

Tales from Topographical Oceans: Brain Topography in TBI

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Diplomate American Board PM&R

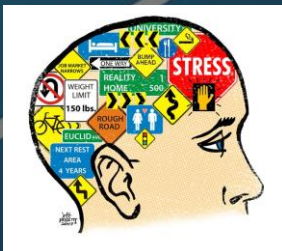
Subspecialty Board Certified Spinal Cord Medicine

Subspecialty Board Certified Brain Injury Medicine

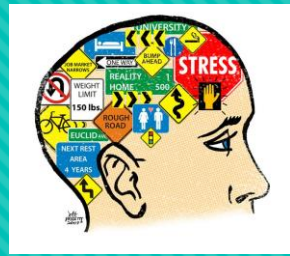
Subspecialty Board Certified Pain Medicine

Diplomate American Board Pain Management

Qualified Medical Evaluator



Learning Objectives



LEARN ABOUT THE FUNCTIONS
OF DIFFERENT PARTS OF THE
BRAIN



UNDERSTAND THE IMPORTANCE
OF THE PREFRONTAL CORTEX



APPLY TOPOGRAPHICAL
KNOWLEDGE OF THE BRAIN TO
A TRAUMATIC BRAIN INJURY

Cognitive Impairments related to TBI

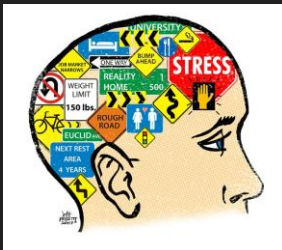
- reaction time
- attention-concentration
- working memory
- general intelligence
- learning and memory
- spatial cognition
- executive function
- social cognition

work·ing mem·o·ry

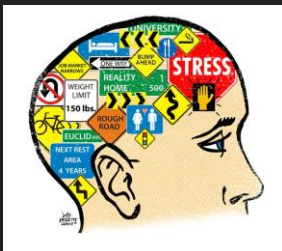
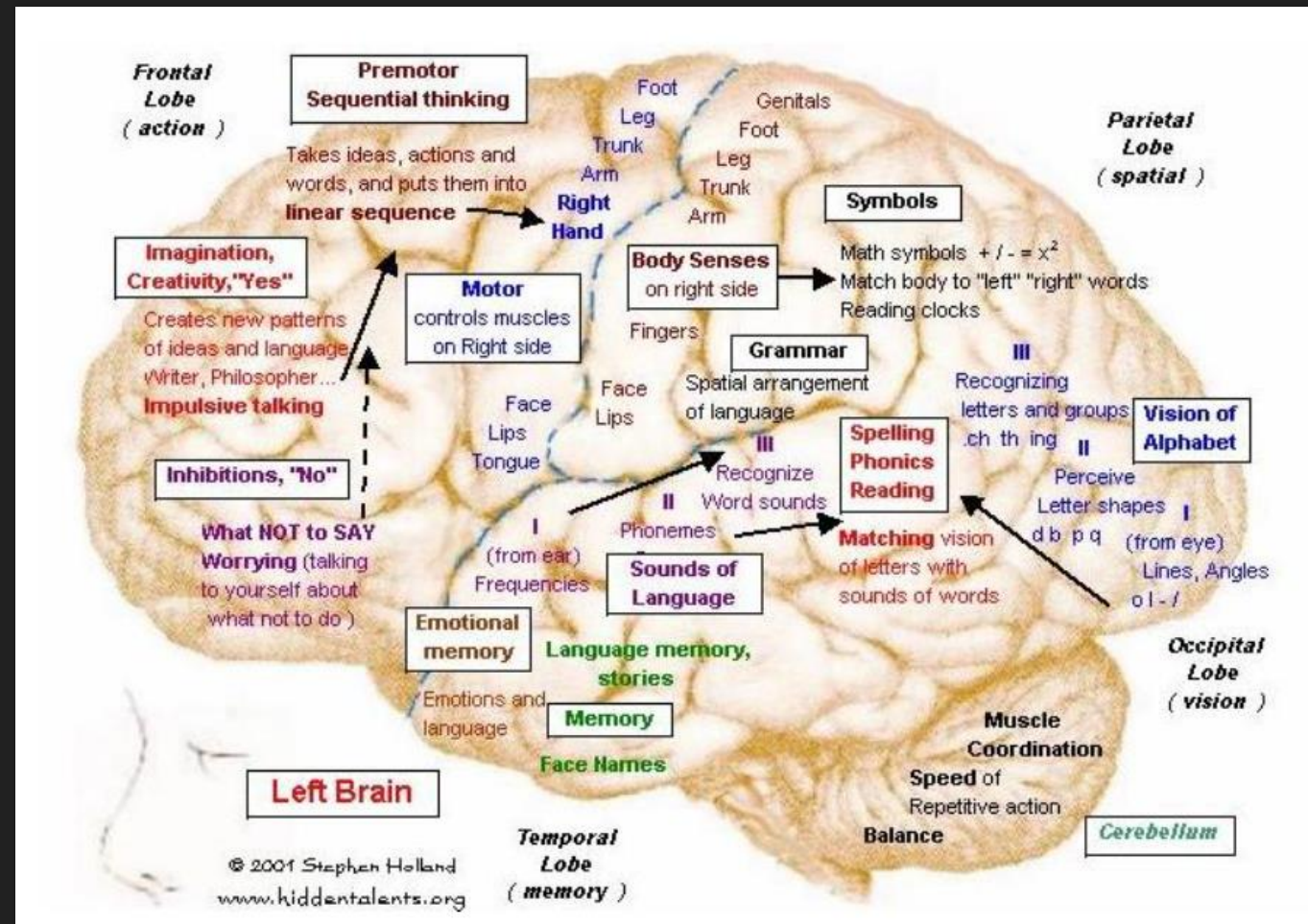
noun **PSYCHOLOGY**

