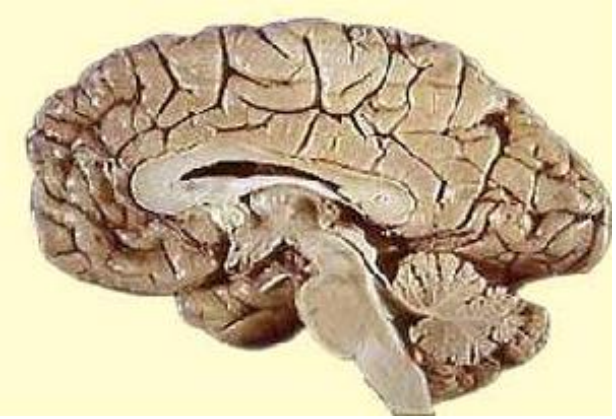
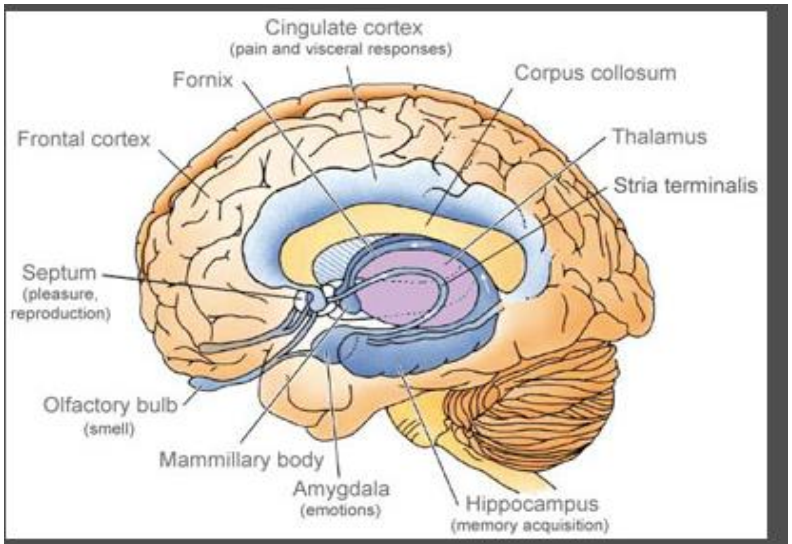
[1]The Impact of prefrontal lobes on sensation seeking in teens and ‘maturing’ in seniors

[2]Teens and Risk Behaviour*

- Until the prefrontal cortex and its connections within and to other parts of the brain are mature, things adults consider obvious and even dangerous may not be interpreted that way by the still incomplete frontal lobes of teenagers
- Without the prefrontal cortex's executive functions to inhibit impulses, weigh consequences of decisions, prioritize, strategize, separate fact from opinion, weigh the validity of information, and analyze risk, teens make decisions based on emotional, reactive, rather than logical, reflective, responses.

