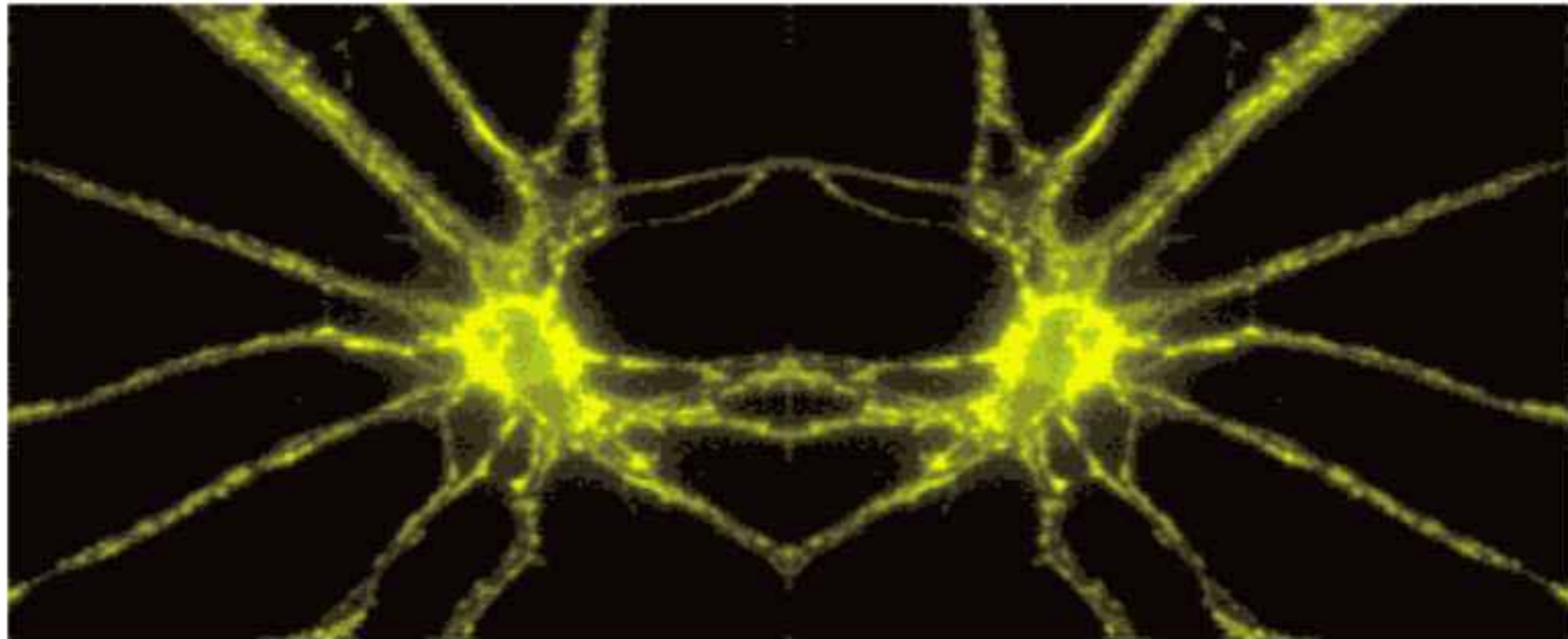


The left, right and centre of male and female brain politics

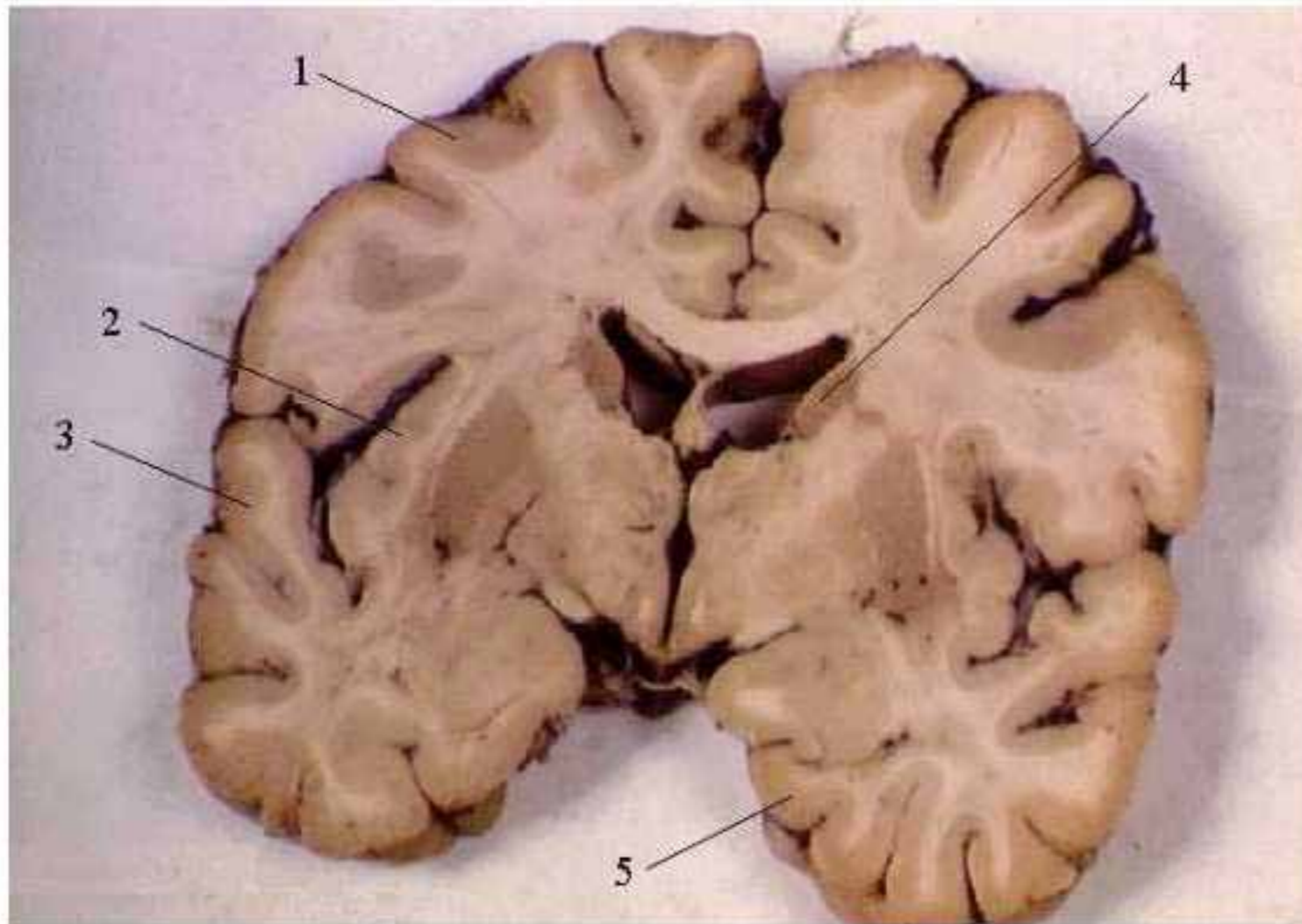


Professor Keith Kendrick



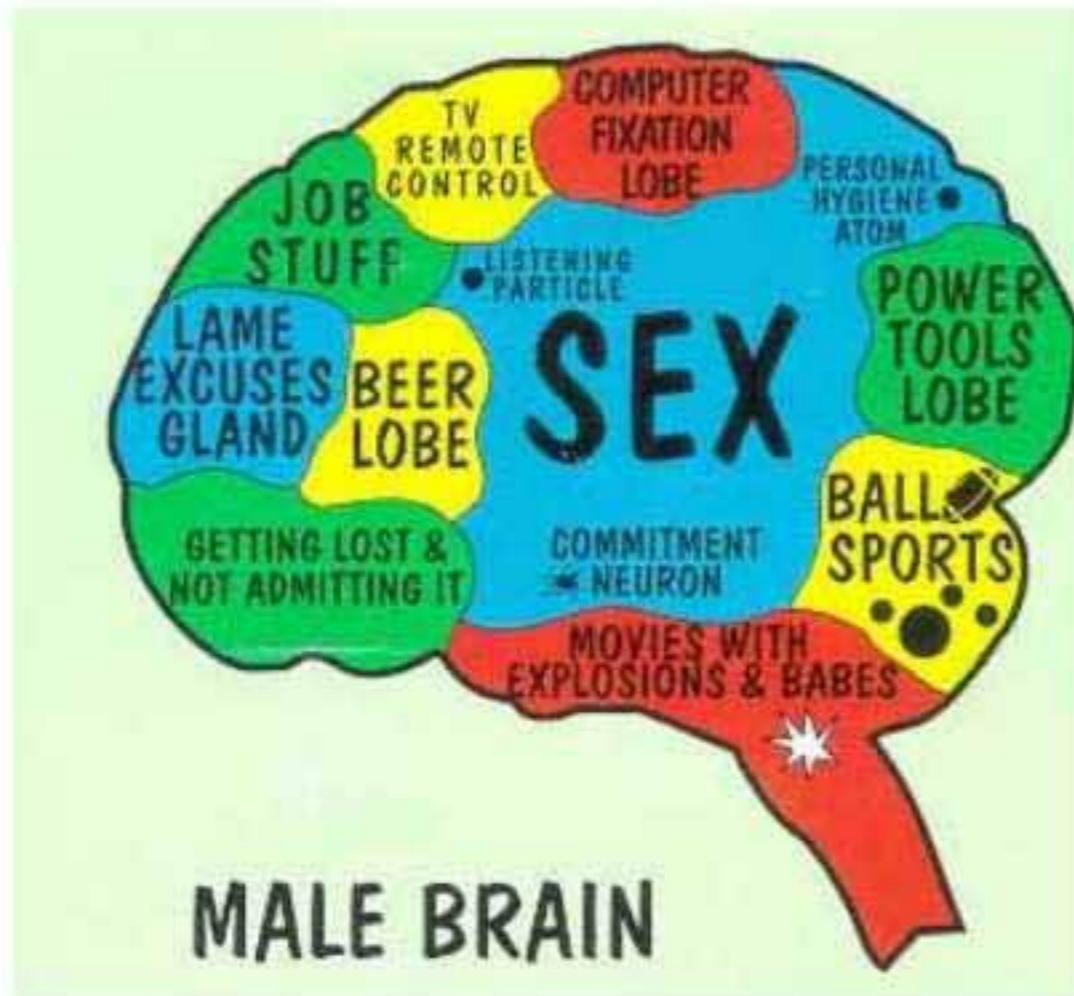
The evolution of two brains in one

Why does the brain have two processors?



The evolution of two brains in one

Are male and female brains wired up differently?



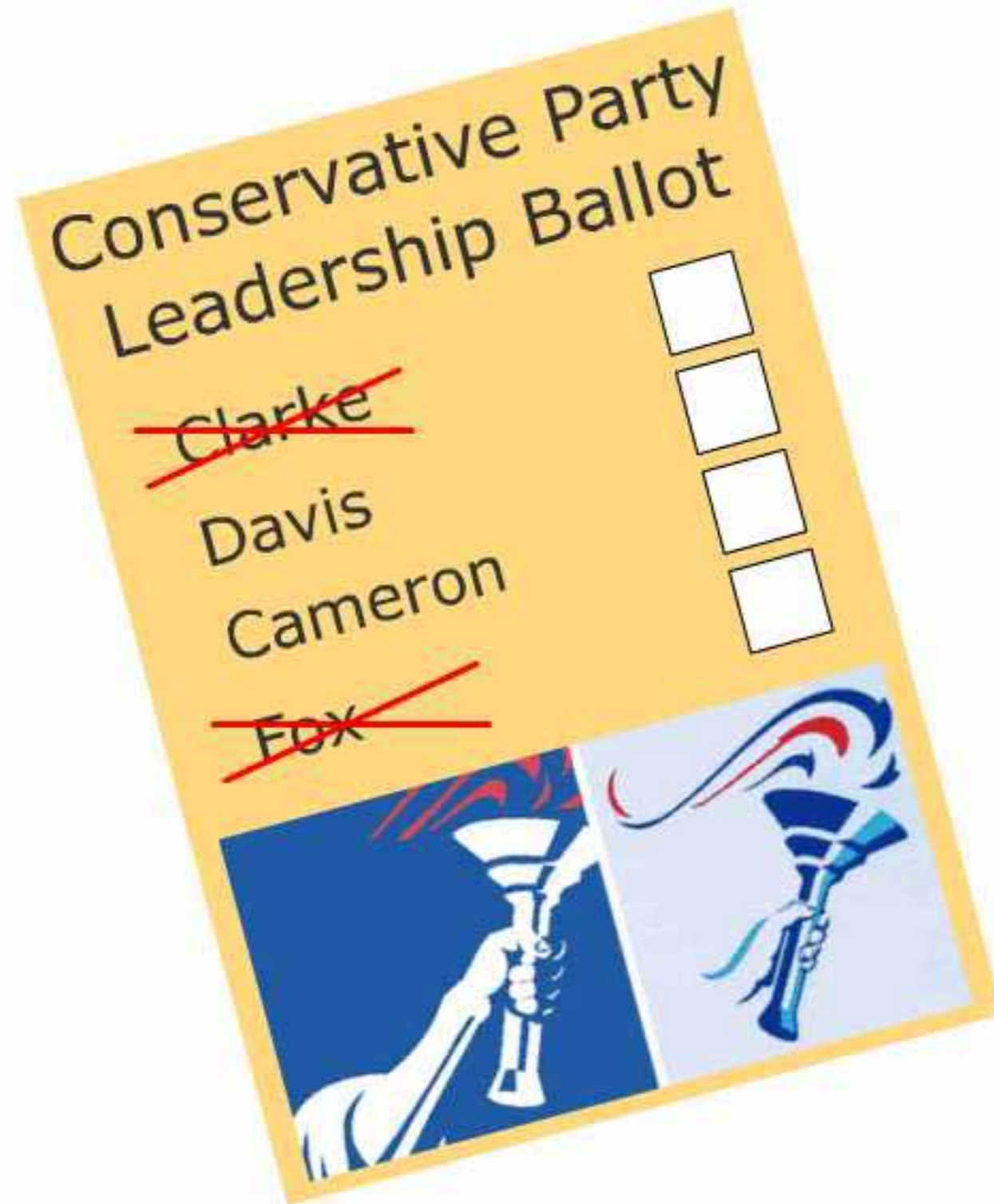
The evolution of two brains in one

The body politic?



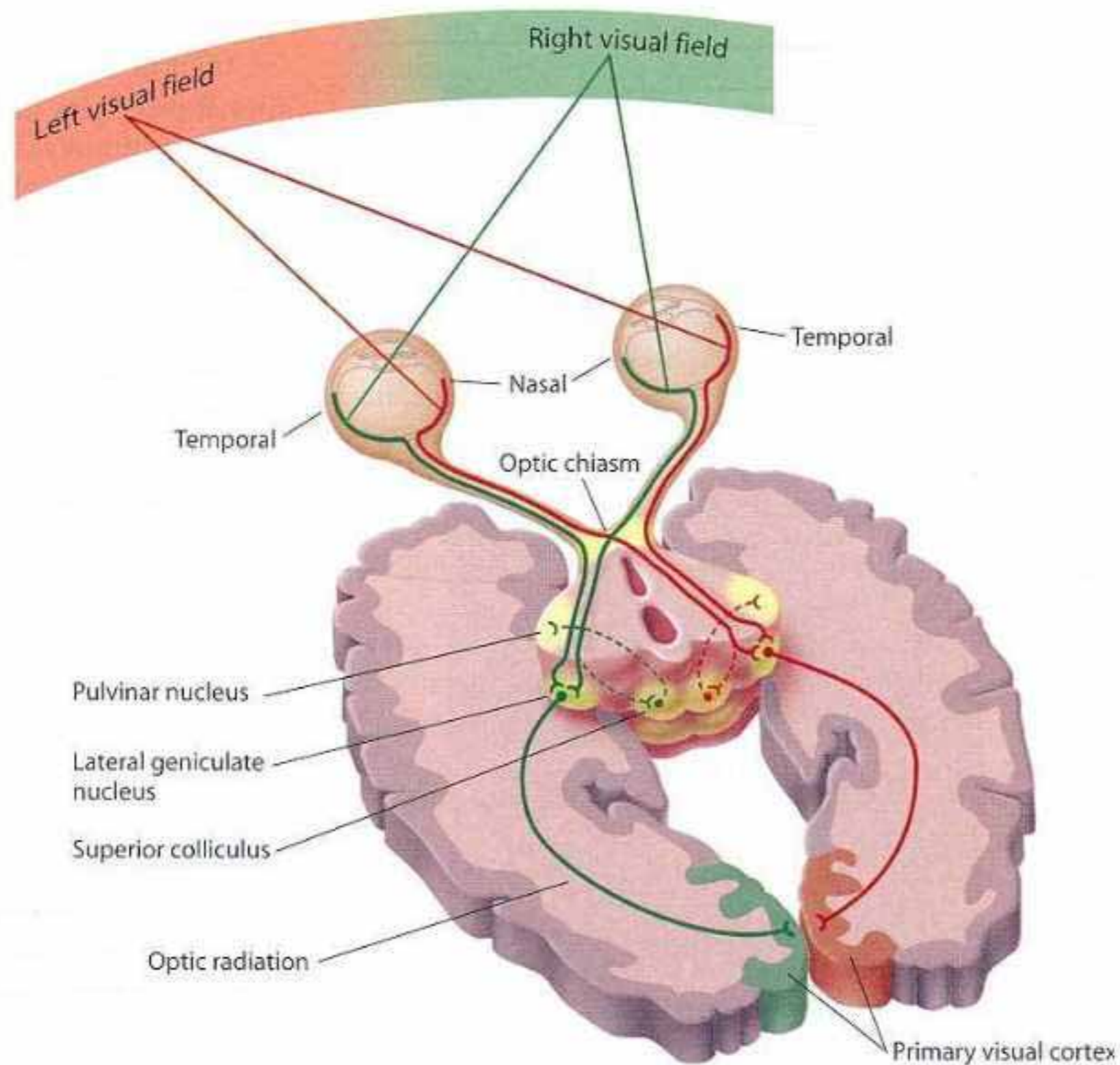
The evolution of two brains in one

A single party offers less choice, competition or flexibility



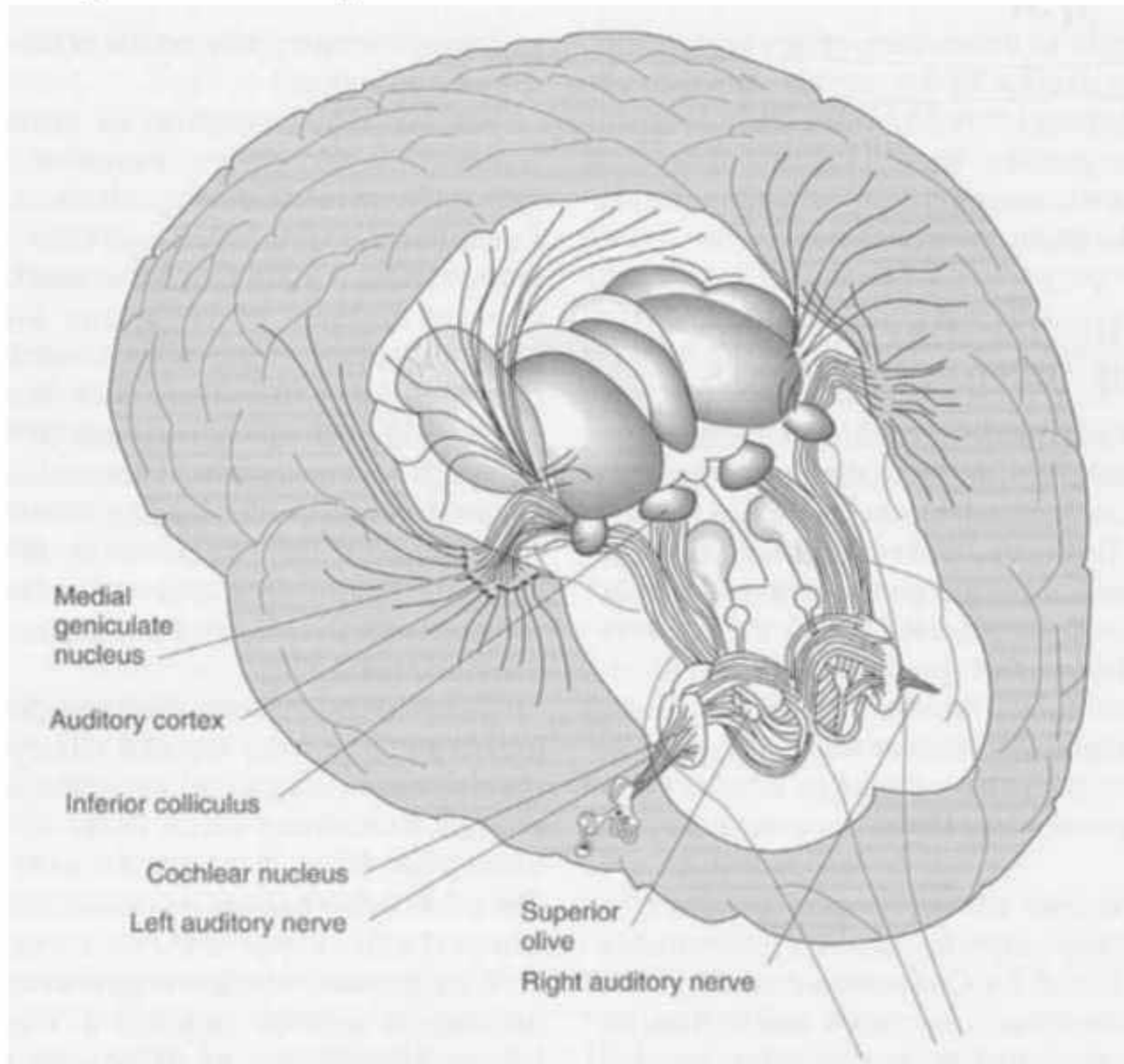
The evolution of two brains in one

A divided joined up world!



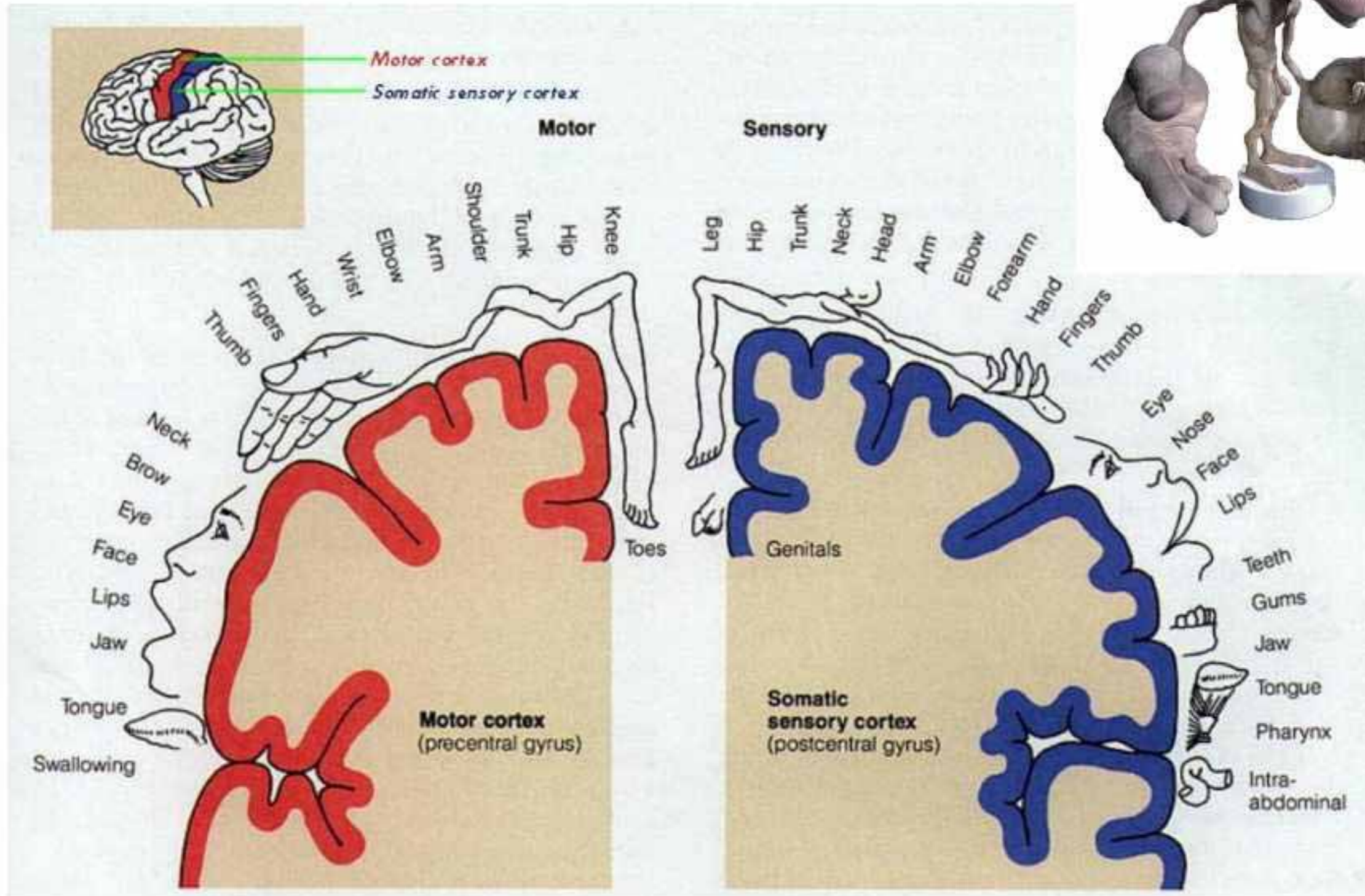
The evolution of two brains in one

A divided joined up world!



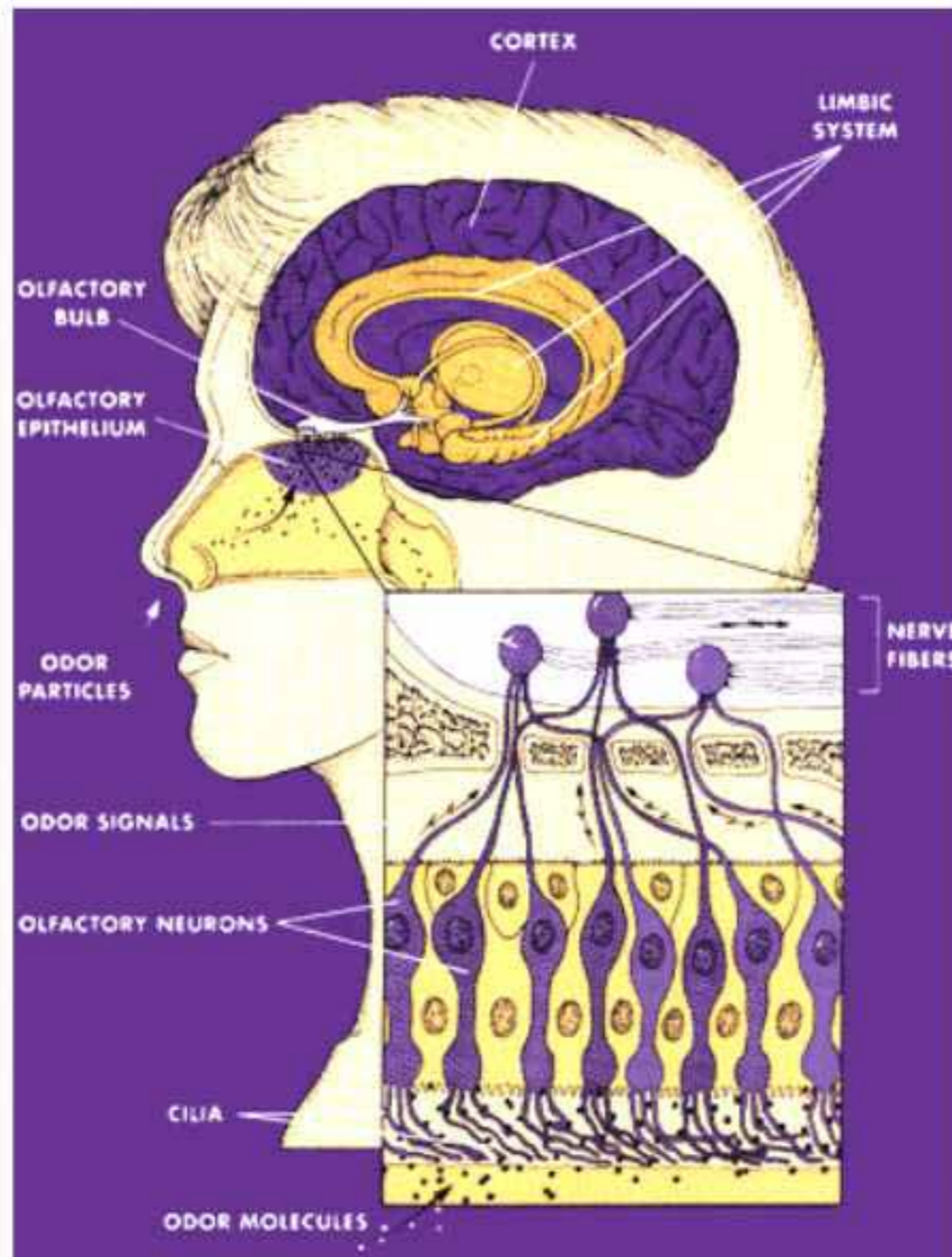
The evolution of two brains in one

A divided joined up world!



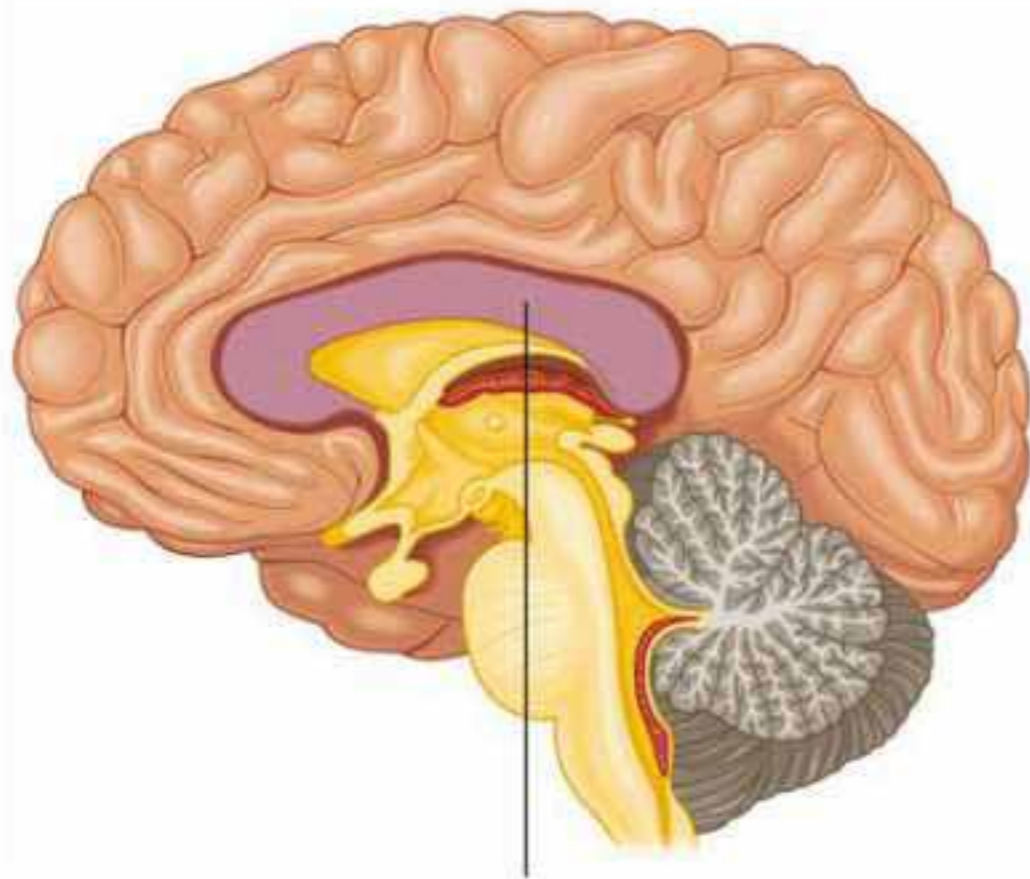
The evolution of two brains in one

A divided joined up world!

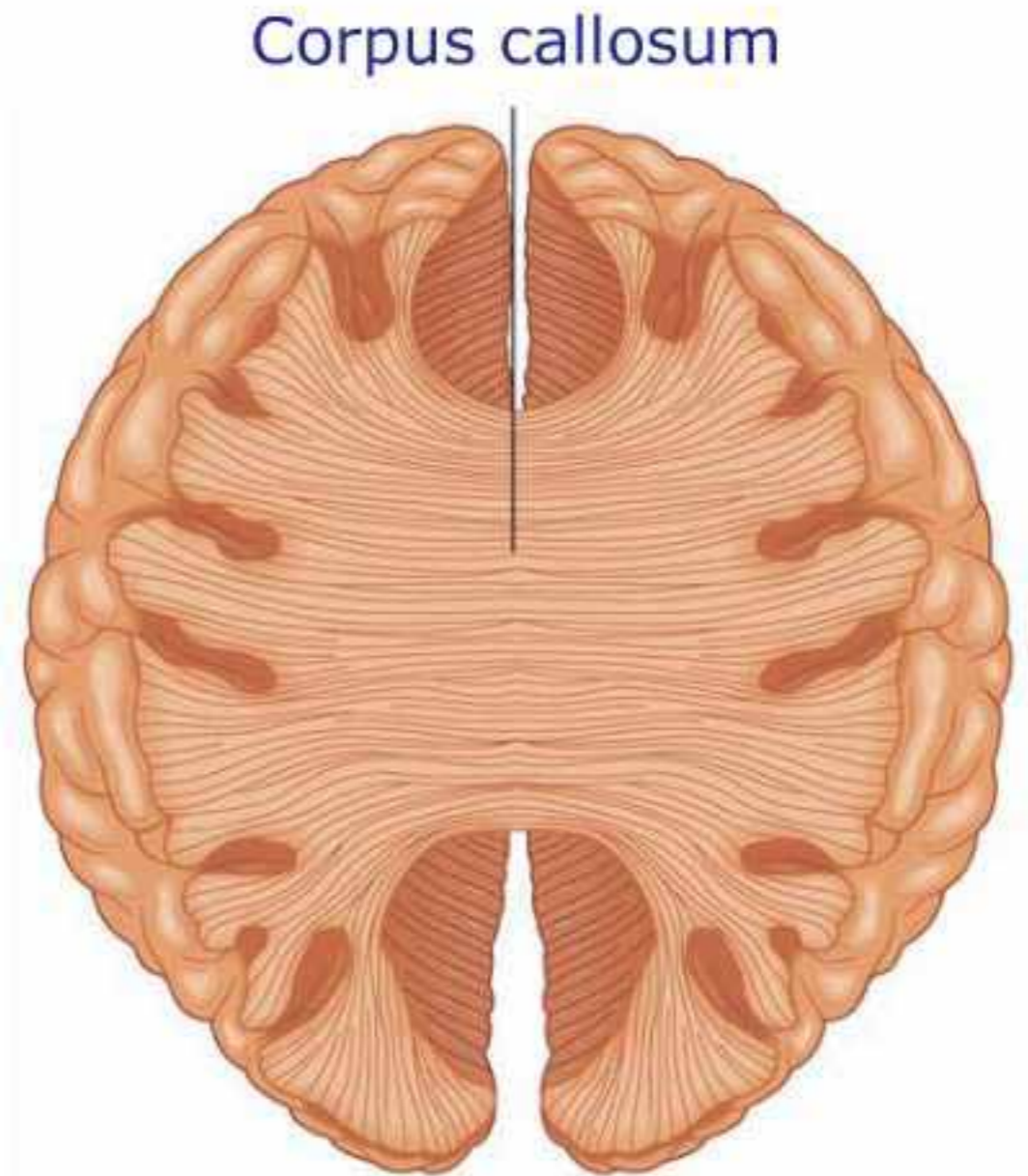


The evolution of two brains in one

A divided joined up world!



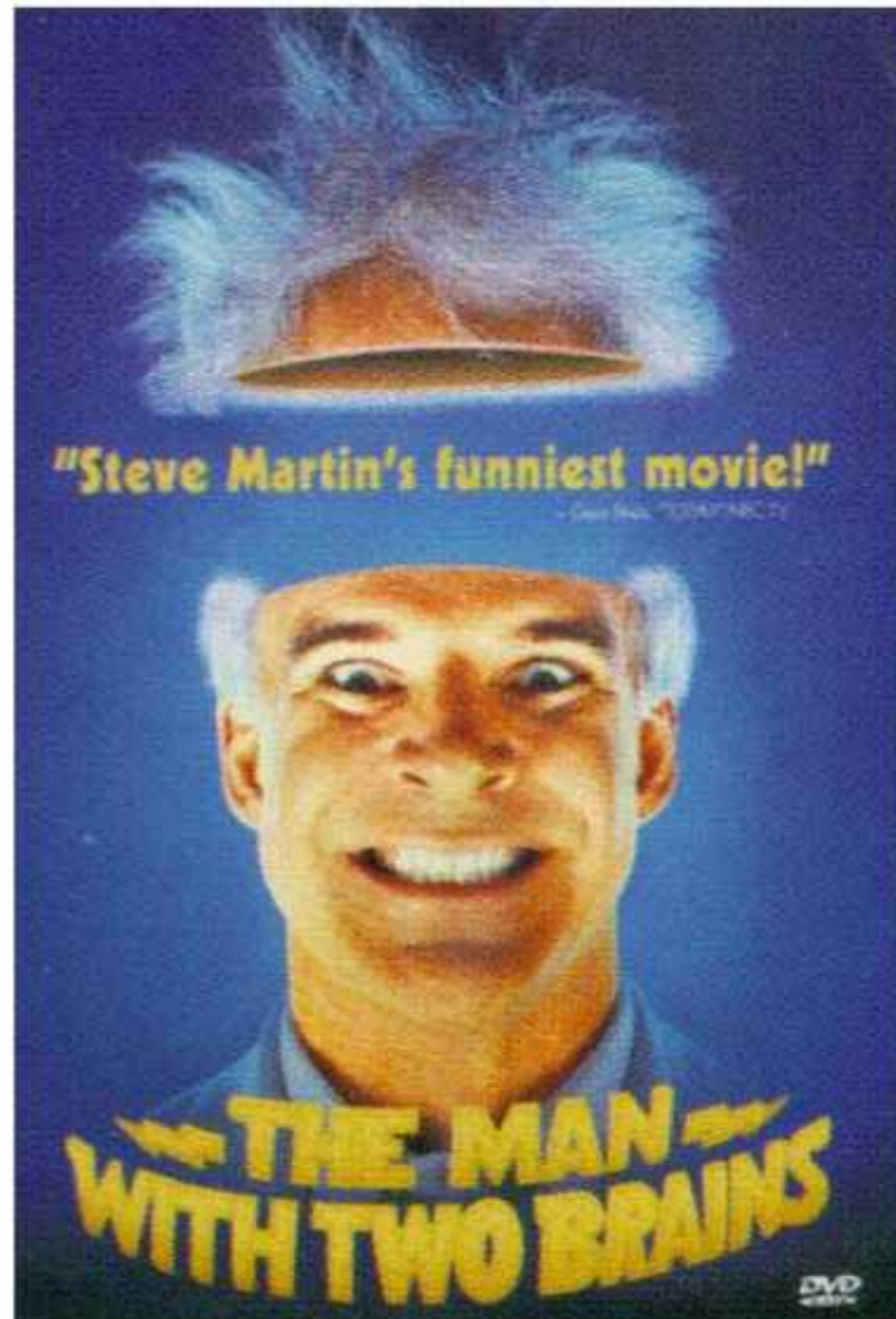
Corpus callosum



Corpus callosum

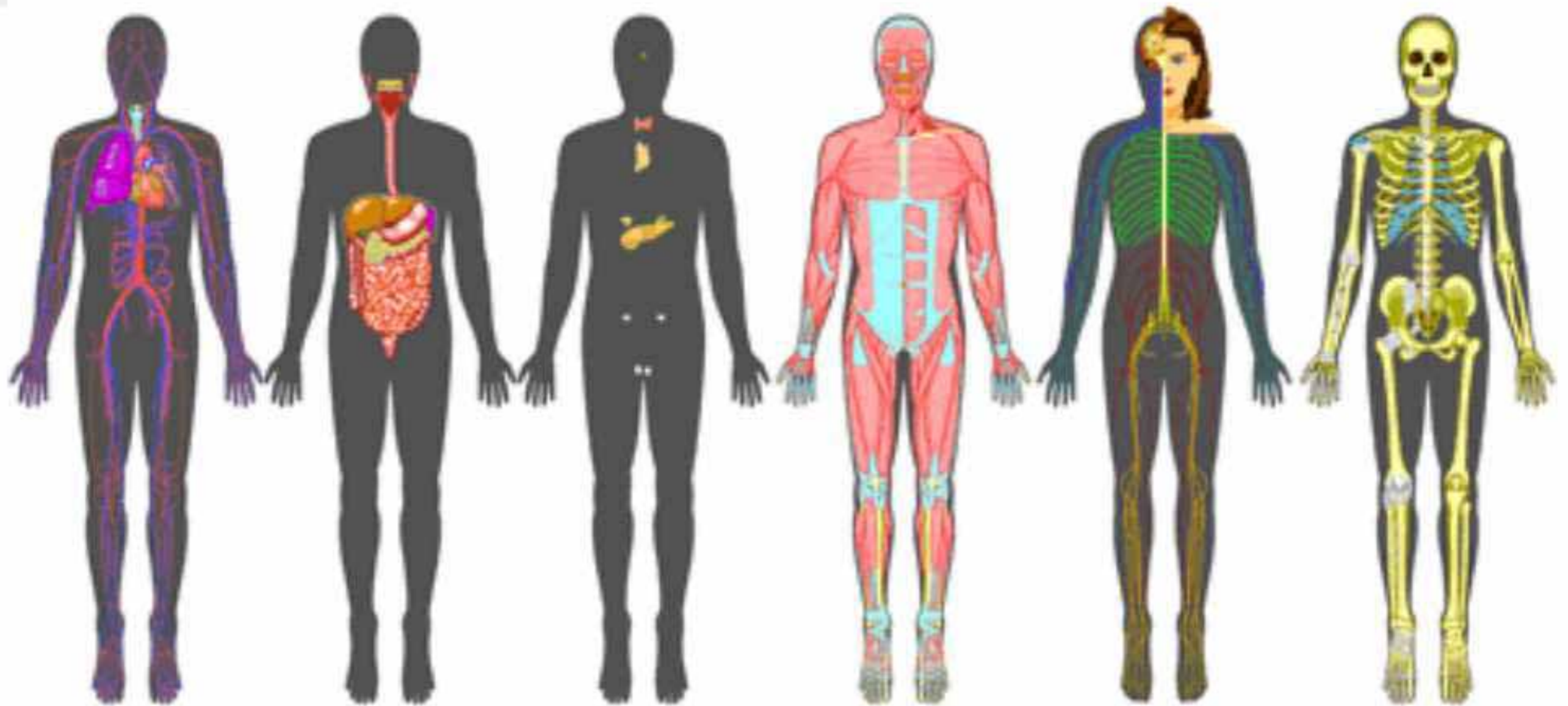
The evolution of two brains in one

Duplication requires a bigger brain, so why?



The evolution of two brains in one

Everything on the outside comes in twos and everything down the centre in ones!



The evolution of two brains in one

Everything on the outside comes in twos and everything down the centre in ones!

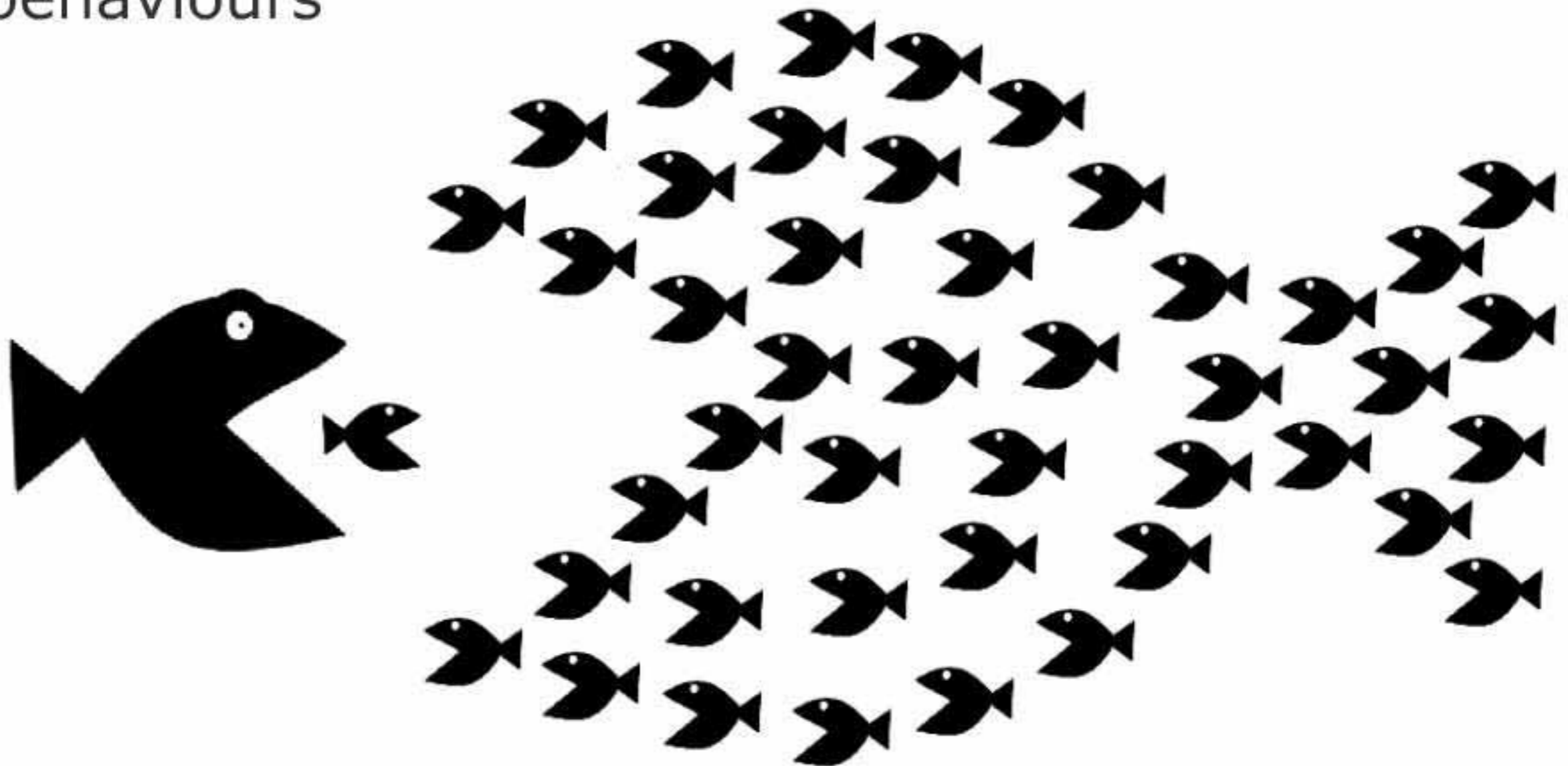
The two sides have evolved to control different behaviours



The evolution of two brains in one

Everything on the outside comes in twos and everything down the centre in ones!

