Juvenile Brain Development

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1241
ARTHUR


GOPHERS

Adolescent Development and Risk - Taking

Risk taking

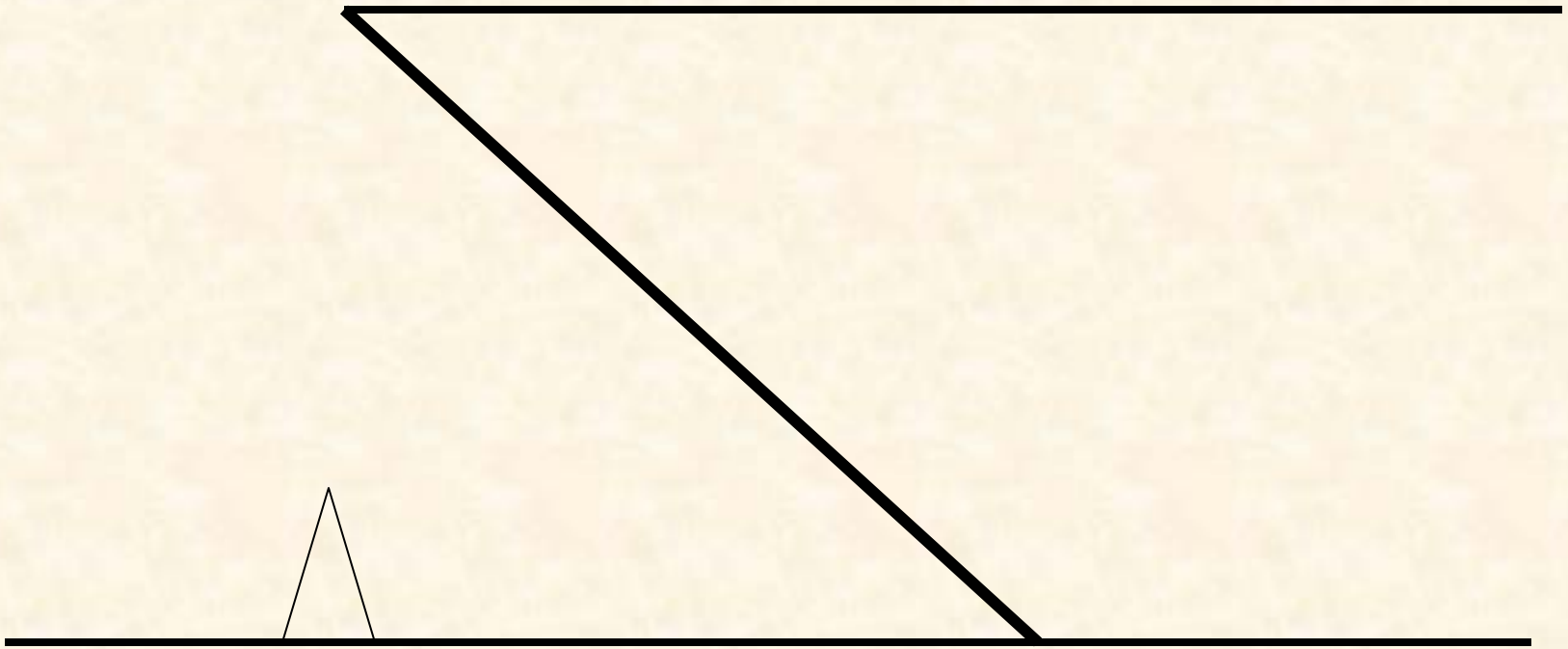
- Novelty/stimulation seeking.
- Enhanced susceptibility to peer influence.
- Shortened time perspective.
- Poor judgment under an emotional “load”.
- Reduced “temperance”.
- Weaker autonomous sense of identity.

Disproven Hypotheses

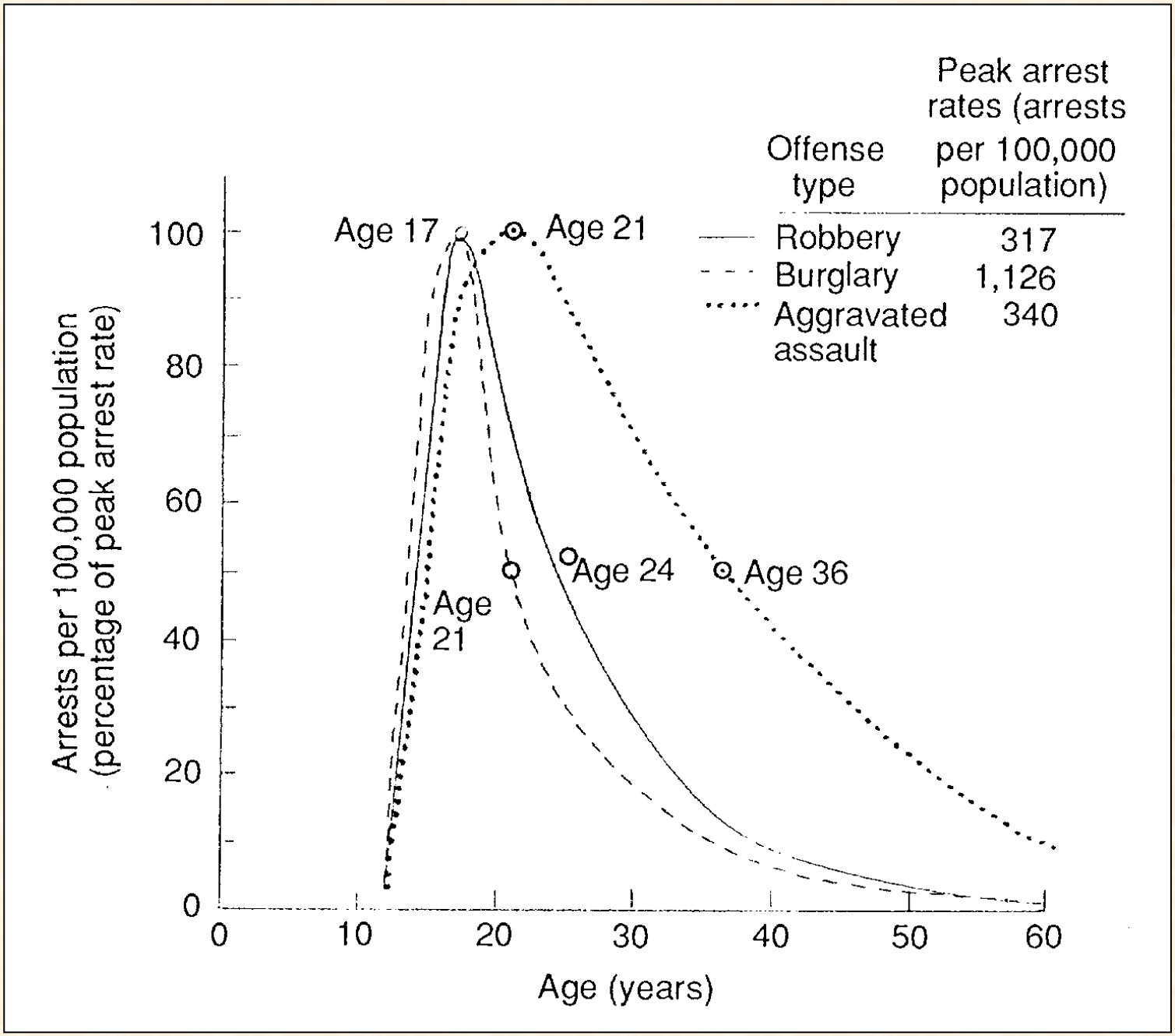
- Adolescents do not perceive risk.
- Adolescents are irrational in their thinking about risk.
- Deficient judgment of the seriousness of consequences of risky behaviors.
- Deficient “Risk salience”: the belief that they could personally be harmed by a negative outcome: Think they are “invulnerable”.

