Neuroscience of Learning

Presented by Michelle Kueh
Director of Schools (Asia Pacific),
Mangahigh.com

Brief background…

1997-2000 Biomedical Science, Monash University, Melbourne Australia

1997-2002 Had the privilege of sparking 'lightbulb' moments in 45+ children with private maths tutoring/mentoring over 5 years

2000-2006 Started my career working in R&D with various government laboratories

2006-2012 Consolidated my passion in education, worked in educational publishing for over 5 years – McGraw-Hill and Pearson

2012+ Joined the EdTech world in Mangahigh.com – sharing my thoughts on how we should use technology for all it's power. Presenting research in cognitive science to improve the use of technology in maths learning.


PROFILE MICHELLE KUEH WWW.MANGAHIGH.COM

"TECHNOLOGY AND THE BRAIN WORKING IN SYNERGY - THAT'S THE POWER OF DIGITAL GAMES BASED LEARNING"

The latest research in cognitive science has afforded more insights into how our brain processes information, stores it in short and long term memory, how memory is retrieved, and information is manipulated in the working memory for problem solving and growth.
With a focus on maths learning, Michelle discusses how a games-based mindset can be strategically implemented in classrooms, to deliver highly effective, goal-oriented learning. A games-based mindset primes learners into a stage of heightened information processing, as the brain opens the synaptic flood gates to neurotransmitters that are responsible for motivation, engagement, attention, and memory formation. Michelle's sessions investigates a gamer's brain to help us understand how *it* (brain) responds to various educational technology, and how games-based inspired lessons optimises the use of technology in our classrooms to enhance learning. When learners experience a digital games based learning lesson, we witness the true power of technology and the brain working in synergy.

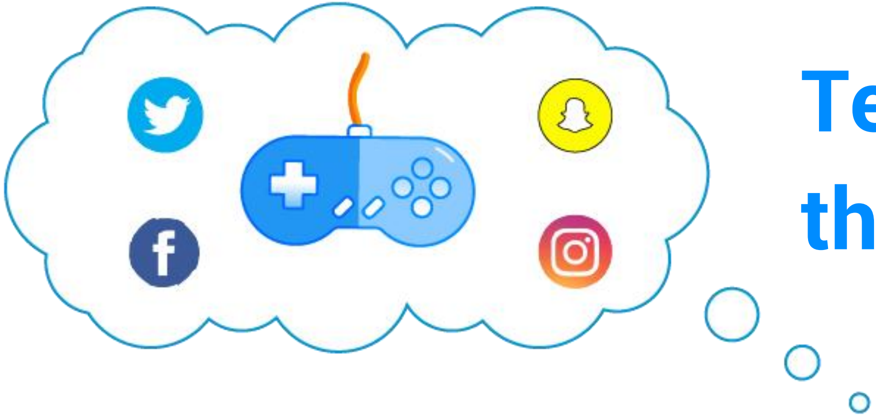
MICHELLE'S PASSION

Trained in Biomedical Science (Pharmacology and Physiology), at Monash University, Melbourne Australia - Michelle now combines her background in science research, and maths education, to provide a unique cognitive science based perspective on how students interact with technology in learning.

Teachers use these cognitive science based insights to evaluate the suitability of digital learning platforms, and how best to integrate technology into their teaching to ensure students are truly benefiting from their use of digital platforms. With 5+ years professional experience working in publishing with McGraw-Hill and Pearson, and 8+ years working in edtech at Mangahigh.com - Michelle now leads Mangahigh's Asia Pacific team in inspiring teachers to explore the use of technology to truly affect change.

Michelle has presented sessions at Edutech (Australia and Asia), and various Maths Association organised conferences across Australia.

If you're interested in connecting with Michelle for a banter in digital games based learning and cognitive learning, feel free to email: michelle.kueh@mangahigh.com



Technology has disrupted the education sector…

Definition of learning

Acquisition of knowledge or skills through study, experience, or being taught

https://theelearningcoach.com/learning/10-definitions-learning/

“We define learning as the transformative process of taking in information that—when **internalized** and **mixed** with what we have experienced—changes what we know and **builds on** what we do. It's based on **input**, **process**, and **reflection**. It is what changes us."

–From The New Social Learning by Tony Bingham and Marcia Conner

How do we learn?

- The brain is responsible for our thinking, learning, and memory
- Our brain cells are physically and chemically changed when we learn
- Changes are reactivated during recall
- Learning is all about making connections


THOMAS

badmephisto's Speedcubing Guide

Arranged by Andy Klise of kungfoomanchu.com

First 2 Layers

You must solve the cross first. It can be done in 6 moves or less ~82% of the time and ≤7 moves 99.95% of the time
These are just optimal example solves; F2L should be solved *intuitively*.

Easy Cases (1-4)

U (R U' R')
Use (R' F R F') if no U face edges are oriented properly on final slot

y' U' (R' U R)
Use (F R' F' R) if no U face edges are oriented properly on final slot

y' (R' U' R)
Note – this image is blue and red because a cube rotation is required

(R U R')
Note – this image is green and red because no cube rotation is required

Reposition Edge (5-8)

(U' R U R') U² (R U' R')

d (R' U' R) U²' (R' U R)

U' (R U²' R') U² (R U' R')

Reposition Edge and Flip Corner

d (R' U' R U')(R' U' R)
y² U' (L U') d' (L' U' L)

U' (R U²' R') d (R' U' R)

d (R' U R U')(R' U' R)
y' U (R' U R U')(R' U' R)

Split Pair by Going Over (15-18)

y' (R' U R U') d' (R U R')
y (L' U L) U² y (R U R')

(R U² R') U' (R U R')

Pair Made on Side (19-22)

U (R U² R') U (R U' R')

U² (R U R' U)(R U' R')

Weird (23-24)

(R U R' U') U' (R U R' U')(R U R')
U² R² U² (R' U' R U') R²

Corner in Place, Edge in U Face (25-30)

d' (L' U L) d (R U' R')
y U' (L' U' L) U (F U F')
U' (F' U F) U (R U' R')

U (R U' R') d' (L' U L)
U (R U' R') U' (F' U F)

(R U' R' U)(R U' R')

y' (R' U R U')(R' U R)
(R U' R') U² (F' U F)

y' (R' U' R U)(R' U' R)

(R U R' U')(R U R')

Edge in Place, Corner in U face (31-36)

(R U' R') d (R' U R)
(R U' R' U)(F' U F)

(R U R' U')(R U R' U')(R U R')

Orient Last Layer

Red = R U R' U' Family, Green = R U R' U Family, Blue = R F' R' F Family
Try to recognize each pattern by viewing the fewest number of faces

All Edges Oriented Correctly (OCLL1-OCLL8) (second part of three look last layer)

(R U R' U) R U² R'
OCLL1 - 27 - Probability = 1/54

R U² R' U' R U' R'
OCLL2 - 26 - Probability = 1/54

[f (R U R' U') f'] [F (R U R' U') F']
R U²' R²' U' R² U' R²' U² R
OCLL3 - 22 - Probability = 1/54

F (R U R' U') (R U R' U') (R U R' U') F'
y (R' U' R) U' (R' U R) U' (R' U² R)
OCLL4 - 21 - Probability = 1/108

(r U R' U') (r' F R F')
OCLL5 - 24 - Probability = 1/54

F' (r U R' U') (r' F R)
OCLL6 - 25 - Probability = 1/54

R² [D (R' U² R) [D' (R' U² R')]
OCLL7 - 23 - Probability = 1/54

Solved
OCLL8 - 58 - Probability = 1/216

Corners Correct, Edges Flipped (E1-E2)

(R U R' U') M' (U R U' r')
E1 - 57 - Probability = 1/108

M' U M U² M' U M
E2 - 28 - Probability = 1/54

P-Shapes (P1-P4)

f (R U R' U') f'
P1 - 44 - Probability = 1/54

f' (L' U' L U) f
P2 - 43 - Probability = 1/54

R U B' U' R' U R B R'
R d L' d' R' U R B R'
P3 - 32 - Probability = 1/54

R' U' F U R U' R' F' R
y² L' d' R d L U' L' B' L
P4 - 31 - Probability = 1/54

W-Shapes (W1-W2)

(R U R' U) (R U' R' U') (R' F R F')
W1 - 38 - Probability = 1/54

(L' U' L U') (L' U L U) (L F' L' F)
W2 - 36 - Probability = 1/54

Squares (S1-S2)

r U² R' U' R U' r'
S1 - 6 - Probability = 1/54

r' U² (R U R' U) r
S2 - 5 - Probability = 1/54

L Shapes (L1-L6)

F (R U R' U') (R U R' U') F'
L1 - 48 - Probability = 1/54

F' (L' U' L U) (L' U' L U) F
L2 - 47 - Probability = 1/54

r' U' L U' L' U L U' L' U² l
y² r' U' R U' R' U R U' R' U² r
L3 - 53 - Probability = 1/54

(r U R' U) R U' R' U R U²' r'
L4 - 54 - Probability = 1/54

(R' F R' F') R² U² y (R' F R F')
L5 - 49 - Probability = 1/54

R' F R² B' R²' F' R² B R'
L6 - 50 - Probability = 1/54

Fish Shapes (F1-F4)

(R' U' R) y' x' (R U') (R' F) (R U R')
(R U R' U') R' F R² U R' U' F'
F1 - 9 - Probability = 1/54

R U R' y R' F R U' R' F' R
(R U R' U) (R' F R F') R U² R'
F2 - 10 - Probability = 1/54

(R U² R') (R' F R F') (R U² R')
F3 - 35 - Probability = 1/54

F R U' R' U' R U R' F'
F4 - 37 - Probability = 1/54

Awkward Shapes (A1-A4)

R² U R' B' R U' R² U R B R'
A1 - 30 - Probability = 1/54

(R U R' U') R U' R' F' U' F R U R'
F (R U R' U') F' U² [(R U R' U') (R' F R F')]
A2 - 29 - Probability = 1/54

[(R U R' U) R U² R'] [F (R U R' U') F']
A3 - 41 - Probability = 1/54

[R' U² (R U R' U) R] y [F (R U R' U') F']
(R' F R F') (R' F R F') (R U R' U') (R U R')
A4 - 42 - Probability = 1/54

Lightning Bolts (L1-L6)

(r U R' U) R U² r'
L1 - 7 - Probability = 1/54

r' U' R U' R' U² r
L2 - 8 - Probability = 1/54

[F' (L' U' L U) F] y [F (R U R' U') F']
y (r U R' U) (R' F R F') R U² r'
L3 - 11 - Probability = 1/54

[F (R U R' U') F'] U [F (R U R' U') F']
L4 - 12 - Probability = 1/54

R B' R' U' R U B U' R'
y² L F' (L' U' L U) F U' L'
L5 - 39 - Probability = 1/54

R' [F (R U R' U') F'] U R
L6 - 40 - Probability = 1/54

T-Shapes (T1-T2)

F (R U R' U') F'
T1 - 45 - Probability = 1/54

(R U R' U') (R' F R F')
T2 - 33 - Probability = 1/54

C-Shapes (C1-C2)

R' U' (R' F R F') U R
C1 - 46 - Probability = 1/54

(R U R² U') (R' F) (R U) (R U') F'
(R U R' U') x D' R' U R U' D x'
C2 - 34 - Probability = 1/54

I Shapes (I1-I4)

R' U² R² U R' U R U² x' U' R' U
I1 - 55 - Probability = 1/108

(R U R' U) R d' R U' R' F'
R' U' R U' R' d R' U R B
I2 - 52 - Probability = 1/54

F (R U R' U') R F' (r U R' U') r'
I3 - 56 - Probability = 1/108

f (R U R' U') (R U R' U') f'
I4 - 51 - Probability = 1/54

Knight Move Shapes (K1-K4)

(r U r') (R U R' U') (r U' r')
K1 - 16 - Probability = 1/54

(l' U' l) (L' U' L U) (l' U l)
K2 - 15 - Probability = 1/54

F U R U' R² F' R (U R U' R')
K3 - 13 - Probability = 1/54

R' F R U R' F' R y' R U' R'
K4 - 14 - Probability = 1/54

No Edges Flipped Correctly (O1-O8)