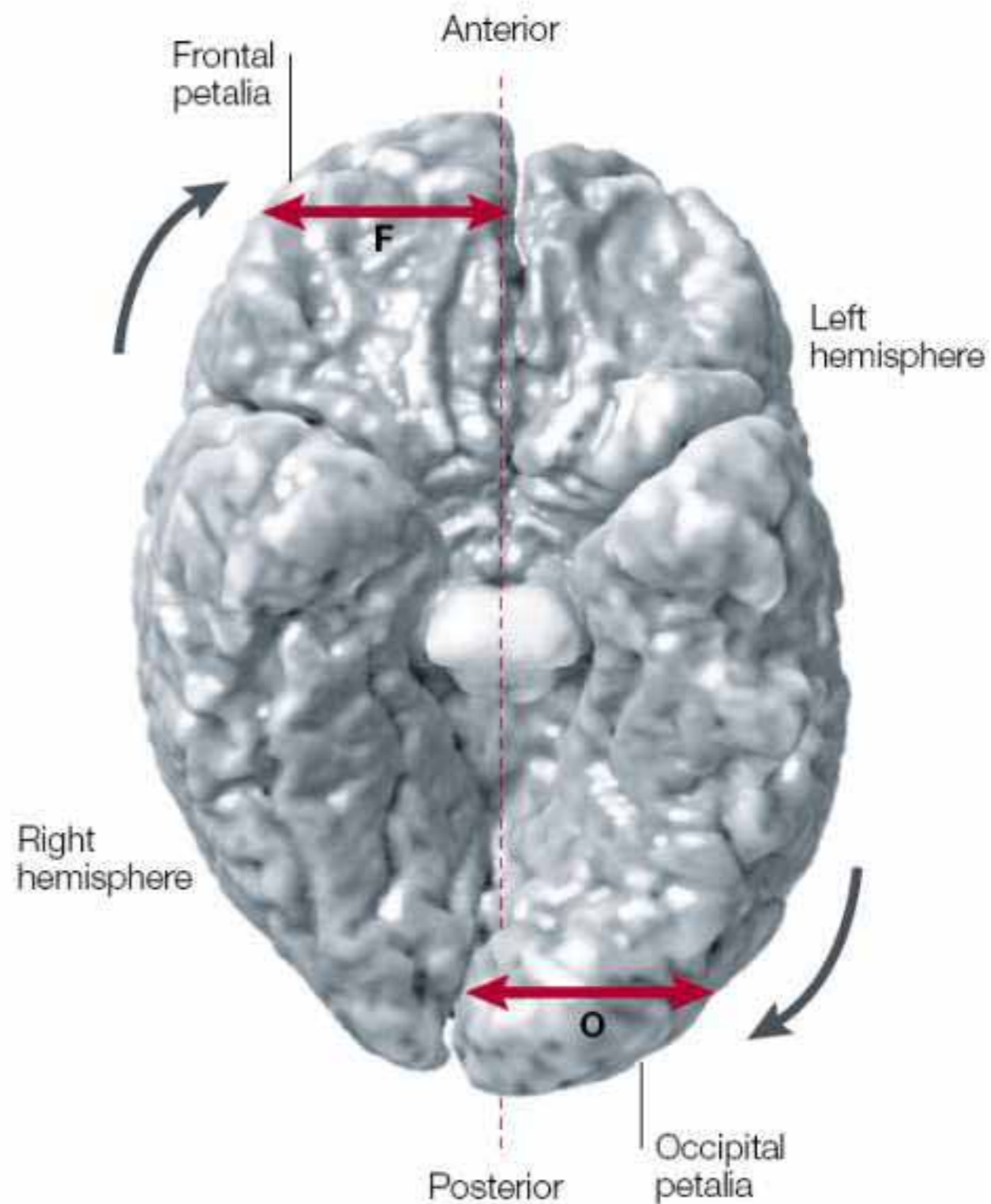
The two sides have evolved to control different behaviours



Gross structural asymmetries

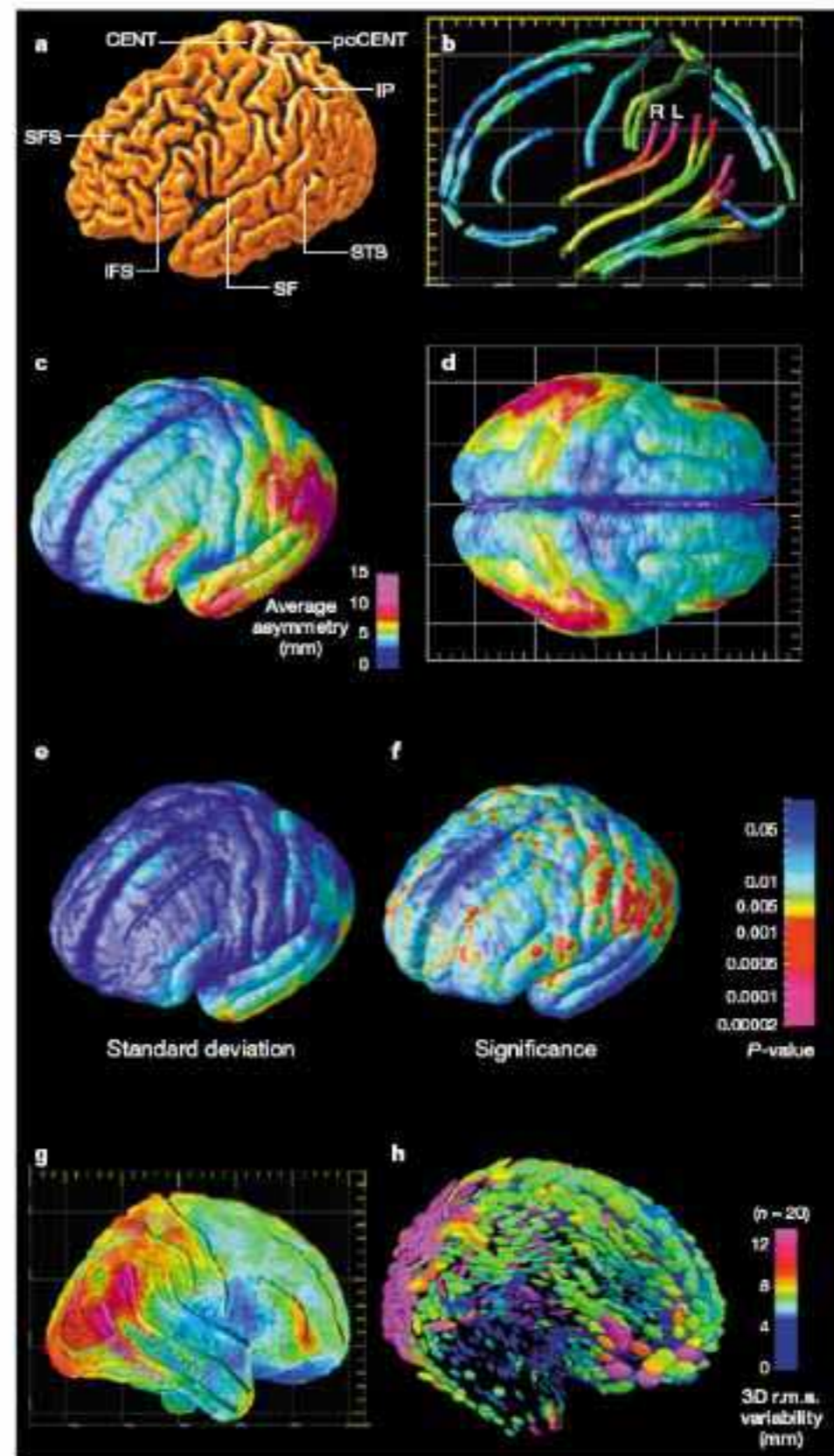
Yakovlevian torque

Petalia



Yakovlevian torque

Petalia



Handedness

90% of us are right handed



Handedness

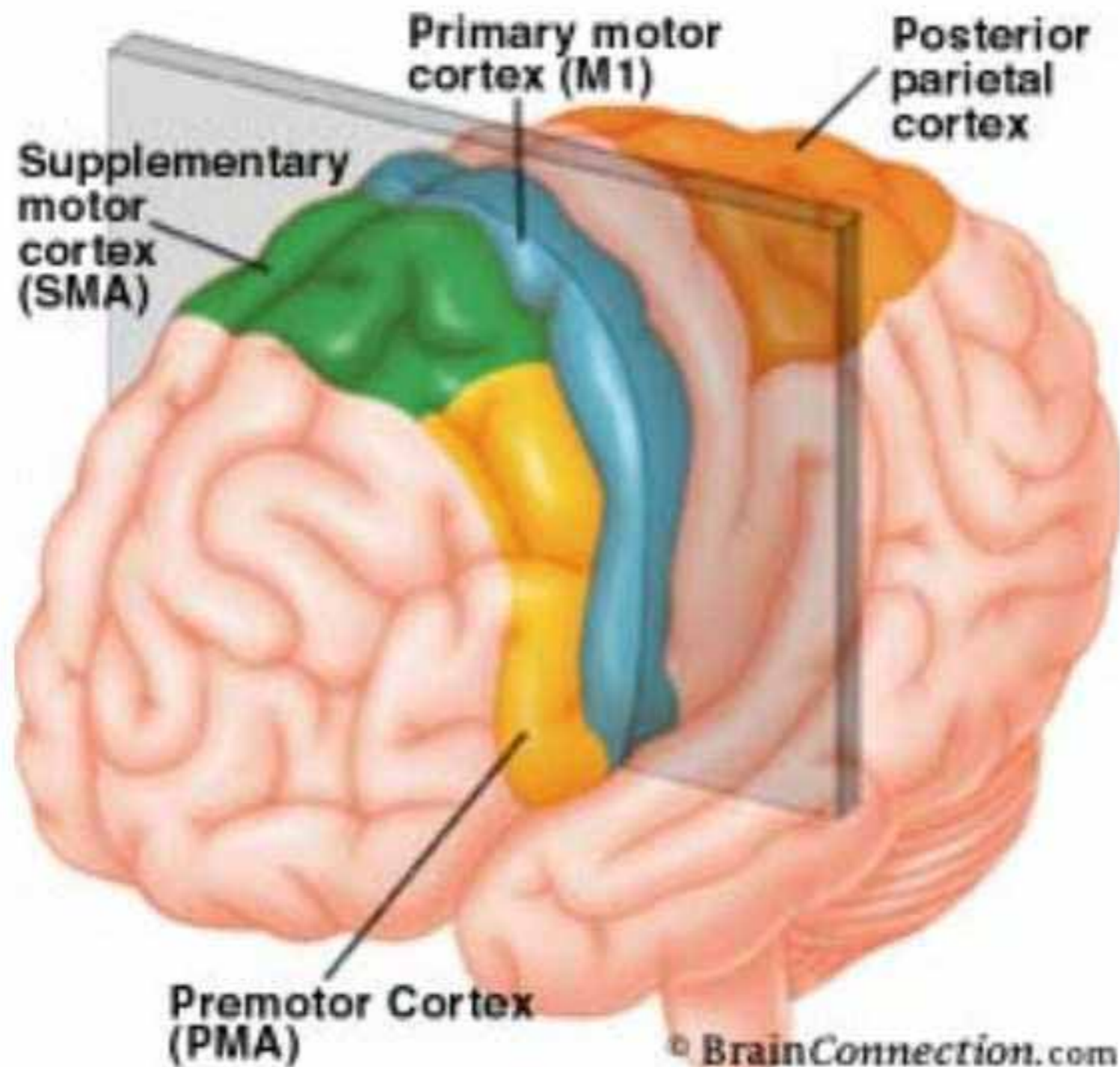
90% of us are right handed

60-70% of many other species are right pawed, clawed or legged



Handedness

Only minor micro-structural changes in motor cortex



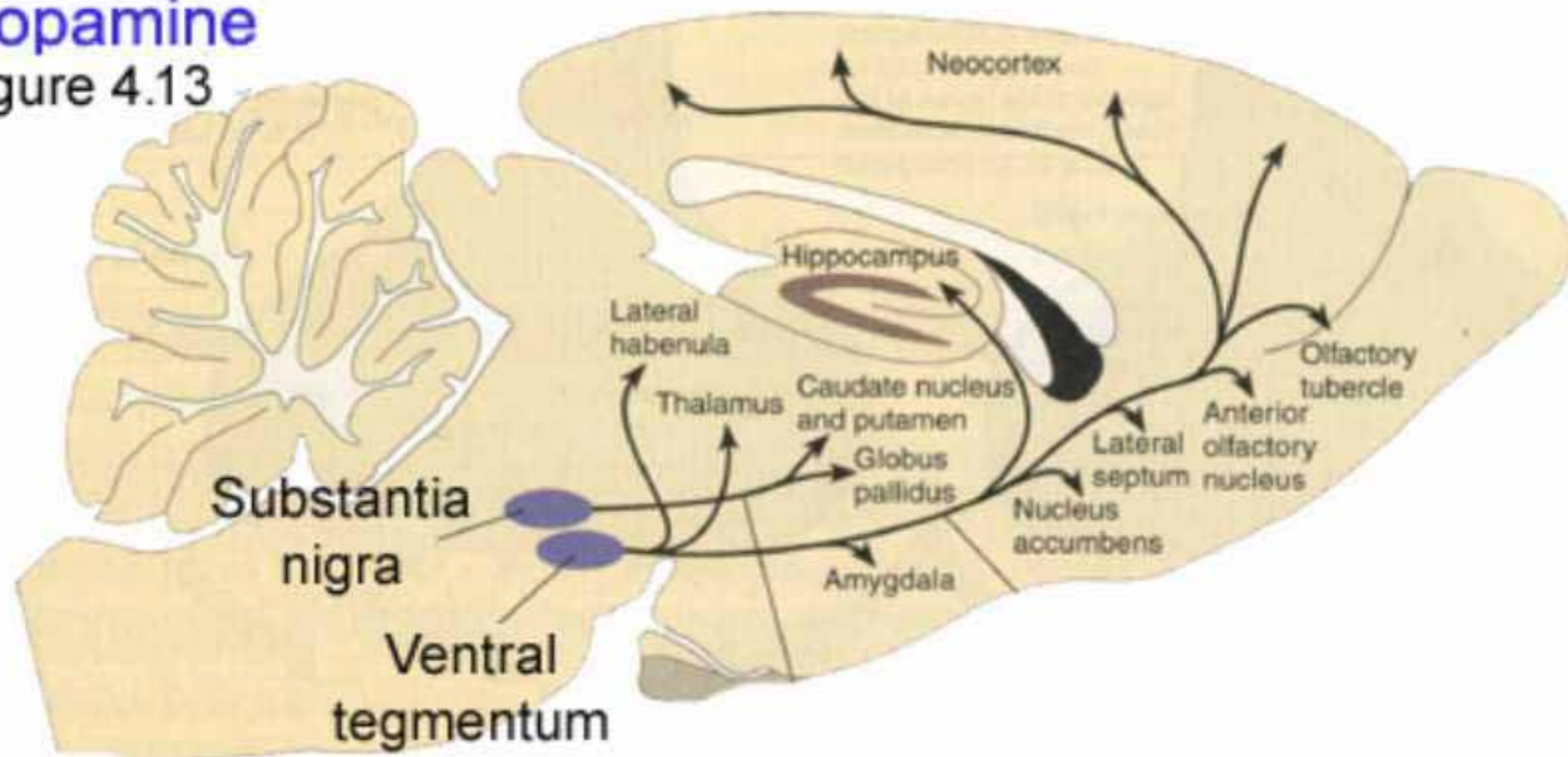
Handedness

Only minor micro-structural changes in motor cortex

Dopamine bias in left hemisphere

Dopamine

Figure 4.13



Handedness

Only minor micro-structural changes in motor cortex

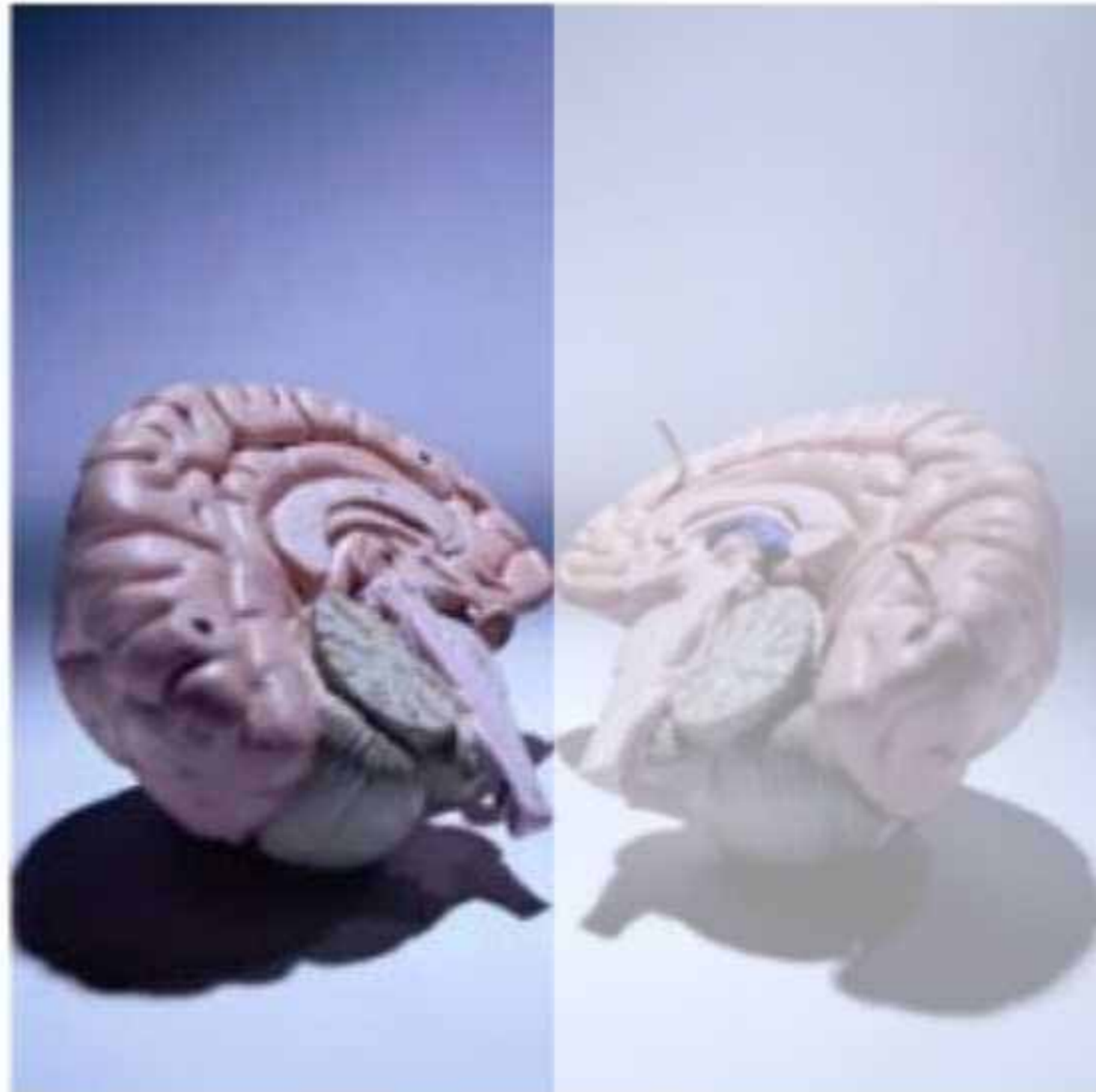
Dopamine bias in left hemisphere

Language is also a motor skill!



Language

Left brain hemisphere

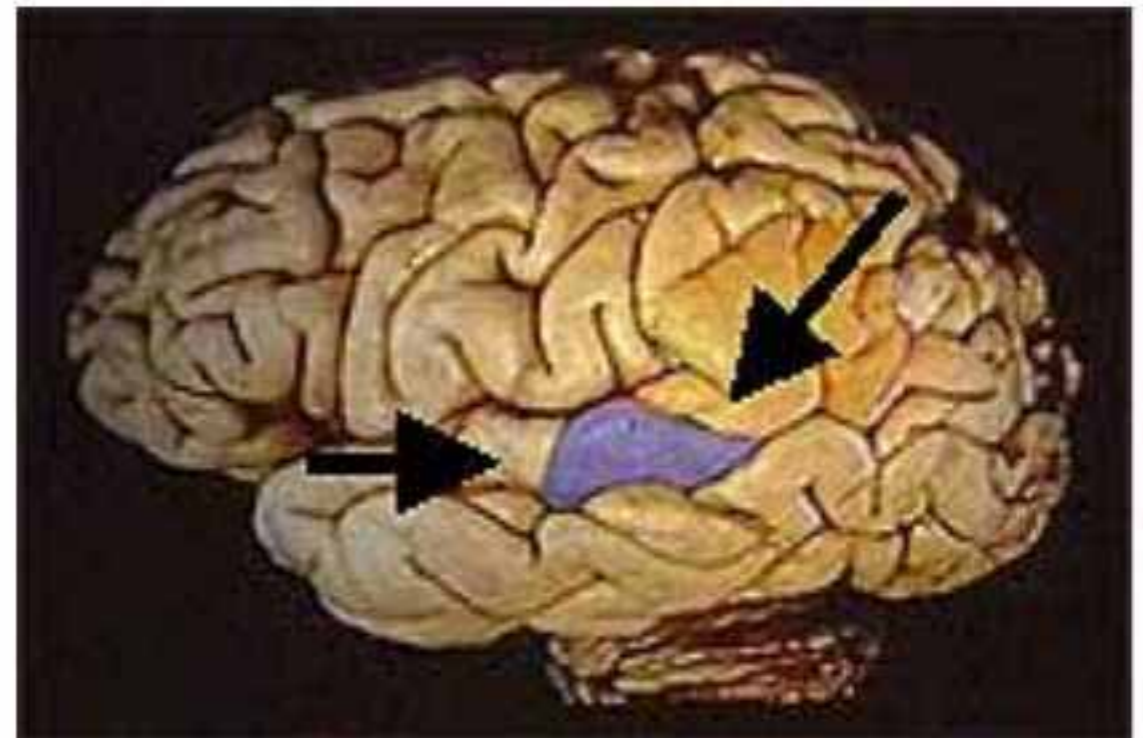
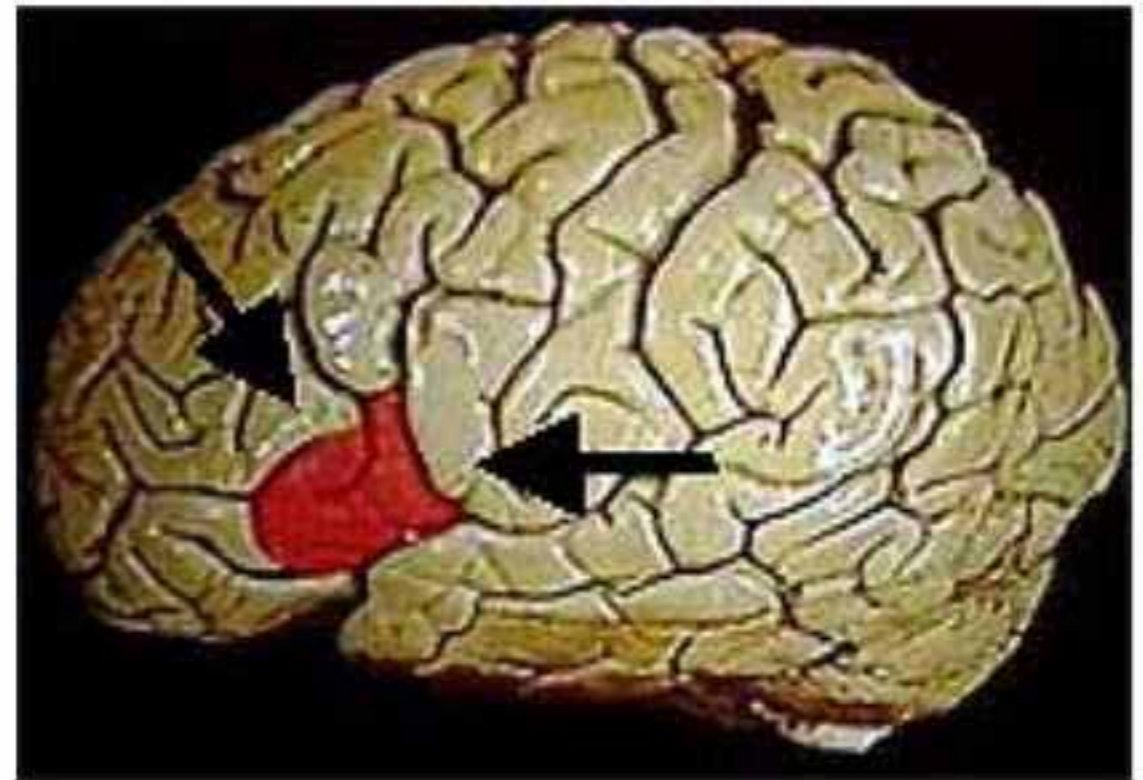


Language

Left brain hemisphere

Broca in 1861

Wernicke in 1874



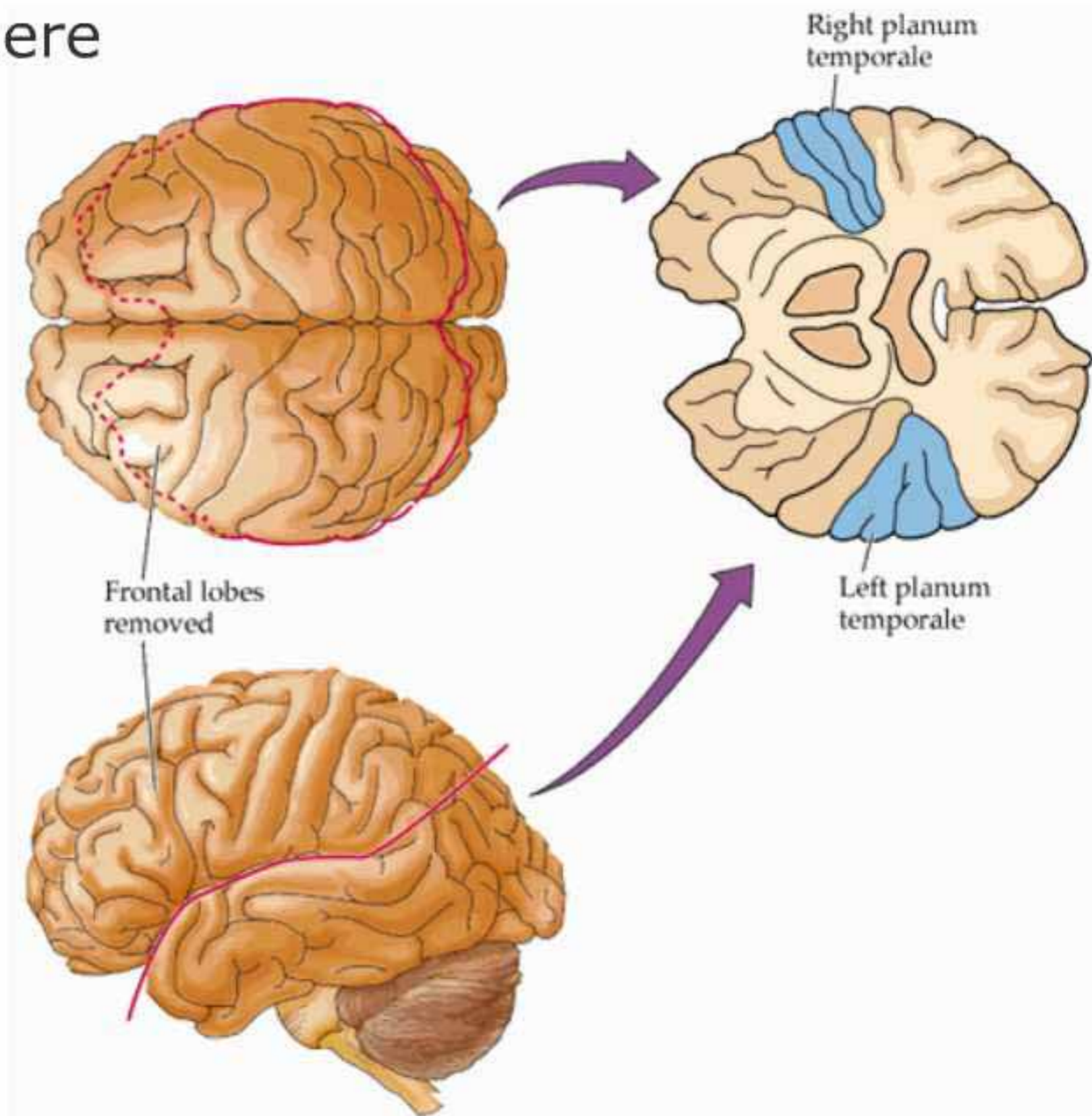
Language

Left brain hemisphere

Broca in 1861

Wernicke in 1874

Planum temporale



Language

Left for 97% of right handers and 70% of left handers



Strauss



Flintoff

Language

Brain specialisations may predate language



Language

Brain specialisations may predate language

Bird song and vocalisations in mammals are also on the left

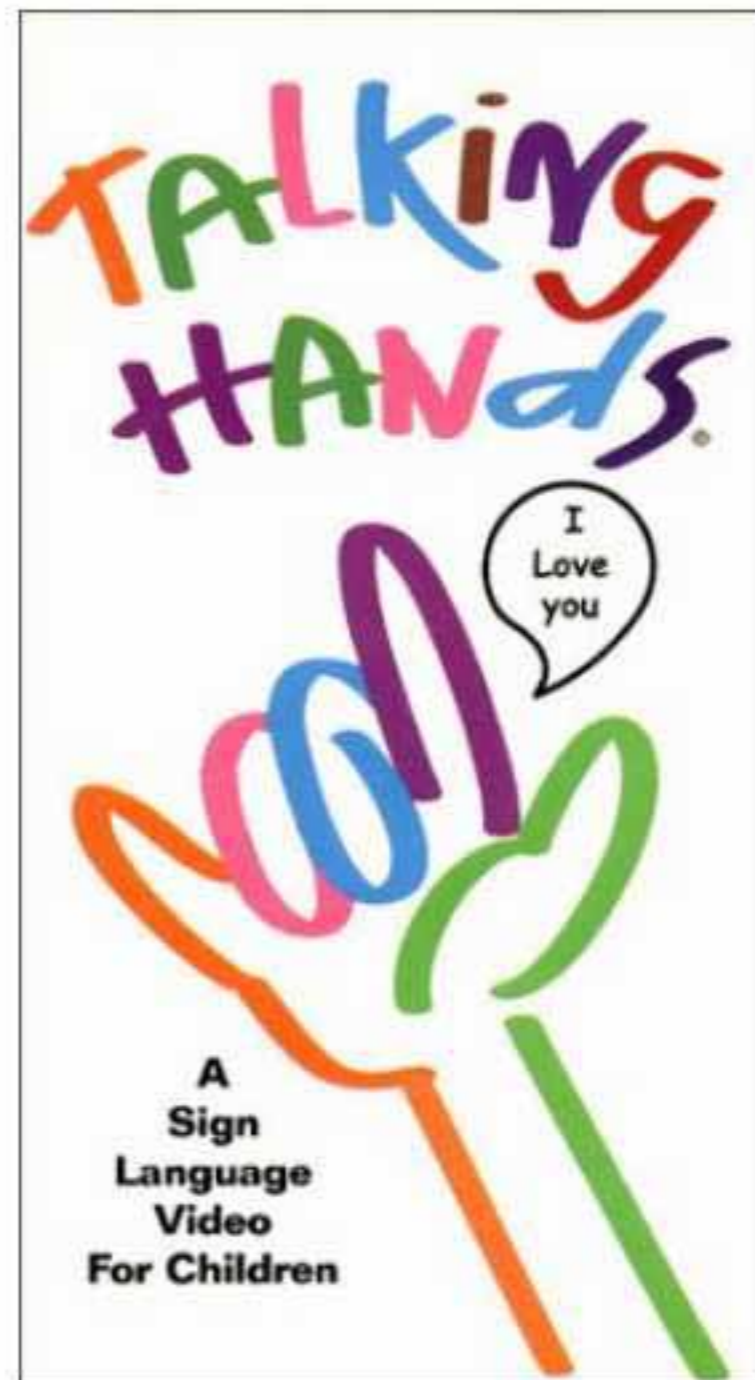


Language

Brain specialisations may predate language

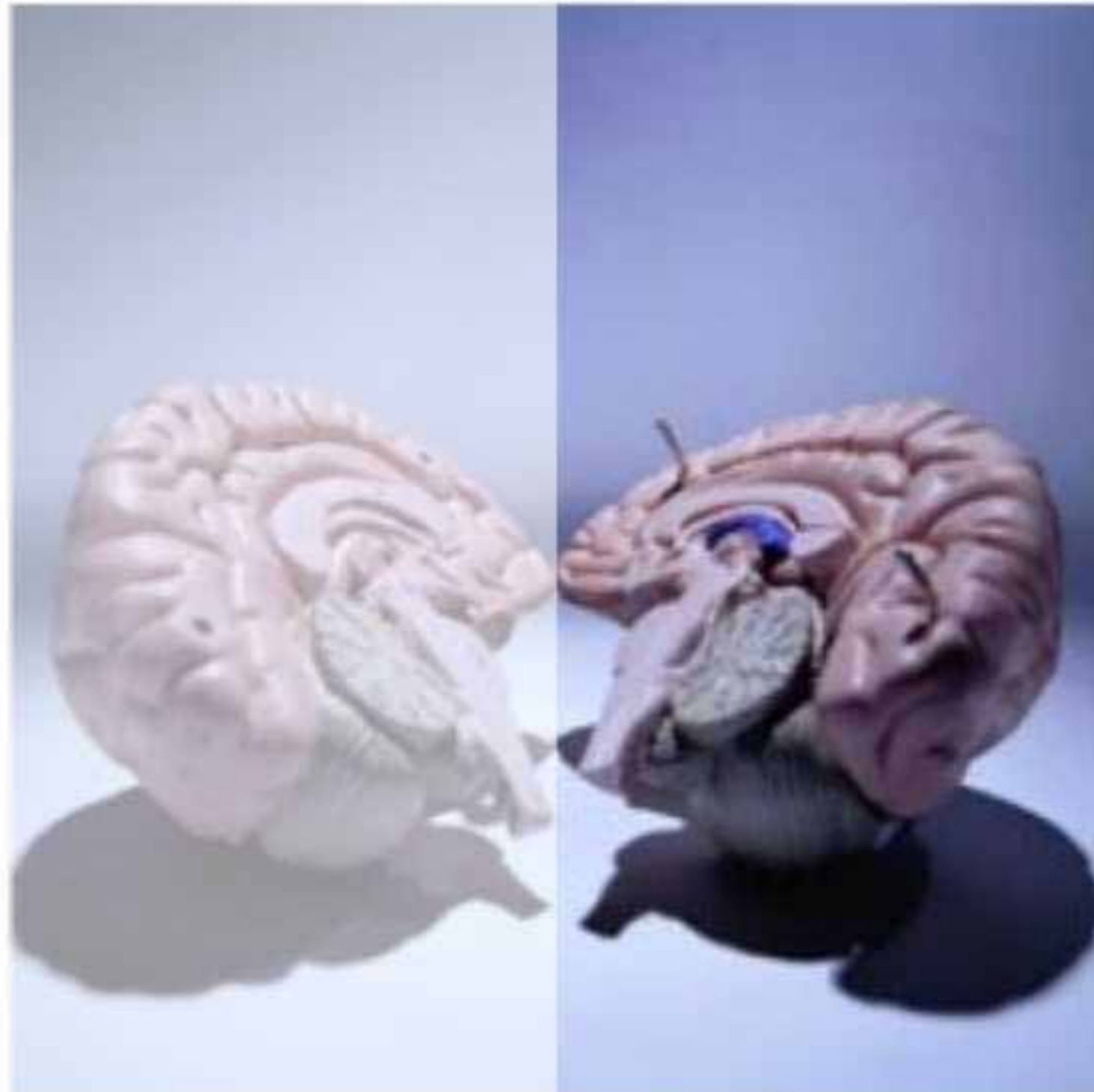
Bird song and vocalisations in mammals are also on the left

Gestures or imitation?



Social recognition

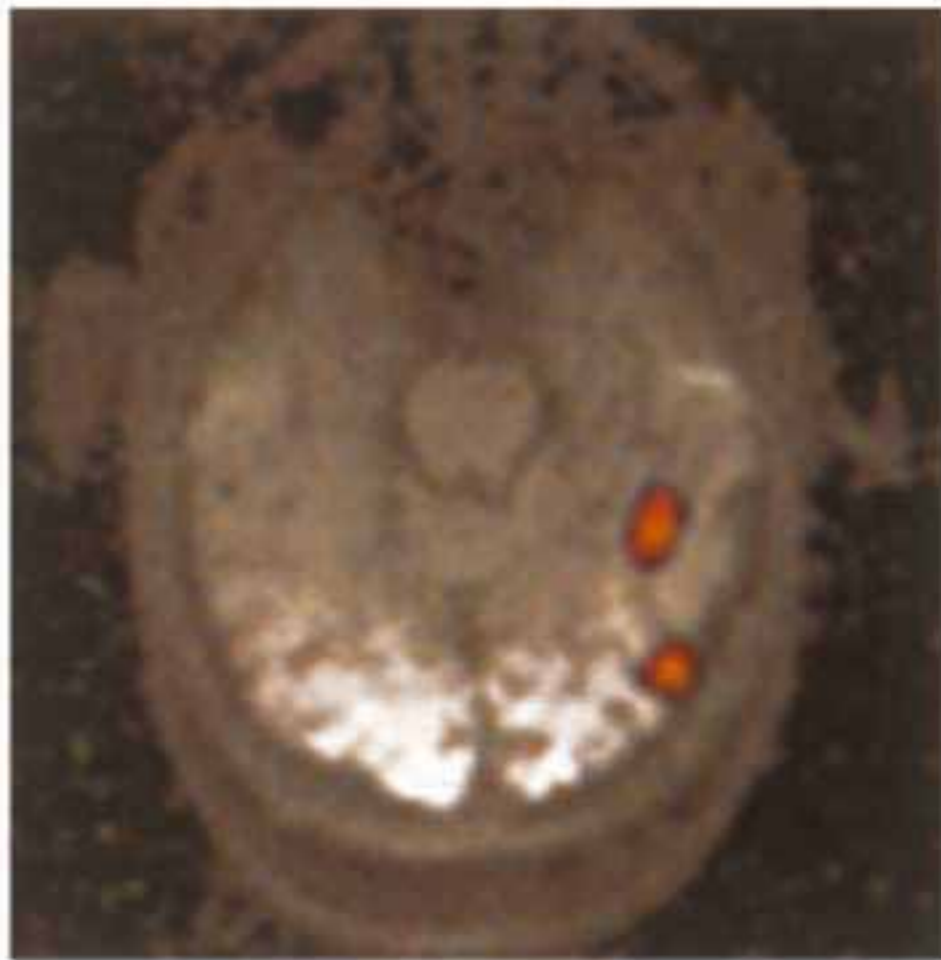
Face recognition – right hemisphere



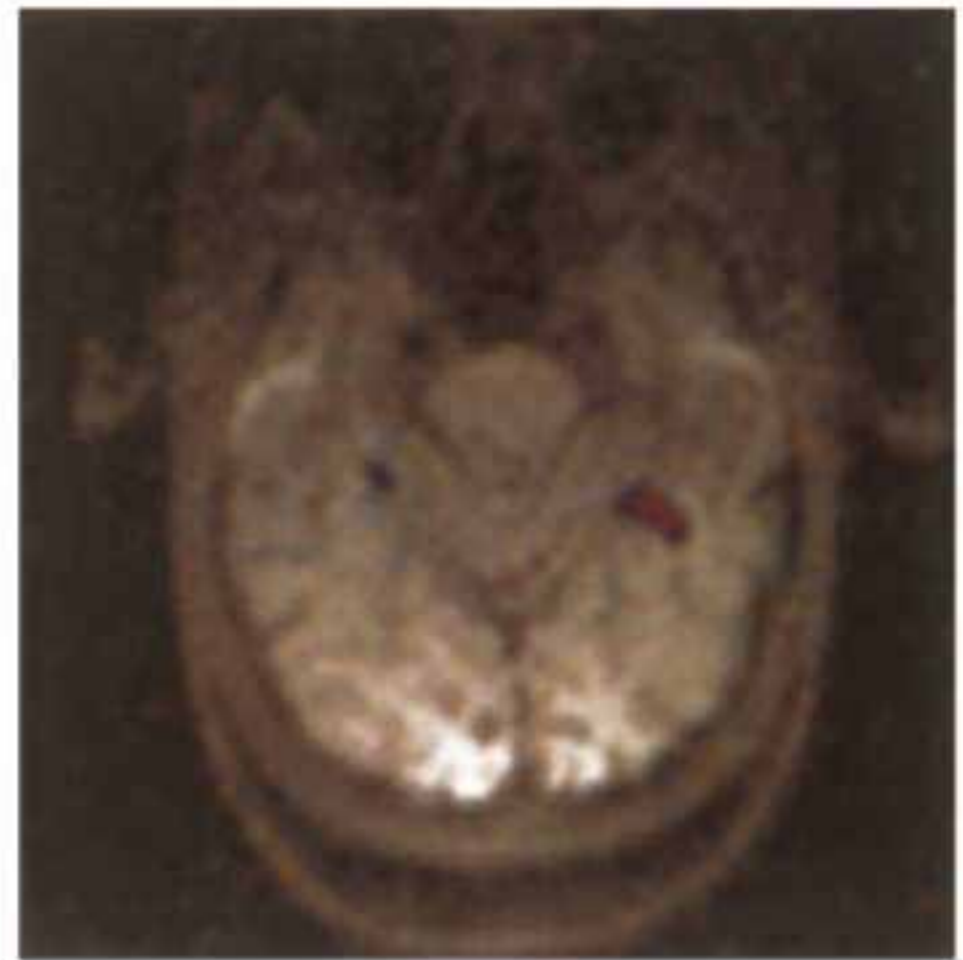
Social recognition

Face recognition – right hemisphere

Identity and emotional expressions



Looking at a face

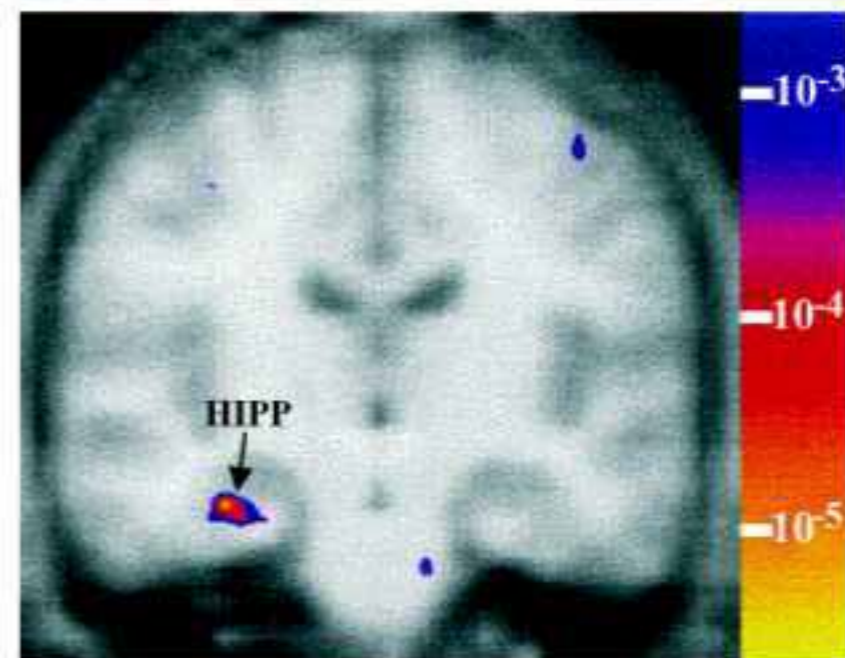
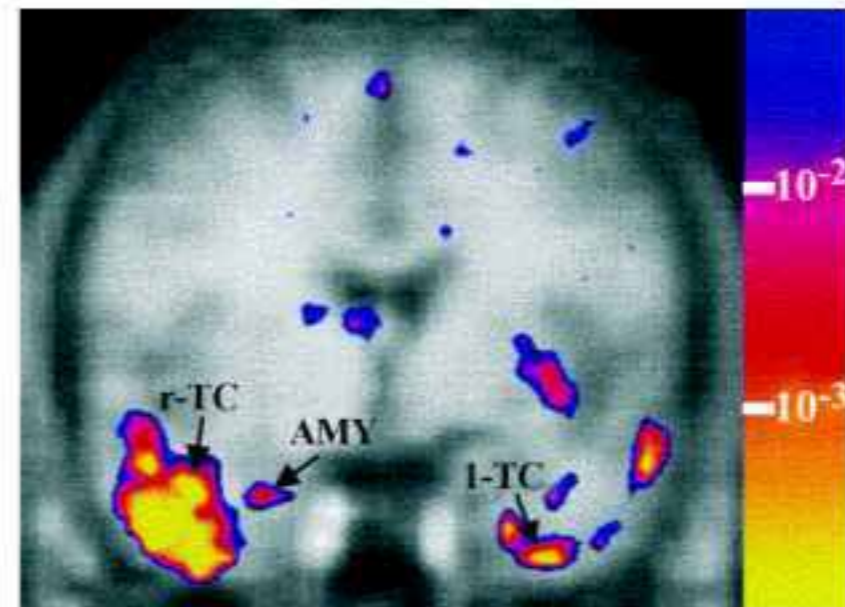


Imagining a face

Social recognition

Face recognition – right hemisphere

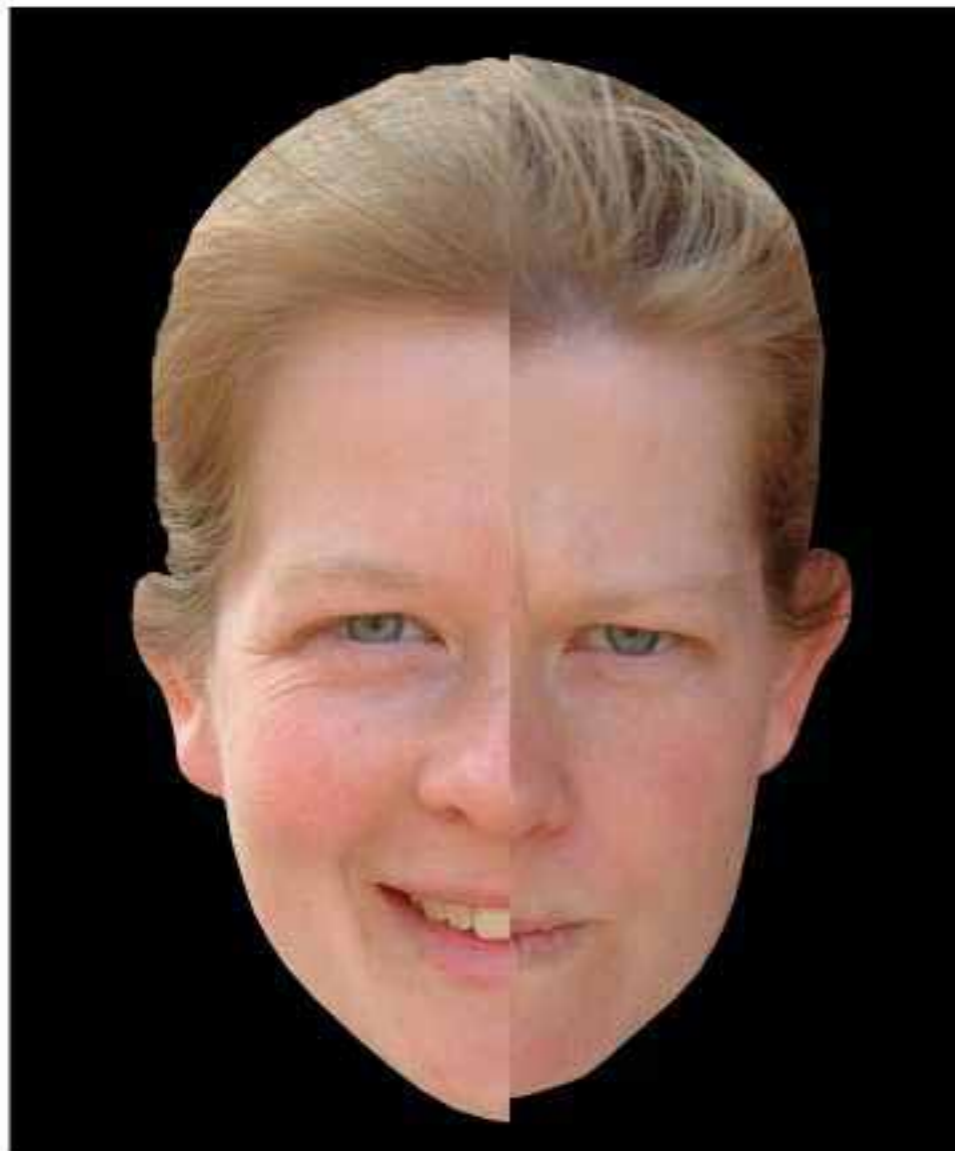
Identity and emotional expressions



Social recognition

Face recognition – right hemisphere

Identity and emotional expressions



Social recognition

Face recognition – right hemisphere

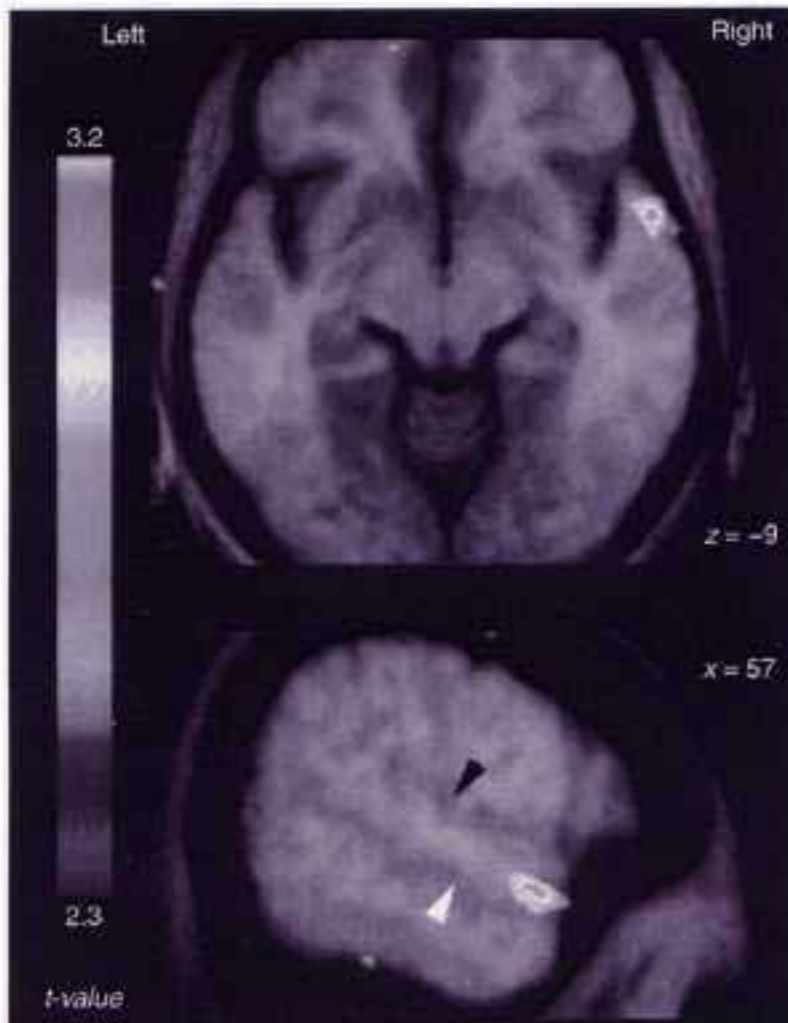
Identity and emotional expressions

Face expression asymmetries



Social recognition

Vocal recognition and emotion processing
– right hemisphere



Belin *et al* 2003



Hauser *et al* 2003

Social recognition

Vocal recognition and emotion processing
– right hemisphere

Smell recognition is equally represented



Emotion and cognition

Intellectual left brain hemisphere and an emotional right one?