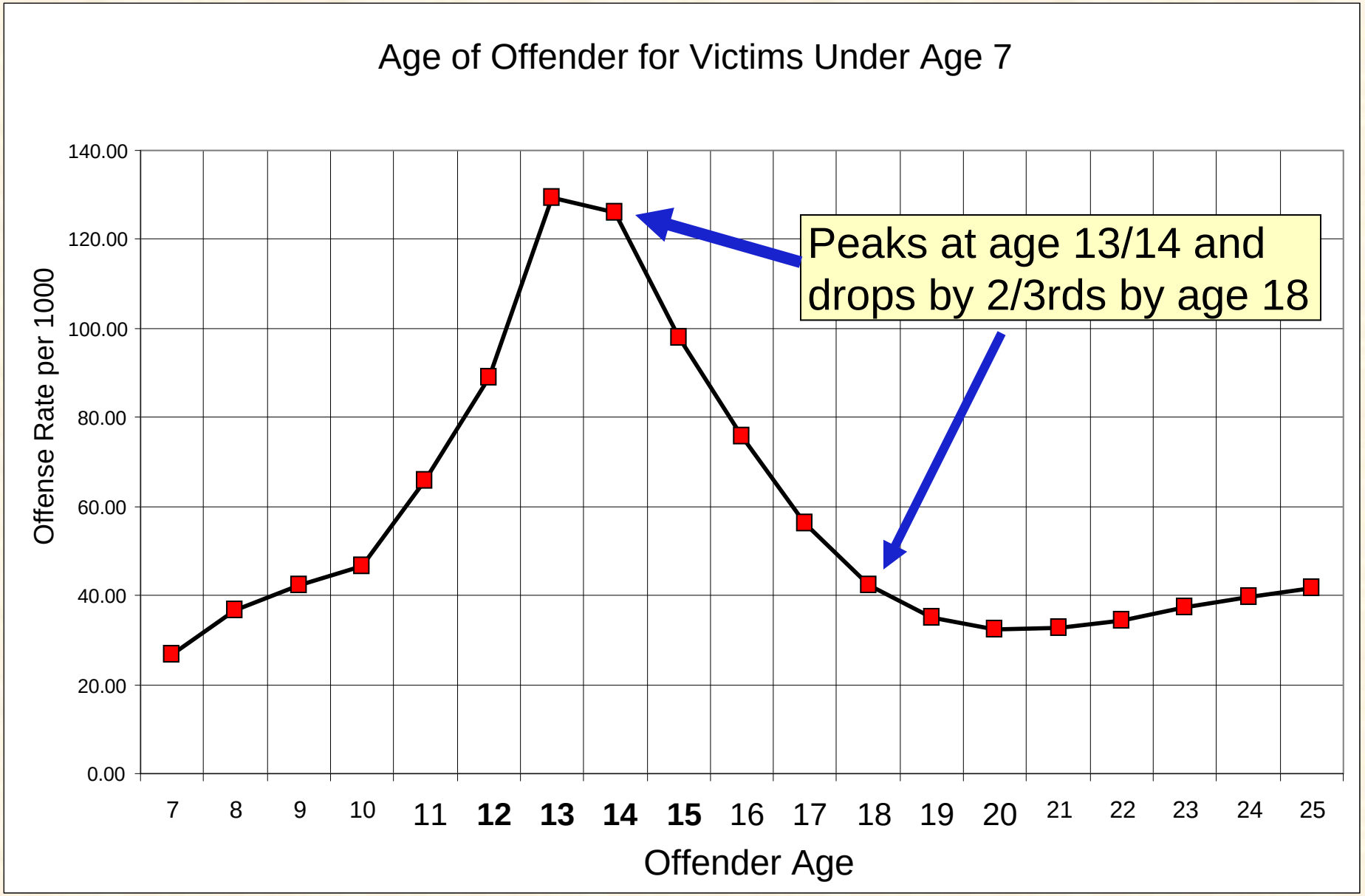
Adolescent psychopathology

- More psychopathology (especially emotional dysregulation like depression and anxiety)
- More personality disturbances with more severe symptoms.
- More behavioral disorders with more severe symptoms.
- More negative psychosocial outcomes (i.e. suicide, accidents)

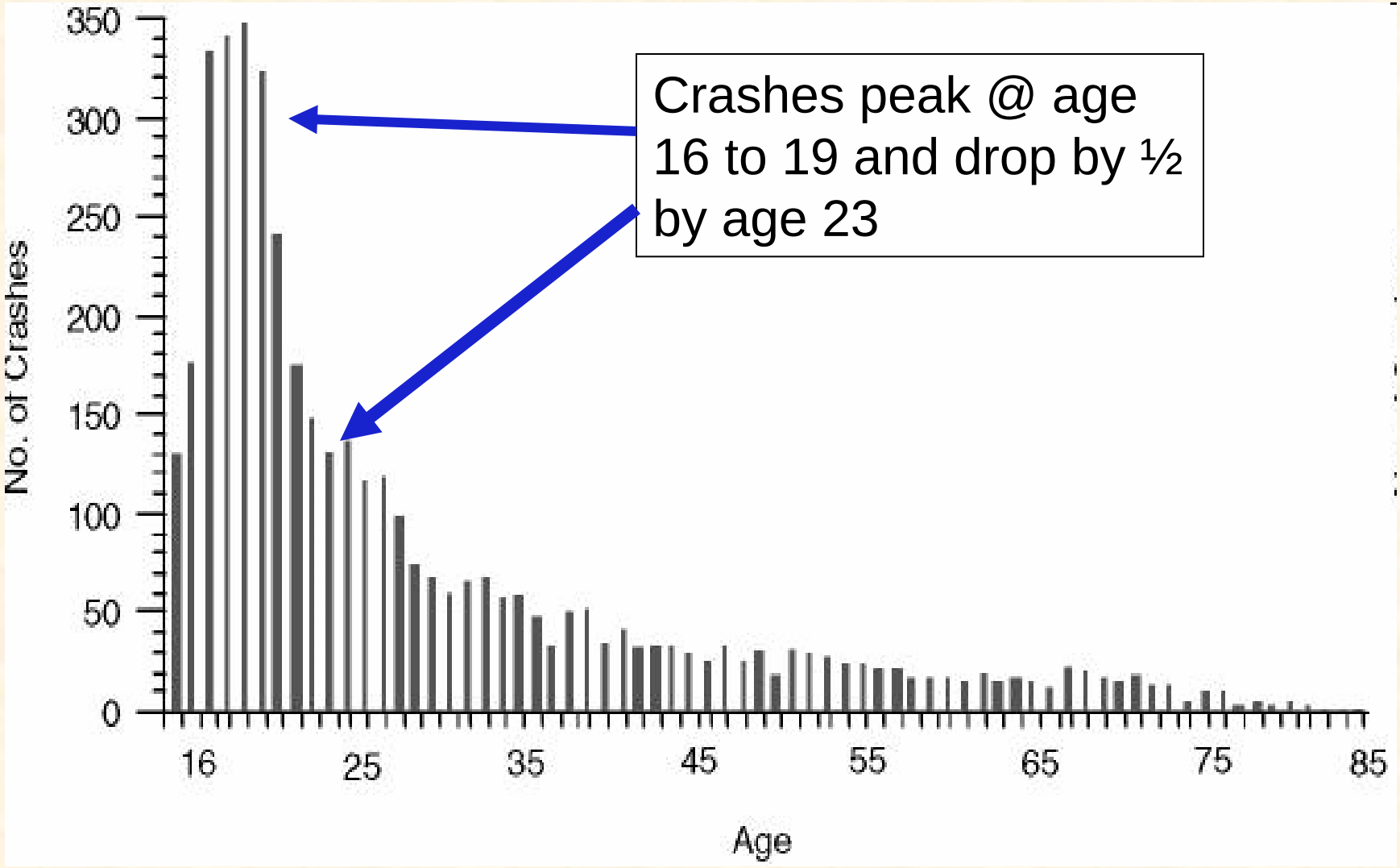


Ship arriving too late to save a drowning witch


Peak arrest rates (arrests per 100,000 population)
Offense type
Robbery 317
Burglary 1,126
Aggravated assault 340
Age 17
Age 21
Age 24
Age 36
Age 21
Arrests per 100,000 population (percentage of peak arrest rate)
100
80
60
40
20
0
0
10
20
30
40
50
60
Age (years)


Age of Offender for Victims Under Age 7
Offense Rate per 1000
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Offender Age
Peaks at age 13/14 and drops by 2/3rds by age 18

Adolescent Development



Adolescent differences: Emotion

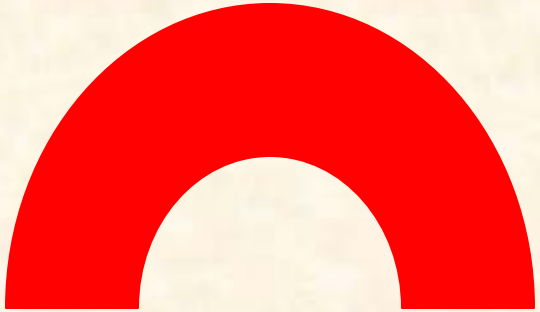
- Adolescents show higher:
  - Reward sensitivity
  - Novelty seeking
  - Emotional intensity

