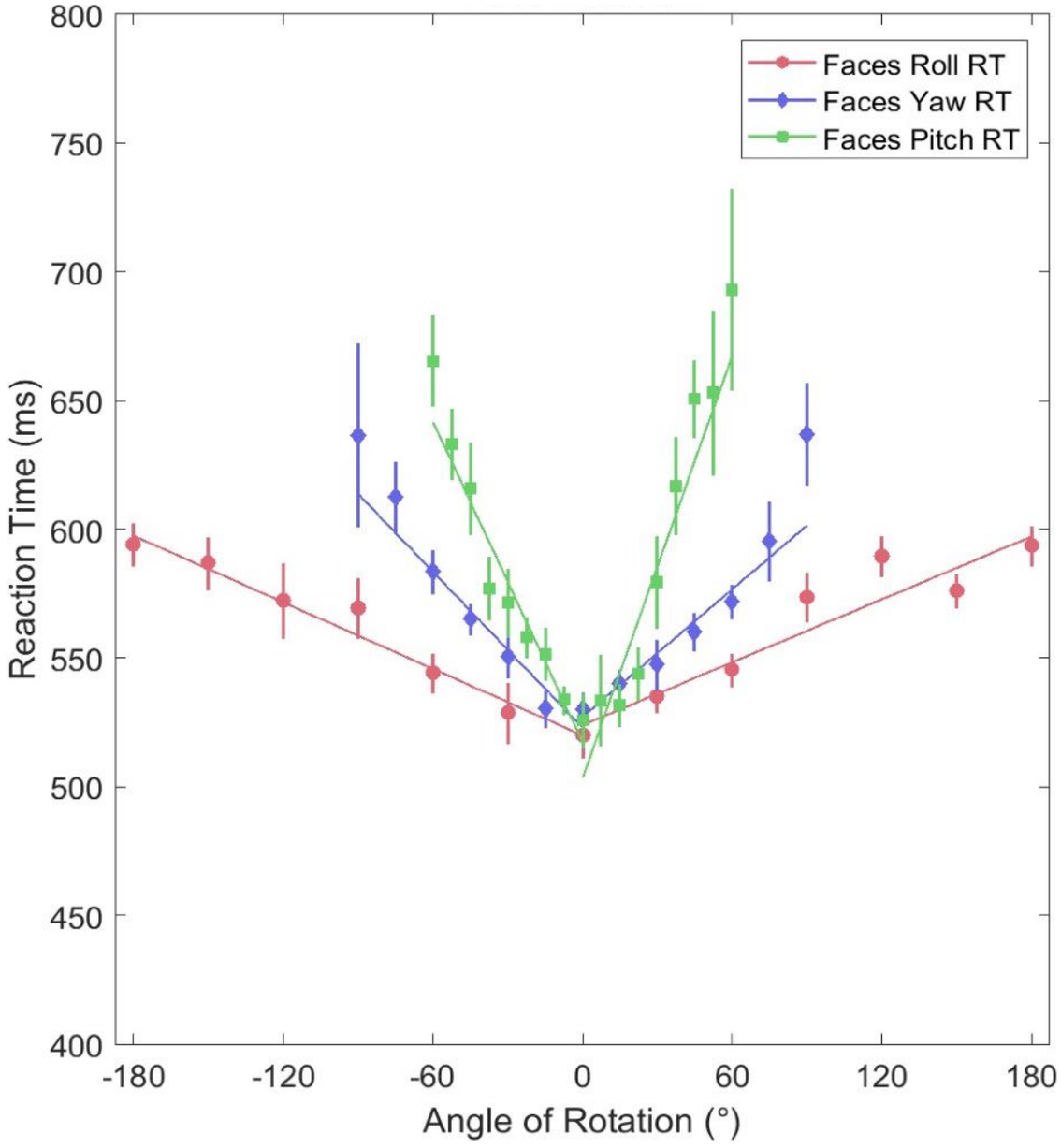
N = 35



Pitch

Yaw

Roll



Four Experimental Papers

Visual Perception of 3D Space and Shapes in Time

- **Part I:** 2D Space Perception by 2D Linear Translation — 52 members
- **Part II:** 3D Space Perception with Holographic Depth — 30 members
- **Part III:** 2D Shape Recognition by Log-scaling — 44 members
- **Part IV:** 3D Shape Recognition by 3D Rotation — 32 members

Total 140 undergrads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UCLA VOLLEYBALL
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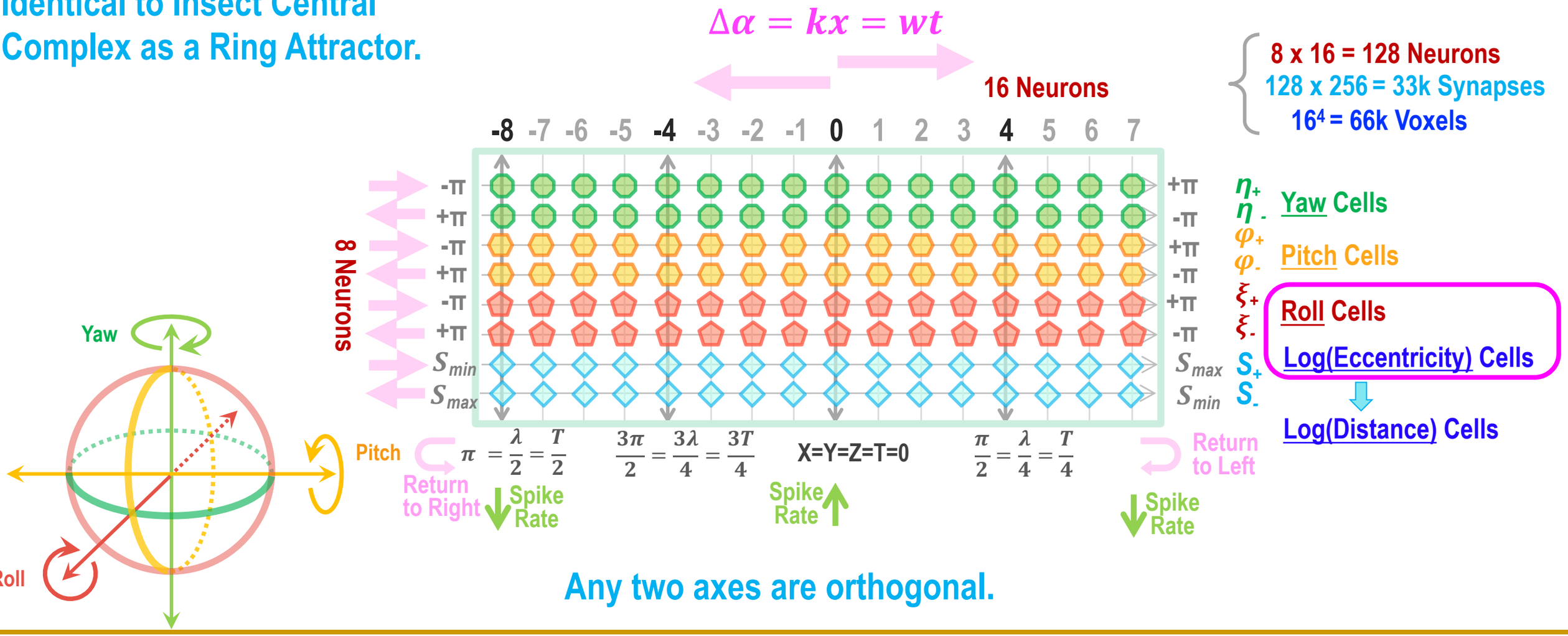
@UCLAMVB
UCLA BASKETBALL

Holographic Ring Attractor Lattice (HAL)

3D Log-polar Vision HAL

Identical to Insect Central Complex as a Ring Attractor.

Three independent Head Direction Cells: (Yaw, Pitch, Roll)



Any two axes are orthogonal.

Holographic Ring Attractor Lattice (HAL)

