Aspects of Attention in Practice – a view from the brain

Sacramento Insight Meditation

March 7, 2024

Rick Maddock

“Everyone knows what attention is.
It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought.”

William James, *The Principles of Psychology* (1890).

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“No one knows what attention is…”
There is a ”tendency to reify attention,” … but “multiple processes underlie what is typically labeled as ‘attention’.”

Hommel et al., (2019).

“Everyone knows what attention is.
It is the taking possession by the mind, **in clear and vivid form**, of one out of what seem several simultaneously possible objects or trains of thought.”

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Attention is the selective focusing on information to guide mentation or action.

(a working definition for our discussion)

Overt attention – external action to selectively focus on information

"Aiming" our sense organ to increase its sensitivity.

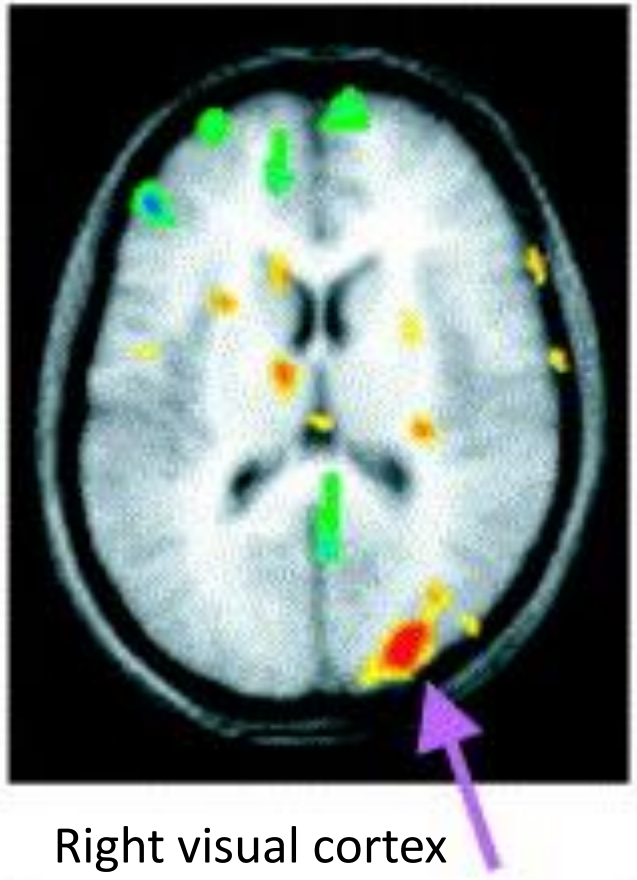
Others can see how we are directing our attention.

Covert attention – internal action to selectively focus attention

Here is a “no look” pass in basketball. The “aiming” happens **only in our mind**.

Changes in brain blood flow while looking straight ahead

Covert attention to Left

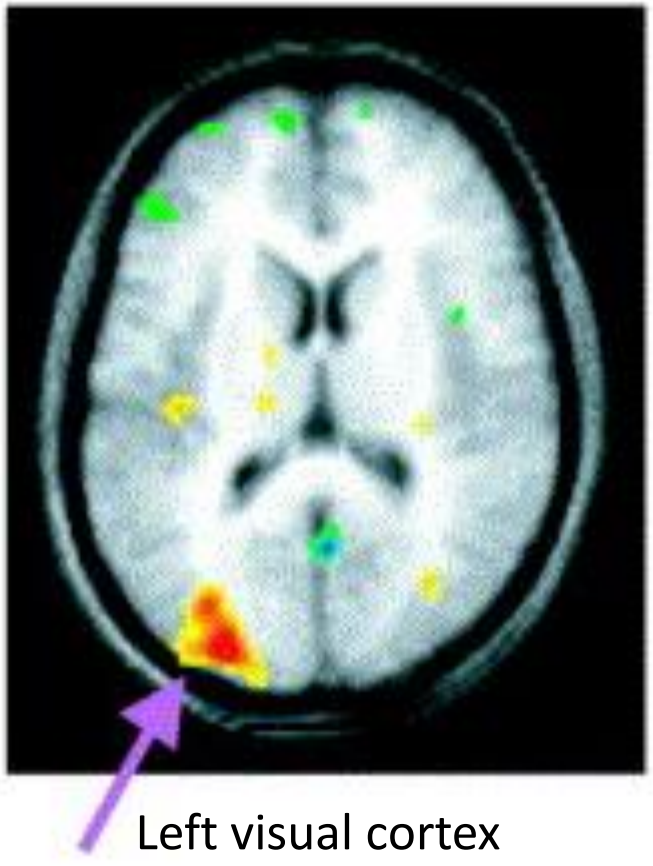


Right visual cortex

decreased blood flow in green/blue

increased blood flow in red/yellow

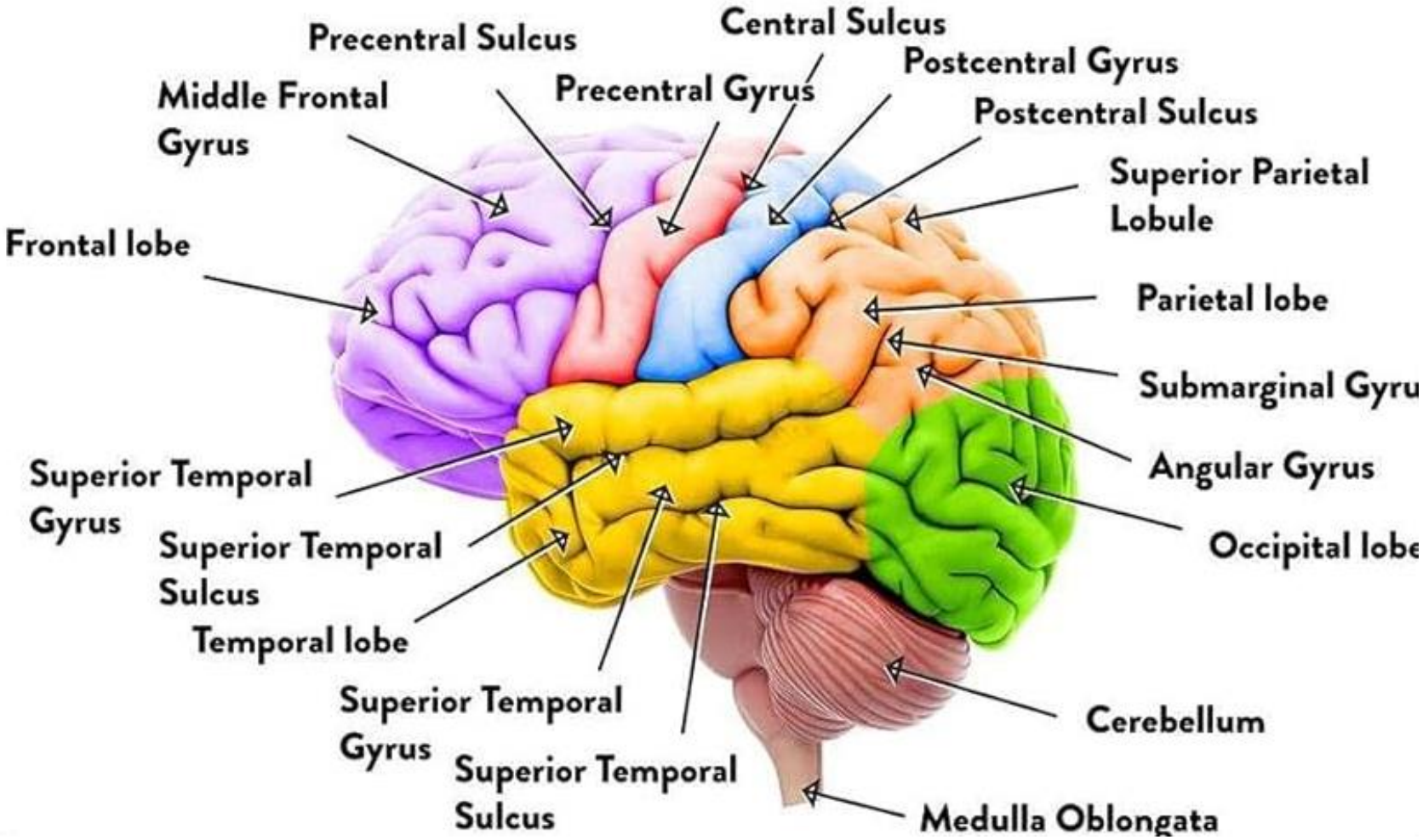
Covert attention to Right



Left visual cortex

Covert attention sensitizes specific brain regions

Waldorf et al. 2002



Attention operates in distinctive ways within different brain circuits

Attention can be understood as a general function that sensitizes particular circuits and capacities in response to changing situations.

Some different ways attention manifests in our experience, including:

Involvement of executive functions:

deliberate or effortful control of attention

monitoring or meta-awareness of attention

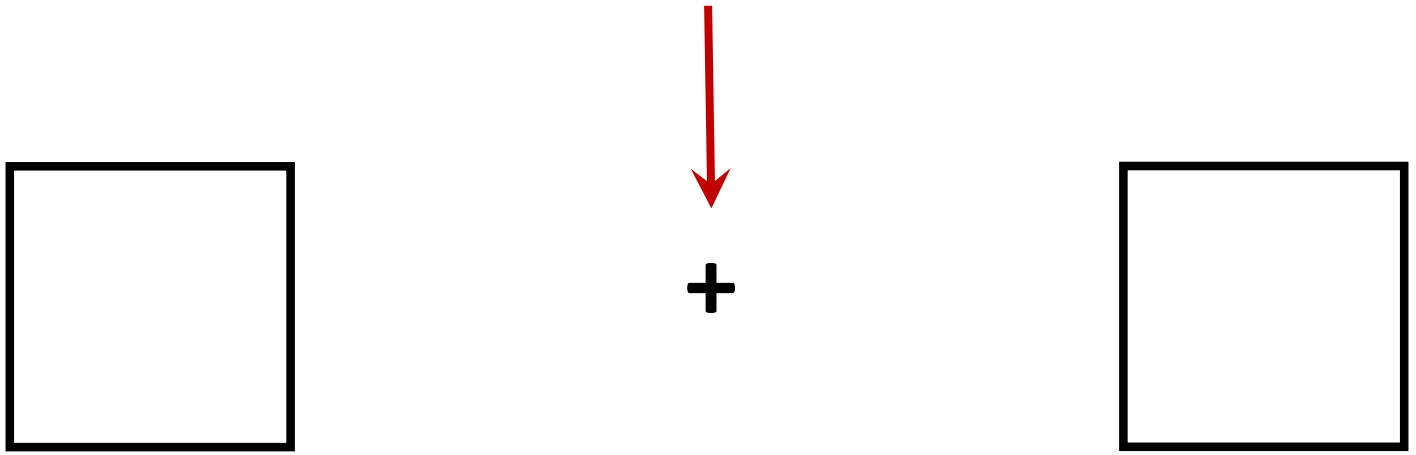
Three phases of attention: directing, sustaining, resetting