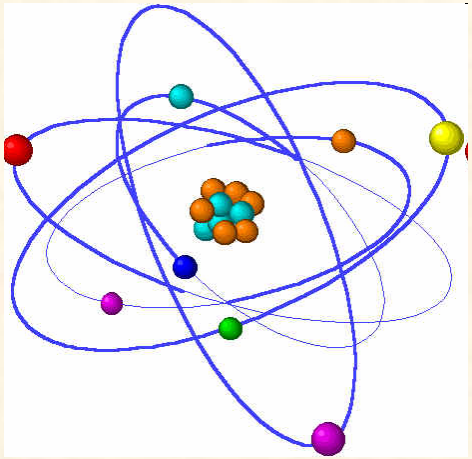
Impulsivity

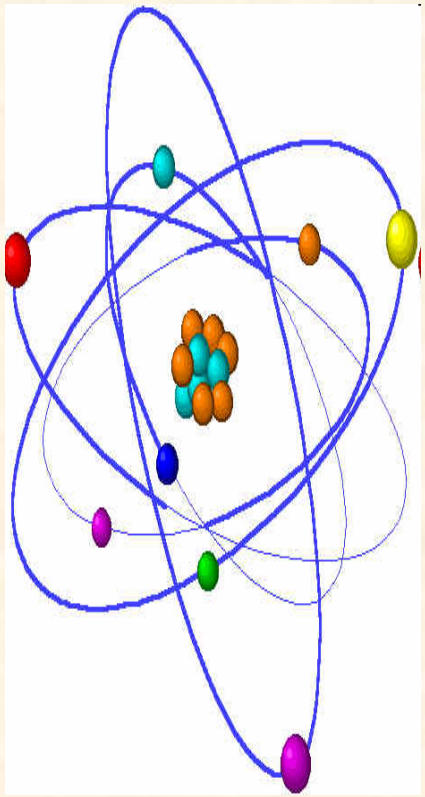
- Measured by self – report or various tasks
- Impulsivity improves with age through adolescence.
- Younger children are more impulsive.

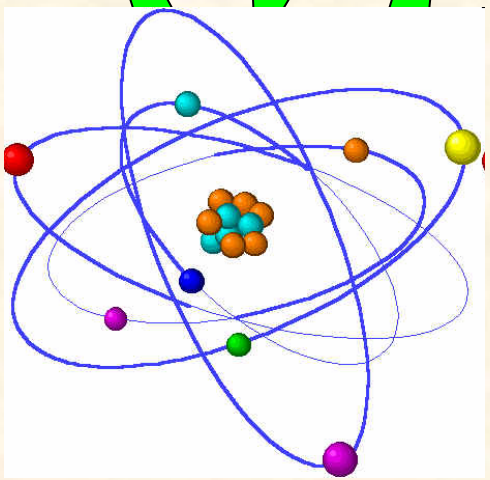
Adolescent differences: Thinking

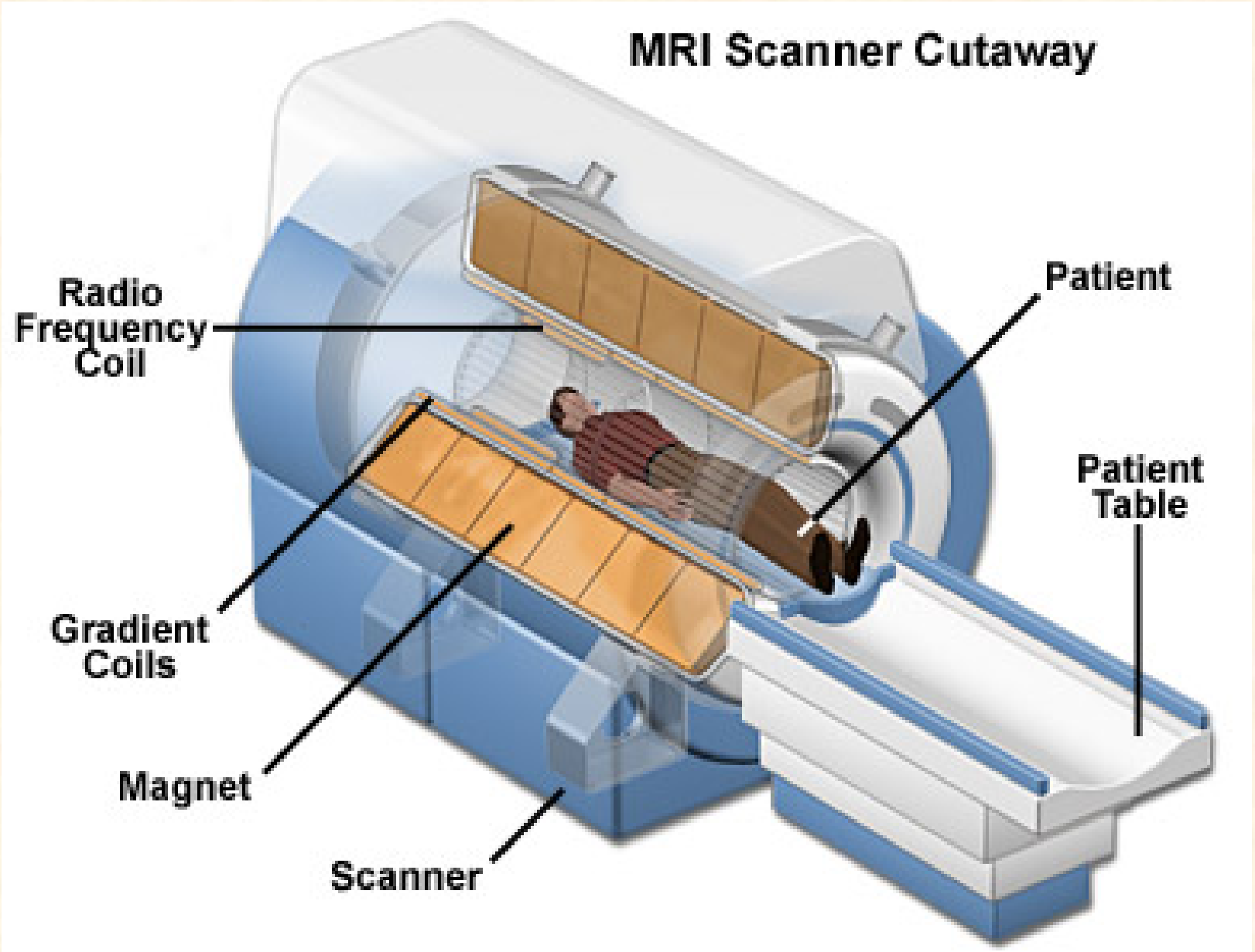
- Adolescents show lower:
  - Future orientation
  - Resistance to peer influences