Emotion and cognition

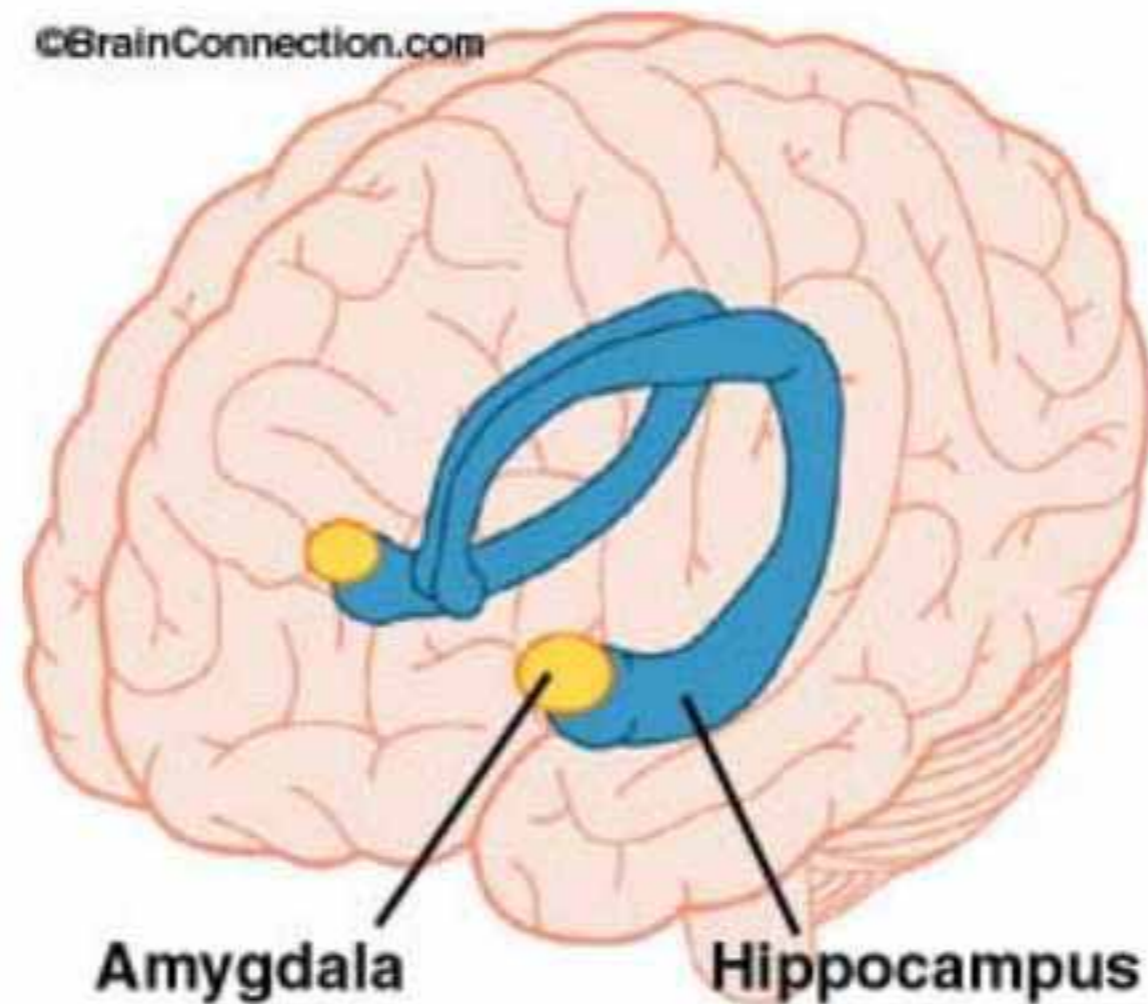
Intellectual left brain hemisphere and an emotional right one?

Left brain happy – right brain sad?



Emotion and cognition

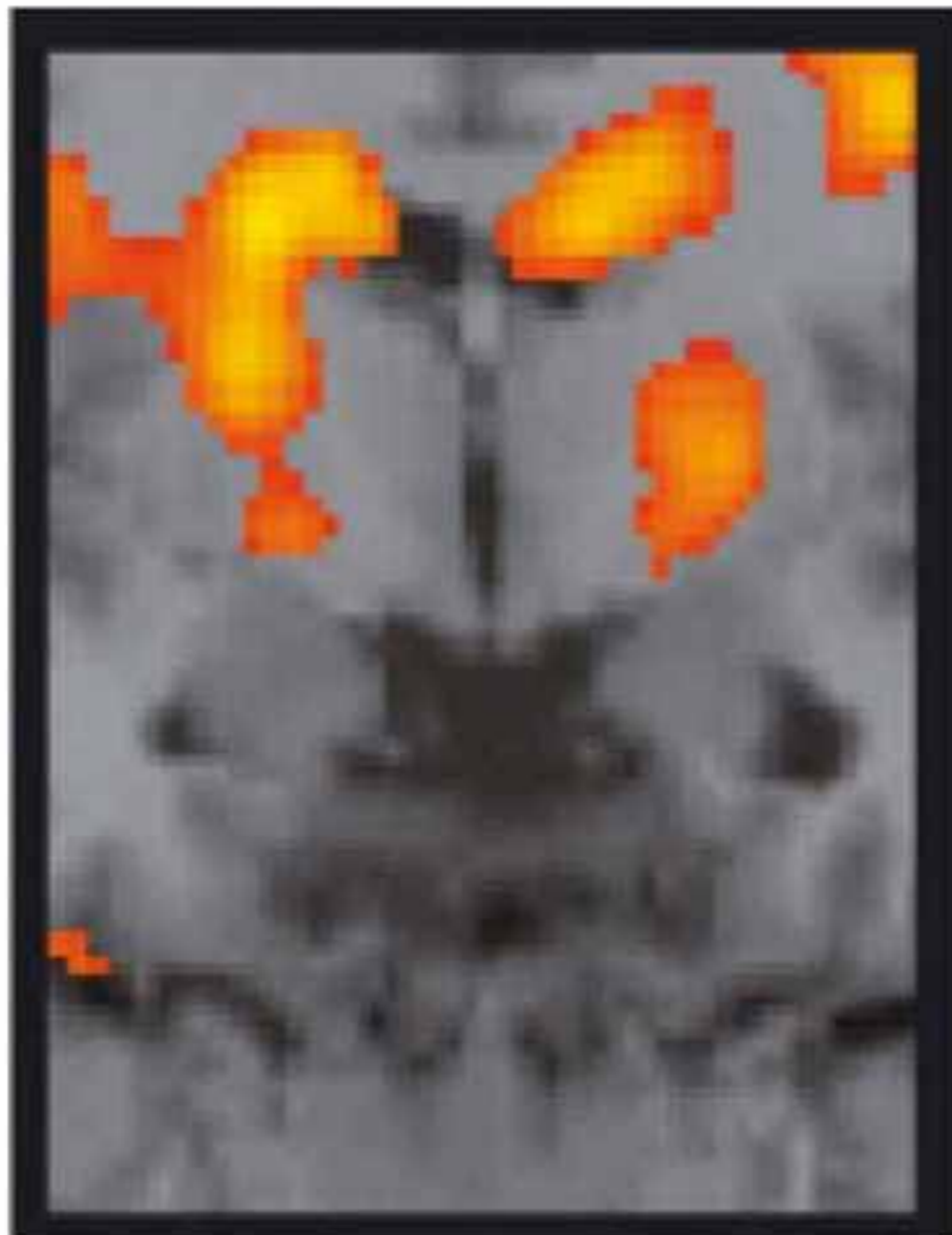
Right intense emotions, left cognitive interpretation and control



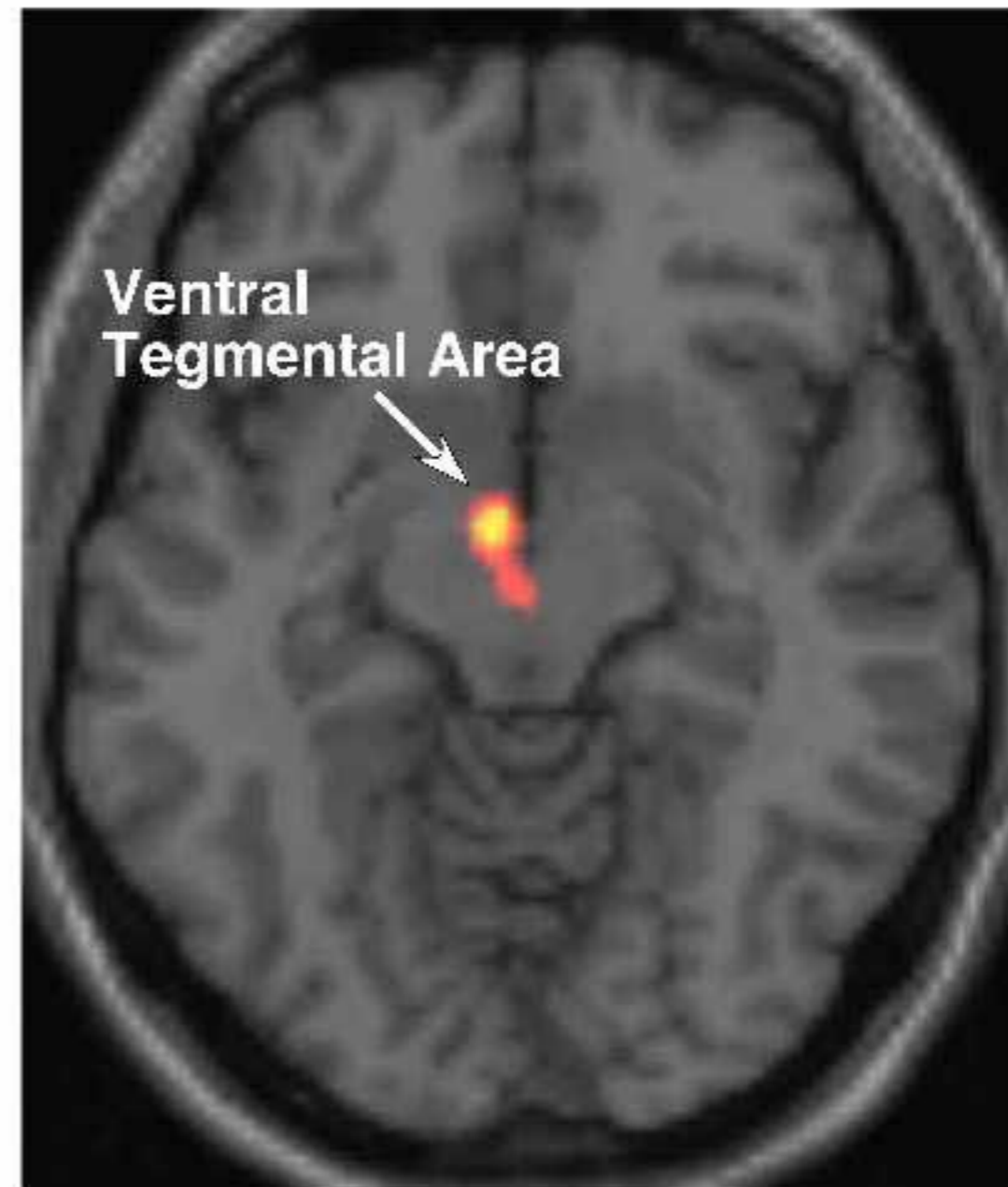
Emotion and cognition

The brain in love

- initial rollercoaster vs. going for the duration!

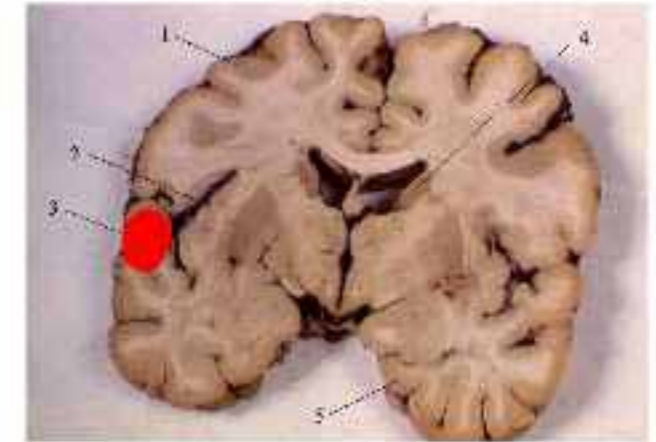
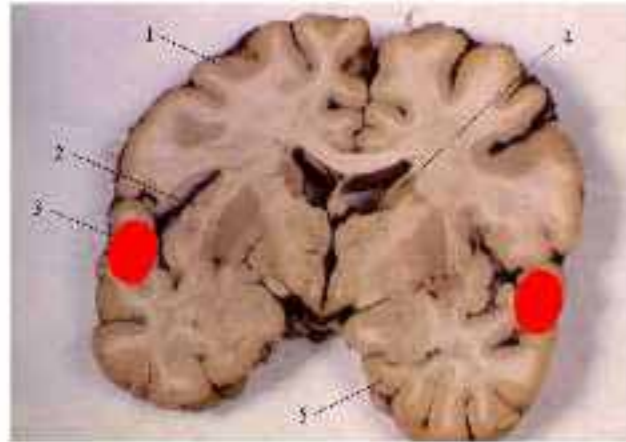


Bartels & Zeki Neuroimage 2004



Aron *et al* 2005

Emotion and cognition



Emotion and cognition

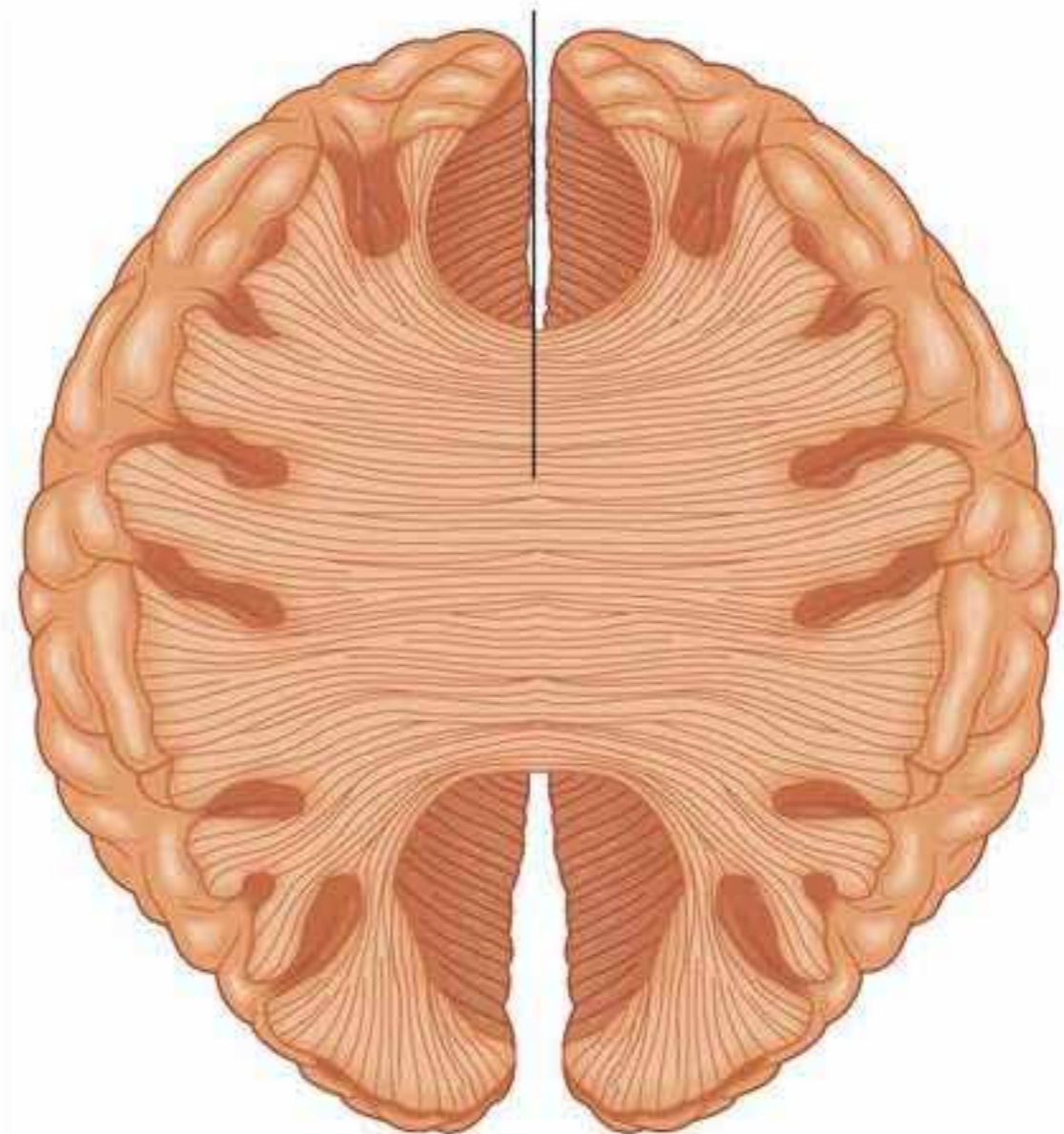
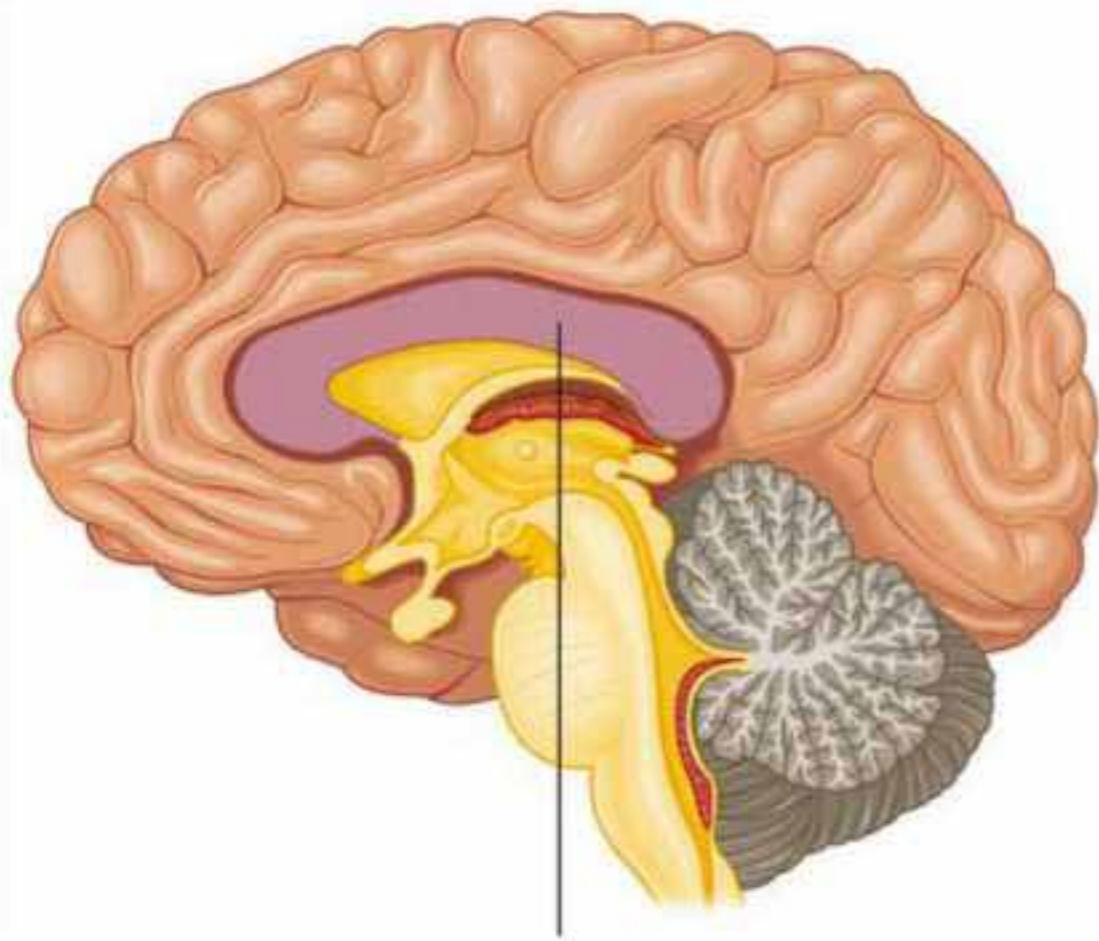
Predictions:



Emotion and cognition

Predictions:

Better hemisphere connections should lead to better emotional control

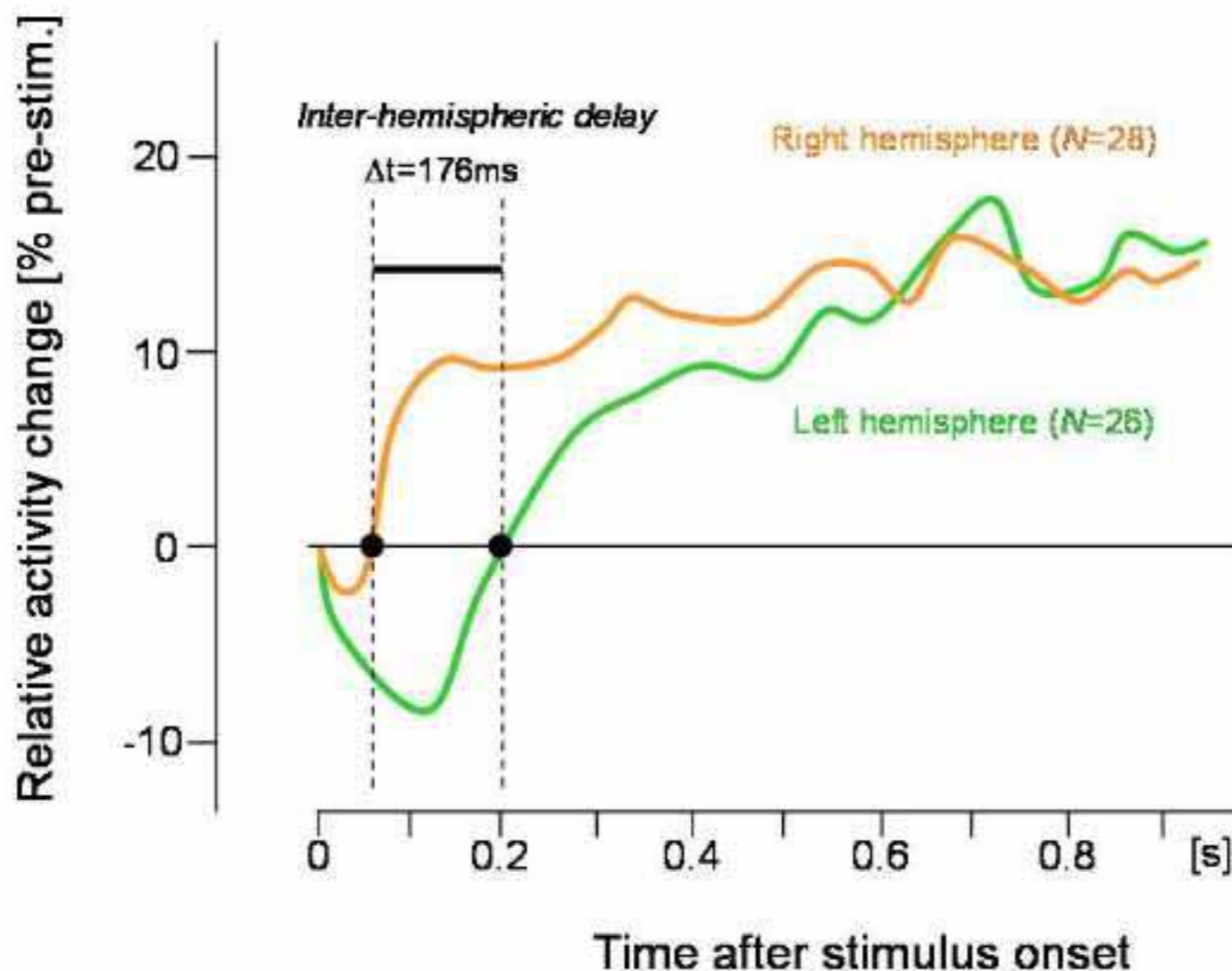


Emotion and cognition

Predictions:

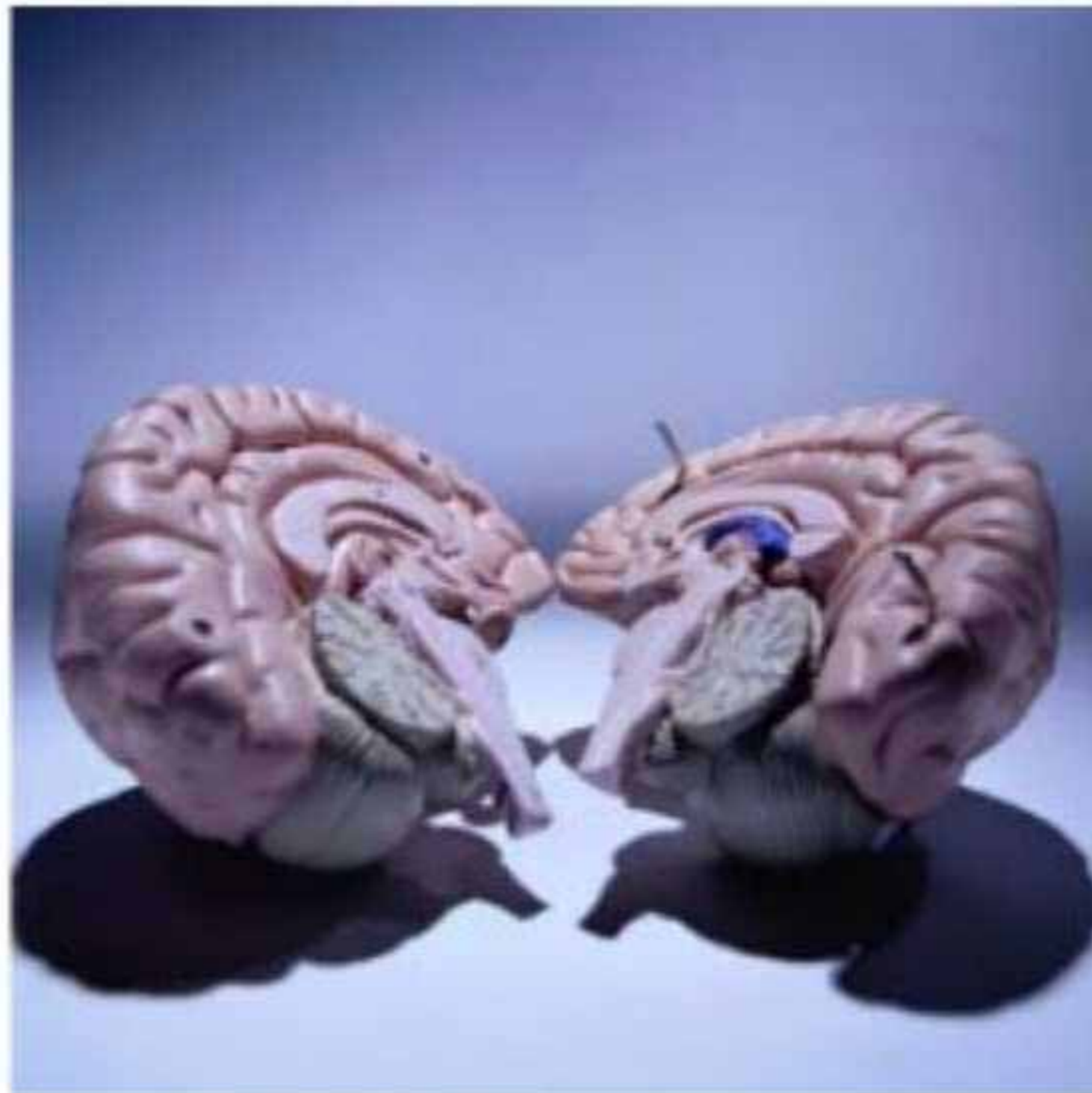
The left should respond to emotional stimuli slower than the right

Hemispheric asymmetry in neuronal response profiles



Emotion and cognition

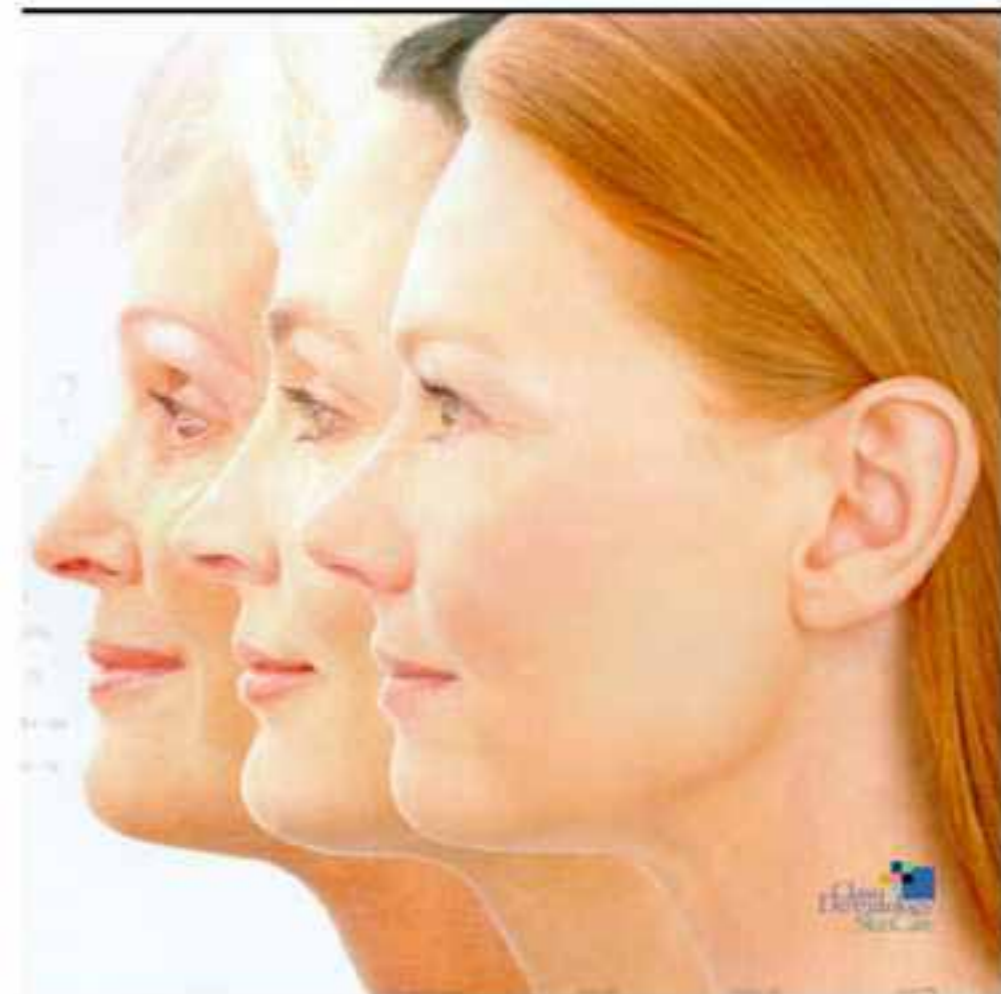
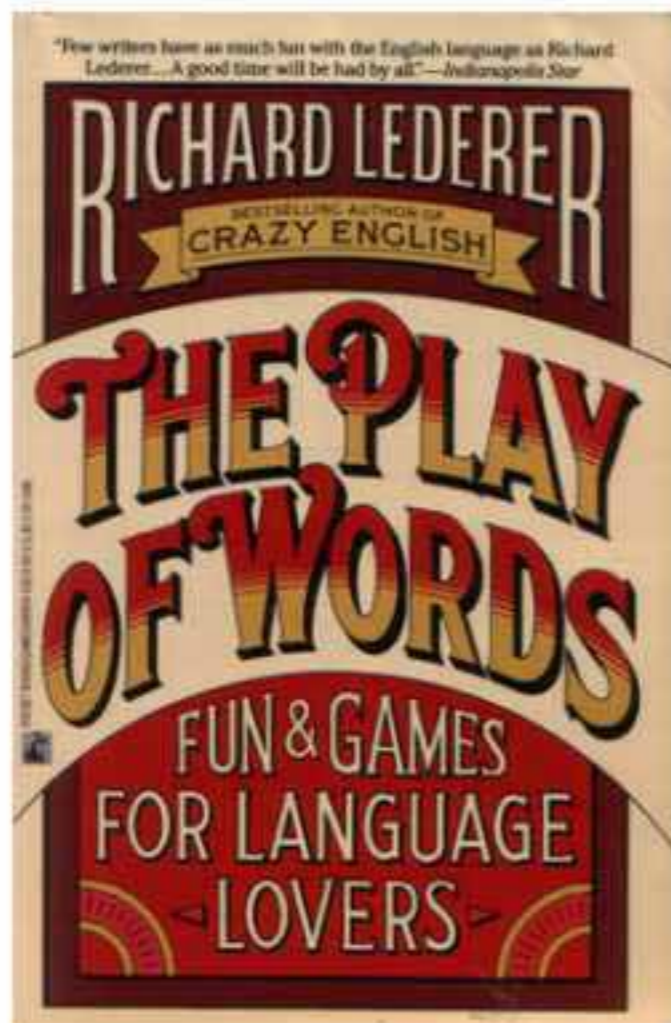
Learning and memory - two hemispheres broadly complementary



Emotion and cognition

Learning and memory - two hemispheres broadly complementary

Lead roles are dictated by the kind of information being learned



Emotion and cognition

Learning and memory - two hemispheres broadly complementary

Lead roles are dictated by the kind of information being learned

- verbal: left hemisphere

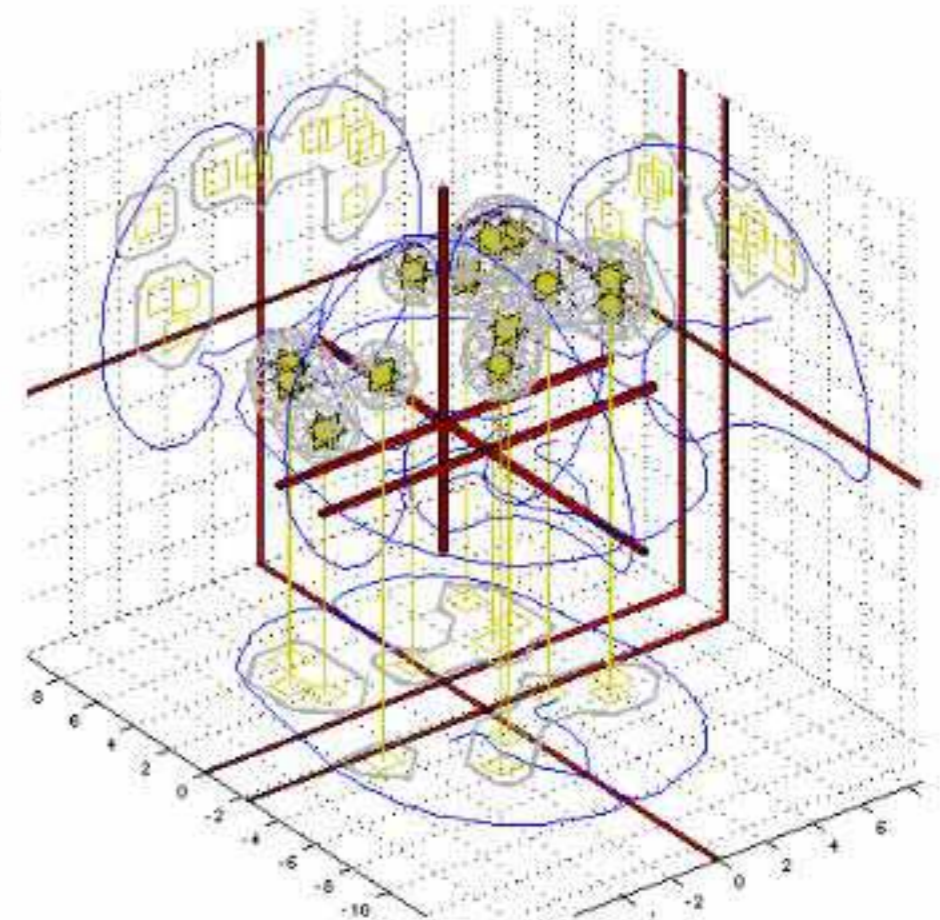


Emotion and cognition

Learning and memory - two hemispheres broadly complementary

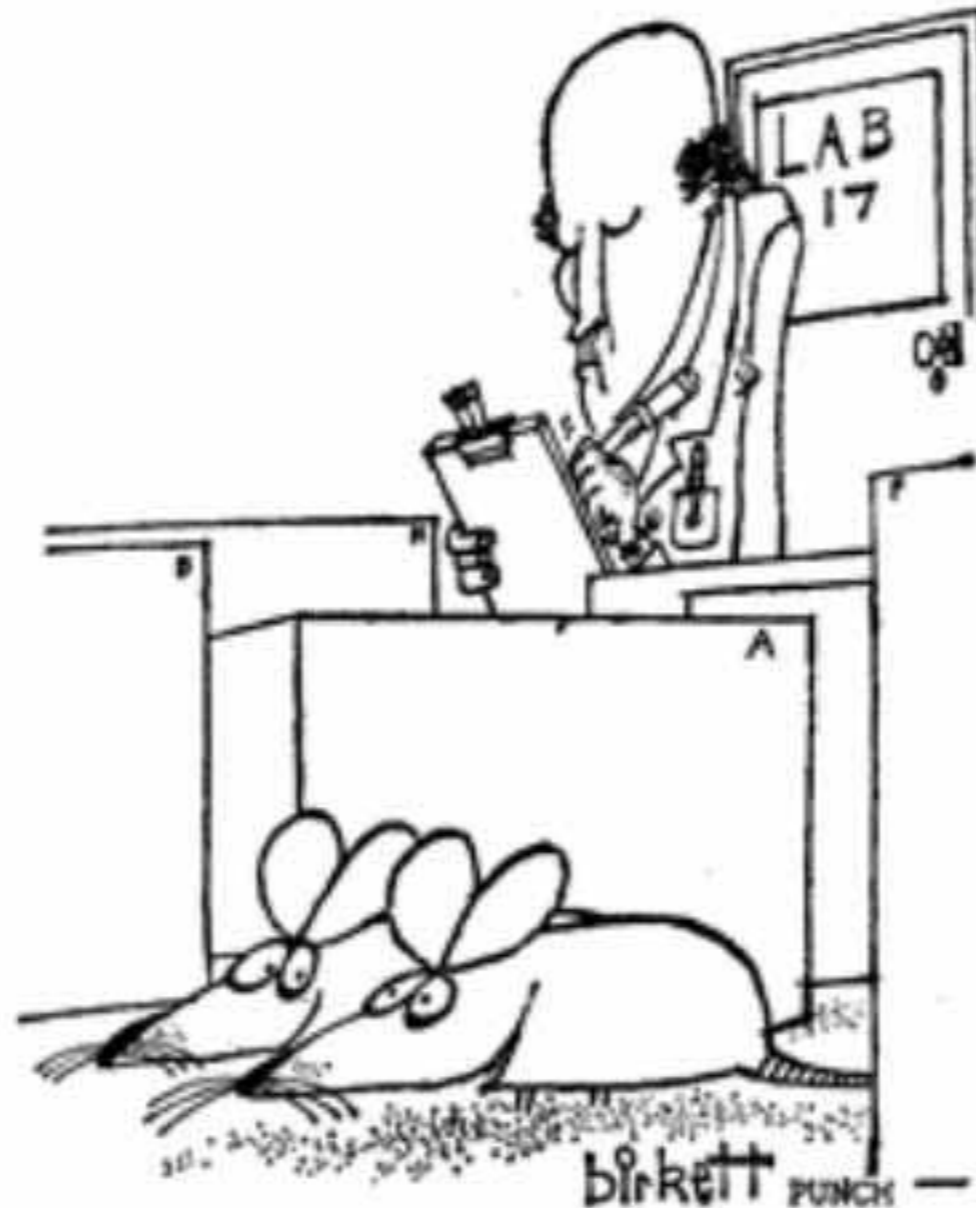
Lead roles are dictated by the kind of information being learned

- verbal: left hemisphere
- visuospatial: right hemisphere



Emotion and cognition

Rats need their right hemisphere to negotiate a maze



"I've got him conditioned perfectly - every time I get through the maze he gives me a piece of cheese!"

Emotion and cognition

Rats need their right hemisphere to negotiate a maze

Dichotic listening, sodium amygdala and 'split brains'



Emotion and cognition

Each hemisphere is independently capable of consciousness

what not to wear



Trinny Woodall & Susannah Constantine



Does experience influence brain politics?

Sensory bias or brain damage



Nelson at the Morning of Trafalgar 1805
By Mackenzie

Does experience influence brain politics?

Sensory bias or brain damage

Early exposure to tactile stimulation, novelty or prenatal stress

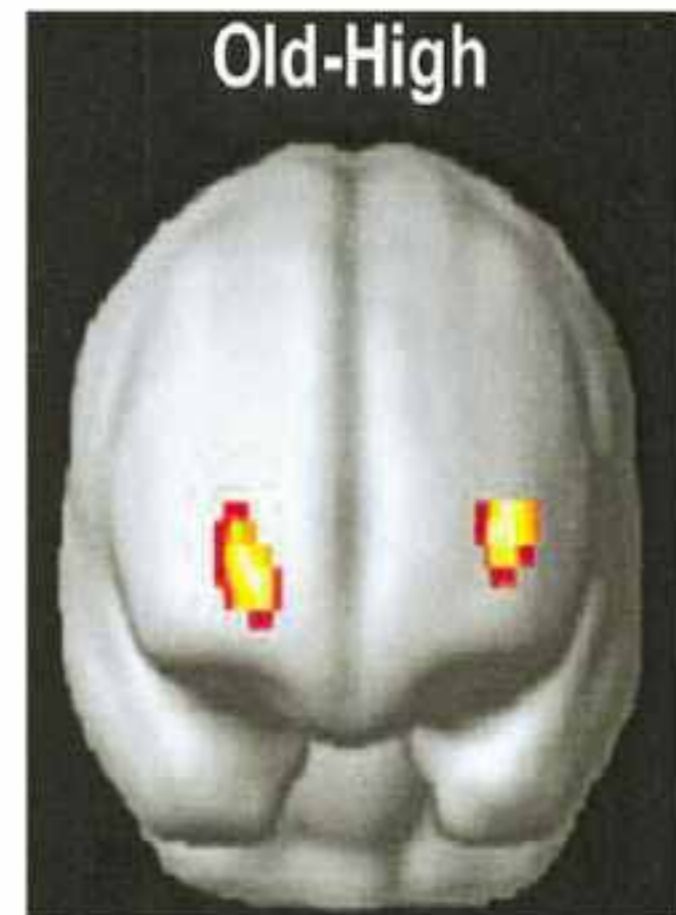
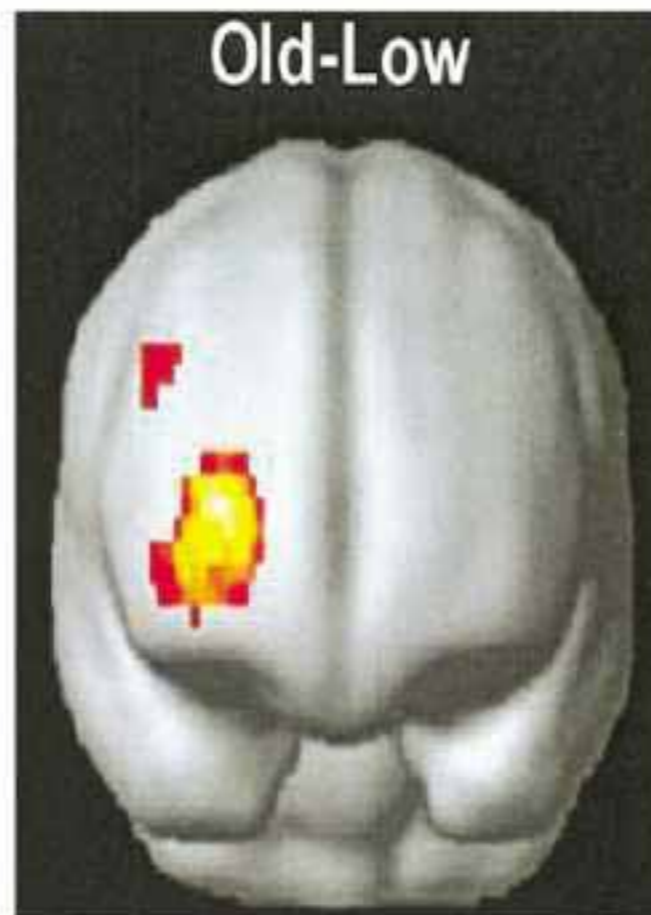
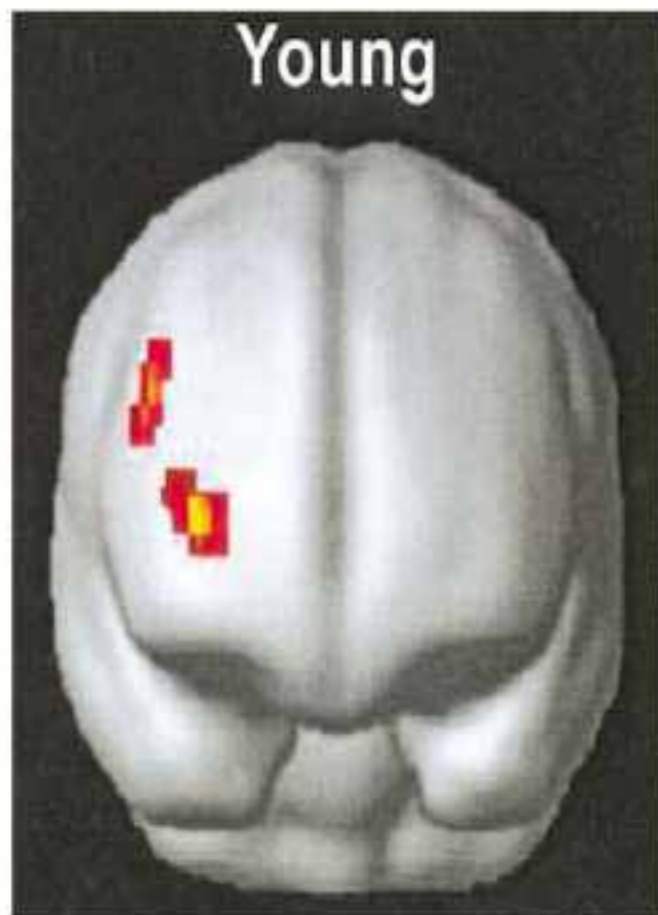


Does experience influence brain politics?