Aperture of attention: narrow or broad

Example: mindfulness of breathing and mind-wandering

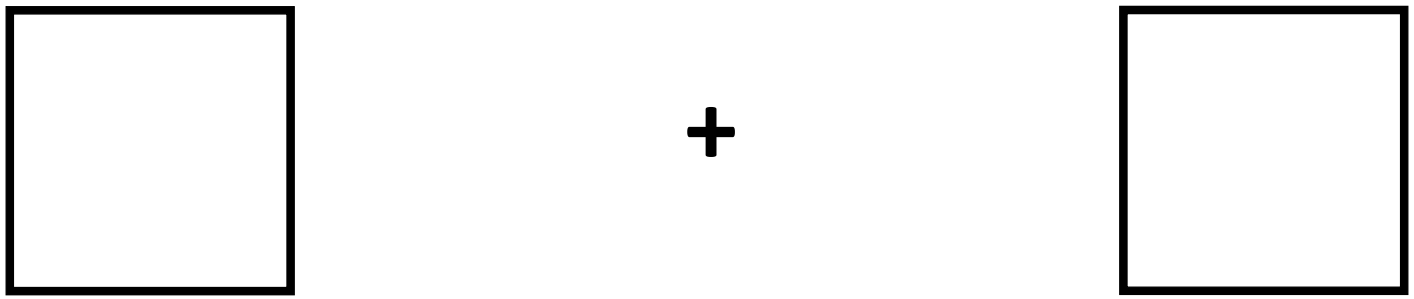
Deliberate vs. automatic movements of attention

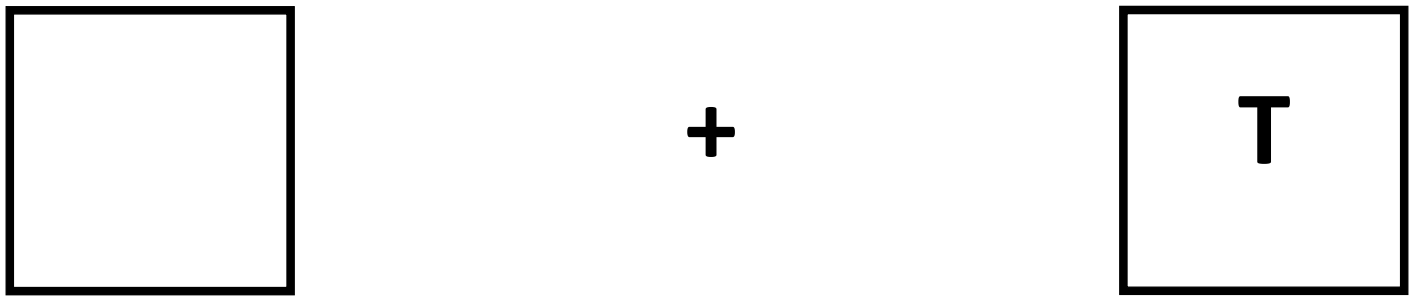
Please focus your eyes on the location of the central + at all times.

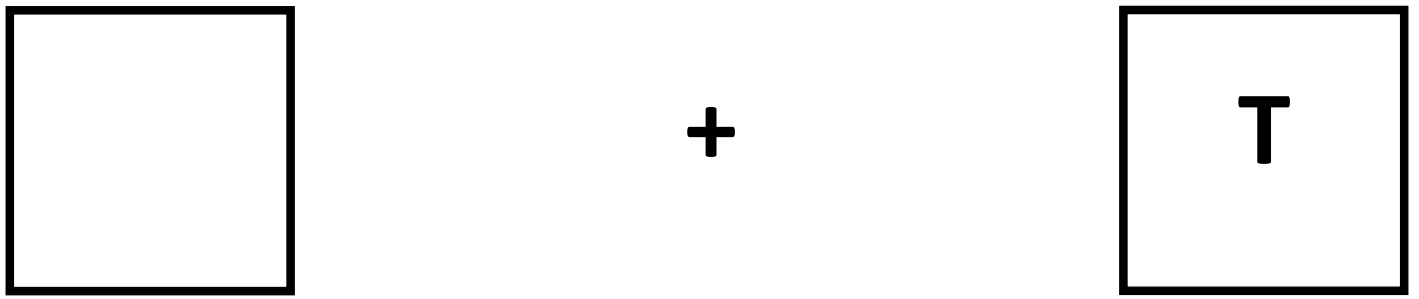


Occasionally the letter **T** will appear in one of the two side boxes.
Please respond as quickly as you can when you see the **T**.

Respond with your left hand when **T** appears on the left,
and with your right hand when **T** appears on the right.

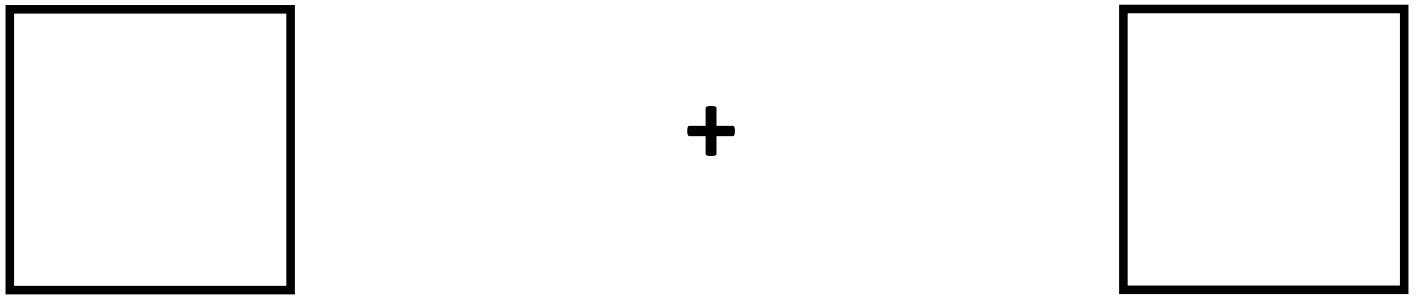



+
T



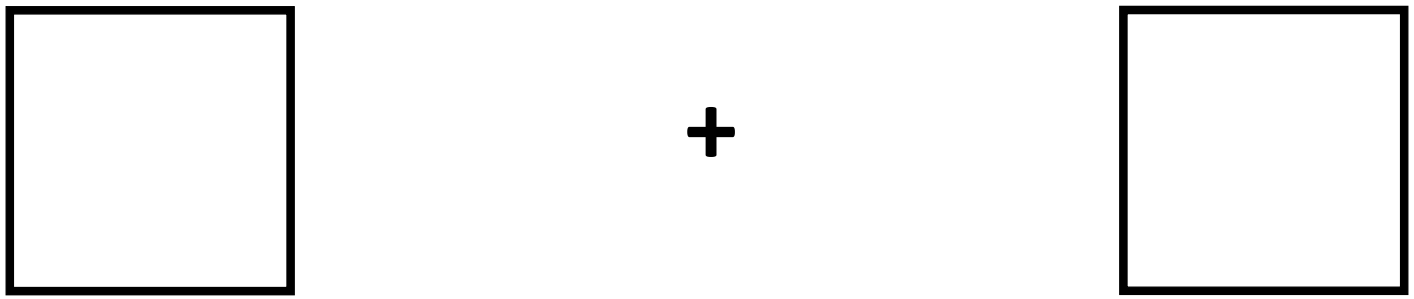
The sudden appearance of the **T**
automatically attracts your attention.

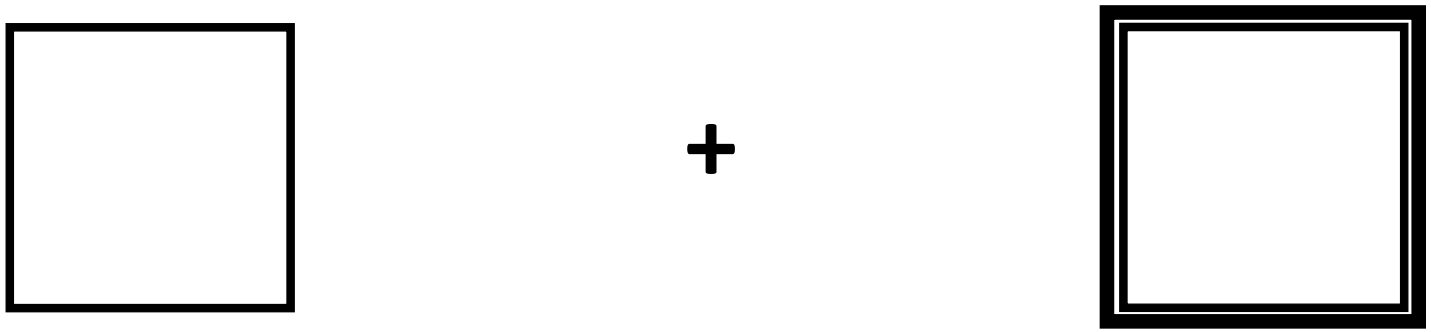
Most people respond in about 350 milliseconds

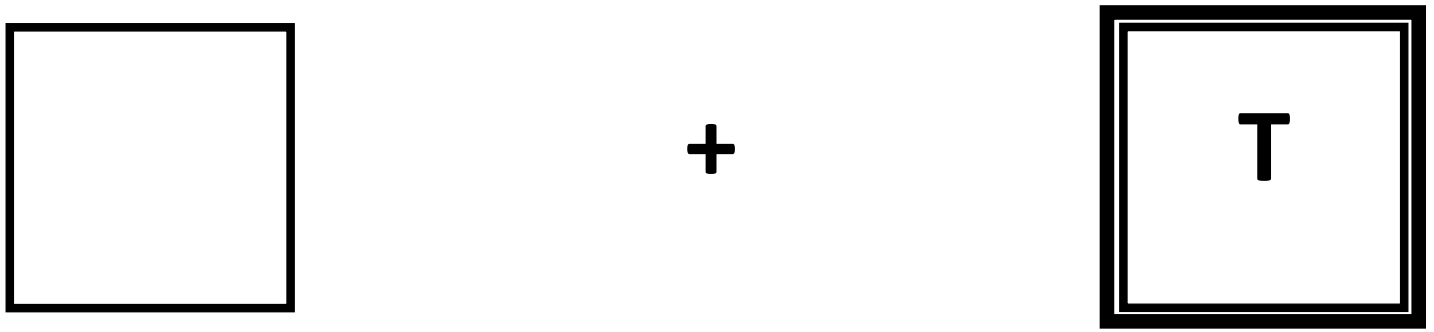


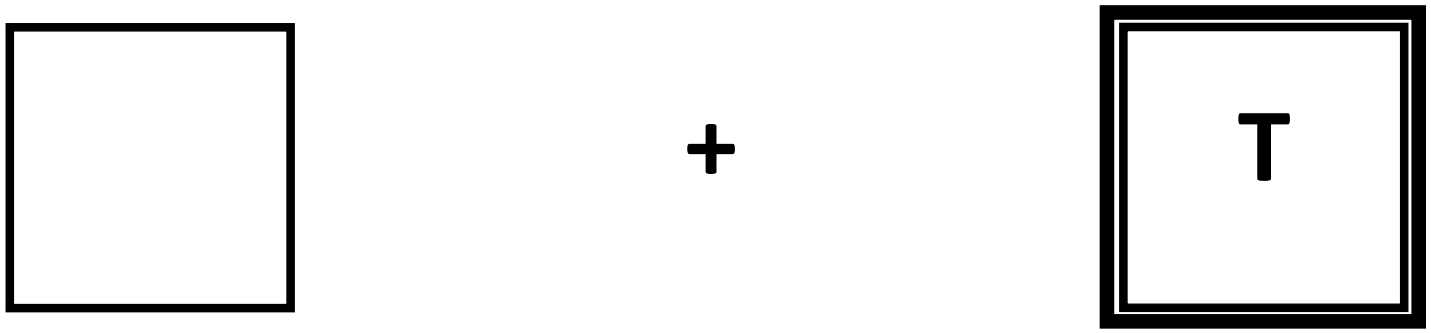
Still keeping your eyes focused on the central **+**,

now you'll see a ***cue*** telling you in which box the **T** will soon appear.