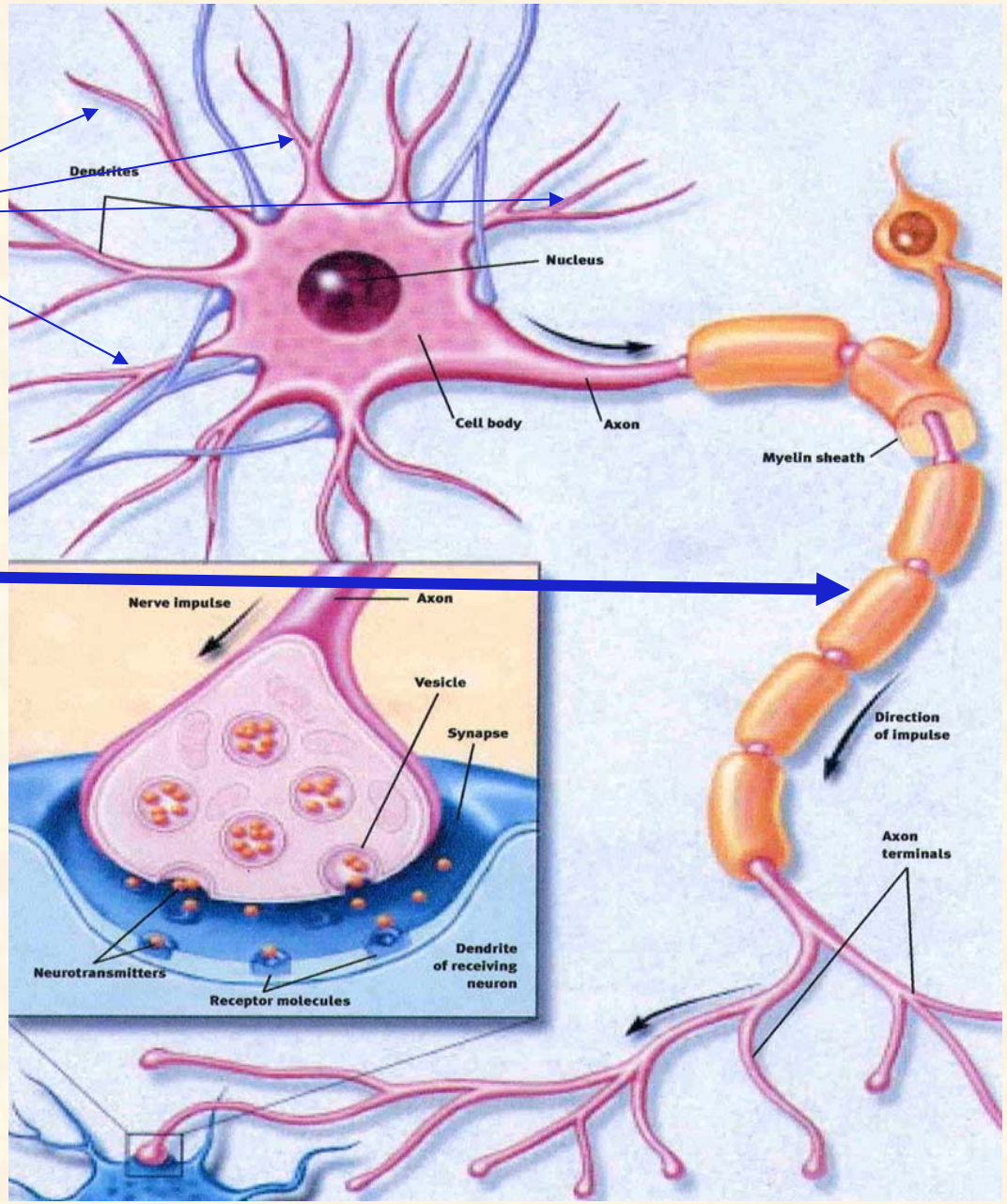


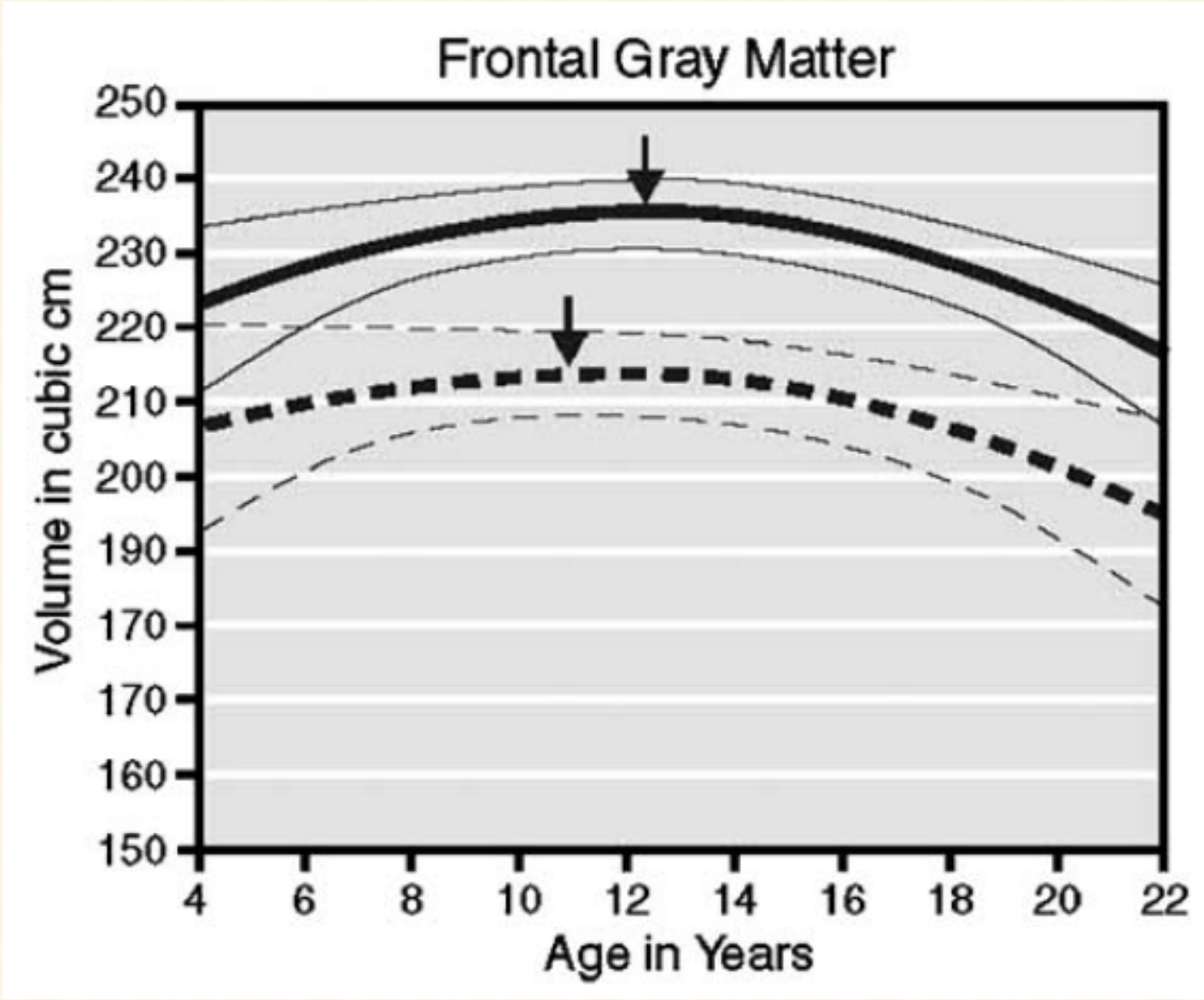



MRI Scanner Cutaway
Radio Frequency Coil
Patient
Patient Table
Gradient Coils
Magnet
Scanner

Dendrites

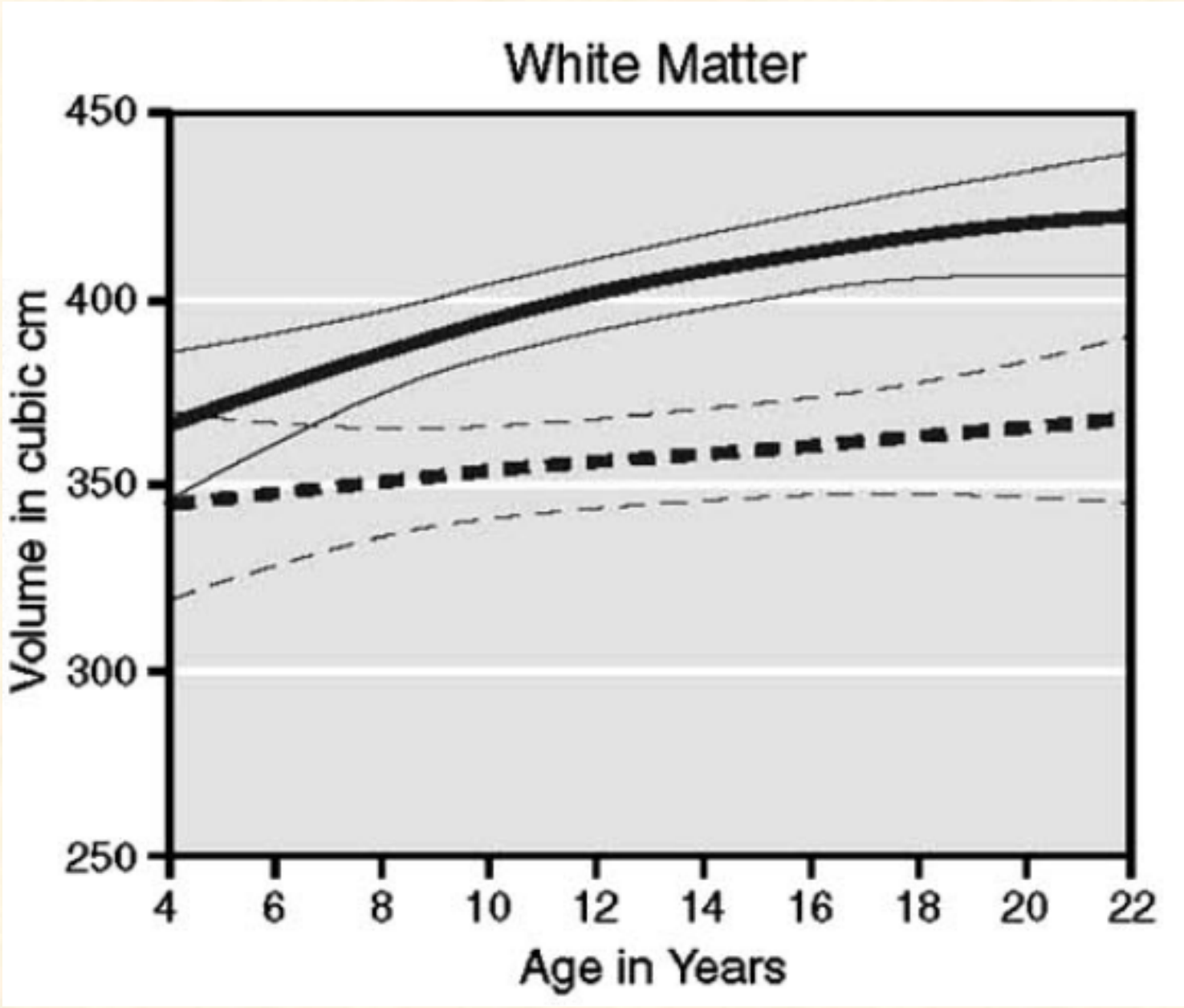
Myelin sheath




Frontal Gray Matter
Volume in cubic cm
250
240
230
220
210
200
190
170
170
160
150
4
6
8
10
12
14
16
18
20
22
Age in Years

PRUNING

- **“USE IT OR LOSE IT”–** Reading, sports, music, video games, x-box, hanging out—whatever a child/teen is doing—these are the neural synapses that will be retained and strengthened.
- Less used “side roads” are pruned so that “main highways” work more efficiently.