3 Teens and Risk Behaviour*

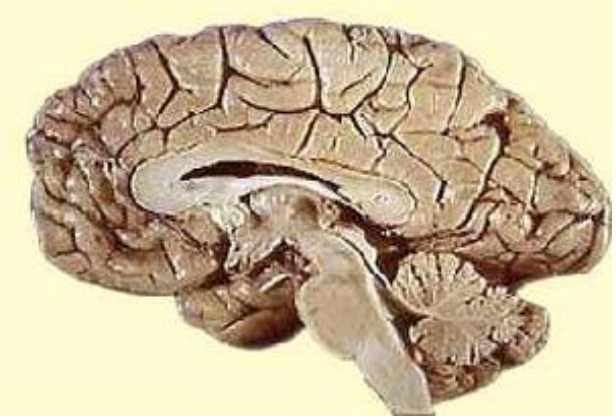


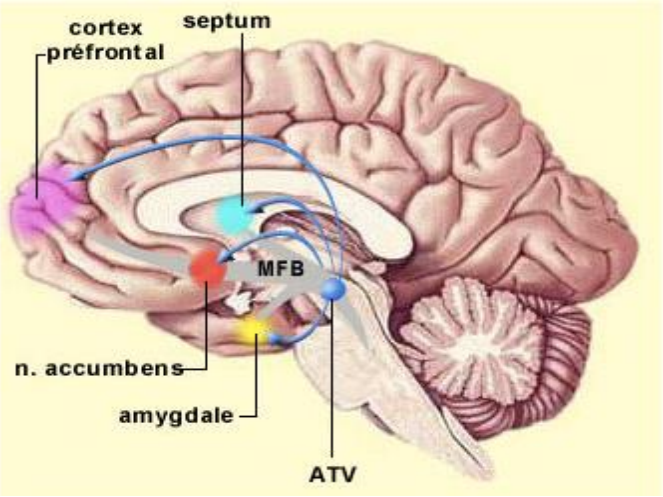


The limbic system (dark blue) and surrounding structures

- The immaturity of the connections between the limbic system and the prefrontal cortex, and the research around the amygdala, provide support to this theory
- The amygdala in the limbic system plays an important role in regulation of emotions especially in fear and aggressive reactions.
- When potentially dangerous stimuli are detected by amygdala they alert other brain structures that co-ordinate the fight-or-flight response

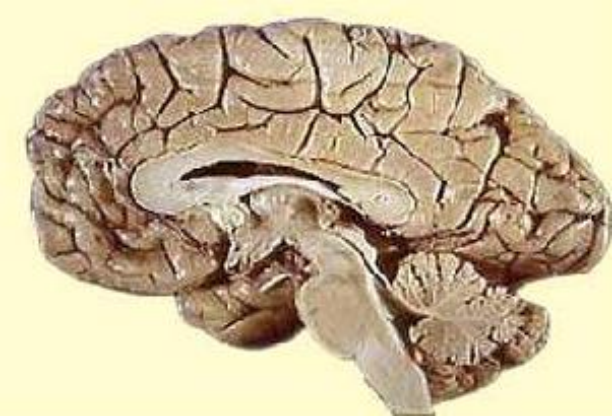
Teens and Risk Behaviour*

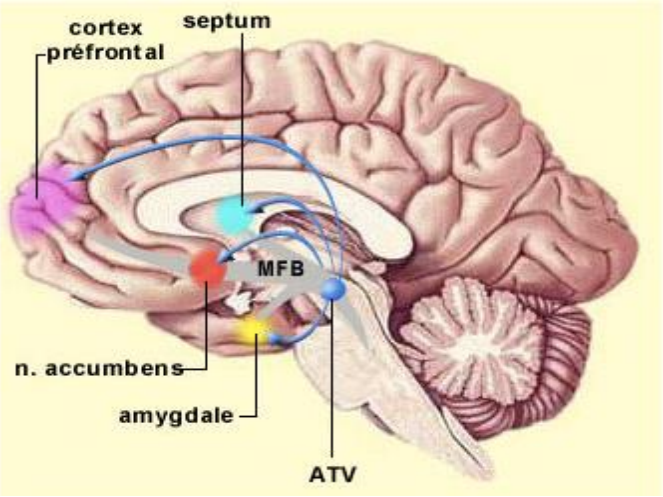




- Nucleus Accumbens
- Part of the brain's reward system also located in the limbic system.
- This area processes information related to motivation and reward
- MRI studies have shown that this structure is highly sensitized in adolescents
- It sends out strong impulses when faced with opportunity to obtain something desirable- sensation seeking

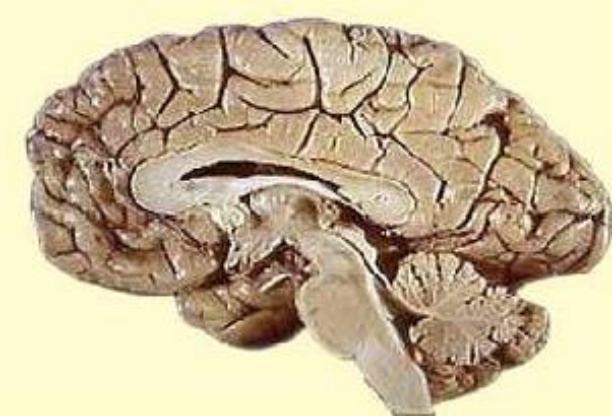
Teens and Risk Behaviour Remarkable recent findings*