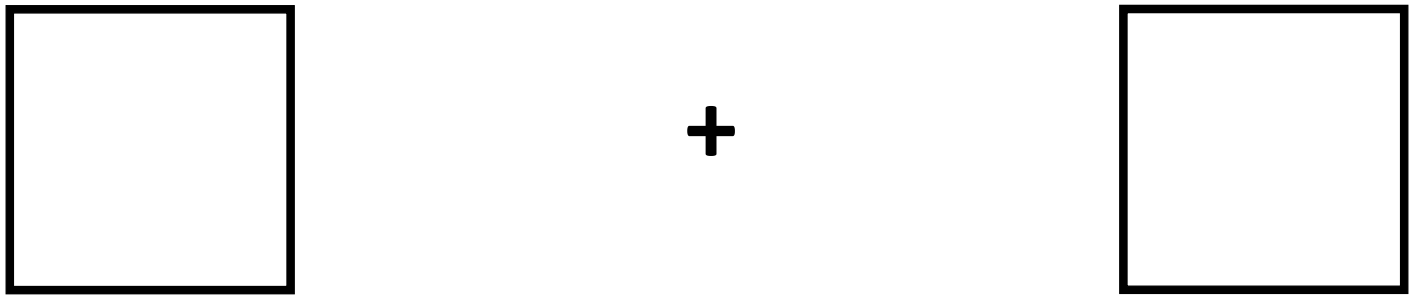



T



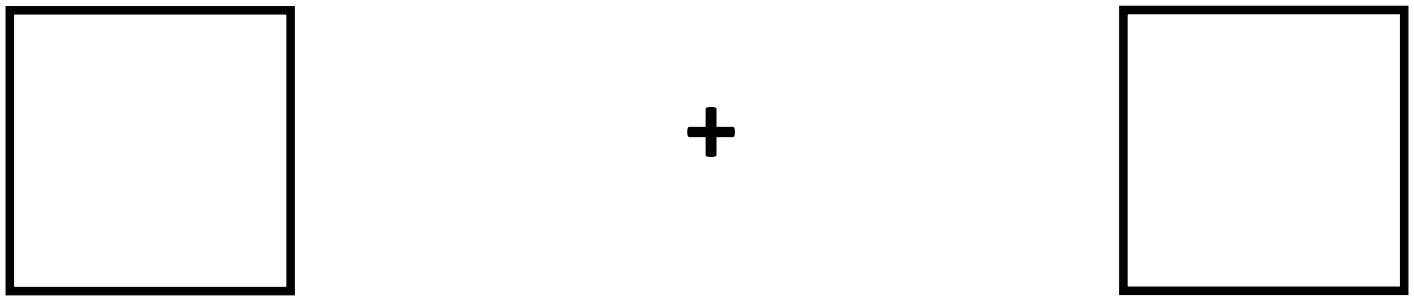
The sudden appearance of the **Box Cue** automatically draws your attention to the right, before the **T** appears.

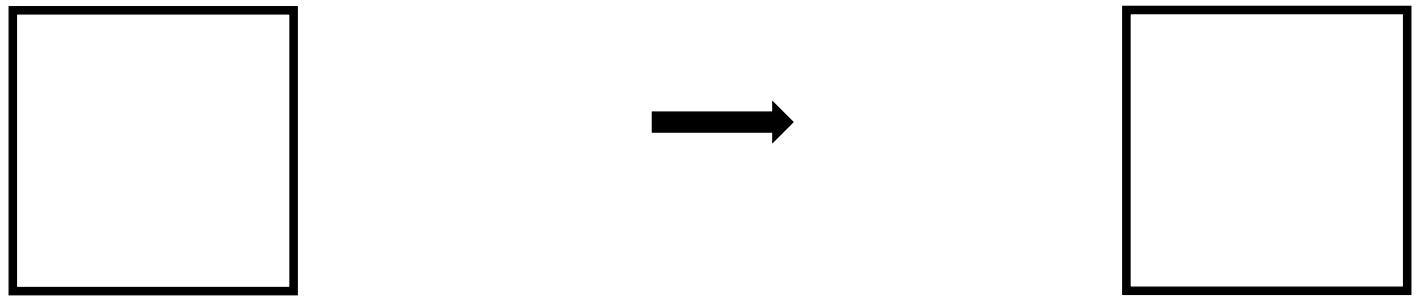
Most people respond in about 325 milliseconds

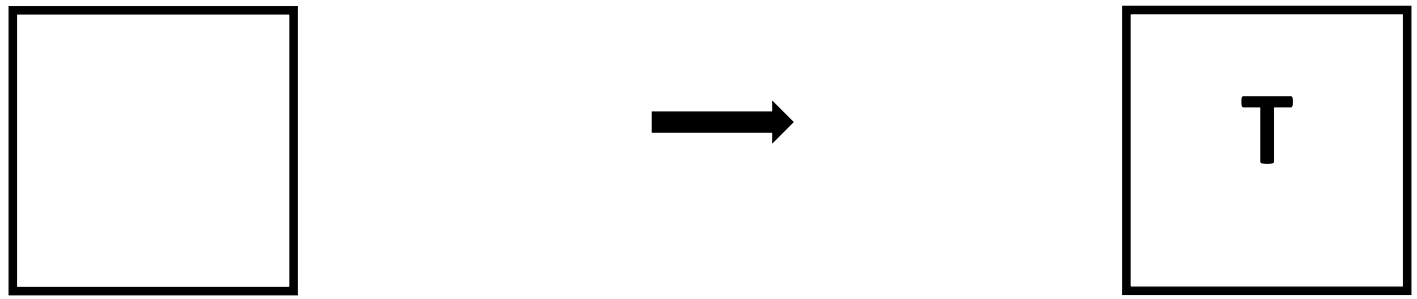


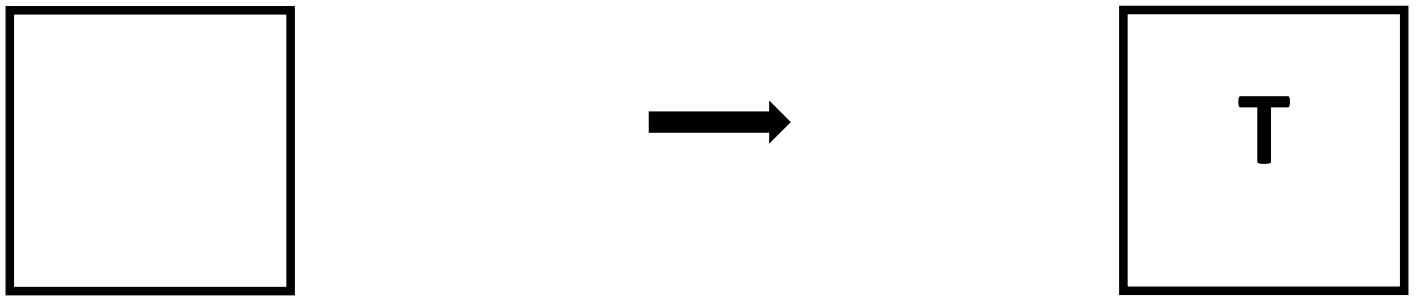
This time, you'll see a different kind of cue.

An arrow will point toward the box in which the **T** will soon appear.



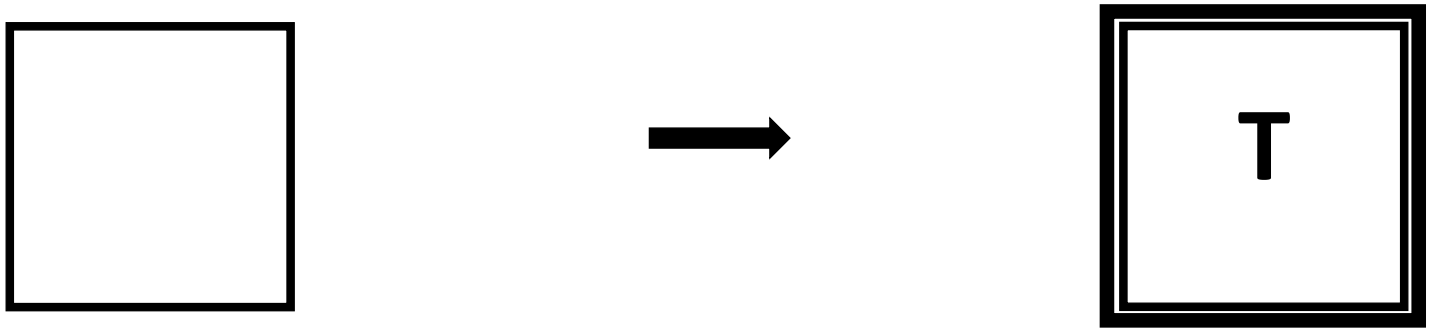



T



The arrow cue elicits a **cognitive intention** to deliberately move your attention to the right, before the **T** appears.

Most people respond in about 325 milliseconds



Automatic versus deliberate movements of attention are two different processes.

We experience both frequently in everyday situations (also in meditation practice).

Typical triggers of automatic attentional orienting

Sudden or Intense or Unexpected phenomena

Phenomena with strong Vedana (pleasant or unpleasant feeling tone)

Phenomena relevant to current goal states

Phenomena to which we habitually attend

Effortful Attention to task goals

Please silently name the color of the font
with which each word is written.

green
red
yellow
green
blue
blue

Effortful Attention to task goals

Please silently name the color of the font
with which each word is written.

green	yellow
red	red
yellow	blue
green	red
blue	green
blue	yellow

Effortful Attention to task goals

Effortful control of attention to task in police recruits in training

Effort has no role in some aspects of practice

MN 16 Cetokhilasutta (transl. Sujato)

…Suppose there was a chicken with … twelve eggs.
And she properly sat on them to keep them warm and incubated.

Even if that chicken **doesn't wish**: 'If only my chicks could break out of the eggshell with their claws and beak and hatch safely!' Still they can break out and hatch safely.

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AN 10.2 Volition Sutta (transl. Fronsdal)

Bhikkhus, for a virtuous person, one whose behavior is virtuous,
no volition need be exerted*:* "Let non-regret arise in me."
It is ***natural*** that **non-regret** arises in a virtuous person, one whose behavior is virtuous.

For one without regret, ***no volition need be exerted***: "Let gladness arise in me."
It is ***natural*** that ***gladness*** arises in one without regret.

Meta-awareness is central to mindfulness practice.

Knowing what the mind is doing while it is doing it.