White Matter
450
400
350
300
250
Volume in cubic cm
4
6
8
10
12
14
16
18
20
22
Age in Years

Brain Studies

- Recent Magnetic Resonance Imaging studies have shown changes in:
  - Myelination (coating of nerve cells that improves their efficiency and speed)
  - Pruning (loss of nerve cells that serve little – used tracks). This improves the efficiency of more commonly used tracks.
- Myelination is not evenly distributed through adolescence; decision-making areas myelinate last.

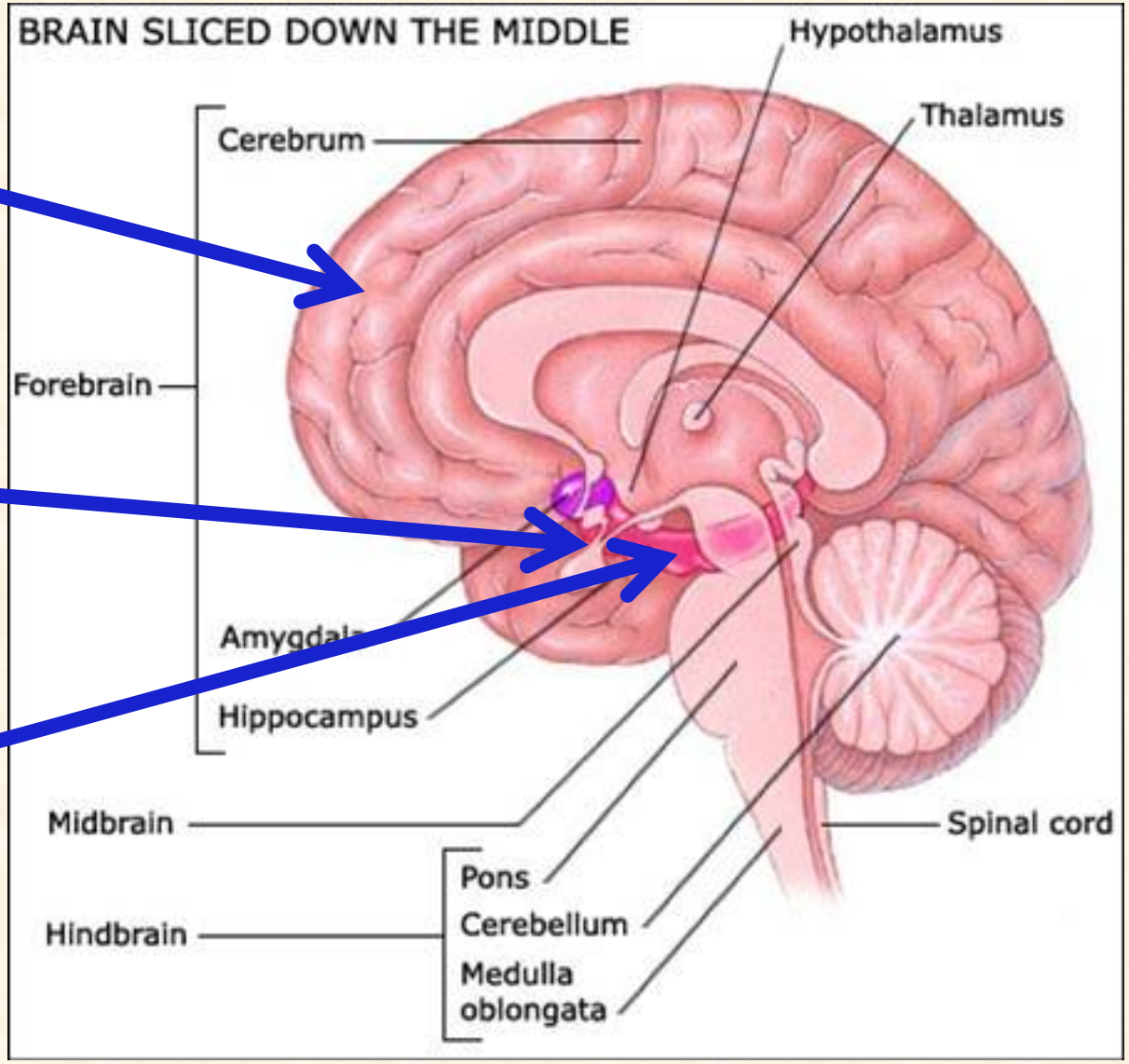
Brain maturation

- Myelination is inhibited by:
  - Stress hormones; exposure to adverse living environment.
  - Lack of adequate sleep (9.25 hrs per night optimal)
  - Nutrition (**not** MacDonalds).
  - Exposure to toxins and some drugs.
- There are individual differences in the brain maturation timetable.

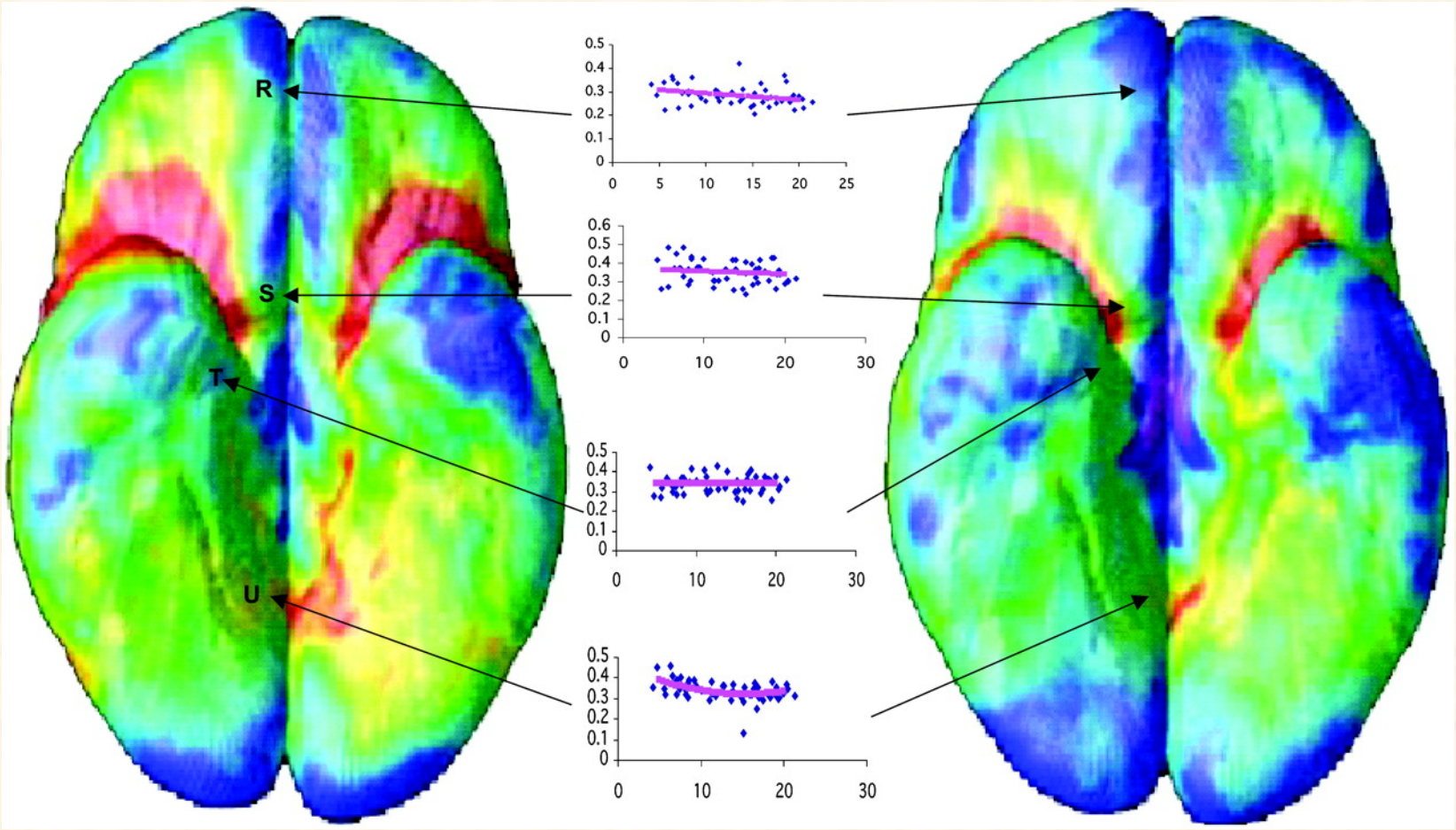
Executive decision – making **(regulation)**