R U² R' (R' F R F') U² (R' F R F')
O1 - 1 - Probability = 1/108

[F (R U R' U') F'] [f (R U R' U') f']
O2 - 2 - Probability = 1/54

[f (R U R' U') f'] U' [F (R U R' U') F']
O3 - 3 - Probability = 1/54

[f (R U R' U') f'] U [F (R U R' U') F']
O4 - 4 - Probability = 1/54

[F (R U R' U) F'] y' U² (R' F R F')
O5 - 18 - Probability = 1/54

M U (R U R' U') M' (R' F R F')
O6 - 19 - Probability = 1/54

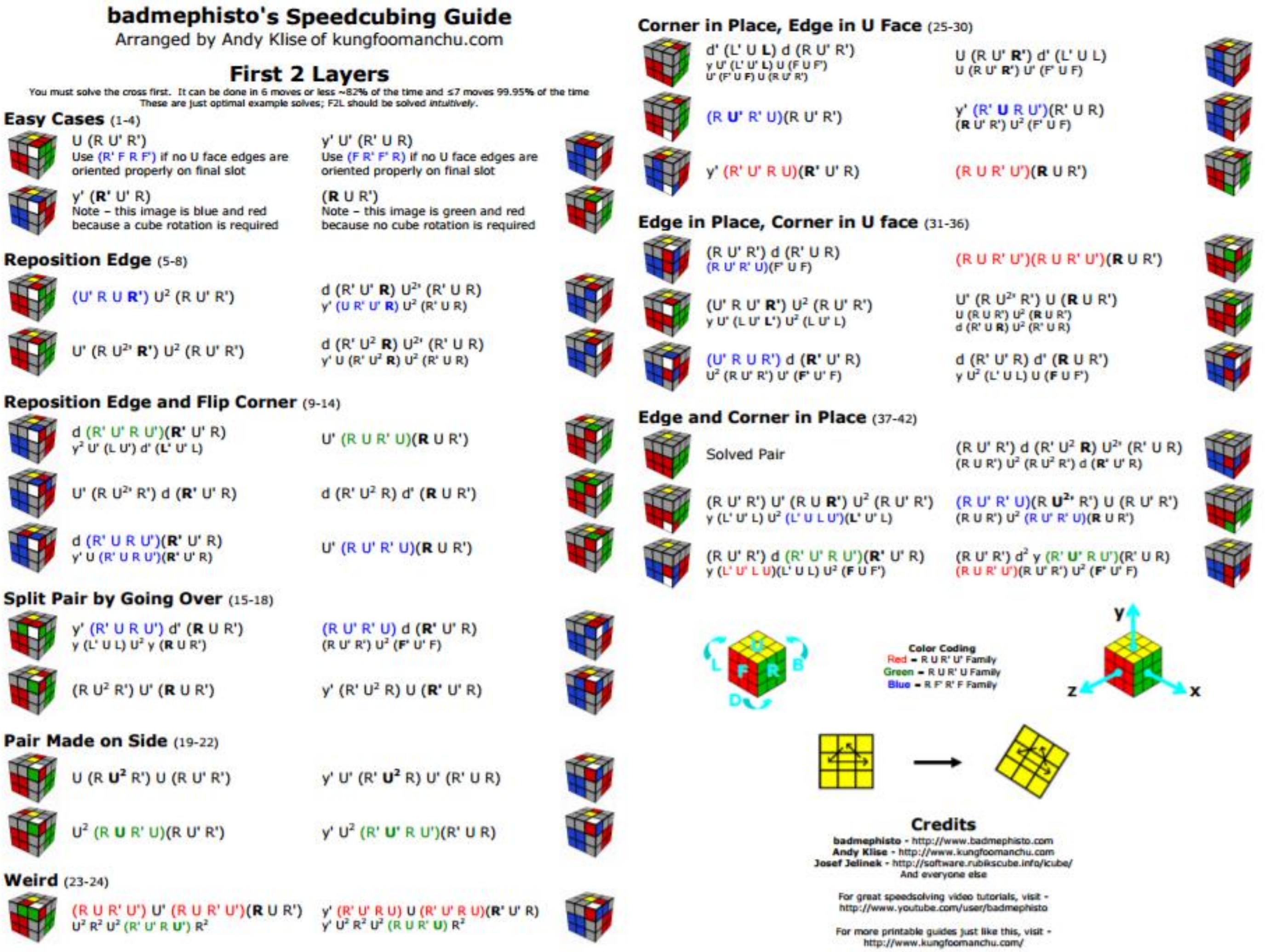
(R U R' U) (R' F R F') U² (R' F R F')
O7 - 17 - Probability = 1/54

M U (R U R' U') M² (U R U' r')
O8 - 20 - Probability = 1/216

For great speedsolving video tutorials, visit - http://www.badmephisto.com or http://www.youtube.com/user/badmephisto

For more printable guides just like this, visit - http://www.kungfoomanchu.com

- Algorithms to be stored in long term memory
- ‘muscle memory’
- Working memory is very limited in capacity



badmephisto's Speedcubing Guide

Arranged by Andy Klise of kungfoomanchu.com

First 2 Layers

You must solve the cross first. It can be done in 6 moves or less ~82% of the time and ≤7 moves 99.95% of the time
These are just optimal example solves; F2L should be solved *intuitively*.

Easy Cases (1-4)

U (R U' R')
Use (R' F R F') if no U face edges are oriented properly on final slot

y' U' (R' U R)
Use (F R' F' R) if no U face edges are oriented properly on final slot

y' (**R'** U' R)
Note – this image is blue and red because a cube rotation is required

(**R** U R')
Note – this image is green and red because no cube rotation is required

Reposition Edge (5-8)

(U' R U **R'**) U^2 (R U' R')

d (R' U' **R**) $U^{2'}$ (R' U R)
y' (U R' U' **R**) U^2 (R' U R)

U' (R $U^{2'}$ **R'**) U^2 (R U' R')

d (R' U^2 **R**) $U^{2'}$ (R' U R)
y' U (R' U^2 **R**) U^2 (R' U R)

Reposition Edge and Flip Corner (9-14)

d (R' U' R U')(**R'** U' R)
y^2 U' (L U') d' (**L'** U' L)

U' (R U R' U)(**R** U R')

U' (R $U^{2'}$ R') d (**R'** U' R)

d (R' U^2 R) d' (**R** U R')

d (R' U R U')(**R'** U' R)
y' U (R' U R U')(**R'** U' R)

U' (R U' R' U)(**R** U R')

Split Pair by Going Over (15-18)

y' (R' U R U') d' (**R** U R')
y (L' U L) U^2 y (**R** U R')

(R U' R' U) d (**R'** U' R)
(R U' R') U^2 (**F'** U' F)

(R U^2 R') U' (**R** U R')

y' (R' U^2 R) U (**R'** U' R)

Pair Made on Side (19-22)

U (R **U^2** R') U (R U' R')

y' U' (R' **U^2** R) U' (R' U R)

U^2 (R **U** R' U)(R U' R')

y' U^2 (R' **U'** R U')(R' U R)

Weird (23-24)

(R U R' U') U' (R U R' U')(**R** U R')
U^2 R^2 U^2 (R' U' R **U'**) R^2

y' (R' U' R U) U (R' U' R U)(**R'** U' R)
y' U^2 R^2 U^2 (R U R' **U**) R^2

Corner in Place, Edge in U Face (25-30)

d' (L' U **L**) d (R U' R')
y U' (L' U' **L**) U (F U F')
U' (F' U **F**) U (R U' R')

U (R U' **R'**) d' (L' U L)
U (R U' **R'**) U' (F' U F)

(R **U'** R' U)(R U' R')

y' (R' **U** R U')(R' U R)
(**R** U' R') U^2 (F' U F)

y' (R' U' R U)(**R'** U' R)

(R U R' U')(**R** U R')

Edge in Place, Corner in U face (31-36)

(R U' R') d (R' U R)
(R U' R' U)(F' U F)

(R U R' U')(R U R' U')(**R** U R')

(U' R U' **R'**) U^2 (R U' R')
y U' (L U' **L'**) U^2 (L U' L)

U' (R $U^{2'}$ R') U (**R** U R')
U (R U R') U^2 (**R** U R')
d (R' U **R**) U^2 (R' U R)

(U' R U R') d (**R'** U' R)
U^2 (R U' R') U' (**F'** U' F)

d (R' U' R) d' (**R** U R')
y U^2 (L' U L) U (**F** U F')

Edge and Corner in Place (37-42)

Solved Pair

(R U' R') d (R' U^2 **R**) $U^{2'}$ (R' U R)
(R U R') U^2 (R U^2 R') d (**R'** U' R)

(R U' R') U' (R U **R'**) U^2 (R U' R')
y (L' U' L) U^2 (L' U L U')(**L'** U' L)

(R U' R' U)(R **$U^{2'}$** R') U (R U' R')
(R U R') U^2 (R U' R' U)(**R** U R')

(R U' R') d (R' U' R U')(**R'** U' R)
y (L' U' L U)(L' U L) U^2 (**F** U F')

(R U' R') d^2 y (R' **U'** R U')(R' U R)
(R U R' U')(R U' R') U^2 (**F'** U' F)

Color Coding
Red = R U R' U' Family
Green = R U R' U Family
Blue = R F' R' F Family

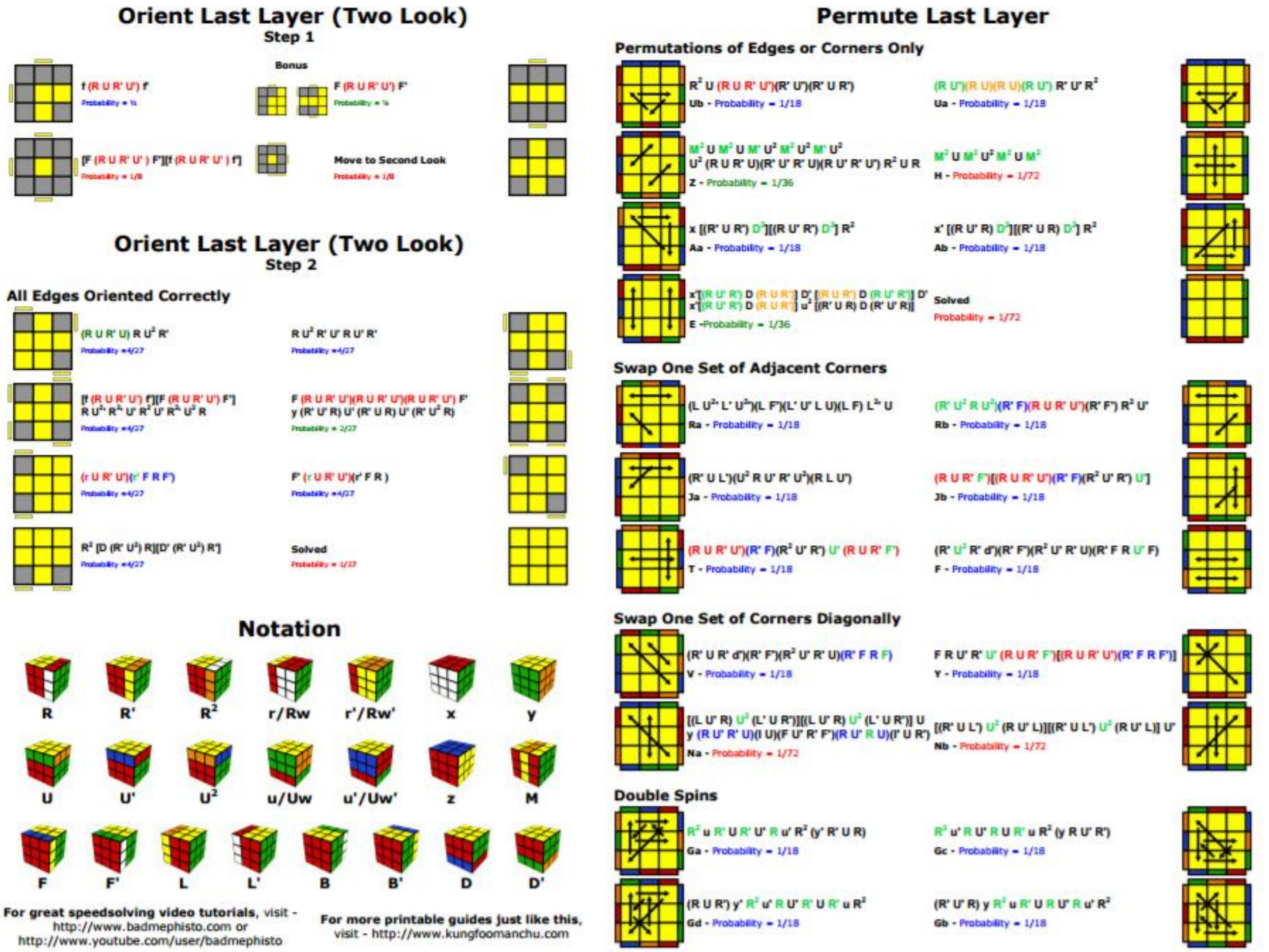
Credits

badmephisto - http://www.badmephisto.com
Andy Klise - http://www.kungfoomanchu.com
Josef Jelinek - http://software.rubikscube.info/icube/
And everyone else

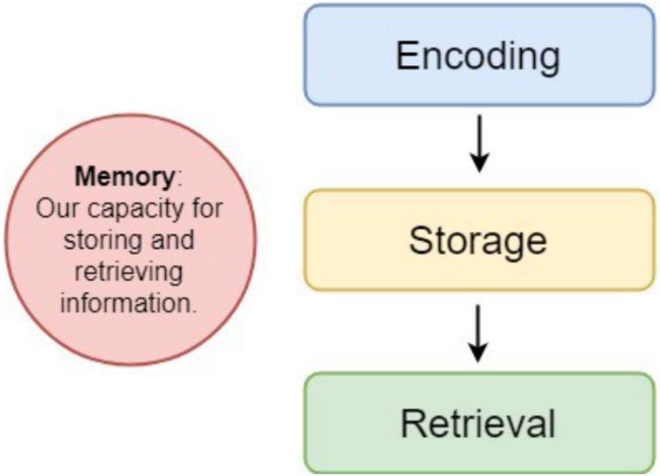
For great speedsolving video tutorials, visit - http://www.youtube.com/user/badmephisto

For more printable guides just like this, visit - http://www.kungfoomanchu.com/

- Algorithms to be stored in long term memory
- ‘muscle memory’
- Working memory is very limited in capacity

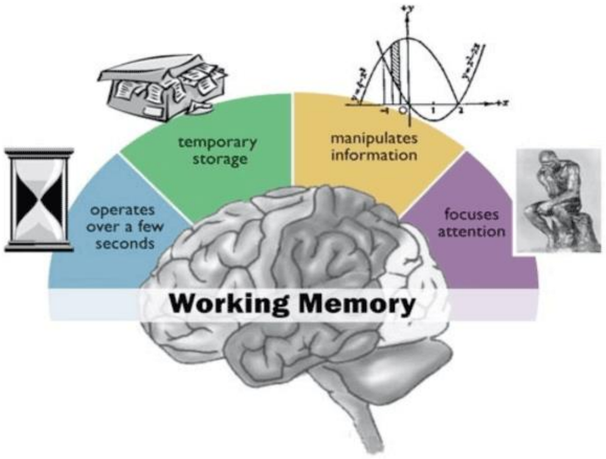


Forming memories



1. ENCODING – acquiring information. Perceive and interpret information
2. CONSOLIDATION & STORAGE – maintaining information. Physical and chemical changes in our brain
3. RETRIEVAL – recalling information. Bring information back to mind.