Satipatthana Instructions

In regard to the body a monk abides contemplating the body, diligent, *fully aware*, and *mindful*, free from desires and discontent in regard to the world.

-Satipatthana Sutta MN 10 (Analayo & Nyanamoli)

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Fully aware: *Sampajāna* – situational awareness, seeing the bigger picture

Mindful: *Sati* – recollecting the present moment with open awareness e.g. *of the body*

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"the intention to pay attention in a particular way…
the ability to **recollect what is going on in the present moment**"

"we can do this in a… fashion which is much more **focused**
or we can do it in a **wider sense**"

-John Peacock in Mindfulness, Attention, Awareness (on Dharmaseed)

Three phases of attention

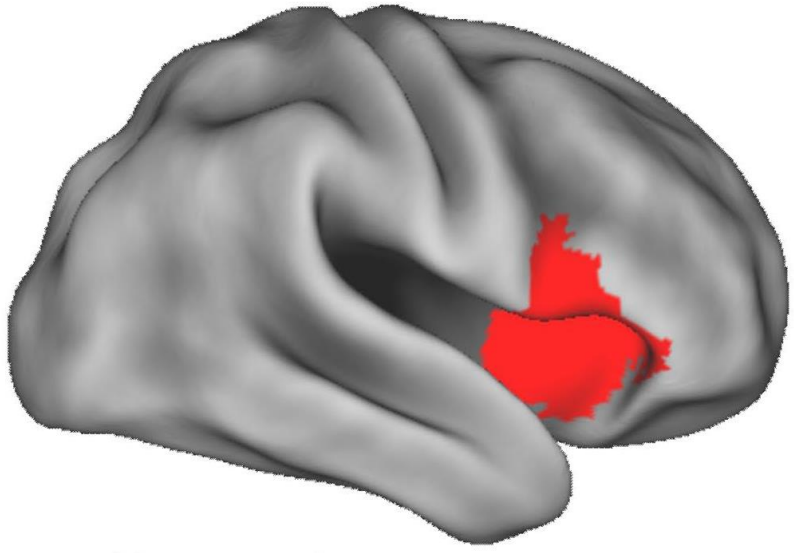
Directing attention – Vitakka: initial application of the mind

Sustaining attention – Vicara: sustained application of the mind

Resetting attention – disengagement from an attended object

The resetting function is important and sometimes under-appreciated…

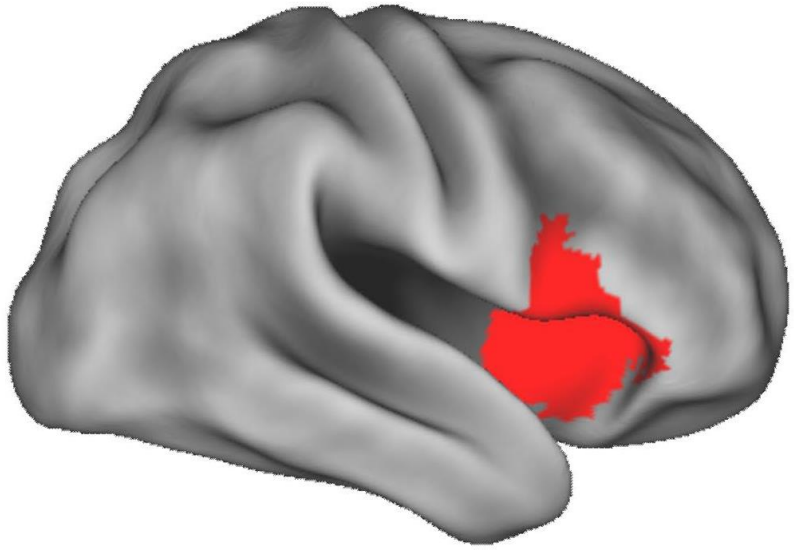
Brain regions involved in “resetting” attention



Ventral Prefrontal cortex (right)
Inhibition of current attentional targets

Shulman et al. (2009)

Brain regions involved in “resetting” attention



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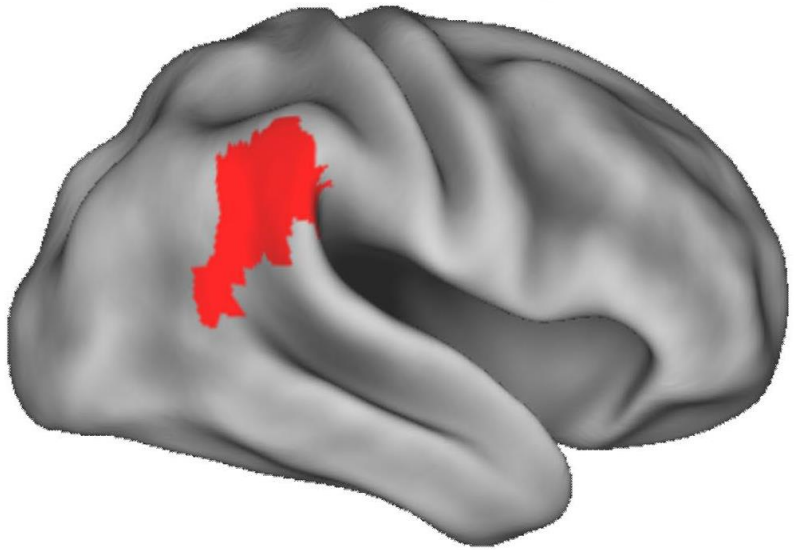

Temporo-Parietal junction (right)
Broad & flexible survey of possible new targets

Setting aside the current frame of reference

Shulman et al. (2009)

Sight, sound, touch and memory have distinct neural circuits for **Broad** and **Narrow** perceptions.

One is sensitized by attention to
focus narrowly on a specific object.

The other is sensitized by attention to
focus broadly on a whole field or a complex situation.

Most people are more familiar with object focused attention.
Situational attention is also important in practice.

The role of broad attention in practice

Attention to the big picture and how we are engaging with the current situation

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Fully aware: *Sampajāna* – situational awareness (Sujato),
wisdom in action (Buddhadasa)
seeing the bigger picture

Attention to the present moment

The present moment is a *situation* and involves a broad focus of attention

"… a chief requirement of satipatthana is that the practitioner remains **mentally anchored in the present moment**."

"…present-moment awareness needs to be **somewhat broad or panoramic**."

"… being mindful is like taking a picture with a **long exposure time and a wide-angle lens**."

-Analayo in Perspectives on the Satipatthana

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"a type of attention that is **fluid and flexible**… It is **not fixated** on any particular object…
It is an open **spacious field of attention**."

-John Peacock in Mindfulness, Attention, Awareness (on Dharmaseed)

Mindfulness with sampajāna (clear comprehension, full awareness) emphasizes *breadth* of awareness and attention to our *intentions*

Sampajāna is often combined with … mindfulness (*sati–sampajāna*), in which case the former term refers to detailed, micro-awareness while the latter indicates a **broader, more global awareness of an object as it is viewed in its wider context**.

- Andy Olendzki, commentary on Anapanasati Sutta, Insight Journal 2009

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”Cultivating clear comprehension, knowing *what we are doing and why*, is a profound and transforming practice. It highlights the understanding that mindfulness is more than simply being present.”

“With clear comprehension … we *understand the motivations* behind our actions.”

-Joseph Goldstein in Mindfulness – A Practical Guide to Awakening

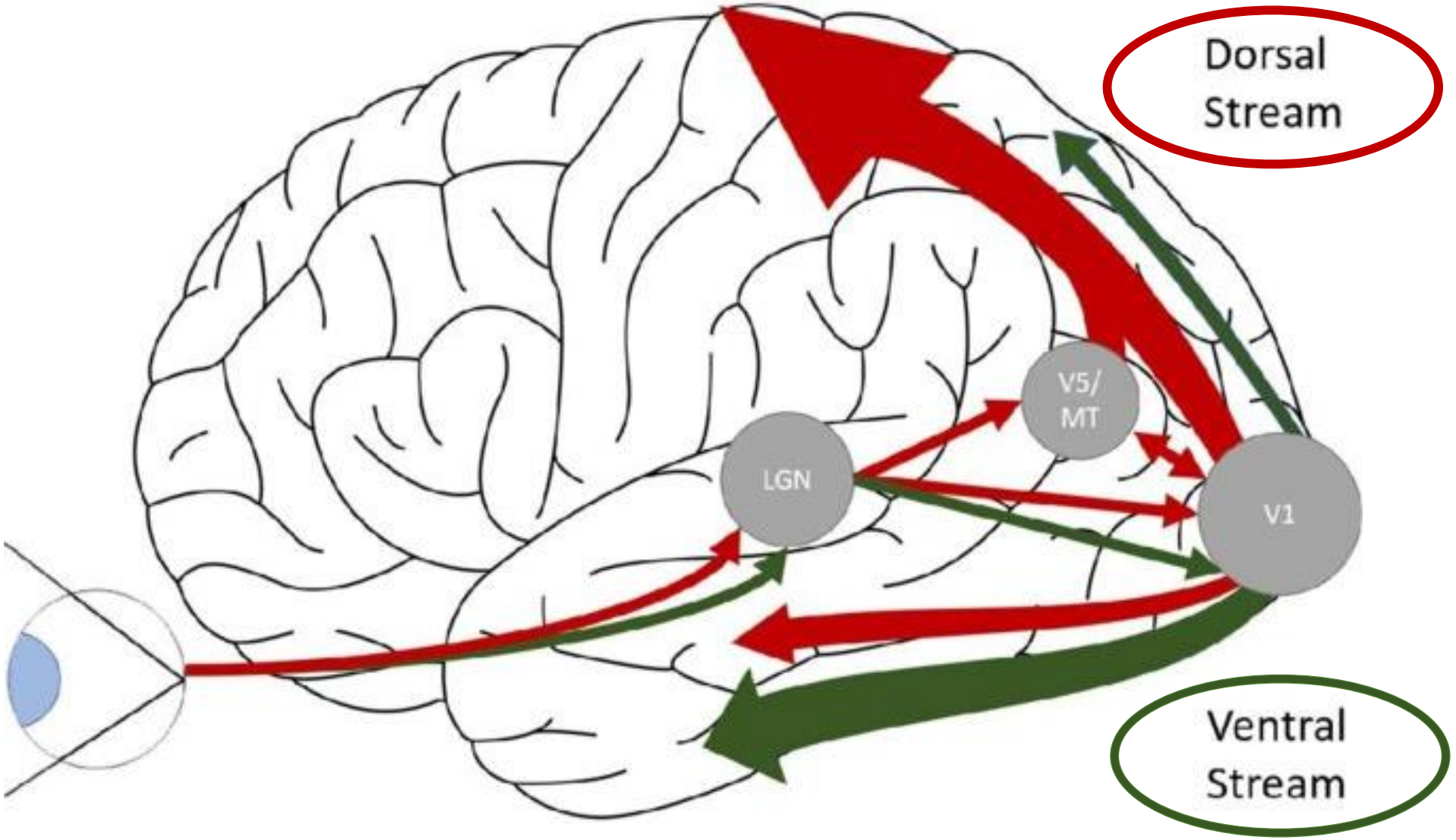
Humans have two *anatomically distinct* circuits for perception and attention:

known as **the Dorsal and Ventral Streams**

VISION

Dorsal Stream → Situations, "how" stream, perception for situations & actions

Ventral Stream → Objects, "what" stream, perception for objects & cognitions



Humans have two *anatomically distinct* formats for perception and attention:

known as **the Dorsal and Ventral Streams**

Anatomically Dorsal *(higher)* ***= how/where***

Anatomically Ventral (lower) = **what/who**

Dorsal = Enactive/Pragmatic

Ventral = **Categorical/Semantic**

Dorsal = Situations

Ventral = Objects

Dharma practice includes cultivation of both

What **are** these things?