3D Linear-polar Vision HAL

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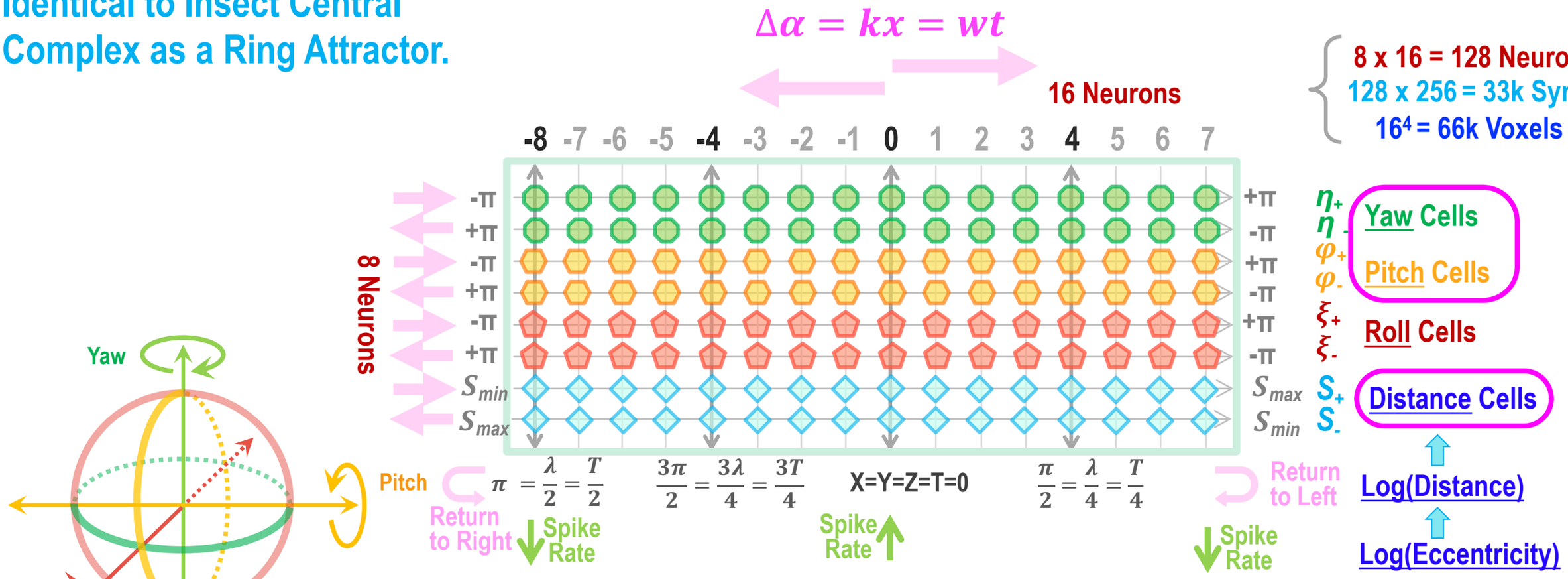
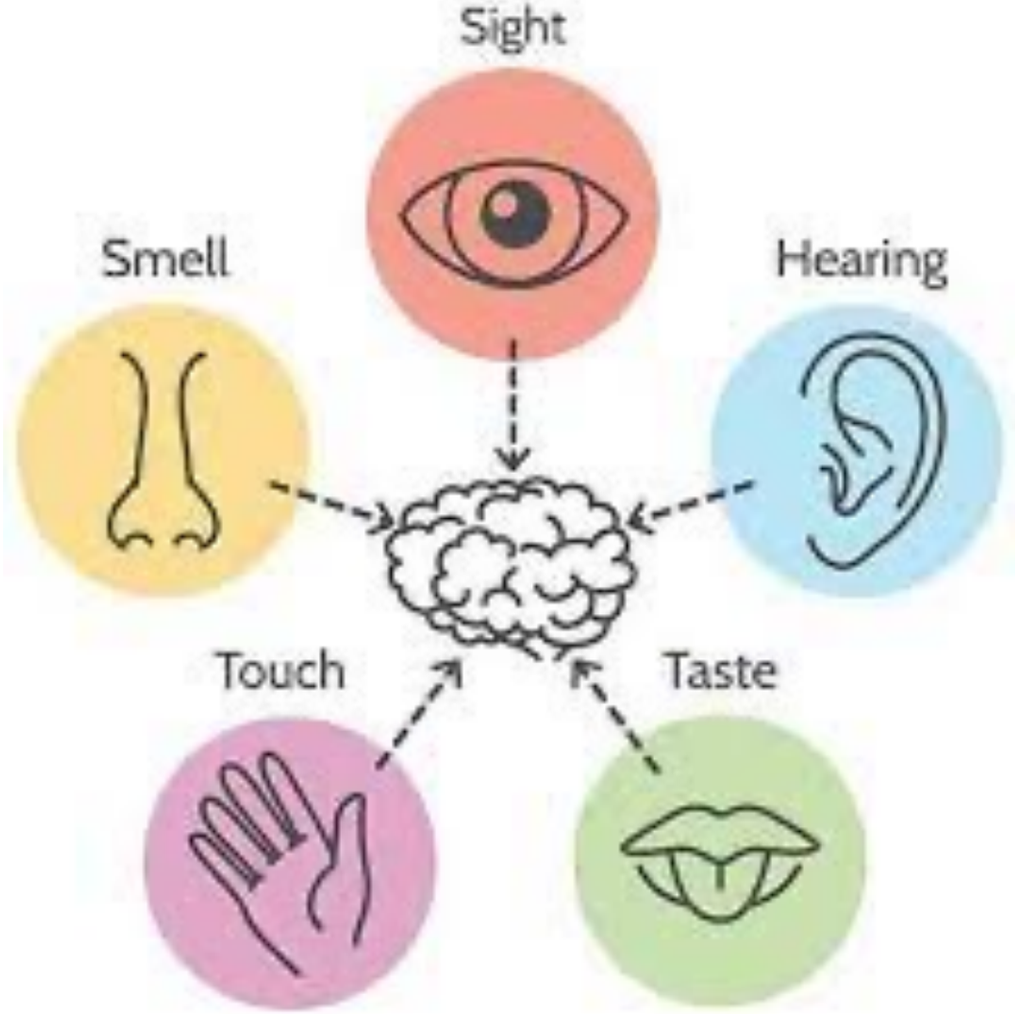
Three independent Head Direction Cells: (Yaw, Pitch, Roll)

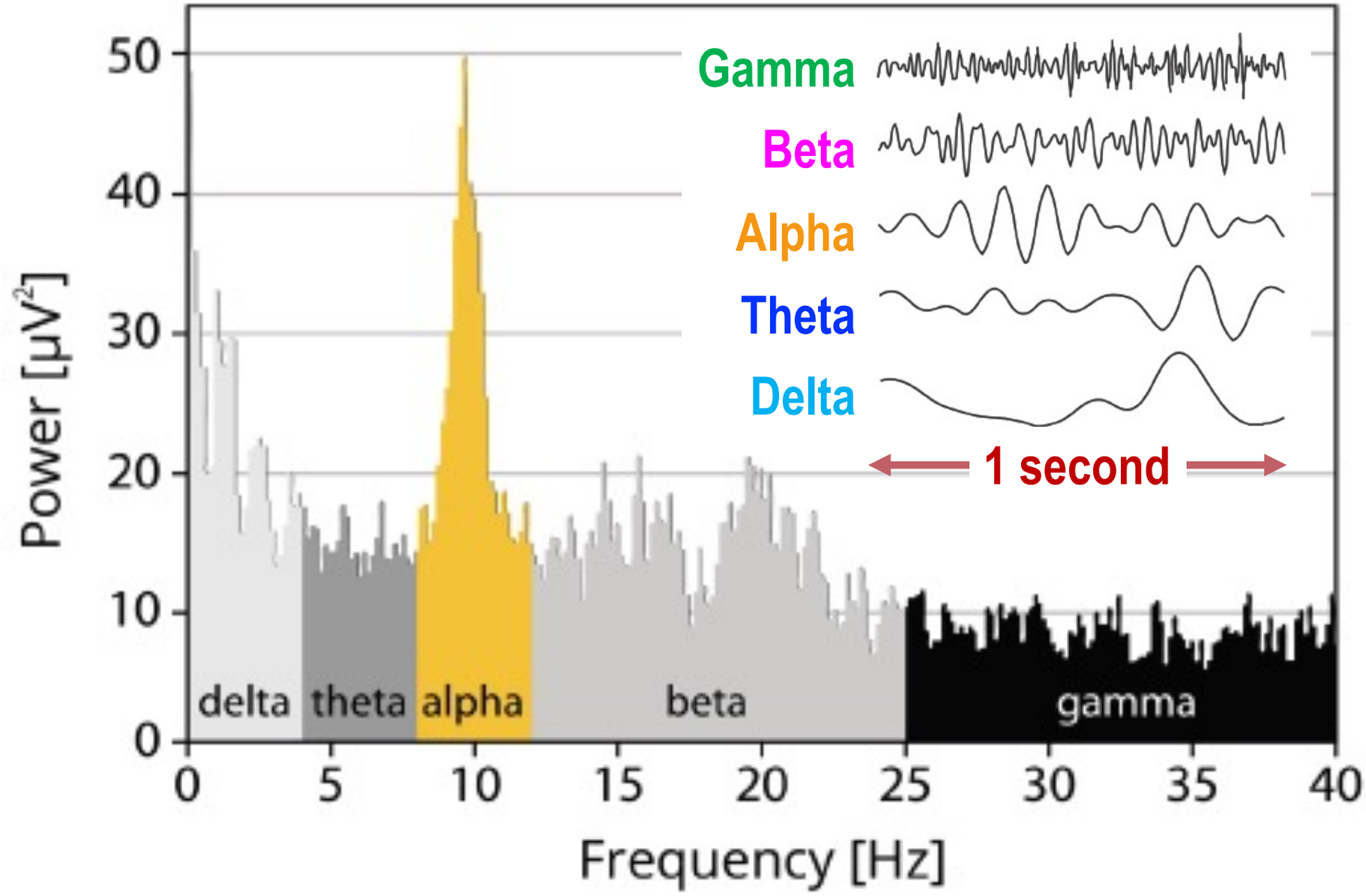


Any two axes are orthogonal.