the part of short-term memory that is concerned with immediate conscious perceptual and linguistic processing.

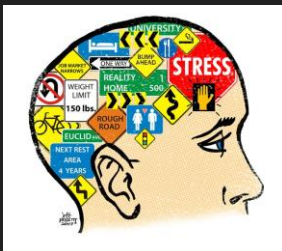
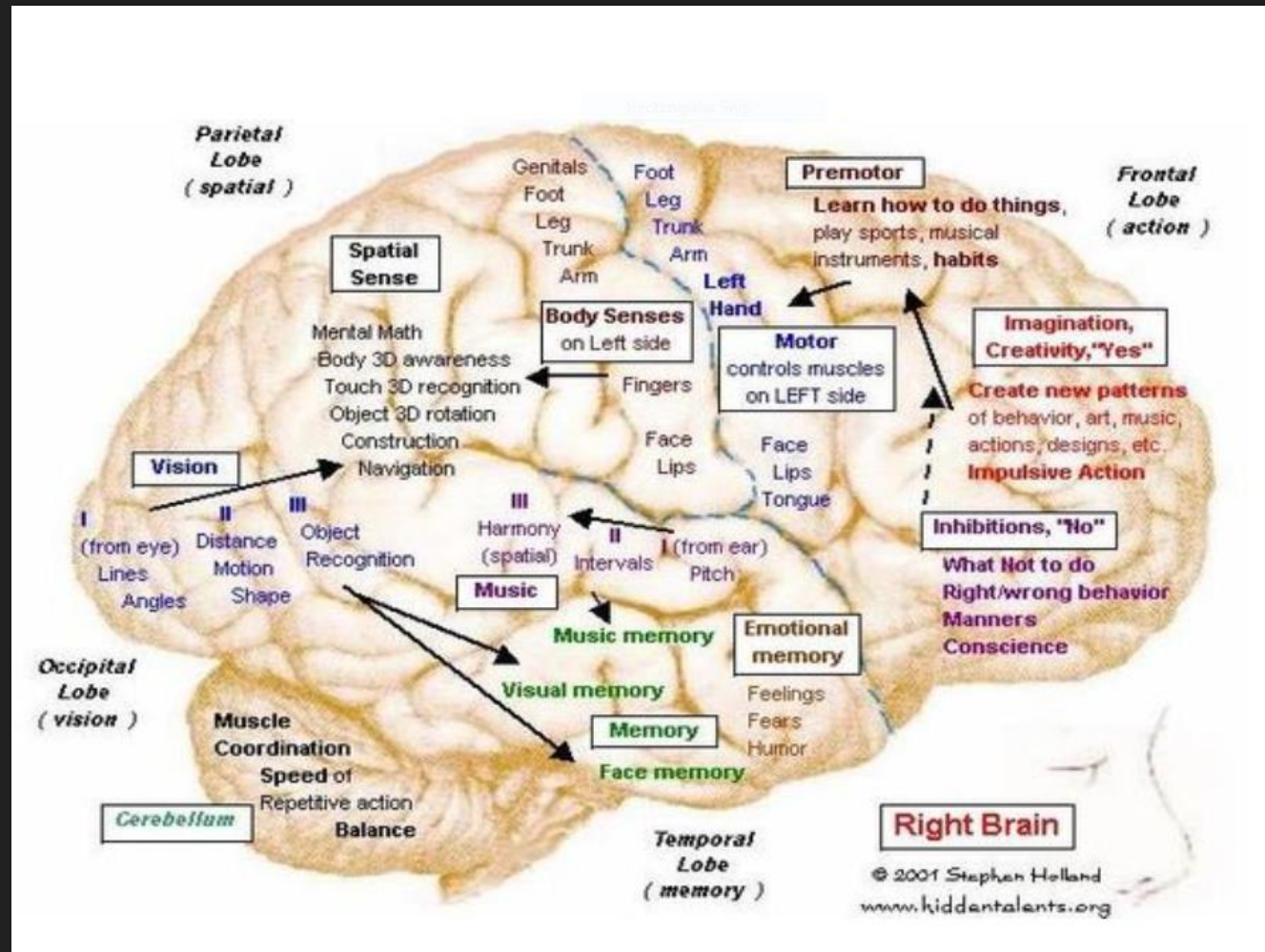
- **COMPUTING**
an area of high-speed memory used to store



