

Neuroscience and Learning

Mirela Ramacciotti



Challenges fuel our brain, the organ of all learning. Creating a **meaningful environment** for learning demands creativity and knowledge of the learning process. The educator, based on principles of how nature works must rely on **cognitive and metacognitive strategies** to captivate students' interest, engage their attention, maintain their focus and consolidate their learning. But now, more than ever, educators need nurture: for the self, the students and the environment, either presential or virtual. Based on principles of Mind, Brain, and Education, educators can nurture the environment in which the pedagogical process unravels by implementing **evidence-based practices** that optimize learning in these challenging times. Knowing these **principles** and some of the **best practices** based on evidence will be the focus of this lecture.

Bransford, Brown and Conking, 2000; Frith, 2012; Immordino-Yang and Damasio, 2007; Perry, Turner & Meyer, 2006; Shernoff & Csikszentmihalyi, 2009; Tokuhama-Espinosa, 2014.

OBJECTIVES

1. Challenges
2. Meaningful environment
3. Cognitive and metacognitive strategies
4. Evidence-based: principles and best practices



Before we start on the
objectives...

Views & Perspectives

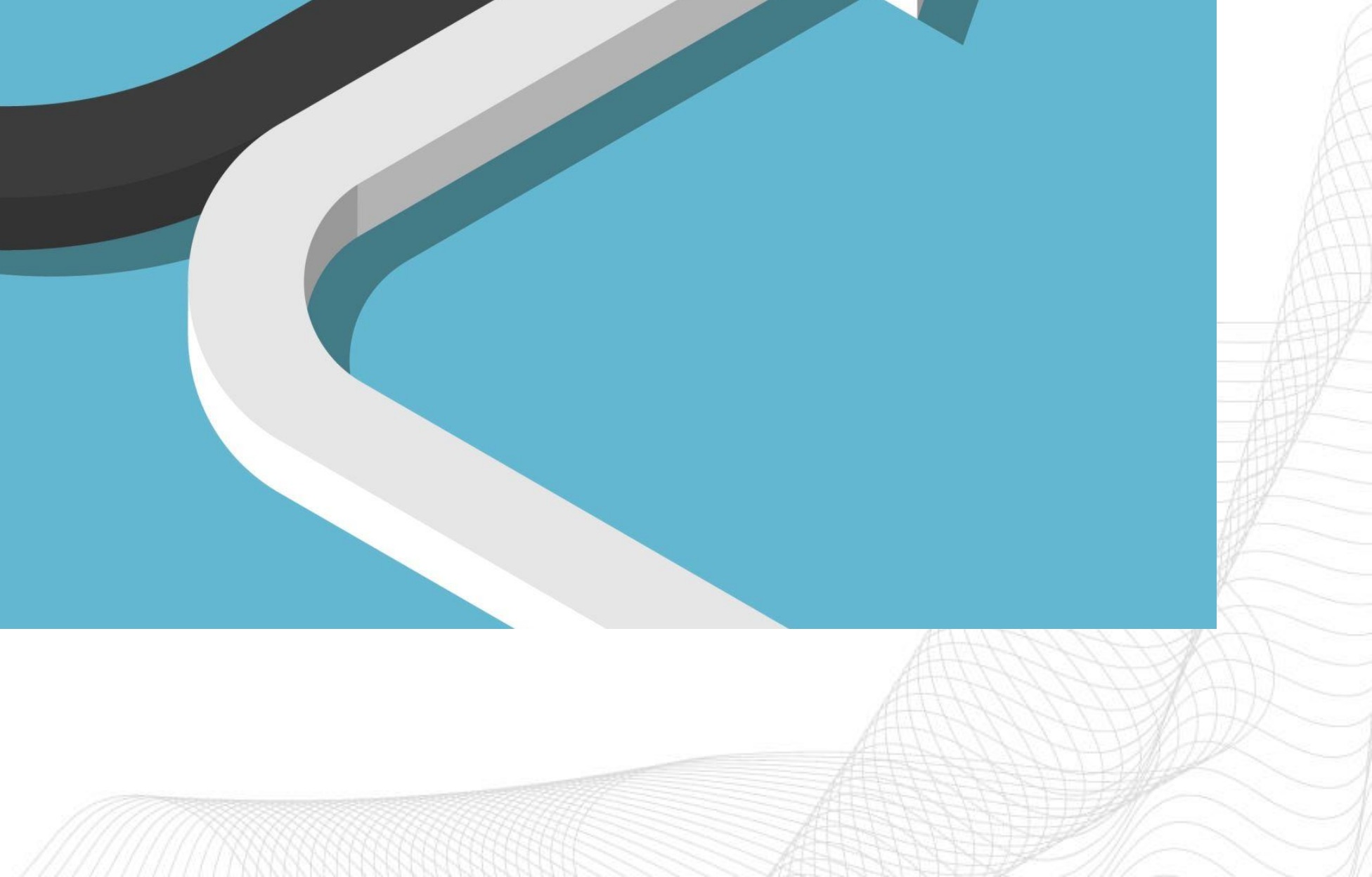
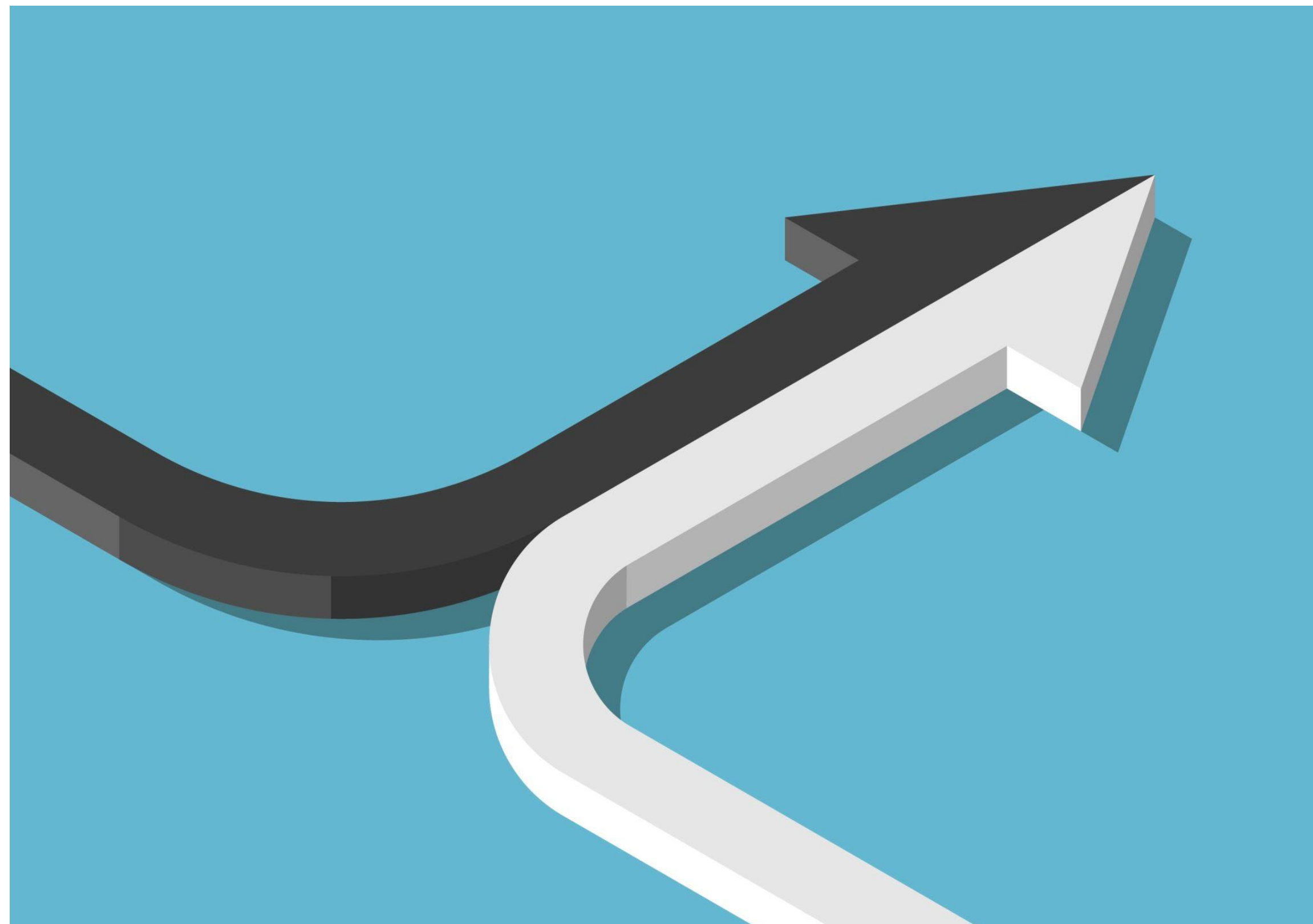




[Esta Foto](#) de Autor Desconhecido está licenciado em [CC BY-SA](#)

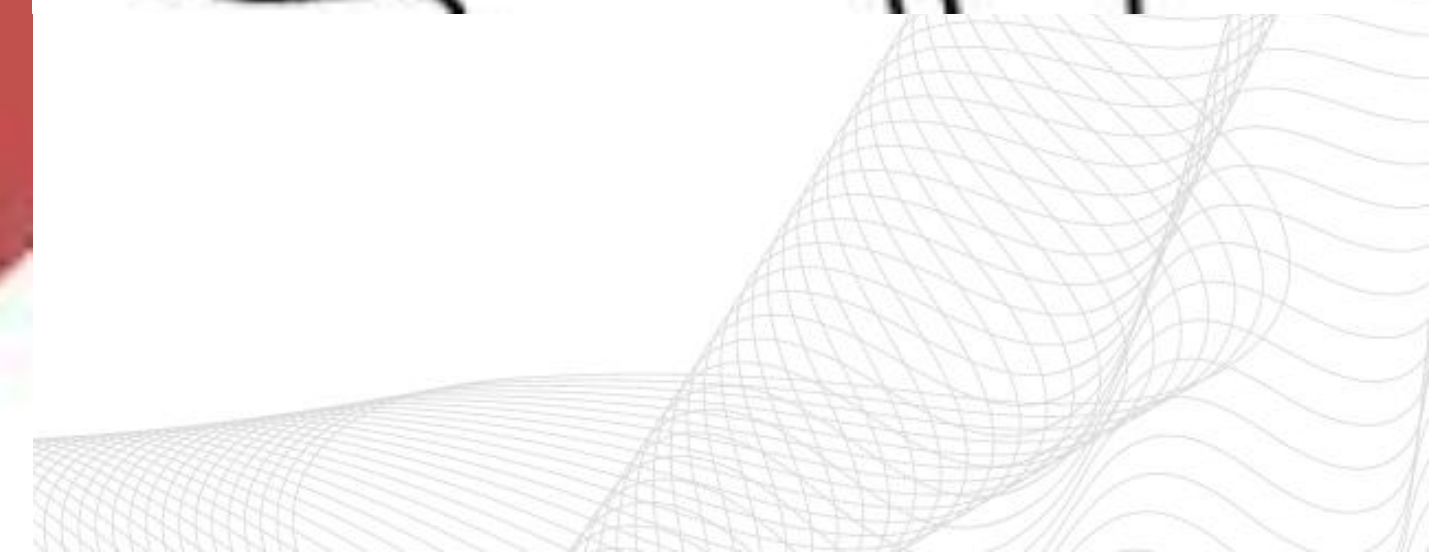
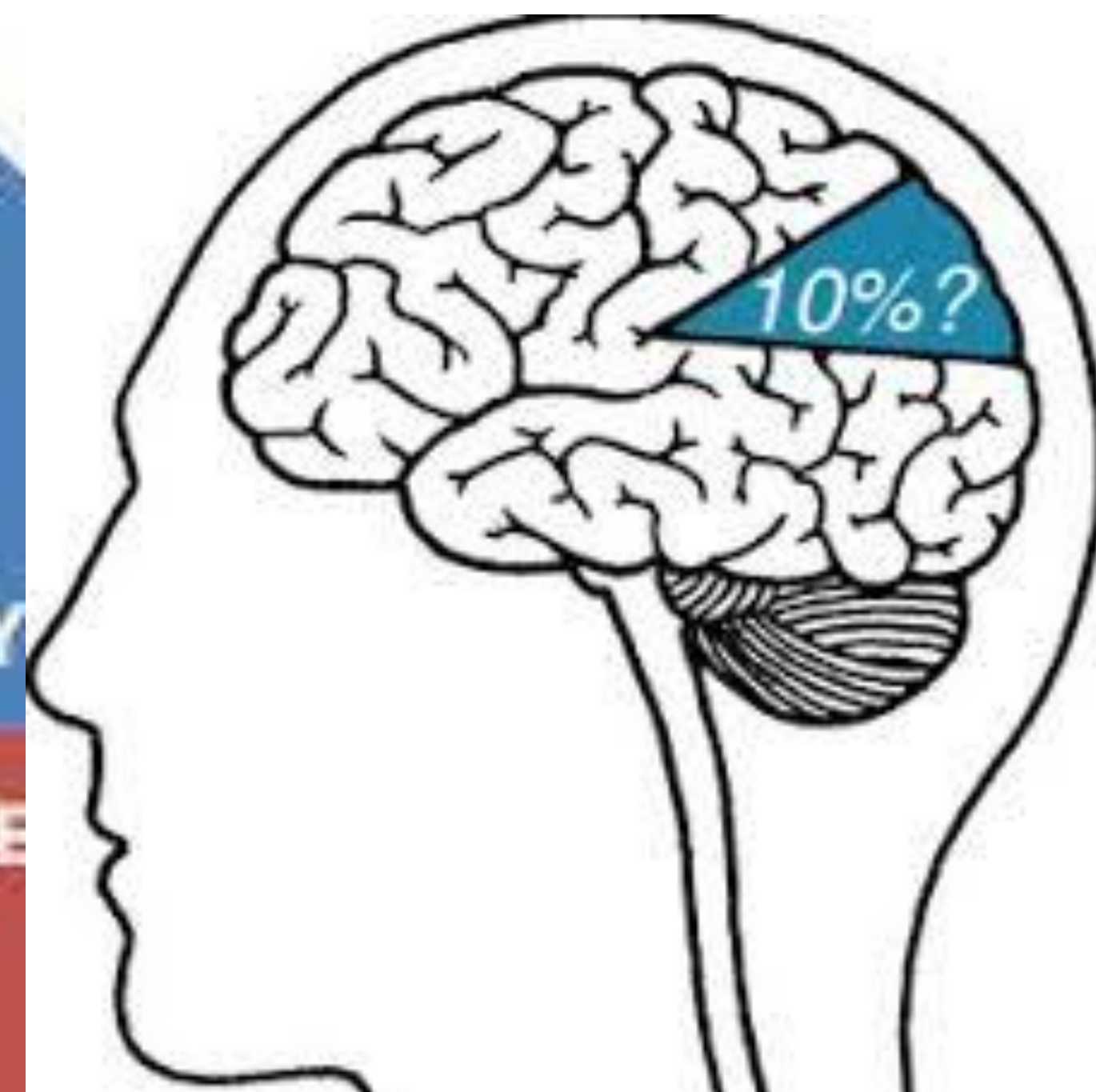
Teacher Development Steps

