

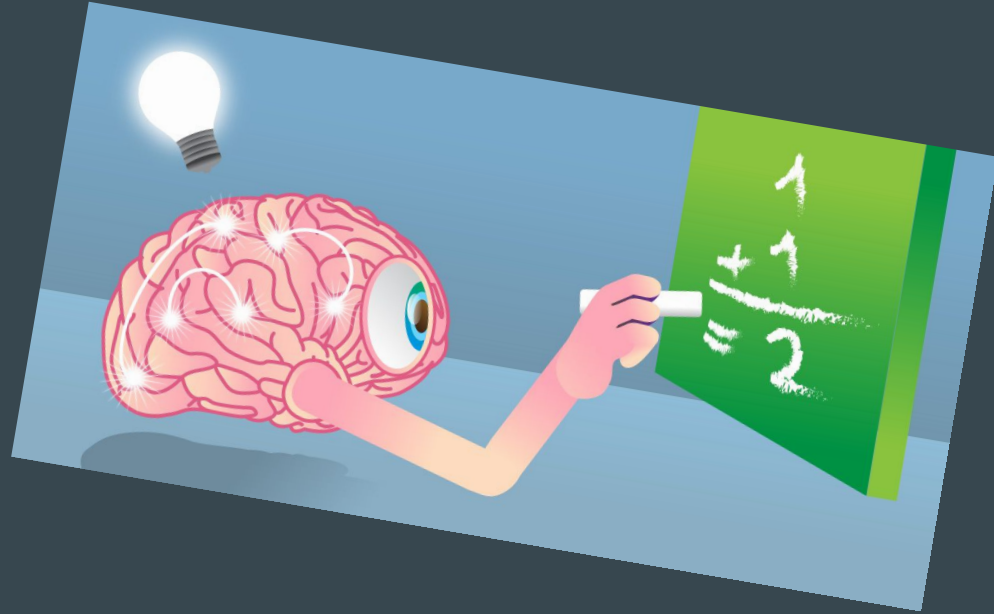
The Calculating Brain



Ashton Hare
&
Cole Hyland

Outline:

- Piaget's stages of development
- Gelman & Gallistel
- Approximate number system
 - Elementary activity
 - Secondary activity
- Constructing exact numbers
- BODY BREAK
- Triple code organization
- Prefrontal Cortex
 - Activity
- Dyscalculia
- Acalculia
- Strengthen your brain



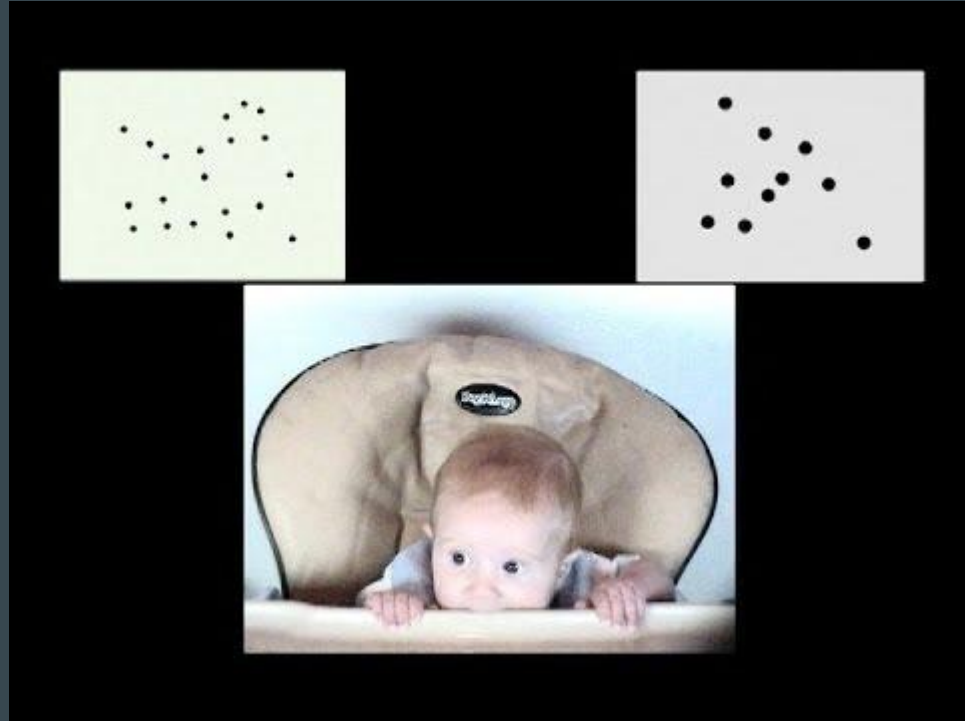
Piaget

- Mathematical knowledge and development
- Stages of development
- Inability to understand arithmetic
- Number conservation
- Misleading