Left Brain



Right Brain



Frontal Lobe: Functions

consciousness /what we are doing with our environment

initiation of activity in response to our environment

judgment about what occurs in our daily activities

control of our emotional response

control of our expressive language

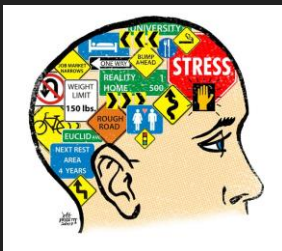
assign meaning to the words we choose

involve word associations

judgment about what occurs in our daily activities

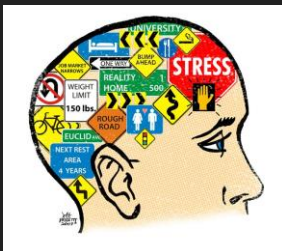
memory for habits and motor activities

Insight into our abilities and shortcomings



Frontal Lobe: observed problems in TBI

- loss of simple movement of various body parts
- inability to plan a sequence of complex movements needed to complete multi stepped tasks (sequencing)
- loss of spontaneity in interacting with others
- loss of flexibility and thinking
- persistence of a single thought (perseveration)
- inability to focus on task (attending)
- mood changes (emotional lability)
- changes in social behavior
- changes in personality
- difficulty with problem solving
- inability to express language



Parietal Lobe: Functions

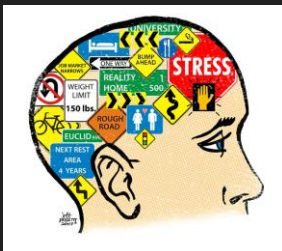
location for visual attention

location for touch perception

goal directed voluntary movements

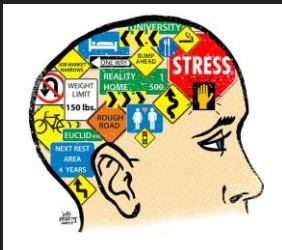
manipulation of objects

integration of different senses that allows for understanding of single concept



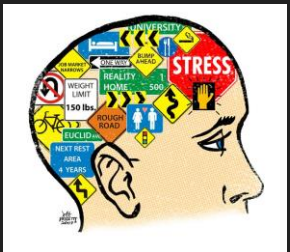
Parietal Lobe: observed problems in TBI

- inability to attend to more than one object at a time
- inability to name an object (anomia)
- inability to locate words for writing (agraphia)
- difficulty with drawing objects
- difficulty in distinguishing left from right
- difficulty with doing mathematics (dyscalculia)
- lack of awareness of certain body parts and /or surrounding space (apraxia) that leads to difficulties in self care / kinesthetics
- inability to focus visual attention
- difficulties with eye-hand-coordination