(based on Tokuhamma-Espinosa,
2018)



Step 1

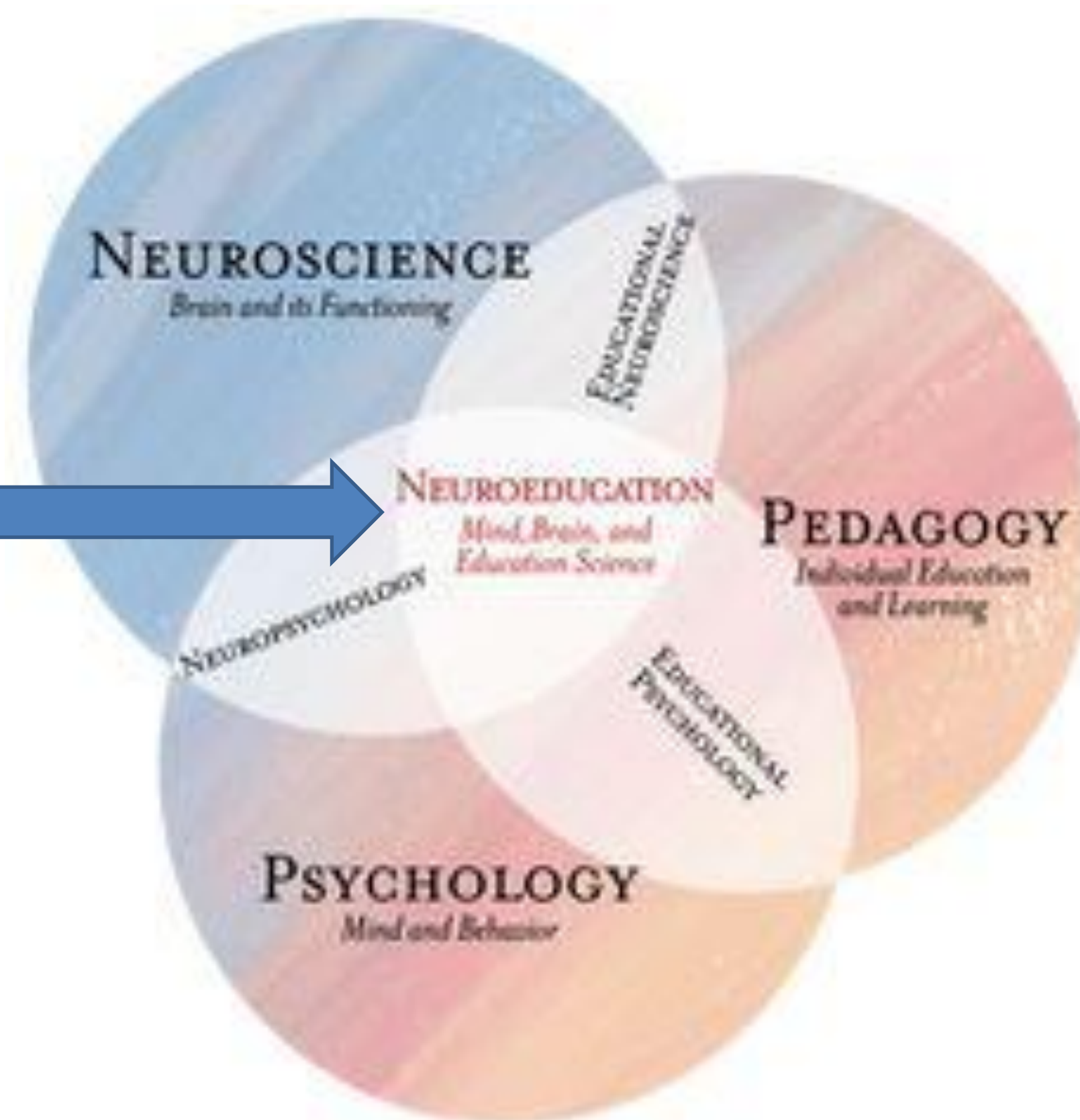
ELIMINATE FALSE INFORMATION
ABOUT THE BRAIN AND LEARNING



Step 2

Principles: universal aspects of learning

1. UNIQUENESS
2. CONTEXT
3. EXPERIENCE
4. NEUROPLASTICITY
5. PREVIOUS EXPERIENCE
6. MEMORY + ATTENTION



Tokuhama-Espinosa, 2010

Step 3

Tenets: individual modulation for

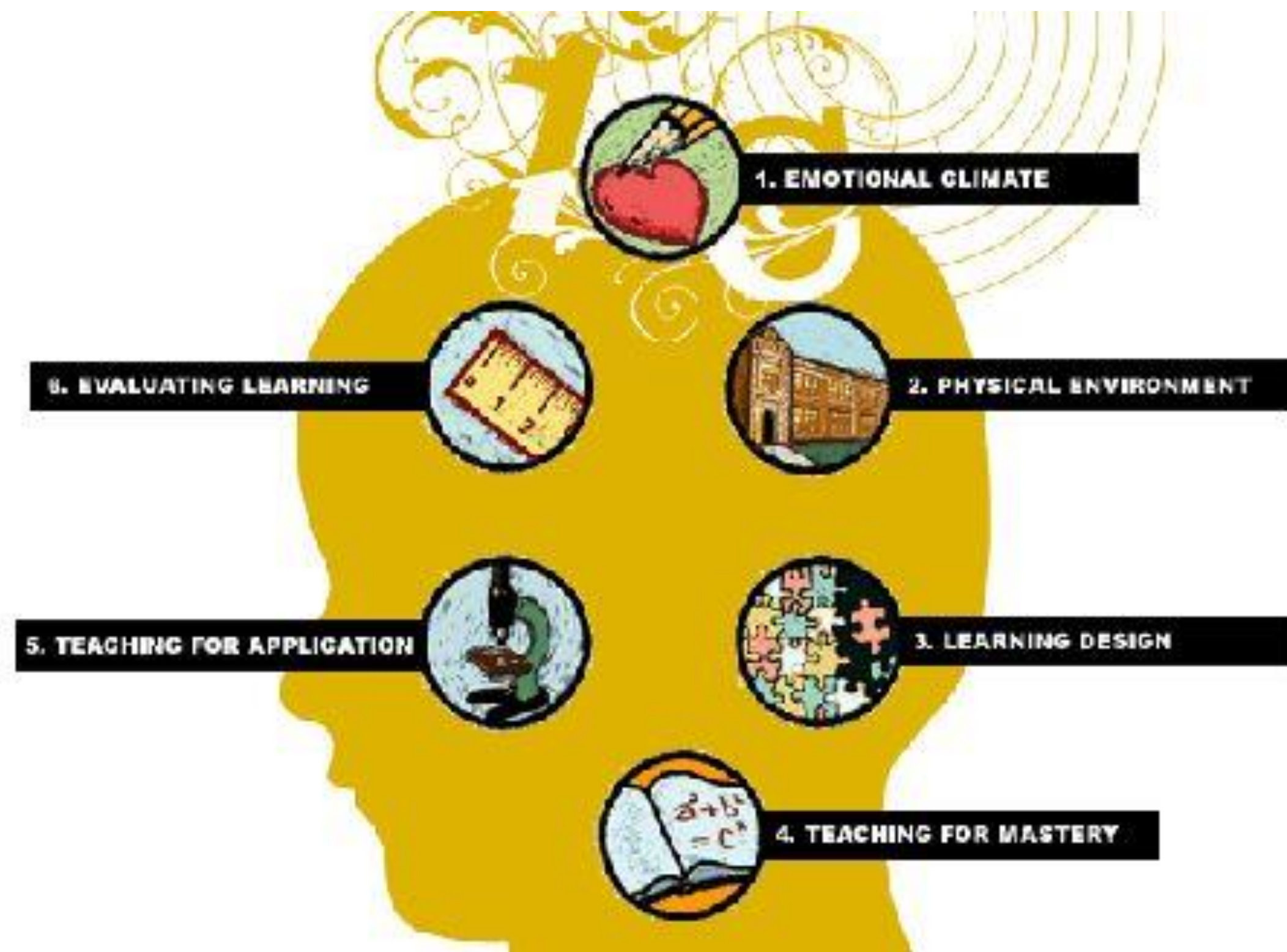
- Nutrition
- Sleep
- Movement
- Motivation
- Challenge