Grand Unification of Five Senses



Frequency of Human Brainwave



Local Five Senses

3D Direction

3D Vision

4D Location

(Breathing)

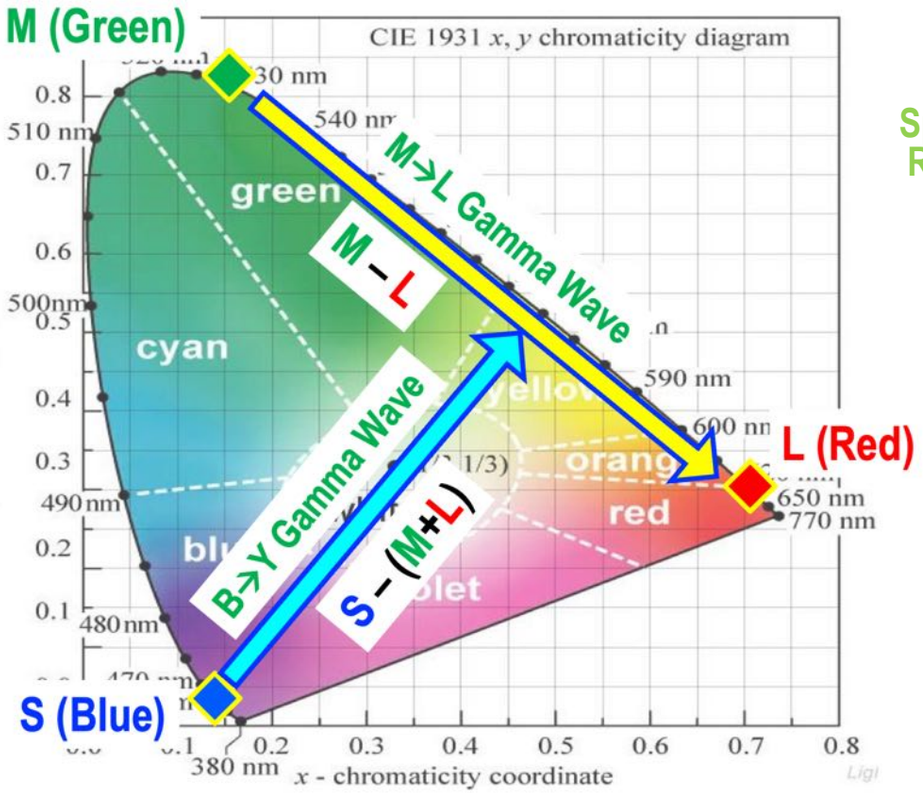
HAL for Color Vision by Gamma Waves

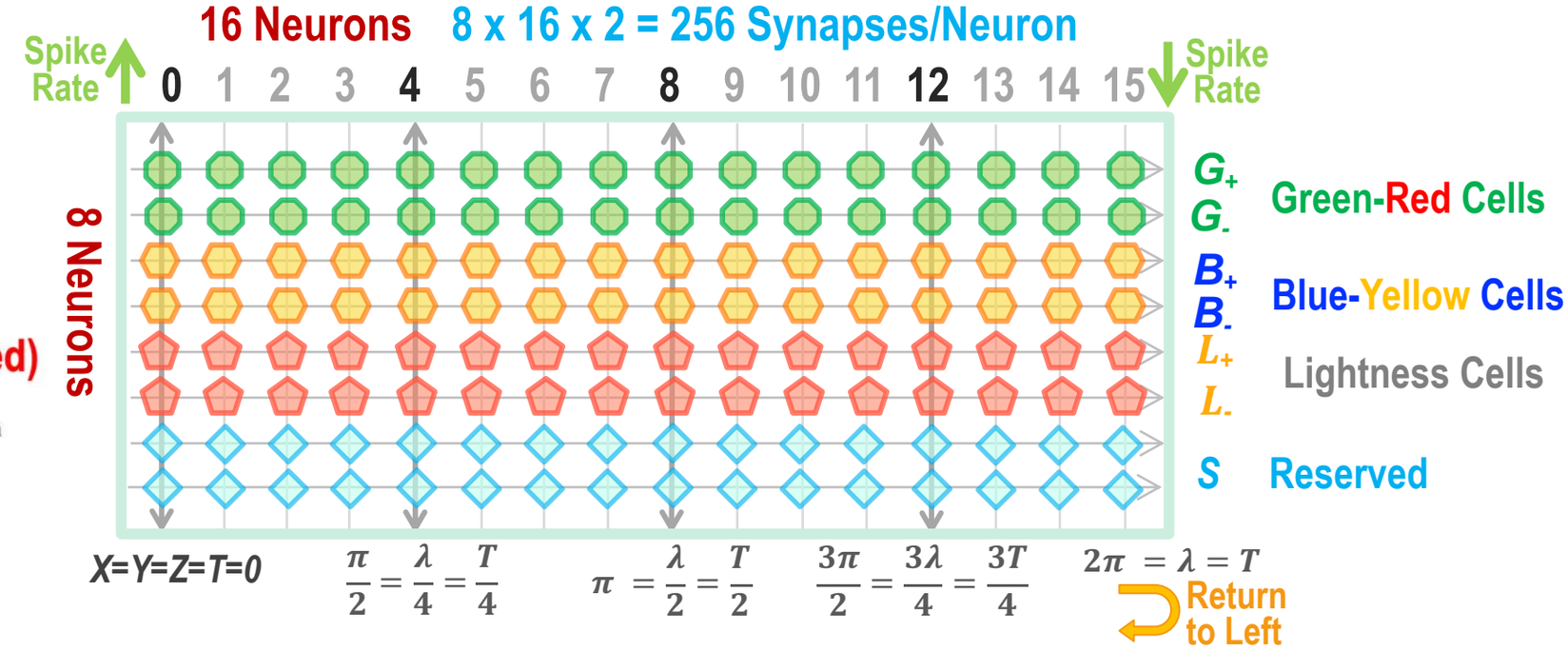
Color HAL

Gamma (50-80 Hz)