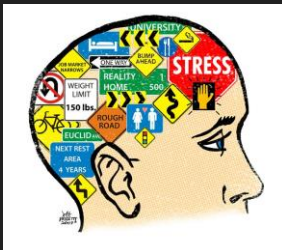
Occipital Lobe : Function

Vision



Occipital Lobe: observed problems in TBI

- deficits in vision including visual field cuts
- difficulty with locating objects in environment
- difficulty with identifying colors (color agnosia)
- production of hallucinations (visual)
- visual illusions –inaccurately seeing objects
- word blindness –inability to recognize words
- difficulty in recognizing drawn objects
- inability to recognize movement of an object (movement agnosia)
- difficulties with reading and writing



Temporal Lobes : Functions

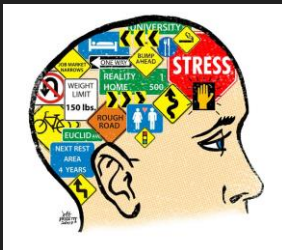
hearing ability

memory acquisition

some spatial perceptions

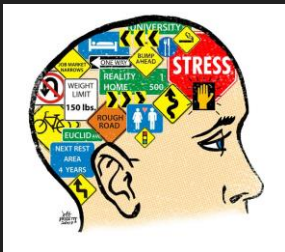
categorization of objects

language/prosody



Temporal Lobes: observed problems in TBI

- difficulty in recognizing faces (prosopagnosia)
- difficulty in understanding spoken words (Wernicke's aphasia)
- disturbance was selective attention to what we see and hear
- difficulty with identification of and verbalization about objects
- short term memory loss
- interference with long-term memory
- increased or decreased interest in sexual behavior
- inability to categorize objects (categorization)
- right lobe damage can cause persistent talking
- increased aggressive behavior



Brain Stem : Functions

breathing

heart rate

swallowing

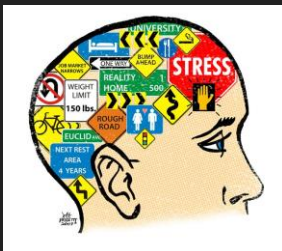
reflexes to seeing and hearing (startle response)

controls sweating , blood pressure, digestion, temperature (ANS)

affects level of alertness

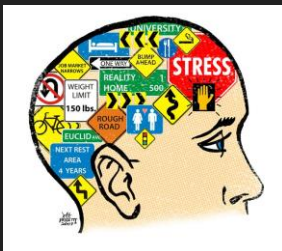
ability to sleep

sense of balance (vestibular function including MLF)



Brainstem: observed problems in TBI

- decreased vital capacity and breathing, important for speech
- dysphagia
- difficulty with organization /perception of environment (basic)
- problems with balance and movement
- dizziness and nausea / vertigo
- sleeping difficulties (insomnia, sleep apnea)



Cerebellum: Functions

coordination of voluntary movement

balance and equilibrium

visuospatial function

executive function

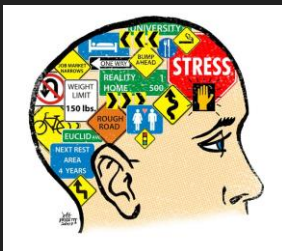
language function

affect and behavior



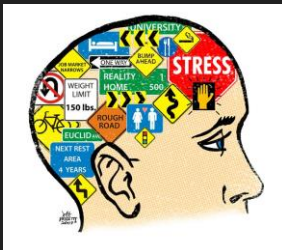
Twenty-five years of discovery have converged to suggest that the majority of the human cerebellum is connected to cerebral association networks. The revelation that the cerebellum possesses prominent association zones has far-reaching implications for how we explore its function and also view mental disturbances that arise from network disruptions. The recognition of the cerebellum's importance to cognition is also a remarkable story of scientific discovery. Initial insights arose from the unconventional thoughts of a unique interdisciplinary team (Henrietta Leiner, Alan Leiner, and Robert Dow) and an observation made serendipitously during an early neuroimaging study of human cognition. Modern anatomical techniques were necessary to give traction to the discovery while neuroimaging techniques able to broadly survey the brain were best suited to reveal a parsimonious map that connects the motor zones of the cerebellum to the newly discovered association zones.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4723423/>