Step 4

Cultural modulation for

- contexts
- contents
- interactions

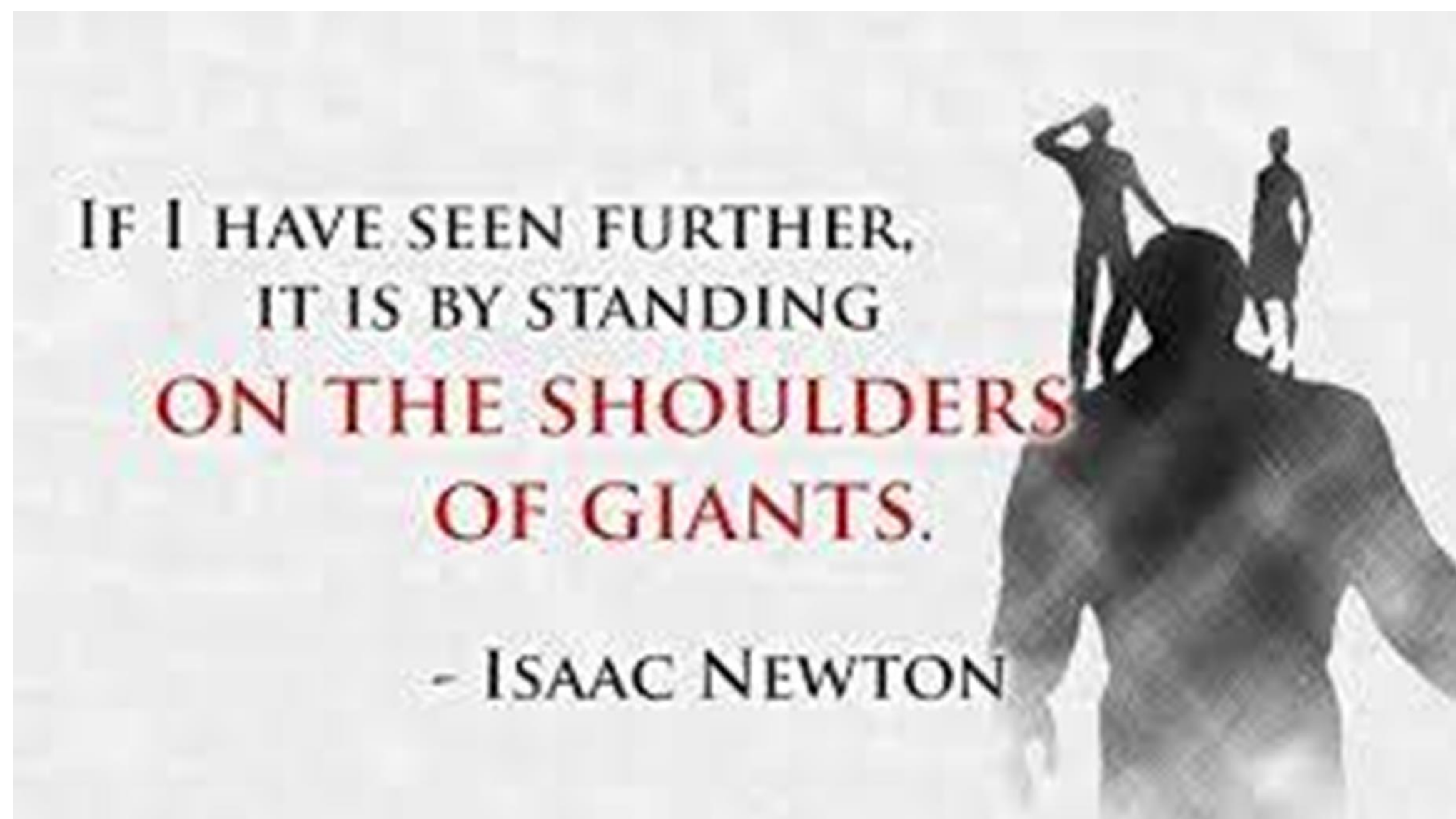


Hardiman, 2012

Step 5

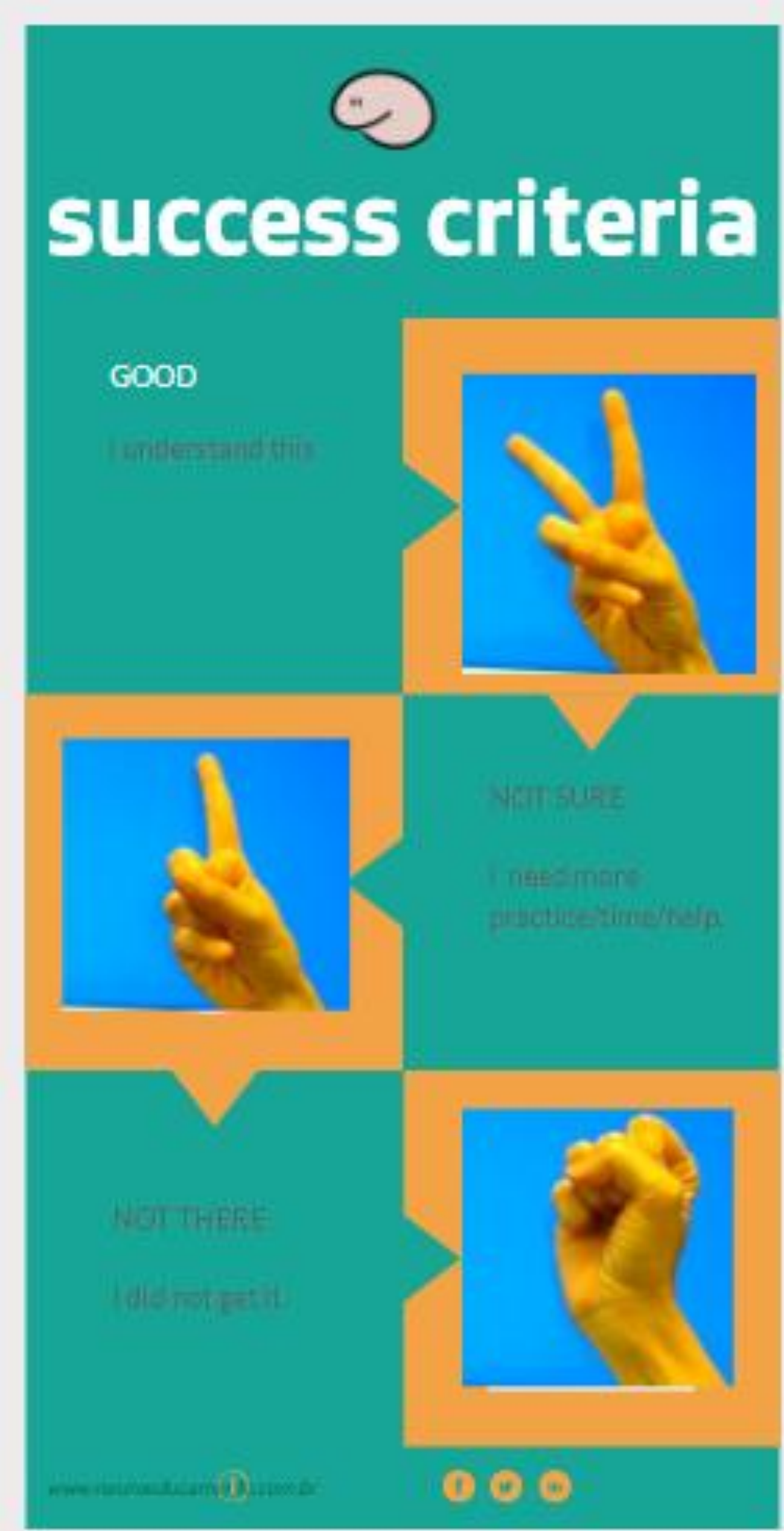
Application





Feedback

AFTER EACH OBJECTIVE






A poster titled "success criteria" with a brain icon. It features three levels of understanding: "GOOD" (I understand this) with a peace sign, "NOT SURE" (I need more practice/time/help) with one finger up, and "NOT THERE" (I did not get it) with a fist. The poster includes a URL and three small icons at the bottom.

success criteria

GOOD
I understand this

NOT SURE
I need more practice/time/help.

NOT THERE
I did not get it.

www.letsstalk.com   

OBJECTIVES

1. Challenges
2. **Meaningful environment**
3. Cognitive and metacognitive strategies
4. Evidence-based: principles and best practices

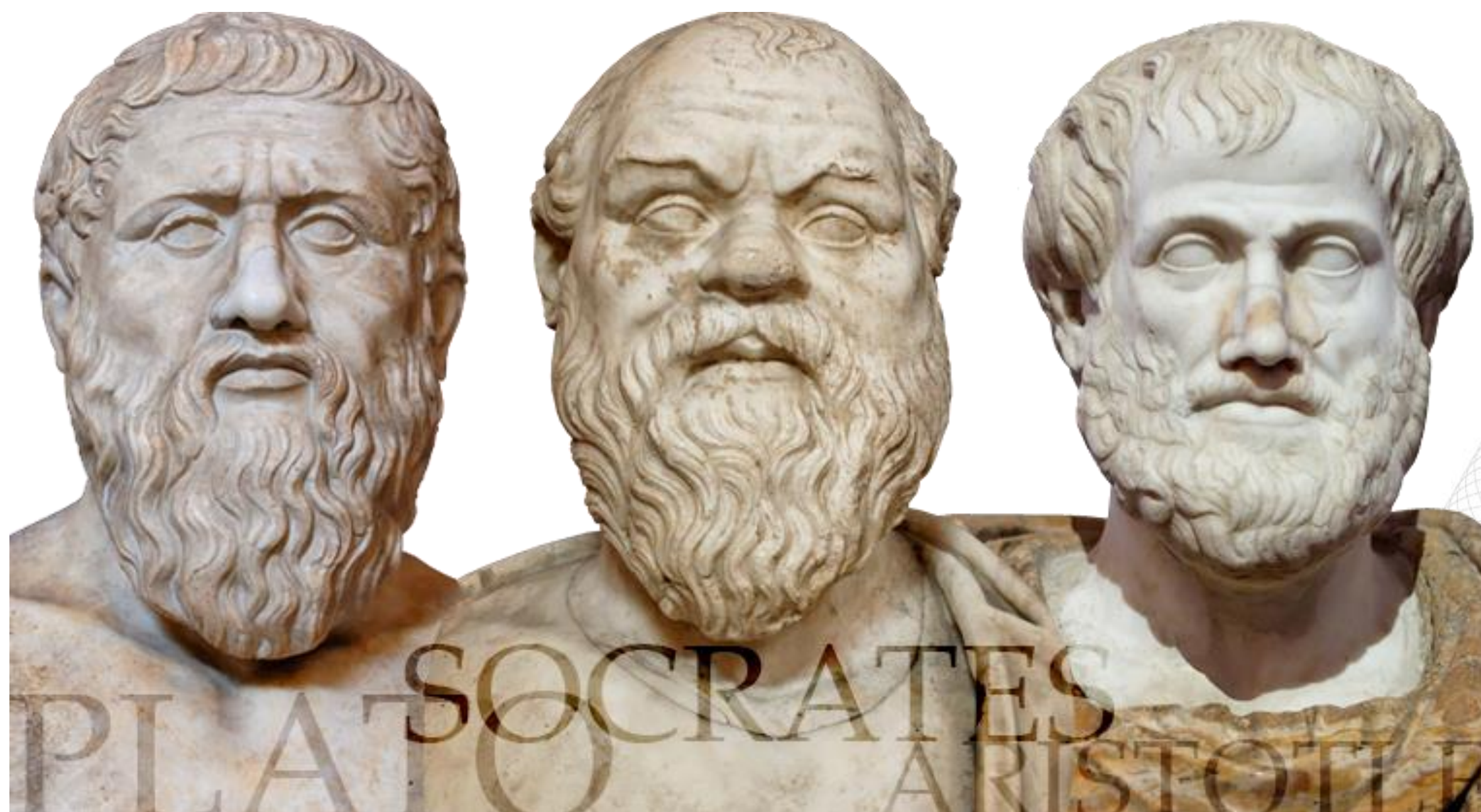


CHALLENGES

- LEARNERS' INTERESTS
- DIFFERENTIATION

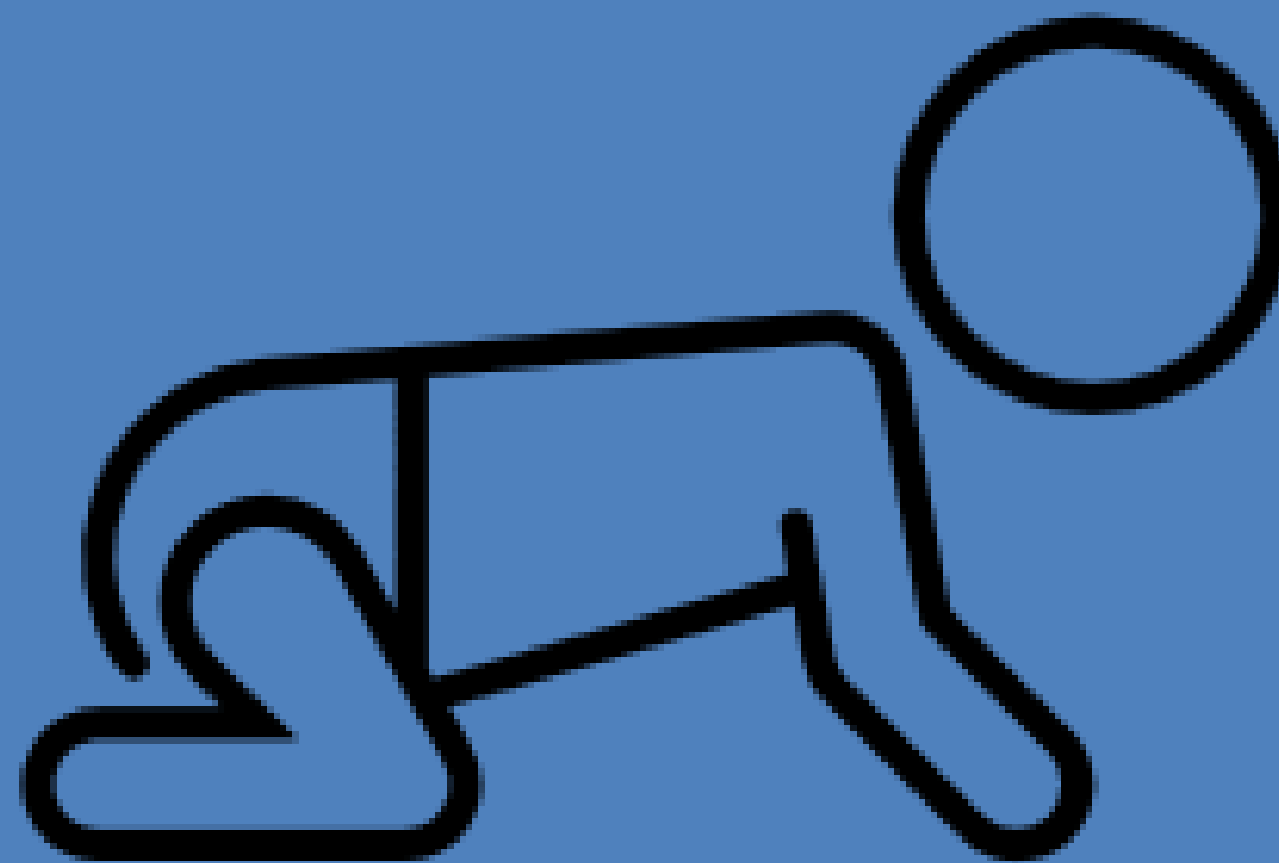


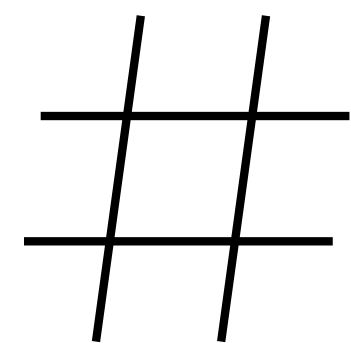
Plato
(4th century BC)



Relating learning to interests

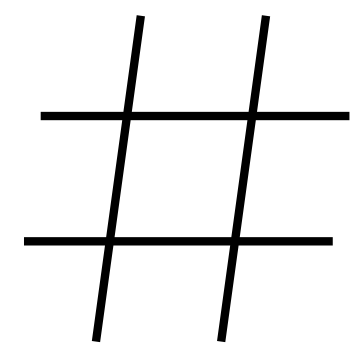
Plato (V century BC)
“Knowledge that is acquired under compulsion obtains no hold on the mind” (Plato, trans. 2009, p. 226)





The importance of emotions





The importance of emotions

KNOWLEDGE



EMOTIONS



The importance of emotions



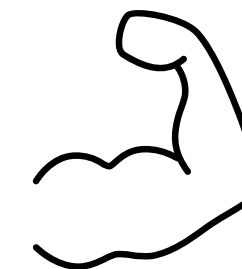
Development & Learning

Vygotsky (1920): sociocultural theory (transactionism)