$$\Delta\Upsilon = kx$$
$$= wt$$

8 x 16 = 128 Neurons
128^2= 16k Synapses
16^4 = 66k voxels

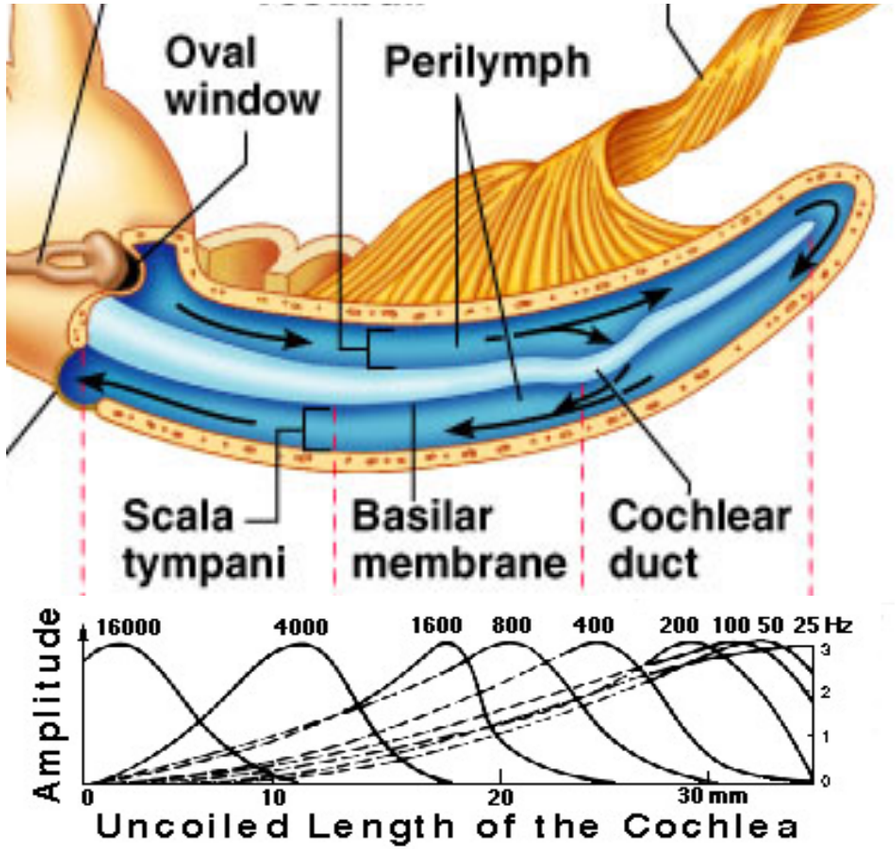




HAL for Simple Sound by Gamma wave

Sound HAL

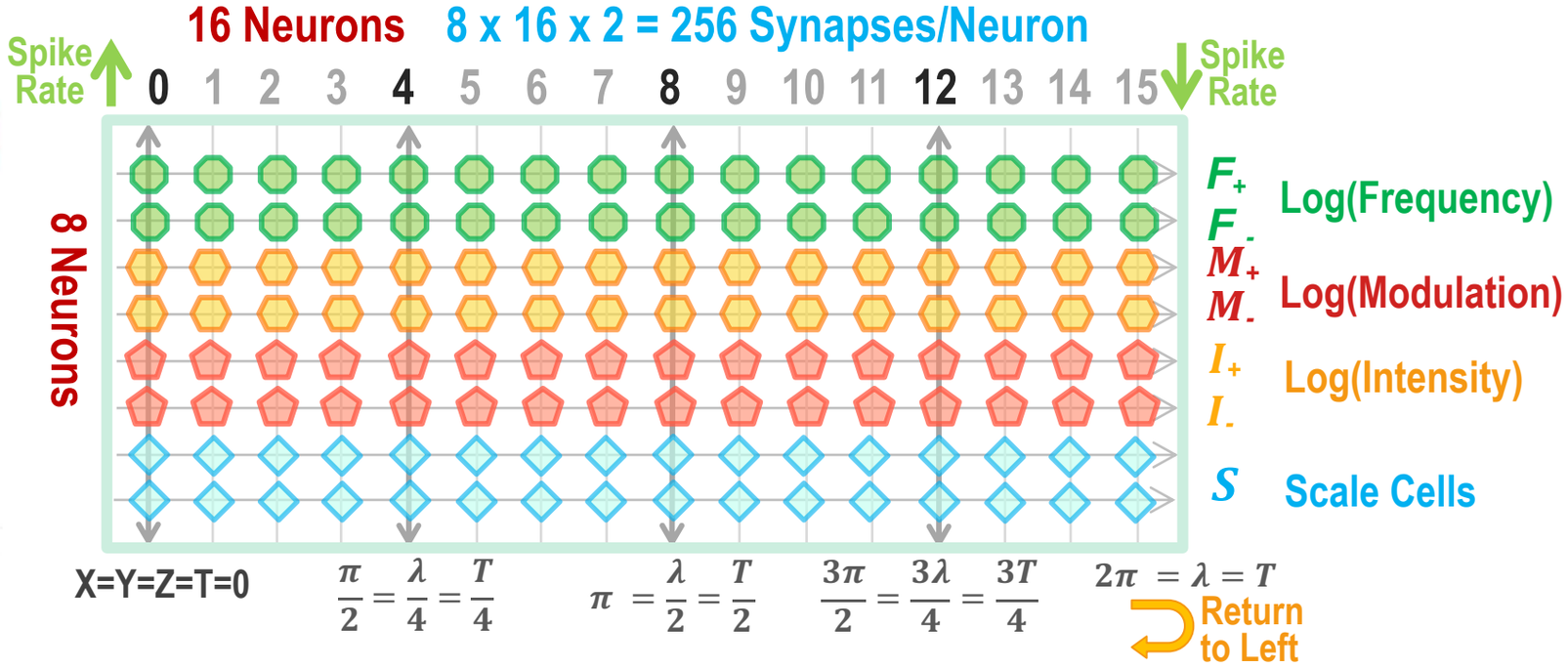
3D Sound Space



Gamma (70-150 Hz)

$$\Delta\Upsilon = kx = wt$$

Log(Frequency, Modulation)

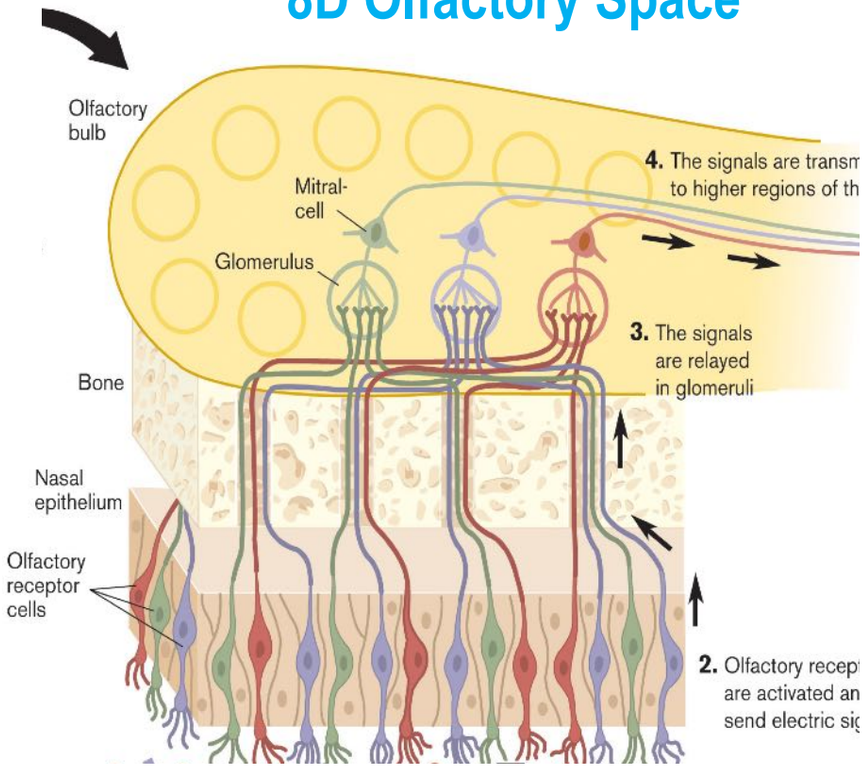


7D Smell HAL for by Beta/Gamma wave

Smell HAL

Gamma (40-60 Hz)

8D Olfactory Space



$\Delta\beta = wt$

$\Delta\Upsilon = wt$

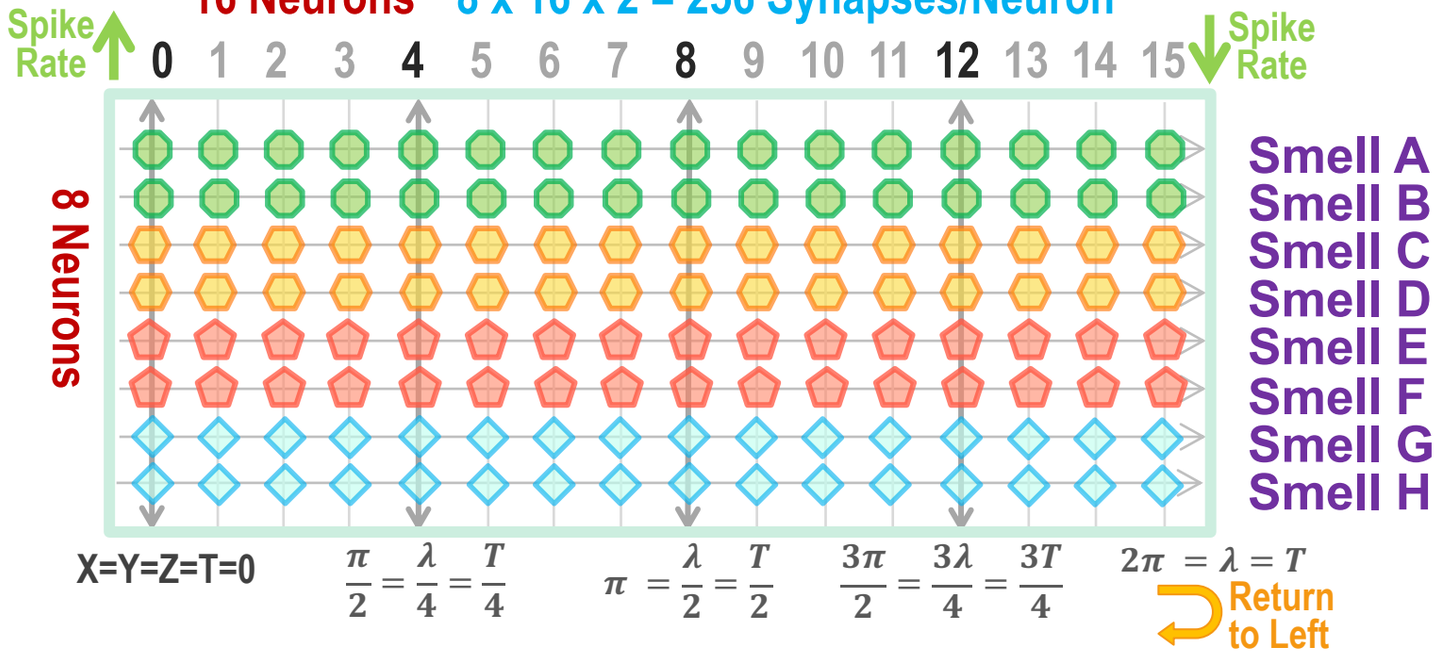
Log(Smell)

Beta (15-20 Hz)

Gamma (40-60 Hz)