Emotions and behavioral impulses

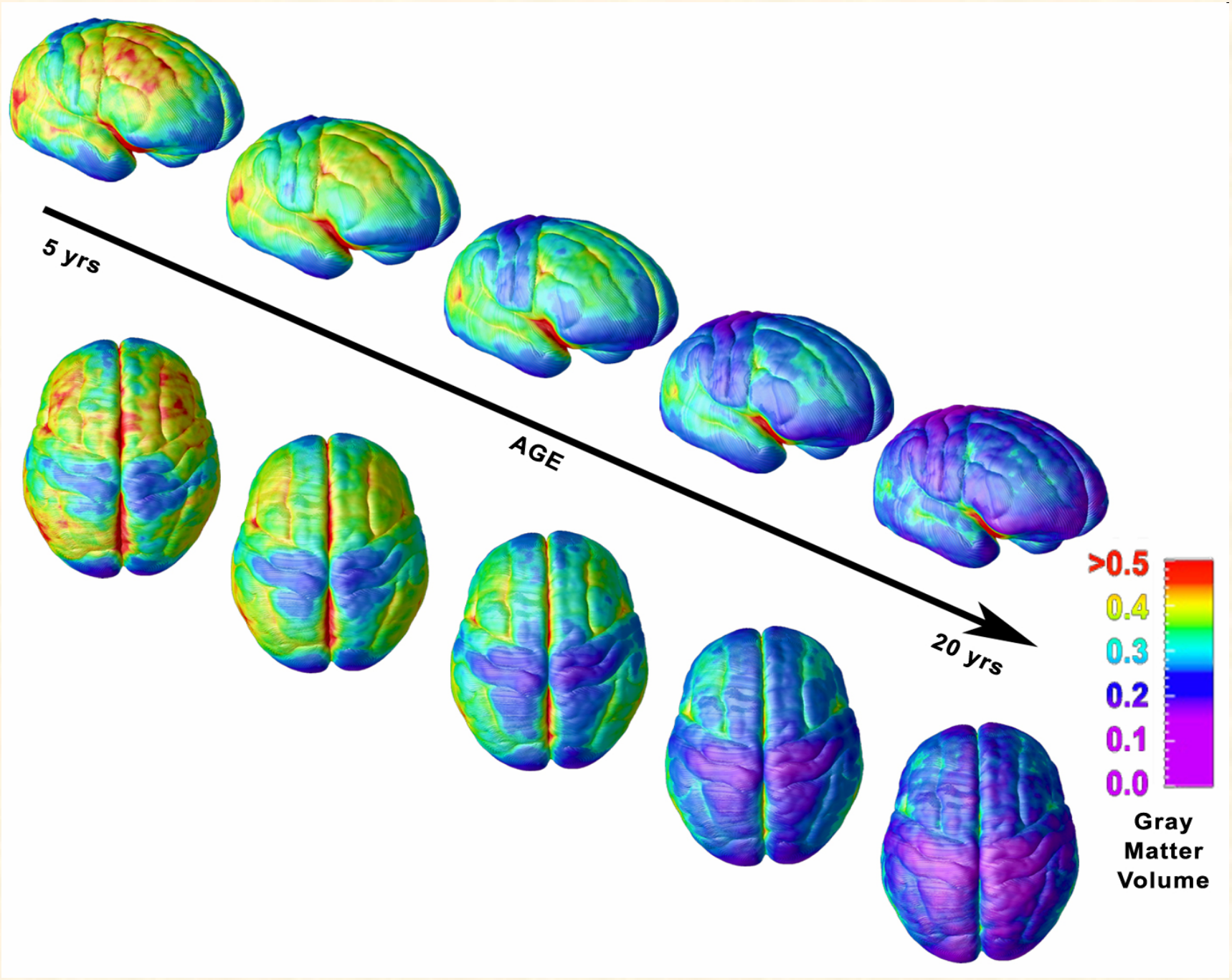
Pleasure and reward centers **(appetites)**