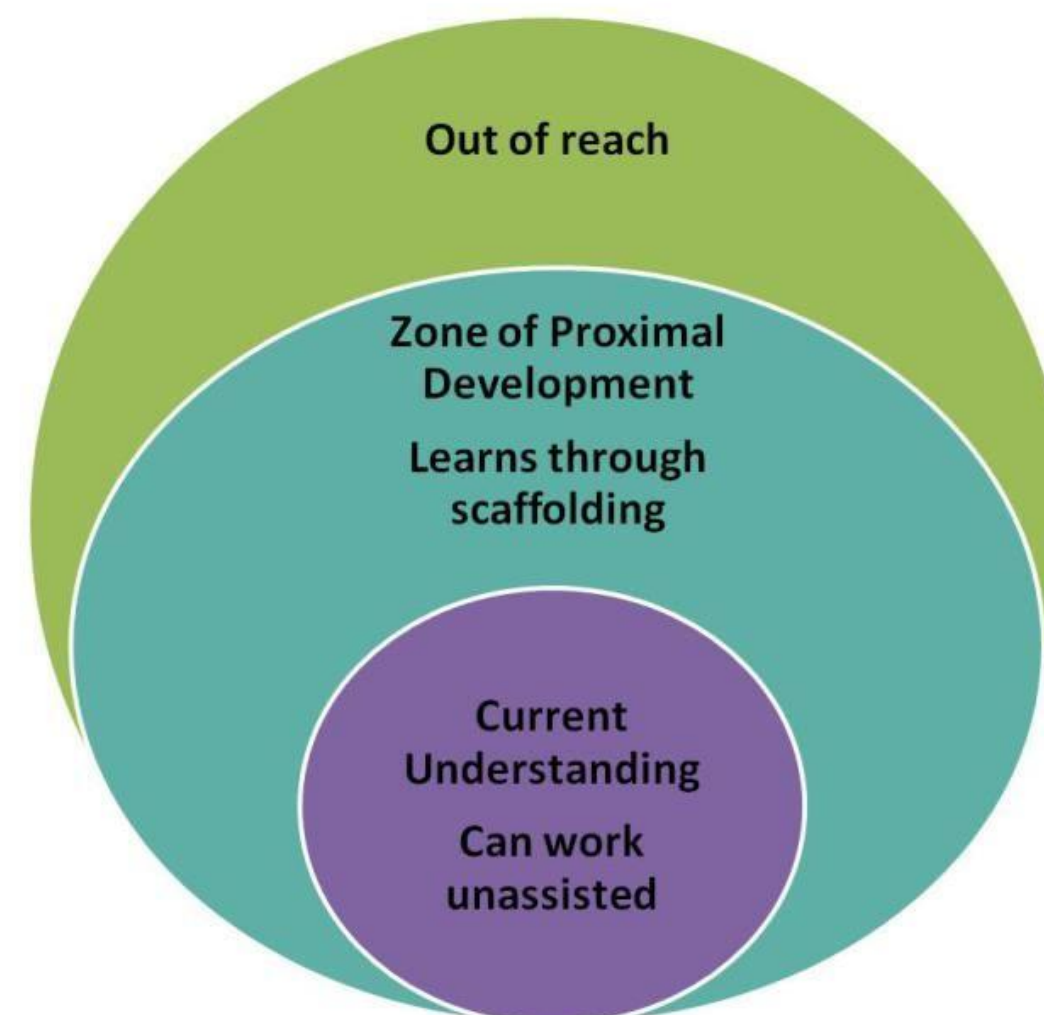
ZPD = zone of proximal development

Social Interactions/Mediation(adult – children/adolescents) & Content (thought/language)

Foundation for Scaffolding



Zone of Proximal Development



Relating learning to interests

Plato (V century BC)

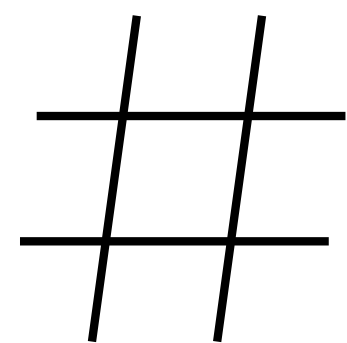
“Knowledge that is acquired under compulsion obtains no hold on the mind” (Plato, trans. 2009, p. 226)

Vygotsky

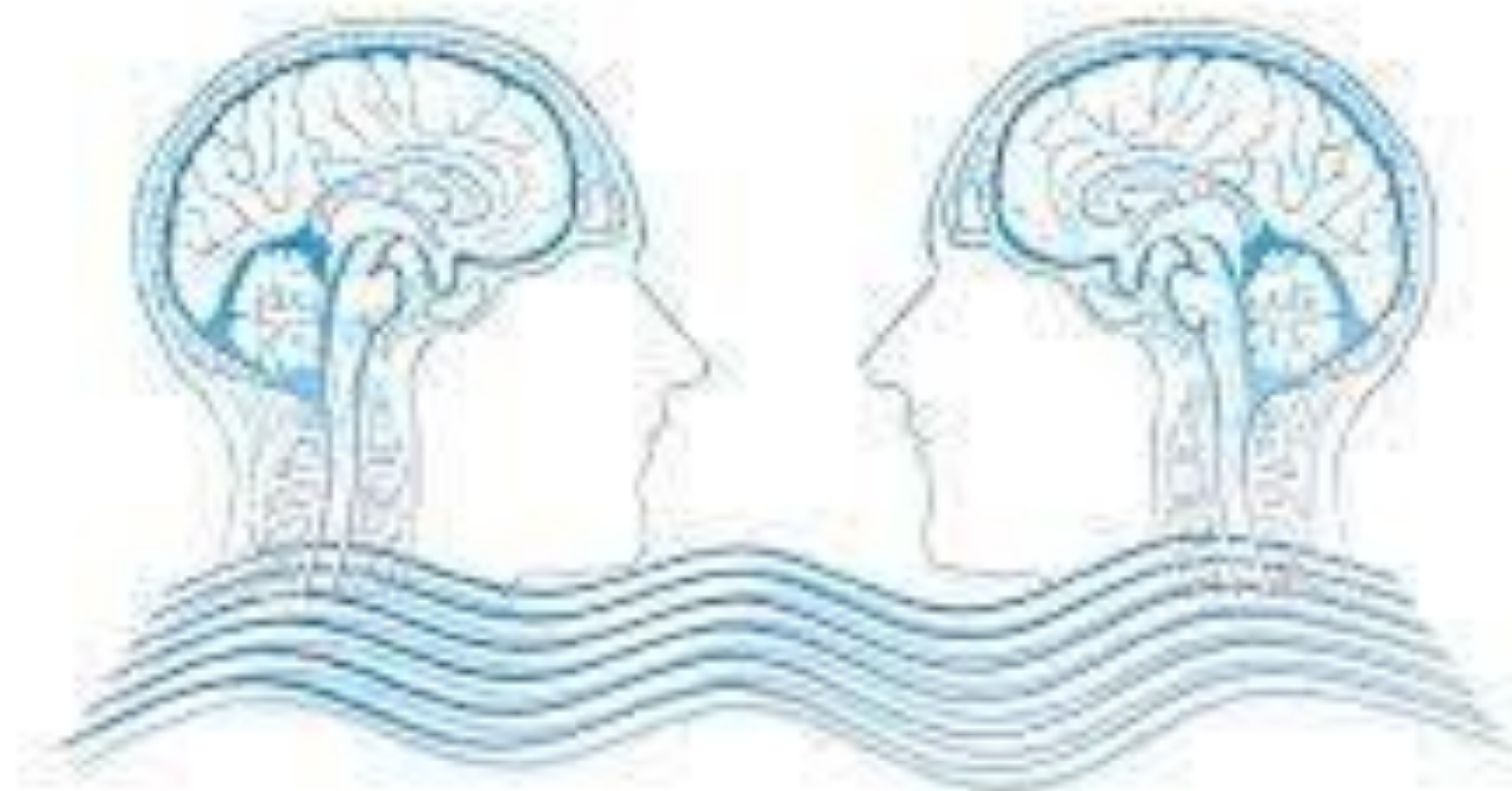
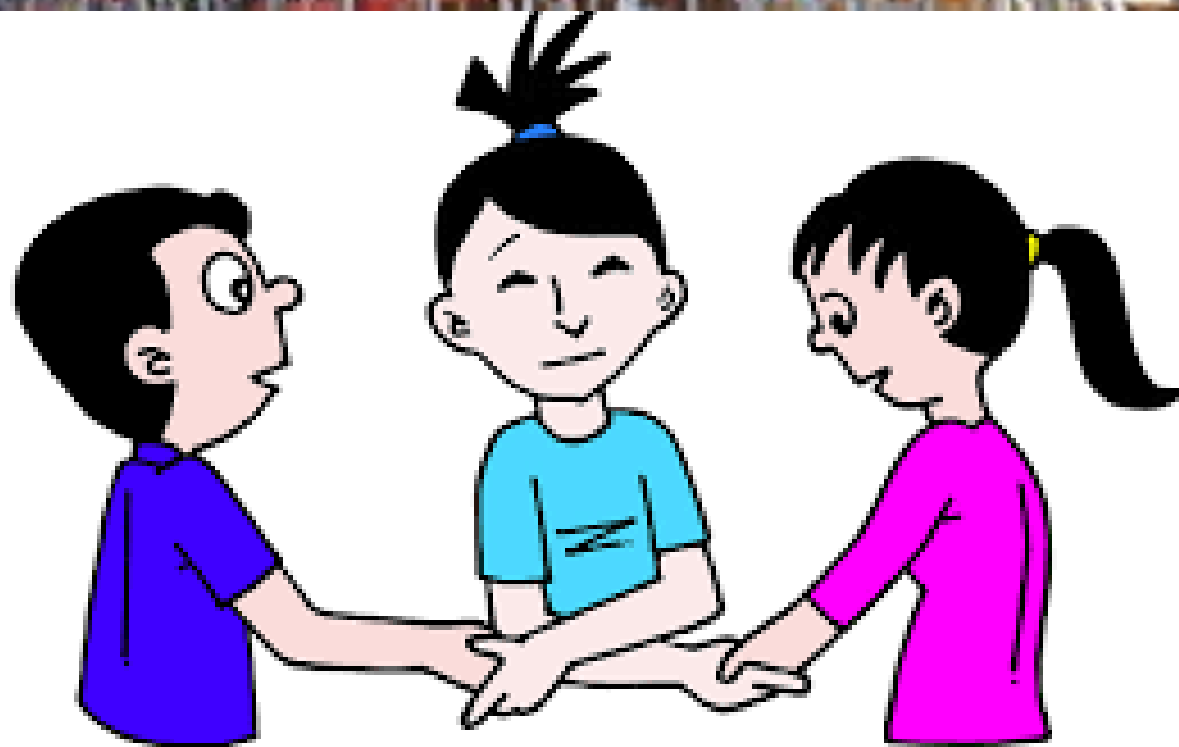
ZPD
Zone of Proximal Development

(Vygotsky, 1978)





Social Cognition: joint attention

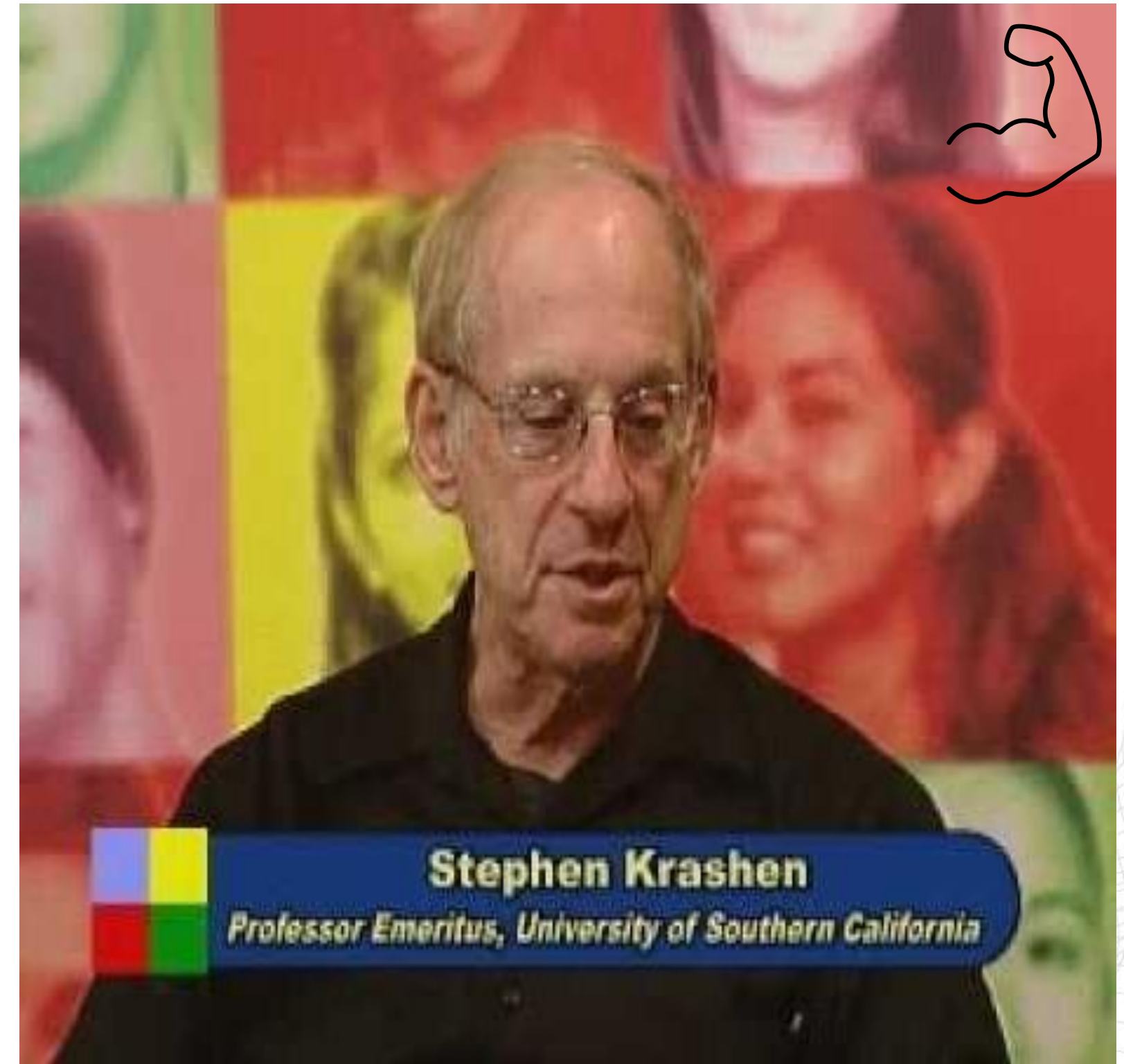


ATTENTION MODULATES PERFORMANCE

Bialystok, 2015; Carpenter et al., 1998; Mundy et al., 2009; Tomasello, 1995

Krashen's Theories for Language Learning

- 1.the Acquisition-Learning hypothesis
- 2.the Monitor hypothesis
- 3.the Natural Order hypothesis
- 4.the Input hypothesis
- 5.the Affective Filter hypothesis
- 6.the Reading hypothesis