Blue Plastic

and Metal

Egg beater

Green

Plastic

Watering Can

This object information is automatically attended to and perceived in the ***ventral*** visual stream

How can you **engage** with these things?

Can be held by its handle

Can be spun using its crank

Can whip cream

Can be held by its handle

Can be filled thru its top

Can water plants

This “affordance” information is automatically attended to and perceived in the ***dorsal*** visual stream.
Attention to intentions is one aspect of dorsal stream attention.

Object vs. Enactive Distinction in Vision

Ventral Stream (**Who/What**)

Object categories and identity
(foods, tools, animals, people, etc.)
“What kind of mushroom is this?”

Object vs. Enactive Distinction in Vision

Ventral Stream (**Who/What**)

Object categories and identity (foods, tools, animals, people, etc.)
"Which mushroom is this?"

Dorsal Stream (**How/Where**)

Situational awareness pertaining to intentions
Trajectories of movement
Maps of spatial relations
"Is this the way to where I'm going?"

Blurred pictures of scenes that are primarily perceived by either the dorsal or ventral stream

Object vs. Situational Attention

Well-suited for action planning, intuitive thinking, process memory
(implicit – subconscious)

Many mammals have a similar system

Object vs. Situational Attention

Sumerian Cuneiform Writing

Well-suited for language, abstract thinking, representational memory
(explicit – conscious)

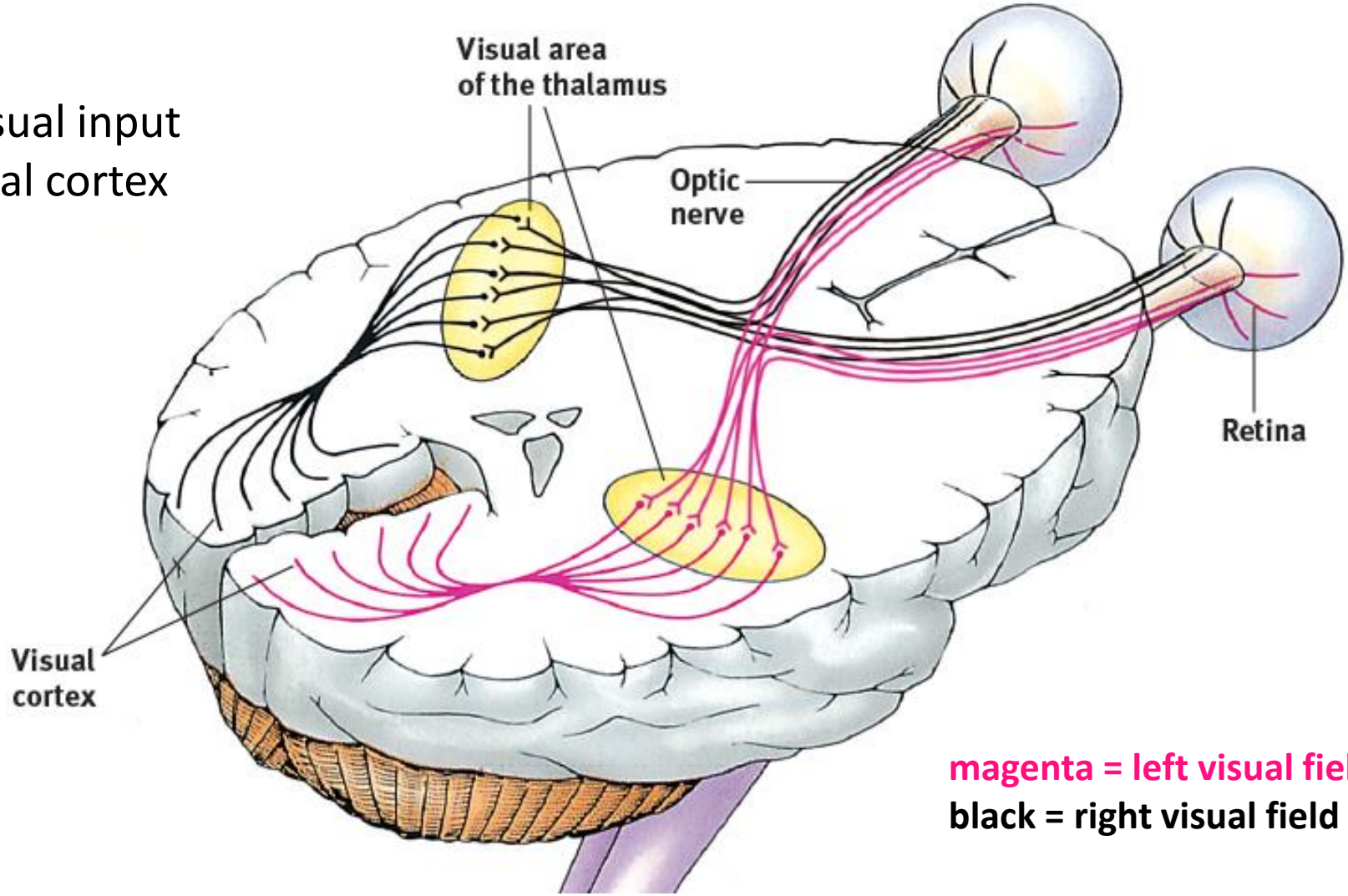
Sophistication unique to humans
(among mammals)

Well-suited for action planning, intuitive thinking, process memory
(implicit – subconscious)

Many mammals have a similar system

Object and Situational perception and attention circuits have **specialized architecture**

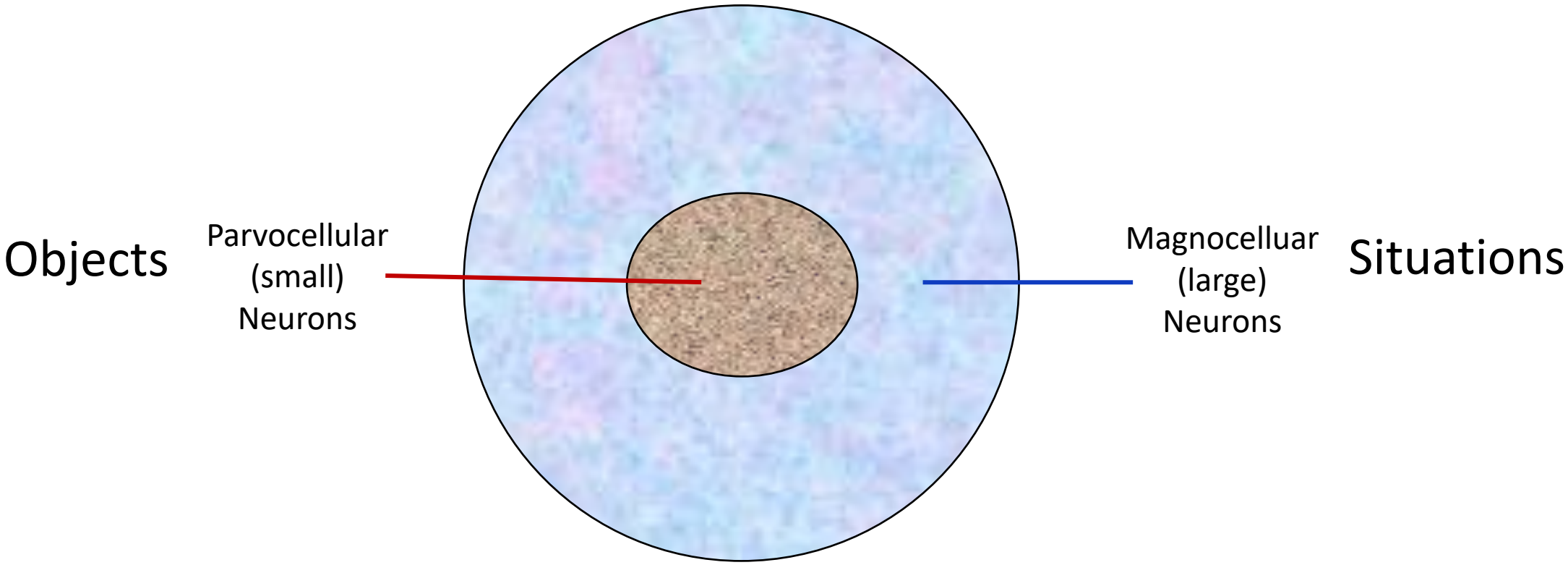
Overview of visual input to primary visual cortex



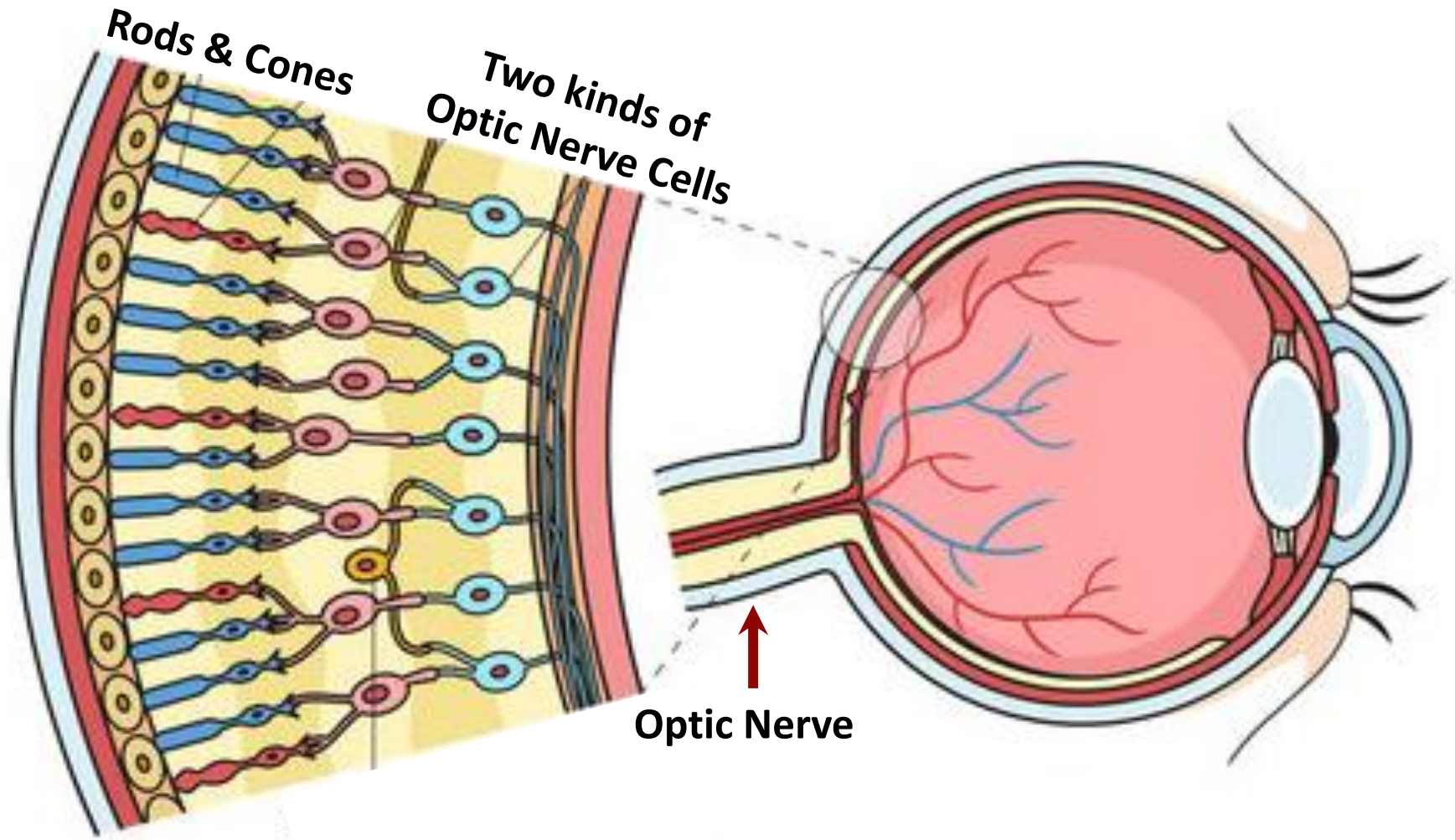
magenta = left visual field
black = right visual field