16 Neurons

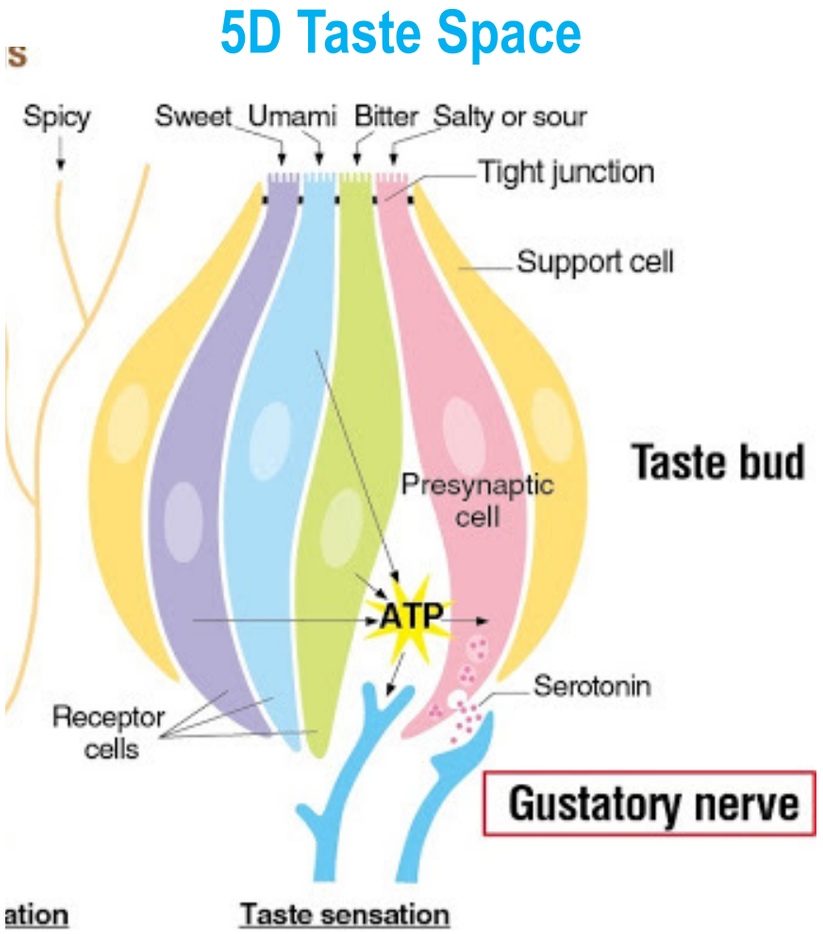
8 x 16 x 2 = 256 Synapses/Neuron



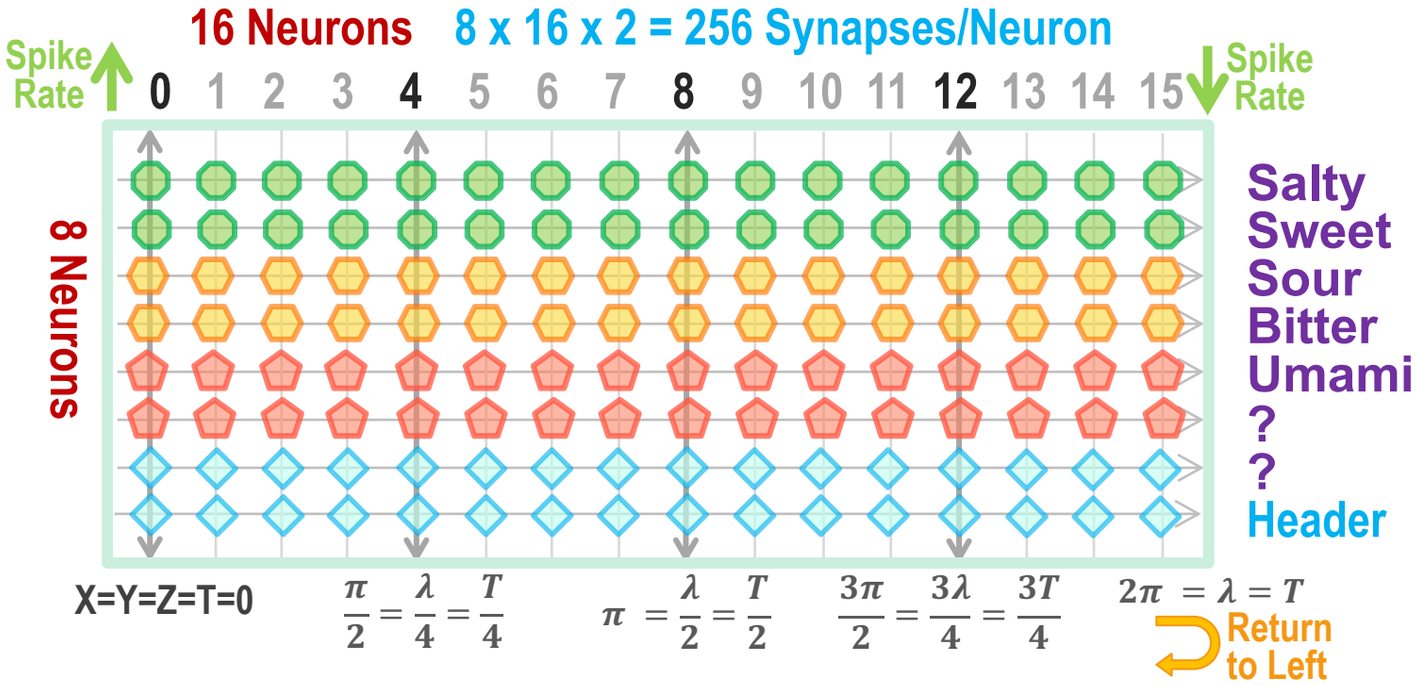
5D Taste HAL for by Delta wave

Taste HAL

Gamma (40-60 Hz)



$\Delta\delta = wt$ → Log(Taste) Delta (2-4 Hz)

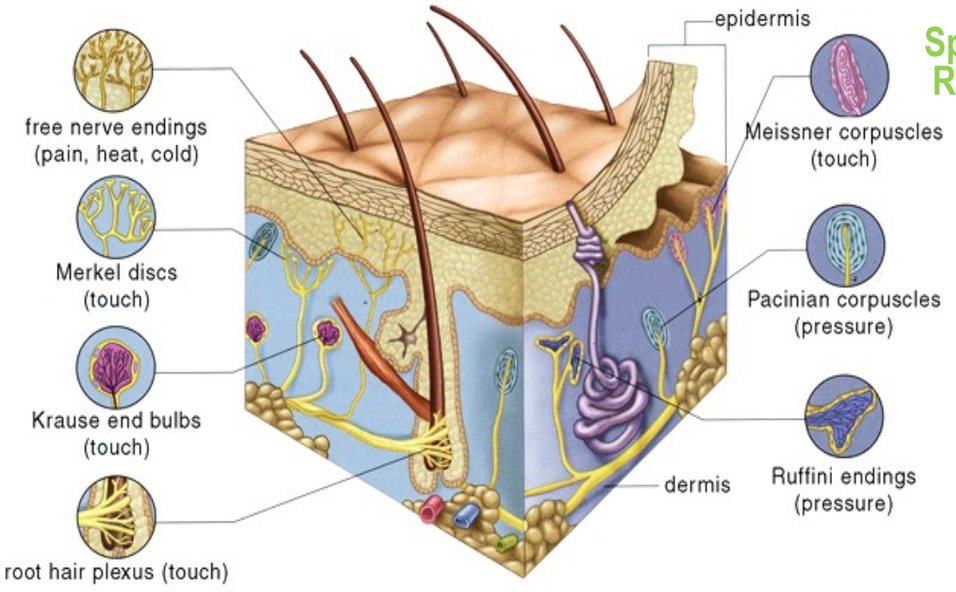


7D Tactile HAL for by Gamma wave

Tactile HAL

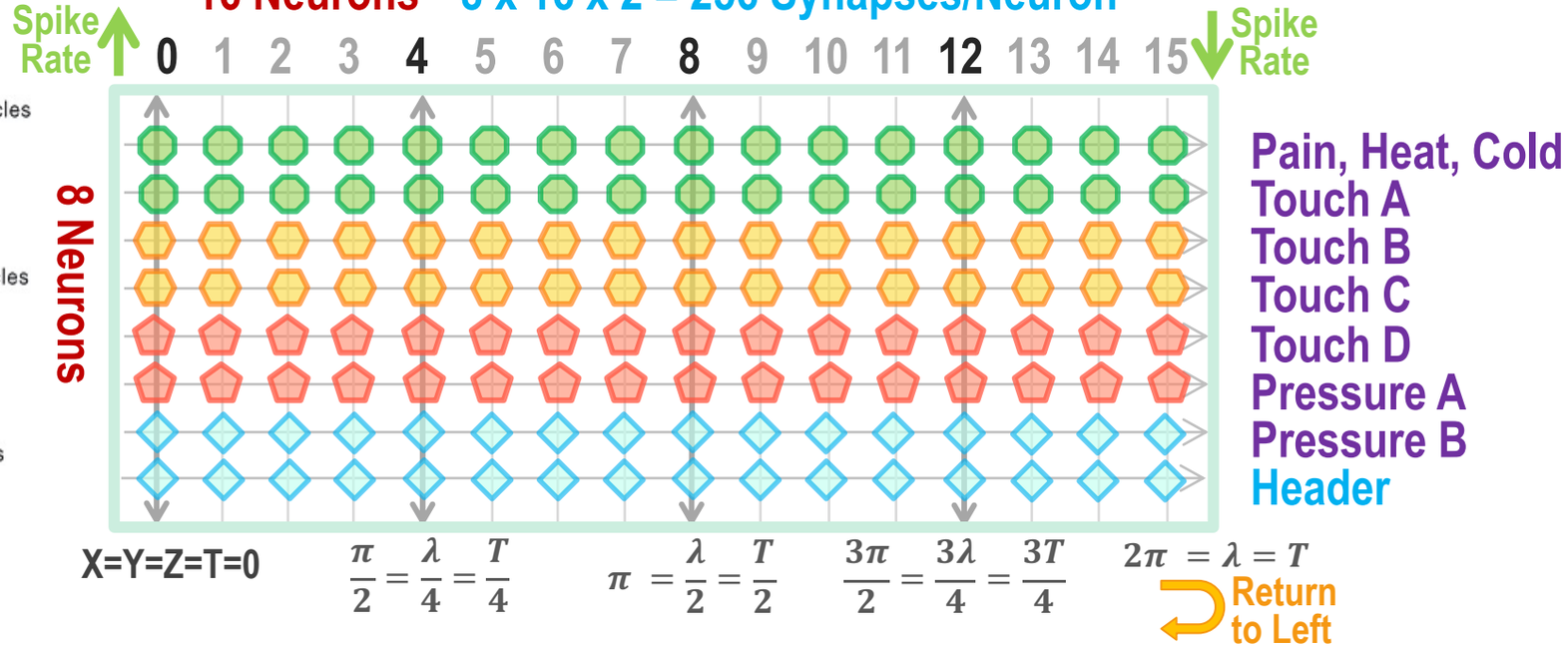
Gamma (40-60 Hz)