Relating learning to interests

Plato (V century BC)

“Knowledge that is acquired under compulsion obtains no hold on the mind”
(Plato, trans. 2009, p. 226)

Vygotsky

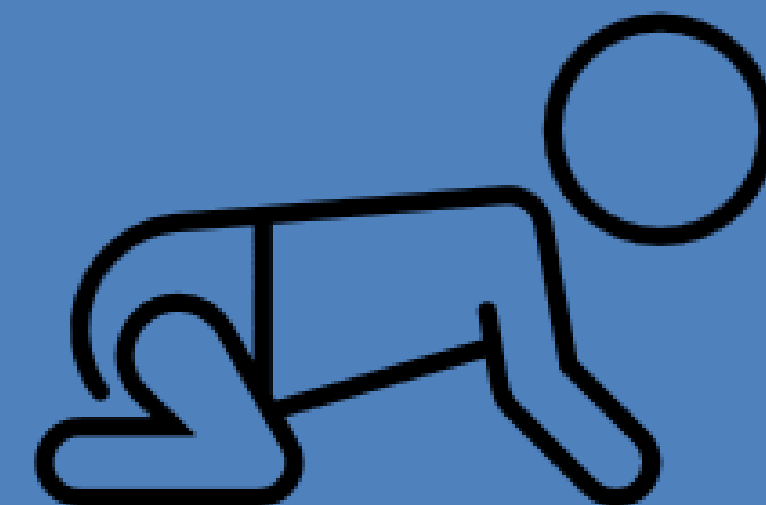
ZPD
Zone of Proximal Development

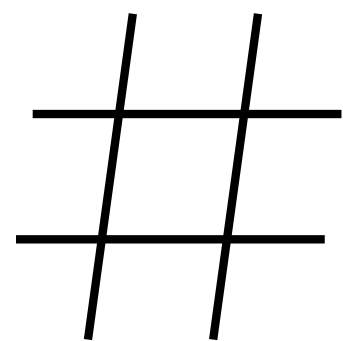
(Vygotsky, 1978)

Krashen

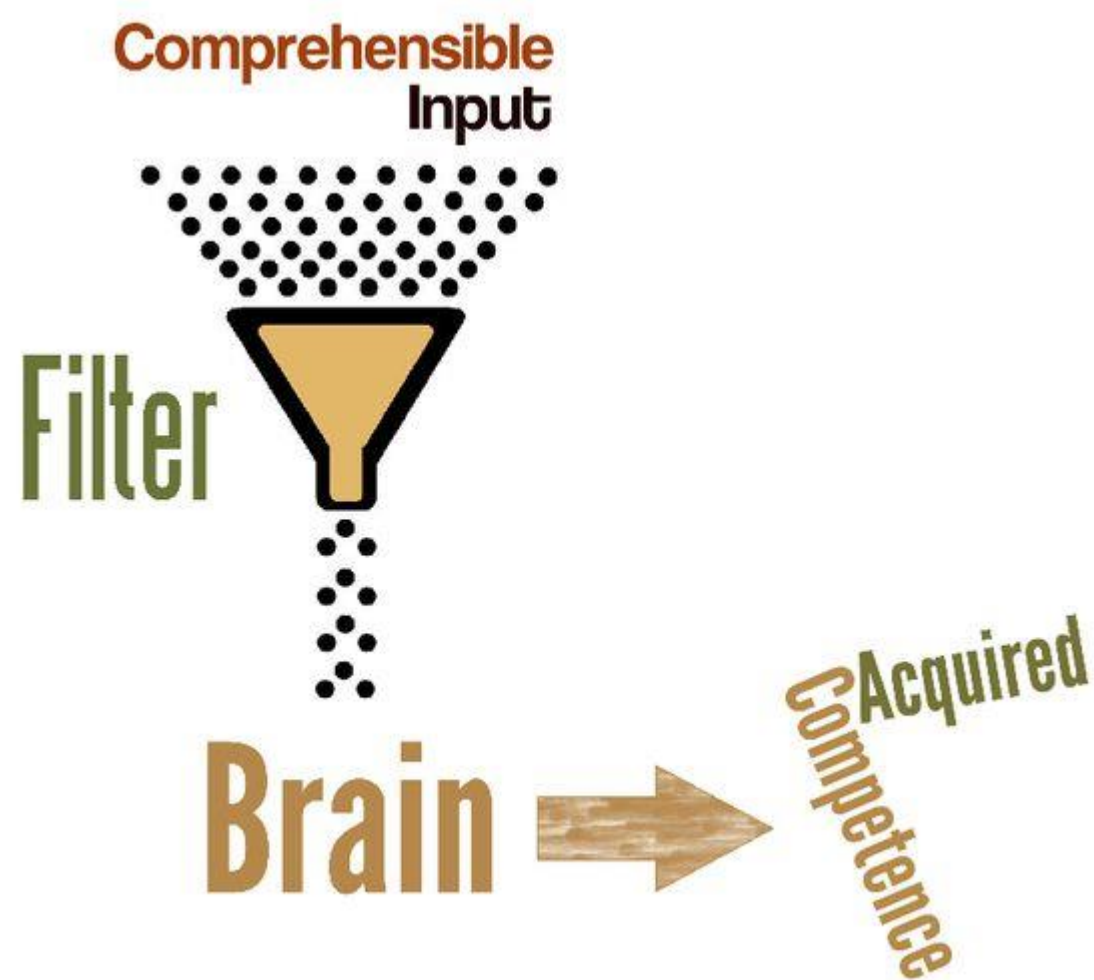
$i+1$
Comprehensible input
Affective Filter

(Krashen, 1982)

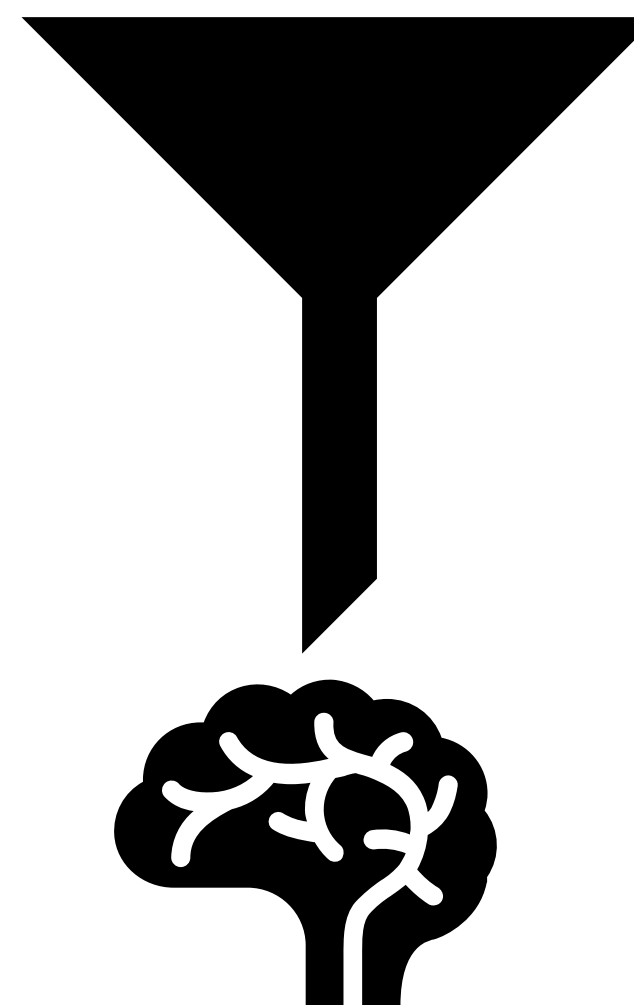




Beyond comprehension and affection: modulation



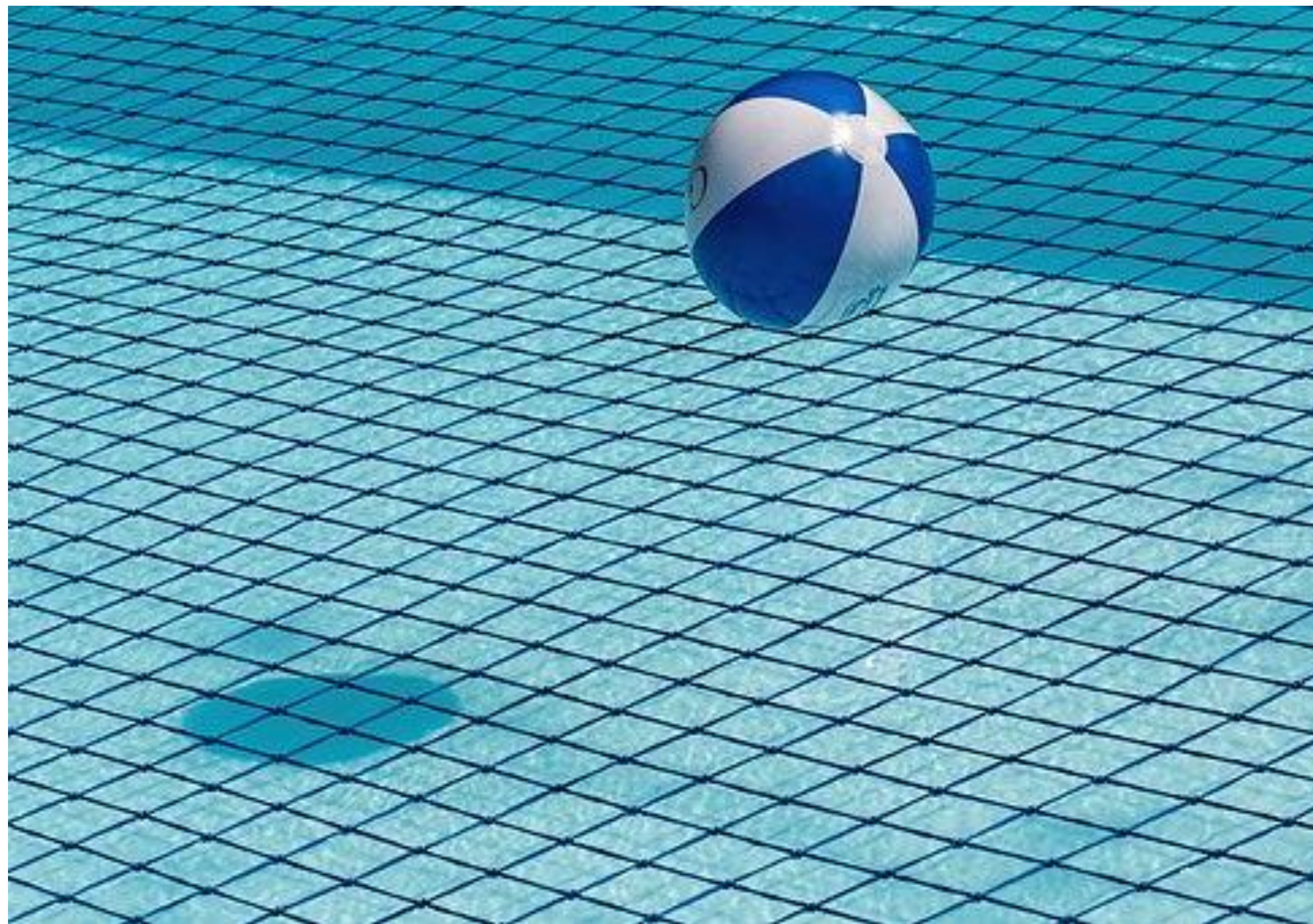
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Berry et al., 2018; Duszkievicz et al., 2019; Gorno-Tempini et al., 2001; Lane et al., 1997; Pawlak et al., 2013; Zubieta et al., 2003

Safety for learning

Optimal Conditions



To Create
and
Promote Focus

**Remove
Stressors**



Balancing (= optimal
stimulation)