Sensory bias or brain damage

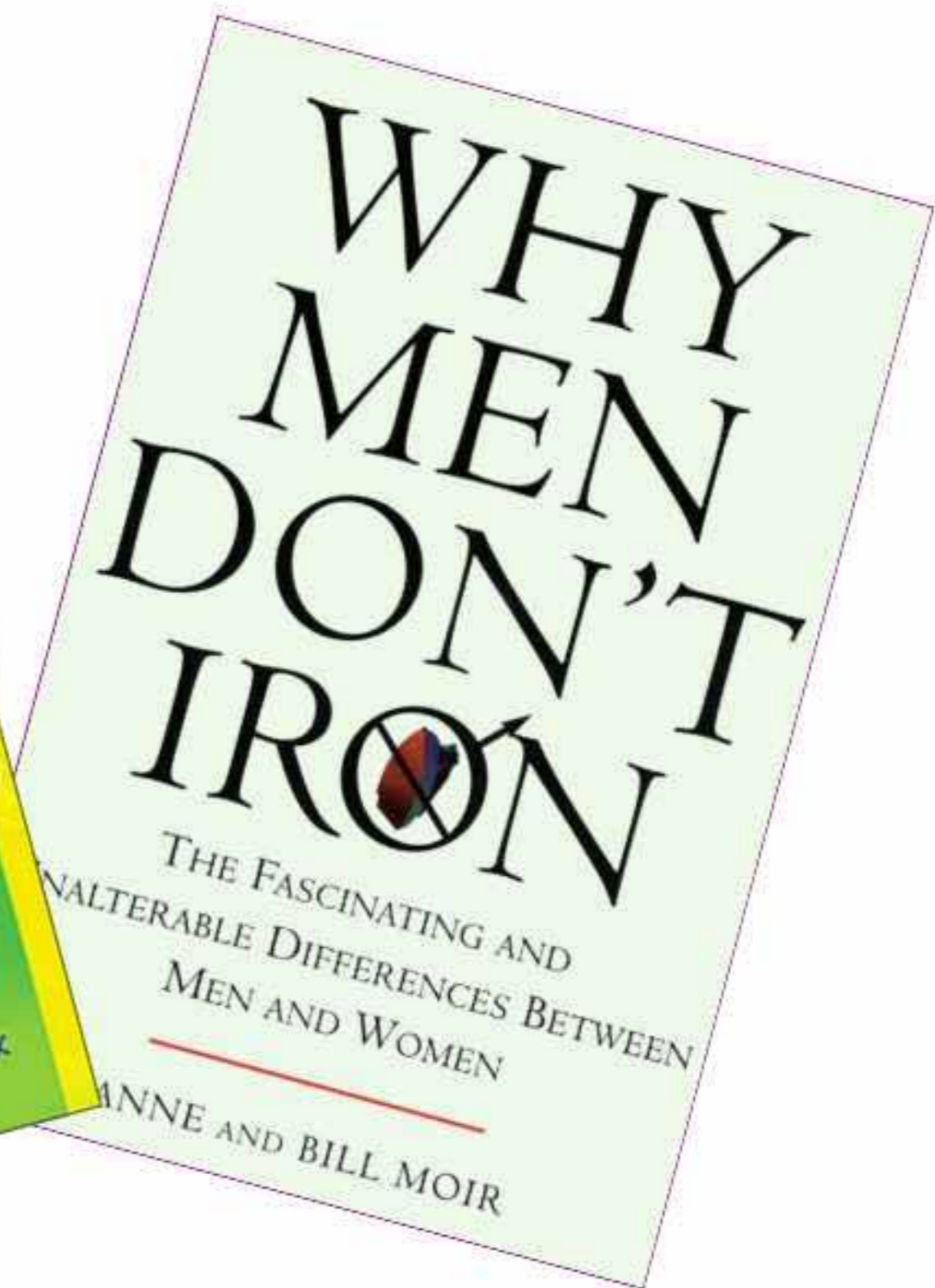
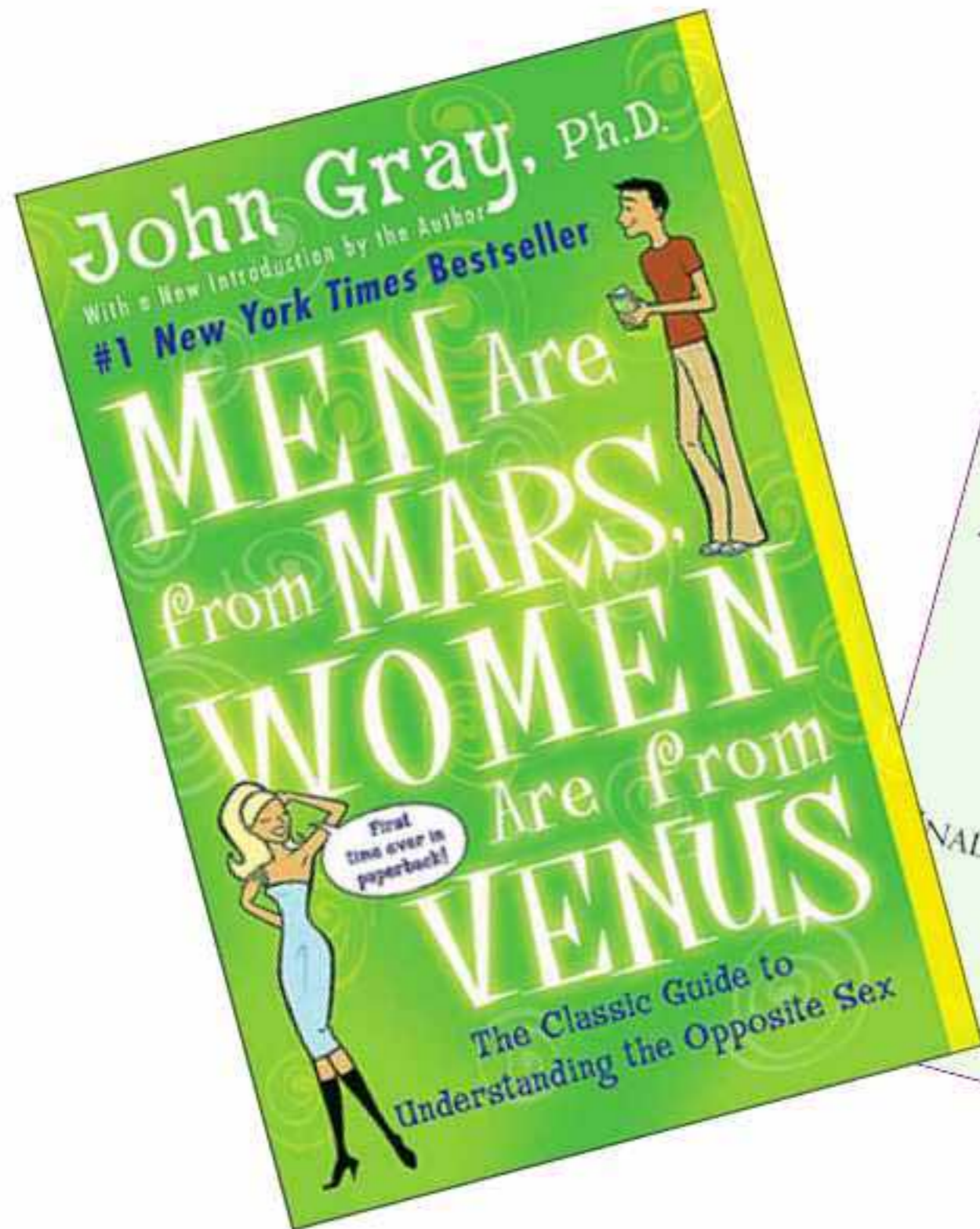
Early exposure to tactile stimulation, novelty or prenatal stress

Use it or lose it and the ageing brain



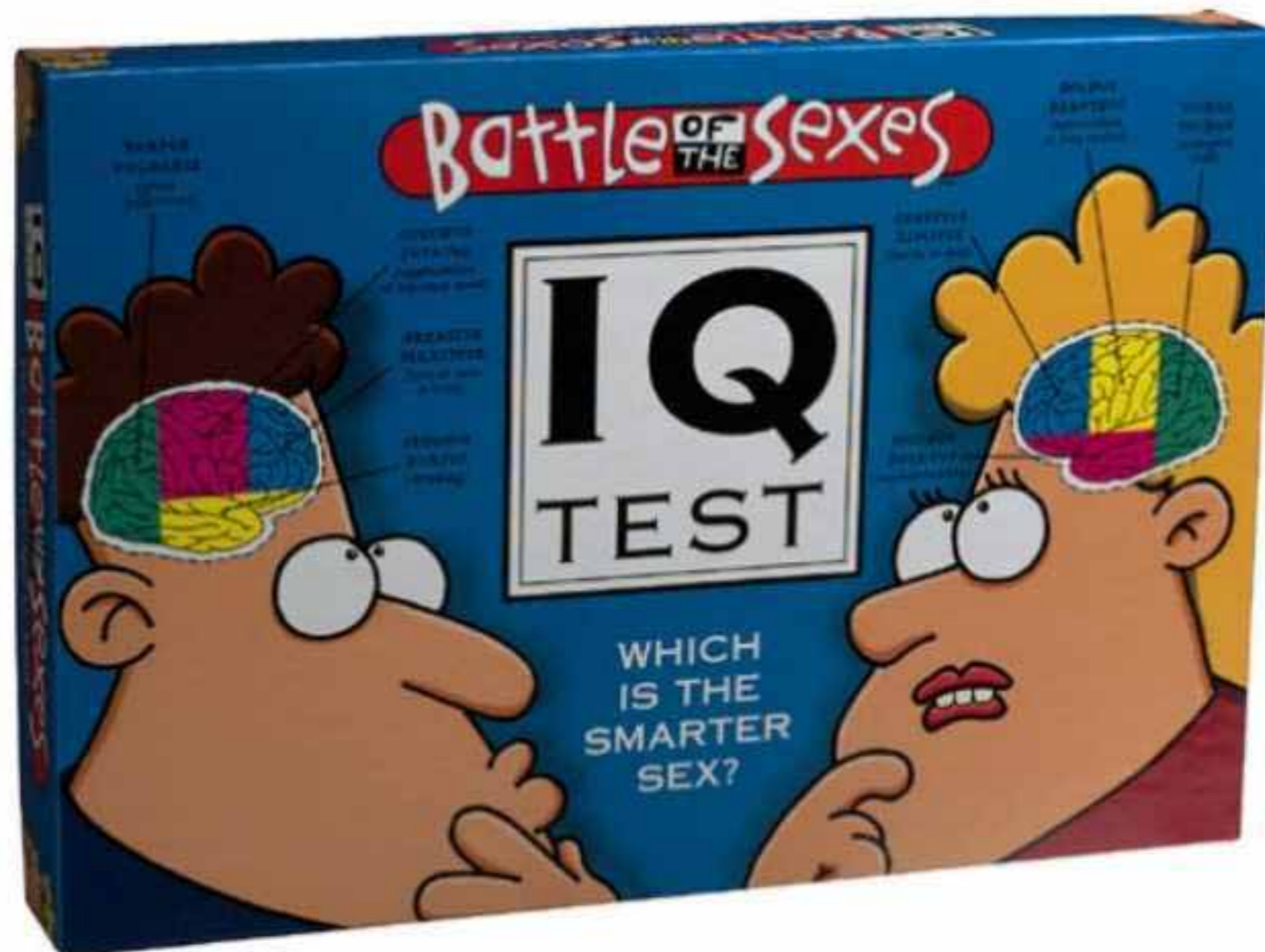
Sex/gender differences in the brain

Extreme popularist views



Sex/gender differences in the brain

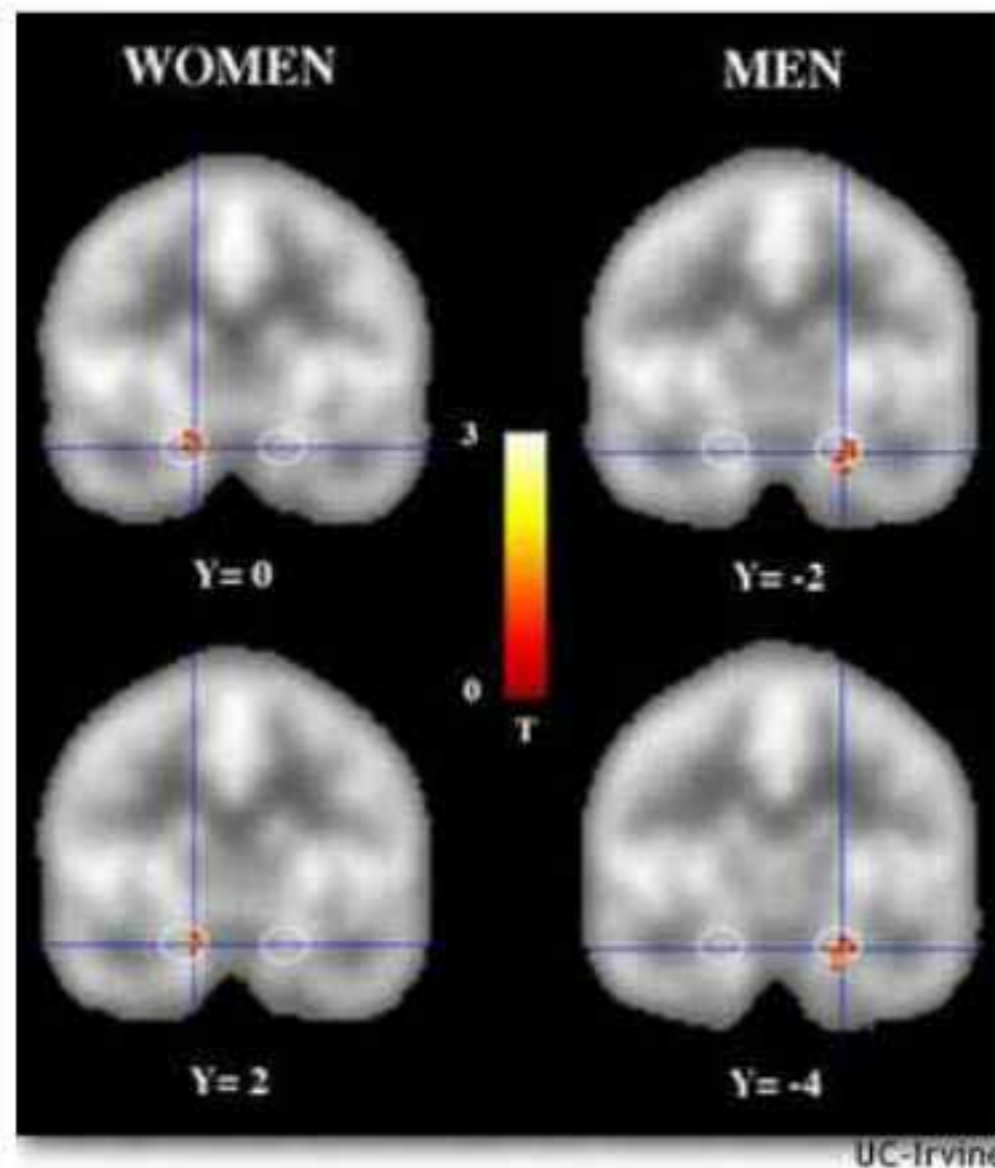
Differences within sexes are usually greater than those between them!



Sex/gender differences in the brain

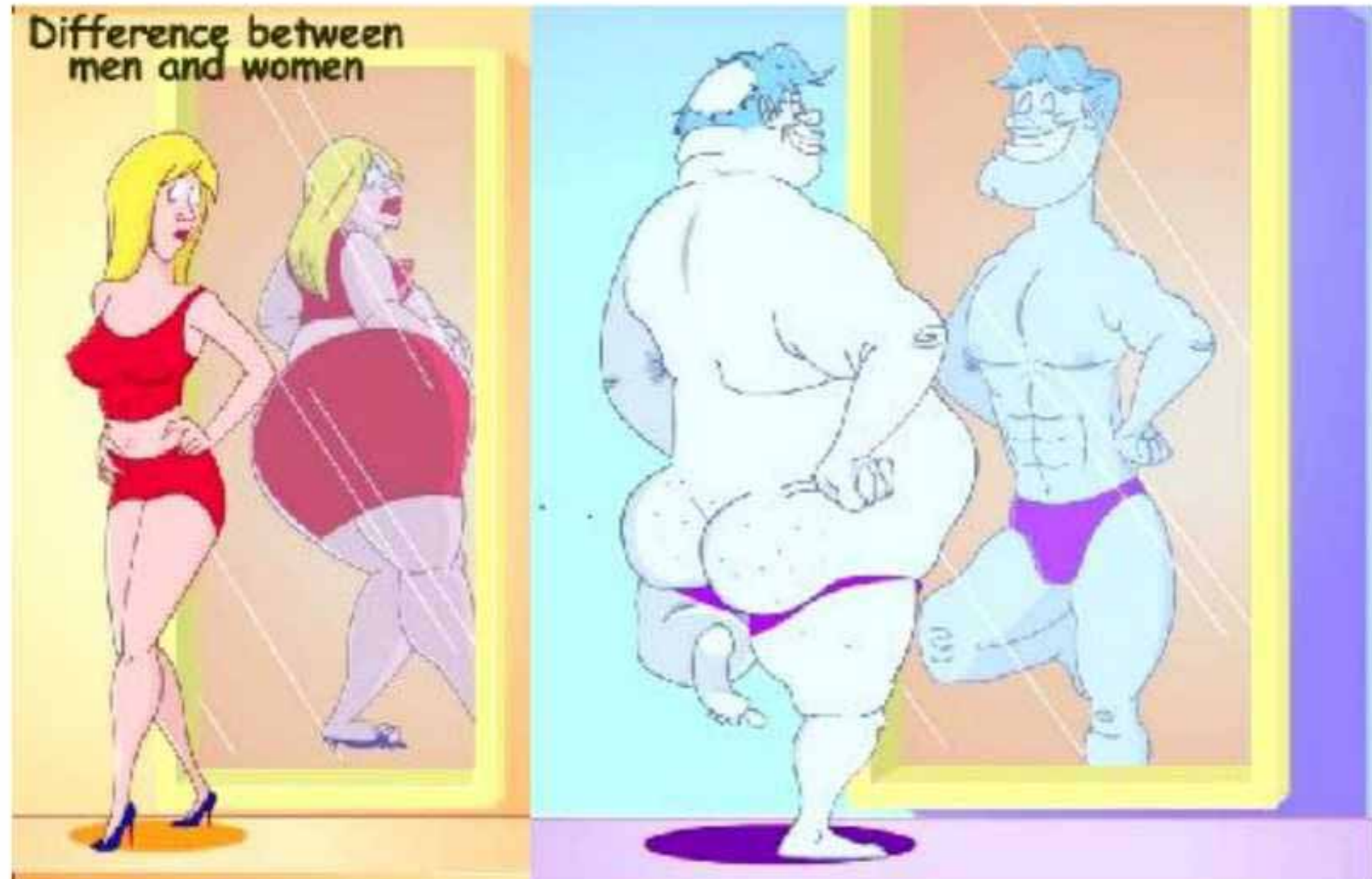
Differences within sexes are usually greater than those between them!

Males can have more female type brains and vice versa



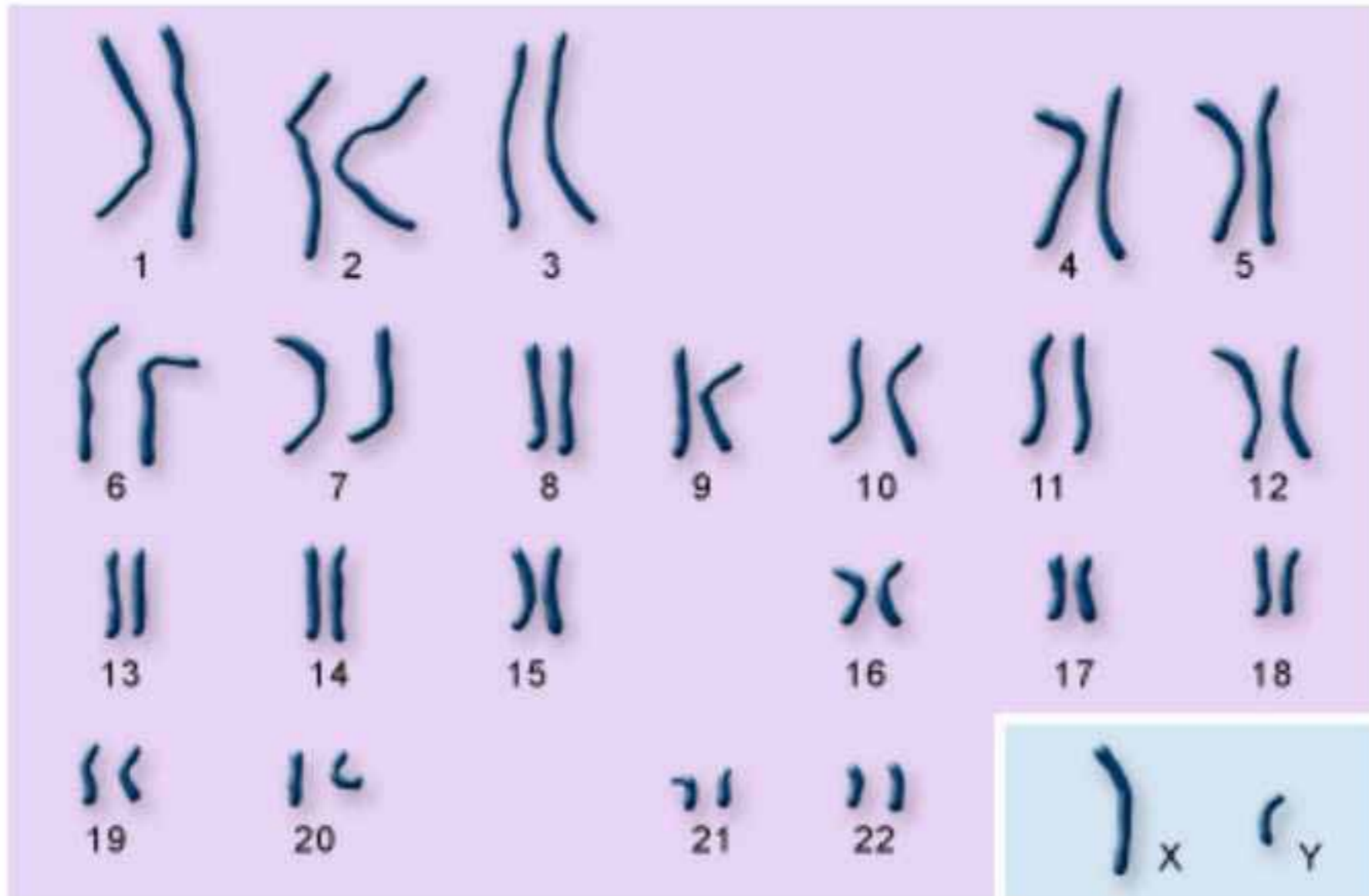
Sex/gender differences in the brain

Biology, cultural expectations, experience?



Sexual reproduction and orientation

XX – XY



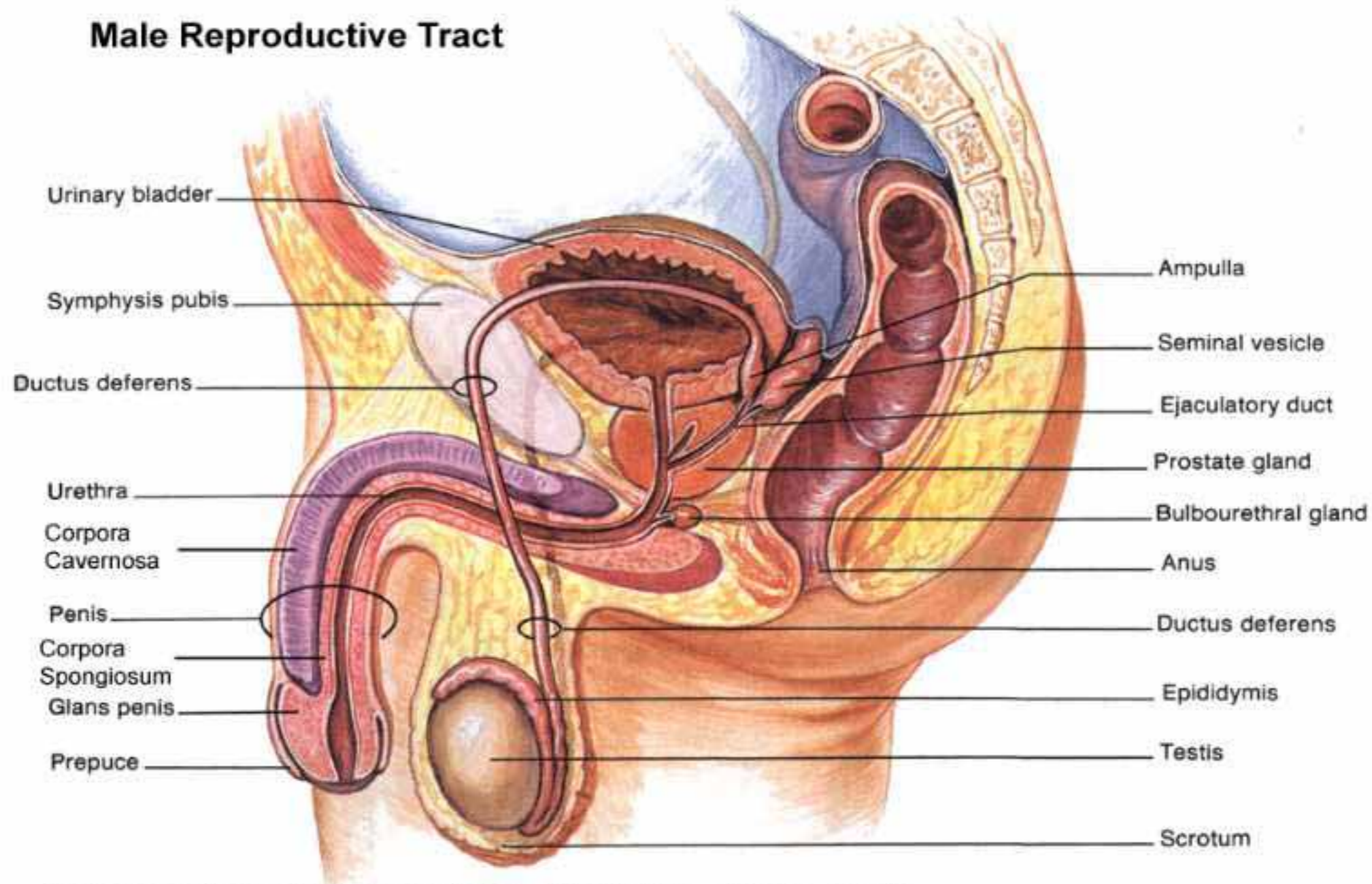
autosomes

sex chromosomes

Sexual reproduction and orientation

XX – XY

Male Reproductive Tract

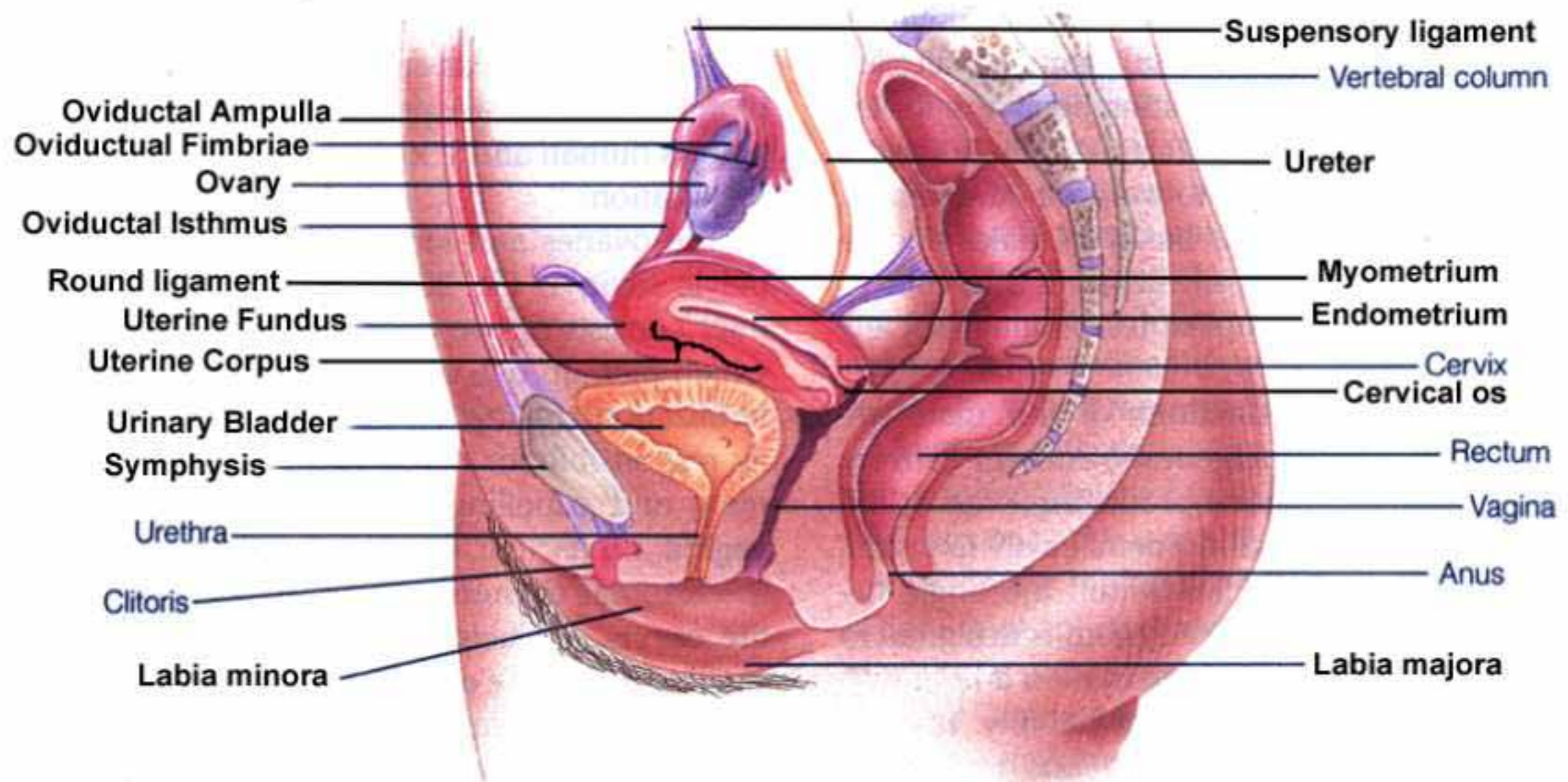


Modified from Van De Graaff, *Human Anatomy*, Wm. C. Brown: Dubuque, IA, 1988.

Sexual reproduction and orientation

XX – XY

Female Reproductive Tract

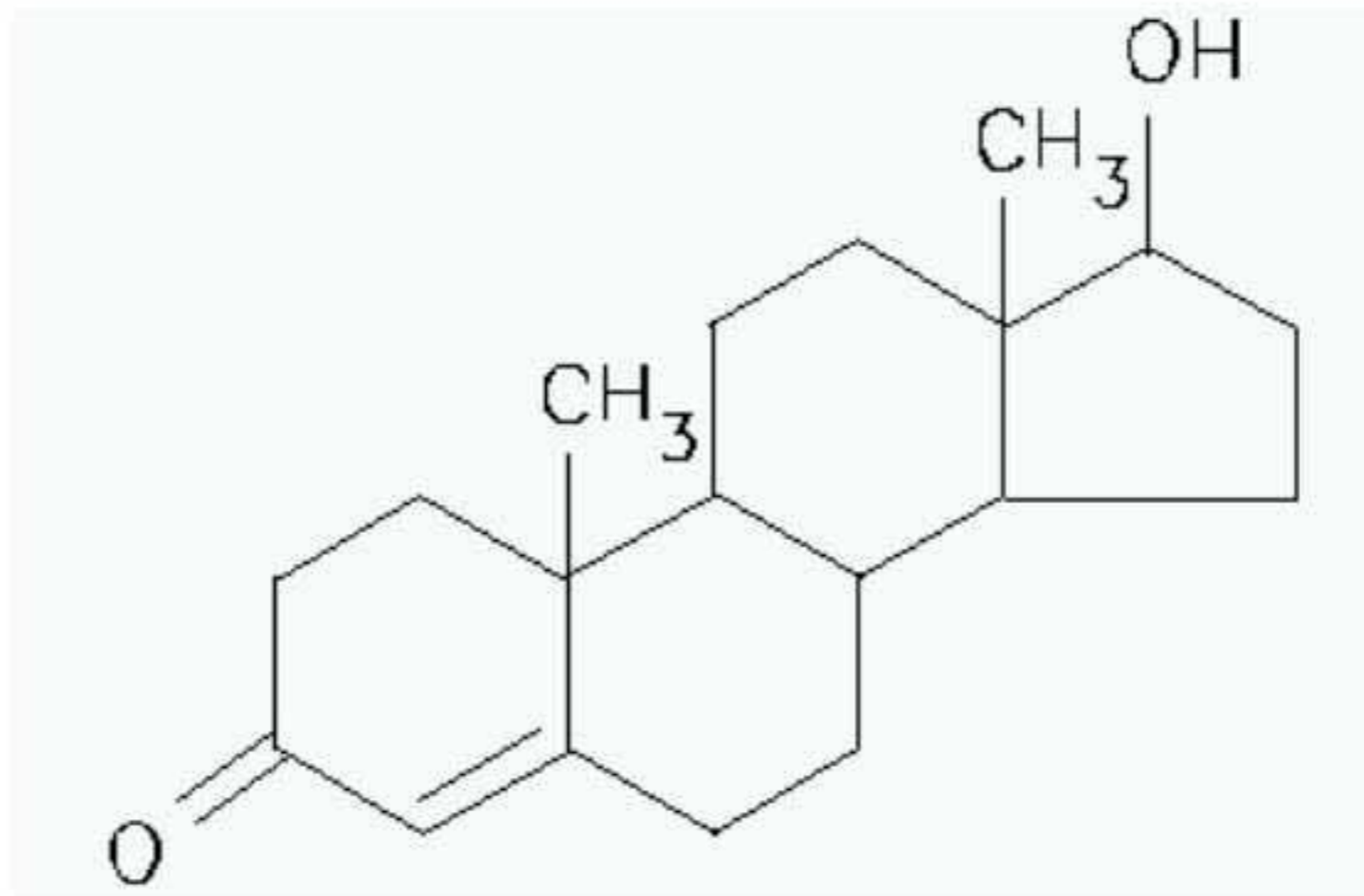


Modified from Sherwood, *Human Physiology: From Cells to Systems, 2nd Ed*, West Publishing: St. Paul, MN, 1993.

Sexual reproduction and orientation

XX - YY

Early exposure to testosterone masculinises the brain



Sexual reproduction and orientation

XX – YY

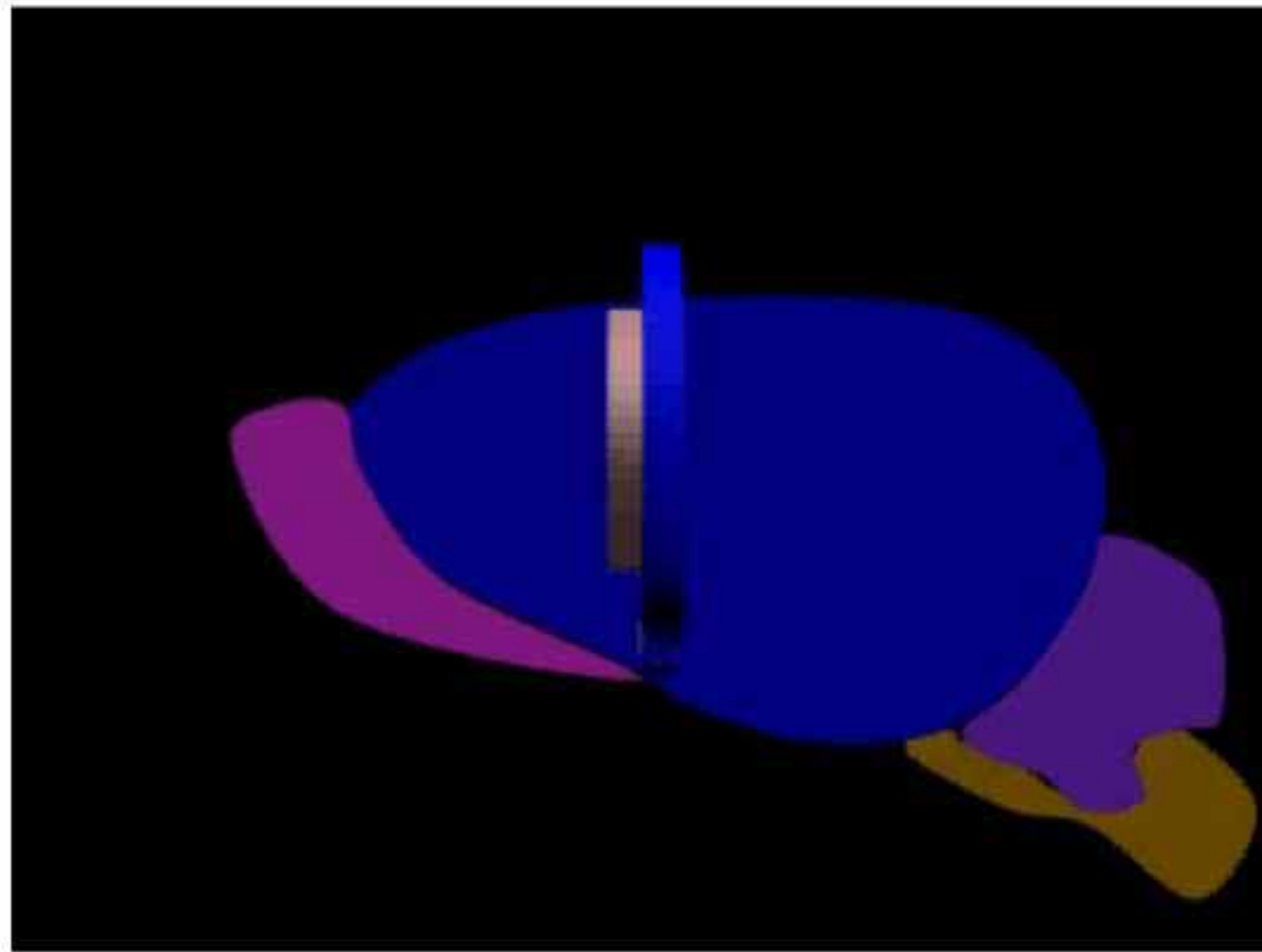
Early exposure to testosterone masculinises the brain

Brain sex and body sex can be dissociated



Sexual reproduction and orientation

Sexually dimorphic nuclei

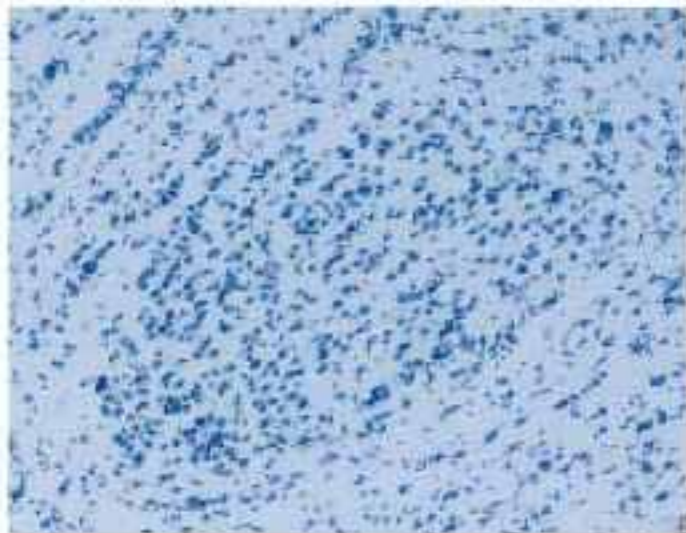


Sexual reproduction and orientation

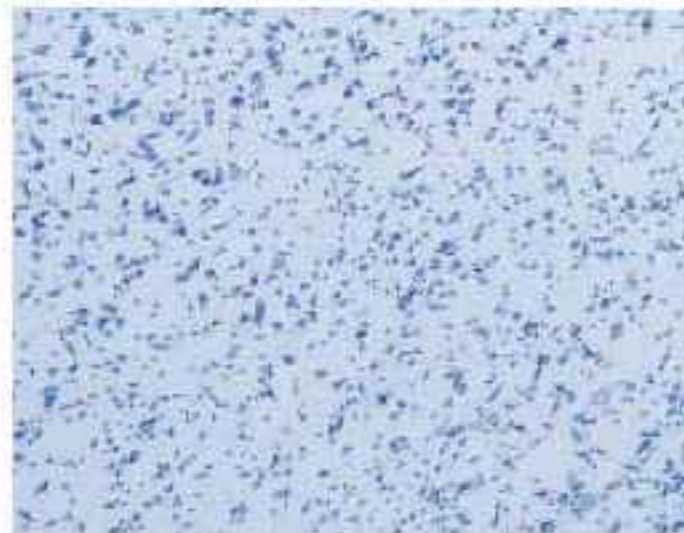
Sexually dimorphic nuclei

Homosexuals tend to have more female type brain patterns

Cells in INAH 3
(from Scientific American)

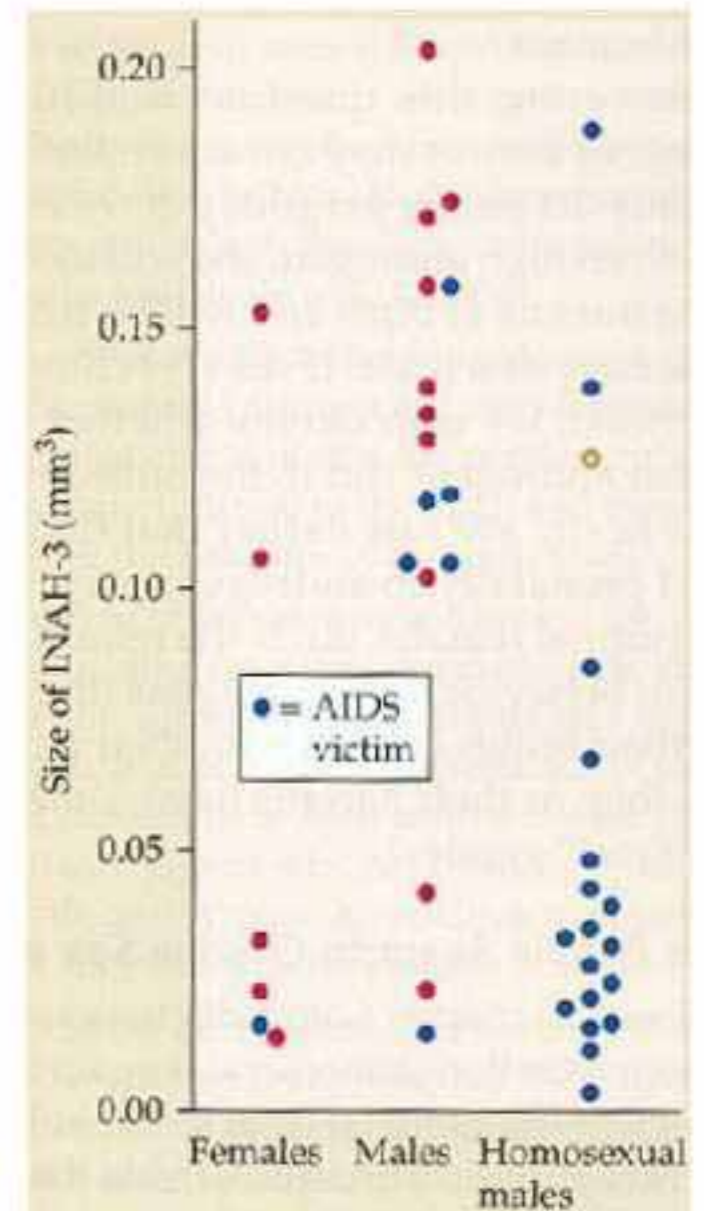


Heterosexual man



Homosexual man

Data from LeVay and Hamer 1991



Sexual reproduction and orientation

Sexually dimorphic nuclei

Homosexuals tend to have more female type brain patterns

Homosexual sheep show the same patterns as in humans



Romantic love

Males attracted by:

visual features in females

Emmanuelle



Romantic love

Males attracted by:

visual features in females
baby faces



Romantic love

Males attracted by:

visual features in females

baby faces

symmetrical features



Romantic love

Males attracted by:

visual features in females

baby faces

symmetrical features

skin quality



Romantic love

Males attracted by:

visual features in females

baby faces

symmetrical features

skin quality

body shape



Romantic love

Males attracted by:

visual features in females

baby faces

symmetrical features

skin quality

body shape

size of breasts



Romantic love

Males attracted by:

visual features in females

baby faces

symmetrical features

skin quality

body shape

size of breasts

Fall in love more quickly



Romantic love

Females attracted by:

tight butts and other visual features



Romantic love

Females attracted by:

tight butts and other visual features

but much more interested in
weighing up the total package
...including resource provision



Romantic love

Females attracted by:

tight butts and other visual features

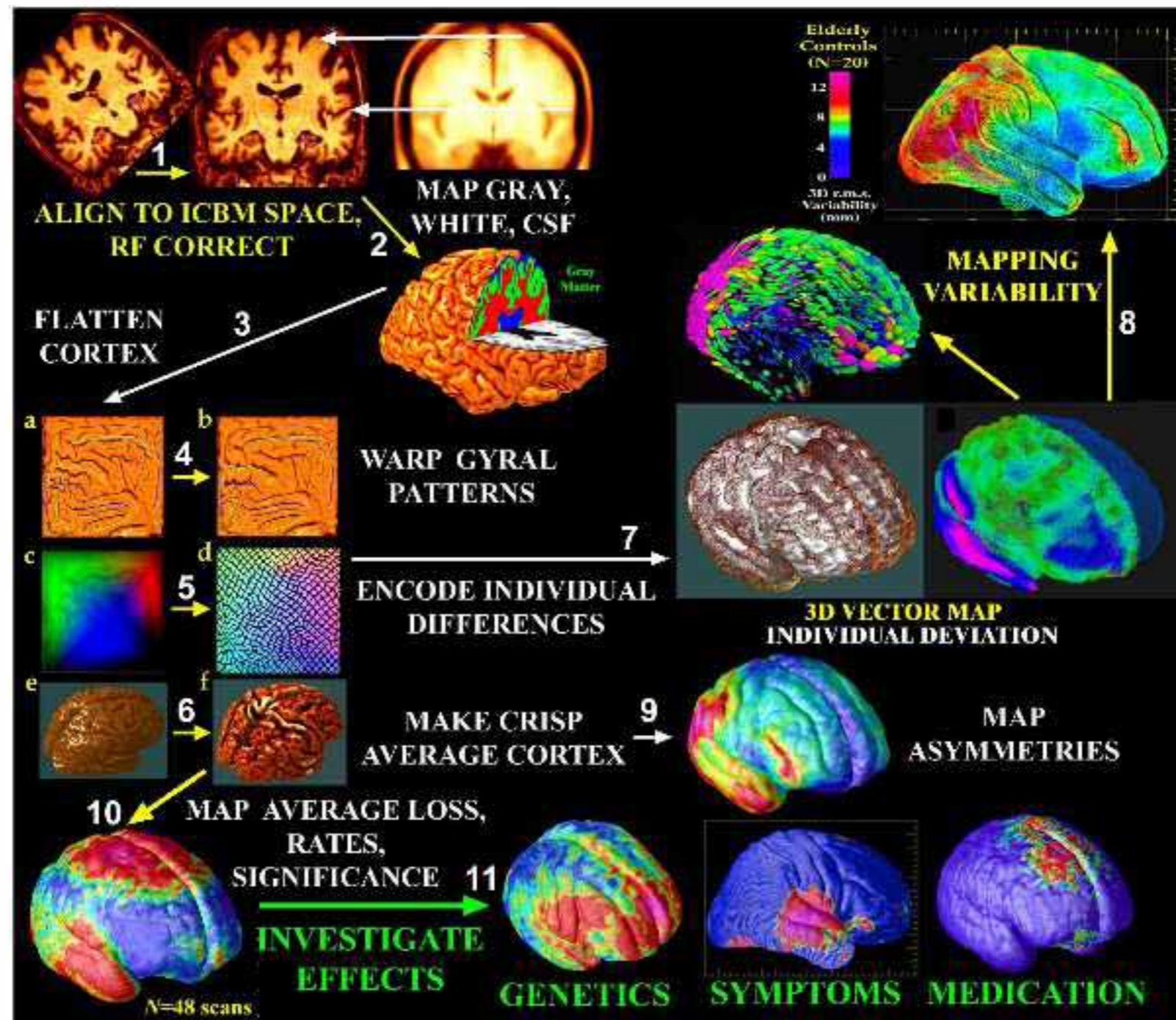
but much more interested in
weighing up the total package
...including resource provision

More likely to report feeling
'lighter than air' when in love



Romantic love

Brain imaging studies have not yet reported fundamental sex differences



Romantic love

Brain imaging studies have not yet reported fundamental sex differences

Seeing partner and ejaculation/orgasm activate similar areas



Romantic love

Brain imaging studies have not yet reported fundamental sex differences

Seeing partner and ejaculation/orgasm activate similar areas

Brain memory mechanisms > in females?

Romantic love

Testosterone is important for sex drive in both sexes

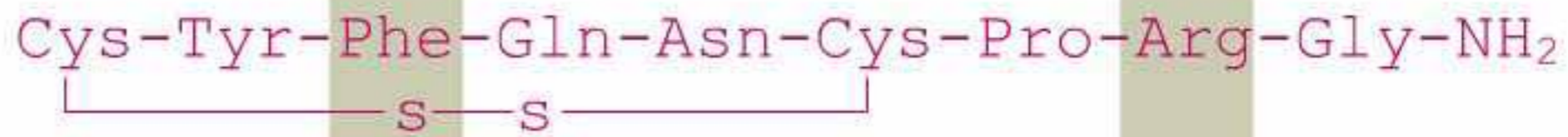
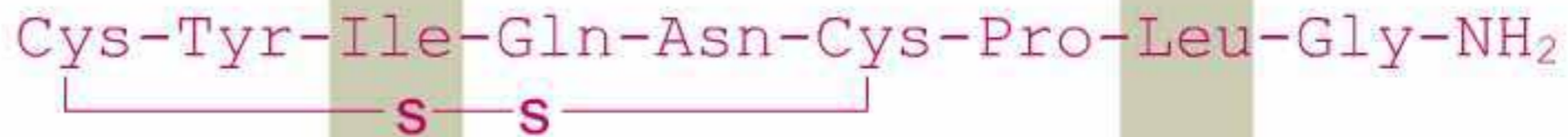


Romantic love

Testosterone is important for sex drive in both sexes

Males and females may have different bonding hormones

- females: oxytocin

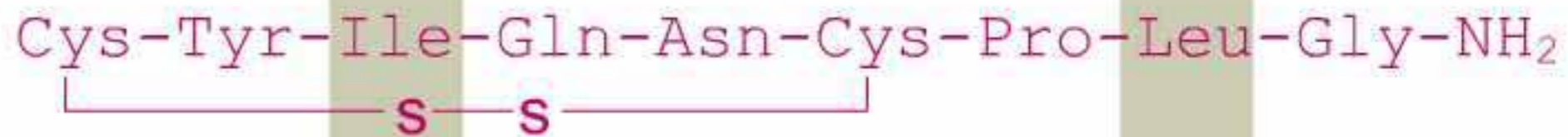


Romantic love

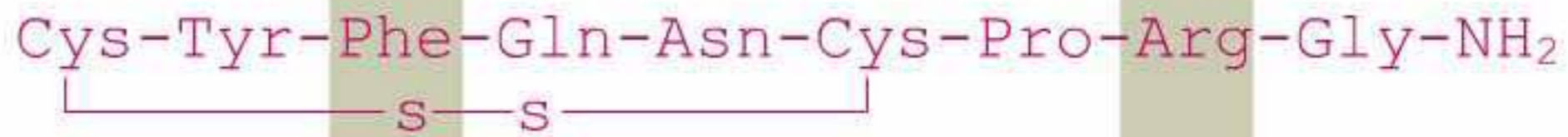
Testosterone is important for sex drive in both sexes

Males and females may have different bonding hormones

- females: oxytocin



- males: vasopressin



Romantic love

Monogamy vs. promiscuity

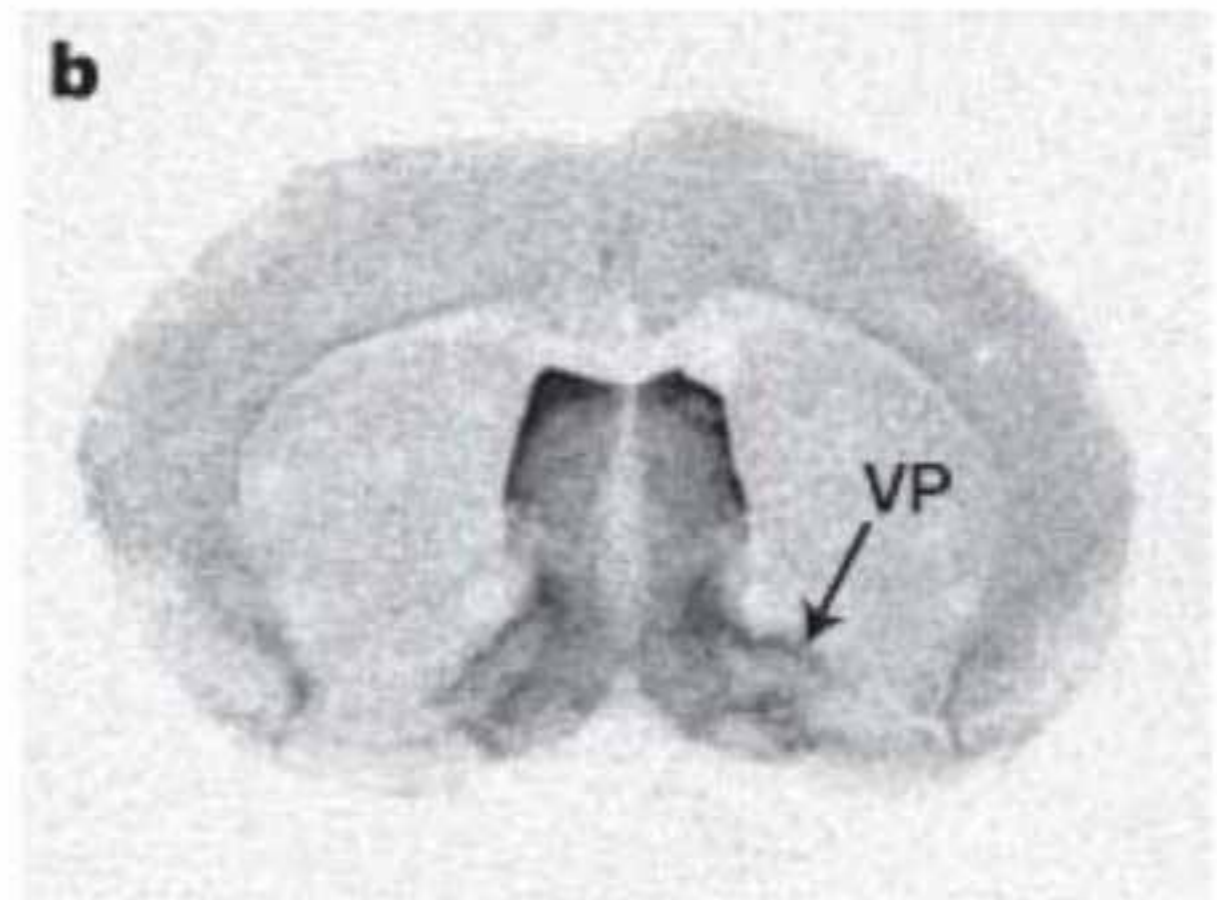
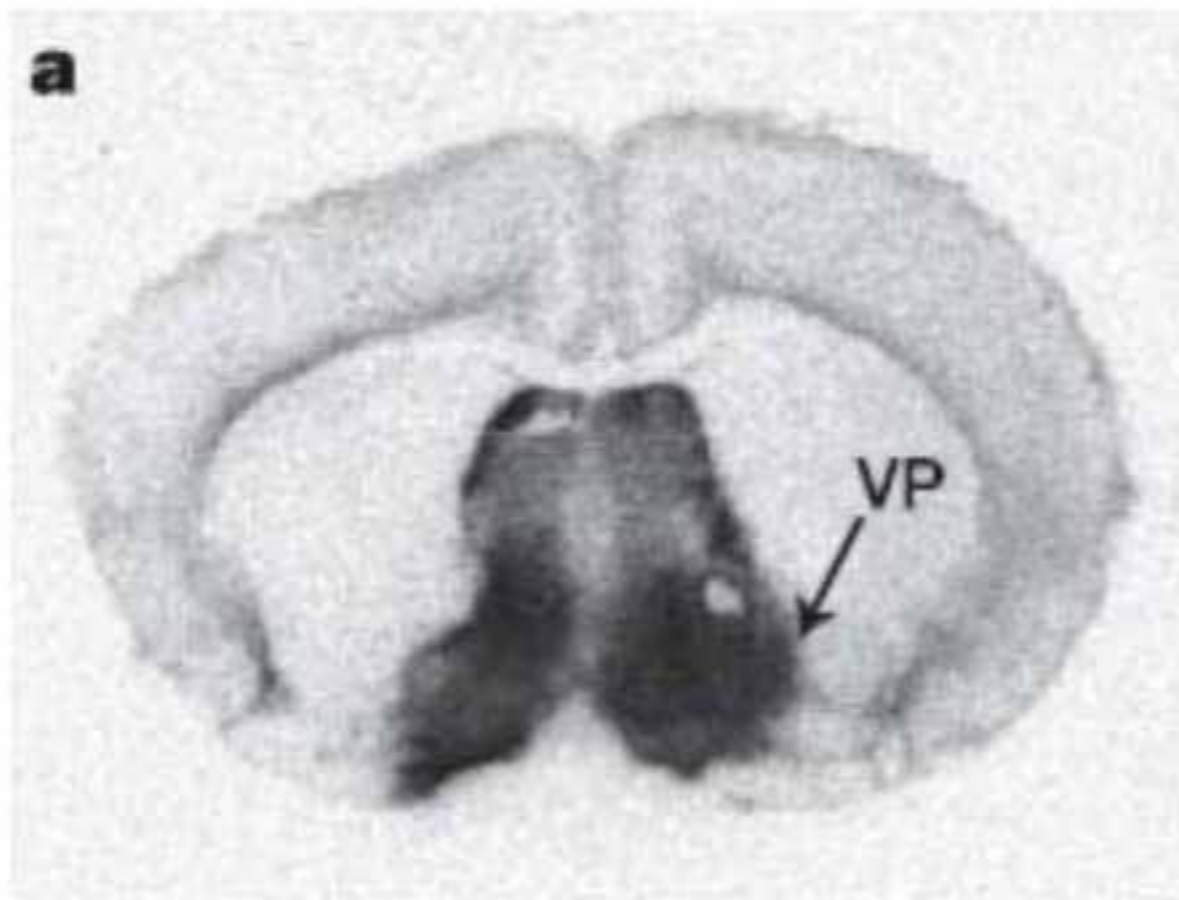


Romantic love

Monogamy vs. promiscuity

Linking the bonding hormones
with reward

Lim et al Nature 2004



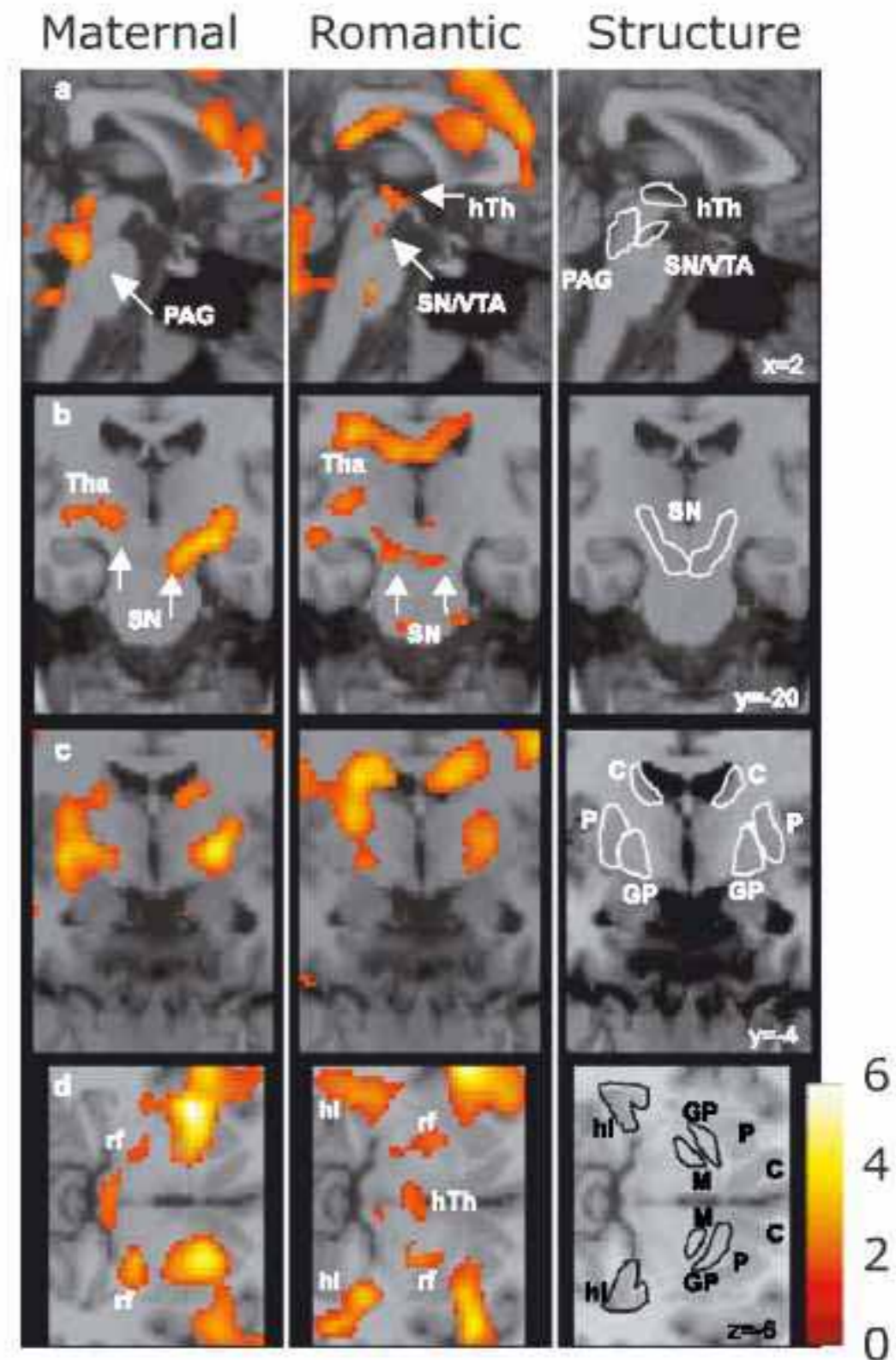
Romantic love

Monogamy vs. promiscuity

Linking the bonding hormones with reward

Humans?