Cerebellum: observed problems in TBI

- loss of ability to coordinate fine movements
- loss of ability to walk
- inability to reach out and grab objects
- tremors
- dizziness (Vertigo)
- slurred speech (scanning speech)
- inability to make rapid movements
- behavior/language/executive dysfunction??



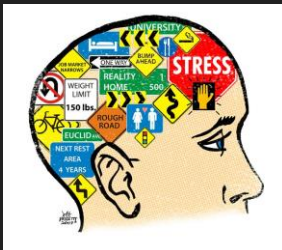
executive functions

decision making

cognitive organization

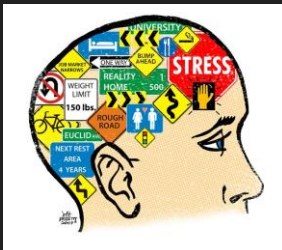
network locations

- orbital prefrontal
- medial prefrontal
- dorsolateral prefrontal
- ventral frontal
- anterior superior medial prefrontal (anterior cingulate)

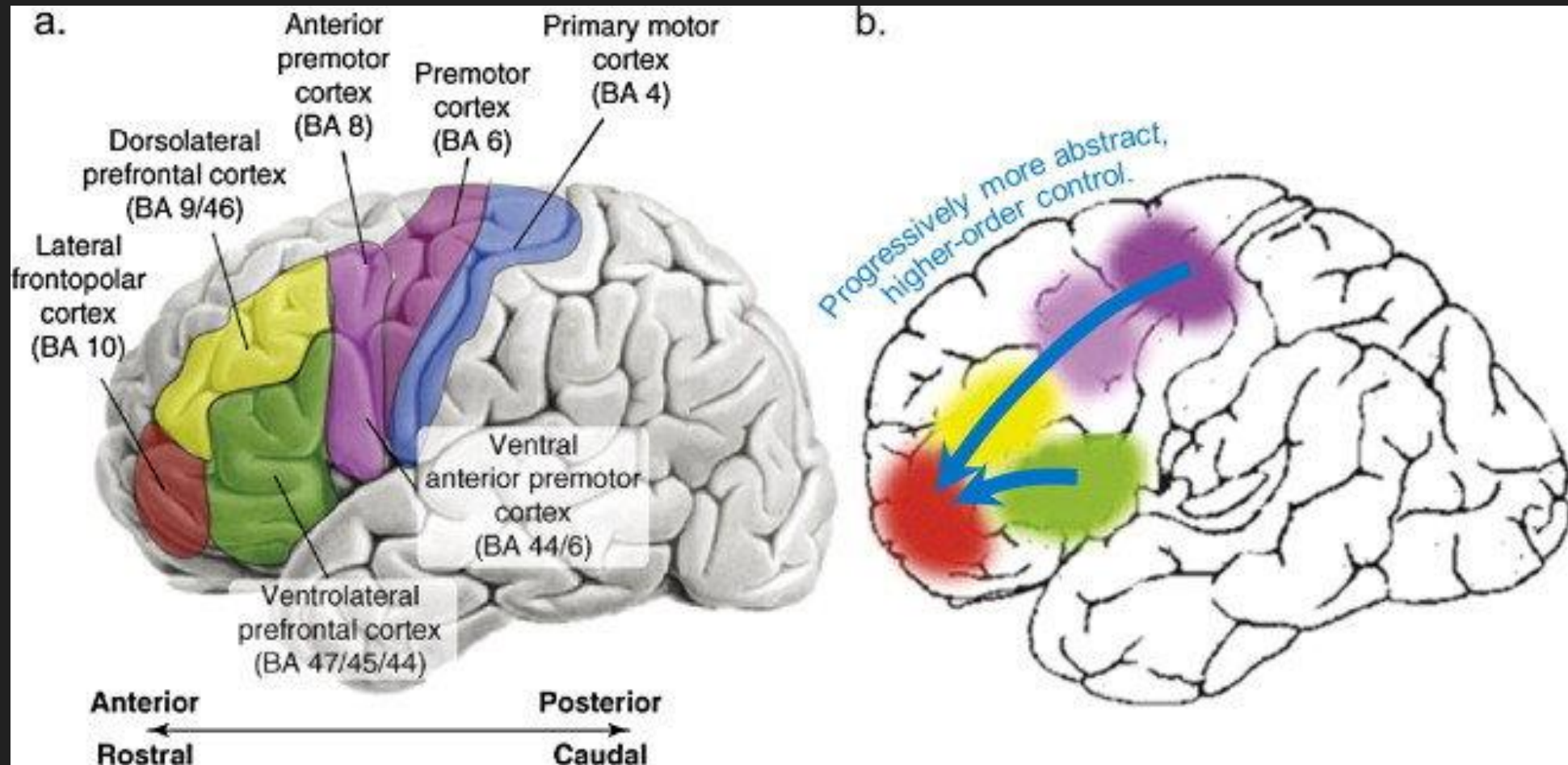