Optimize
instruction and
content



building NOVELTY in learning for DIFFERENTIATION

Willis, 2010

Souza & Tomlinson, 2011



Modulate your voice



Mark key points on a chart/bulletin board



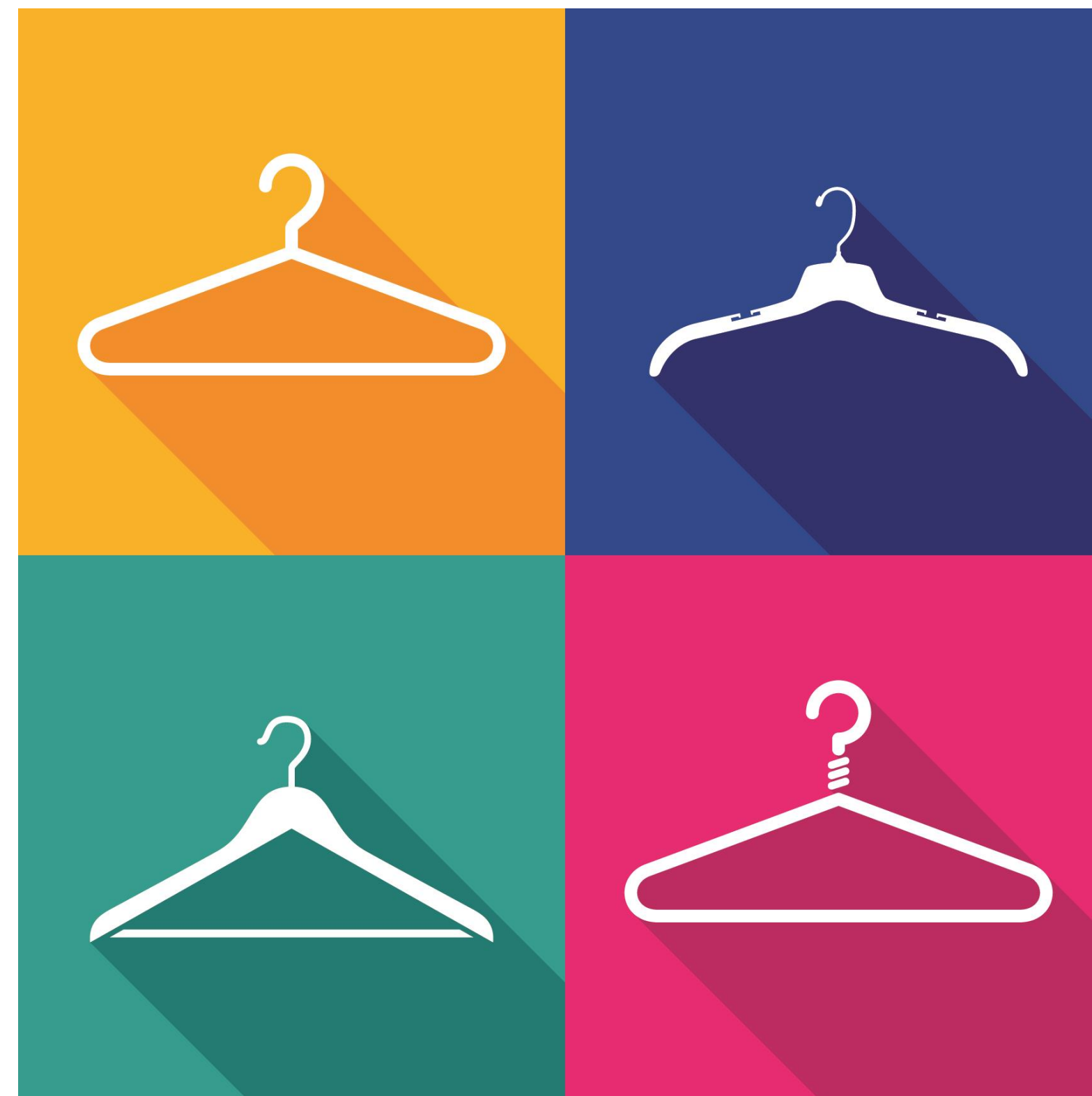
Vary font size



Change settings

building NOVELTY in learning for DIFFERENTIATION

| | |
|--------|-------------------------------|
| Add | photos to boards |
| Prime | new content (Curiosity Hooks) |
| Use | upbeat music (for starters) |
| Change | your behavior |



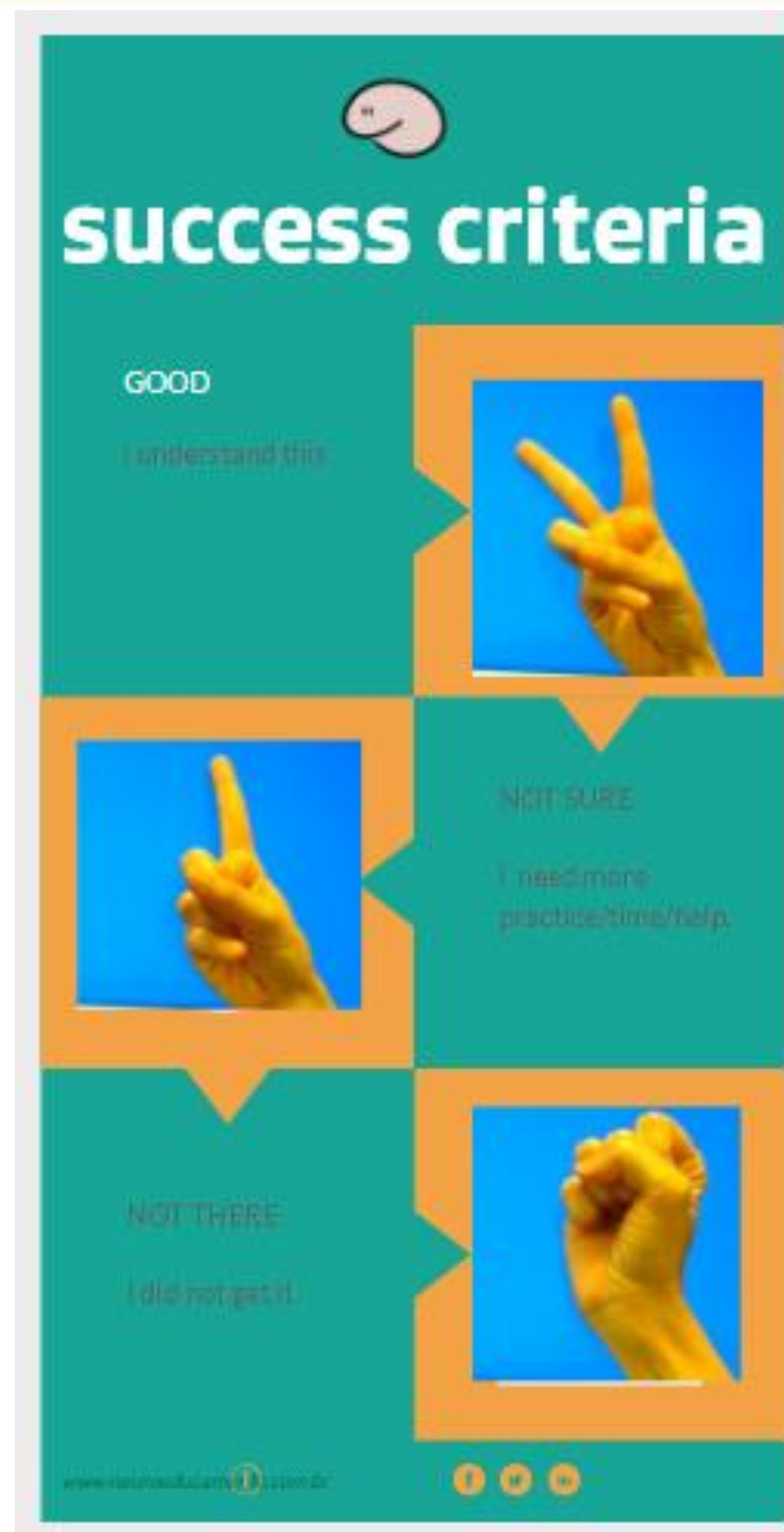
Feedback

CHALLENGES LEARNERS' INTERESTS

EMOTIONS
SOCIAL COGNITION
POSITIVE INPUT

DIFFERENTIATION

08 WAYS TO BUILD NOVELTY



OBJECTIVES

1. Challenges
2. **Meaningful environment**
3. Cognitive and metacognitive strategies
4. Evidence-based: principles and best practices