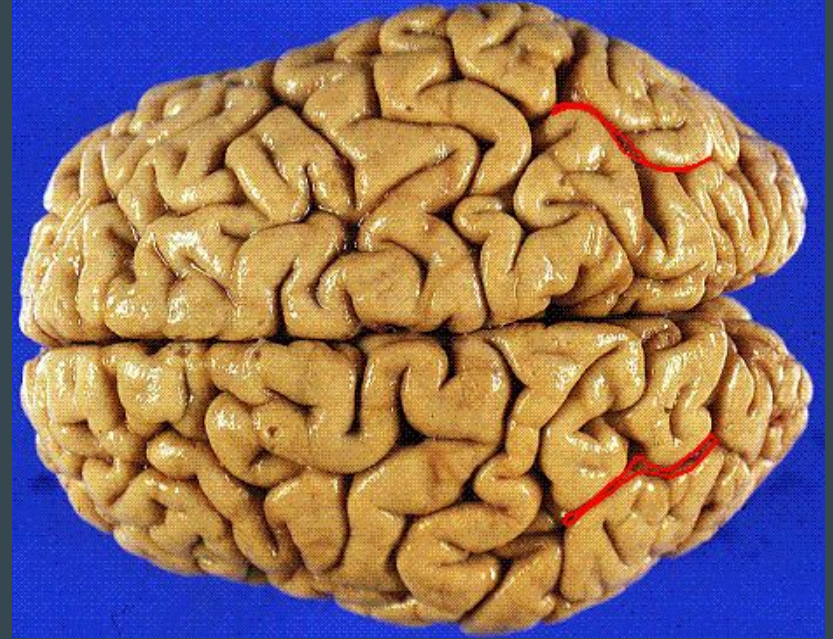
Gelman & Gallistel

- Overturned Piaget's theory
- Preschoolers have intuition to arithmetic
- Experiment:
 - Magic show
- Measured results through surprise



Approximate Number System

- Intraparietal Sulcus
- Activated when number task is performed
- The degree of activation depends on the degree of difficulty
- Number sense 15% accuracy



FAST EYES

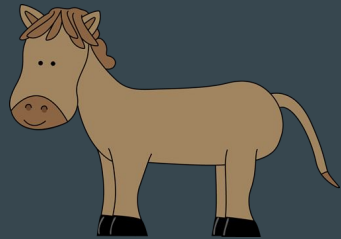
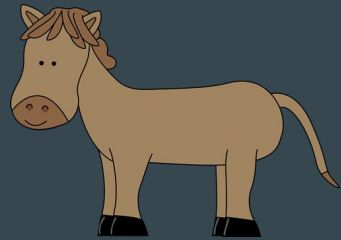
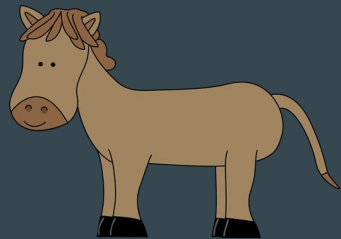
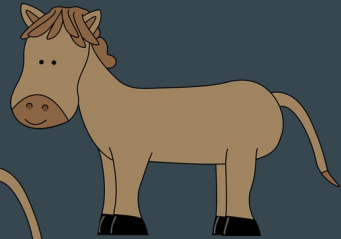
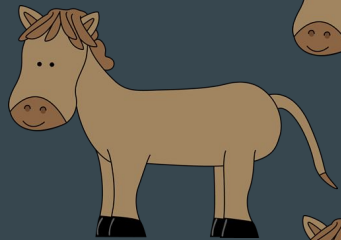
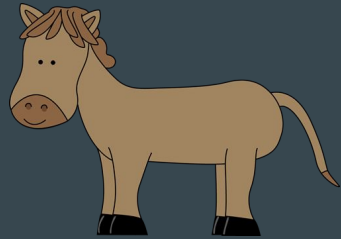
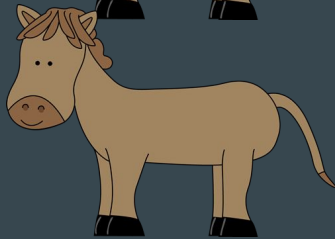
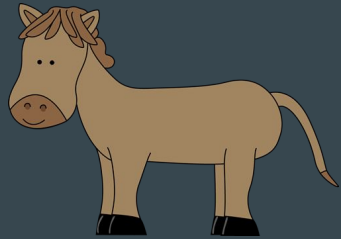
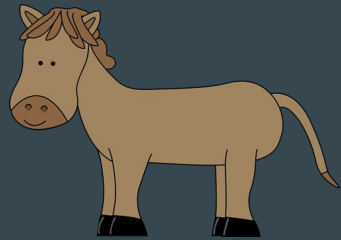
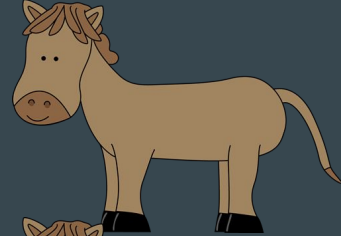
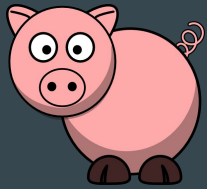