Types of memory



- LONG TERM MEMORY – store unlimited information for an entire lifetime
- WORKING MEMORY – the processing unit. Used to solve problems. Limited in capacity.

What about understanding?

1. Recognising old from new
2. Link new knowledge to something already known
3. Give meaning to it = understanding. This means we need to retrieve (old) information from long term memory in order to develop understanding

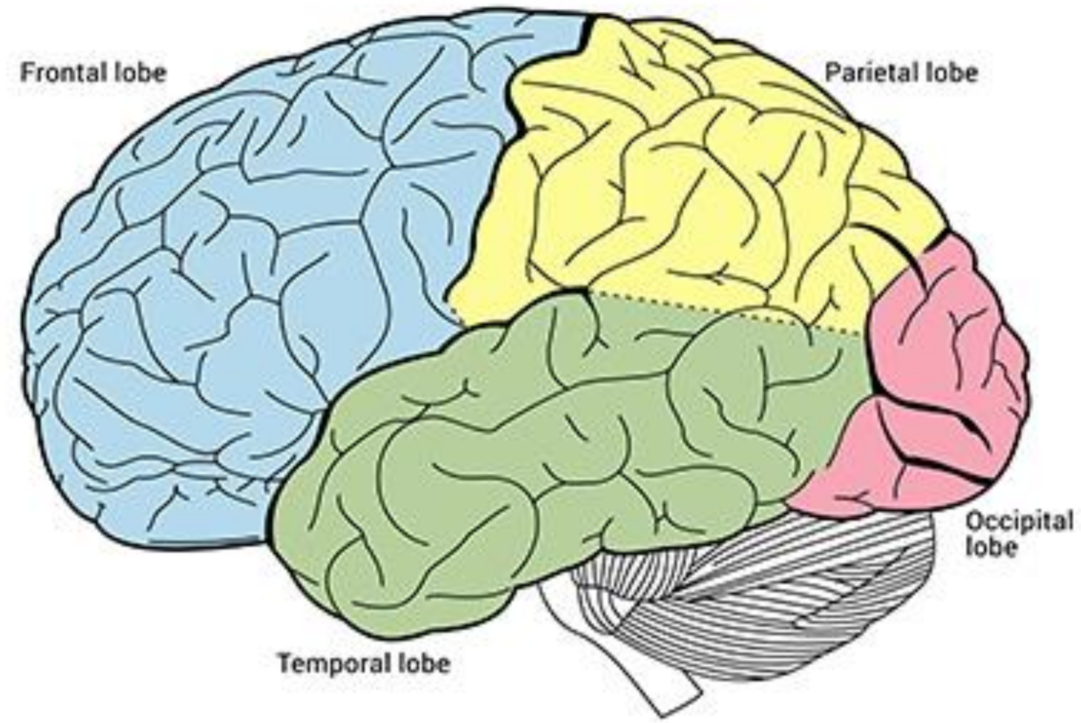
Understanding is making association

1. Recognising old from new
2. Link new knowledge to something already known
3. Give meaning to it = understanding. This means we need to retrieve (old) information from long term memory in order to develop understanding

Neuroscience of learning

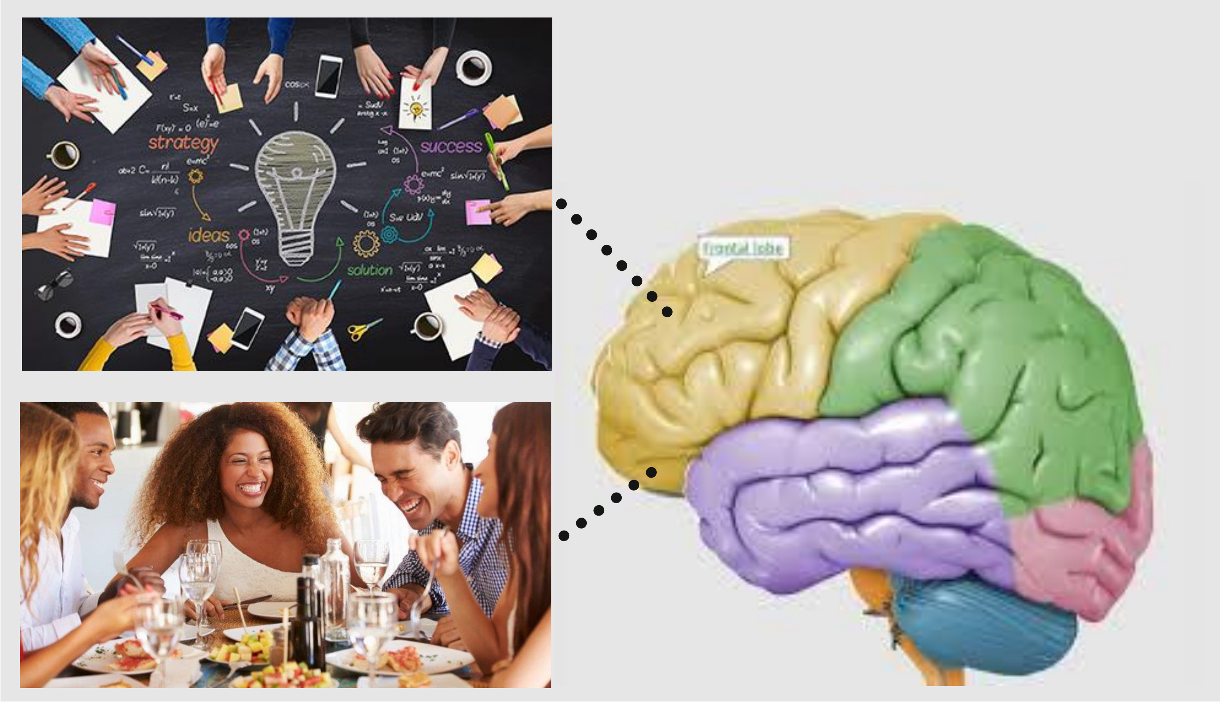
Structure of the brain

- Two cerebral hemispheres
- Four lobes
  - frontal
  - parietal
  - temporal
  - occipital



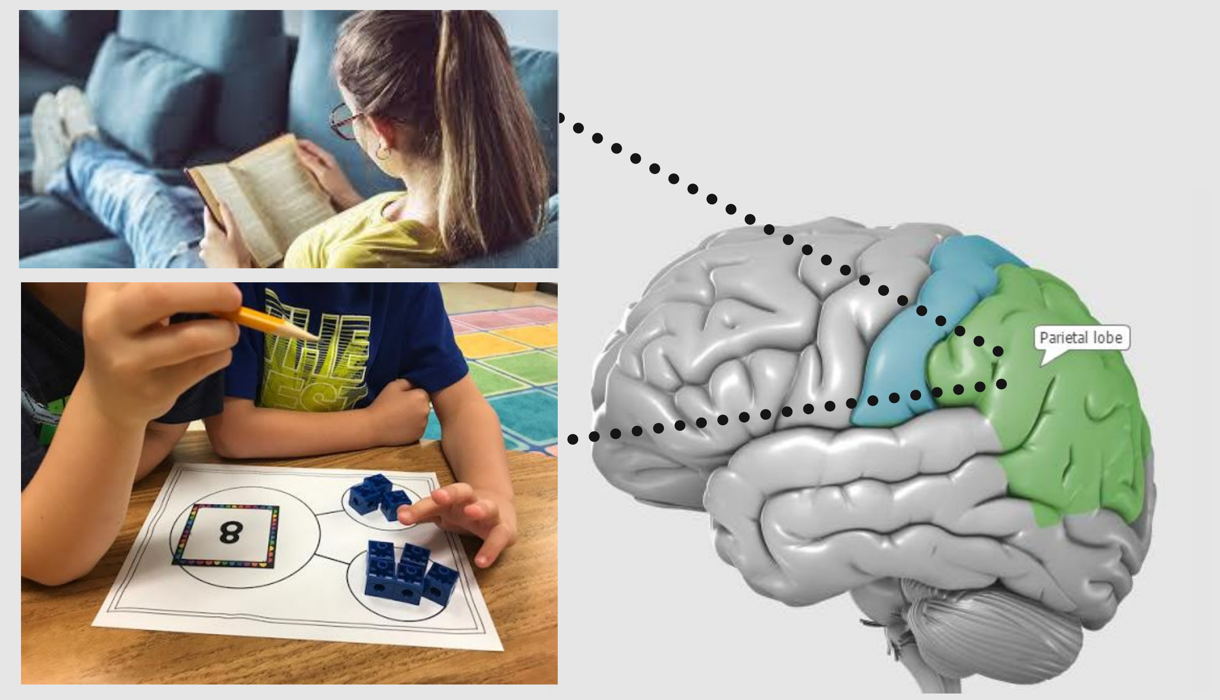
Frontal lobe

- Executive functions
- Problem solving
- Emotional regulation
- Reasoning
- Higher order thinking
- Social interactions
- https://youtu.be/9oRaXZfVJik



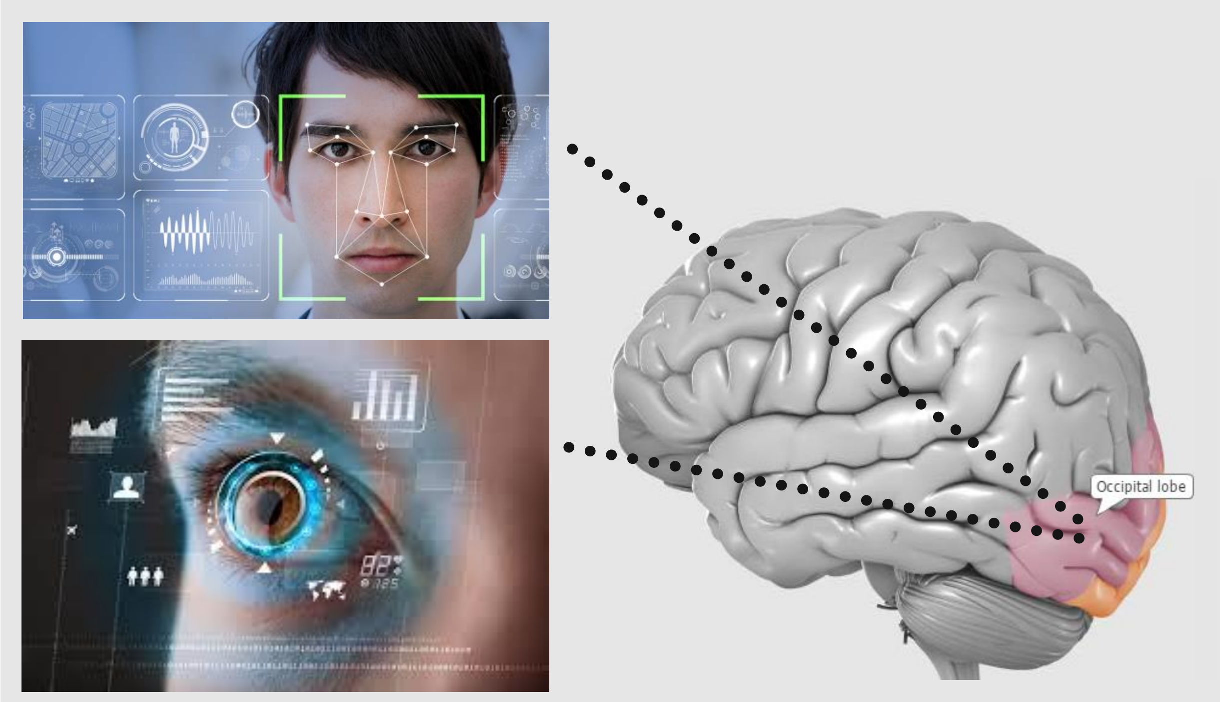
Parietal lobe

- Integrating information
- Visual and spatial processing
- Reading
- Understanding language
- Representing numbers
- https://youtu.be/lyhsdw86y1k