Myers/DeWall, *Psychology in Everyday Life*, 4e, © 2017 Worth Publishers

Cross-section of the Optic Nerve



Two different, specialized kinds of nerve cells in the Optic Nerve


Rods & Cones
Two kinds of
Optic Nerve Cells
Optic Nerve

Small cell system in retina
specialized for *small features* & **object construction**

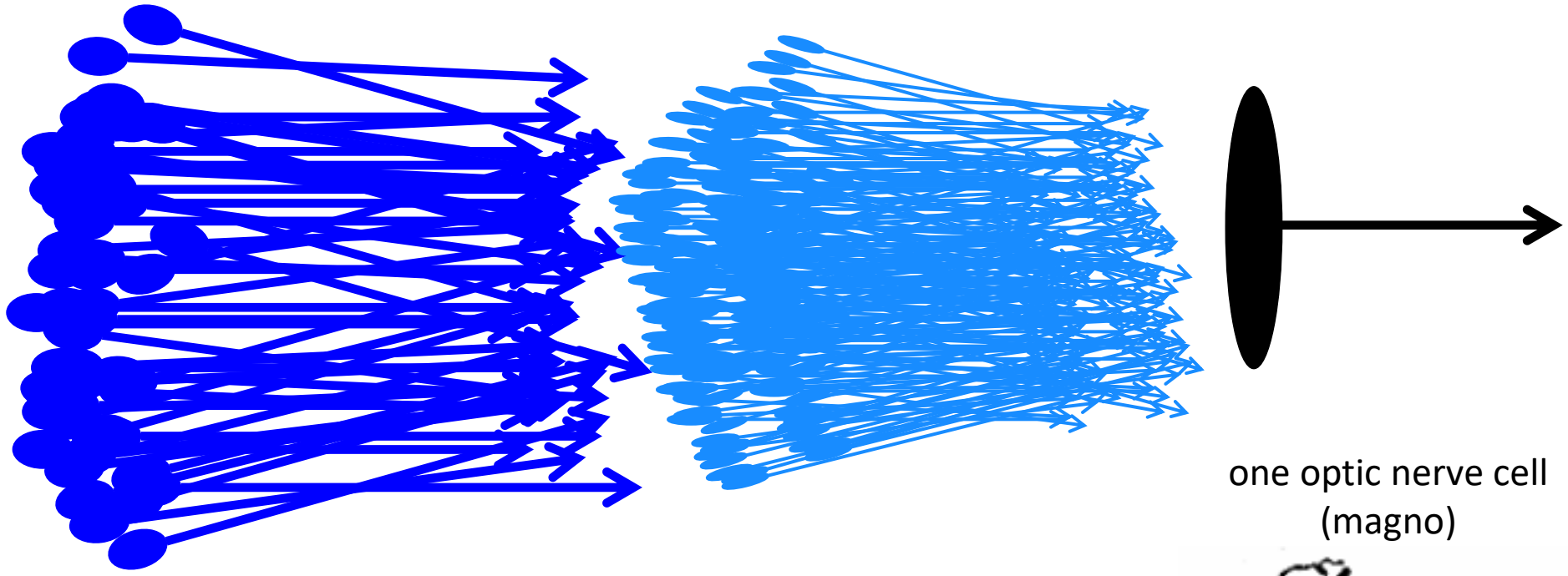
one cone cell

two intermediate neurons

one optic nerve cell (parvo)

One optic nerve cell corresponds to one cone cell

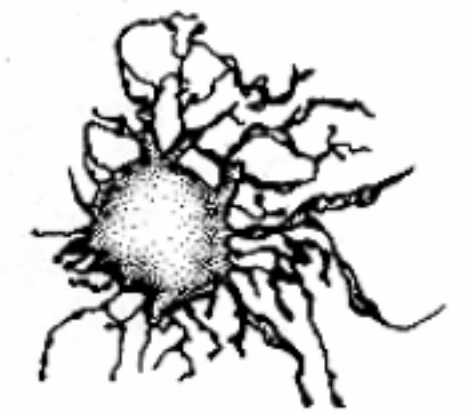
Large cell system in retina
specialized for *large features* & **situation construction**



~ 50 rods & cones

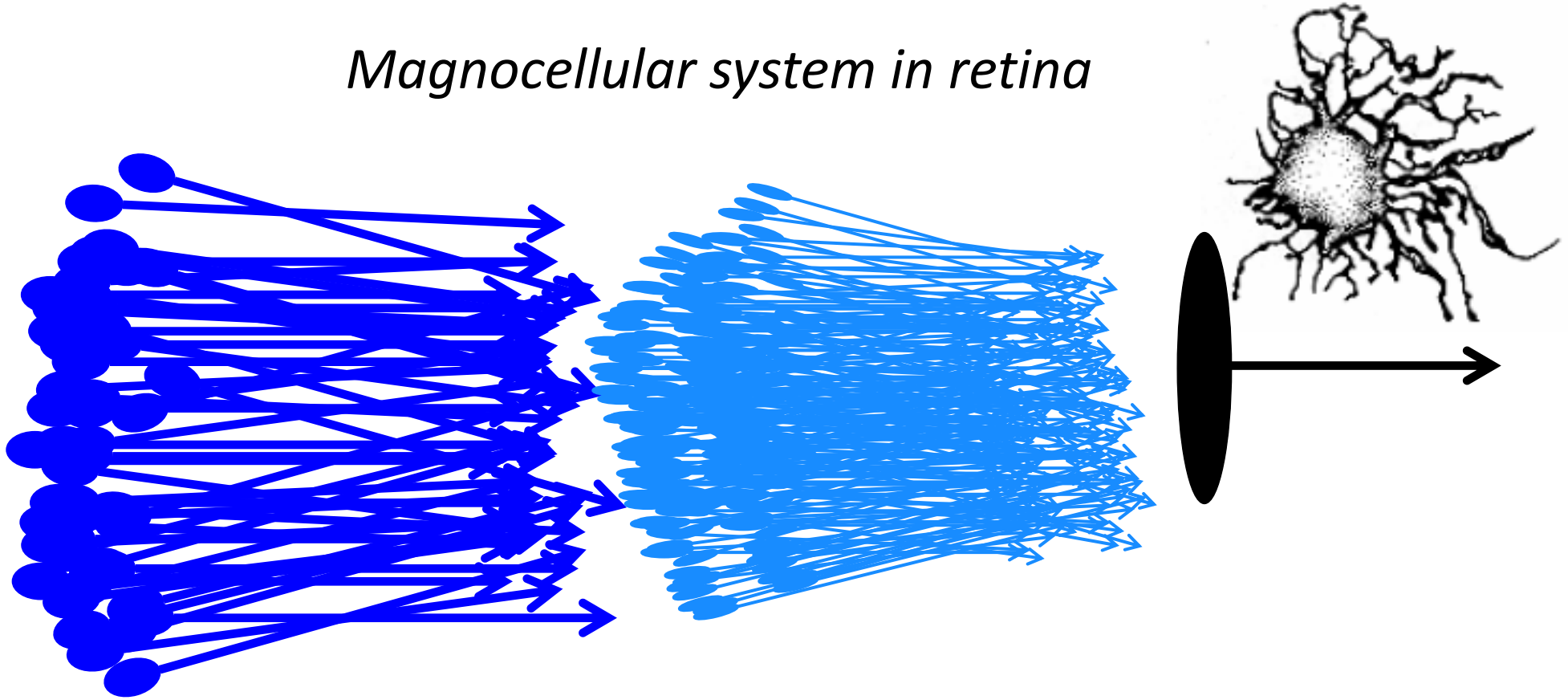
~ 200 intermediate neurons

one optic nerve cell (magno)