Bartels & Zeki Neuroimage 2004



Parenting

Males only do parenting in 3-4% of monogamous mammalian species



Parenting

Males only do parenting in 3-4% of monogamous mammalian species

When they do they become like females!

- testosterone decreases and oestrogen increases
- prolactin increases and may cause lactation



Parenting

However oxytocin may make mums and vasopressin dads



Effects of offspring bonds

Mums have more influence on social and sexual preferences of sons



Effects of offspring bonds

Mums have more influence on social and sexual preferences of sons

Caused by organisational effects of testosterone on male brain

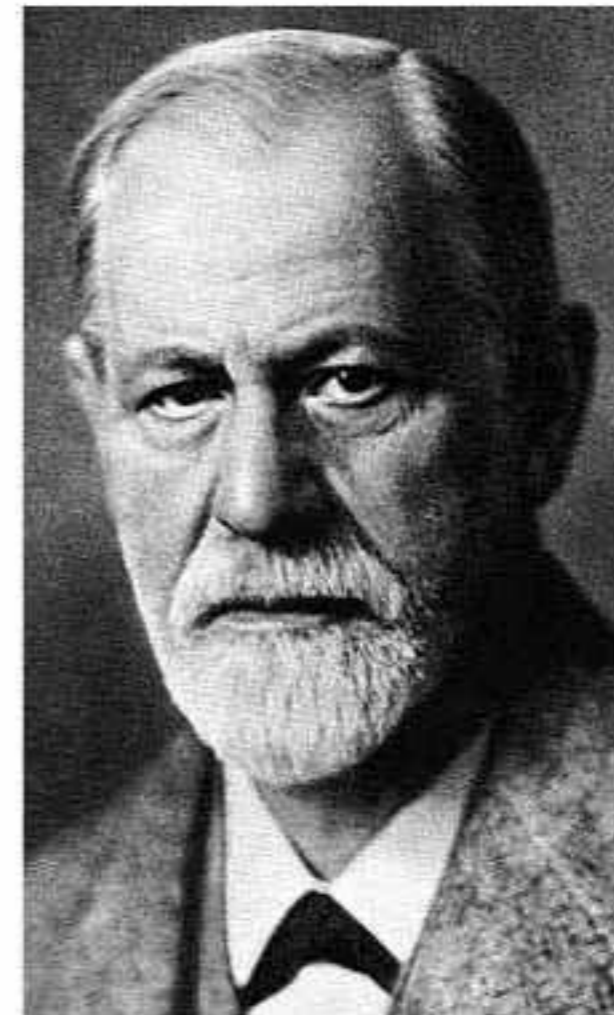


Effects of offspring bonds

Mums have more influence on social and sexual preferences of sons

Caused by organisational effects of testosterone on male brain

What about humans?



Sensory perception and attention

Smell and taste:

Females are more sensitive for both



Sensory perception and attention

Smell and taste:

Females are more sensitive for both

Females are 1000 times more sensitive to musk smell in their own perfumes!



Sensory perception and attention

Touch:

Females more sensitive – the vagina being the most sensitive of all

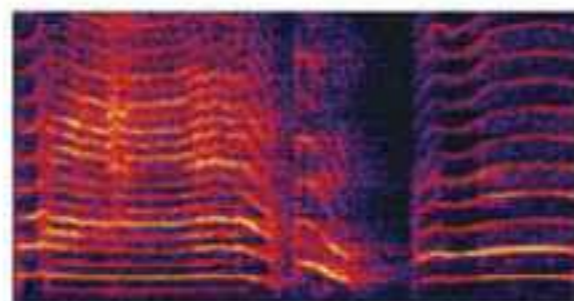
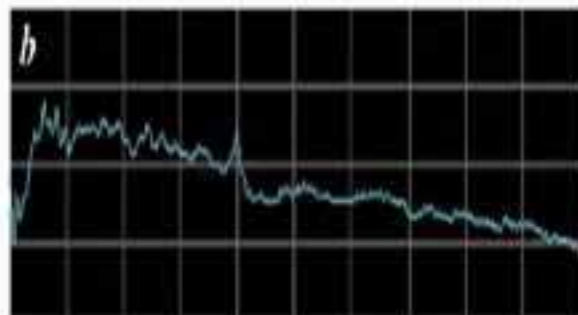
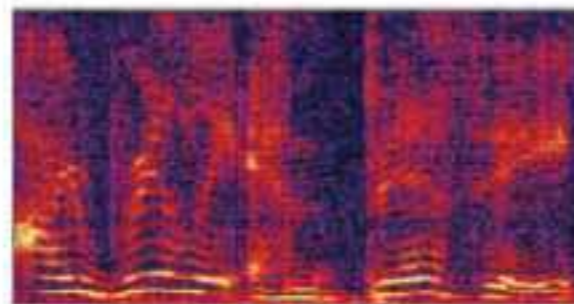
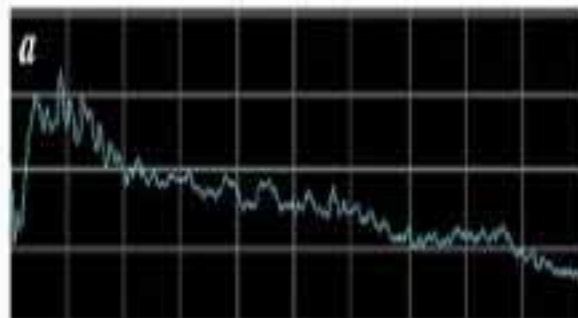


Sensory perception and attention

Hearing:

Females detect pure tone sounds better across the frequency spectrum

- particular advantage at frequencies above 4KHz



Sensory perception and attention

Vision:

Females have slightly better visual acuity

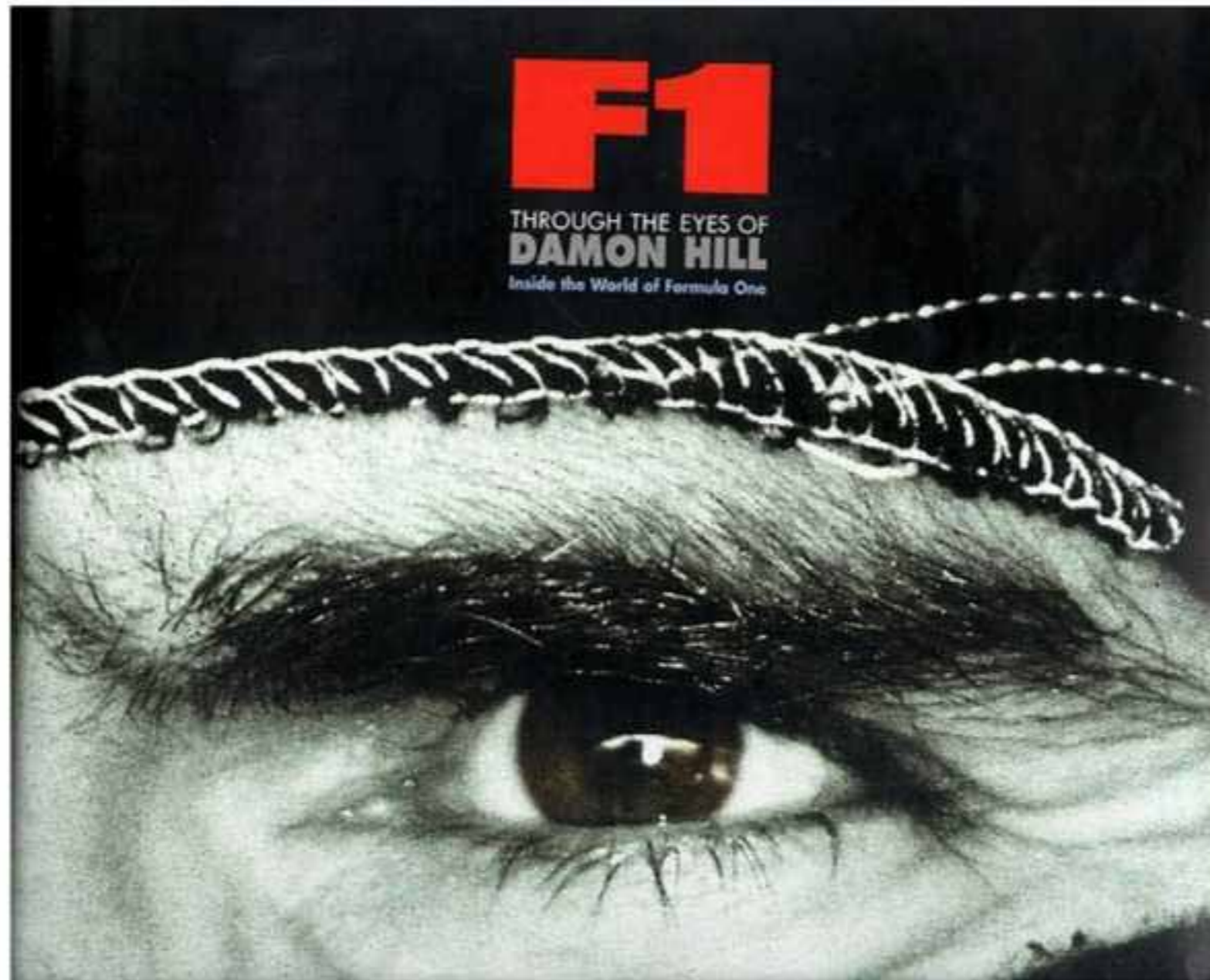
Males are better at detecting movement using peripheral vision



Sensory perception and attention

Attention:

Males have better focused attention



Sensory perception and attention

Attention:

Males have better focused attention

Females have better divided attention



Sensory perception and attention

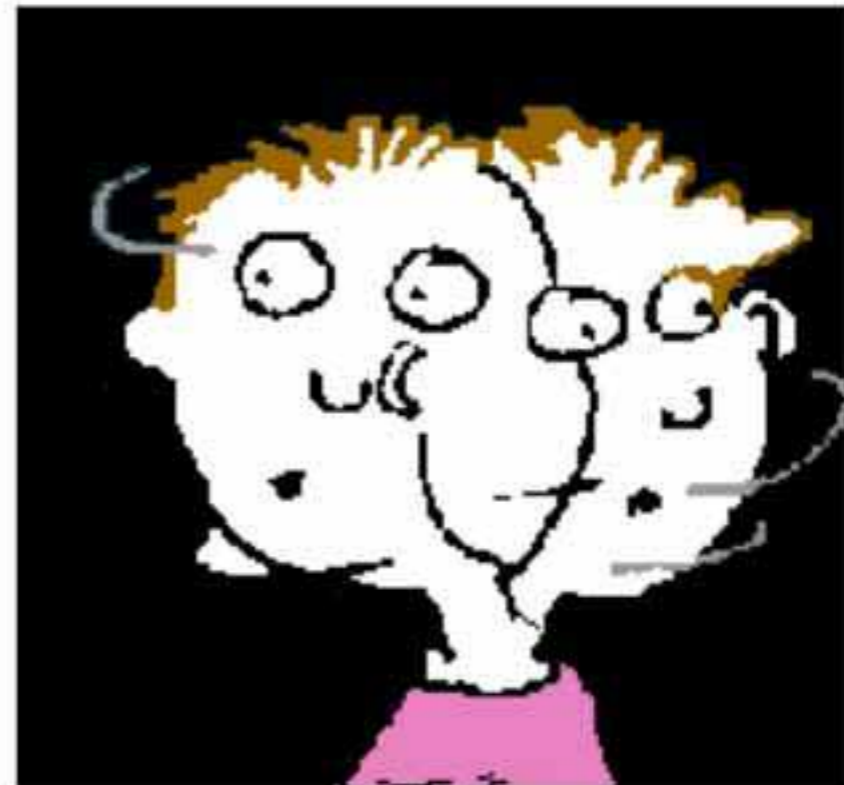
Attention:

Males have better focused attention

Females have better divided attention

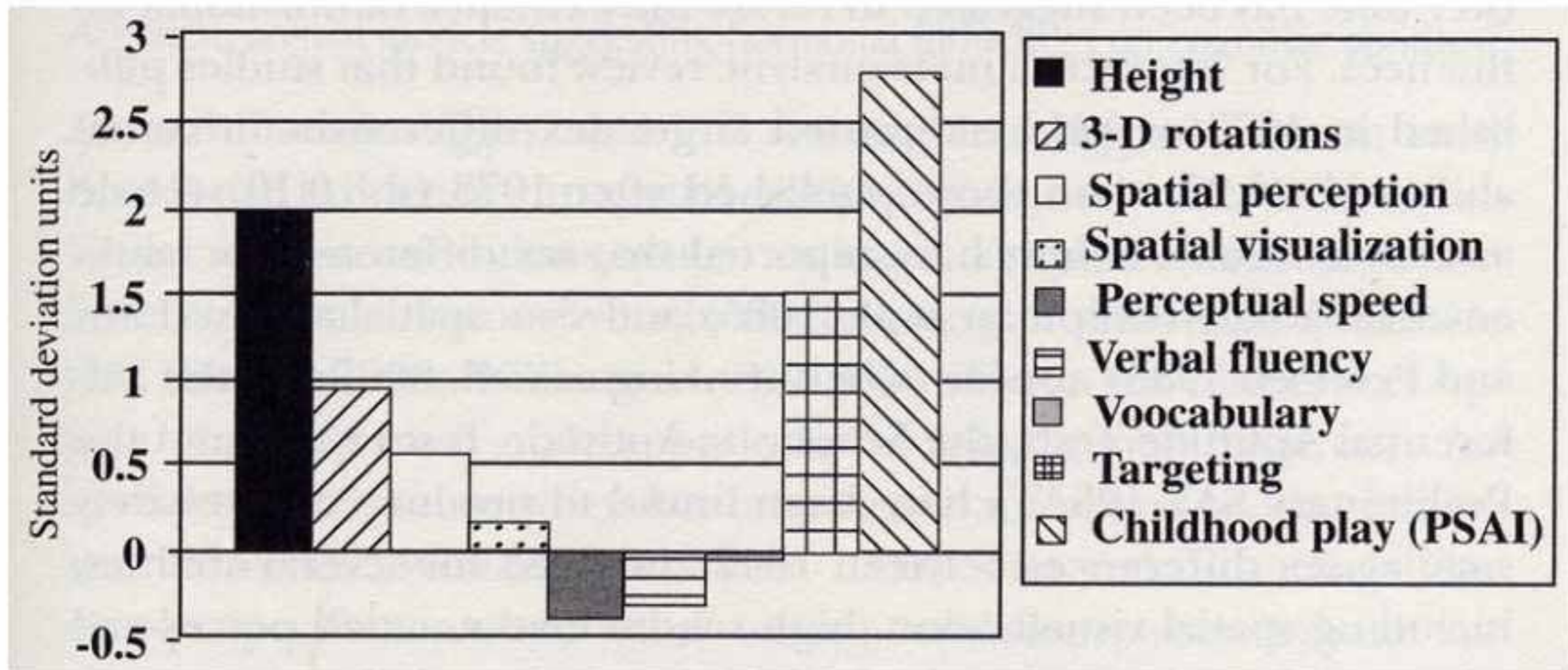
Males are more susceptible to attention disorders

- such as ADHD



Play

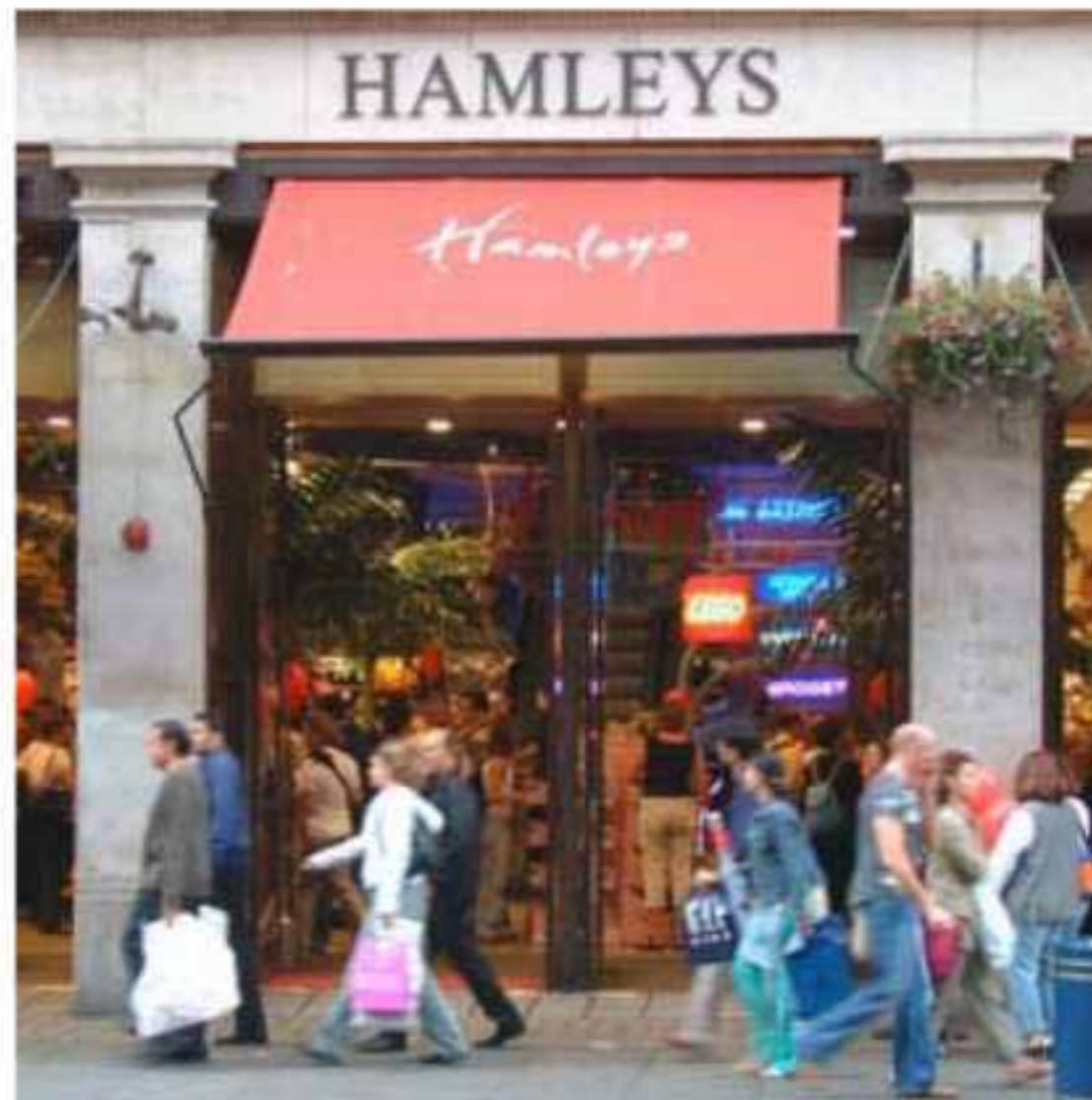
Sex differences in play behaviour are greater than those for height!



Play

Sex differences in play behaviour are greater than those for height!

Boys and girls prefer different toys from an early age



Play

Sex differences in play behaviour are greater than those for height!

Boys and girls prefer different toys from an early age

- boys: cars, trucks and guns



Play

Sex differences in play behaviour are greater than those for height!

Boys and girls prefer different toys from an early age

- boys: cars, trucks and guns
- girls: dolls and tea-sets



Play

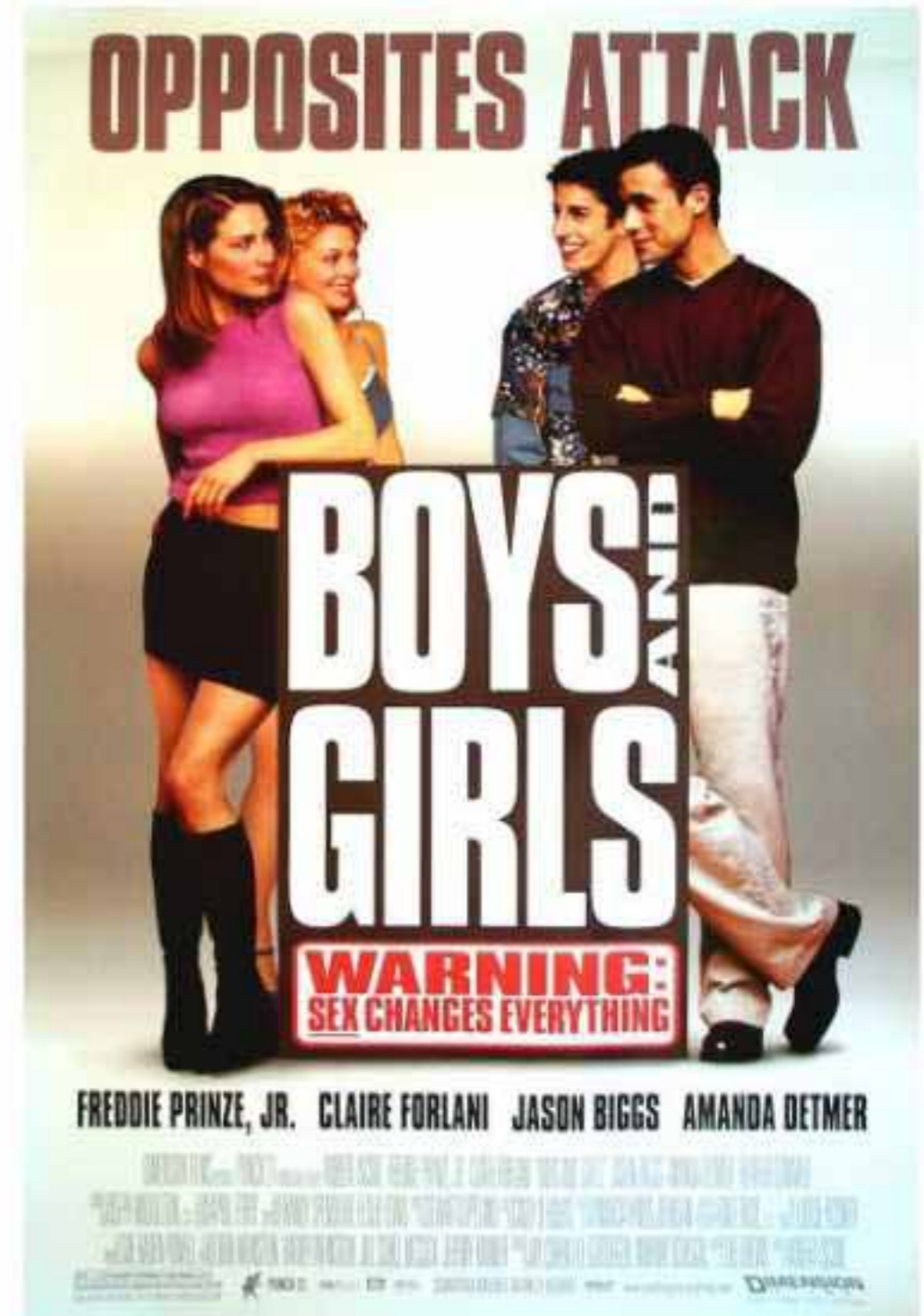
Boys engage in more rough and tumble play



Play

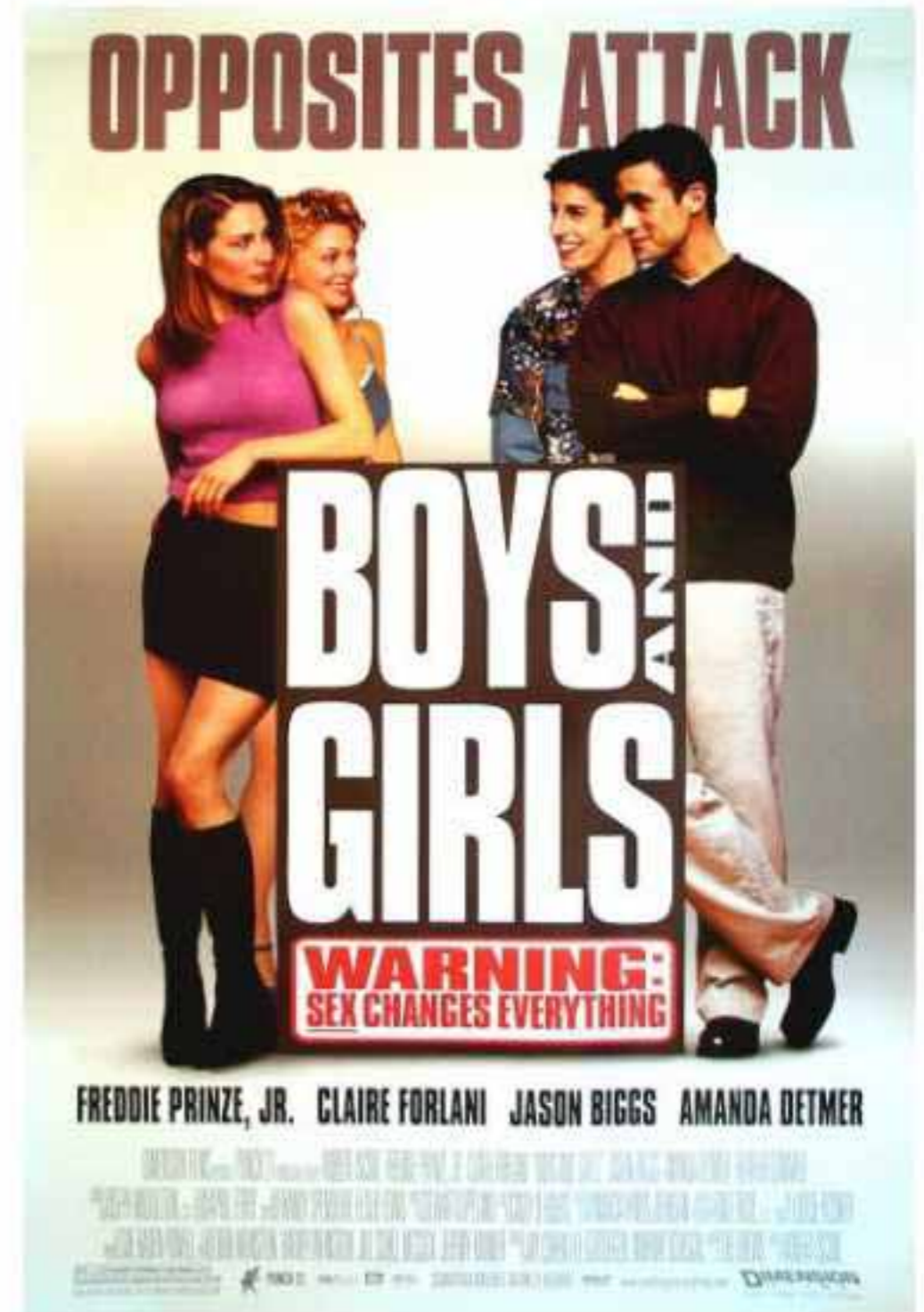
Boys engage in more rough and tumble play

Boys and girls mainly choose playmates of their own sex (80-90%)



Play

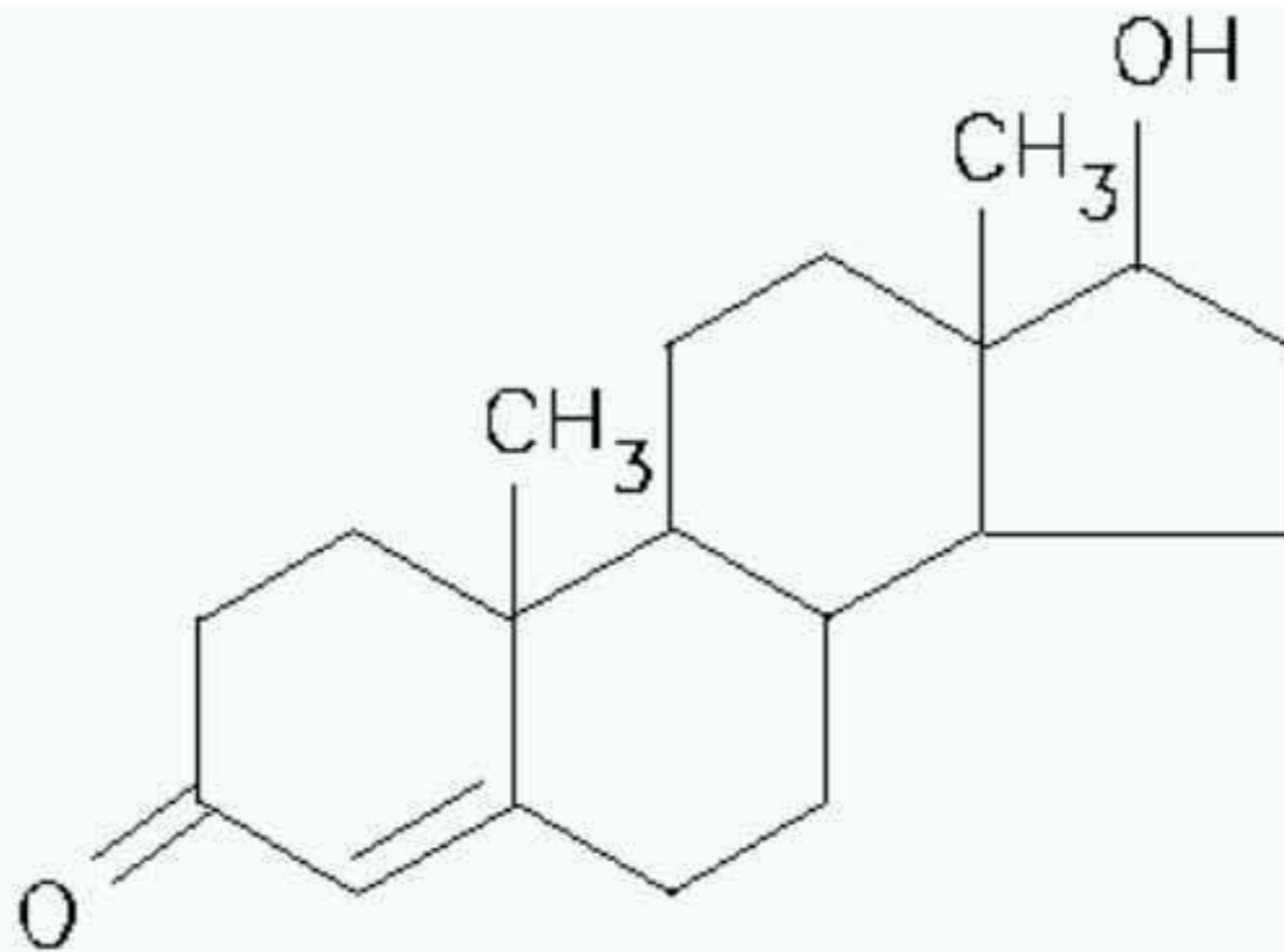
Biology or cultural expectations?



Play

Biology or cultural expectations?

Male play behaviours are stimulated by early exposure to testosterone

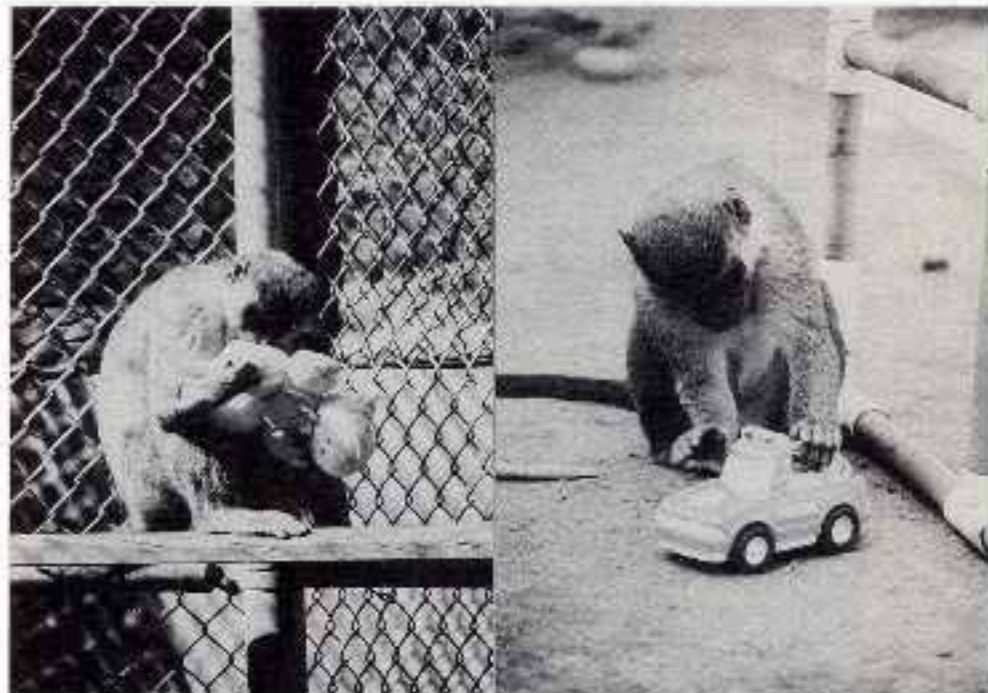


Play

Biology or cultural expectations?

Male play behaviours are stimulated by early exposure to testosterone

Male monkeys also prefer to play with cars and trucks!



Play

Doll play in girls - greater interest in social interactions



Play

Doll play in girls - greater interest in social interactions

Cars and trucks for boys - greater interest in action, movement and function of objects



Aggression

Sex differences in aggression not as strong as might be thought

All sex hormones can contribute to an aggression phenotype

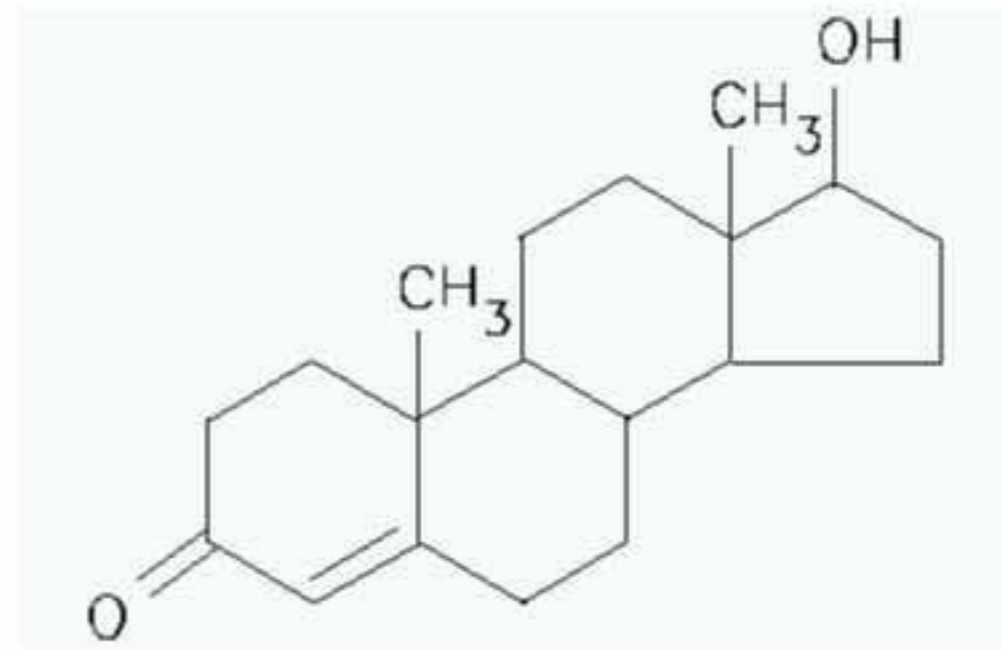


Aggression

Sex differences in aggression not as strong as might be thought

All sex hormones can contribute to an aggression phenotype

Levels of aggression don't correlate well with amount of testosterone

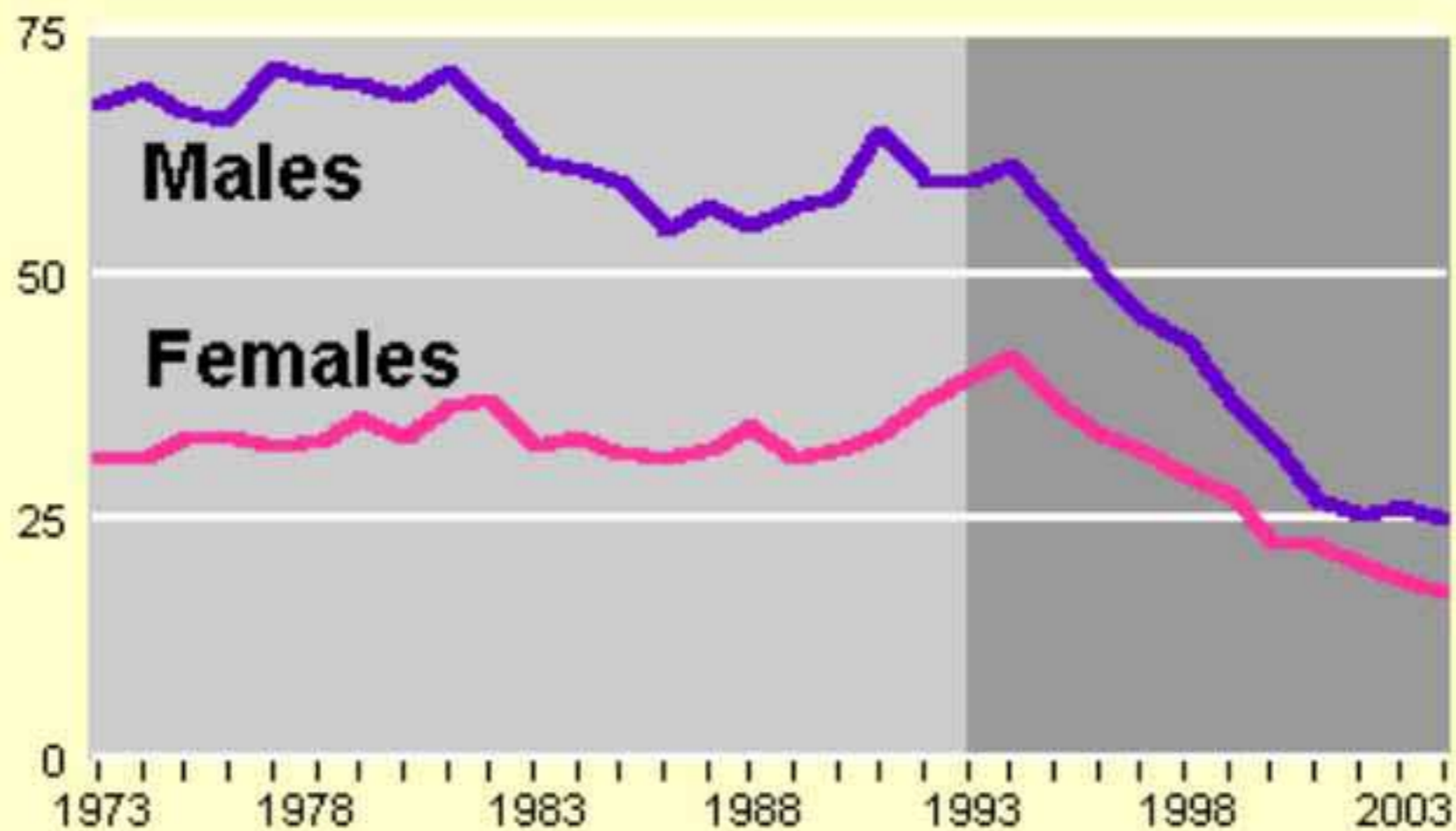


Aggression

Men commit more violent crimes

Violent crime rates by gender of victim

Adjusted victimization rate
per 1,000 persons age 12 and over



Aggression

Men commit more violent crimes

Females can be very violent in protecting young



Aggression

Men commit more violent crimes

Females can be very violent in protecting young

There is more physical inter-male than inter-female aggression



Aggression

Men commit more violent crimes

Females can be very violent in protecting young

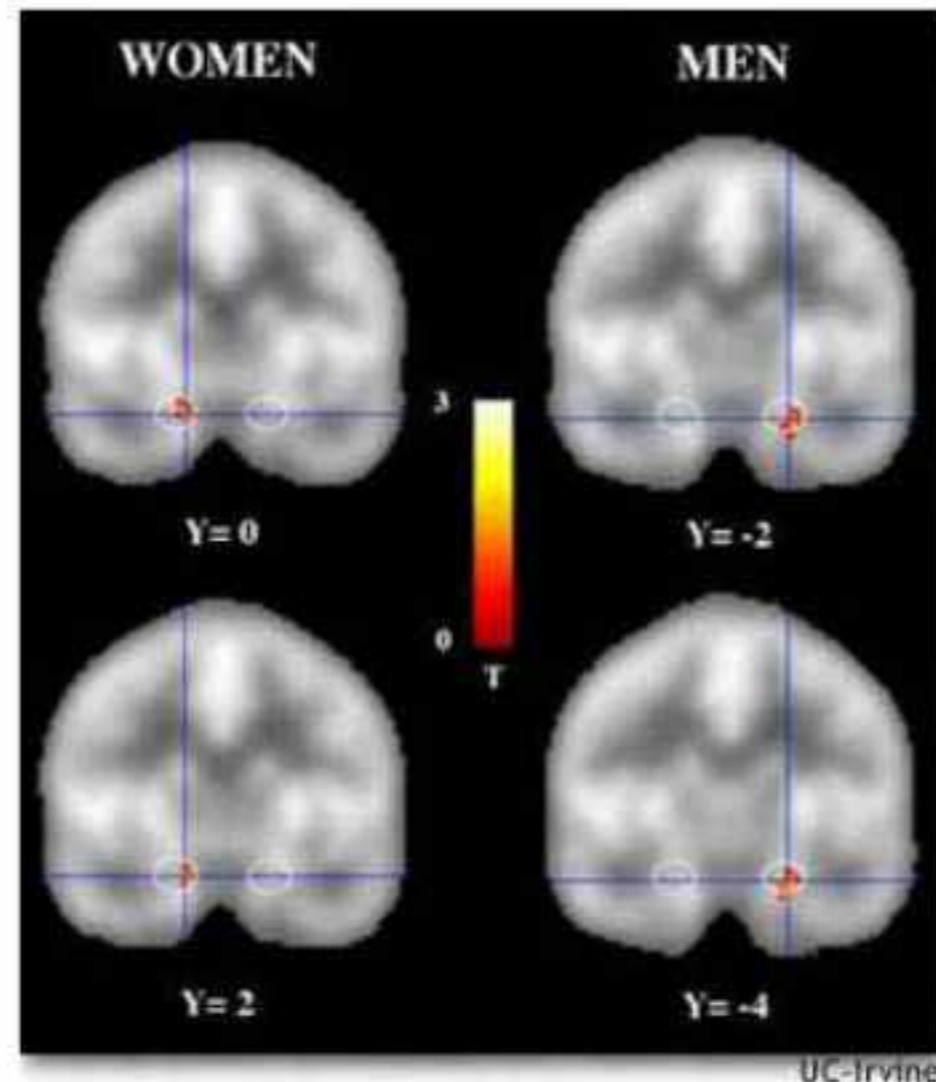
There is more physical inter-male than inter-female aggression