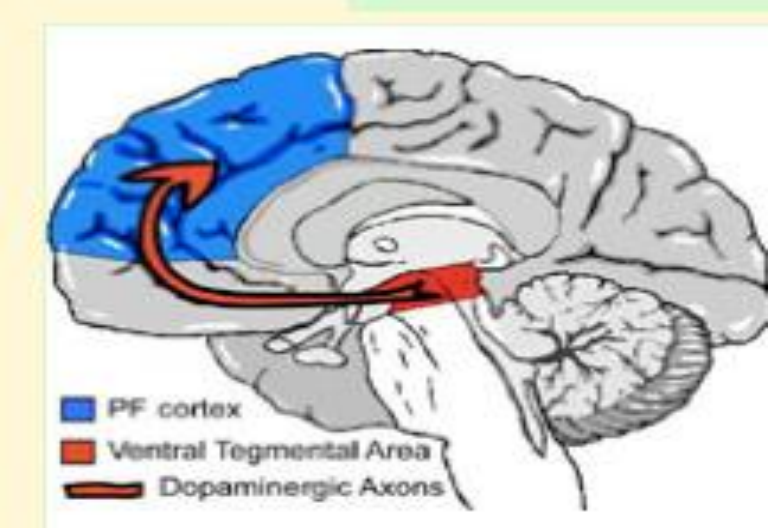




- Nucleus Accumbens
- Using fMRI found exaggerated activity relative to orbitofrontal (inhibition of prepotent responses) in adolescents compared to children and adults
- So area of sensitivity to reward is disproportionately activated relative to later maturing top-down control systems thus biasing the adolescent's action toward immediate over long-term gains.

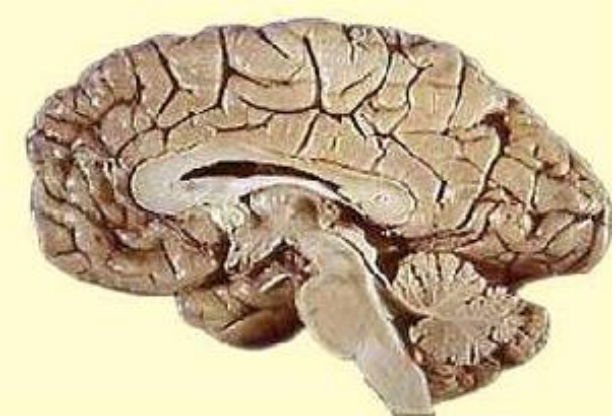
[6]Teens and Risk Behaviour/Sensation seeking*

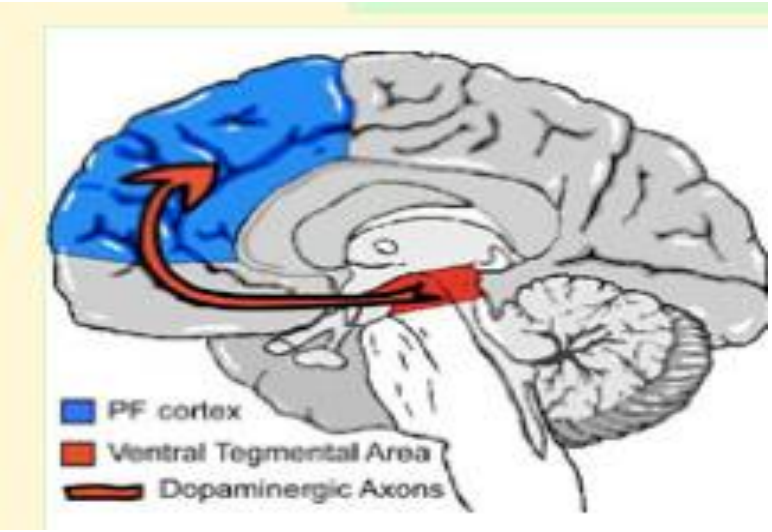




- Located in the midbrain, at the top of the brainstem, the VTA (ventral tegmental area) is one of the most primitive parts of the brain.
- It is the neurons of the VTA that synthesize dopamine, which their axons then send to the nucleus accumbens.
- Another structure involved in pleasure mechanisms is the prefrontal cortex, whose role in planning and motivating action we have talked about is modulated by dopamine.
- So here we have a circuit for sensation seeking which, of course, leads to risk behaviour.