7D Texture Space

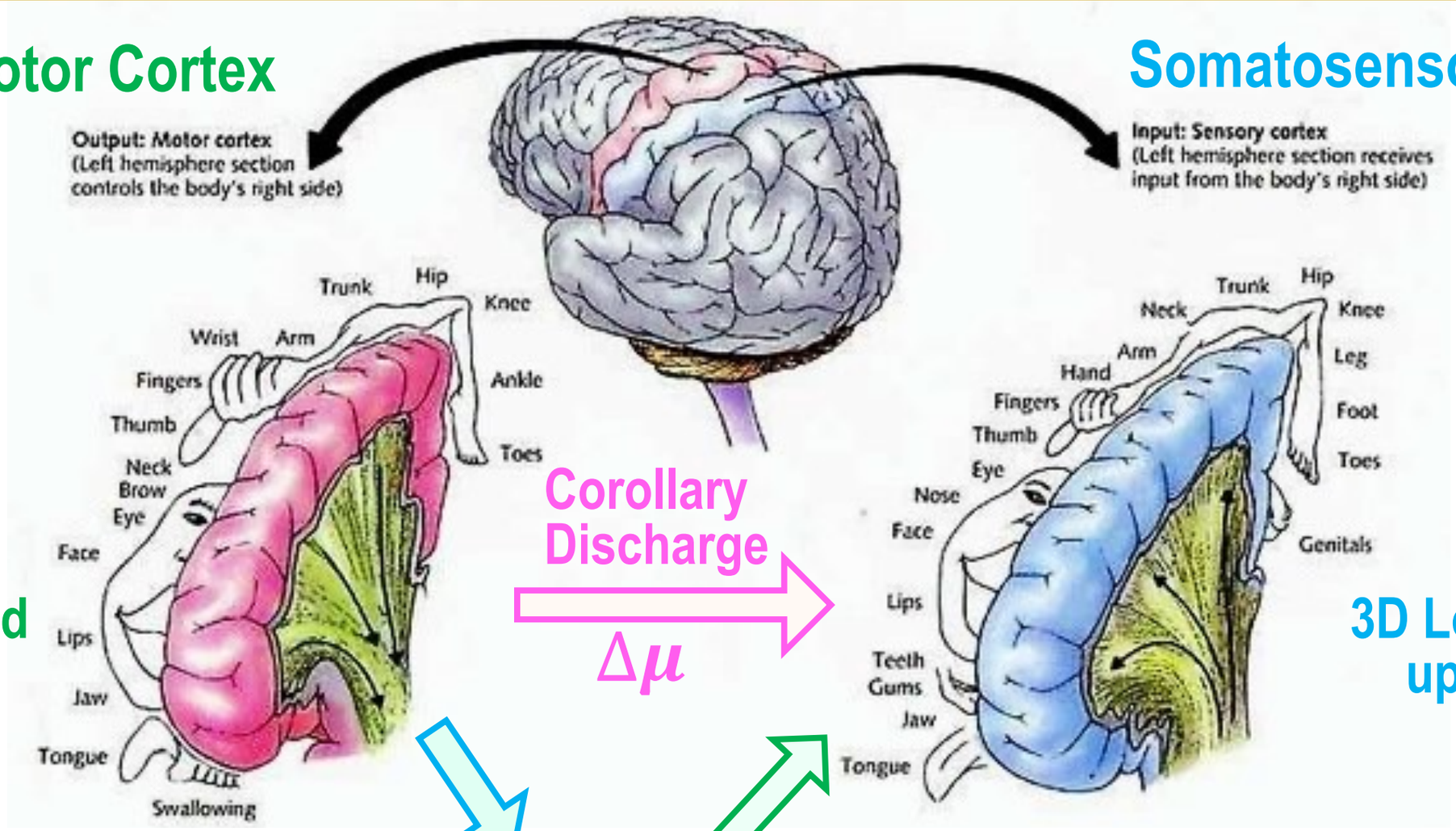


$\Delta\Upsilon = wt$ → Log(Tactile)

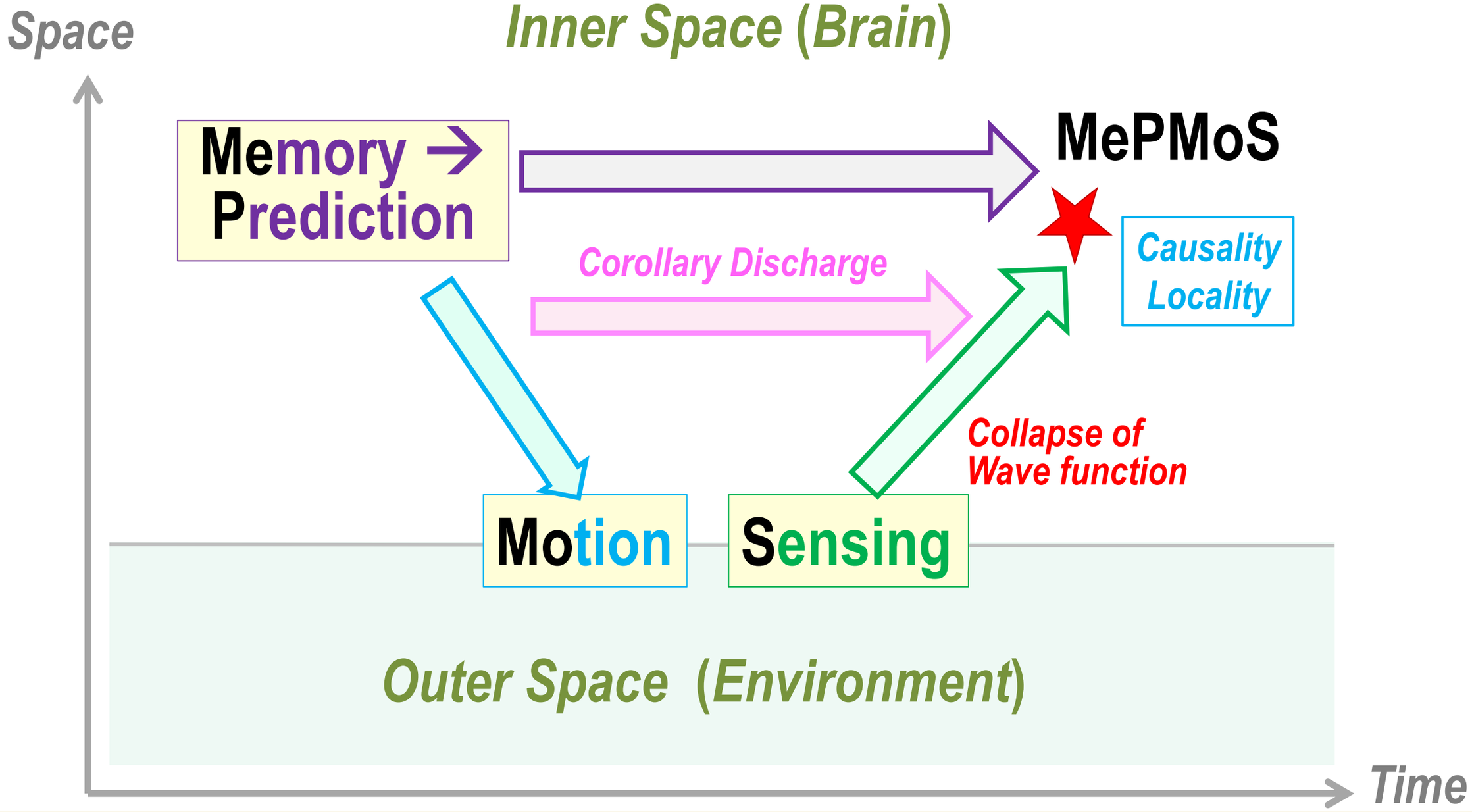
16 Neurons 8 x 16 x 2 = 256 Synapses/Neuron



Somatosensory Cortex



New Space-Time Diagram of Sensorimotor Integration



Triple Coincidence of a Clap

3D Location of a Clap

All three locations must agree one another.

⇩

Perception of the 3D space by Vision, Hearing, and Touch.