Prefrontal Cortex

- the prefrontal cortex is an important way station between the frontal lobe and other areas of the brain including the hippocampus, amygdala, and parietal lobes



Frontal/Prefrontal Cortex



Dorsolateral Prefrontal Cortex

loss of working
memory

inability to perform
delay response
tasks

memory recall and
context in which
memory was
originally founded

difficulty with rule
changing in the
moment

abstract reasoning

planning

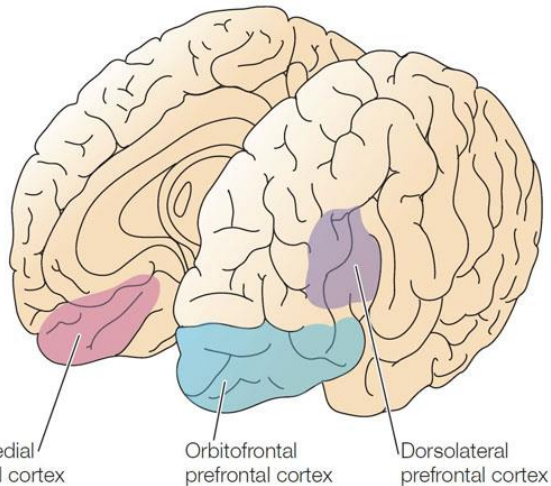
insight

divided attention

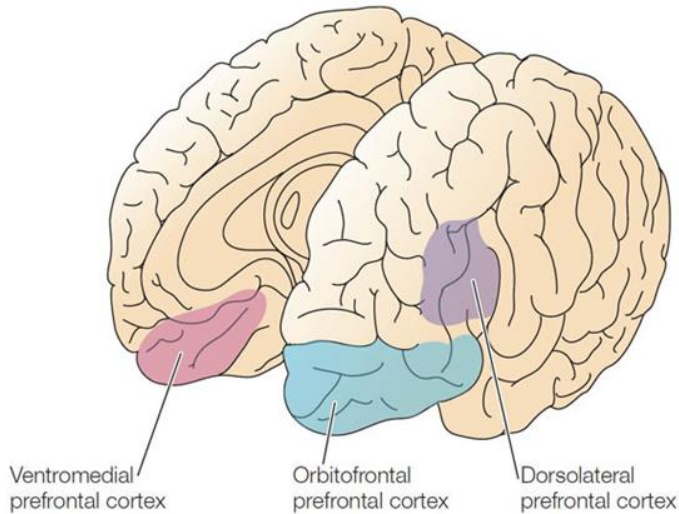
reduced relational
reasoning

set shifting

discourse abilities
(storytelling)