[7]Teens and Risk Behaviour/Sensation seeking*



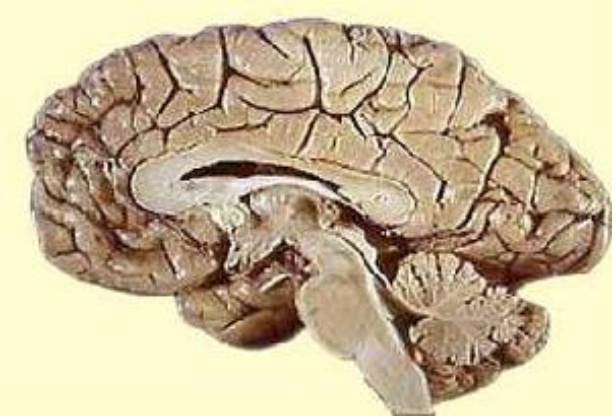


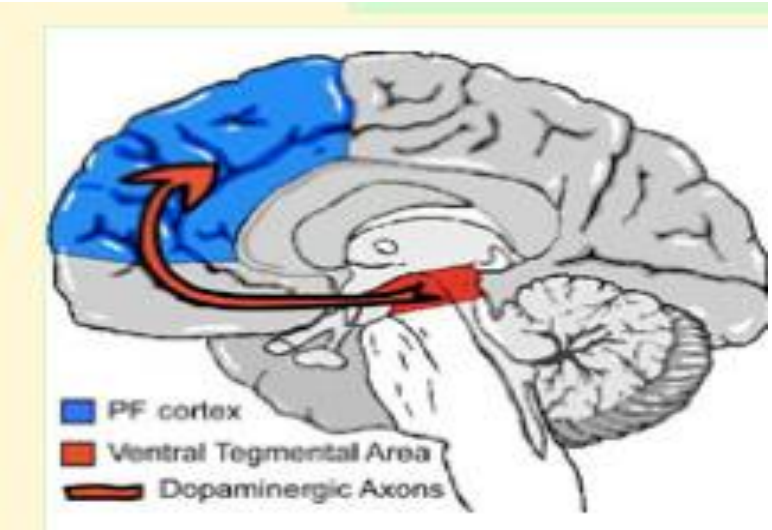
In the frontal part of the brain, the part of the brain involved in judgment, organization, planning, strategizing -- those very skills that teens get better and better at -- this process of thickening of the gray matter peaks at about age 11 in girls and age 12 in boys, roughly about the same time as puberty.

But - and here is the critical point

After that peak, the gray matter thins as the excess connections are eliminated or pruned..

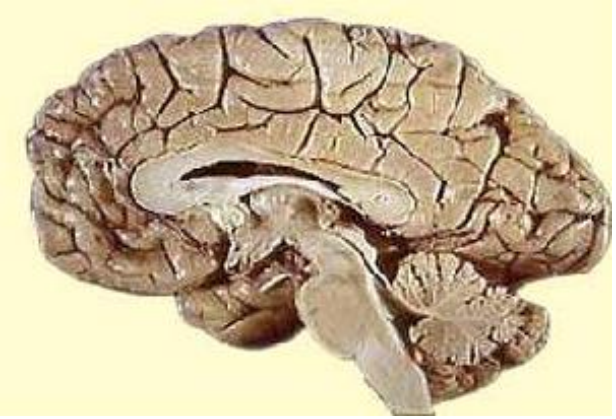
[8]Teens and Risk Behaviour/Sensation seeking*