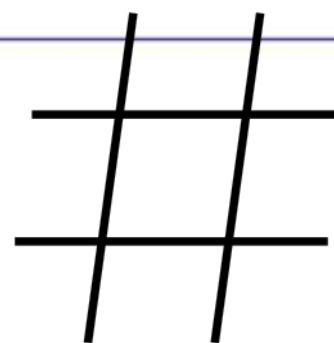


MEANINGFUL ENVIRONMENTS

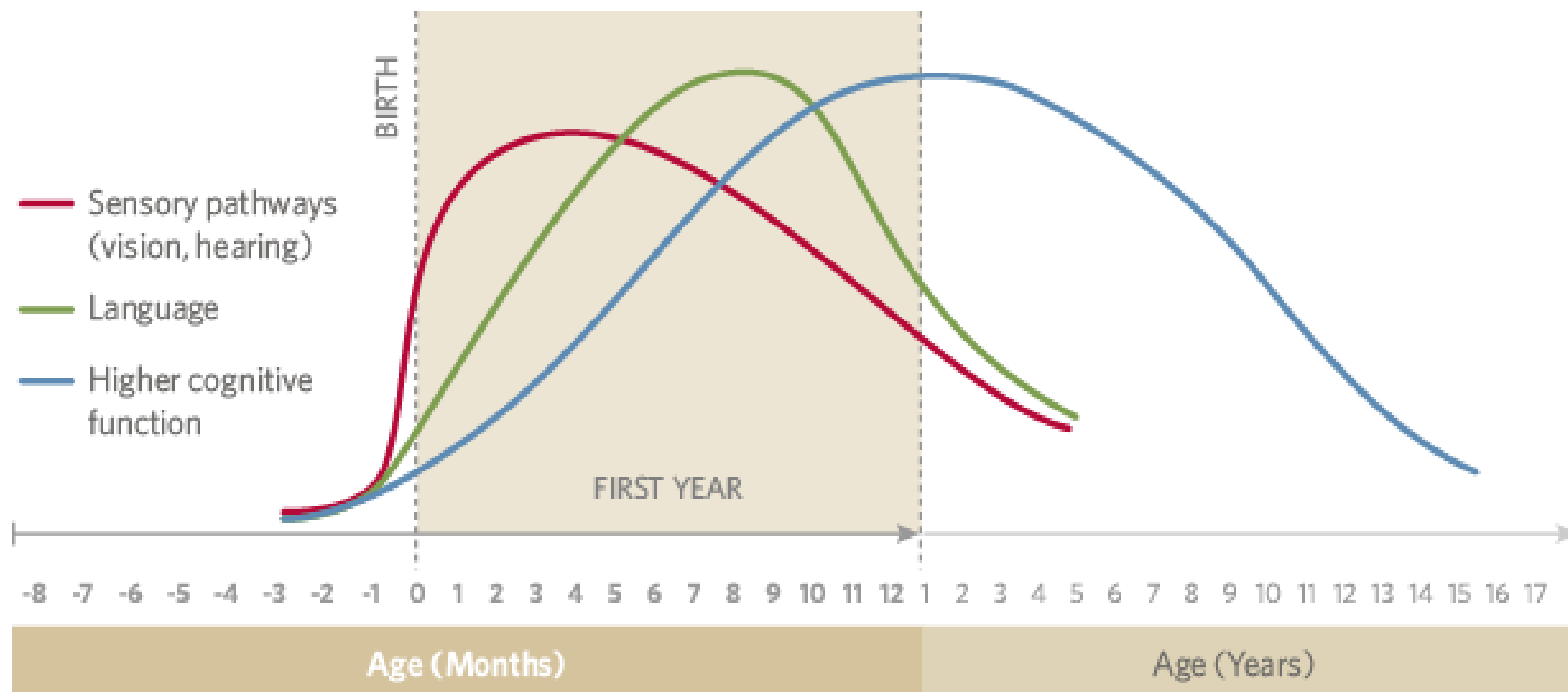
EXPERIENCE



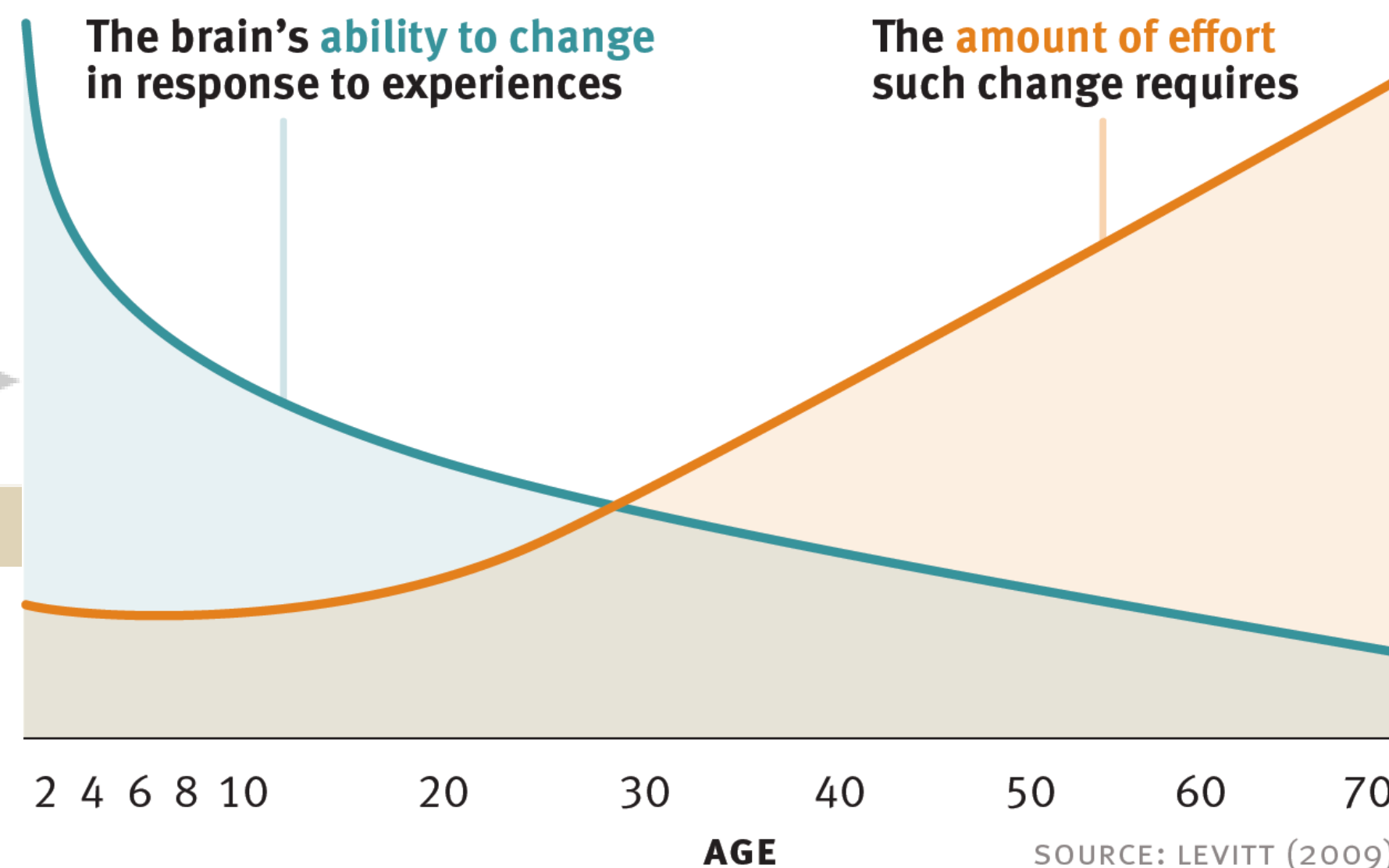
Development & Experience



Human Brain Development



Source: Nelson, C. (2000). From *Neurons to Neighborhoods: The Science of Early Childhood Development*. Washington, DC: The National Academies Press.

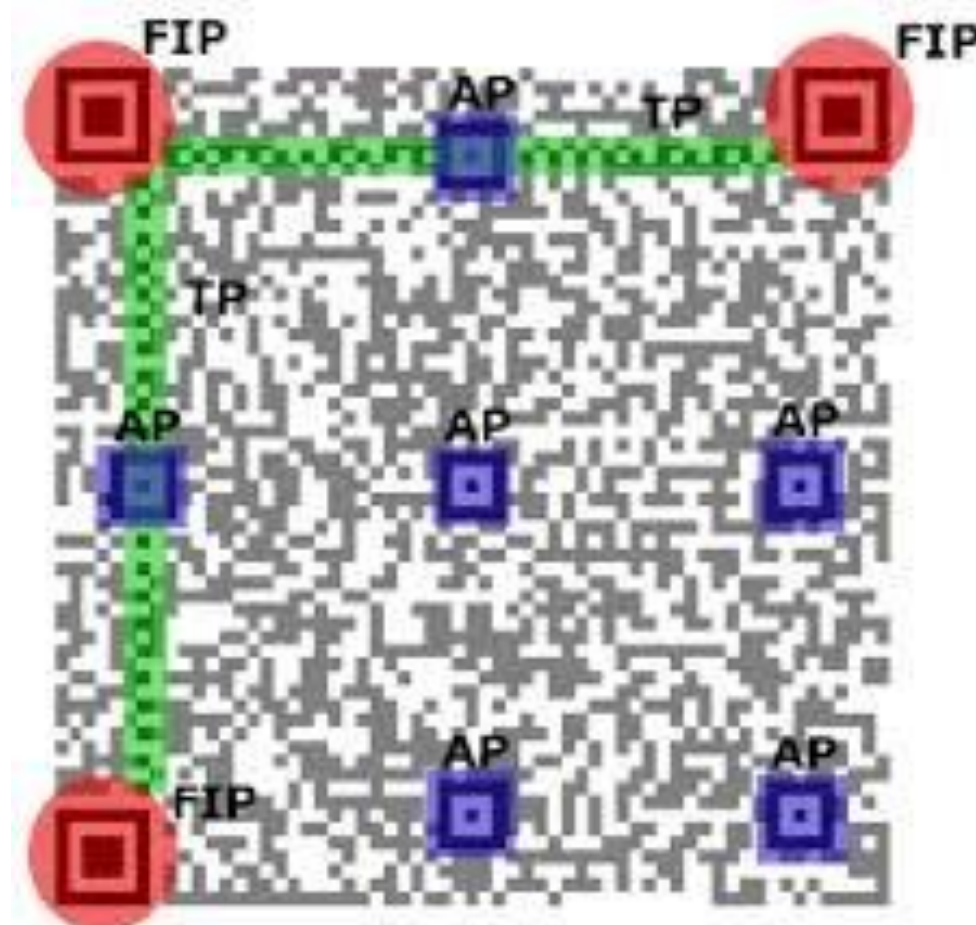


Finding Meaning



THE BRAIN IS A
PATTERN-
& SEEKER
FINDER

w The brain, a pattern-finding organ, seeks to create meaning through establishing or refining existing neural networks; this is learning. Emotion affects what is learned and what is retained.



Wolfe, P. (2006). The role of meaning and emotion in learning. *New directions for adult and continuing education*, 110, 35-41.