3D Vision HAL

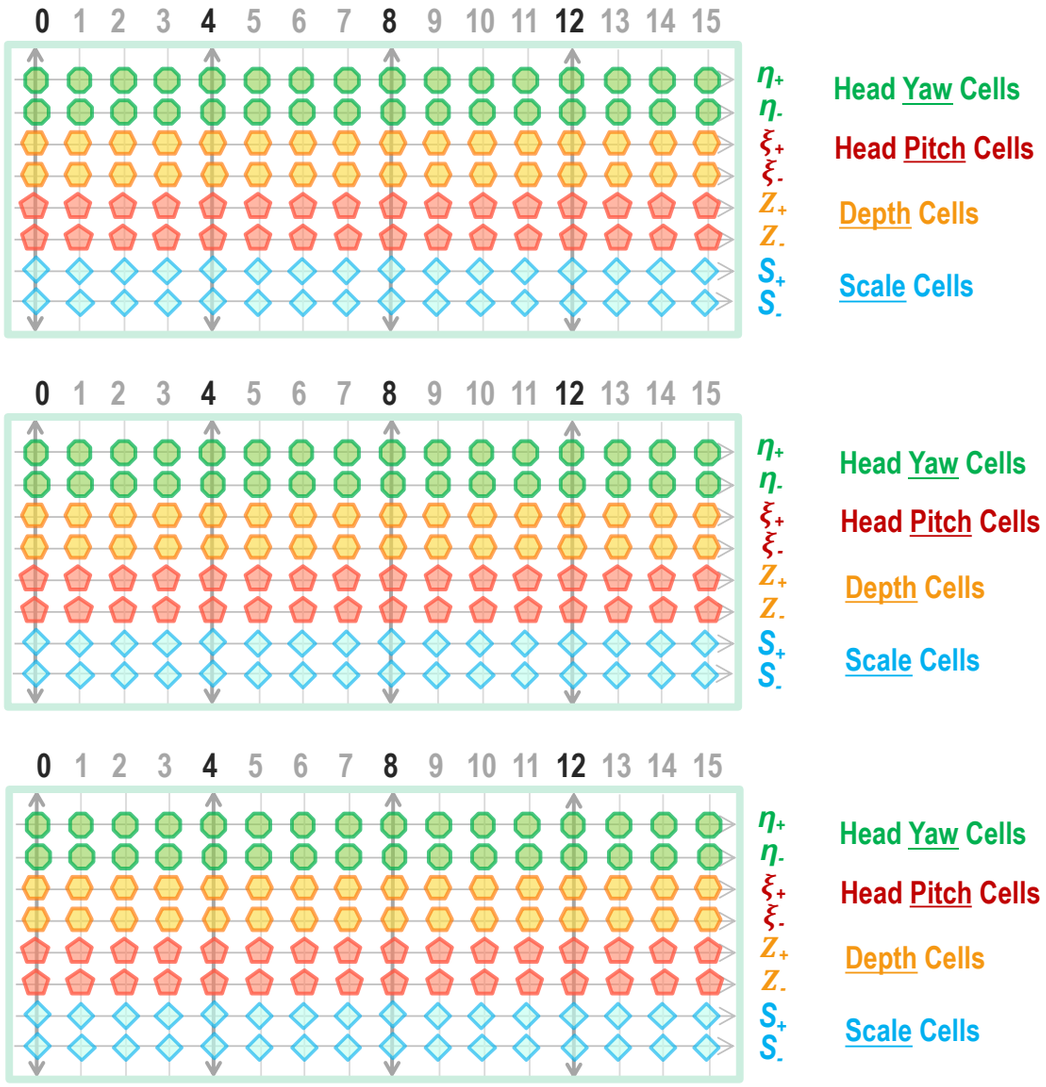
Alpha (8-12 Hz)

3D Sound HAL

Alpha (7-13 Hz)

3D Tactile HAL

Mu (8-13 Hz)



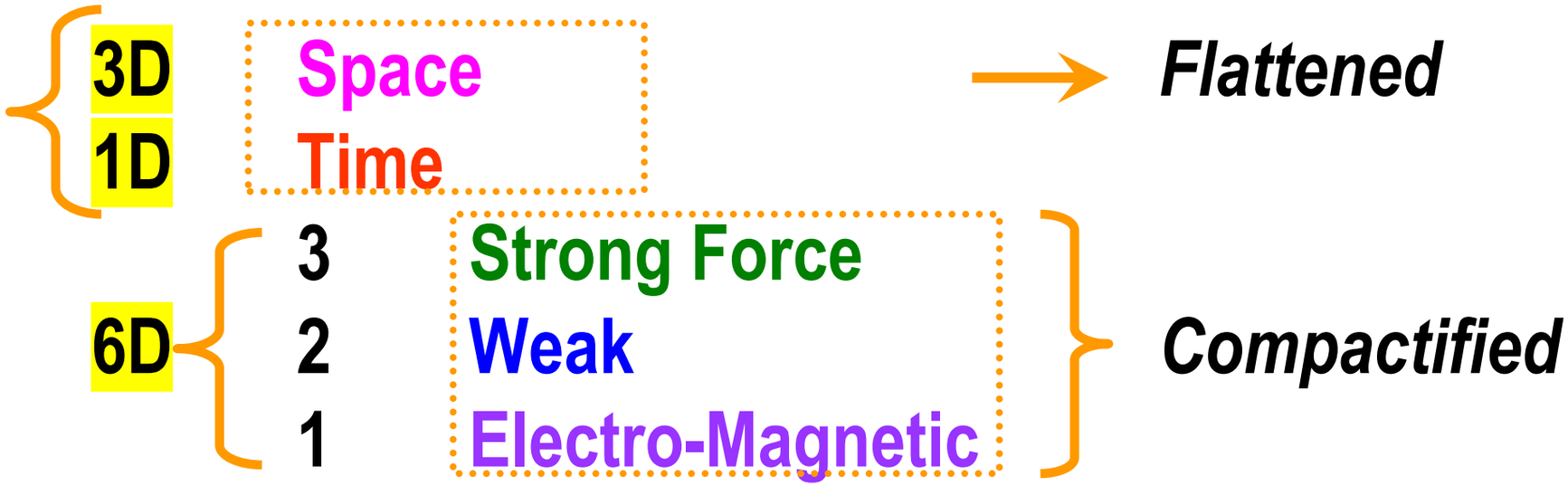
Grand Unified Theory of Mind and Brain

- **Inner Universe (= Brain) is evolving to the extra dimensional space.**
  - **3D Body-centric Space**
    - 3D Vision — Alpha (10 Hz)
    - 3D Sound localization — Alpha (10 Hz)
    - 3D Touch localization — Mu (10 Hz)
  - **4D Allocentric Space-time**
    - 4D Cartesian — Space Invariant — Theta (5 Hz)
    - 3D Polar — Path Integration — Beta (20 Hz)
  - **5D Landmarks with Semantic Information (= Five Senses)**
    - Vision — Local Shape, 3D Color (HSL) — Gamma (40 – 80 Hz)
    - Sound — Frequency, Modulation — Gamma (70 – 150 Hz)
    - Touch — Pain, Touch, Pressure… — Gamma (30 – 90 Hz)
    - Smell — Smell A, B, C, D… — Gamma (60 Hz)
    - Teste — Salty, Sweet, Sour, Bitter, Umami — Delta (3 Hz), Gamma (~50 Hz)

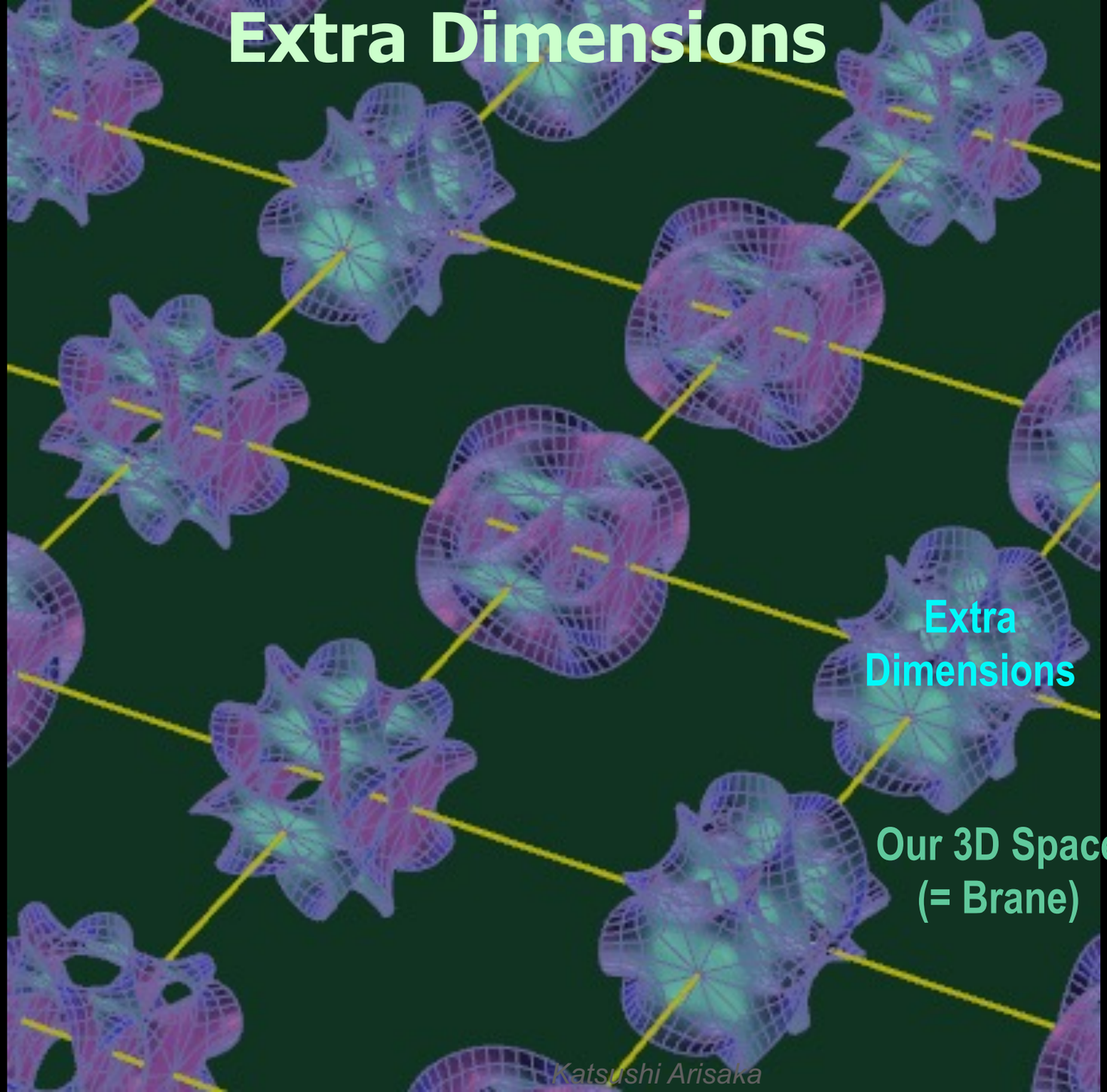
The Beginning of the Universe

- Everything was the same ↔ Perfect symmetry.
  - All the particles are the same as photons.
  - All four forces are the same.