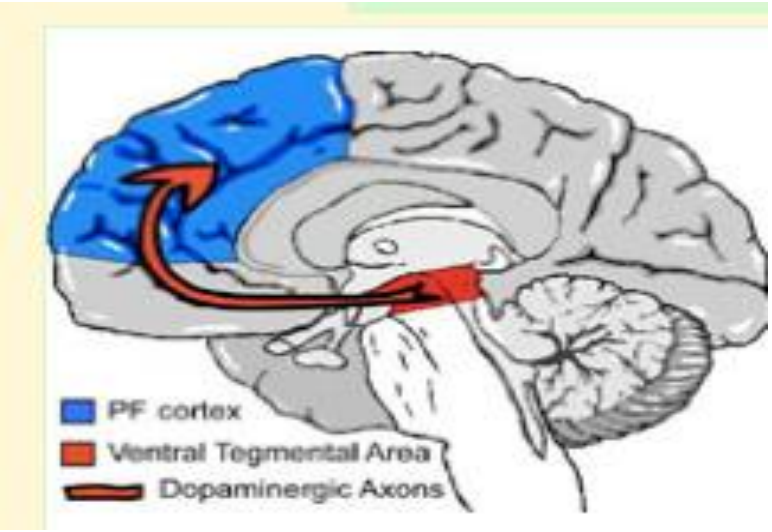




- .This pruning-down phase is important because of the the "use it or lose it" principle.
- Those cells and connections that are used will survive and flourish. Those cells and connections that are not used will wither and die.
- “Neurons that fire together wire together”
- Right around the time of puberty and on into the adult years is a particularly critical time for the brain sculpting to take place...

[5]Teens and Risk Behaviour/Sensation seeking*





- new studies about early teenage use of marijuana showed that young adults who started smoking pot regularly before they were 16 performed significantly worse on cognitive tests of brain function than those who had started smoking later in adolescence- particularly on tests assessing executive function.
- Imaging scans found alterations in the frontal cortex white matter tracts of the brain in the early-starters

[9]Aging and Executive functioning

- while the brain undergoes significant structural change with age, the greatest declines are found within the frontal lobes.
- both gray and white matter show significant decline across the lifespan, with the prefrontal cortex (PFC) showing the greatest amount of loss and the steepest declines.

[10]Frontal lobes & Aging -Deterioration & Compensation*

- Some general observations about cognitive functioning as one gets older
- Paper and pencil tests relying on speed and new learning declines after middle age
- Memory for names, places and events decline - <u>explicit memory</u>
- (Emotional memories such as attachment, fear, procedural memories such as playing an instrument, habits - <u>implicit memory</u> - are relatively unimpacted by aging)
- These two memories are processed by different neural networks

[11]Frontal lobes & Aging -Deterioration & Compensation*

- The pattern of blood flow in the prefrontal cortex in the brains alters with age during multi-tasking

- In 2013 brain researchers from Japan and USA have compared brain activity during single and dual tasks (a physical task and a calculation task) for young (aged 21 to 25) and older (over 65) people.

[12]Frontal lobes & Aging -Deterioration & Compensation*

- The main difference between the groups was only seen when performing the physical and mental tasks at the same time - older people had a higher prefrontal cortex response which lasted longer than the younger group.
- during the dual task it seems that the older people turn their attention to the calculation at the expense of the physical task, while younger people are able to maintain concentration on both.
- it seems that this requirement for increased activation of the prefrontal cortex is part of normal decrease in brain function (efficiency) associated with aging.