Ventromedial / Orbital Prefrontal



confabulation

poor judgment

emotional
lability

inappropriate
euphoric affect

distract ability
(stimulus
boundedness:
"here /now ")

impulsivity

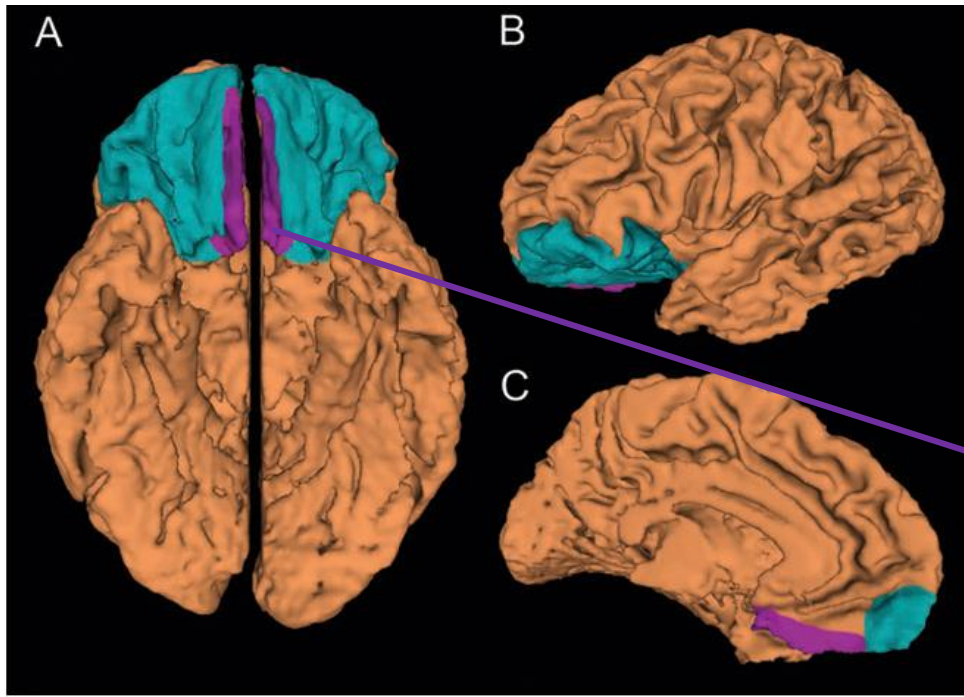
disinhibited
behavior

childlike /
childish

stubborn

tactless

Ventral Frontal



difficulty in reward-based contingency learning

decision making tasks requiring emotional processing

gyrus rectus



Anterior/Posterior Medial (Cingulate) Prefrontal (*deep*)

social
judgement

initiation

inhibition/ self
control

motivated
behavior

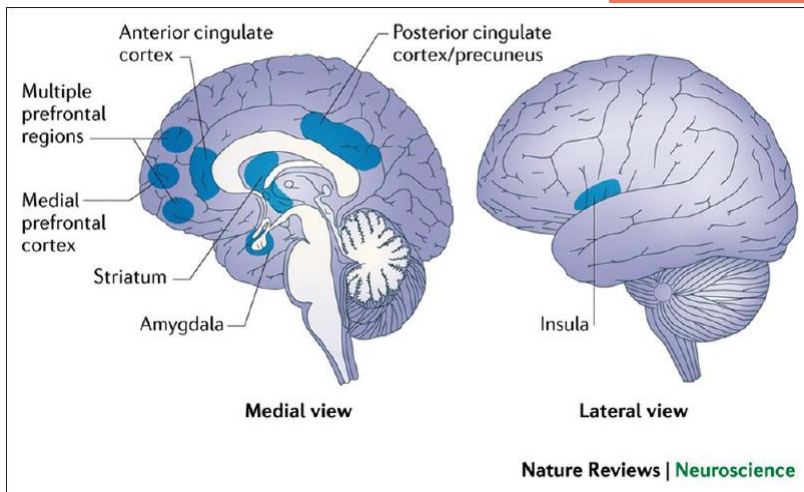
lethargy

disinterest

reduced
drive

inability to
act decisively
(abulia)

motivation



Is the anterior cingulate cortex regarded as
part of the prefrontal cortex ?



Neuropsychological Testing

attention /concentration

motor

sensory

verbal memory

non-verbal memory

neurobehavioral

personality

motivation /effort

Tidbit of information:
if someone cannot do neuro-psych testing, only 6% are statistically employed at one year period