However, females use psychological aggression more than physical



Intelligence, language, cognition & emotion

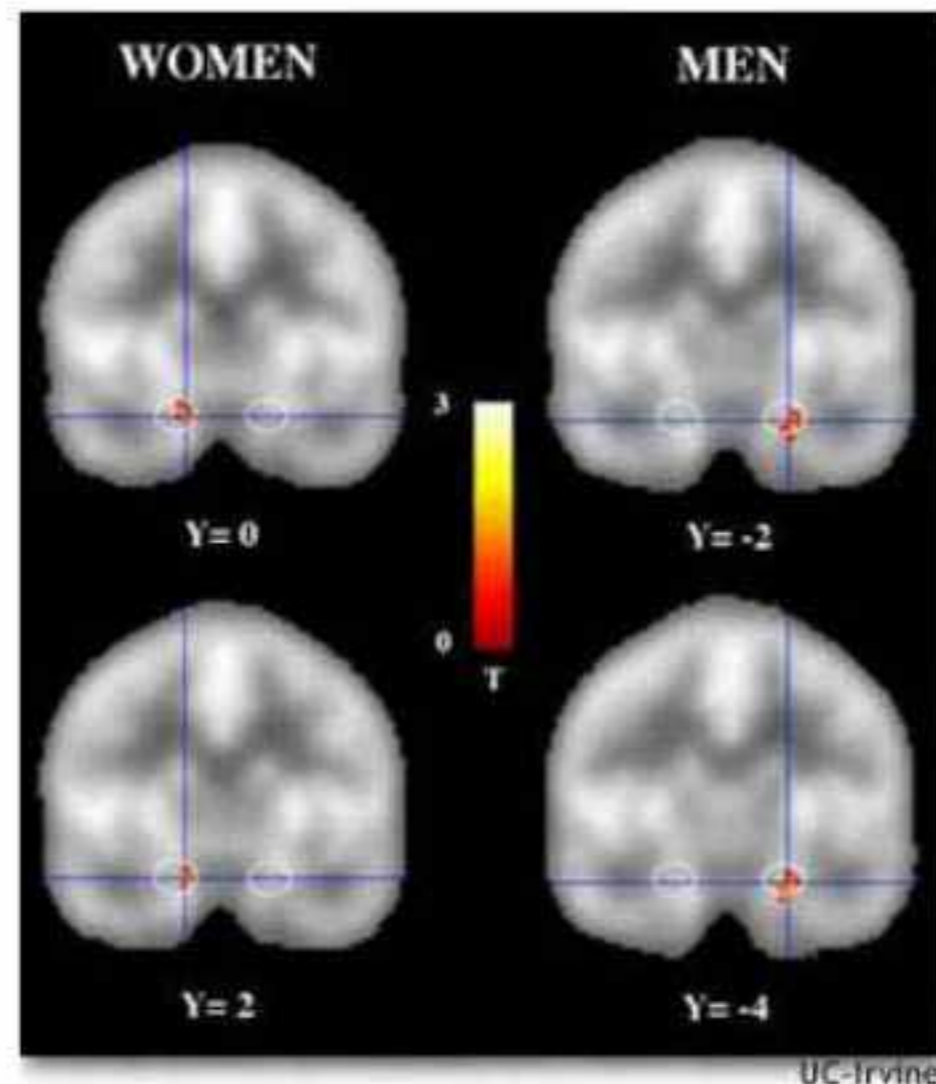
Hugely contentious and with many contradictory observations



Intelligence, language, cognition & emotion

Hugely contentious and with many contradictory observations

Differences are small but male and female brains may use different strategies

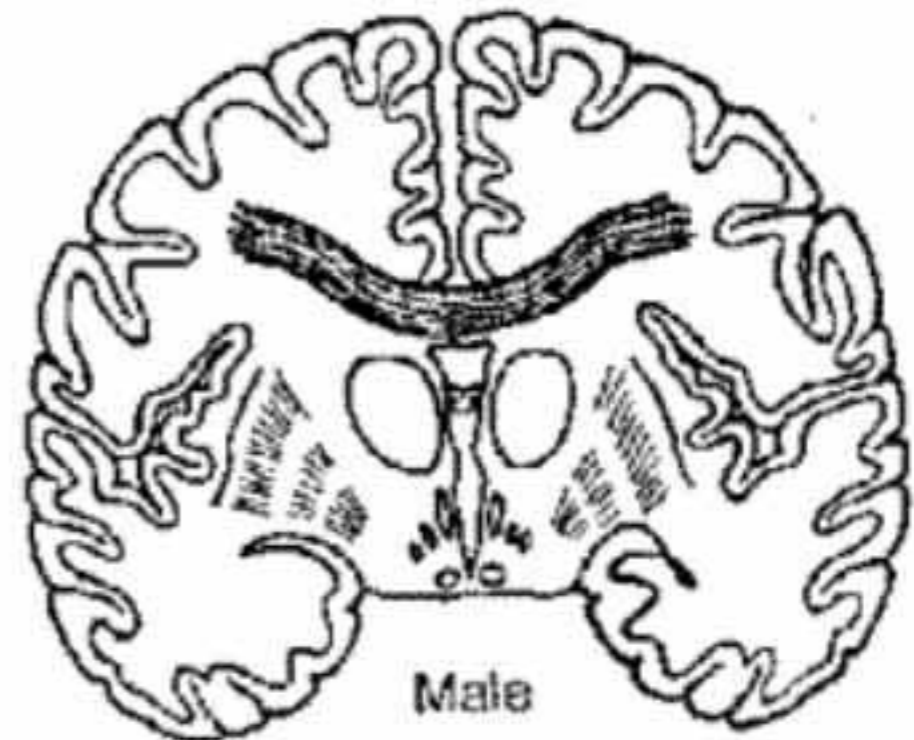
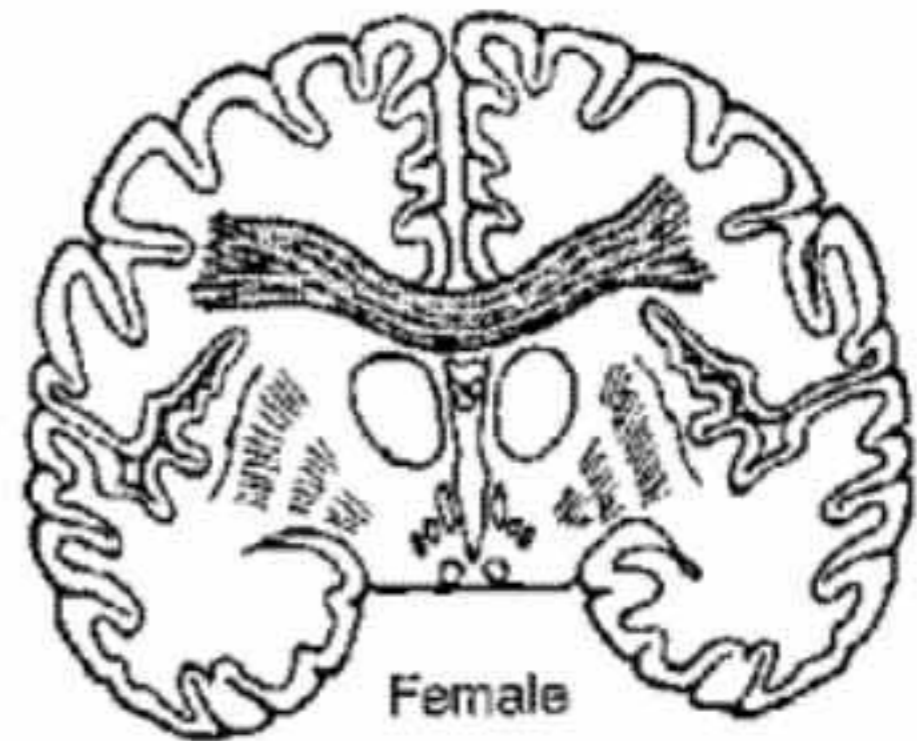


Intelligence, language, cognition & emotion

General intelligence

Brain size > males

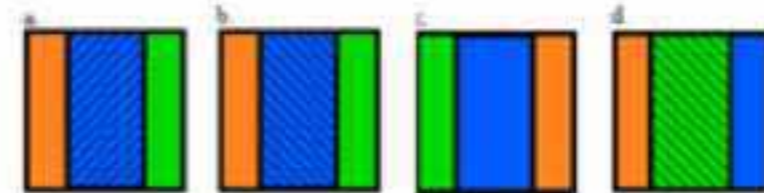
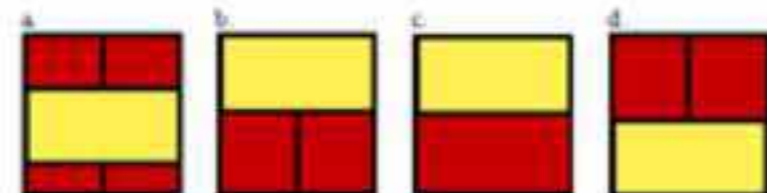
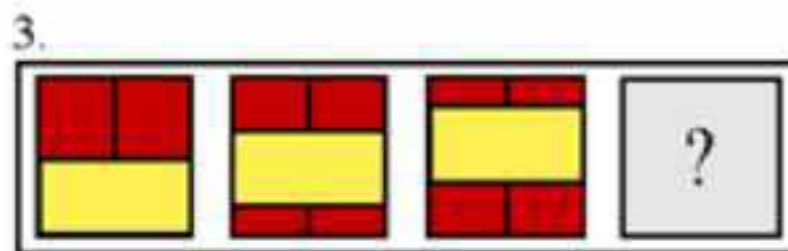
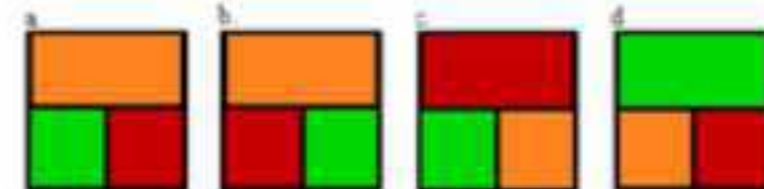
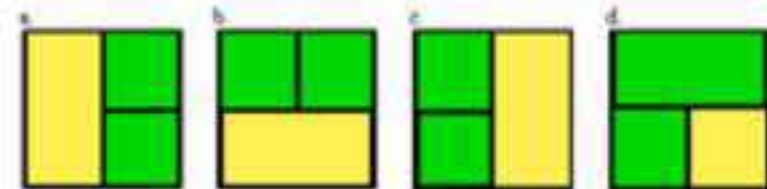
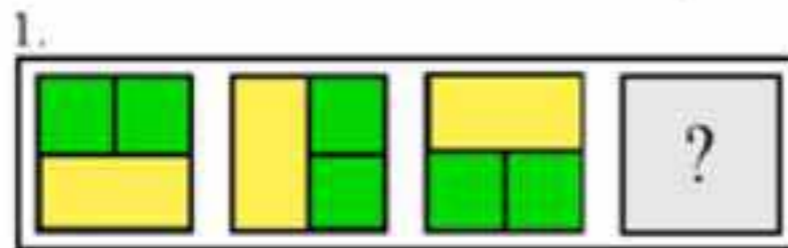
- 1442 cm³ for males
- 1332 cm³ for females



Men end up with a slight IQ advantage
(2-8 points)

Spatial IQ Test

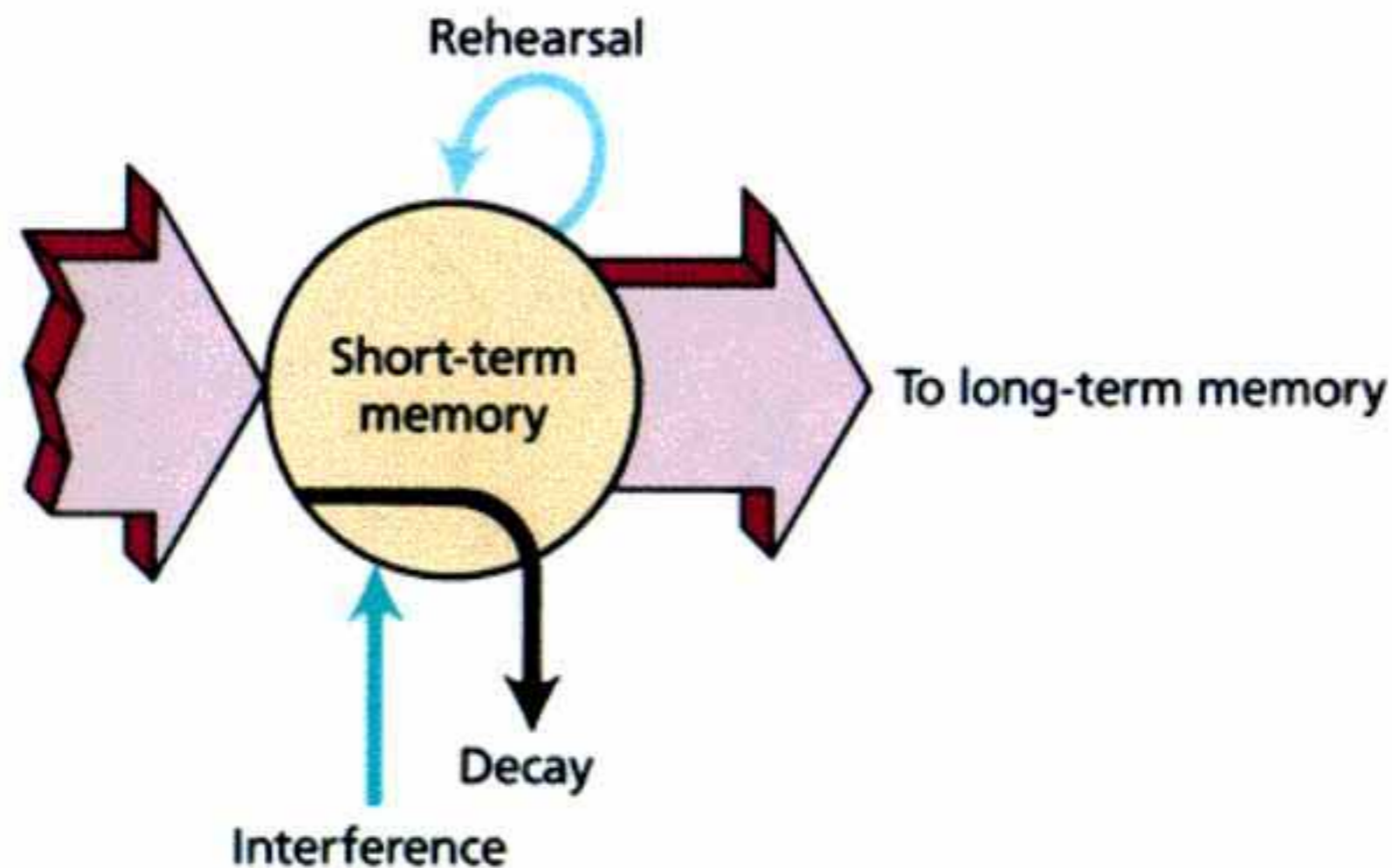
Circle the image which should come next in the sequence.



Intelligence, language, cognition & emotion

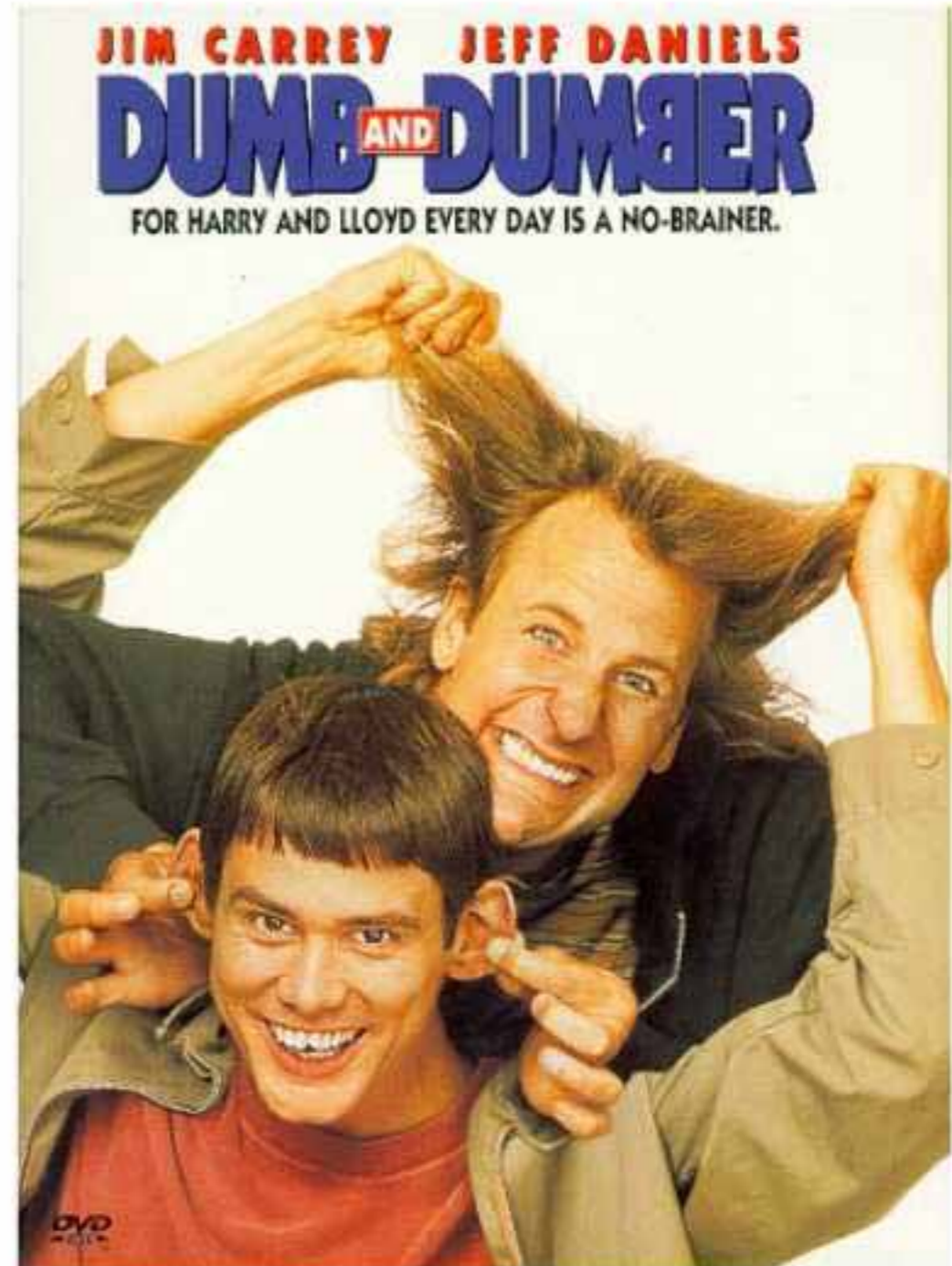
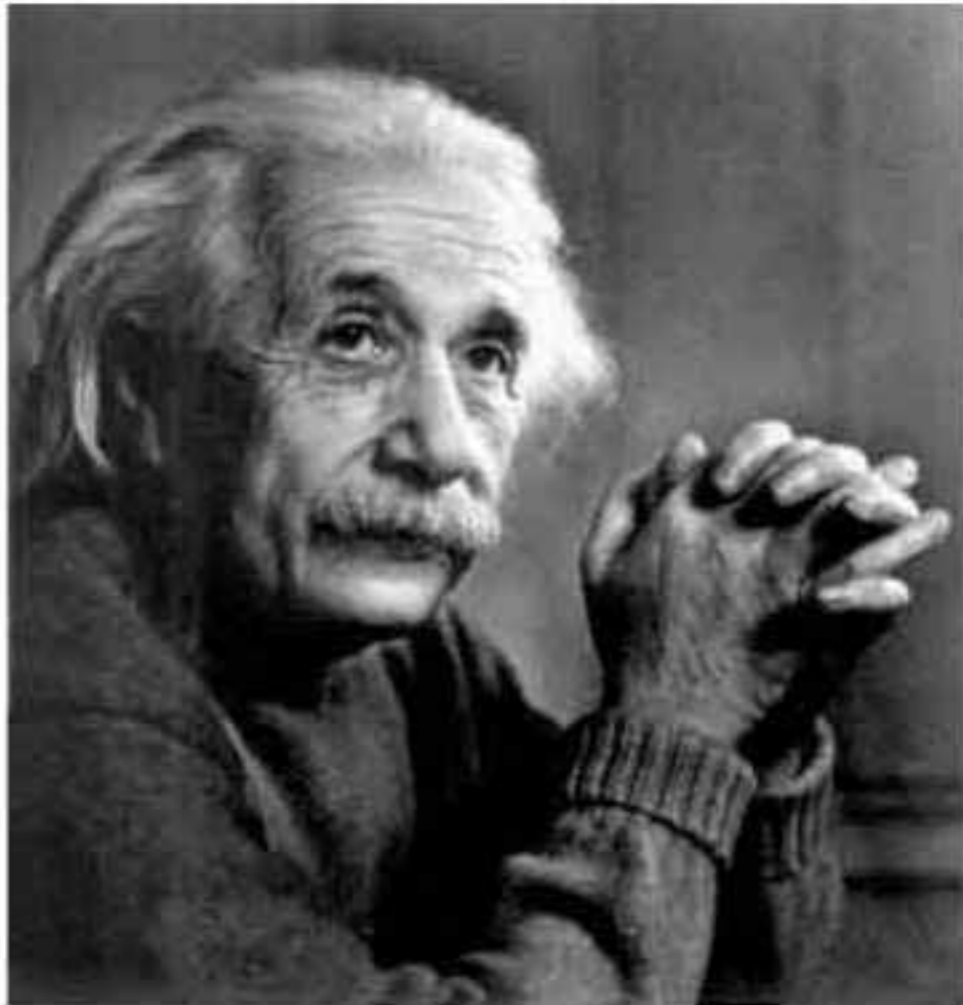
Men end up with a slight IQ advantage
(2-8 points)

Women do better on short-term memory tests
(2-8 points)



Intelligence, language, cognition & emotion

Males have more overall variation in IQ – more geniuses but more idiots



Intelligence, language, cognition & emotion

General knowledge:

Males outperform females in history, politics, geography and science while females are superior in art (Rolfhus & Ackerman 1999)



Intelligence, language, cognition & emotion

General knowledge:

Male undergraduates perform better in knowledge of sport, science, affairs, geography, politics and history while females are better on medicine and cookery (Lynn & Irwing 2002)



Intelligence, language, cognition & emotion

General knowledge:

In 60-75% of areas tested there were no sex differences



Intelligence, language, cognition & emotion

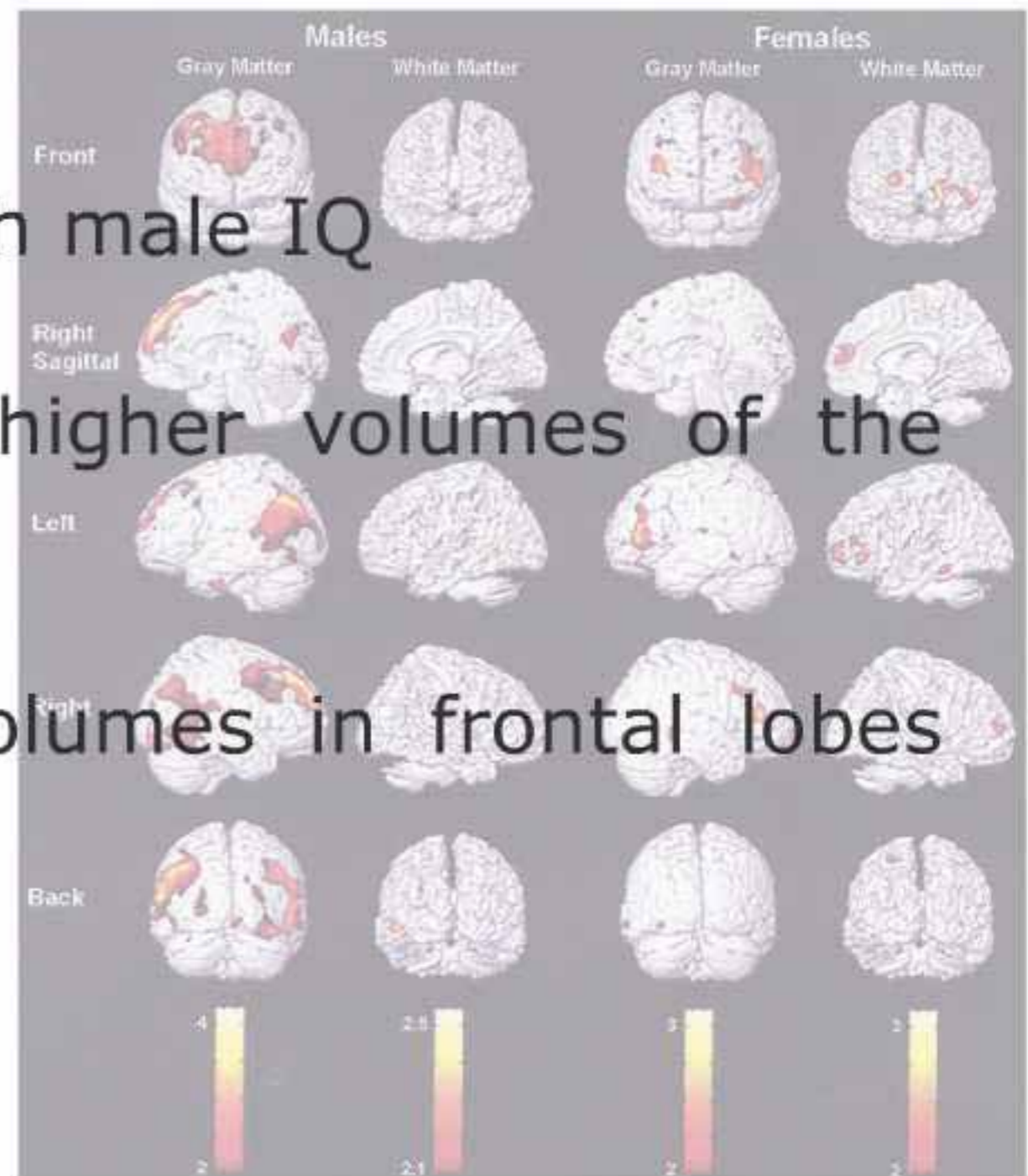
Evidence for females using different parts of the brain

Brain gray matter (cells):

- strongest correlation with male IQ

Male IQ correlated with higher volumes of the frontal and parietal lobes

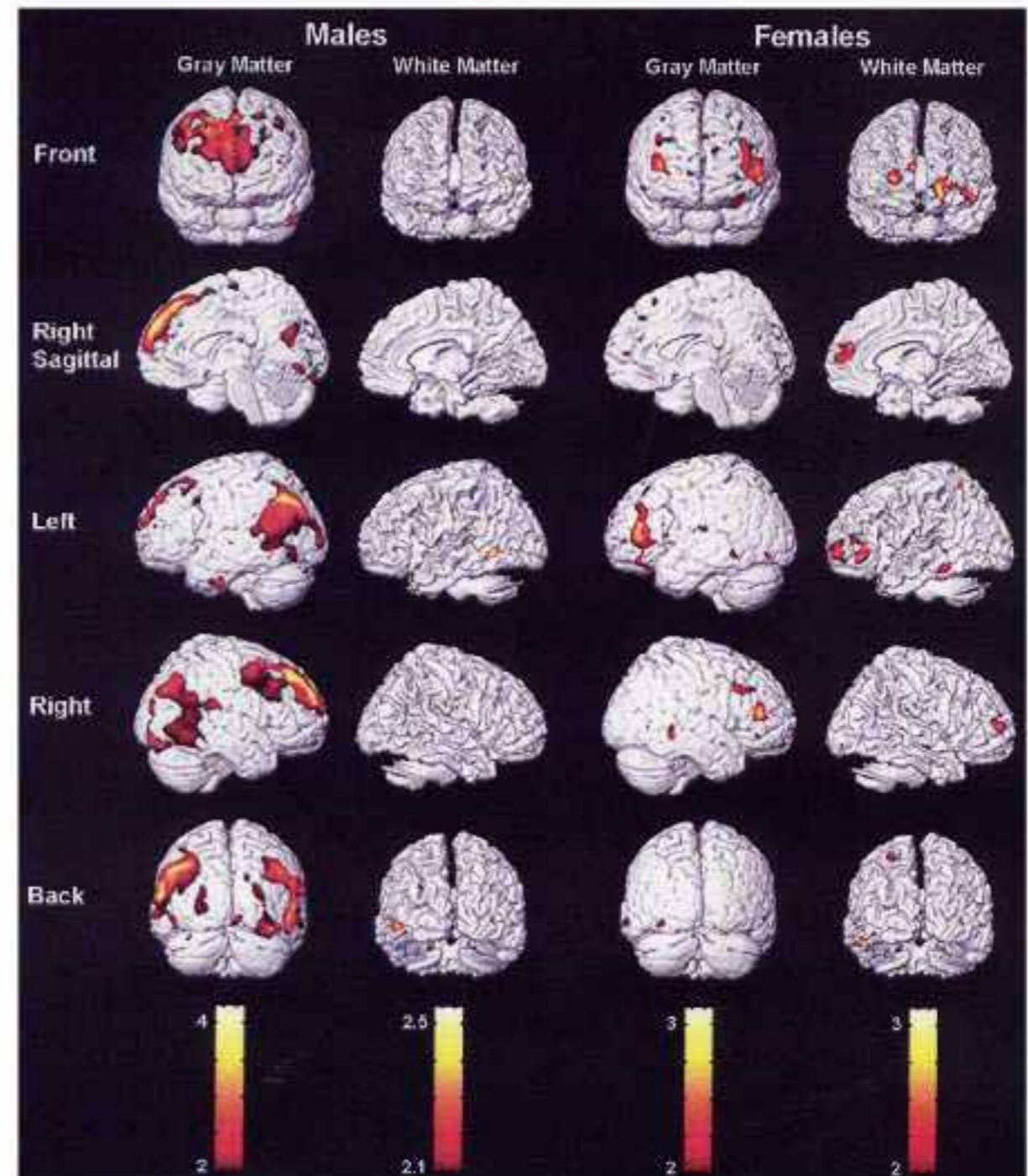
Female IQ with higher volumes in frontal lobes and Brocas area



Intelligence, language, cognition & emotion

Brain white matter (fibres):

- strongest correlation with female IQ



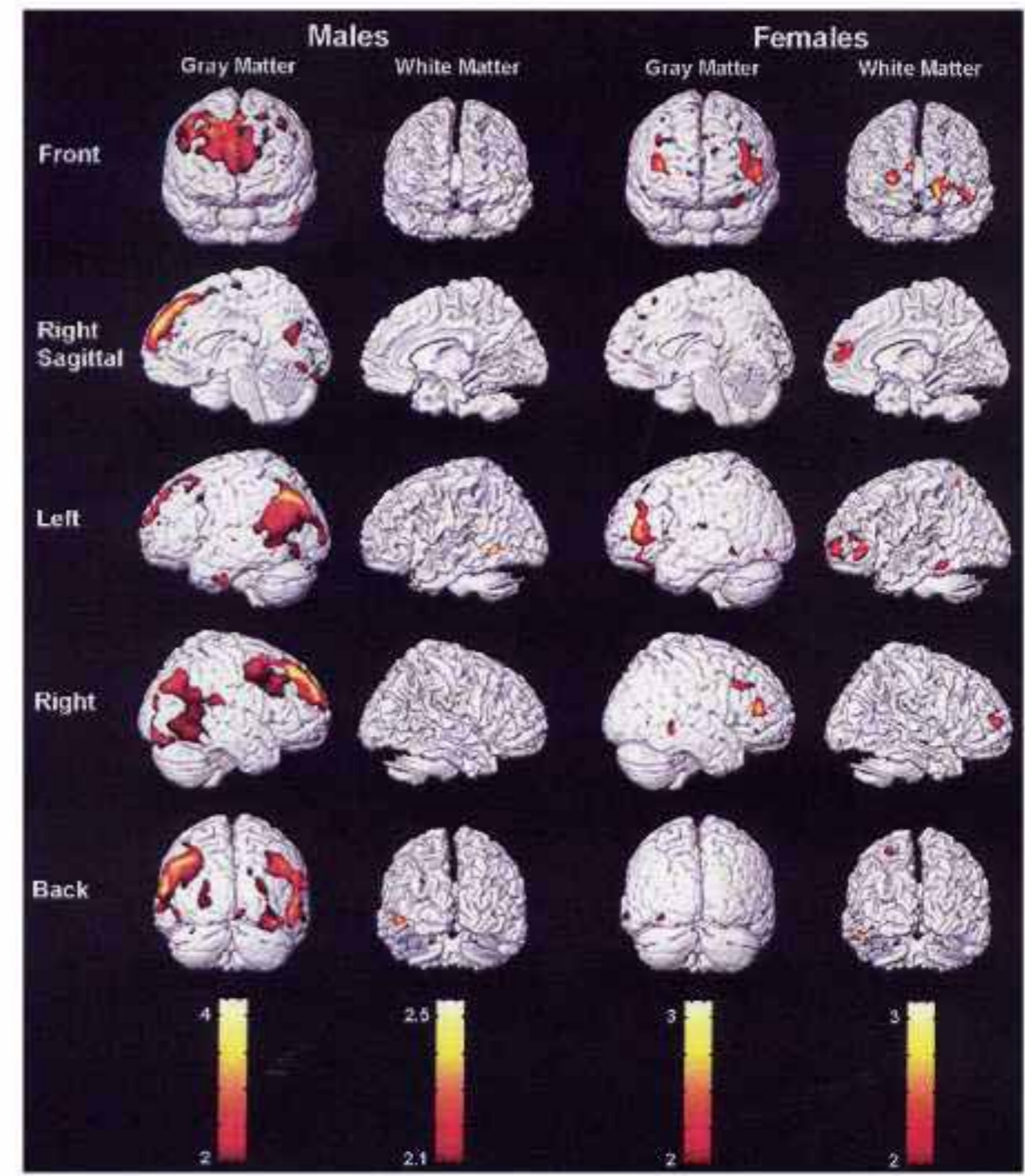
Intelligence, language, cognition & emotion

Brain white matter (fibres):

- strongest correlation with female IQ

Intelligence quotient

- local processing in male brain
- connectivity in female brain?



Language and verbal abilities

During pre-school and early school years, girls do better than boys in most aspects of verbal performance including:

Saying their first word earlier

Articulating more clearly at an earlier age

Using longer sentences

Greater fluency

Learning to read sooner



Language and verbal abilities

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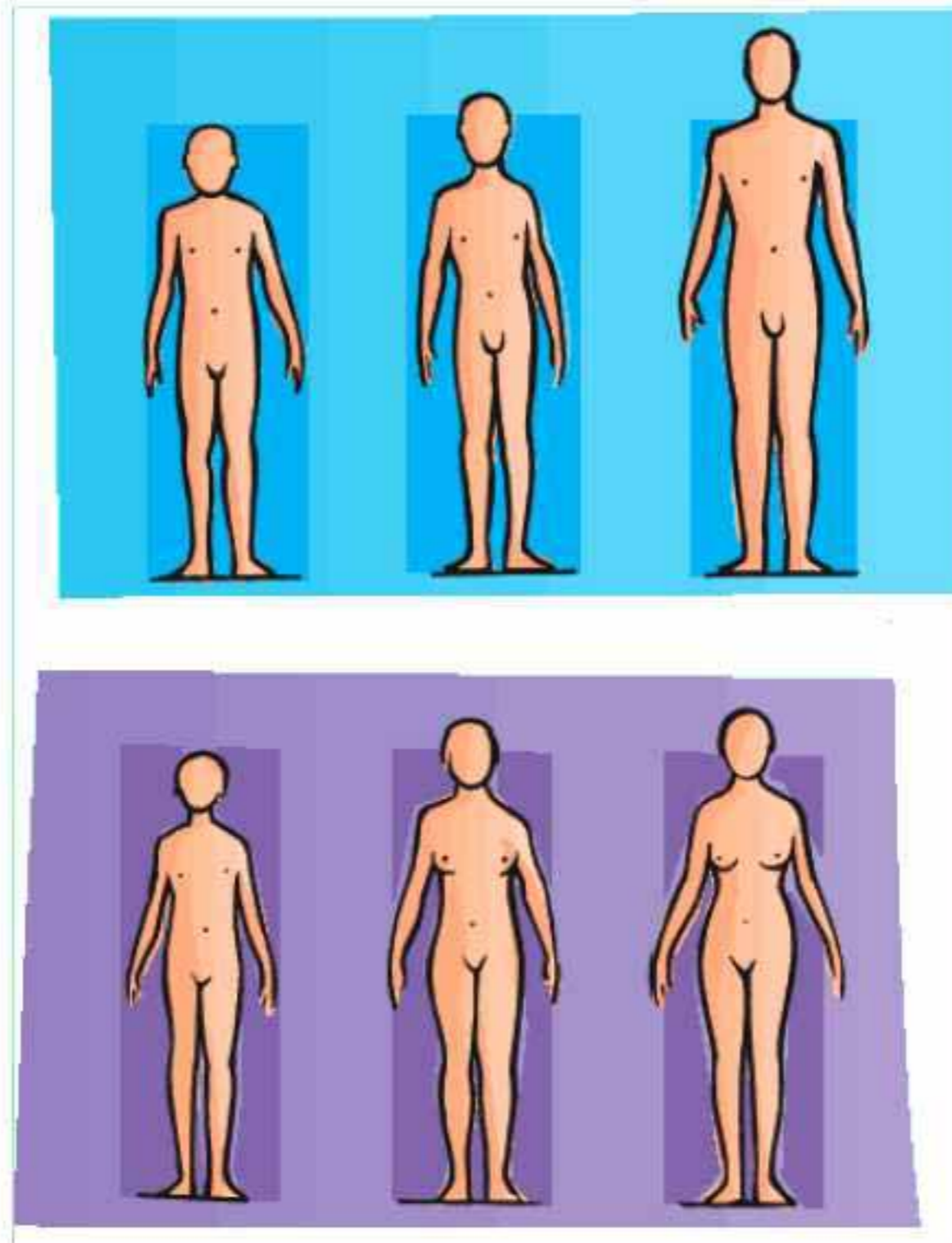
Greater fluency

Learning to read sooner

.....better performance on tests of grammar, spelling and word fluency....

Language and verbal abilities

But girls mature faster than boys



Language and verbal abilities

Mums talk more with girl babies and encourage social interaction



Language and verbal abilities

Mums talk more with girl babies and encourage social interaction

Encouraging boy babies more towards exploration and achievement



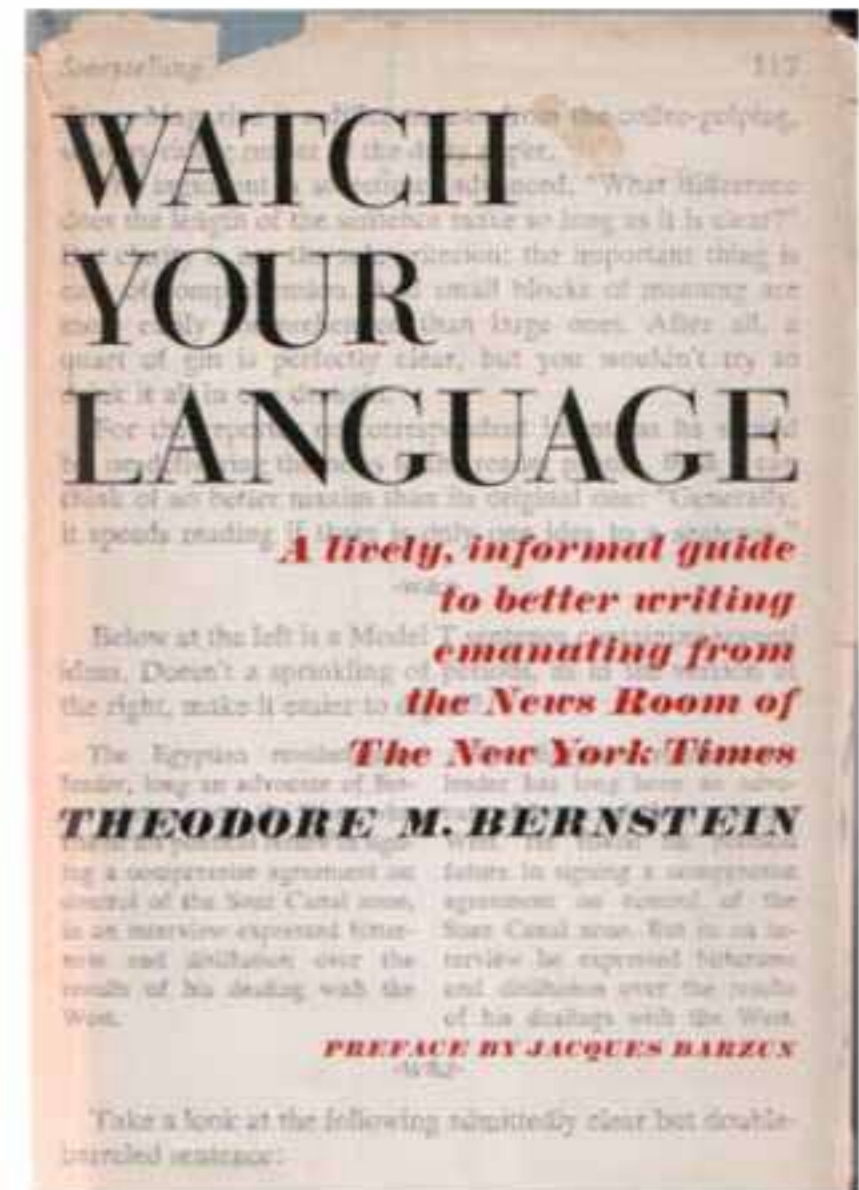
Language and verbal abilities

In adulthood differences in language and verbal skills between the sexes are relatively small



Language and verbal abilities

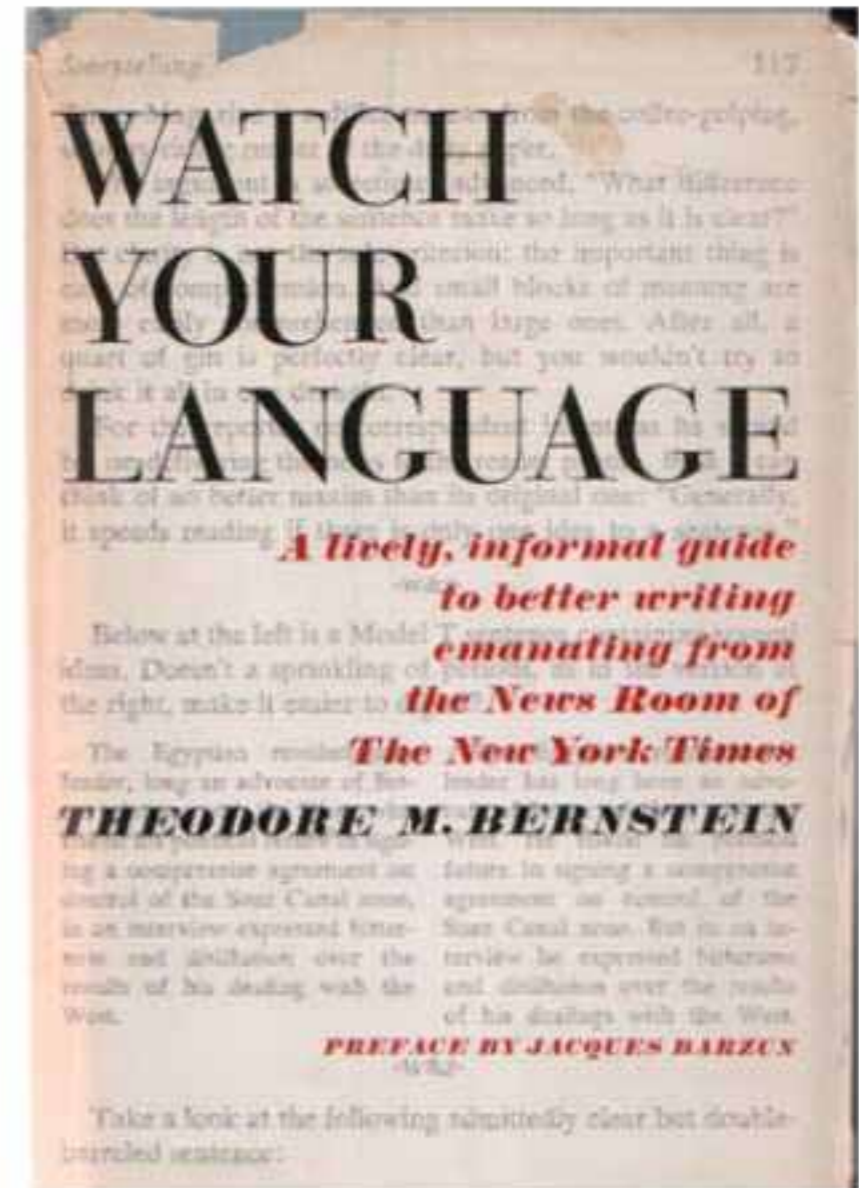
Hyde and Lin (1988) in a meta-analysis of 165 studies concluded:



Language and verbal abilities

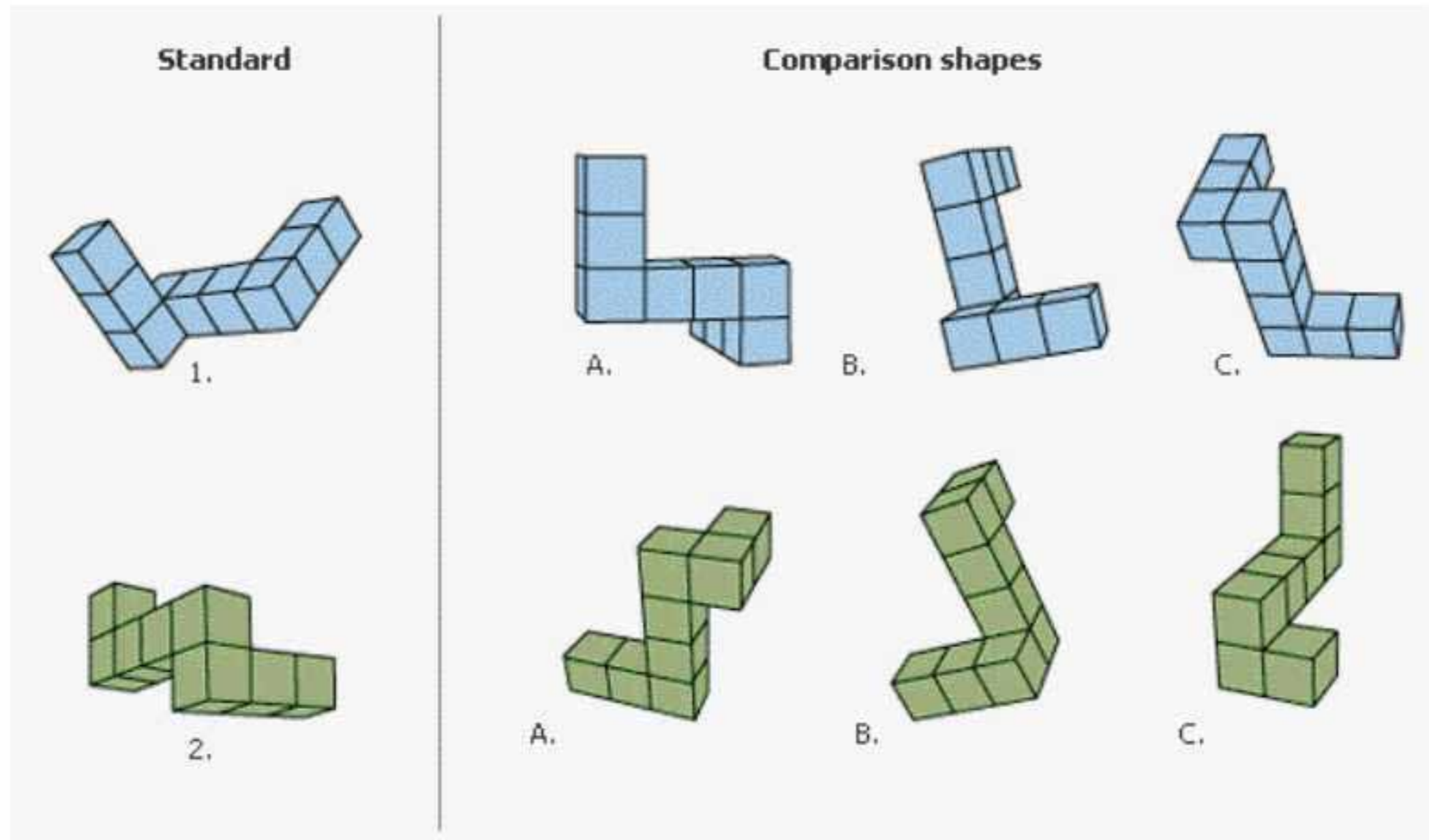
Hyde and Lin (1988) in a meta-analysis of 165 studies concluded:

Females better on verbal fluency and memory and males on verbal analogies



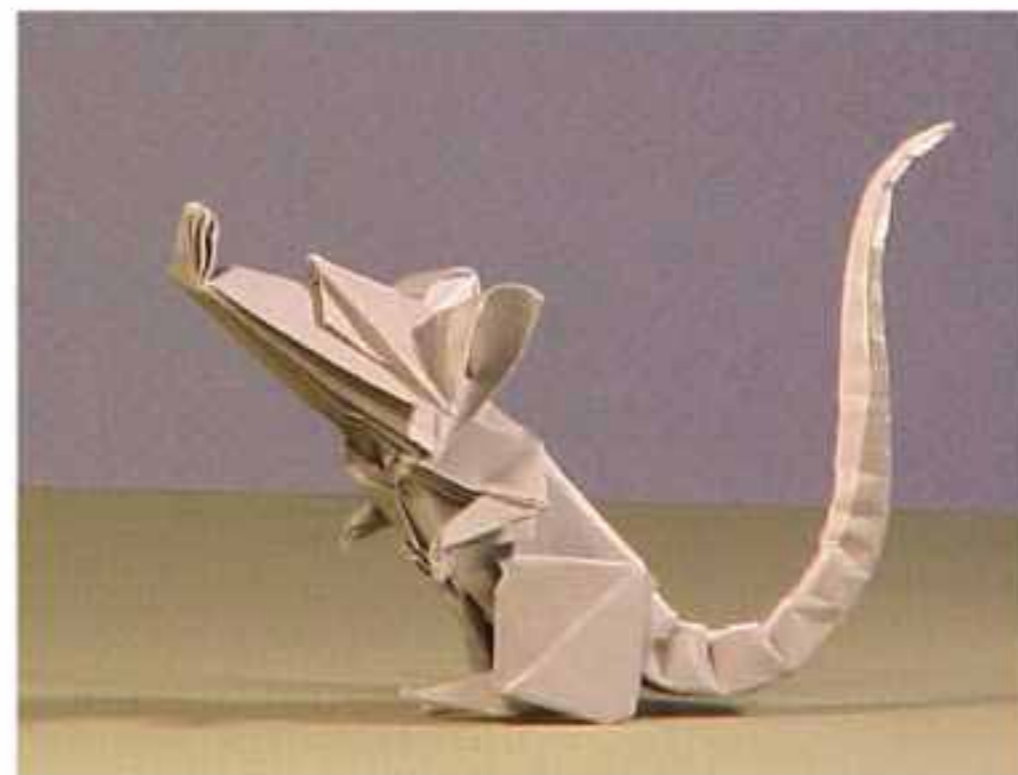
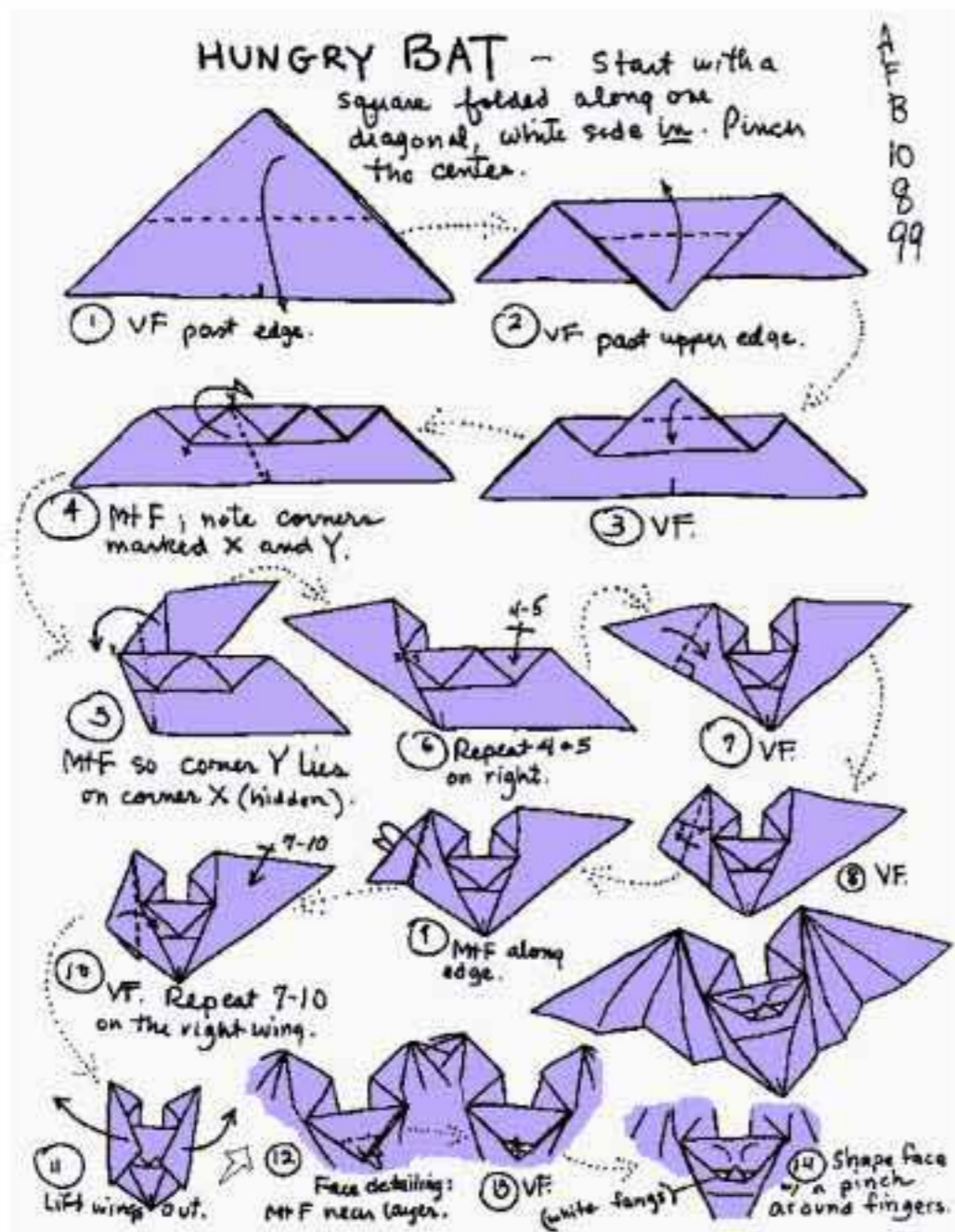
Cognition and emotion: males better

Spatial orientation/mental rotation



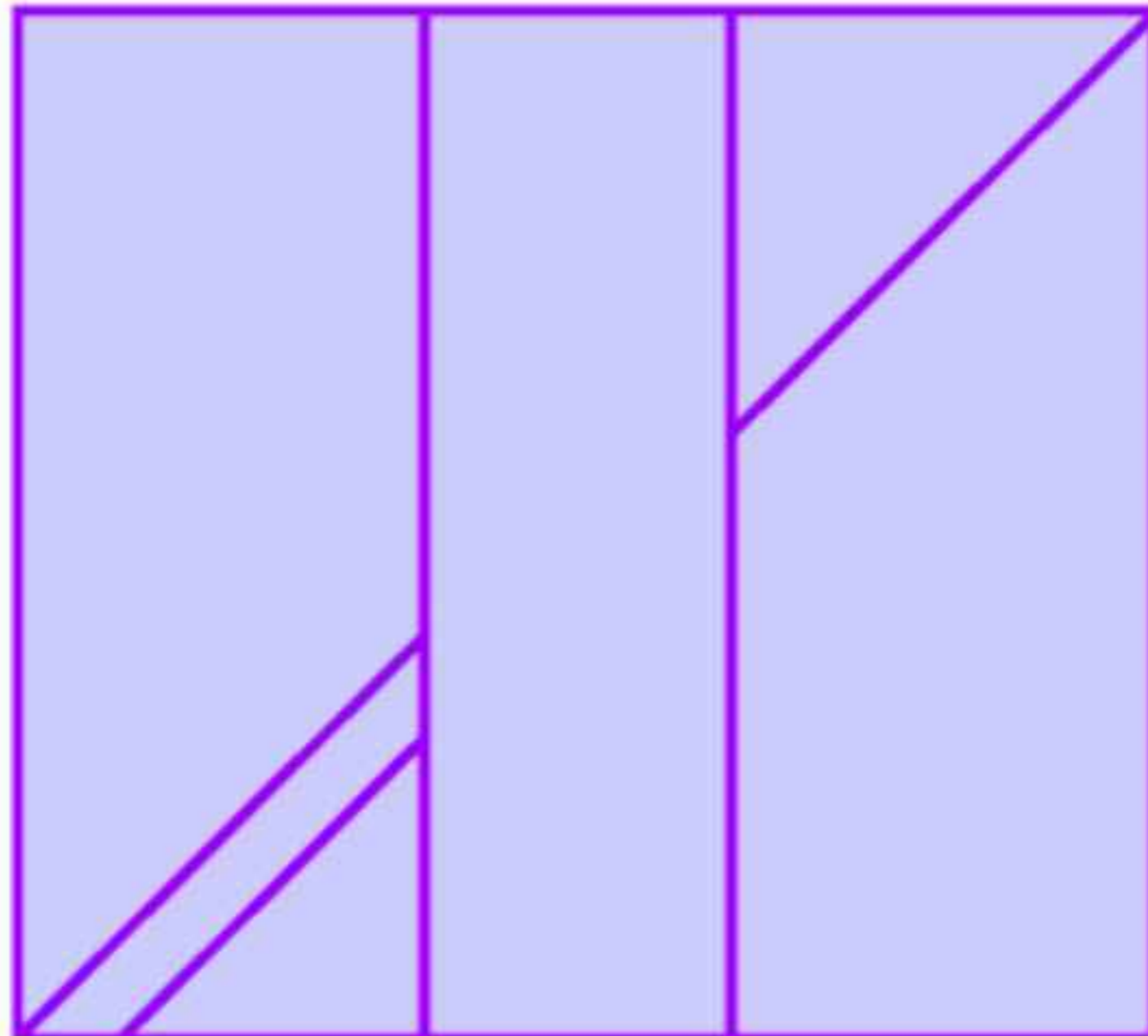
Cognition and emotion: males better

Visualization – how an object will appear when it has been manipulated in some way



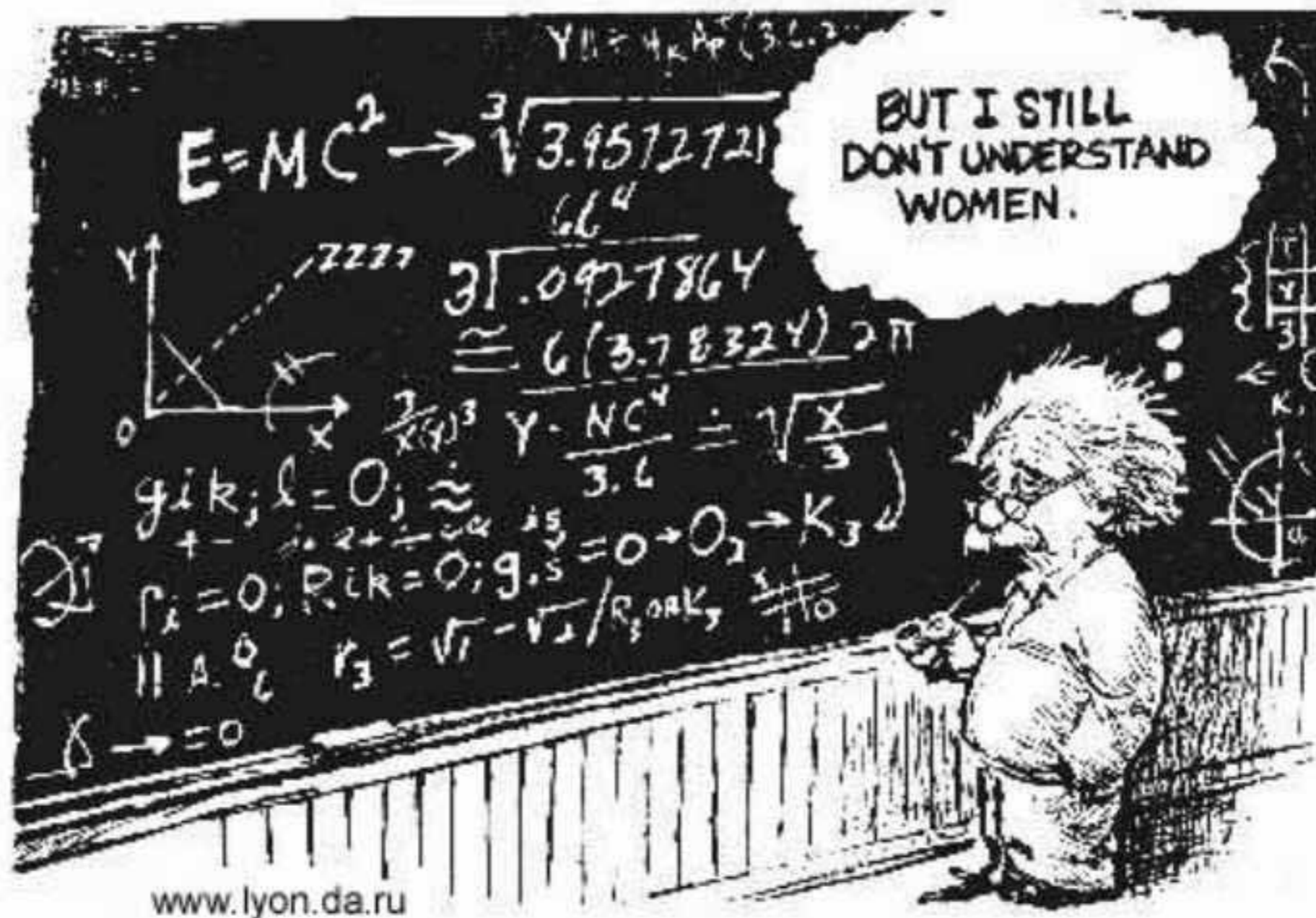
Cognition and emotion: males better

Line orientation – matching the slope of a line



Cognition and emotion: males better

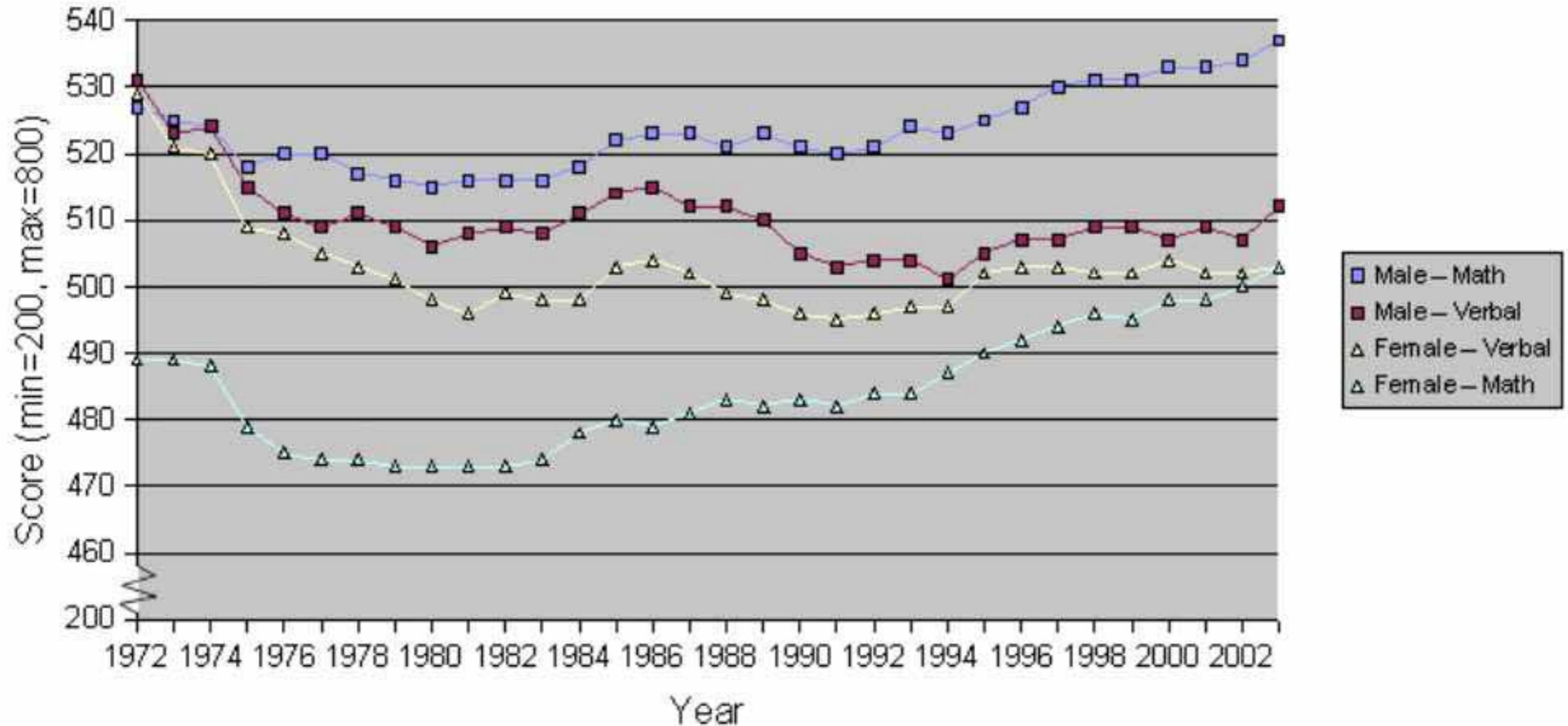
Mathematical reasoning - solving a novel mathematical problem



Cognition and emotion: males better

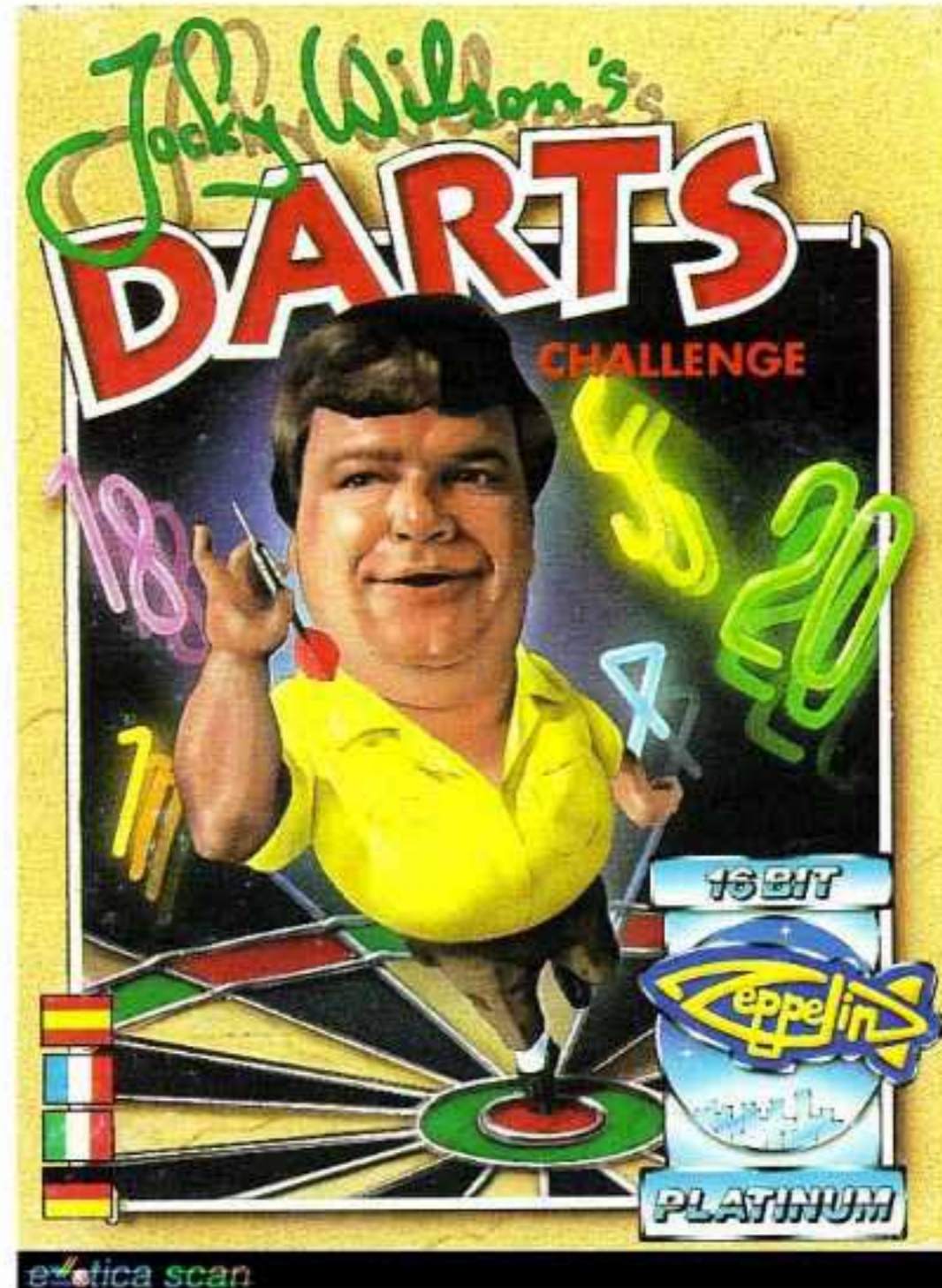
Mathematical reasoning - solving a novel mathematical problem

Average SAT by sex, 1972-2003



Cognition and emotion: males better

Throwing accuracy – hitting a target with some form of projectile



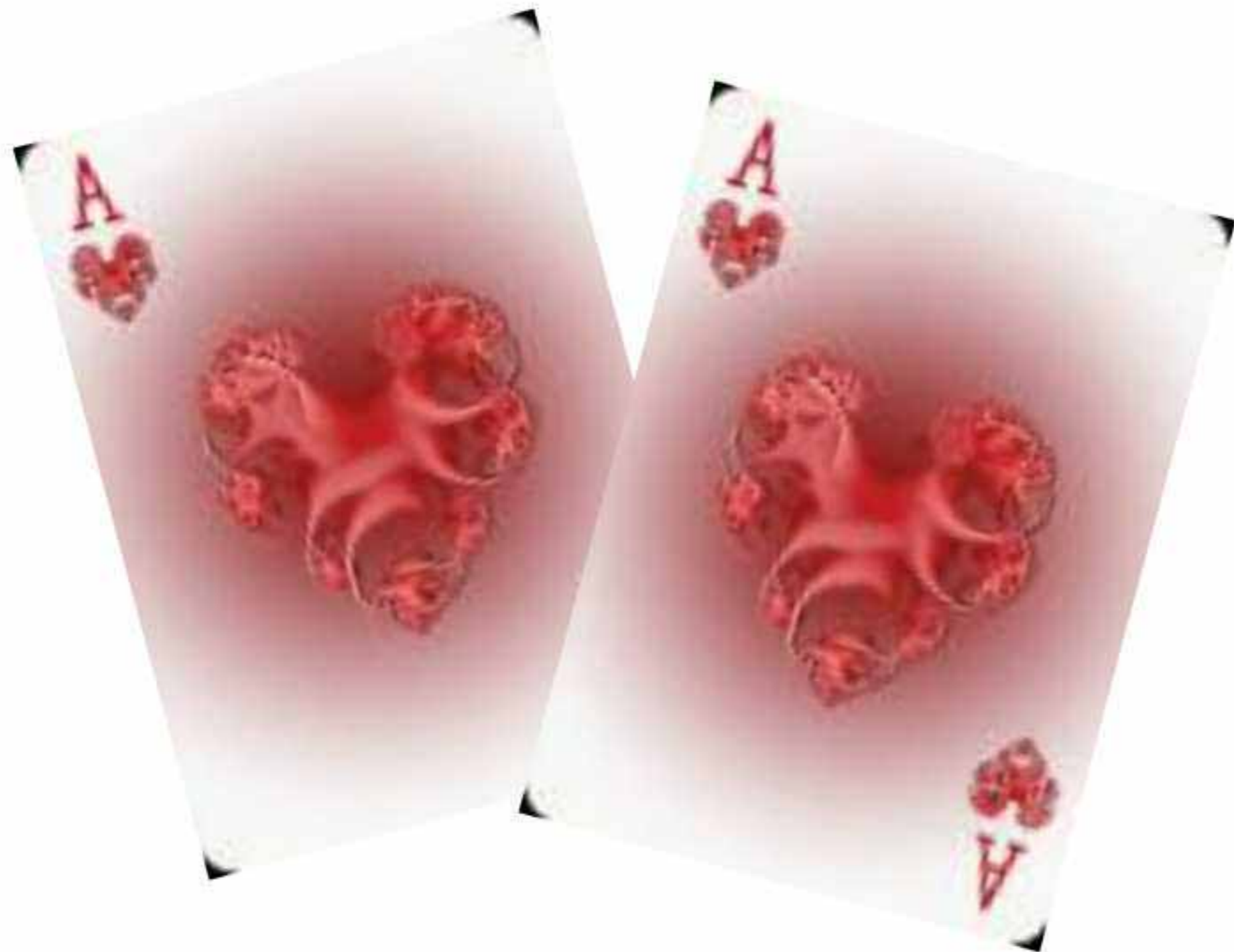
Cognition and emotion: females better

Object location memory – remembering the locations of objects



Cognition and emotion: females better

Perceptual speed – tasks that require matching of objects



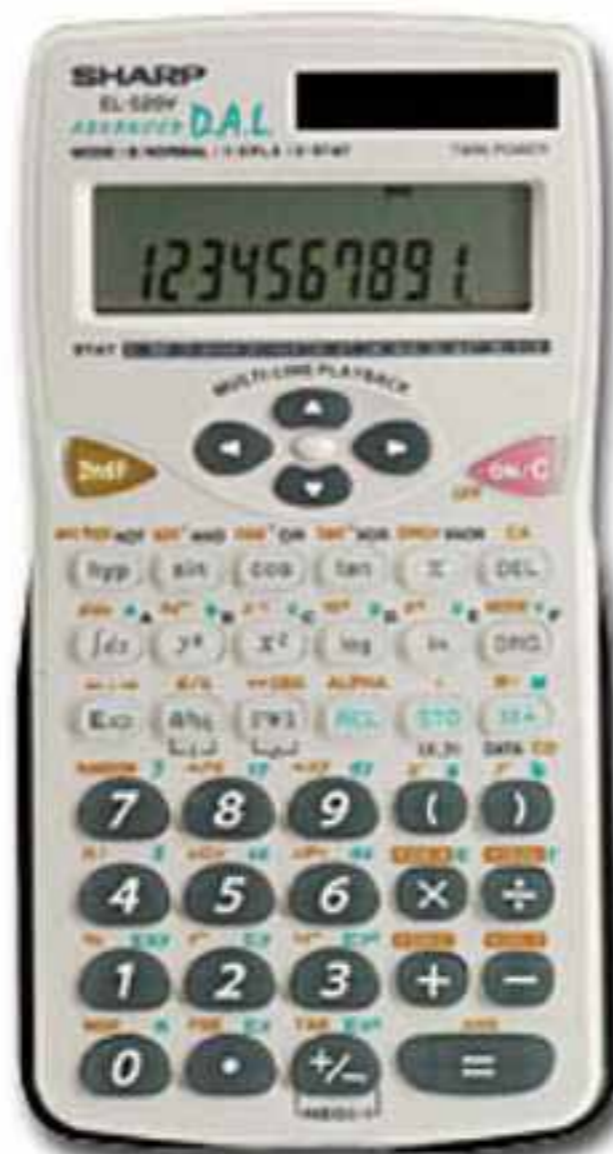
Cognition and emotion: females better

Verbal memory – recall of any materials containing words



Cognition and emotion: females better

Numerical calculations – routine application of learned calculation skills



Cognition and emotion: females better

Dexterity/fine motor control – any tasks that involve fine manipulation control and dexterity



Cognition and emotion: females better

Emotional experiences do not seem to show major sex differences



Cognition and emotion: females better

Emotional experiences do not seem to show major sex differences

Females are more emotionally expressive



Cognition and emotion: females better

Emotional experiences do not seem to show major sex differences

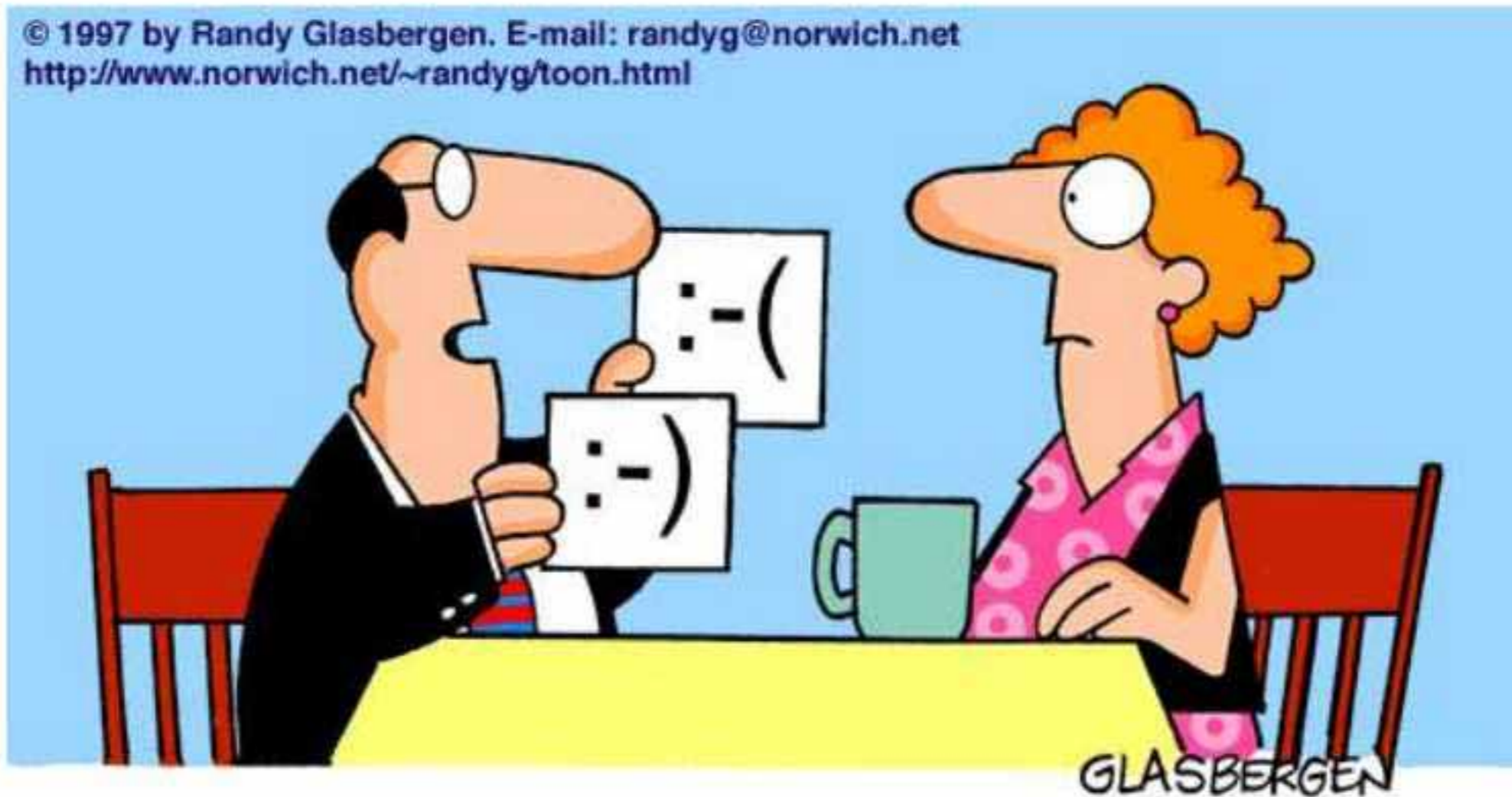
Females are more emotionally expressive

They smile much more, and are more likely to show face expressions of sadness, disgust, fear and surprise



Cognition and emotion: females better

This supports the folklore that women are better at communicating their emotions than men!



“You always complain that I don’t know how to show my emotions, so I made these signs.”

Male vs. female brain politics

Male and female top executives



Males:

Top end - more focussed, innovative & ruthless

Bottom - useless

Male vs. female brain politics

Male and female top executives

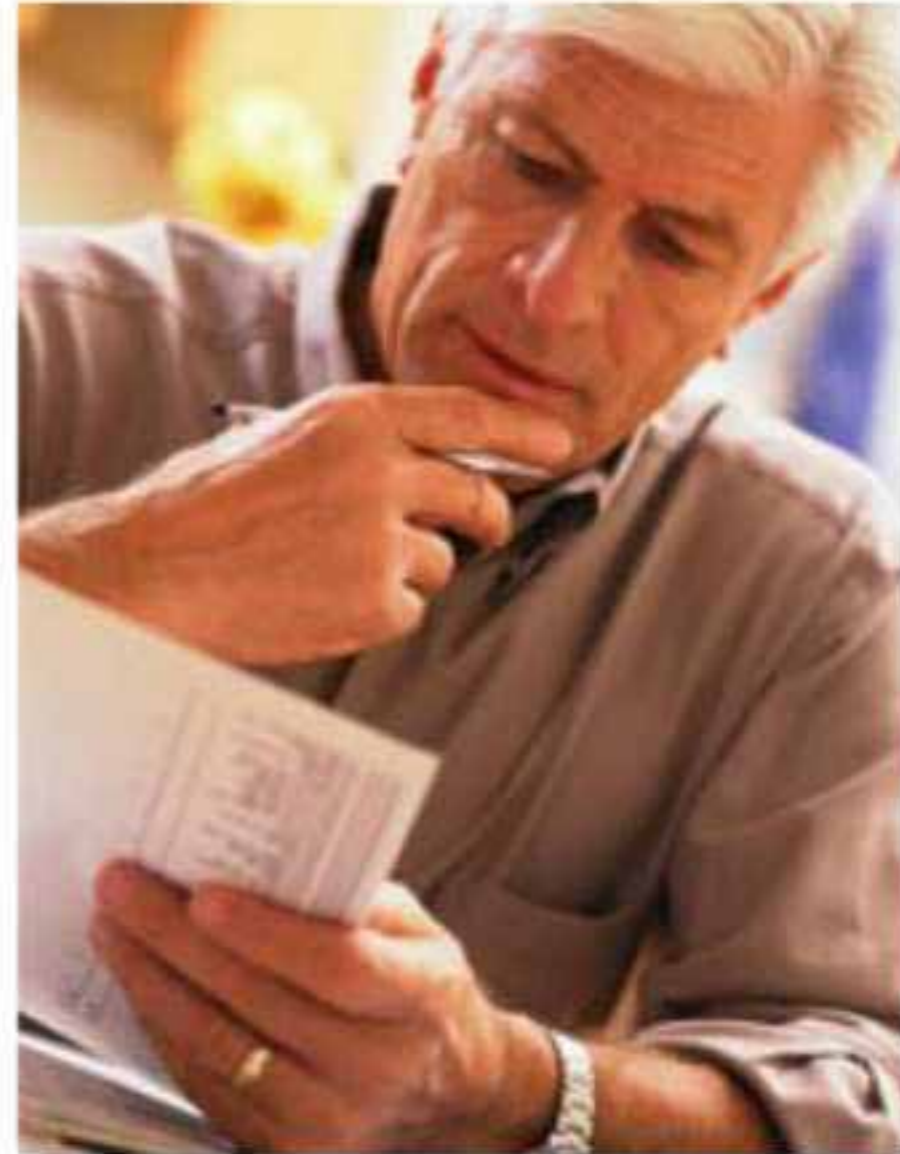


Males:

Top end - more focussed, innovative & ruthless
Bottom - useless

Females: more reliable, appliers of knowledge,
team players, get the job done

Male vs. female brain politics



Male vs. female brain politics

Female brains seem to be less lateralised than male ones

Advantages for social and emotional integration and control

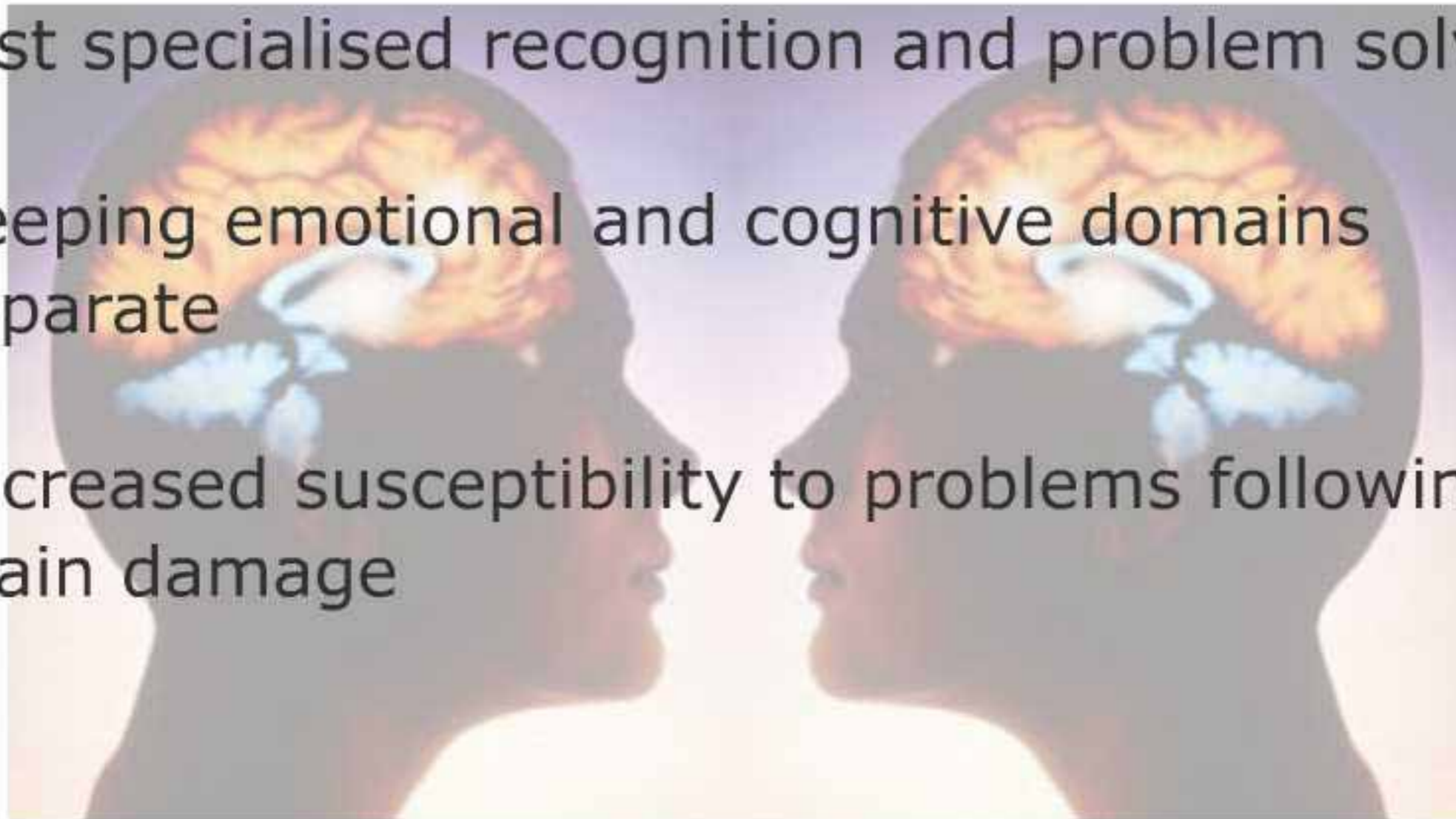
- multi-tasking
- reduced susceptibility to problems following brain damage



Male vs. female brain politics

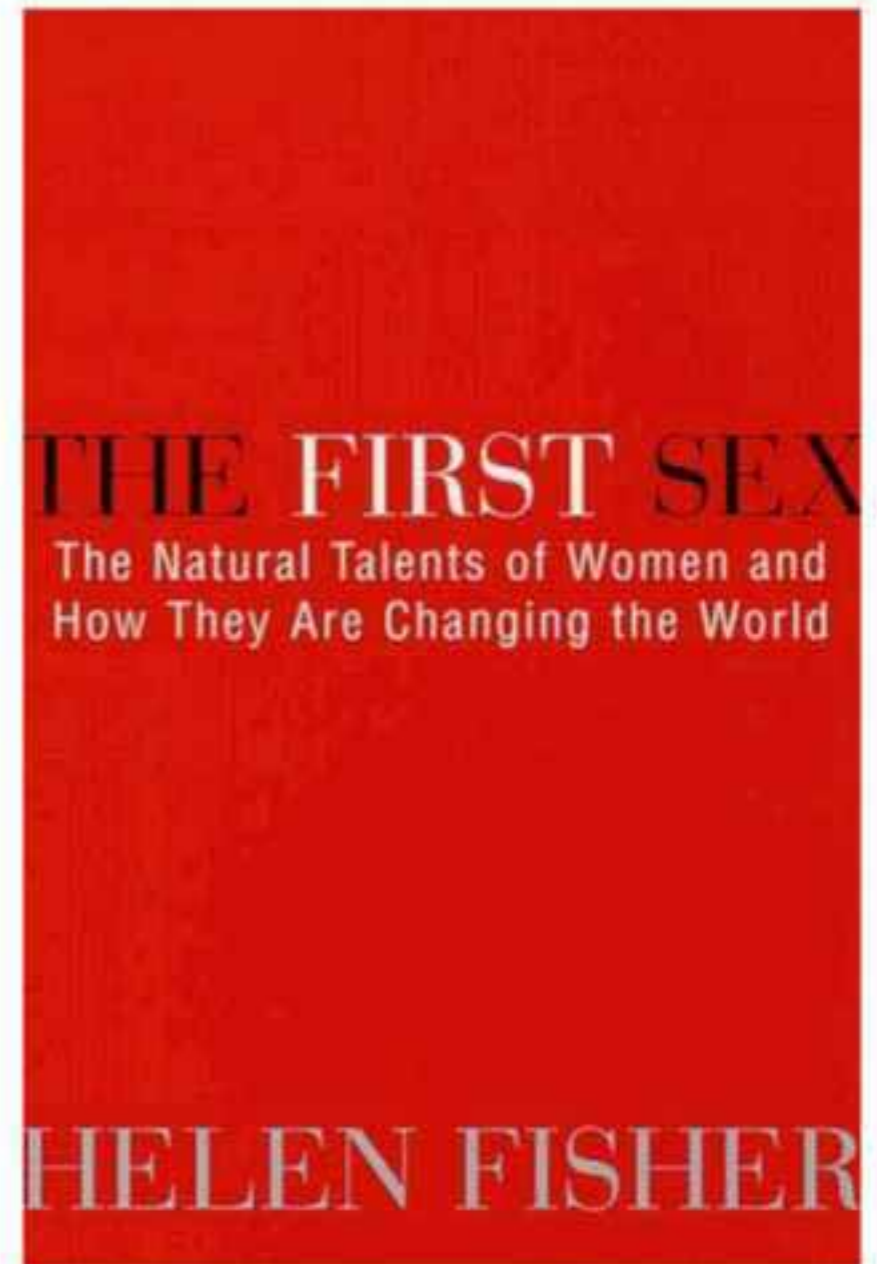
The more lateralised male brain may be better for focussed attention on tasks

- fast specialised recognition and problem solving
- keeping emotional and cognitive domains separate
- Increased susceptibility to problems following brain damage



Male vs. female brain politics

Helen Fisher in her book 'The First Sex', describes females as 'web thinkers'



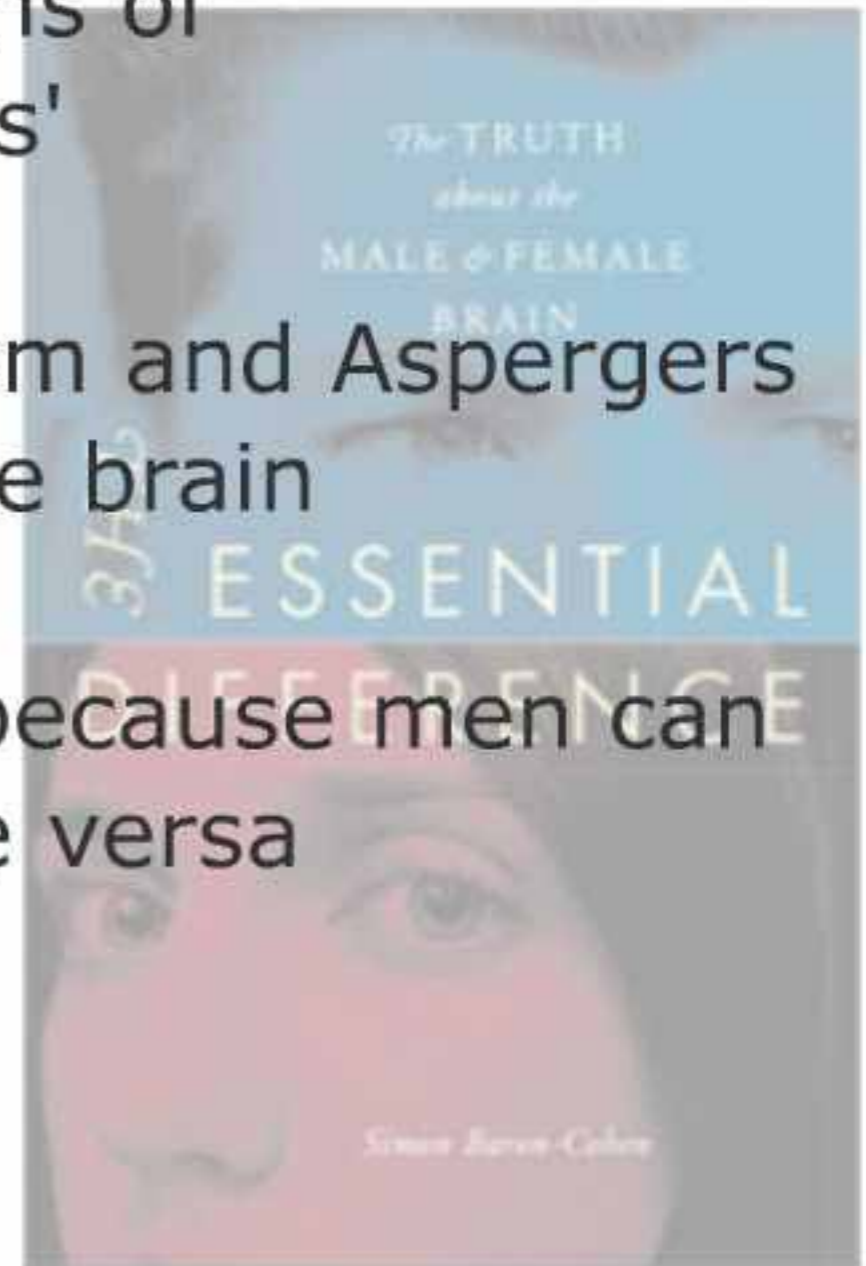
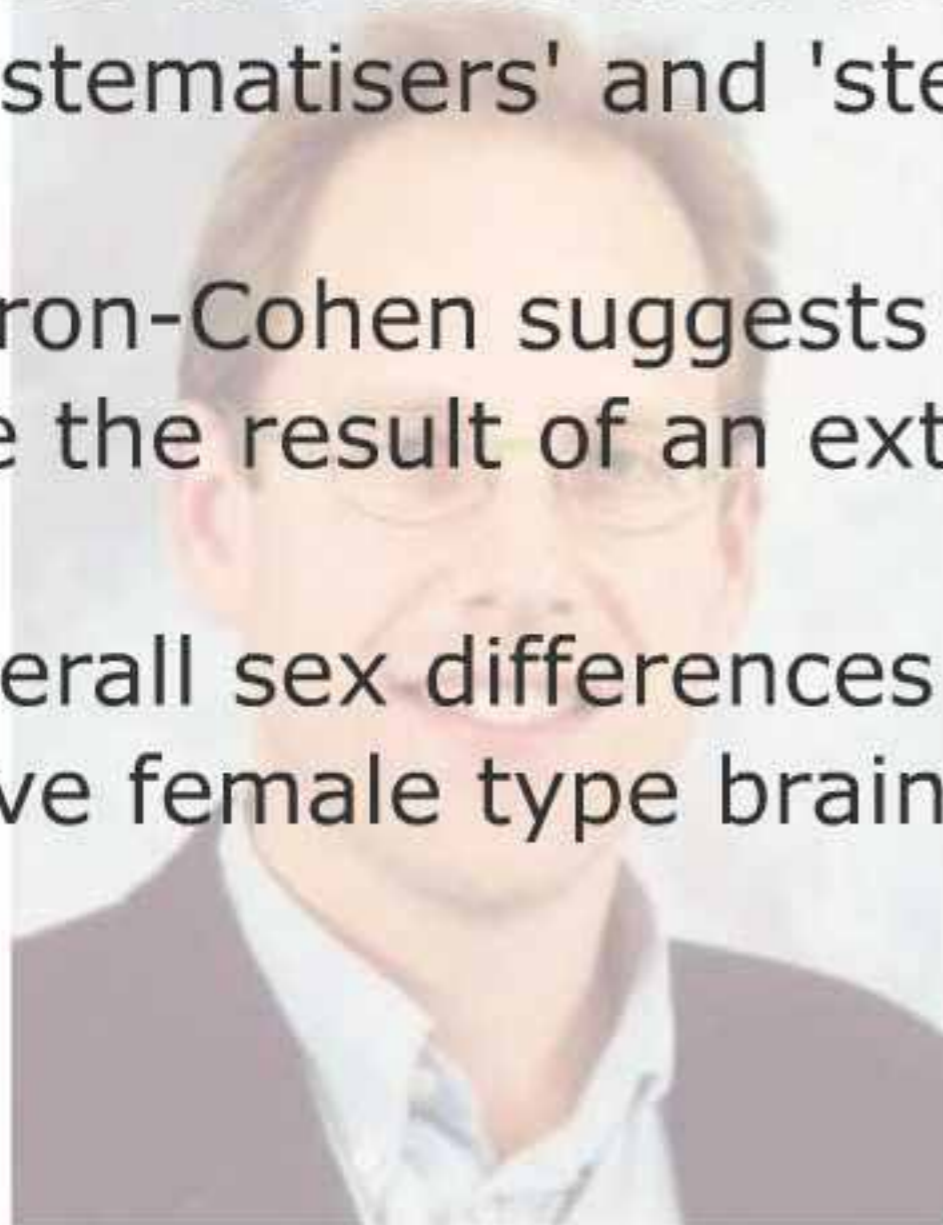
Male vs. female brain politics

Simon Baron-Cohen in 'The Essential Difference' describes the female brain as more 'empathic'

Males are described more in terms of 'systematisers' and 'step-thinkers'

Baron-Cohen suggests that autism and Aspergers are the result of an extreme male brain

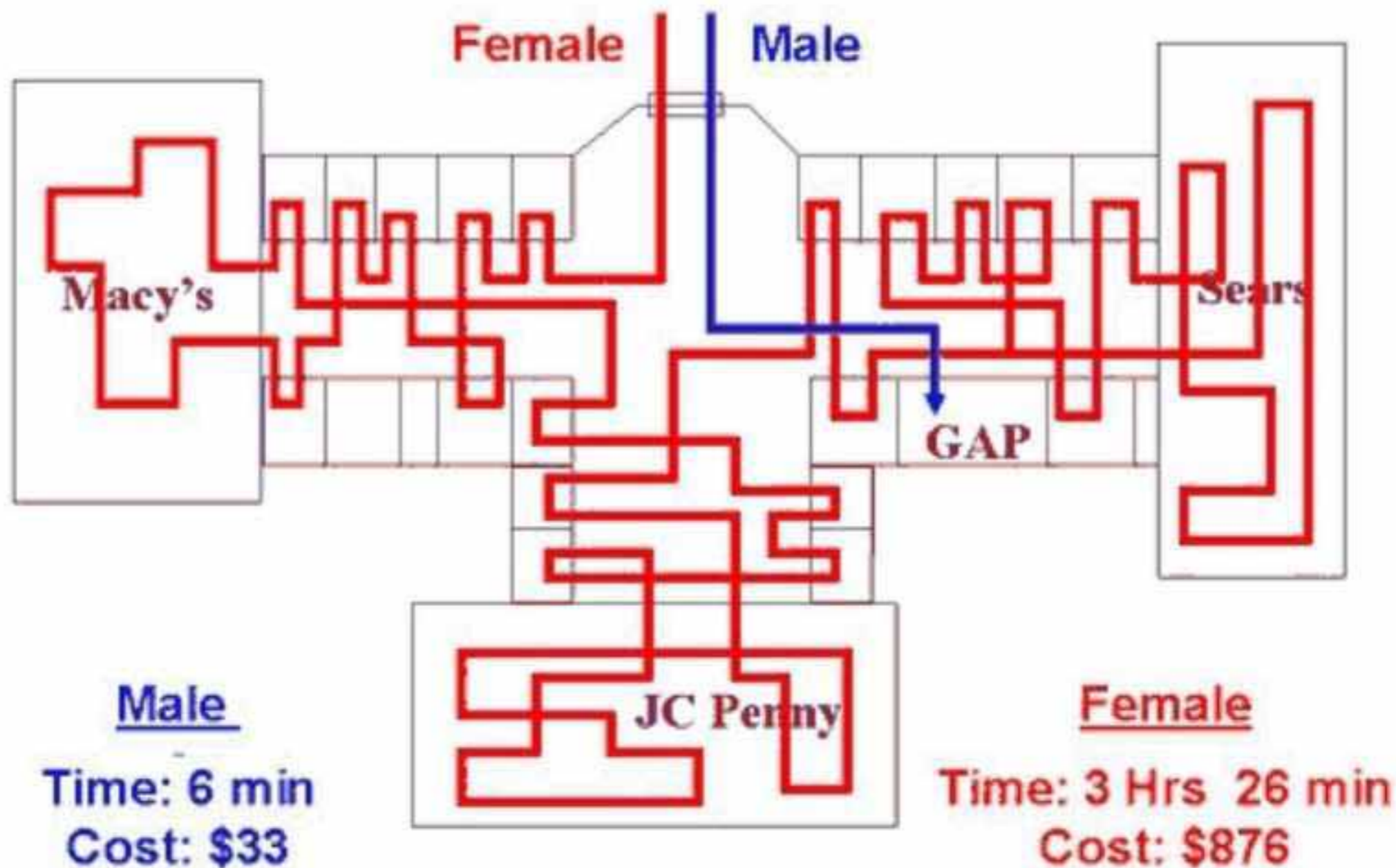
Overall sex differences are less because men can have female type brains and vice versa



So why the male:female difference?