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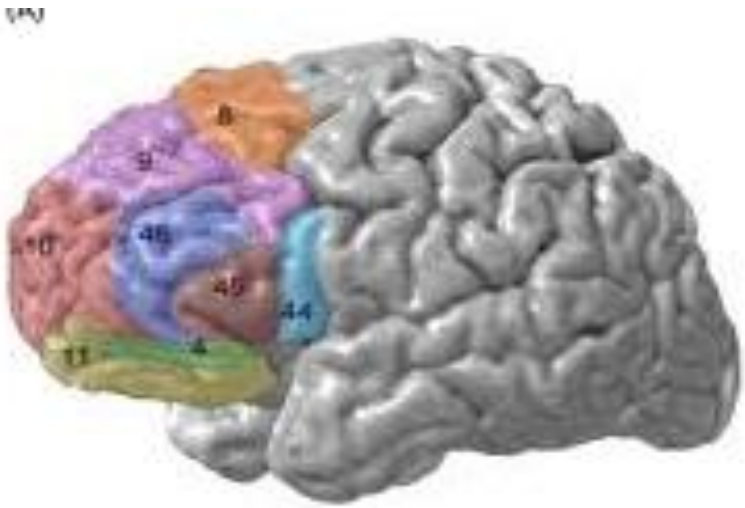
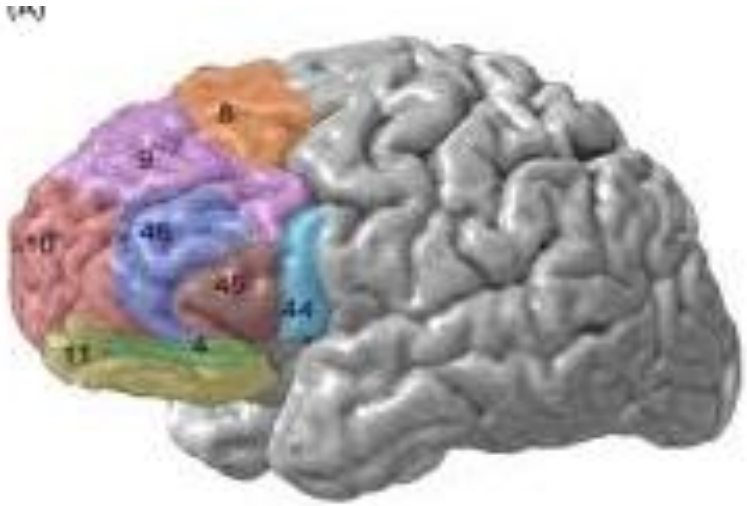
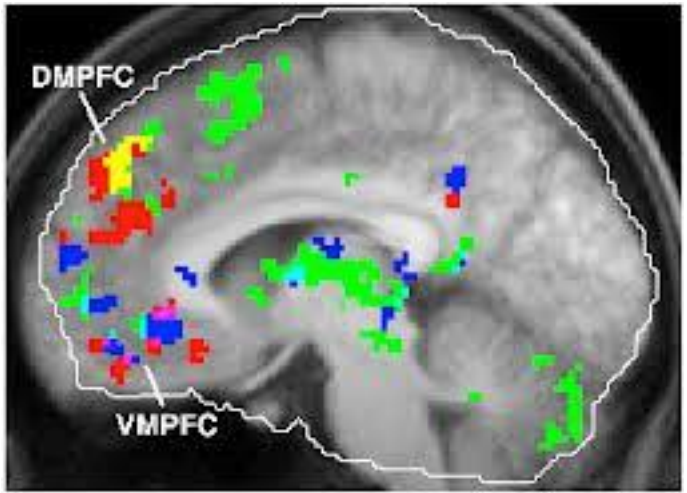


- The top and sides (Dorsolateral -8,9,10,46;Ventrolateral- 44,45) -highly connected to the rest of cortex & hippocampus resulting in combining memory, attention, sensory information, problem solving skills for the purpose of navigating our outer environment, context like who or where (the WHAT that we talked about earlier)