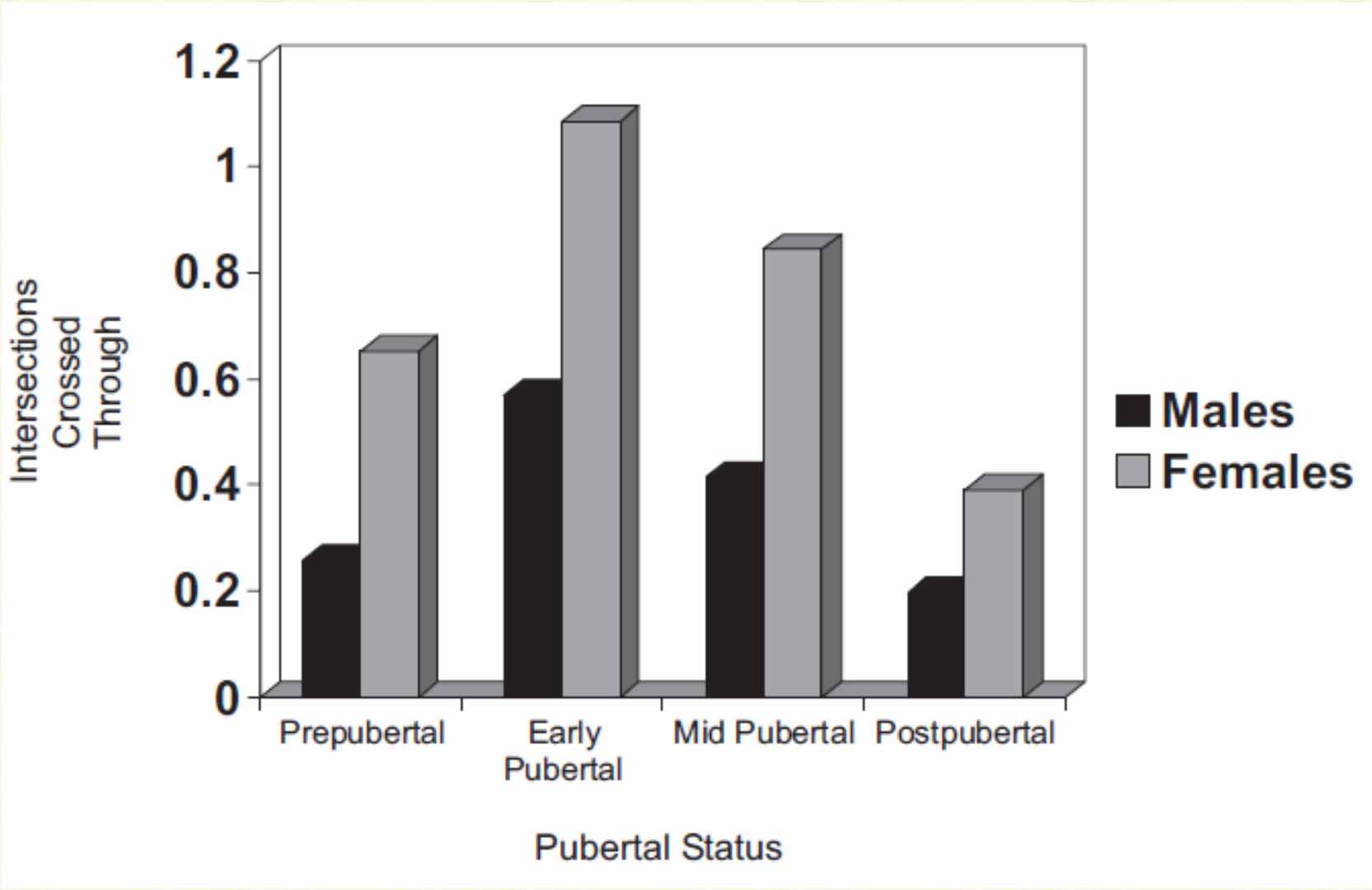


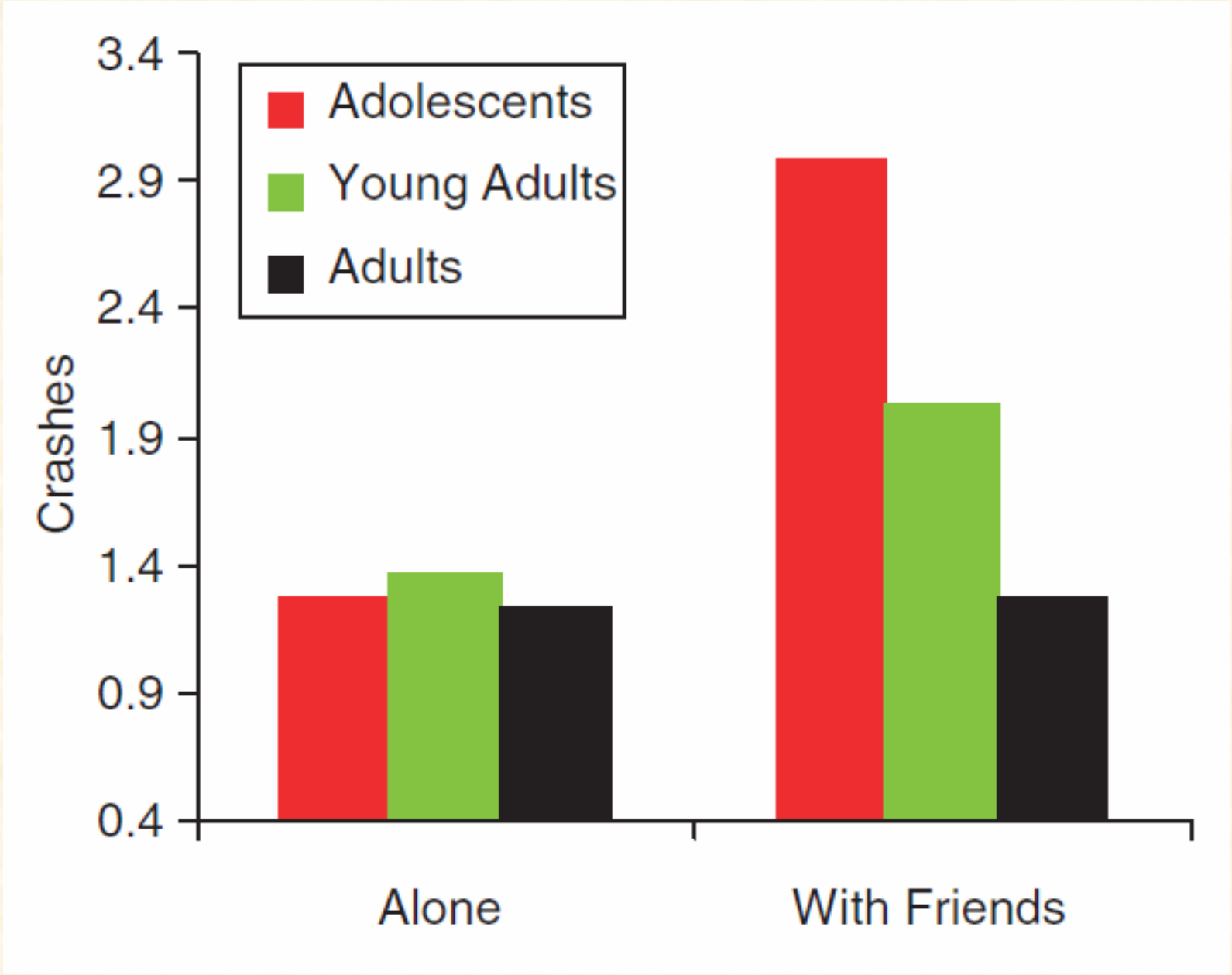
Bottom view of the brain showing early and late time-lapse images.



Gogtay N et al. PNAS 2004;101:8174-8179


5 yrs
AGE
20 yrs
>0.5
0.4
0.3
0.2
0.1
0.0
Gray
Matter
Volume

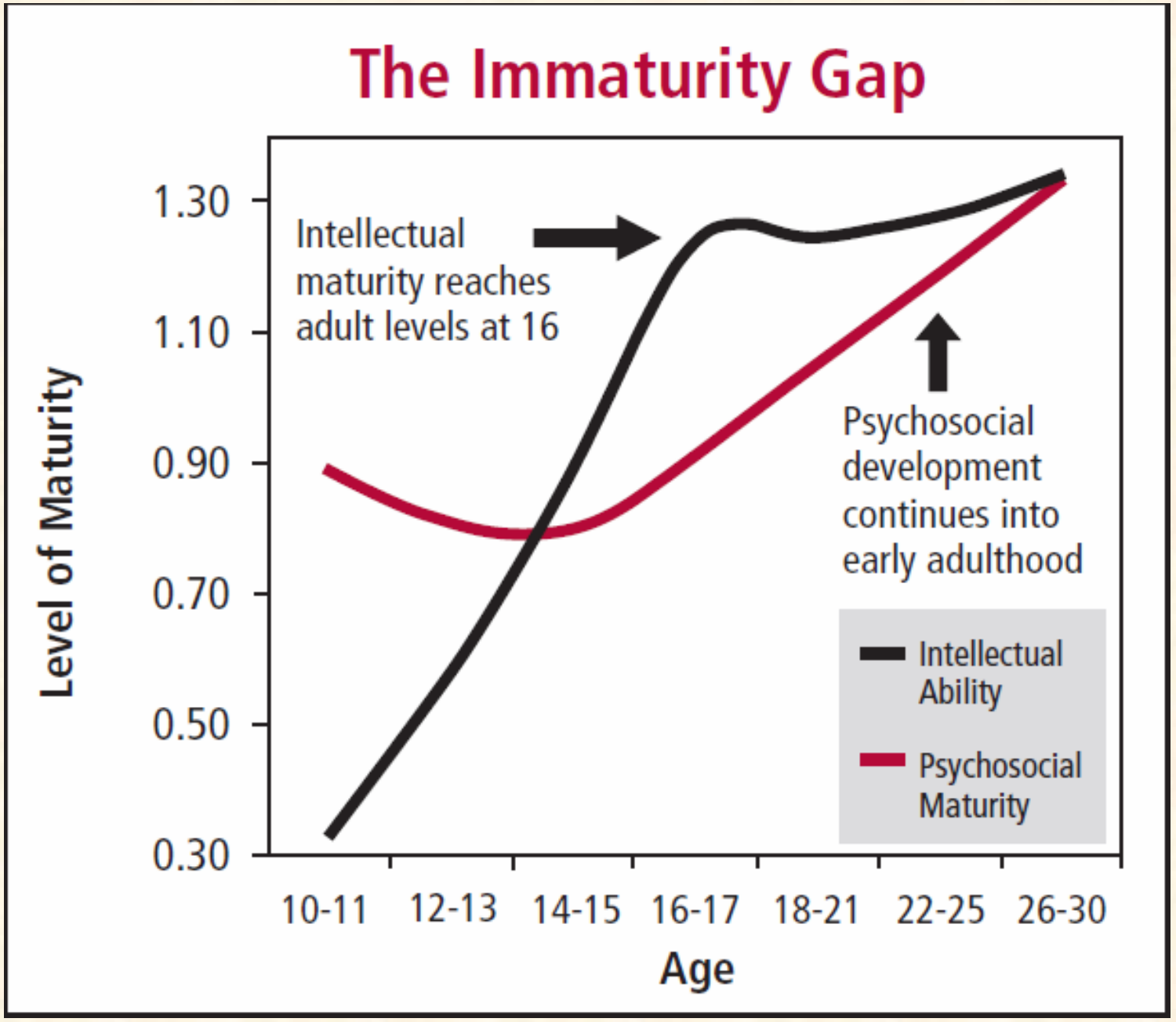

1.2
1
0.8
0.6
0.4
0.2
0
Intersections Crossed Through
Prepubertal
Early Pubertal
Mid Pubertal
Postpubertal
Pubertal Status
Males
Females