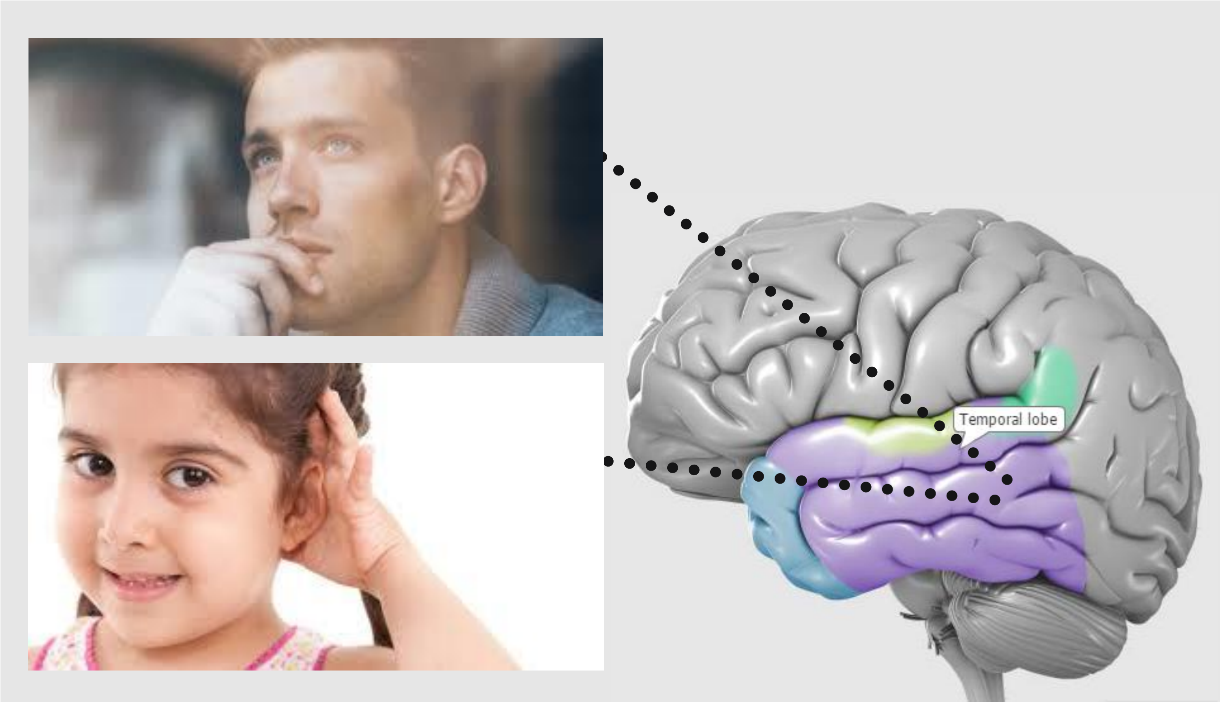
Occipital lobe

- Visual processing
- Object recognition
- Face recognition
- https://youtu.be/uaCm_6B6fhI



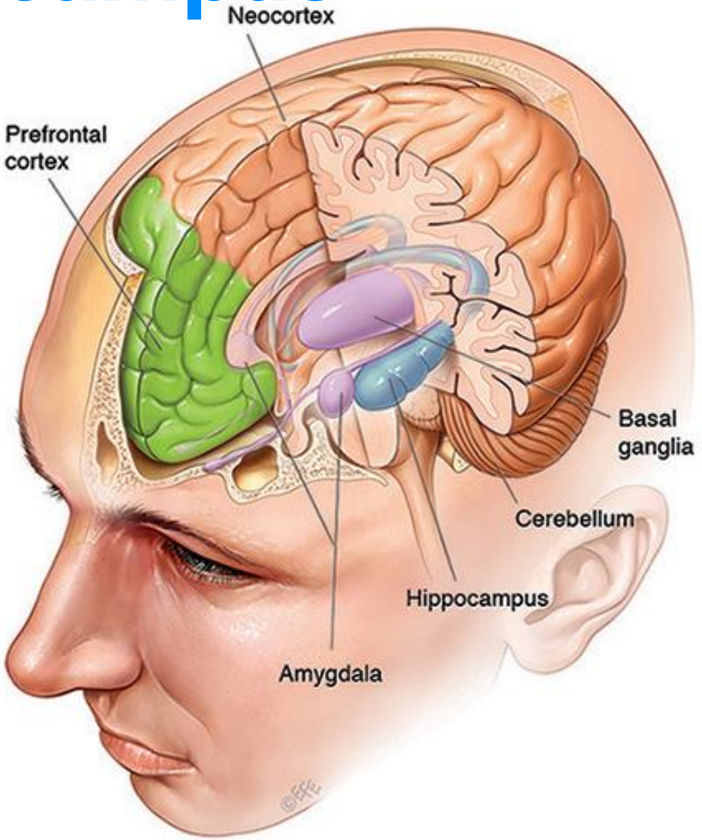
Temporal lobe

- Auditory processing
- Visual processing
- Medial temporal lobe – memory
- Hippocampus
- Pondering
- https://youtu.be/OqJAAV5O8wM



Hippocampus

- Consolidates information
- Stores episodic memories – based on real events
- Semantic memories – facts and information



Put your brain to the test

How quickly can you answer…

2 x 2

7 x 2

4 x 7

7 x 8

17 x 24

What did you just experience?

- Retrieve from memory
- A strain to carry the computation
- Mental work: deliberate, effortful and orderly
- Not just an event of the mind, your body was also involved
- Muscles tensed up
- Your blood pressure rose
- Heart rate increased
- Pupils dilate

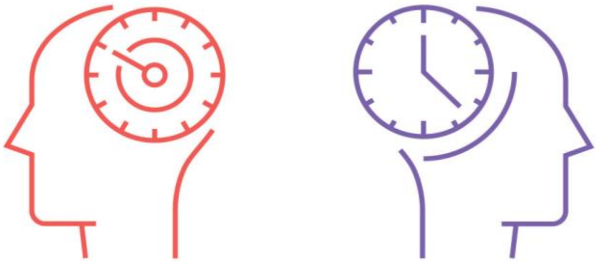
For those of us that need closure…

17 x 24 =

For those of us that need closure…

17 x 24 = 408

System 1 vs System 2



SYSTEM 1
Fast Thinking

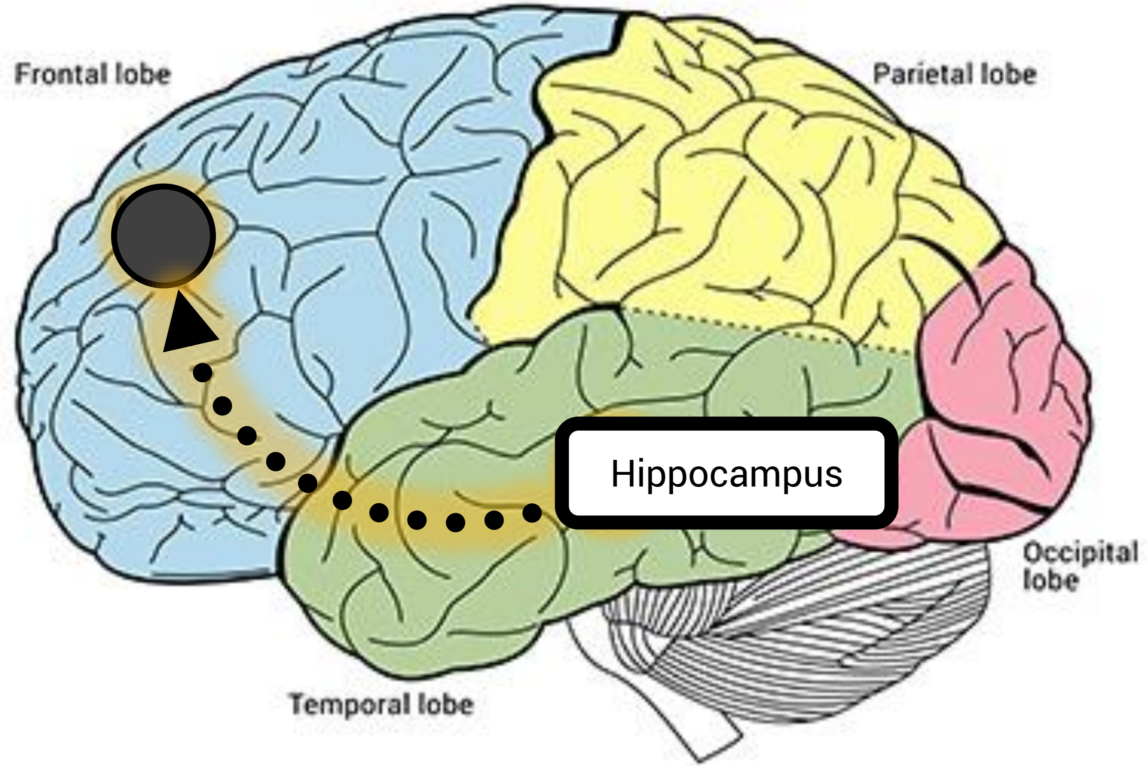
SYSTEM 2
Slow Thinking

- Fast thinking
- Effortless
- Subconscious
- Automatic
- Looks for patterns and causation
- Straightforward cause and effect
- **Declarative memory**
- Hippocampal-frontal circuits

Declarative memory

- Hippocampal-frontal circuits
- Quick recall

1. Forms associative memory
2. Bind new and old information
3. Add to long term memory
4. Generalisation

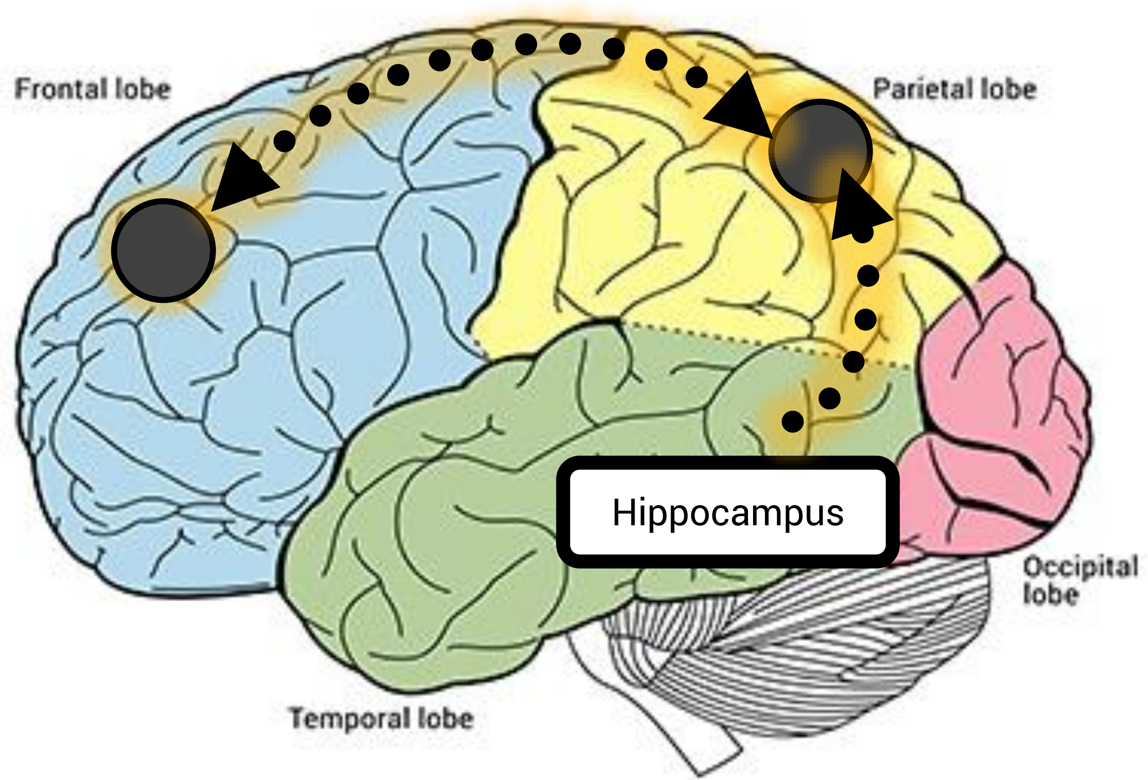


System 1 vs System 2

- Slow thinking
- Effortful, conscious, logical, deliberative
- Can handle creative/abstract concepts
- Problem solving brain
- Requires time, effort and energy
- Can lead to decision fatigue
- Sustained for short period of time
- Starts to feel “too hard”
- **Working memory**

Working memory

- Parietal-frontal circuits
- Manipulation of discrete events



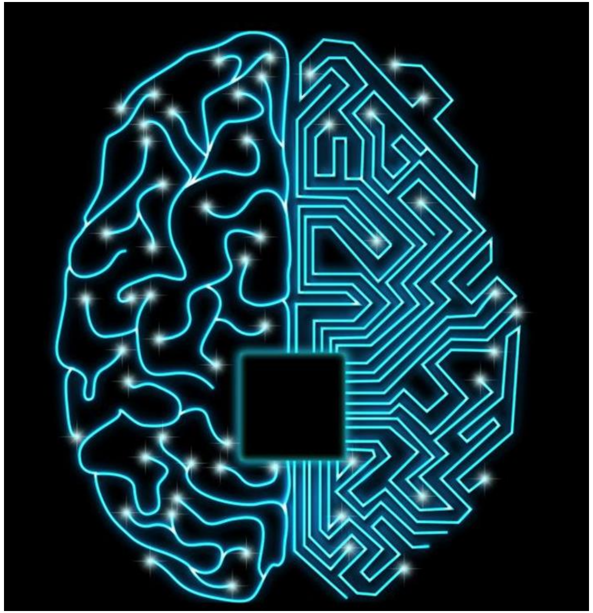
Problem solving

- In young children, problem solving relies on working memory, as even the basic components is not mastered
- Example: counting strategies in simple arithmetic problem solving
- Access multiple working memory components: short term storage, rule-based manipulation, and updating stored contents
- With increased proficiency, shift to fact retrieval strategies, less demand and need for working memory resources