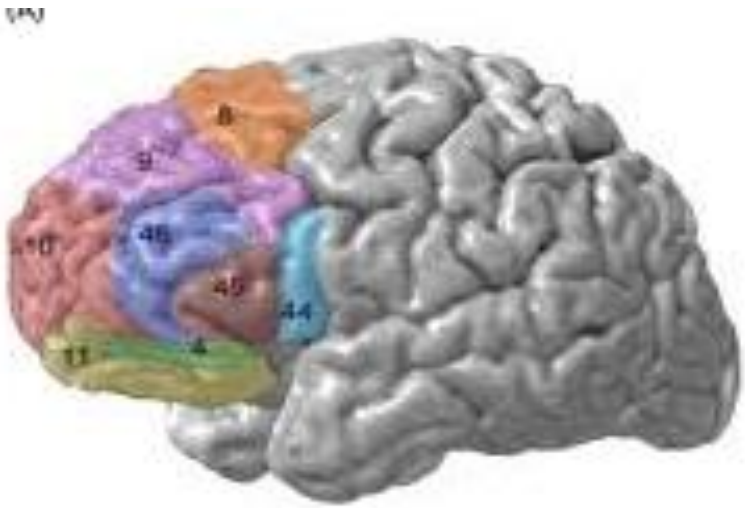
14





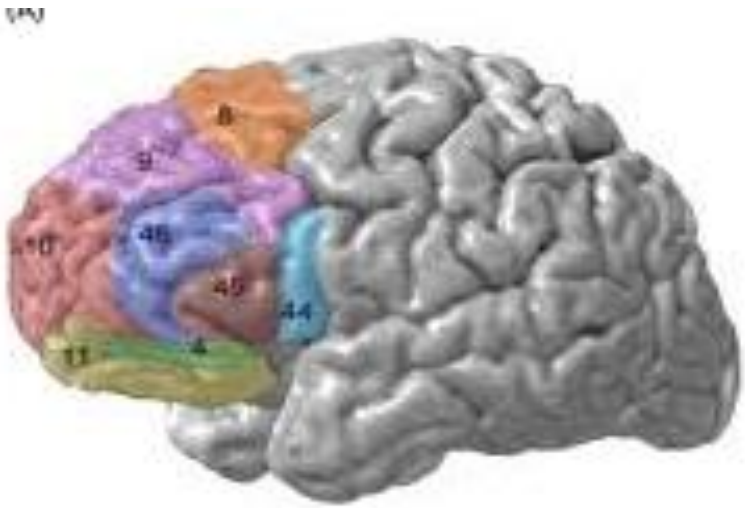
- The orbitofrontal and ventromedial link subcortical regions and the amygdala to the body, organizing emotional processing, fear regulation and attachment in order to navigate our inner experience.

15 *



- Putting these different developmental pathways in slightly different terms
- the top-side prefrontal (dorso and ventral lateral)are principally involved in higher executive functions and they decline with age.

16 *



- The bottom medial system (orbital frontal and ventromedial) are involved in the expression and control of emotional and instinctual behaviors and tend not to diminish with age

[17]Frontal lobes & Aging -Deterioration & Compensation*

- However, recent work has shown that aging can have two opposing effects on brain activity:
- compared to young adults, older adults showed reduced activity in some brain regions but increased activity in other brain regions
- Age-related increases in neural activity were prominent within PFC, where they often involved regions that were not reliably recruited by younger adults.
- These findings challenged the standard assumption that aging is associated with a simple pattern of cognitive and neural decline,
- Rather, cognitive processing in the aging brain is not just a weaker version of cognitive processing in the young brain, it is different.

[18]Frontal lobes & Aging -Deterioration & Compensation*

- why do older adults recruit additional PFC regions?
- *compensation*: the aging brain attempts to counteract neural decline by reorganizing its functions but we have to bear in mind that
- Greater activity is not always associated with better cognitive performance
- it is unclear whether increased activity in older adults reflects compensation or non-selective recruitment (an inability to recruit specialized brain regions).

[19]Frontal lobes & Aging -Deterioration & Compensation

- The age-related decrease in occipital activity coupled with an age-related increase in PFC activity is one of the most consistent findings in functional neuroimaging studies of cognitive aging using visual stimuli.
- It has been suggested that older adults compensated for visual processing deficits (occipital decrease) by recruiting higher-order cognitive processes (PFC increase).