How many snowmen were there?

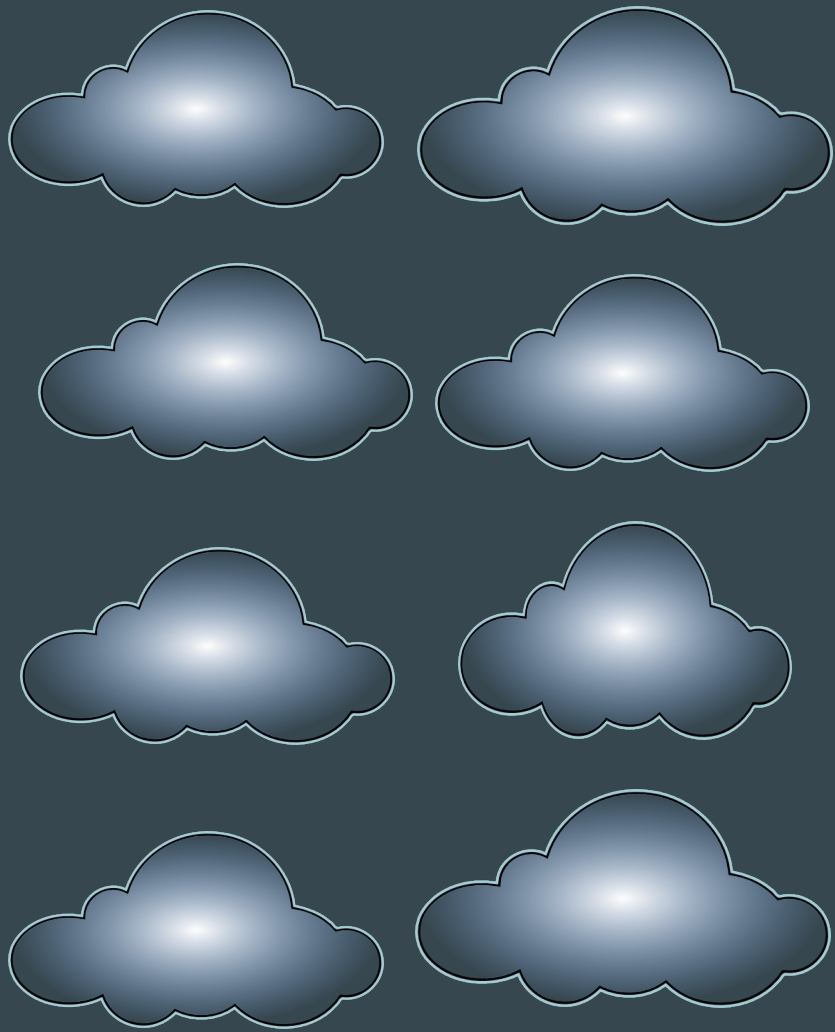
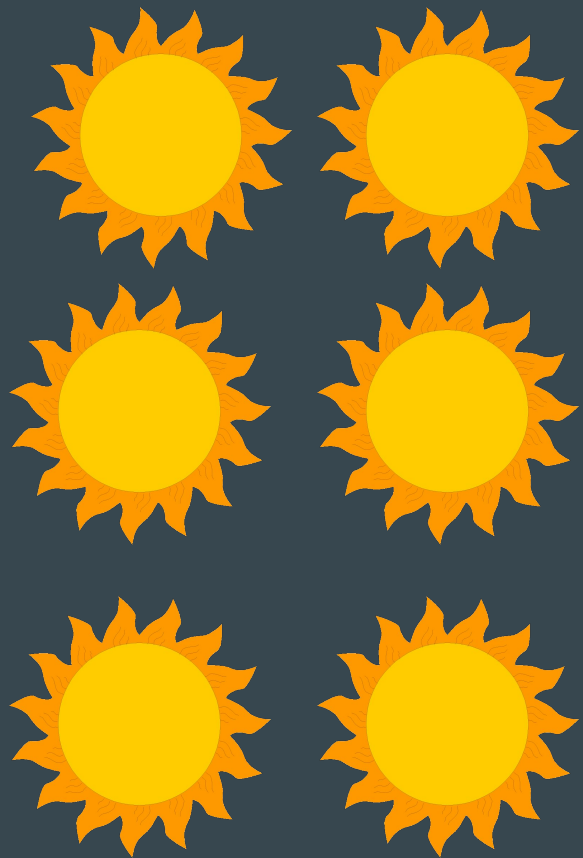
How many hearts were there?