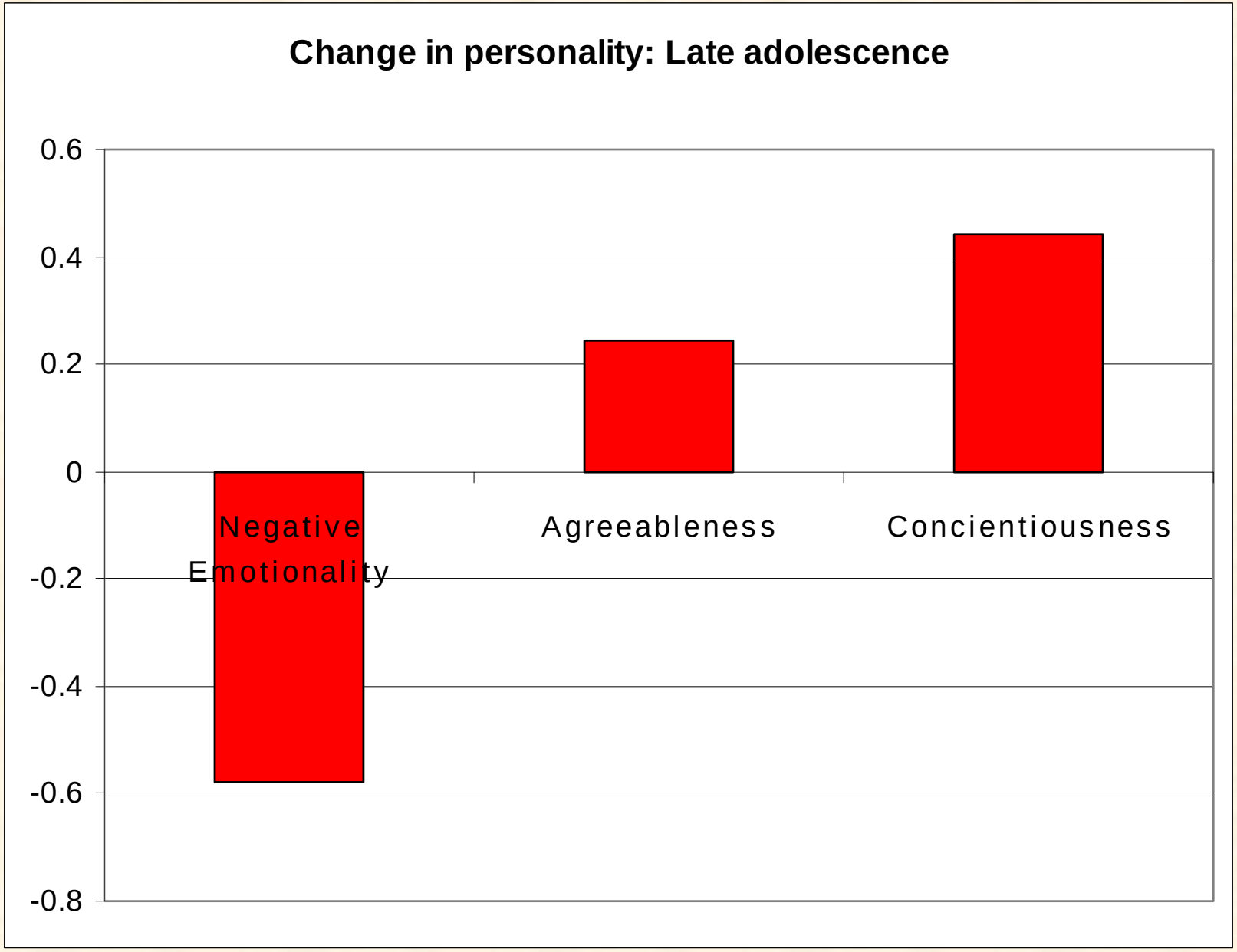

3.4
2.9
2.4
1.9
1.4
0.9
0.4
Crashes
Adolescents
Young Adults
Adults
Alone
With Friends

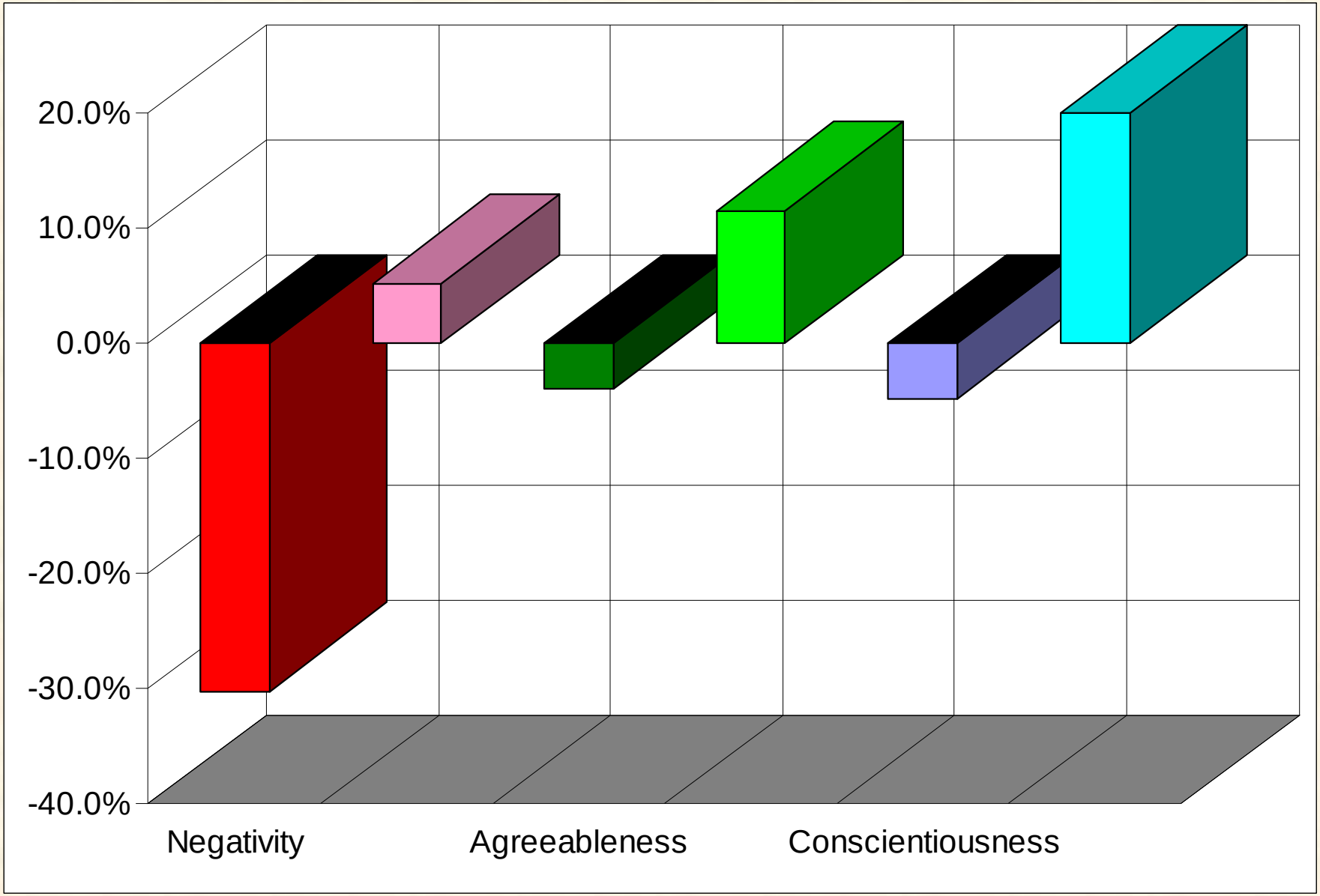
Fatal crashes by 16 year olds

(Percentages)

	Alone	1 teen passenger	2 teen passengers	3 teen passengers
Driver error	72	82	83	90
Speeding	30	45	50	59
Single car	36	51	59	72
.08 BAC	9	8	10	12


The Immaturity Gap
Level of Maturity
1.30
1.10
0.90
0.70
0.50
0.30
Intellectual maturity reaches adult levels at 16
Psychosocial development continues into early adulthood
Intellectual Ability
Psychosocial Maturity
10-11
12-13
14-15
16-17
18-21
22-25
26-30
Age


Change in personality: Late adolescence
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
Negative Emotionality
Agreeableness
Concientiousness


20.0%
10.0%
0.0%
-10.0%
-20.0%
-30.0%
-40.0%
Negativity
Agreeableness
Conscientiousness

Sexual Development

- In most animals the capacity to mate and mating behaviors are genetic and coordinated.
- In primates, the capacity is independent of the mating behavior
- Mating behavior is socially learned in primates
- Puberty and brain development are not on the same timetable. They are not coordinated.

Boys and testosterone: threat or menace?

- Richard Udry (1994) and others have found that the effects of increasing testosterone levels can impact on sexual fantasy and behaviors. In a study of 102 teen boys, 47% of the variance in sexual behavior and fantasy was accounted for by hormone levels.
- Adding permissive attitudes toward sex accounted for 59% of variance.

More hormones

- In apes and humans, hormones affect sexual motivation, not ability.
- Pubescent primate males “mating errors”:
  - become aroused to inappropriate cues (aggression, defecation, etc.).
  - at inappropriate times (i.e., while eating).
  - inappropriate sexual targets (young, old, inanimate objects).

Sexual misconduct in the teen

- Behavior that would be sexually deviant in an adult may not be in a teen
- Maturity of judgement and sexual maturity happen at different times; some kids handle sex well, some don’t.
- Sexual impulses and behavior will improve (become more conventional) with age.

Summary

- Judgement will improve with age
- Ability to delay impusles will improve with age.
- Ability to plan will improve with age
- Resistance to peers will improve with age
- Treatment in teens has the advantage that the teen will develop better capacities with maturity.

Cautions

- Brain development research can’t tell if someone is culpable.
- MRI can’t pinpoint the level of maturity of a person’s brain
- Neuroscience is a study of populations; not individuals
- The connection between brain development and behavior is an inference (a small one).