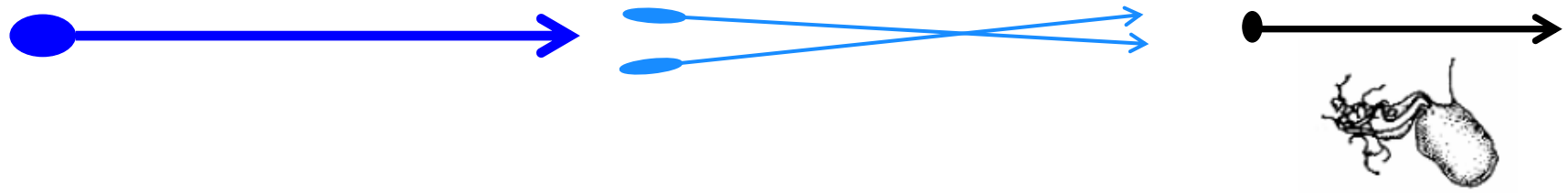


One optic nerve cell corresponds to many rods & cones

Magnocellular system in retina

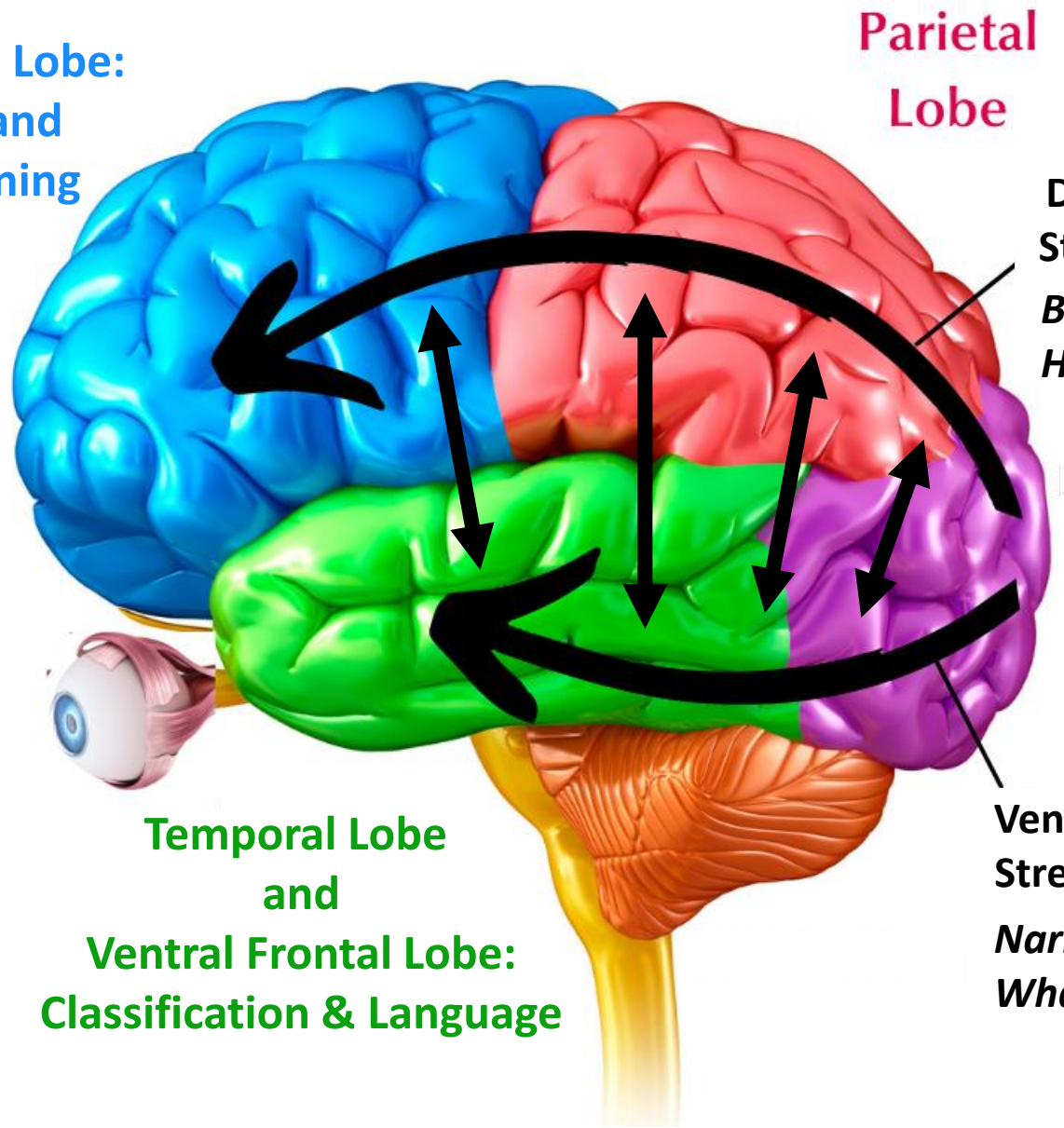


Parvocellular system in retina



Dorsal Frontal Lobe:
Intentions and
Action Planning

The two modes are a spectrum, not a dichotomy and not mutually exclusive.



Dorsal Stream

Broad perceptions.
How do I engage here?

Ventral Stream

Narrow perceptions.
What is this?

Temporal Lobe
and
Ventral Frontal Lobe:
Classification & Language

CVI NOW

--------dorsal--------

Attention to goals
(intentions & motivations)

Attention to Situation

"Sustained Mindfulness Practice"

Present Moment

--------dorsal--------

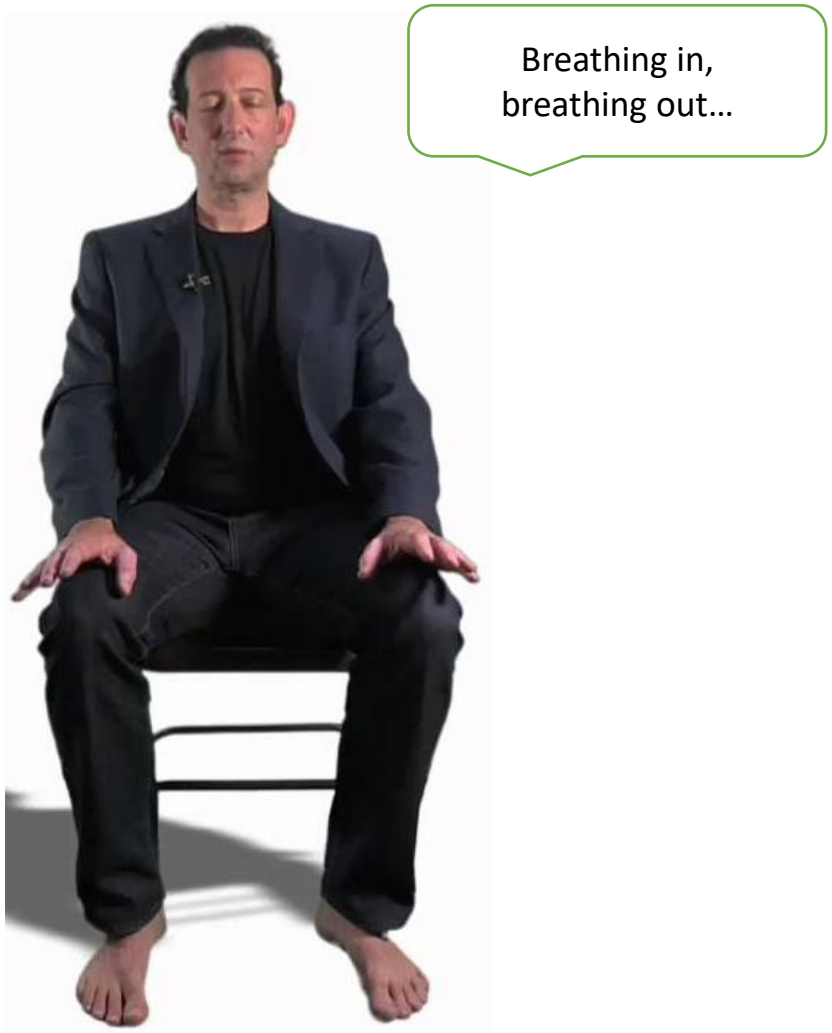
Attention to goals
(intentions & motivations)

Attention to Situation

ventral

------- Attention to Objects -------

"Sustained Mindfulness Practice"



Present Moment

--------dorsal--------

Attention to goals
(intentions & motivations)

"Sustained Mindfulness Practice"

Attention to Situation

Present Moment

ventral

------- Attention to Objects -------

Tweet, tweet…

Bark, bark…

Various phenomena arise without interrupting continuity of mindfulness

--------dorsal--------

Attention to goals
(intentions & motivations)

"Sustained Mindfulness Practice"

ventral

Attention to Situation

------- Attention to Objects -------

Breathing in,
breathing out…

I need to talk to
Jerry at work.

Present Moment

Various phenomena arise
without interrupting
continuity of mindfulness

--------dorsal--------

Attention to goals
(intentions & motivations)

"Sustained Mindfulness Practice"

Attention to Situation

Present Moment

ventral

------- Attention to Objects -------

Vroom, vroom…

Various phenomena arise without interrupting continuity of mindfulness

--------dorsal--------

Attention to goals
(intentions & motivations)

ventral

Attention to Situation

------- Attention to Objects -------

"Solving Work Problem"

Attention is pulled to an alternate goal!

Present Moment

Attention to goals
(intentions & motivations)

--------dorsal--------

Attention to Situation

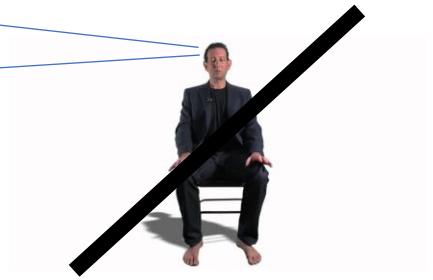
ventral

------- Attention to Objects -------

"Solving Work Problem"

Jerry, Chrystal, etc.

Listen Jerry, you need to coordinate with Chrystal before taking this further...



Continuity of mindfulness is interrupted

Imagined Situation

--------dorsal--------

Attention to goals
(intentions & motivations)

"Solve the Work Problem Later"

"Sustained Mindfulness Practice"

Attention to Situation

Present Moment

ventral

------- Attention to Objects -------

"thinking, thinking"

Breathing in,
breathing out…

Resetting the attention,
Directing it to the breath
and the present moment.

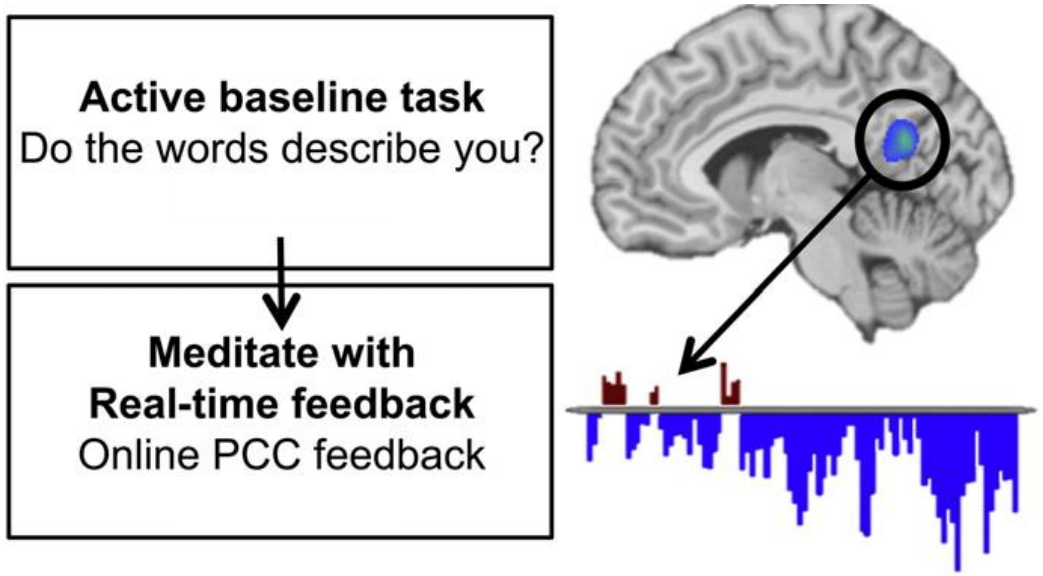
Coming back to mindfulness.

Midline view of brain

Posterior cingulate cortex (PCC)
(Imaginary Situation Room)

"Mind wandering" typically involves activation of a brain region that:

1. retrieves autobiographical memory information
   and
2. "situates" imagery for past or future ***scenarios***.



Experienced meditators and non-meditators were asked to meditate while receiving real-time feedback about activity in the PCC.