How many happy faces were there?



Were there more pigs or horses?



Were there more suns or clouds?



Were there more stars or dogs?

Arithmetic Problems

Train your brain with mental calculation

$$9 \times 94 =$$

Enter your solution and press 'Enter' to submit

+ - x ÷ aⁿ √

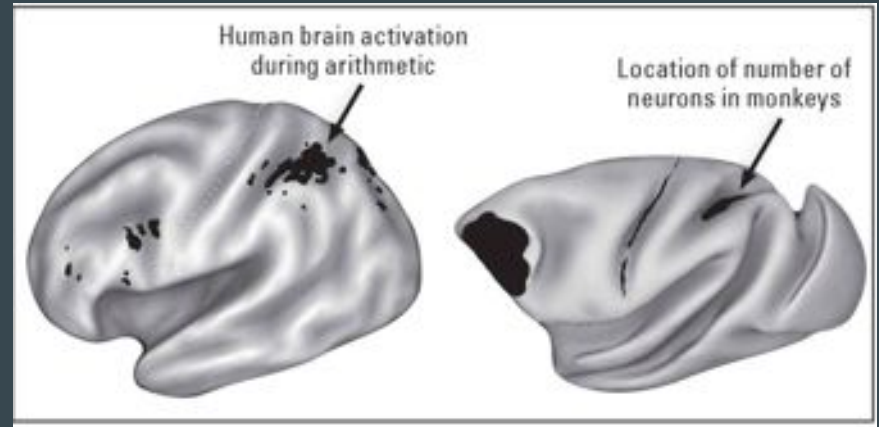
level: 

score: x [reset](#)

<http://www.momonix.com/calc/?typedfield=10>

Approximate Number System

- Research in Monkeys
- Individual neurons prefer a number
- Neurons fire more when they are closer to the number they prefer
- Hundreds of thousands of neurons
- Numbers encoded through the neurons that are firing at a given time