Automaticity

- With automaticity
- Reduces load of working memory
- Does not take up attentional resources
- Allows us to commit to effortful thinking to higher order, more complicated tasks

Circuits in the brain



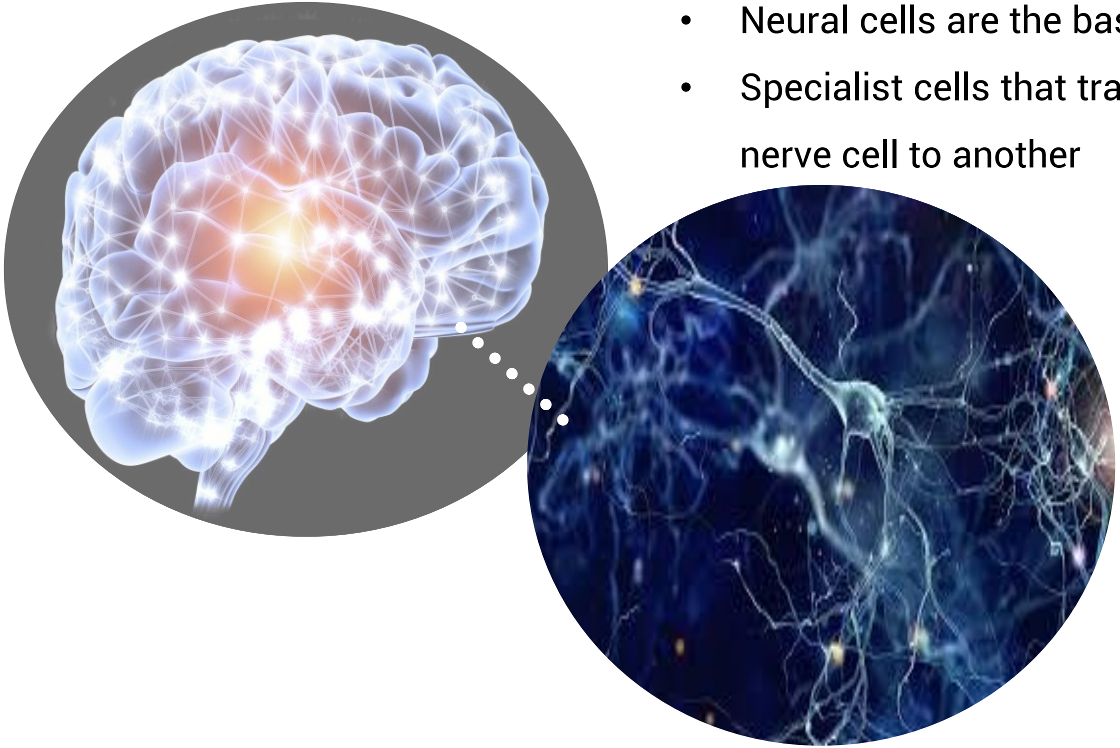
- Cognitive control systems
- Flexible integration of functional circuits
- Guides allocation of attention resources and retrieval of facts from memory
- Goal-directed numerical problem solving

Neurons

- Neural cells are the basic working unit of the brain
- Specialist cells that transmit information from one nerve cell to another

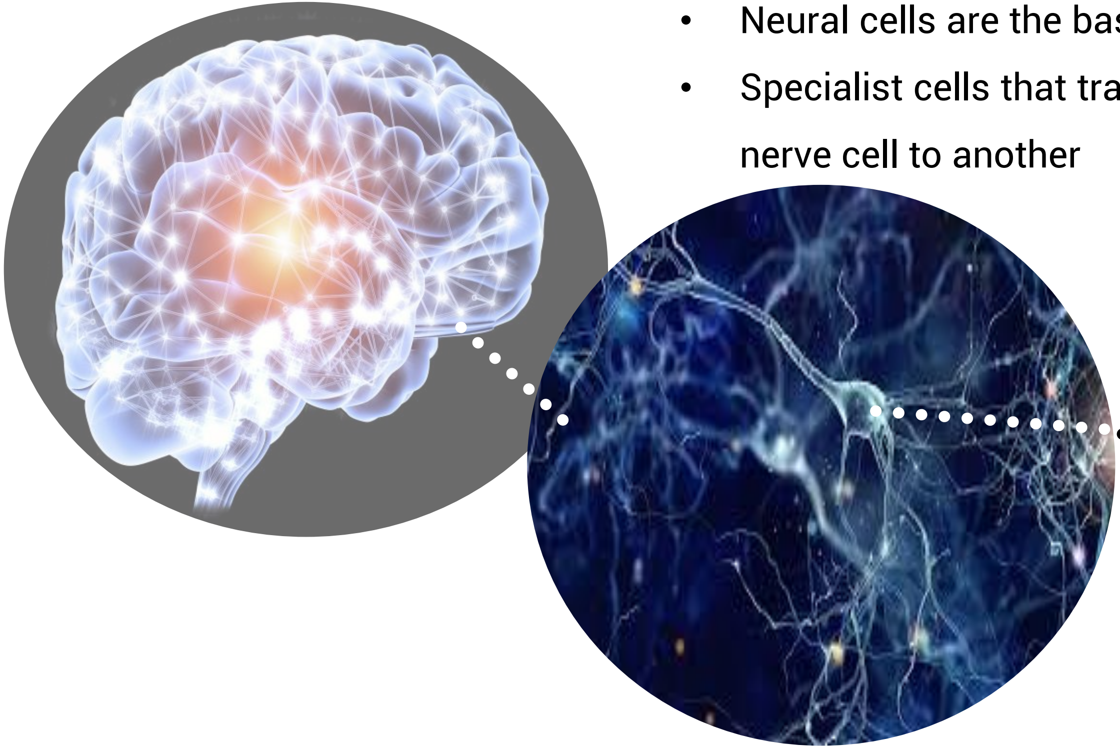
Neurons

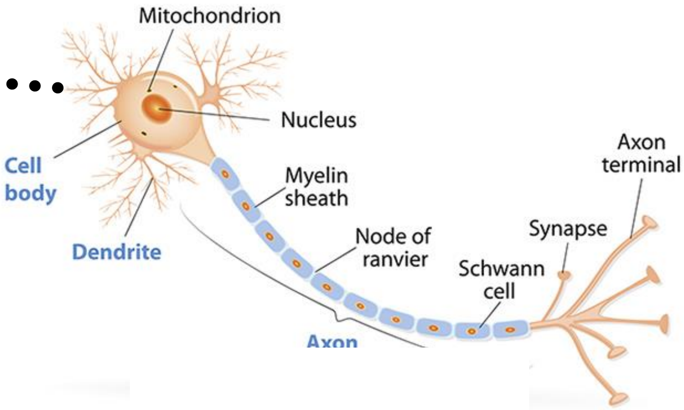
- Neural cells are the basic working unit of the brain
- Specialist cells that transmit information from one nerve cell to another



Neurons

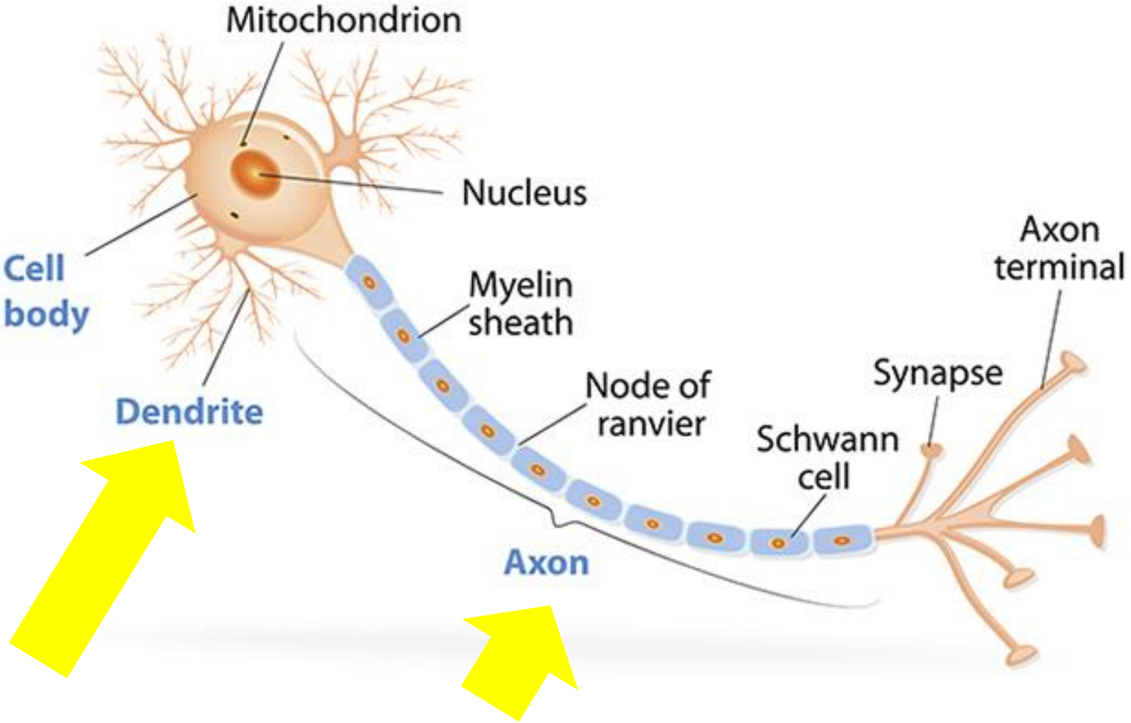
- Neural cells are the basic working unit of the brain
- Specialist cells that transmit information from one nerve cell to another





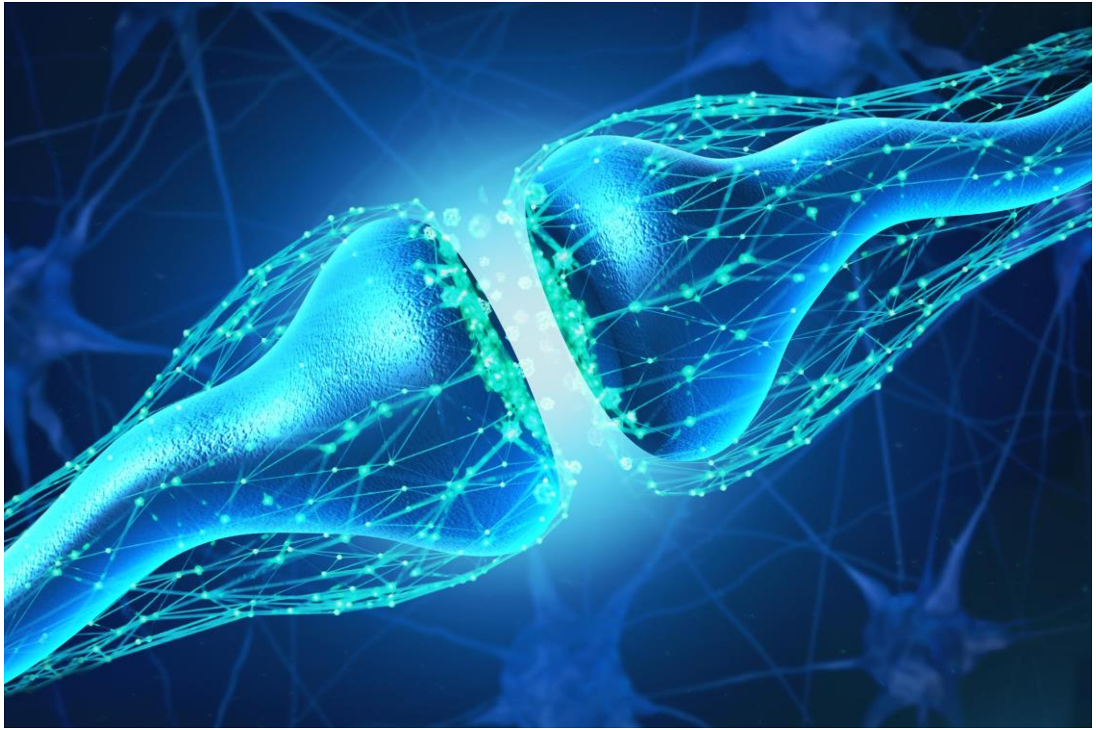
Structure of neuron

- Dendrites and axons
- Communicate with each other through electrochemical processes
- Synapses - point of connection to other neural cells
- Neurotransmitters released to create action potential