- The Universe was 10 dimension.

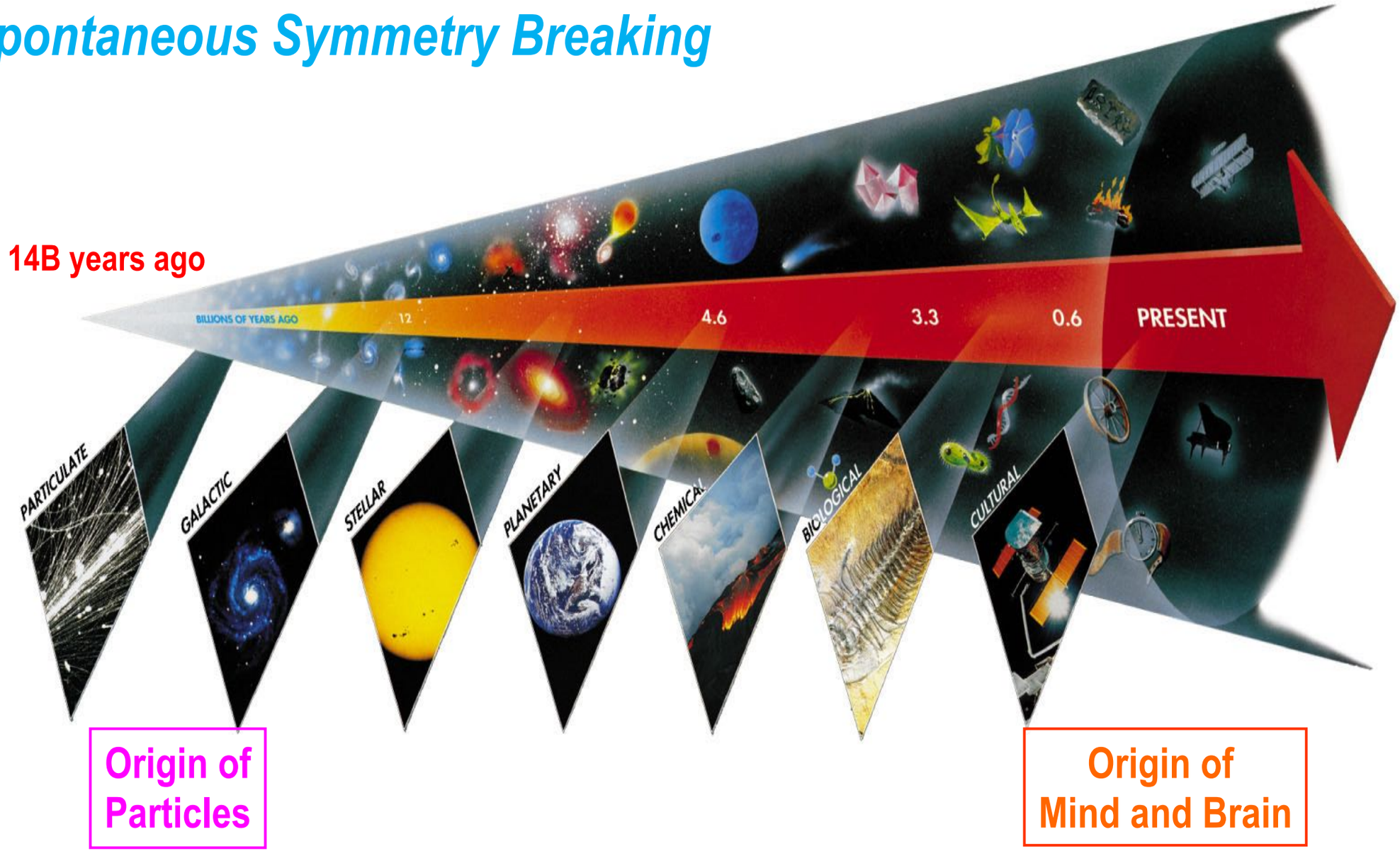


Extra Dimensions



Seven steps of cosmic evolution

Spontaneous Symmetry Breaking



https://www.elegantmind.org/

Elegant Mind Club at UCLA

Search

Home

New Results

Winter 2022

Fall 2021

Senior Sm2021

Fiat Lux W2022

Fiat Lux F2021

Recent Activities

Contact us

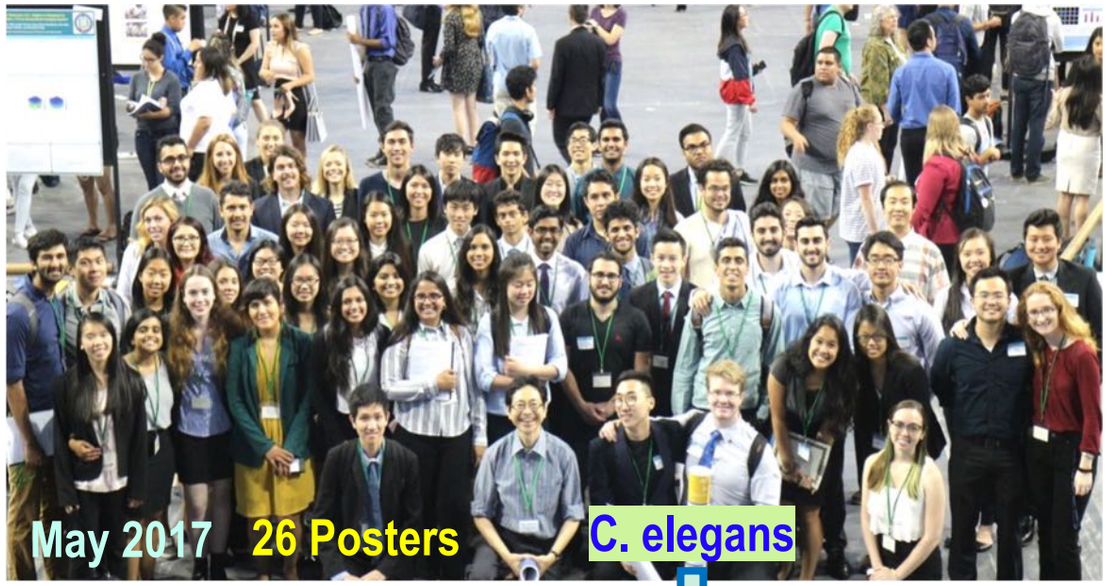
Visual Perception of 3D Space and Shapes in Time

- **Part I:** 2D Space Perception by 2D Linear Translation (PDF)
- **Part II:** 3D Space Perception with Holographic Depth (PDF, bioRxiv)
- **Part III:** 2D Shape Recognition by Log-scaling (PDF)
- **Part IV:** 3D Shape Recognition by 3D Rotation (PDF)

Grand Unified Theory of Mind and Brain

- **Part I:** Space-Time approaches to Dynamic Connectomes of C. elegans and Human Brains by MePMoS (PDF)
- **Part II:** Neural Holographic Tomography (NHT) and Holographic Ring Attractor Lattice (HAL) (PDF)
- **Part III:** Holographic Visual Perception of 3D Space and Shape (PDF)

Elegant Mind Club (2013 – Now) ~500 undergrads



Division	Major	Fall 2020	Fall 2021	Winter 2022	
		Remote	In-person	Senior	New
Life Sciences		**56**	**61**	**44**	**83**
	Neuroscience	16	11	9	24
	Biology	11	18	10	15
	Psychobiology	2	11	1	16
	Psychology	10	2	9	3
	Molecular, Cell, and Developmental Biology (MCDB)	7	7	6	6
	Microbiology, Immunology, and Molecular Genetics (MIMG)	4	5	3	7
	Physiological Science	2	4	2	6
	Cognitive Science	2	2	2	3
	Computational and Systems Biology	2	1	2	3
Physical Sciences		**22**	**26**	**19**	**23**
	Physics	11	12	8	8
	Biochemistry	4	7	6	8
	Biophysics	1	3	2	3
	Astrophysics	4	2	1	2
	Chemistry	0	1	1	2
	Mathematics	1	0	0	0
	Applied Math	1	1	1	0
Engineering		**27**	**11**	**6**	**11**
	Mechanical Engineering	9	4	2	4
	Electical and Computer Engineering	2	4	3	6
	Chemical Engineering	4	0	0	0
	Computer Science	5	1	0	1
	Aerospace Engineering	2	1	1	0
	Bioengineering	4	1	0	0
	Civil Engineering	1	0	0	0
Social Sciences		**4**	**1**	**3**	**5**
	Anthropology	3	0	1	0
	Sociology	0	1	1	0
	History	1	0	0	1
	Gender Studies	0	0	0	1
	Human Biology and Society	0	0	1	3
Total		**109**	**99**	**72**	**122**
				194	