Constructing Exact Numbers

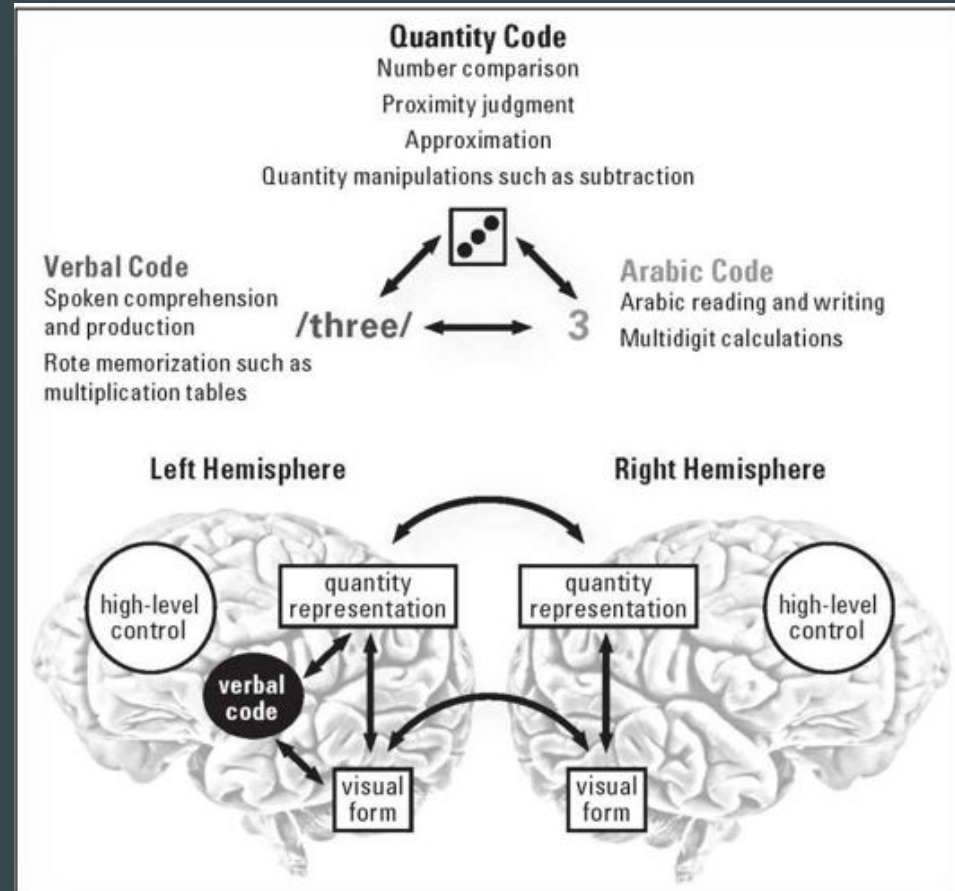
- Between 2 and a half and four
 - Counting abilities
- Serial manner
- 1 is associated with 1 object
- Not fully understood
- Age 5
 - Understand a word applies to a set
 - Continues to apply
 - Ceases to apply
- Verbal knowledge lags
- Once understood, see numbers as discrete entities

BODY BREAK



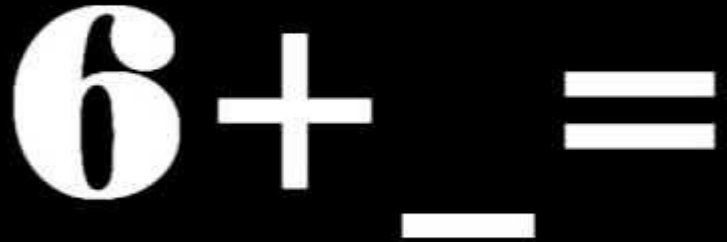
Triple Code Organization

- Intraparietal sulcus does not act alone
- Chain of cortical areas
- Three
 - Left hemisphere verbal code
 - Quantity code
 - Arabic code
- Different forms, different starting points
- Adults unconscious
- Children less efficient



Prefrontal Cortex

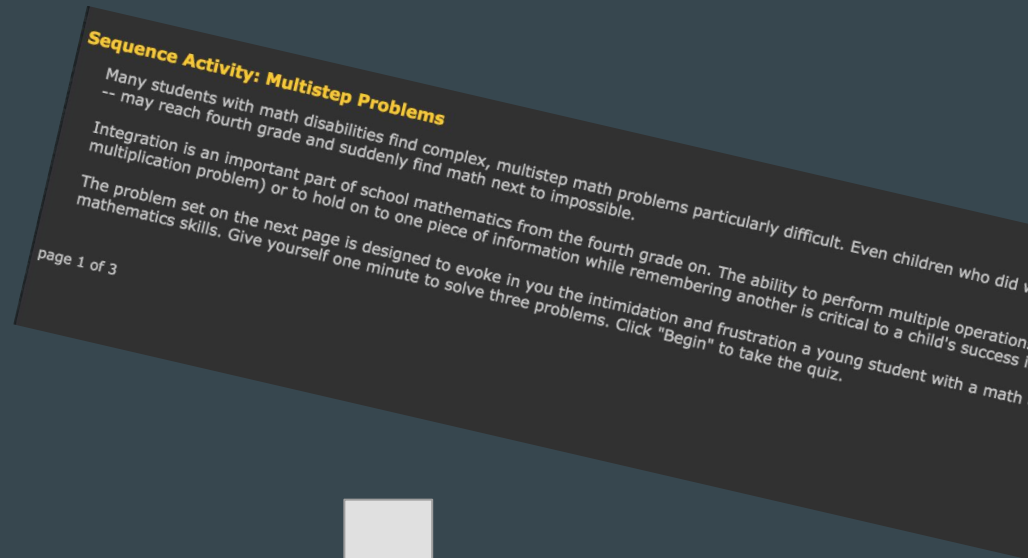
- Non routine strategies
- Can't perform several effortful tasks
- Become expert
 - prefrontal cortex activity decreases
 - replaced by automatic brain systems
 - back of the head
- Before automation
 - prefrontal cortex absorbed by calculation
- Important goal of education
 - free child's mind by creating fluency and automaticity