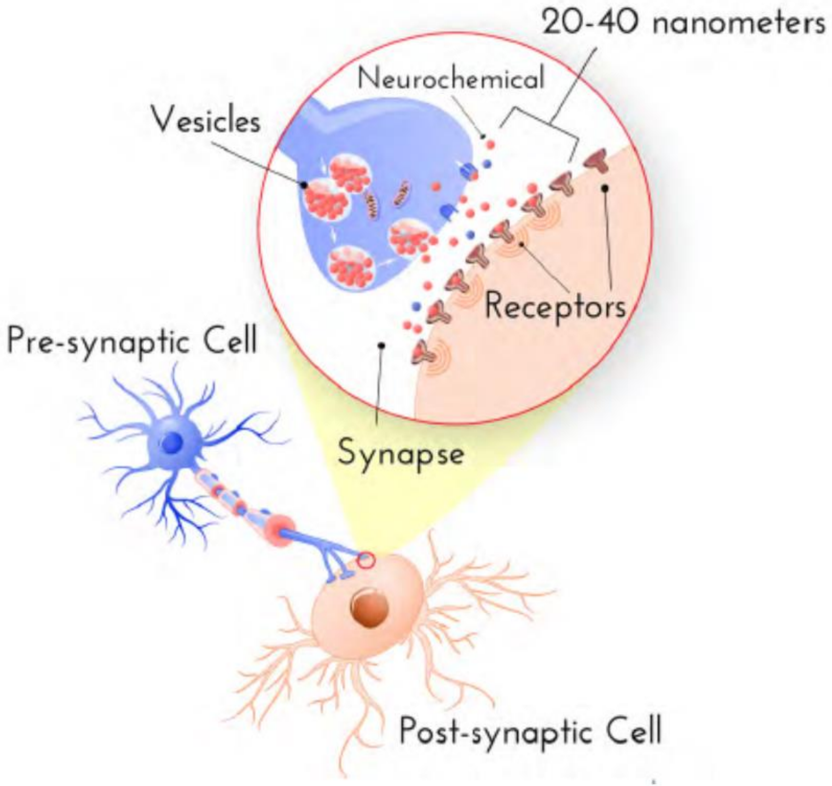
Synapse

- Membrane excitability
- Neurotransmission
- Neuroplasticity
- Neurotransmitters released at the synapse



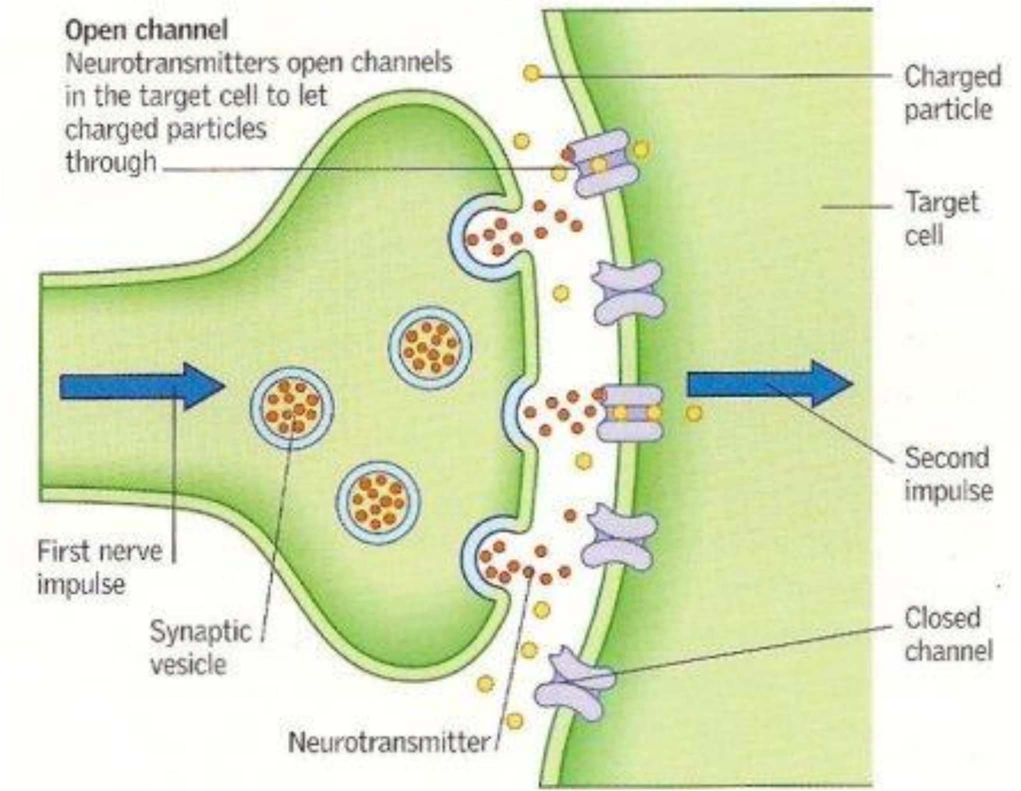
Neurotransmission

- Synaptic transmission
- Release neurotransmitter
- Pre-synaptic and post-synaptic cell
- Power to change the behaviour of both cells
- Excite post-synaptic cell to release it's own neurochemicals



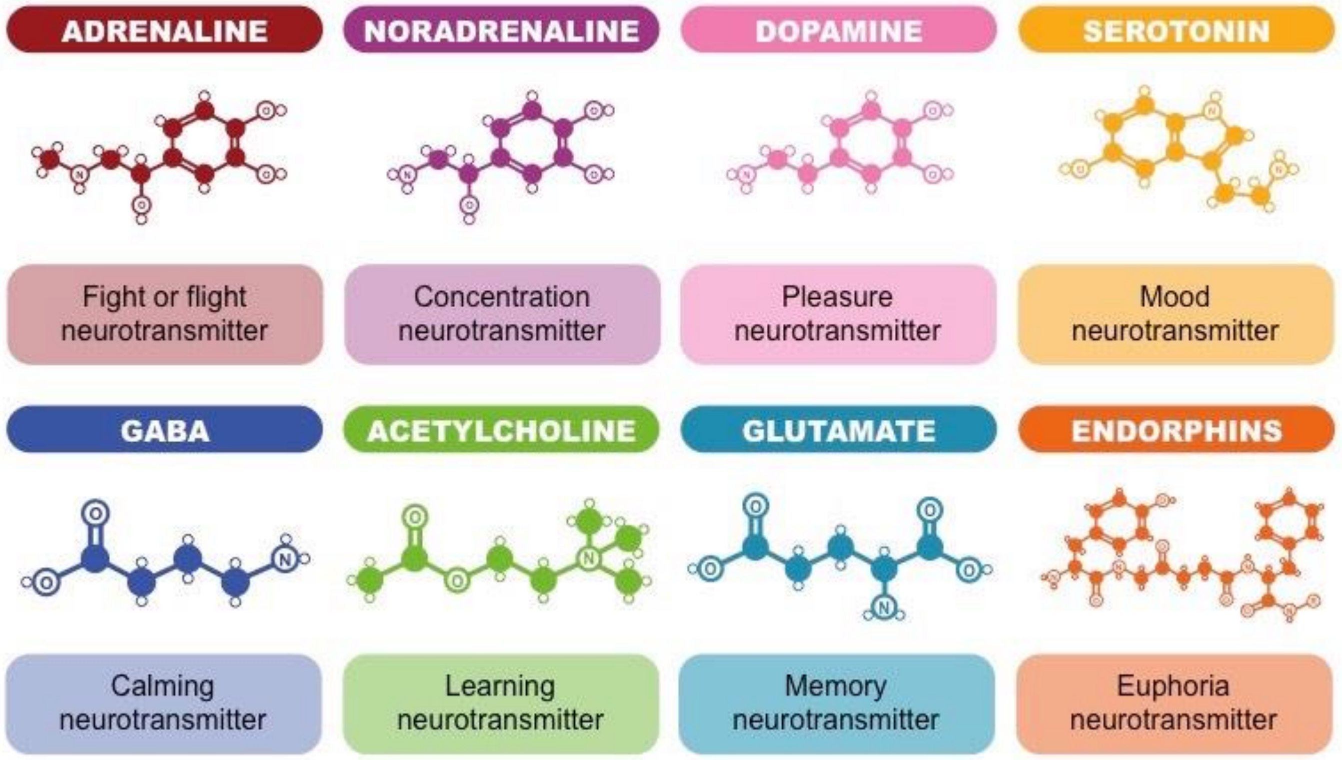
Neurotransmission

- Synaptic transmission
- Release neurotransmitter
- Pre-synaptic and post-synaptic cell
- Power to change the behaviour of both cells
- Excite post-synaptic cell to release it's own neurochemicals

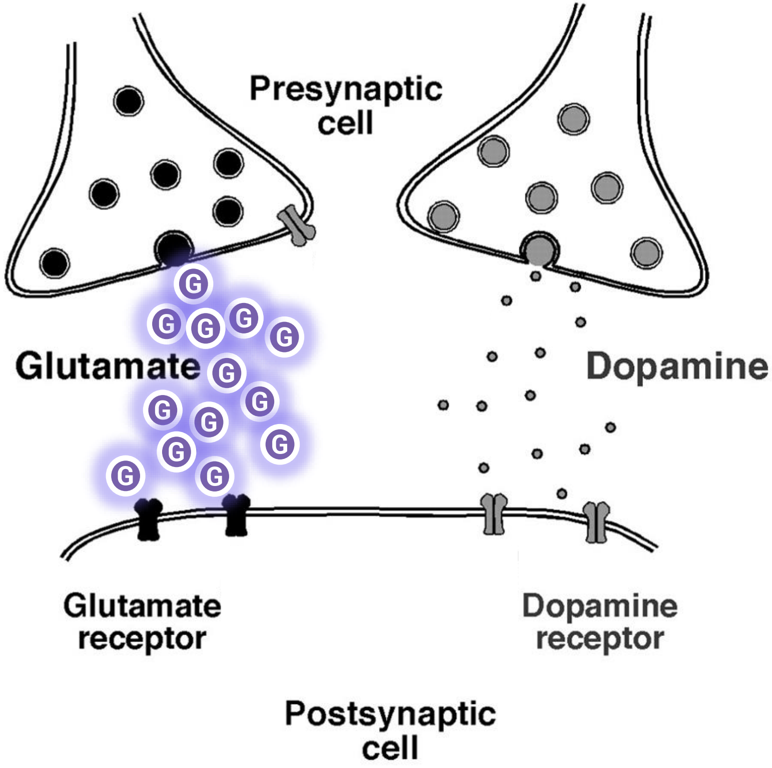


Neurotransmitters

- Chemical messengers
- Glutamate
- Dopamine

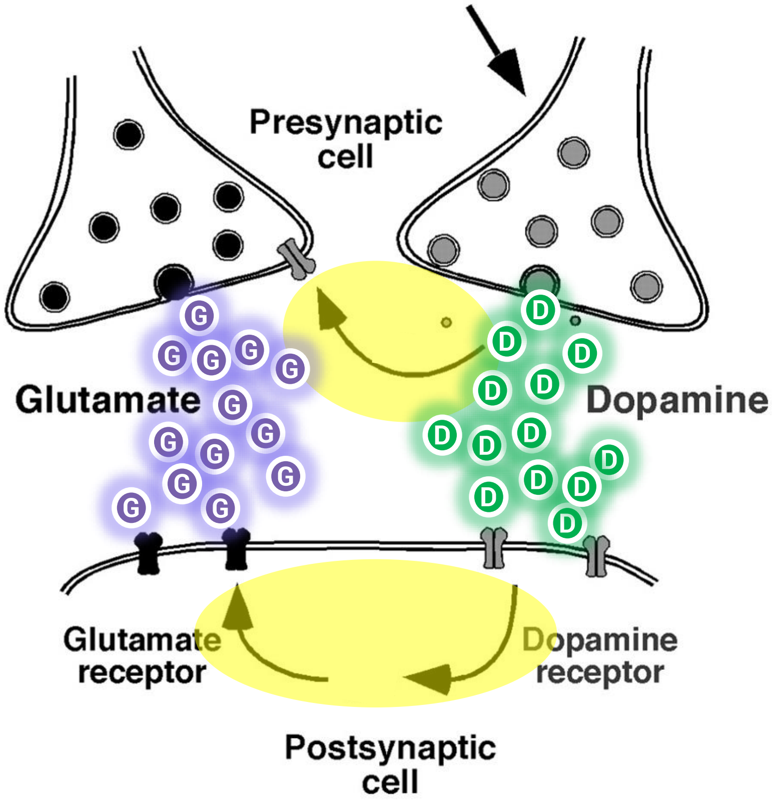


Glutamate



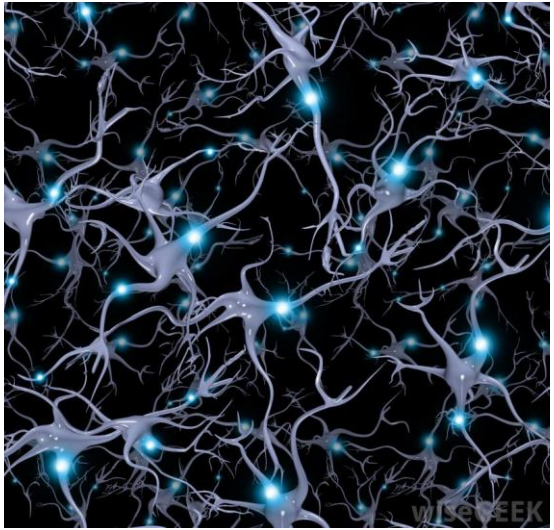
- Body's most prominent neurotransmitter
- Excitatory – excitation of neural cells
- Important for neural communication, memory formation, learning and regulation

Dopamine



- Special kind of neurotransmitter
- ‘regulatory’ or ‘modulatory’ – referring to it’s capability of controlling other neurotransmitters
- Dopamine receptors potentiate glutamate transmission