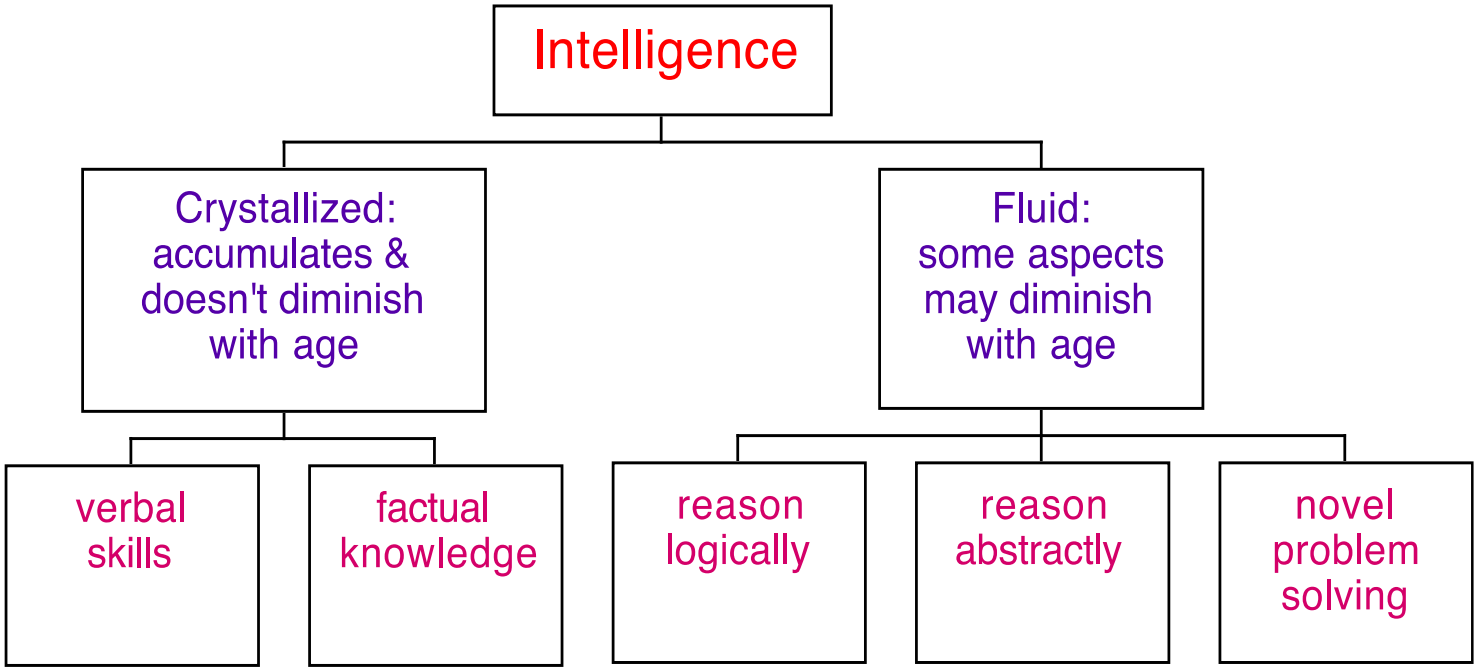
[20]Frontal lobes & Aging -Deterioration & Compensation*

- Interestingly, these global age effects on functional connectivity resemble the two global activation patterns in older adults (1)decreased asymetry; (2) increased PFC activity and decreased occipital activity with visual stimuli)
- (1) there is evidence that aging is not only associated with more bilateral activation pattern but also with an increase in functional connectivity homologous regions in the two hemispheres
- (2) there is evidence of a an age-related reduction in functional connectivity involving posterior brain regions coupled with an age-related increase in functional connectivity with PFC regions

[21]Exercising the Brain*

- A major reason we have memory loss in aging is that we have trouble in registering new events in our nervous system
- Why
- Not so much an issue with transmitters (like most improvement drugs on the market) but rather
- Because our processing speed slows down so that accuracy, strength and sharpness with which we perceive declines
- If you can't register something clearly you won't remember it well

22Two Types of Intelligence



- **<u>Fluid Intelligence</u> may be highly related to Prefrontal lobe Function**