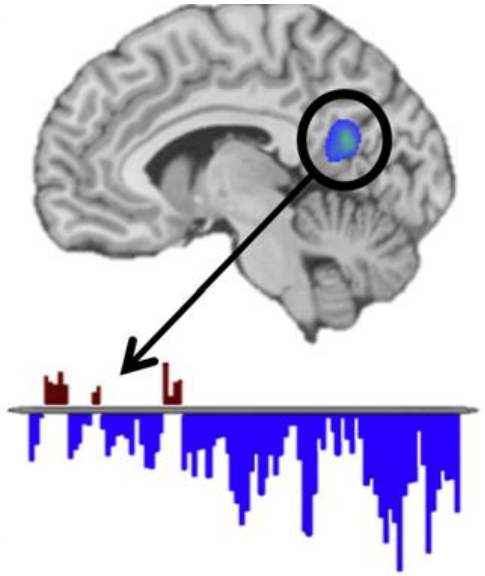
They were told to try to **decrease PCC activity**.

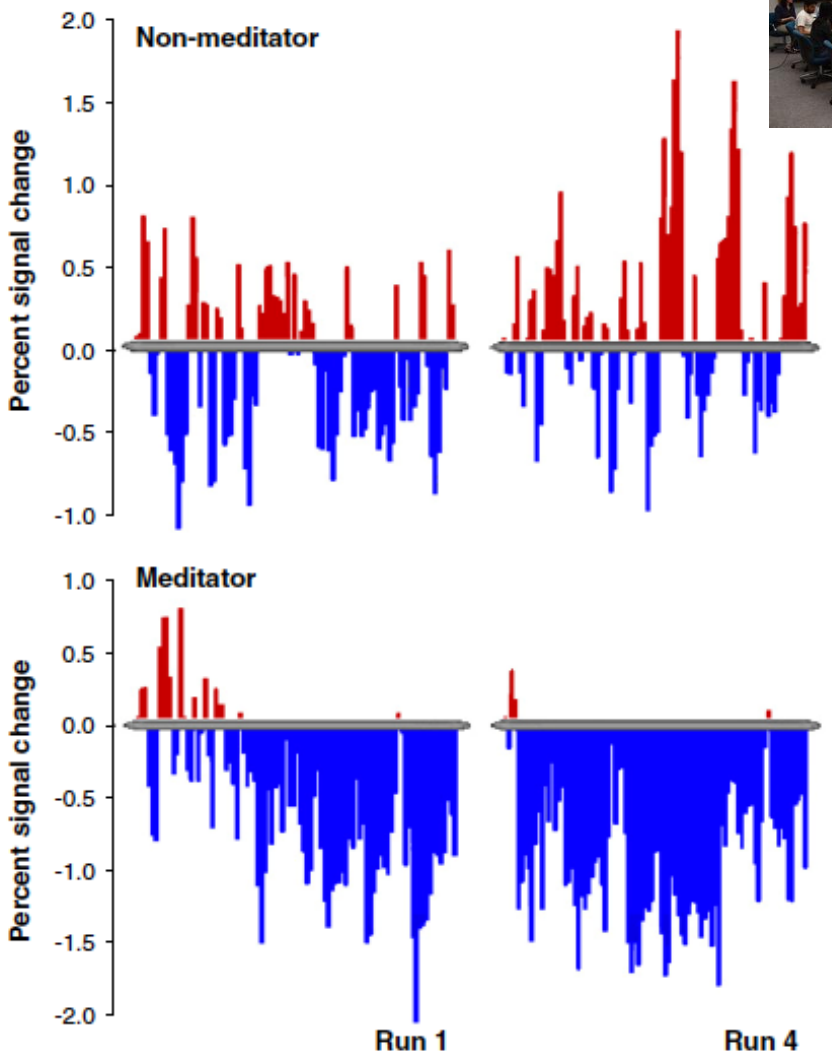
Brewer et al., 2013

Active baseline task
Do the words describe you?

↓

Meditate with
Real-time feedback
Online PCC feedback





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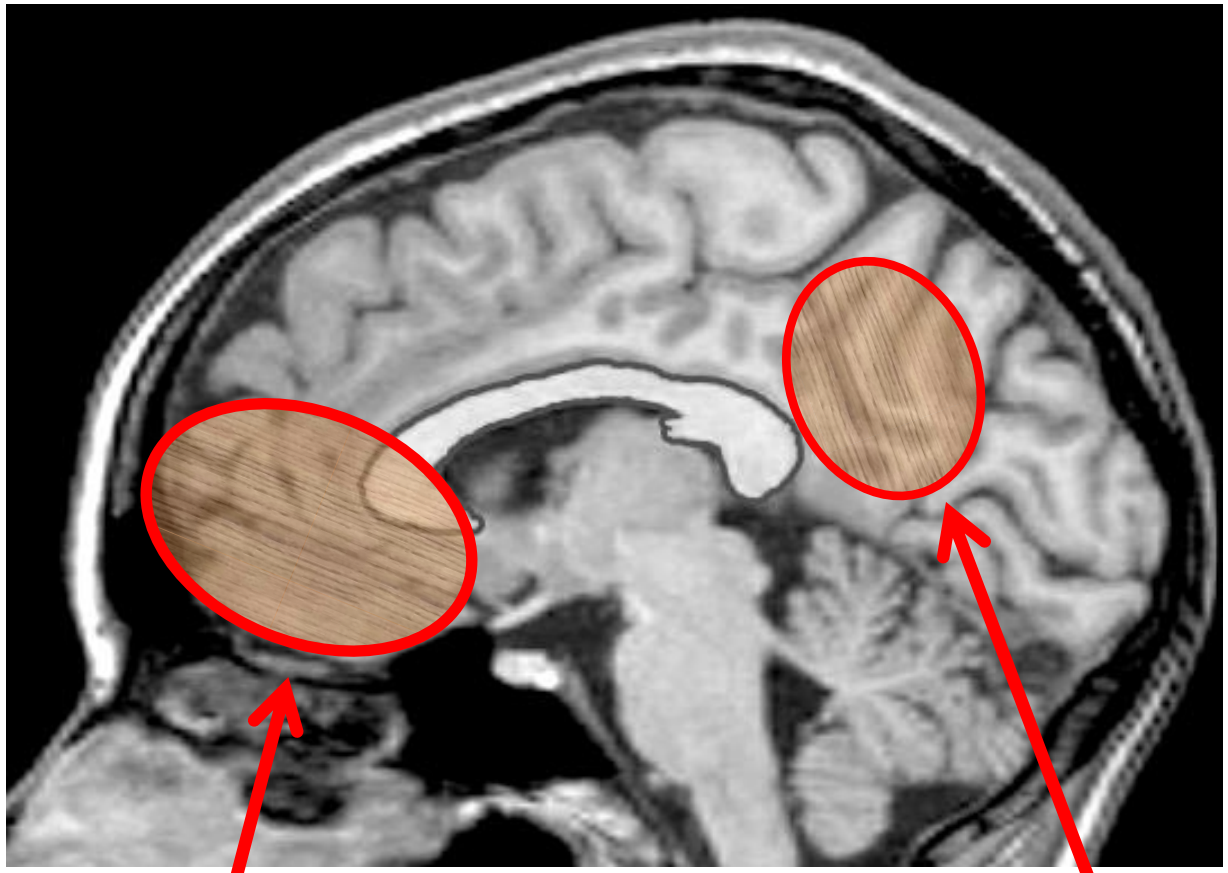
PCC is major node in "default mode network," which activates when the brain is not busy



Why are these fantasies and/or ruminations so compelling and distracting?

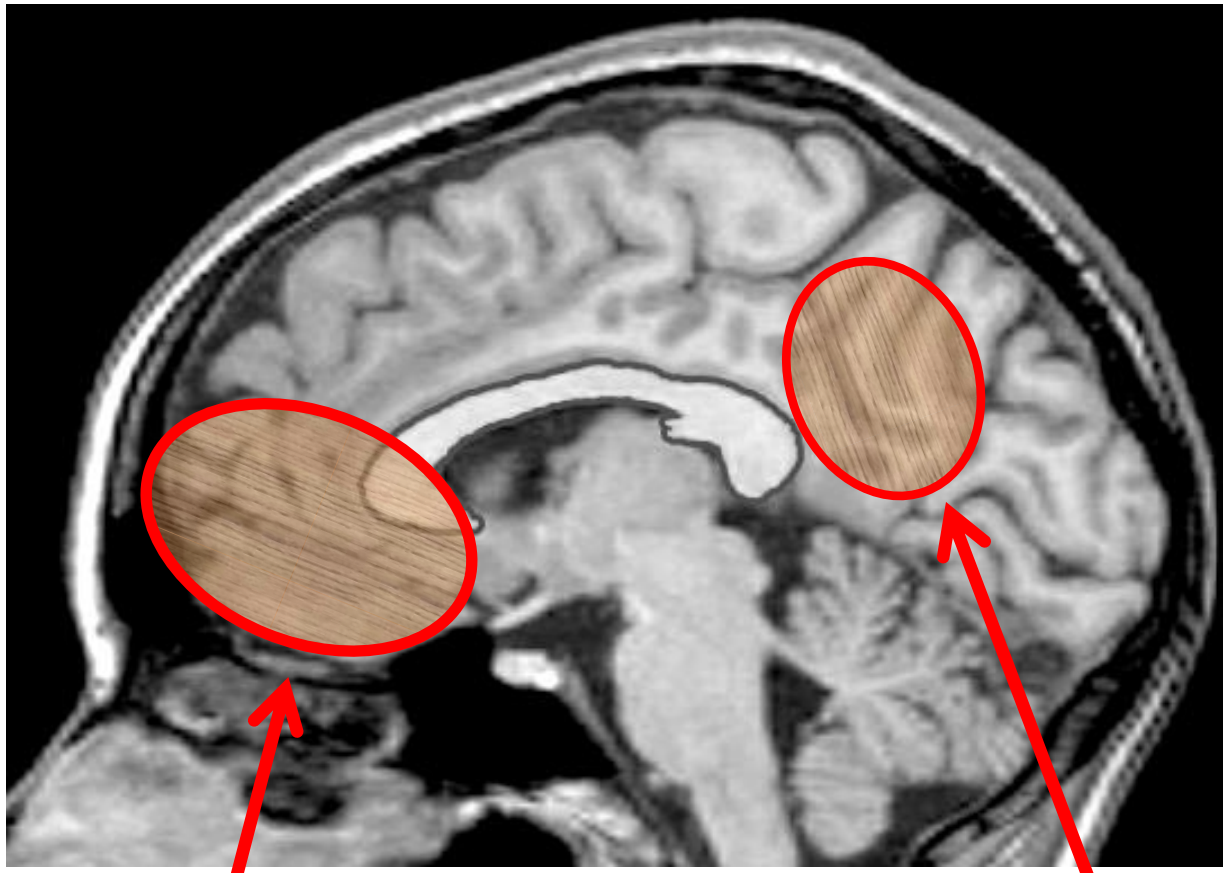
Ventromedial Prefrontal cortex
(Arbiter of Preferences)

VMPFC

Posterior cingulate cortex
(Imaginary Situation Room)

PCC

PCC is major node in "default mode network," which activates when the brain is not busy



Why are these fantasies and/or ruminations so compelling and distracting?

1. The VMPFC keeps track of our "preferences" and what we "care" about.

2. The PCC constructs imagined or remembered situations.

3. The scenarios that arise are ones we care about, which makes them compelling BUT NOT situated in the present moment.

Ventromedial Prefrontal cortex
(Catalog of Preferences)

VMPFC

Posterior cingulate cortex
(Imaginary Situation Room)

PCC