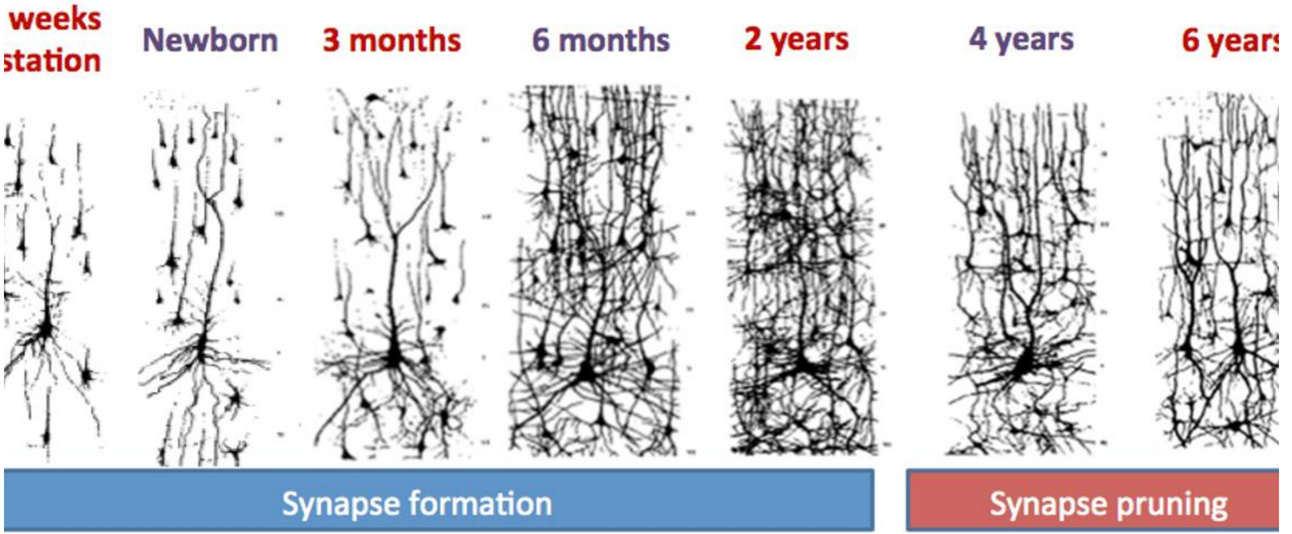
Long term potentiation

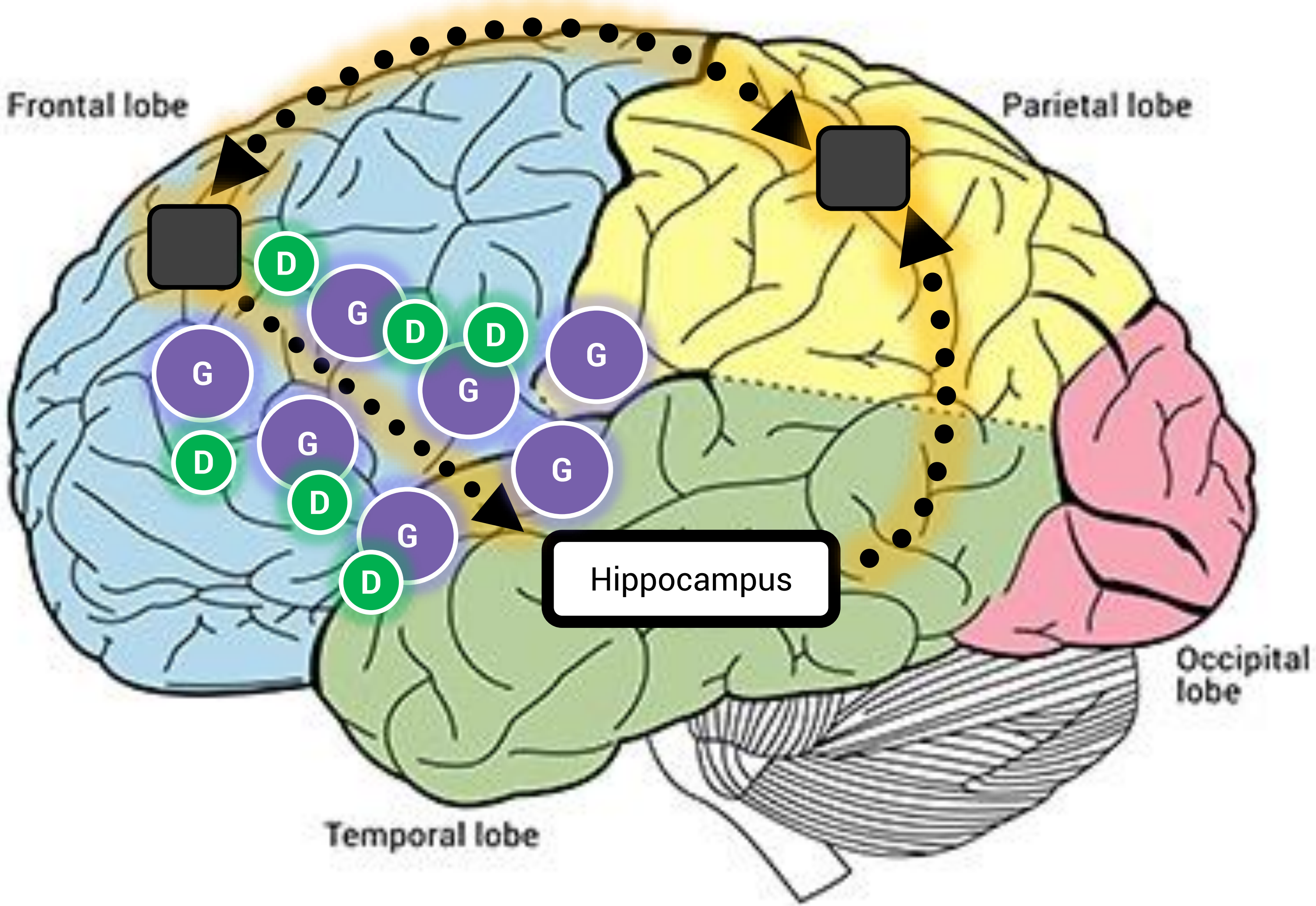


- Mechanism for memory formation and neuroplasticity
- Mechanism of memory formation – activating the same neural pathways over and over
- Persistent strengthening of synapses
- The stronger the synapse, the more influence it can have on neighbouring cells
- Input associativity – relatable (neighbouring) synapses that have weak impulses can LTP together
- Evidence that learning is associative

Long term depression

- Weakening of postsynaptic response
- Weaker structures – synaptic pruning occurs
- Synaptic pruning as a mechanism for specialisation in adolescence




Frontal lobe
Parietal lobe
D
G
D
D
G
G
D
G
G
D
G
D
Hippocampus
Occipital lobe
Temporal lobe

Releasing dopamine

- In anticipation of a reward
- Not just in the state of pleasure
- Change of tasks
- Growth mindset and attitude
- Immediate positive reinforcement
- Generate enthusiasm by making contents exciting and interesting

Attentional resources

- Visual selective attention was assessed
- Brain's ability to focus on relevant visual information, while suppressing less relevant information
- Narrow focus means effective use of energy, improves brain efficiency
- After 1 hour of game play, non-experts had improved
- https://neurosciencenews.com/focus-video-gaming-8513/

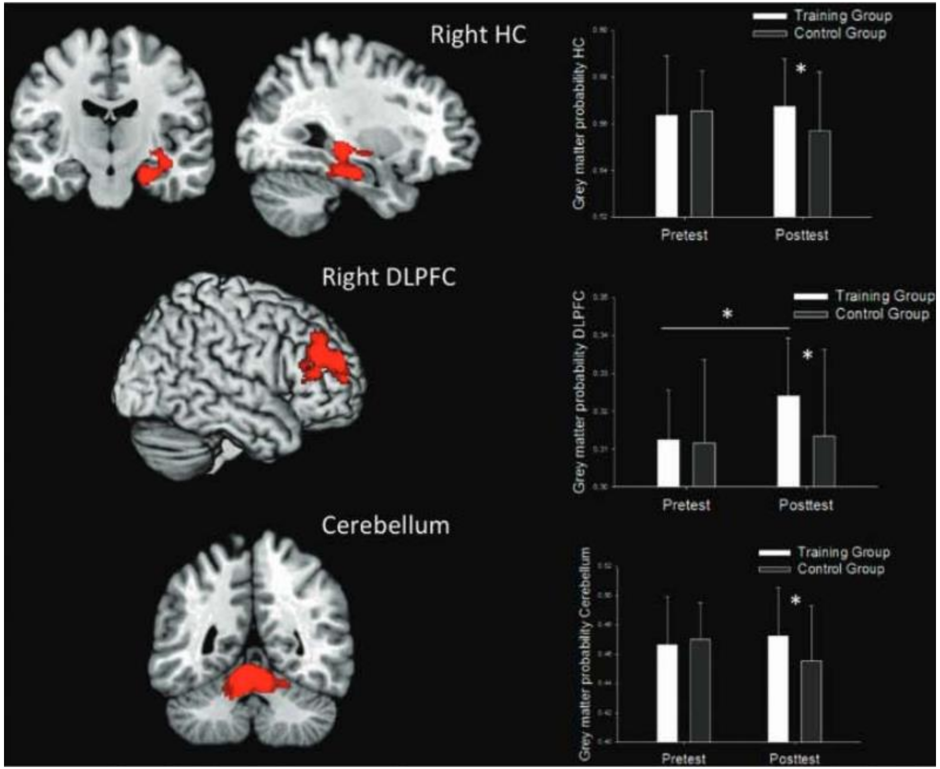
Attentional resources

- Visual selective attention was assessed
- Brain's ability to focus on relevant visual information, while suppressing less relevant information
- Narrow focus means effective use of energy, improves brain efficiency
- After 1 hour of game play, non-experts had improved
- https://neurosciencenews.com/focus-video-gaming-8513/

Increase size in brain regions

Playing Super Mario 64 video game, has shown increased size in brain regions responsible for spatial orientation, memory formation and strategic planning as well as fine motor skills.

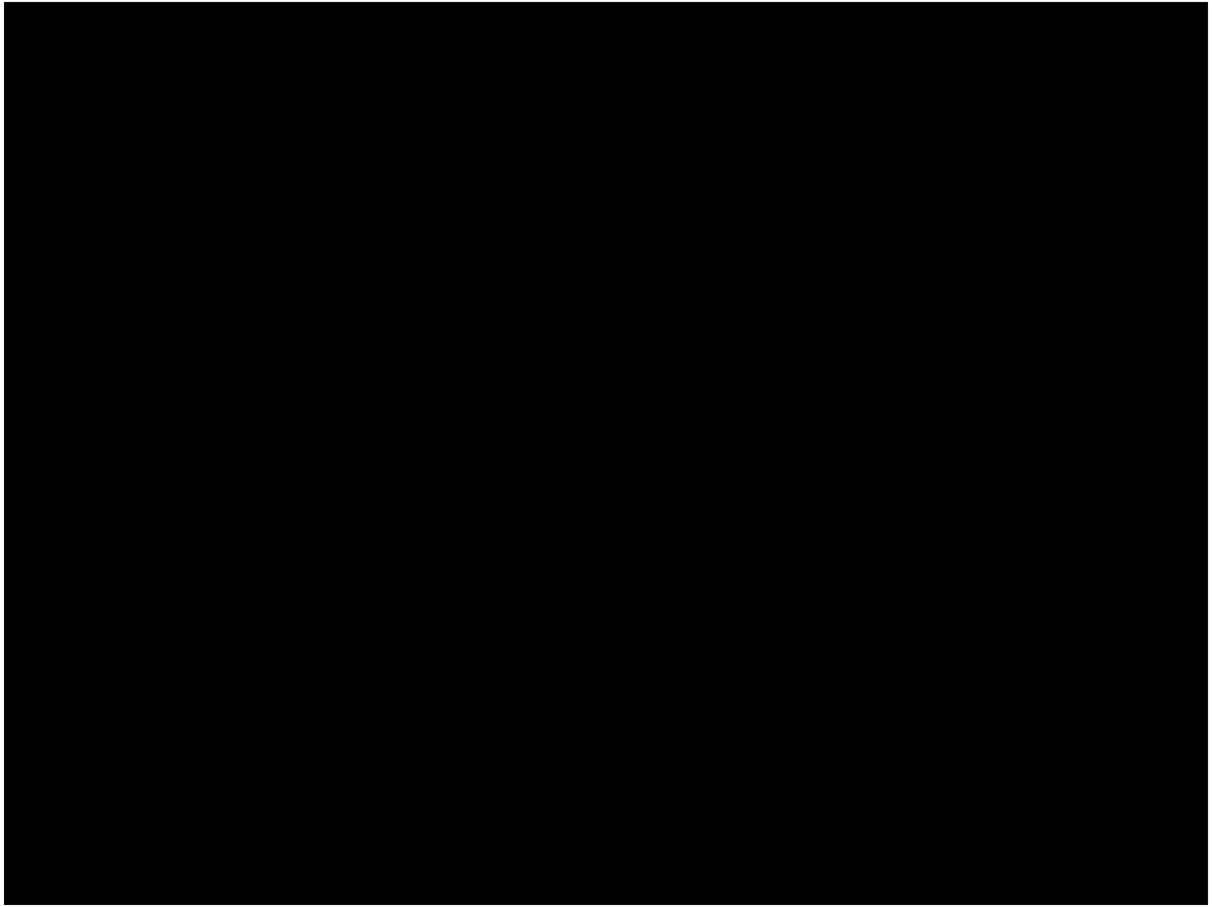
https://www.kurzweilai.net/video-game-playing-found-beneficial-for-the-brain#!prettyPhoto