A large white mathematical equation is displayed on a black background. The equation consists of the number '6', a plus sign '+', an underscore '_' representing a blank space for an operand, and an equals sign '='. The characters are rendered in a bold, serif font.

Dyscalculia

- Referred to as “number blindness”
- Many complex skills involved in math...
 - Relationship between numerals and words
 - Mental math skills
 - “Missing operand” questions
 - Questions relating to real life



Sequence Activity: Multistep Problems

Follow all four instructions below to solve **each** of the three problems. Enter your answer into the space provided.

- A. Multiply the third number in the first row by the seventh number in the third row.
- B. Add this result to the fifth number in the second row.
- C. Add to this total ten times the fourth number in the third row.
- D. Subtract the eighth number in the first row from the result.

Problem 1: 6 5 **8** 7 4 5 6 8 4
3 2 1 9 5 6 4 2 1
6 5 1 5 1 3 **2** 3 5

Answer:

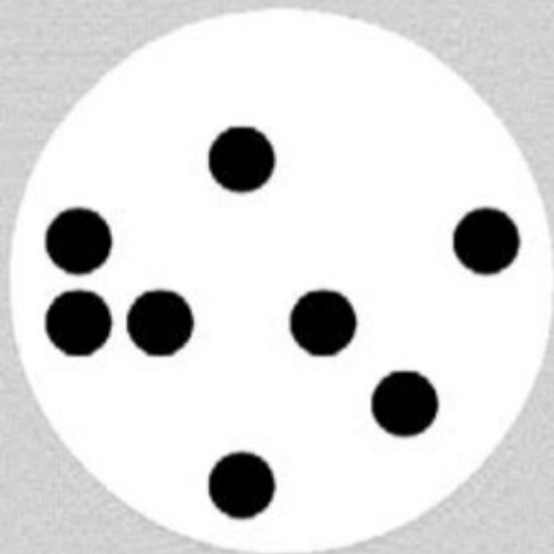
Problem 2: 7 5 4 9 9 5 4 4 1
2 5 1 4 8 9 6 6 8
5 7 5 7 5 7 6 8 2

Answer:

Problem 3: 1 2 3 7 6 5 4 3 2
8 4 3 2 1 6 5 4 8
6 5 5 8 1 7 5 12 6

Answer:

How many SPOTS are there, does this match the NUMBER?



Q W E R
A S D F
Z X C

no

yes

U I O P
J K L ;
N M ,

Which number is more than the other number?

7

2

Q W E R
A S D F
Z X C

more?

more?

U I O P
J K L ;
N M ,

Is this sum correct?

$$3 + 8 = 12$$

Q W E R
A S D F
Z X C

no

yes

U I O P
J K L ;
N M ,

Personalized for Your Child

Off

On

?

Share

Skip

ing Assist

Through Your Child's Eyes

Acalculia

- Impairment in mathematical abilities
 - due to brain damage
- Intraparietal sulcus play a fundamental role
- Damaged due to lesions
- Difficulties with number processing
- Can prevent calculation
- Trouble distinguishing values
- Related to developmental dyscalculia



Lumosity

- Brain training games
- Memory
- Problem solving
- Speed
- Attention
- Research confirms effectiveness
- Few hours a day

<https://www.lumosity.com/app/v4/games>

References

- Sousa, D. A. (Ed.) (2010). *Mind, brain, & education: Neuroscience implications for the classroom*. Bloomington, IN: Solution Tree Press.
- Rickard, T. C., et. al. (1999). *The calculating brain: An fMRI study*. *Neuropsychologia*, 38 (2000), 325-335. <http://timrickard.com/Papers/Rickard-et-al2000.pdf>
- <https://www.flickr.com/photos/60584345@N08/5519724905>