Evolutionary explanation of different sex roles:

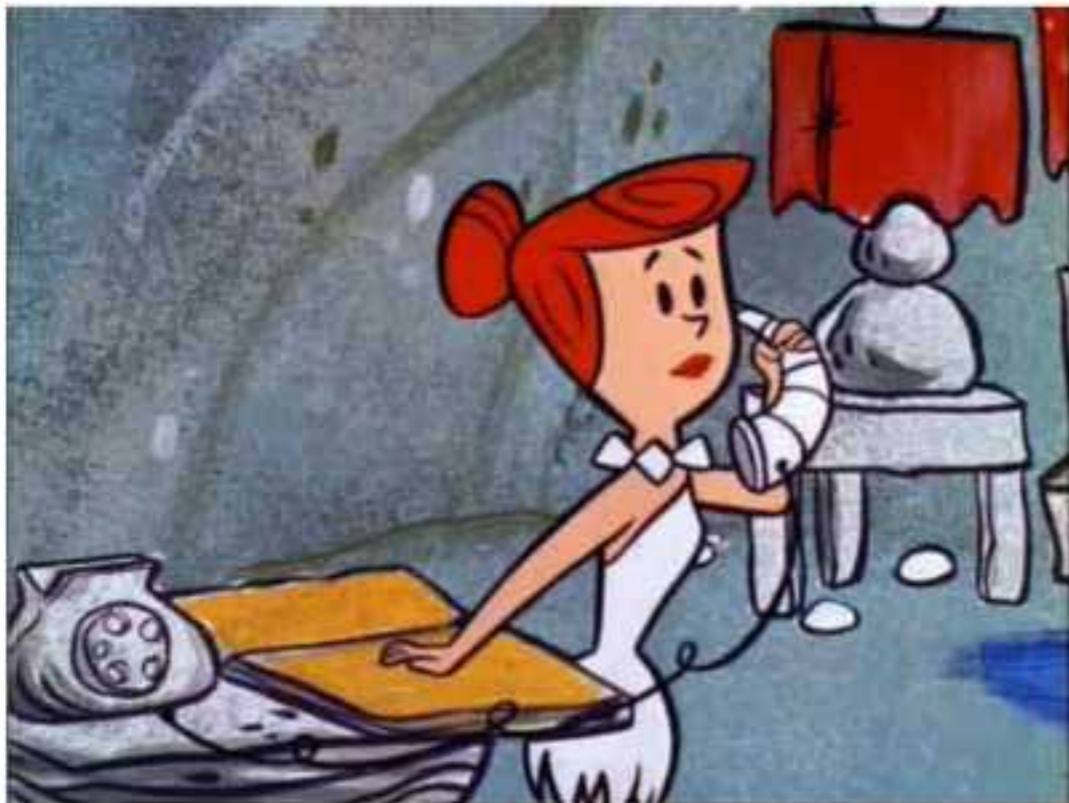
Mission: Go to Gap, Buy a Pair of Pants



So why the male:female difference?

Evolutionary explanation of different sex roles:

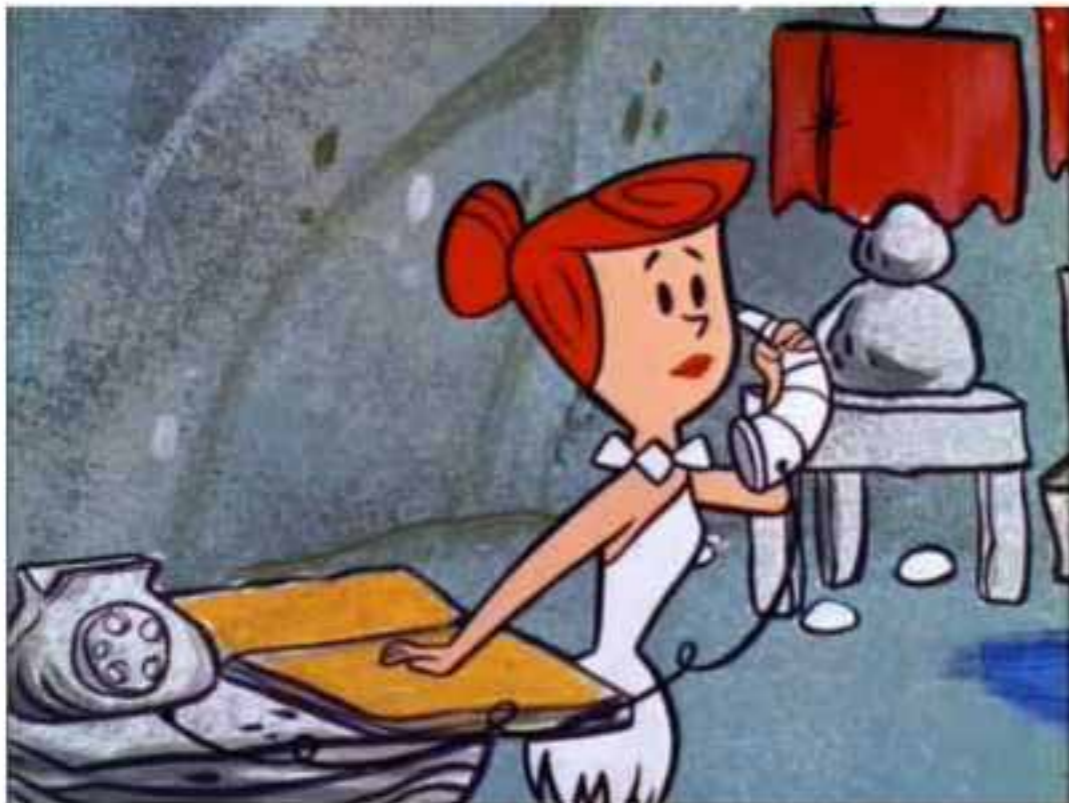
- Females local foragers, preparers, manufacturers, nurturers and requiring social cooperation



So why the male:female difference?

Evolutionary explanation of different sex roles:

- Females local foragers, preparers, manufacturers, nurturers and requiring social cooperation
- Males wide ranging hunters, problem solvers but less nurturing or social



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Other species?



So why the male:female difference?

Evolutionary explanation of different sex roles:

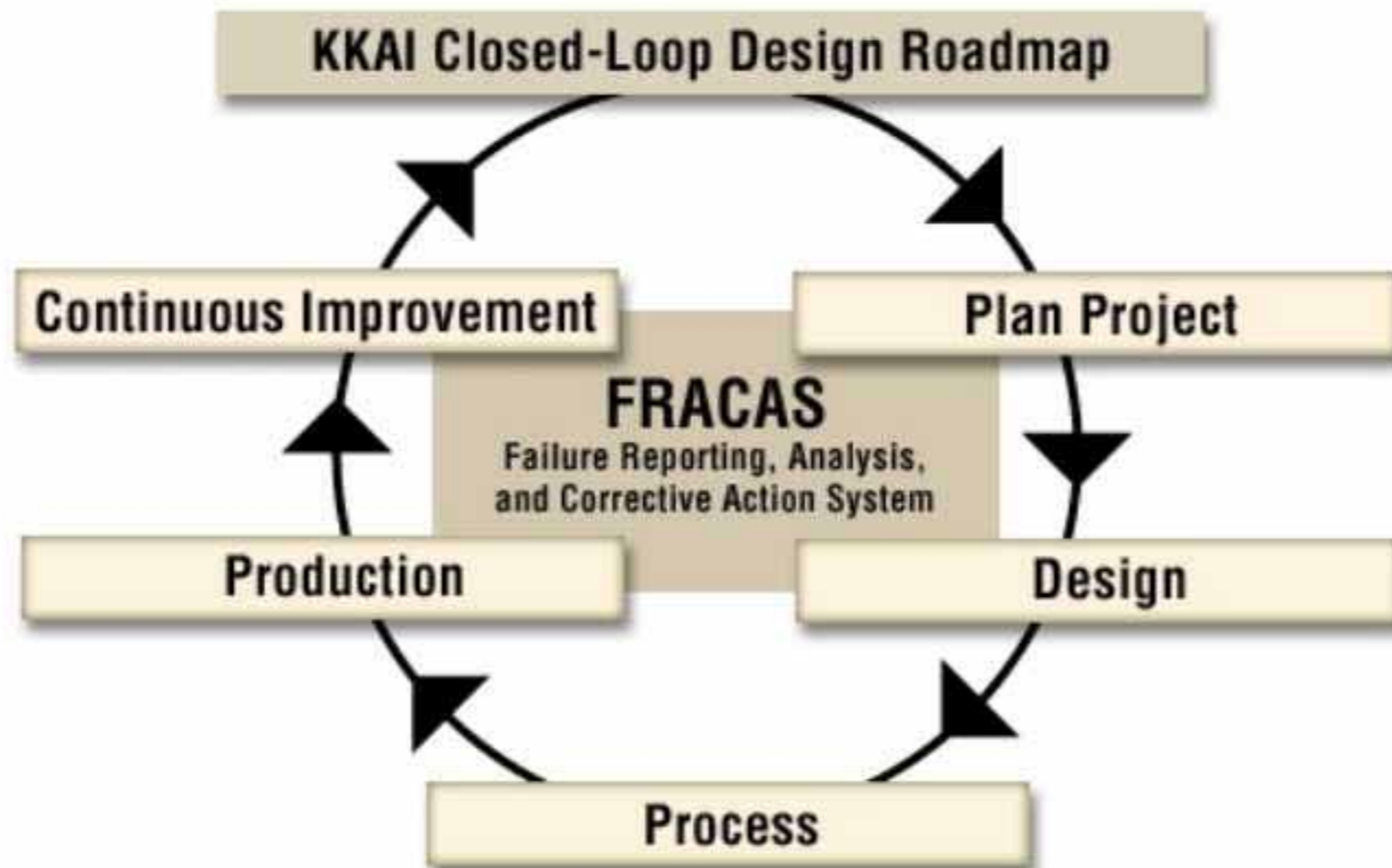
- Females local foragers, preparers, manufacturers, nurturers and requiring social cooperation
- Males wide ranging hunters, problem solvers but less nurturing or social

Other species?

- some evidence that male brain lateralisation is correlated with territory

How do you know the sex of your brain?

The long way – conduct a long series of problem solving tests



How do you know the sex of your brain?

The long way – conduct a long series of problem solving tests

The short way – find out which of your testicles...



How do you know the sex of your brain?

The long way – conduct a long series of problem solving tests

The short way – find out which of your testicles...
...or breasts is larger



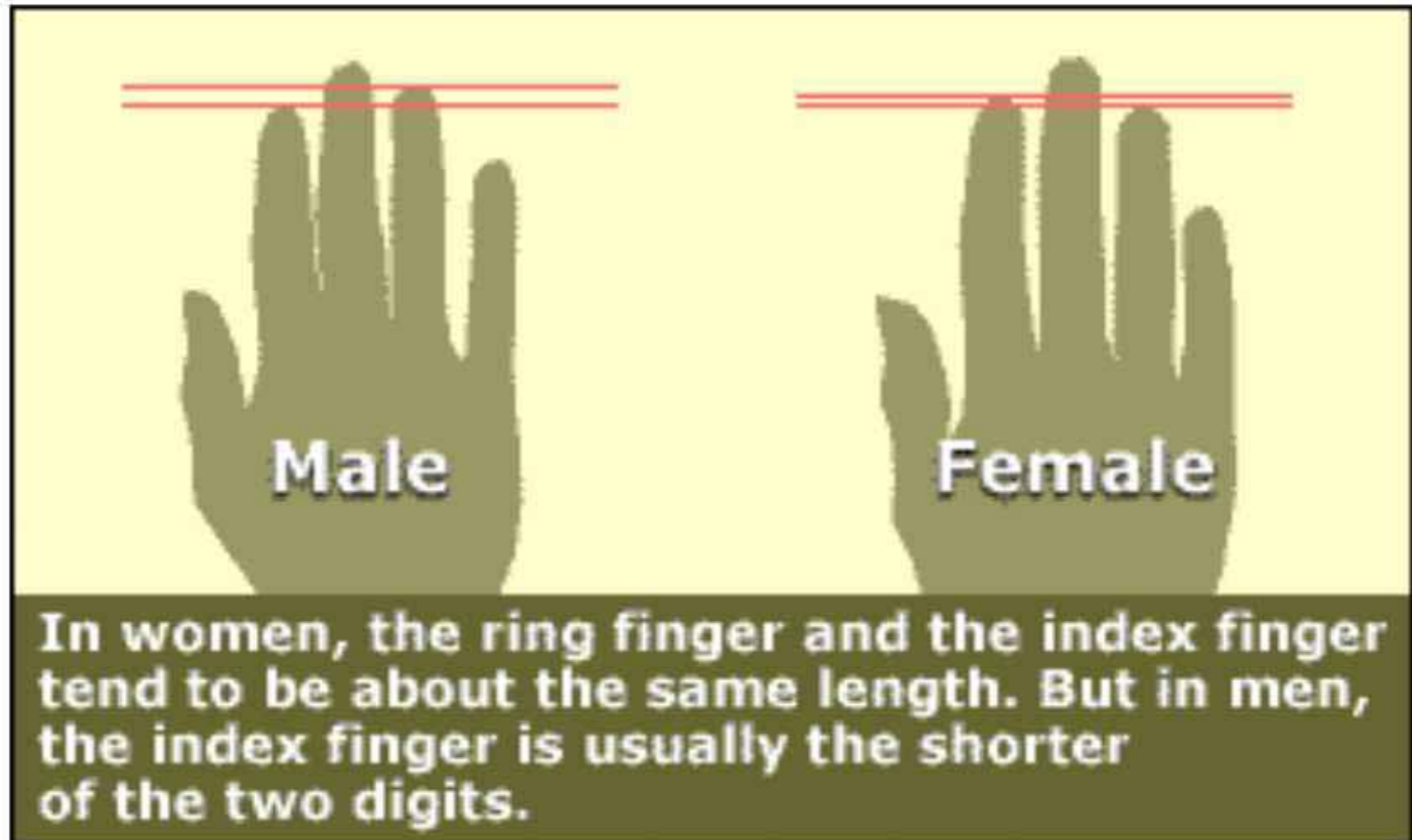
How do you know the sex of your brain?

Less problematic short way – count the lines on the finger prints from each hand



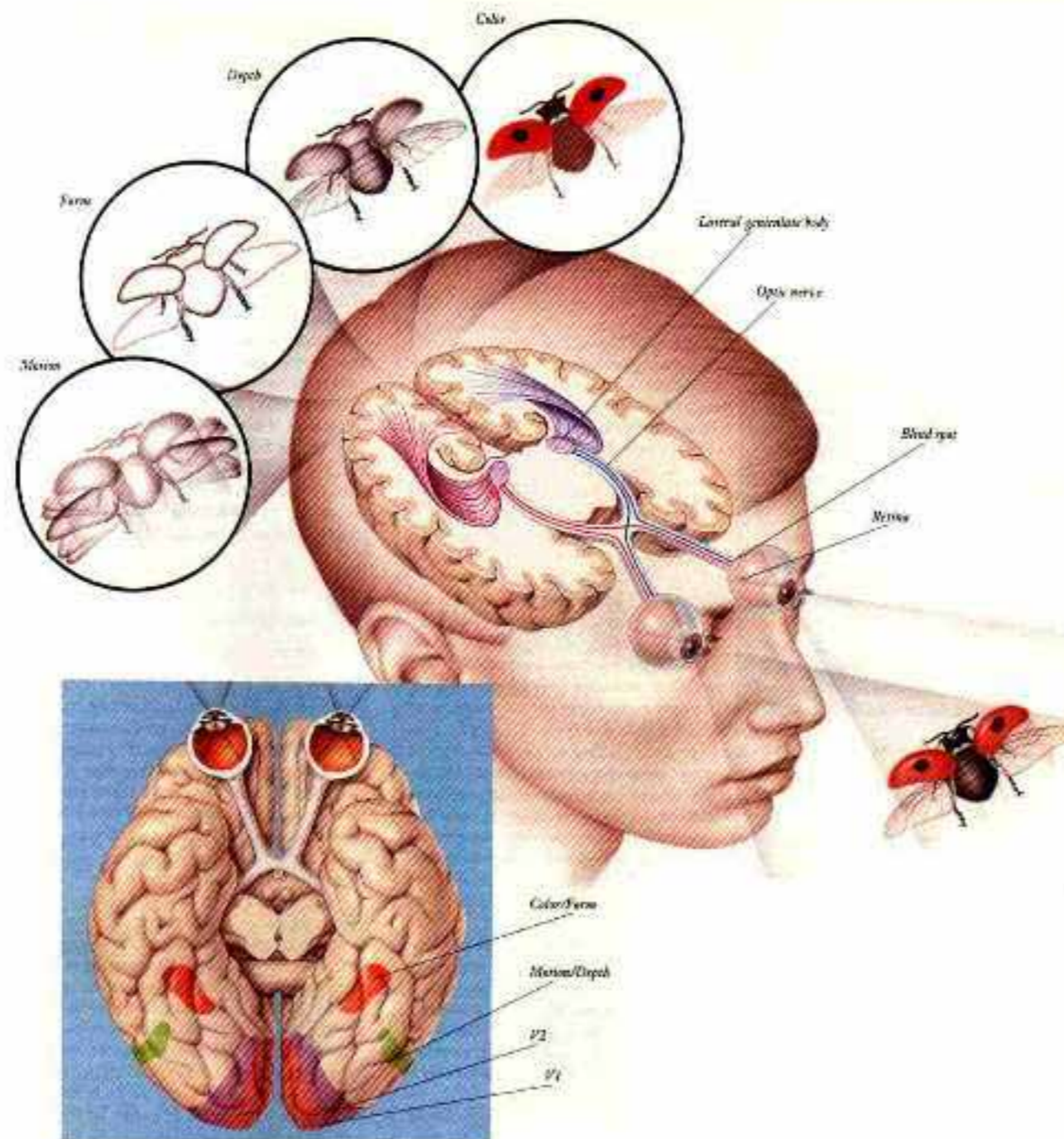
How do you know the sex of your brain?

Or perhaps differences in index and ring finger lengths!



How does the female brain work?

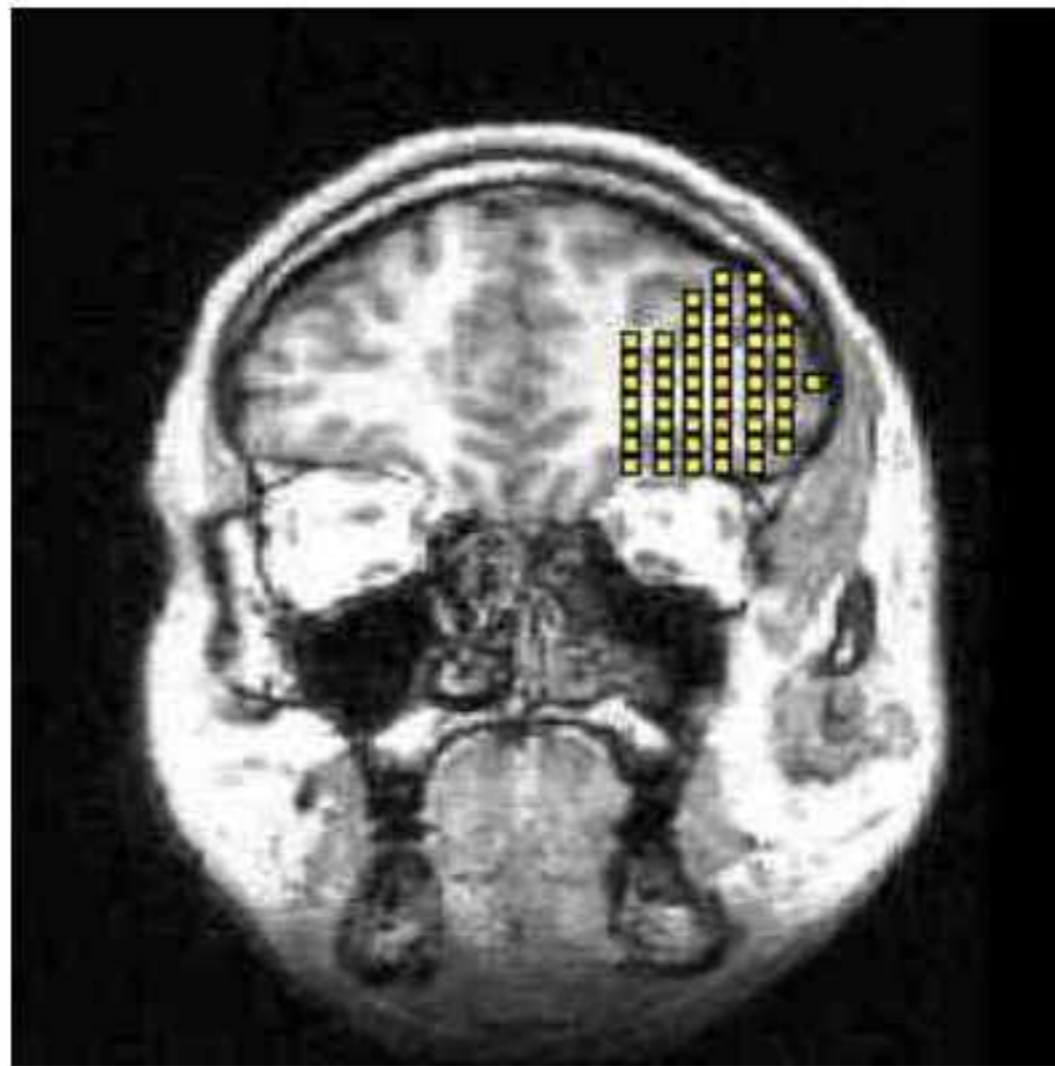
Does the female brain represent and integrate information in a more diffuse fashion?



How does the female brain work?

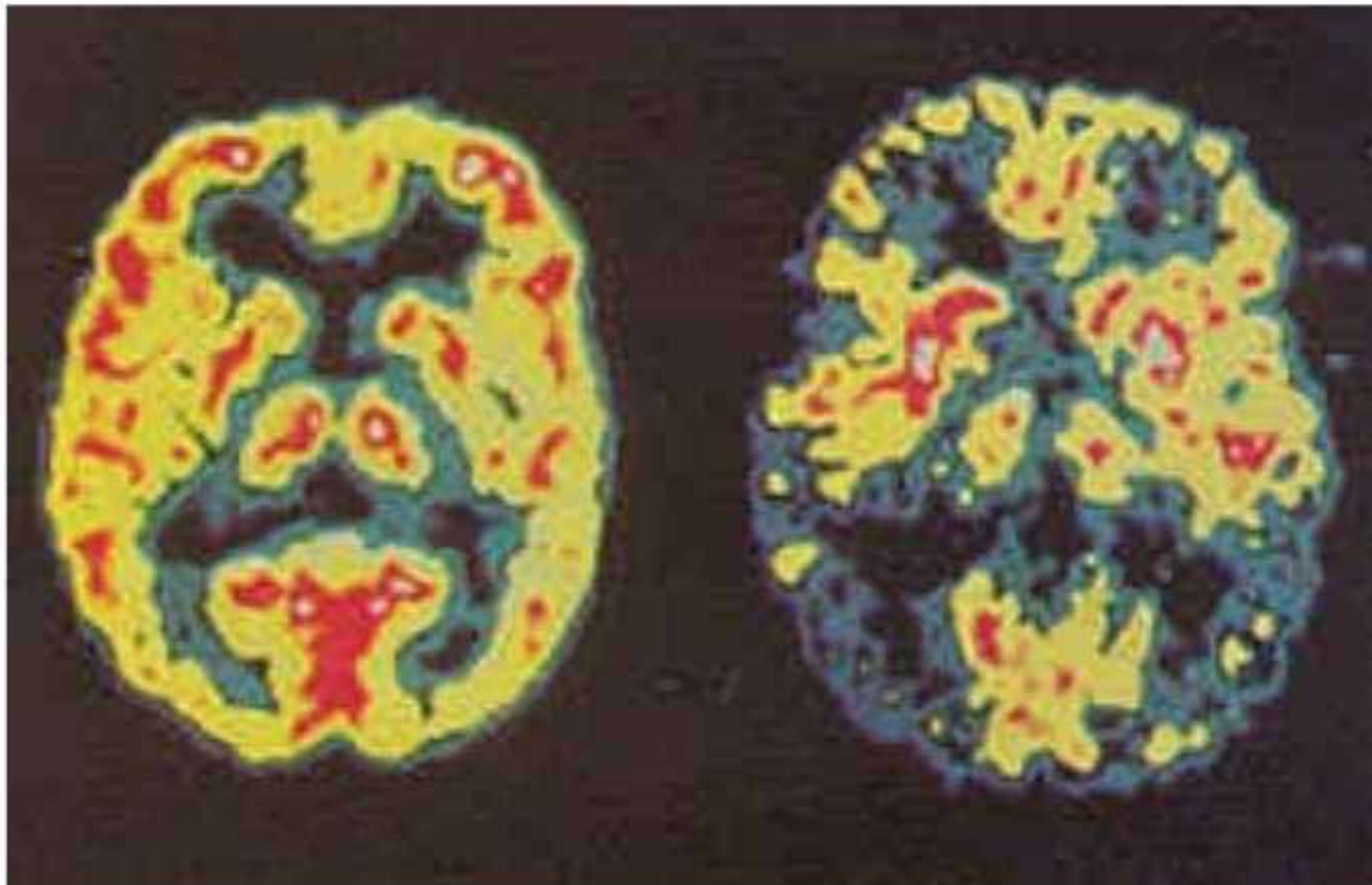
Does the female brain represent and integrate information in a more diffuse fashion?

Men are more likely to suffer from aphasia following left hemisphere strokes



How does the female brain work?

Some studies suggest the female brain is less susceptible to age-related cognitive decline



How does the female brain work?

Some studies suggest the female brain is less susceptible to age-related cognitive decline

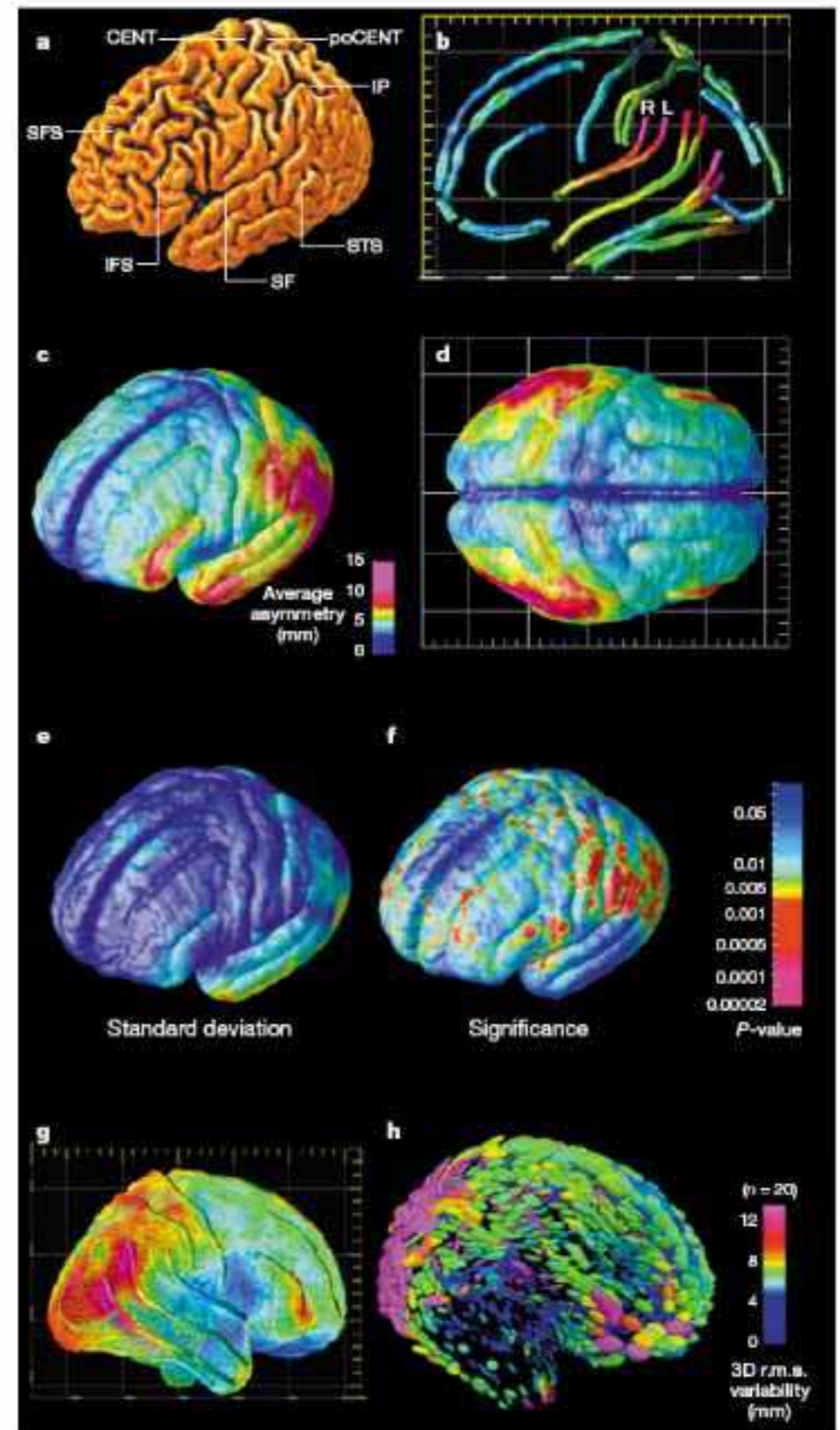
The most recent UK study by the Medical Research Council did not find any significant sex differences

MRC

Medical
Research
Council

How does the female brain work?

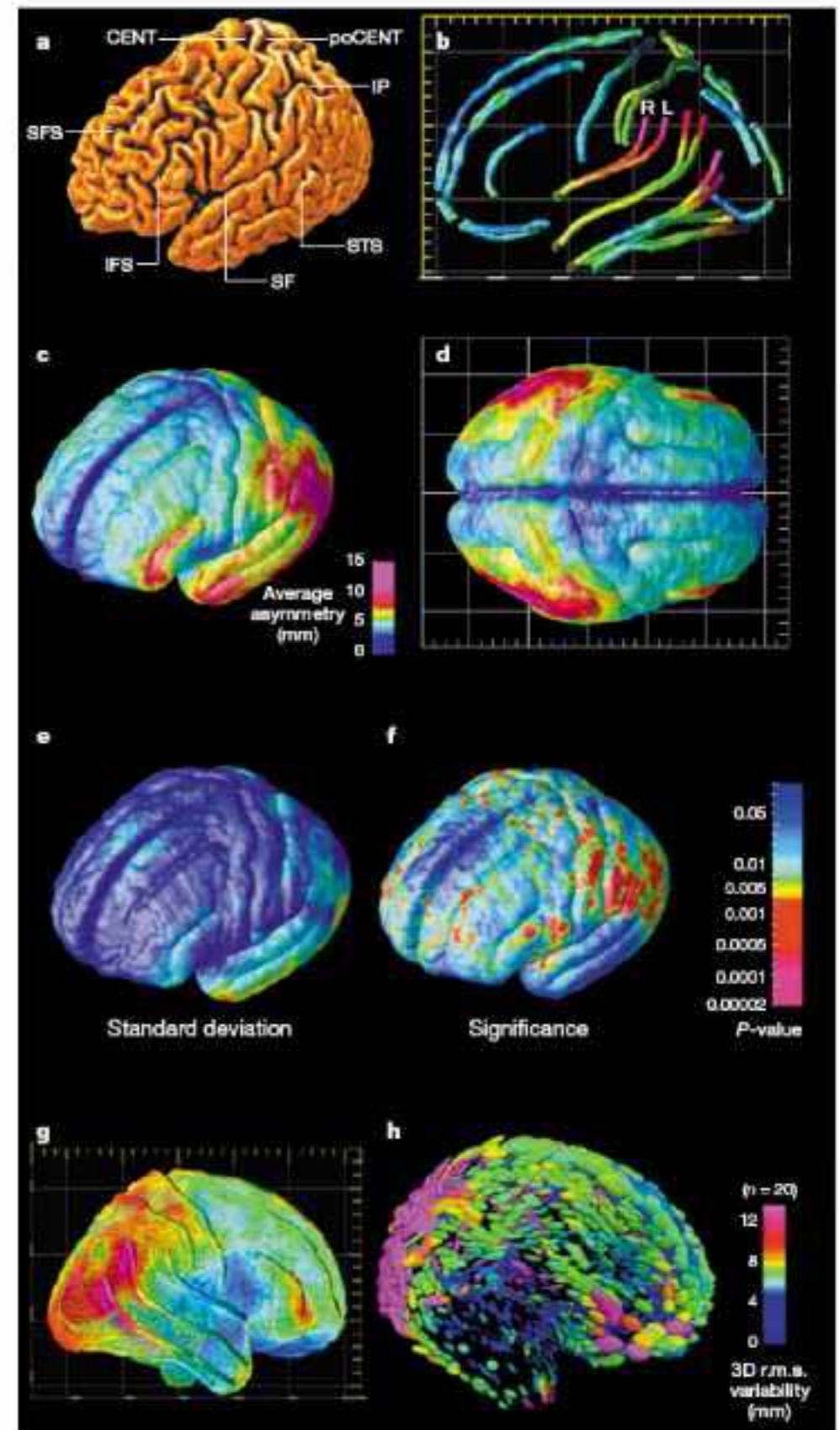
Some brain imaging studies report more diffuse activation patterns in the female brain



How does the female brain work?

Some brain imaging studies report more diffuse activation patterns in the female brain

A recent study reports a large sex difference in processing positive face emotion



How does the female brain work?

Males show greater lateralisation in the right hemisphere

Bourne 2004

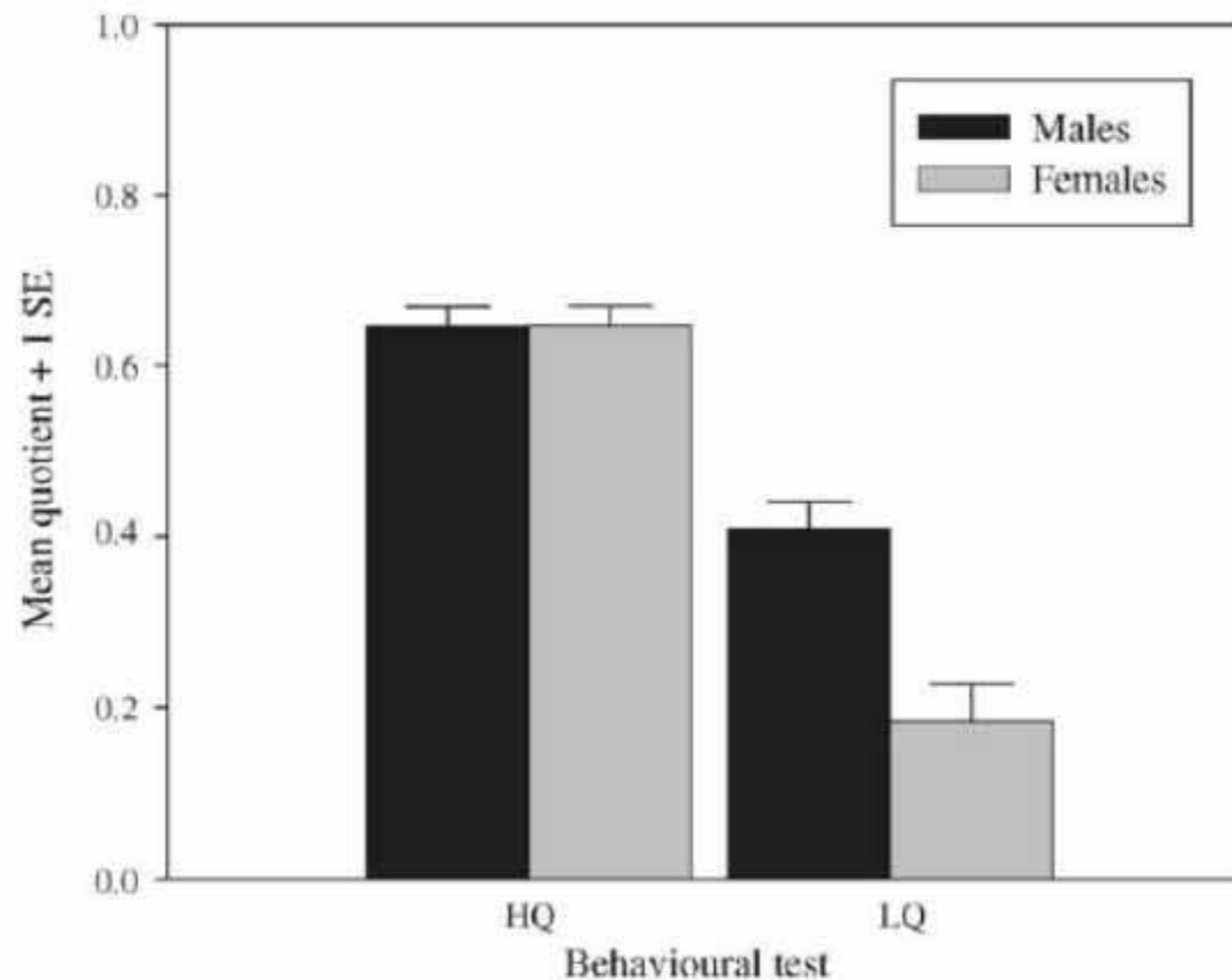
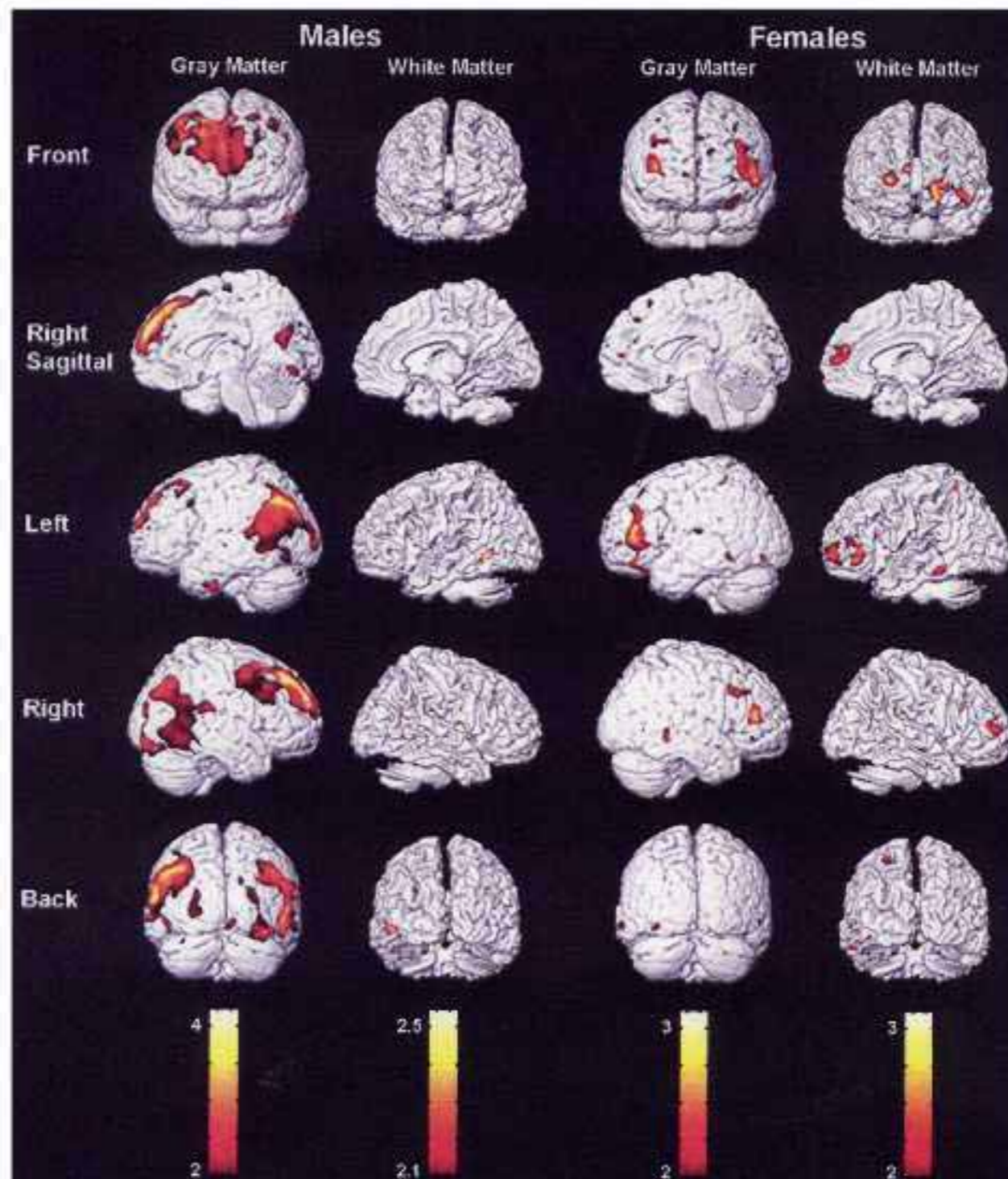


Fig. 1. Mean quotients (+1S.E.) for each behavioural test as a function of sex.

Is the female brain better connected?

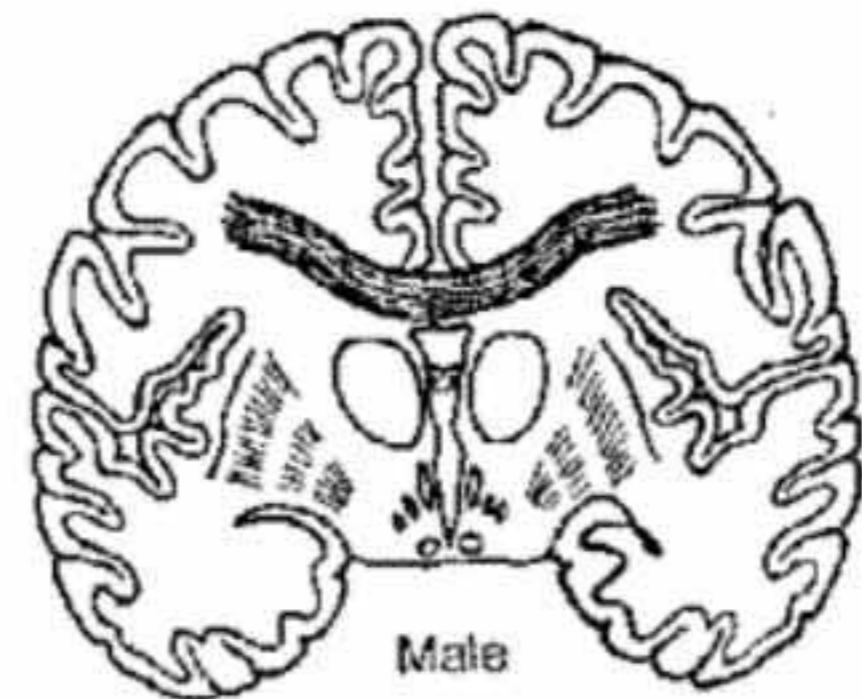
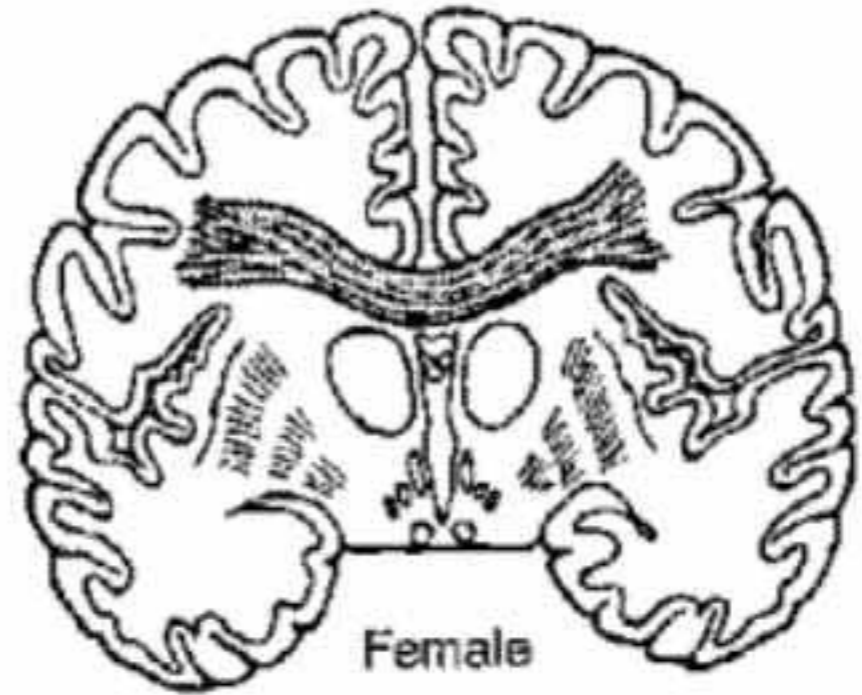
There is proportionately more white matter in female brains



Is the female brain better connected?

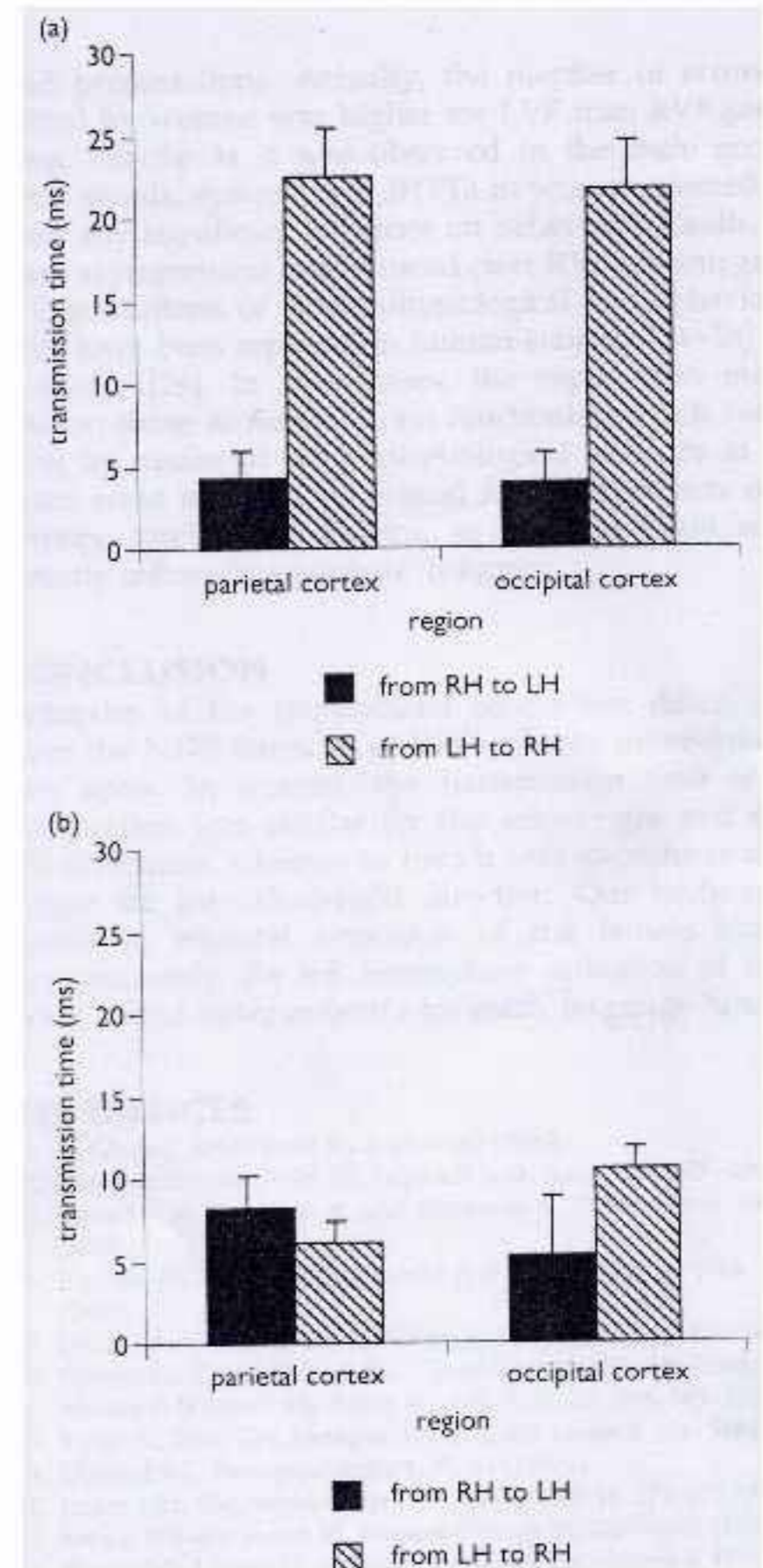
There is proportionately more white matter in female brains

The corpus callosum
– bigger in females?



Is the female brain better connected?

Sex differences in transmission time between brain hemispheres
Nowicka and Fersten 2001



Some final conclusions

Two brains provide both specialisation and flexibility

Language and emotional control and interpretation on left

Social recognition, visuospatial ability and intense emotion response on right

The two sides can work cooperatively and the left may help control the right

No real difference in male and female IQ – but different brain strategies

Some final conclusions

Males better at throwing things – and hitting the target

Females know when something is out of place.....
.....and how to find more of the same

Females guide you with landmarks, males with directions.

Females better at verbal and social skills and multitasking

Males better at focussed attention and mathematical reasoning

Some final conclusions

Females communicate their emotions better

Male brains are more localised

Female brains are better connected

Females reliably better appliers and team players

Males sometimes better innovators and leaders...
... sometimes not much good at anything!

Some final conclusions

Vive la difference!



There is a difference