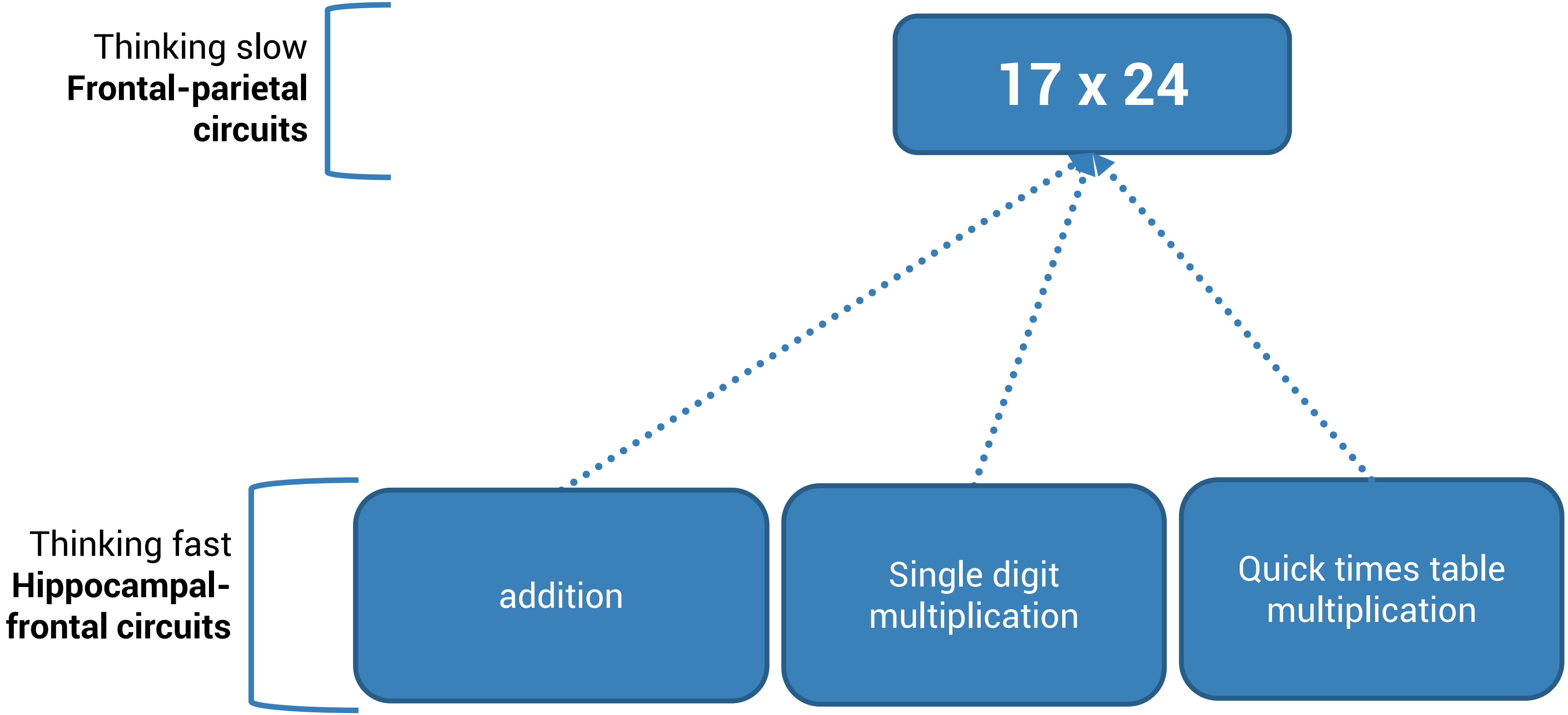
Games technology in maths classrooms

Use games technology

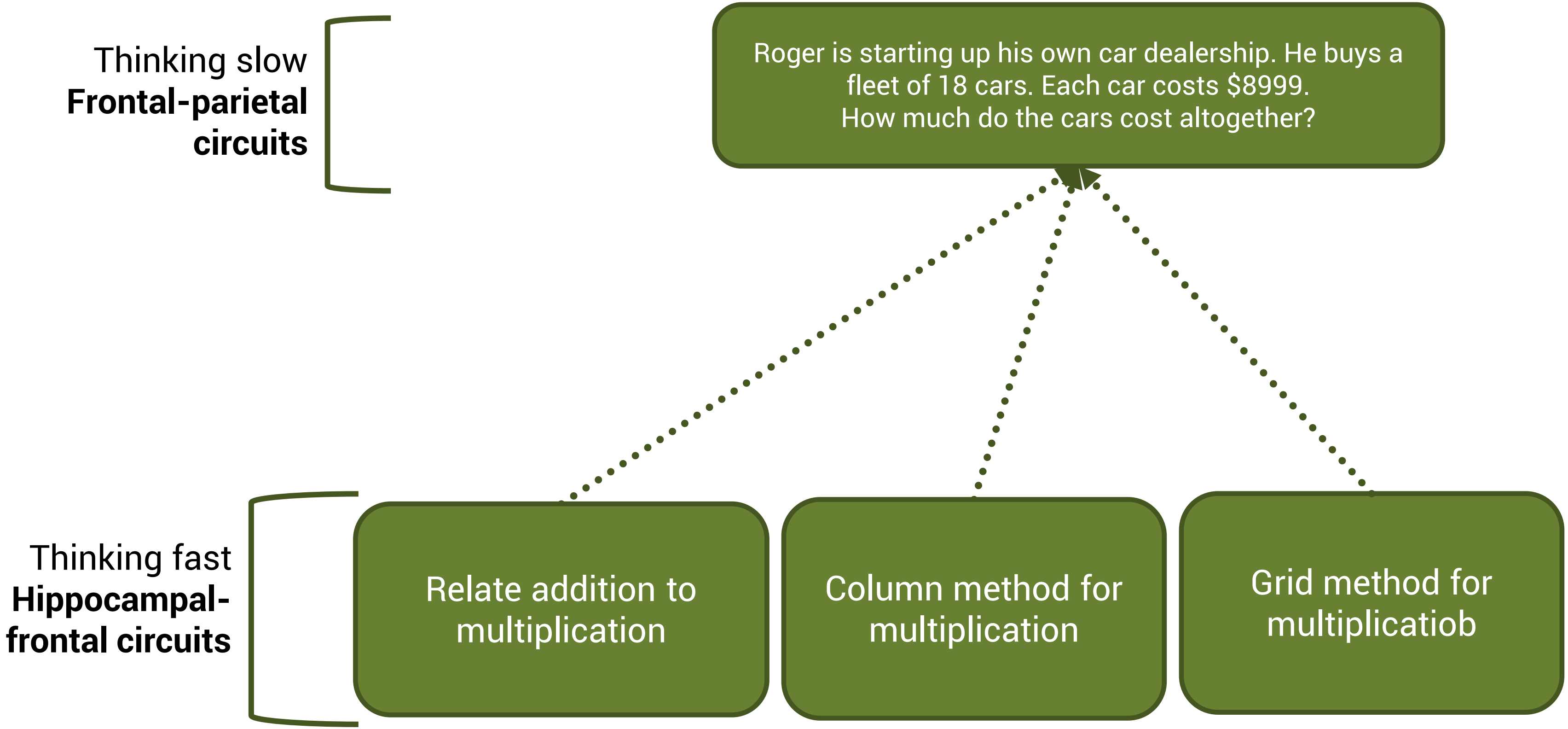
- Build long term memory of lessons
- Use technology for all it's power
- Gradually increase in difficulty



Build on prior knowledge

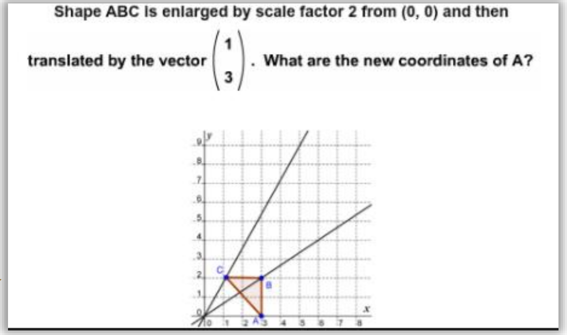


Build on prior knowledge



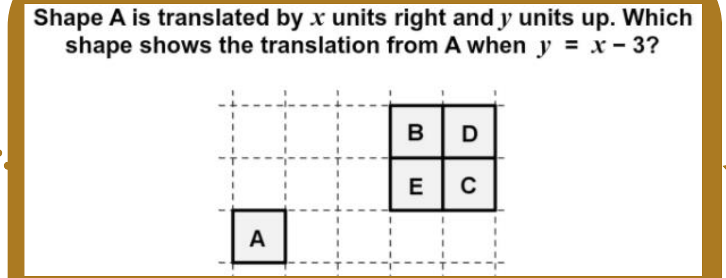
Build on prior knowledge

Thinking slow
Frontal-parietal circuits



Thinking fast
Hippocampal-frontal circuits

Translation with a vector

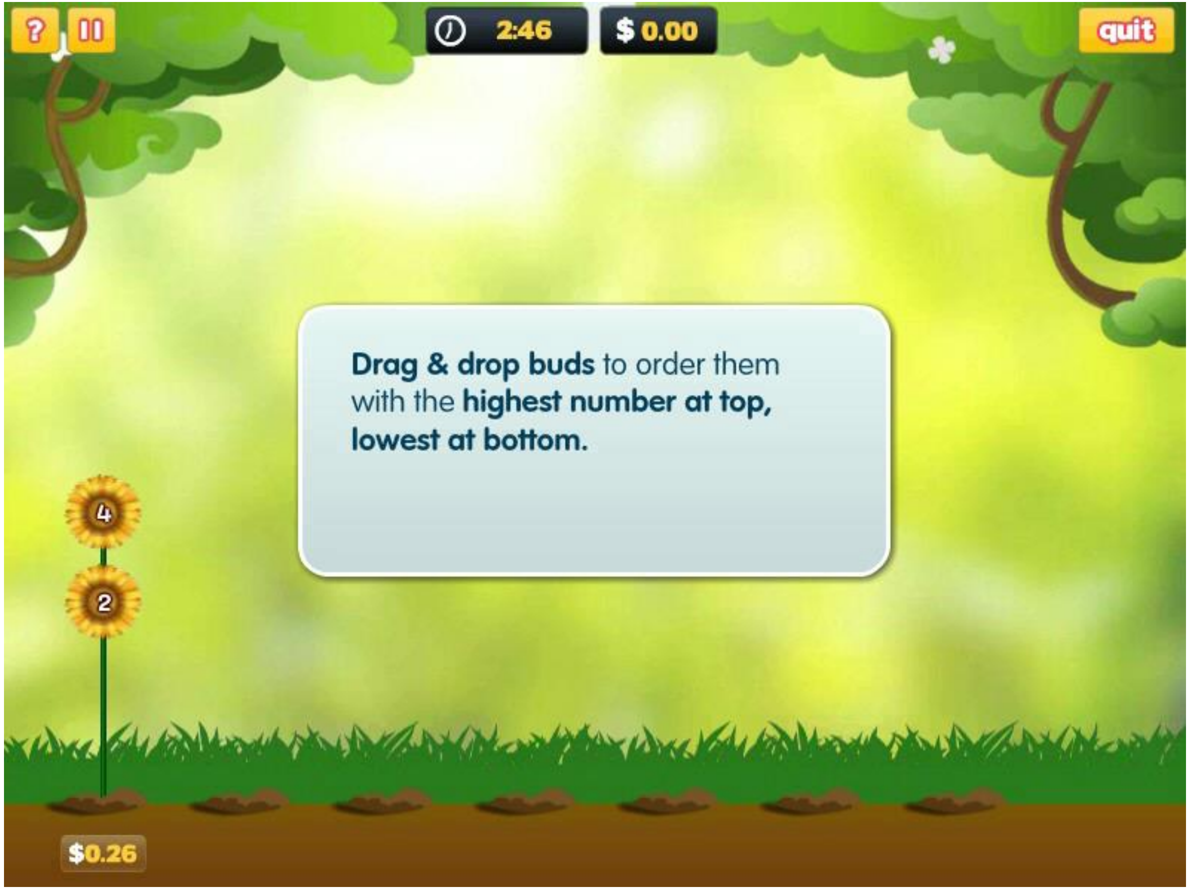


Combined translations

Translation

Instant feedback

- Strategically designed games with real maths learning
- Anticipation of response and/or reward raises dopamine levels
- Dopamine release related to pleasure



Create productive struggle

- Automatic up-levelling
- Productive struggle
- Personalised learning

Growth Mindset

- Believe that their talents can be developed and abilities can be built over time
- View mistakes as an opportunity for growth
- Be aware of how they learn
- Mangahigh is a tool to help develop Growth Mindset

"Mangahigh is successfully delivering fun, competitive, game-based lessons that drive greater engagement and understanding"

Bill Gates

MANGAHIGH
westermann

In summary

Forming memories

- Importance of practise to form long term memory
- Long term memory enables growth
- Keep lessons interesting and exciting
- Games technology can provide instant feedback
- Ensure games chosen has a strong foundation in the educational content that it is being delivered – not just *edutainment*

Join us!

Any questions?

Email: michelle.kueh@mangahigh.com

Web: www.mangahigh.com