Previous Experience

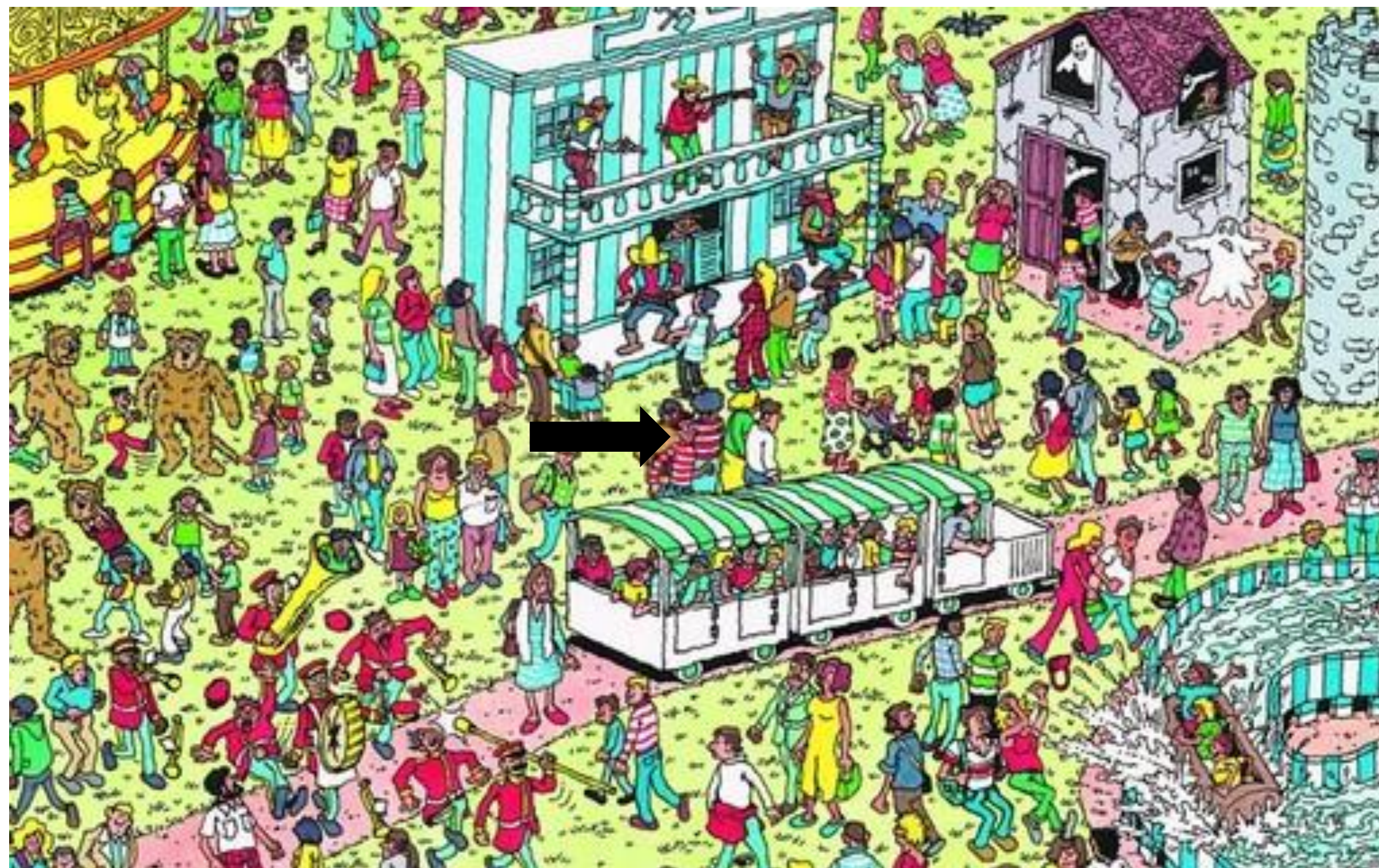


All learning goes through the
filter of PREVIOUS EXPERIENCE



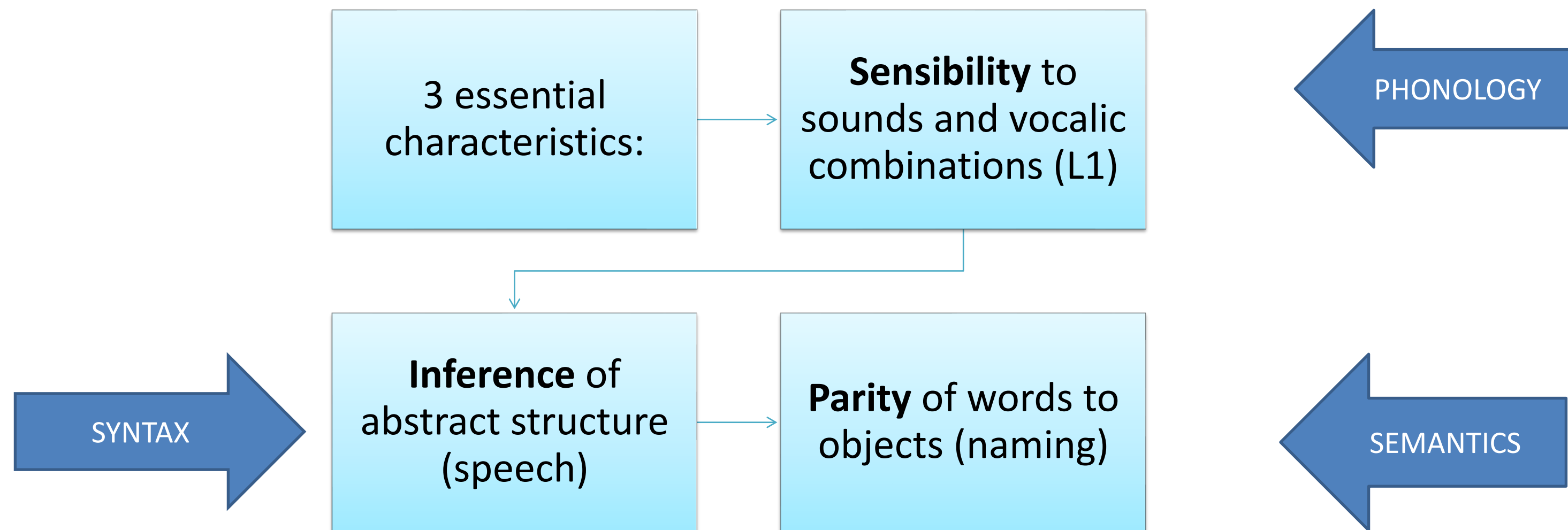
Brain learns with
PATTERNS AND NOVELTY

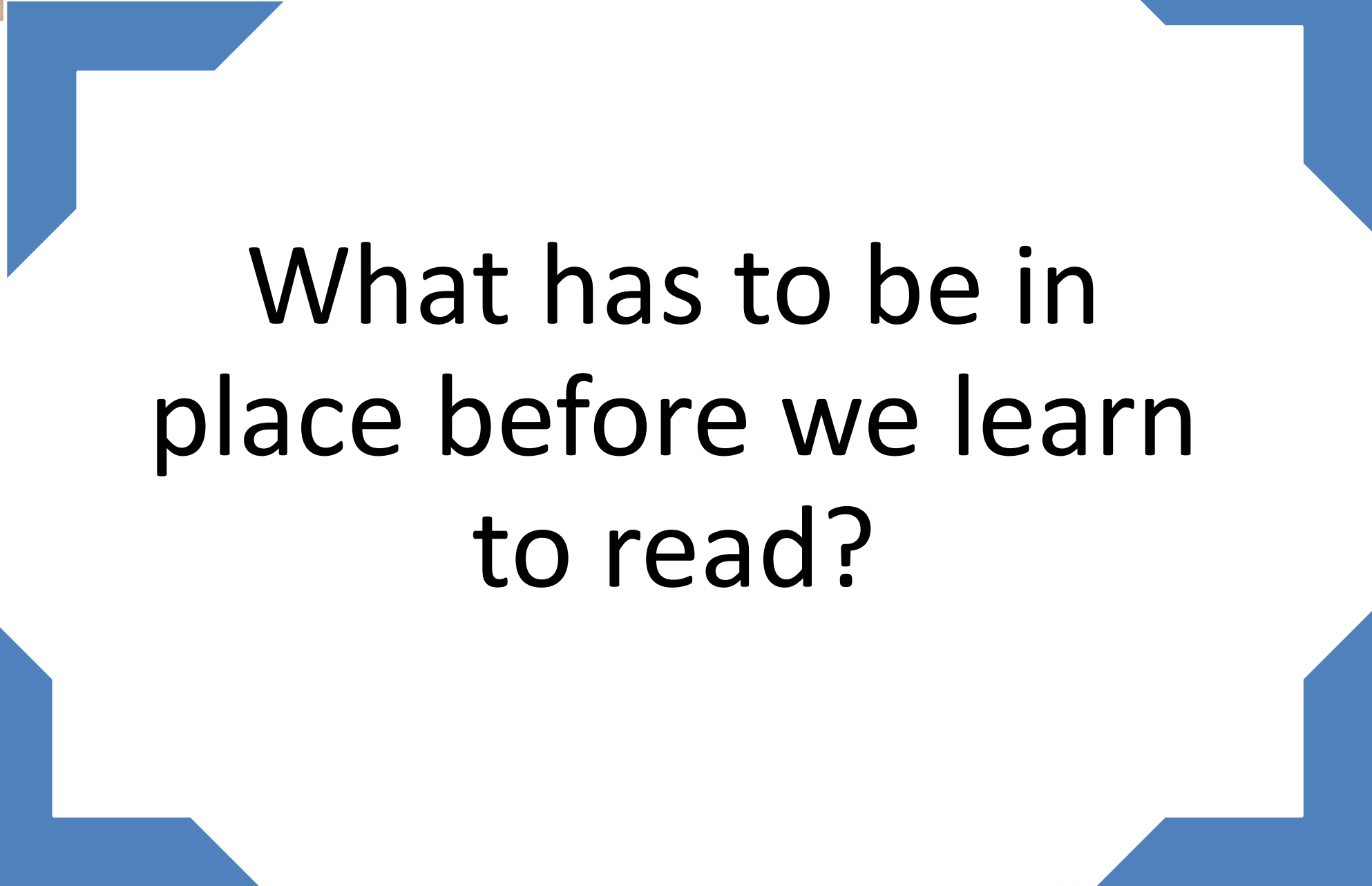
importance of teaching:
similarity and difference



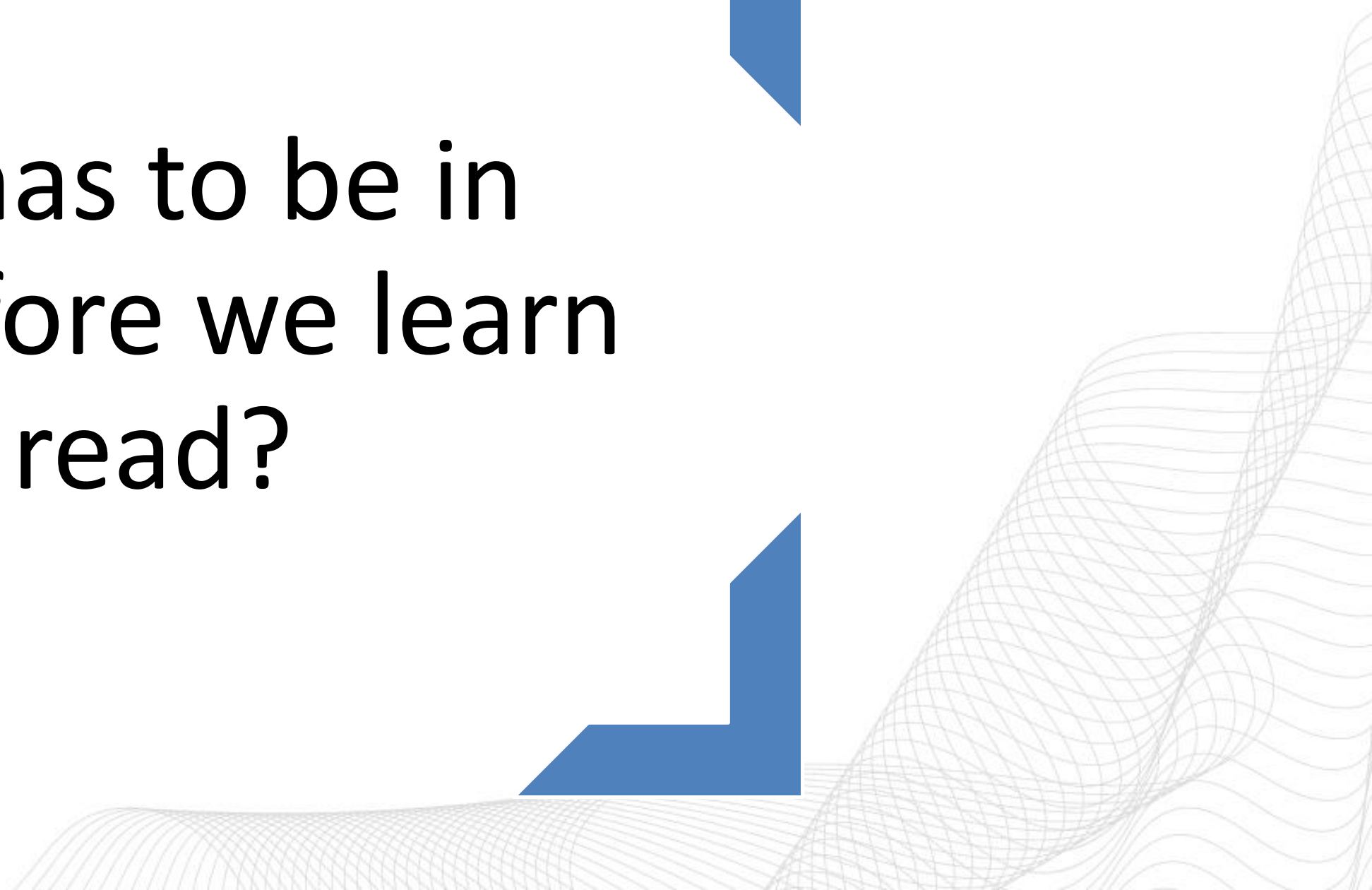
Children's Receptive Skills

(Dehaene-Lambertz & Spelke, 2015)





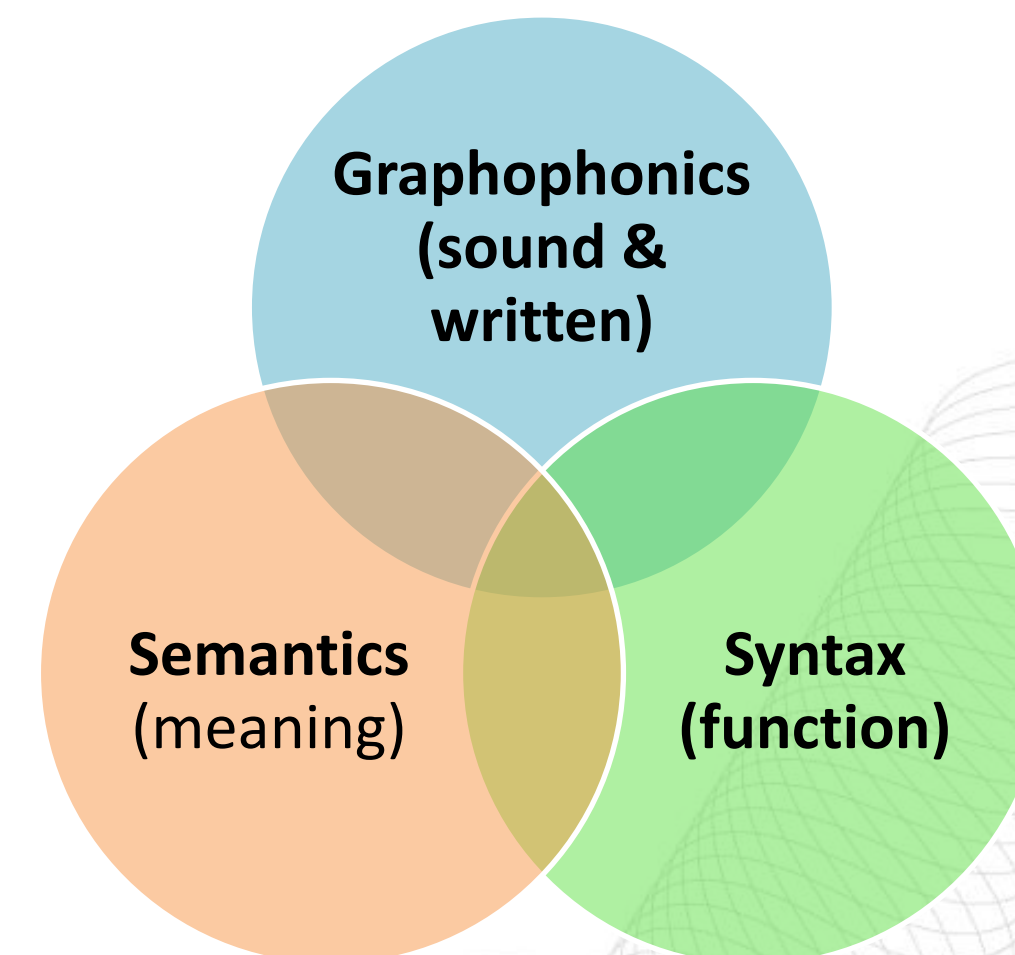
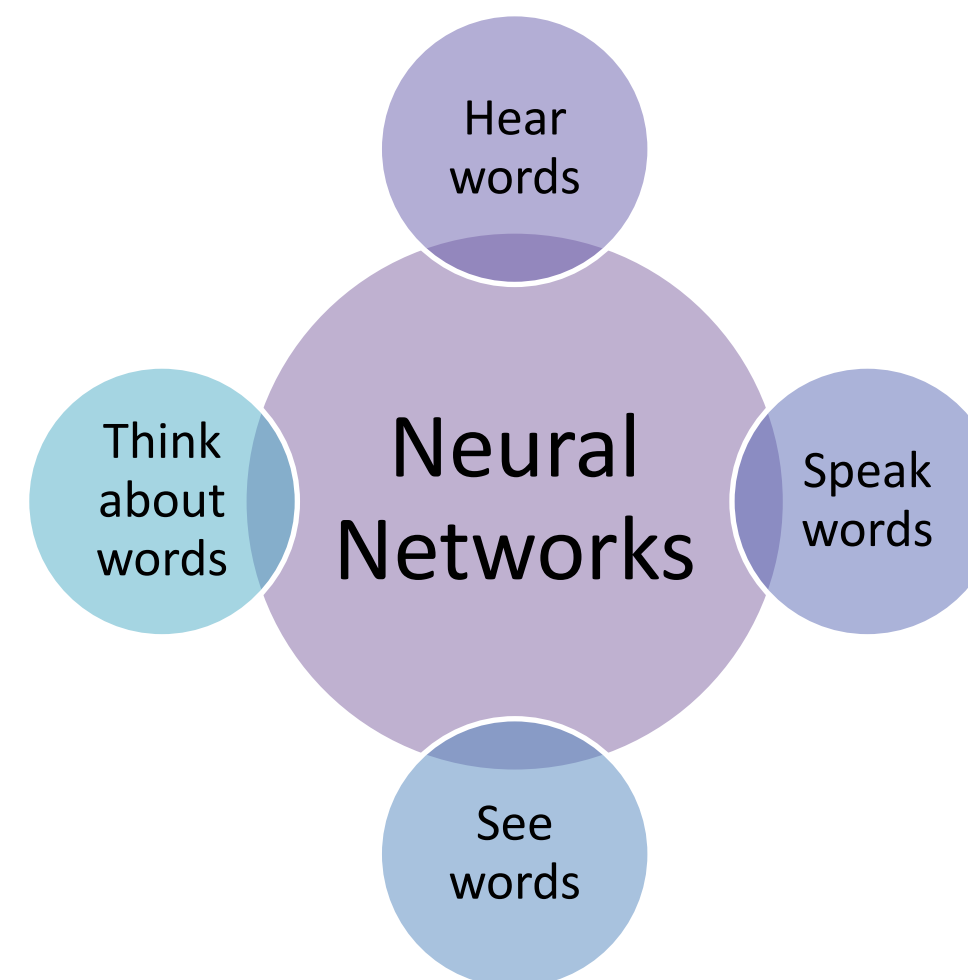
What has to be in
place before we learn
to read?



Neural Networks for Reading

(Pugh et al, 2013)

1. Attentional
2. Visual
3. Symbolic Representations
4. Phonological Loop
5. Phoneme-Grapheme
6. Semantic Recovery
7. Semantic Comprehension
8. Syntactic Comprehension
9. Context and Intonation
10. Coherence structure (sentence level)
11. Conceptual Organization
12. Working memory



SEL factors for reading readiness

(Poldrack et al., 1999; Simos et al., 2001, Turkeltaub et al., 2003)



Image: Edutopia.org

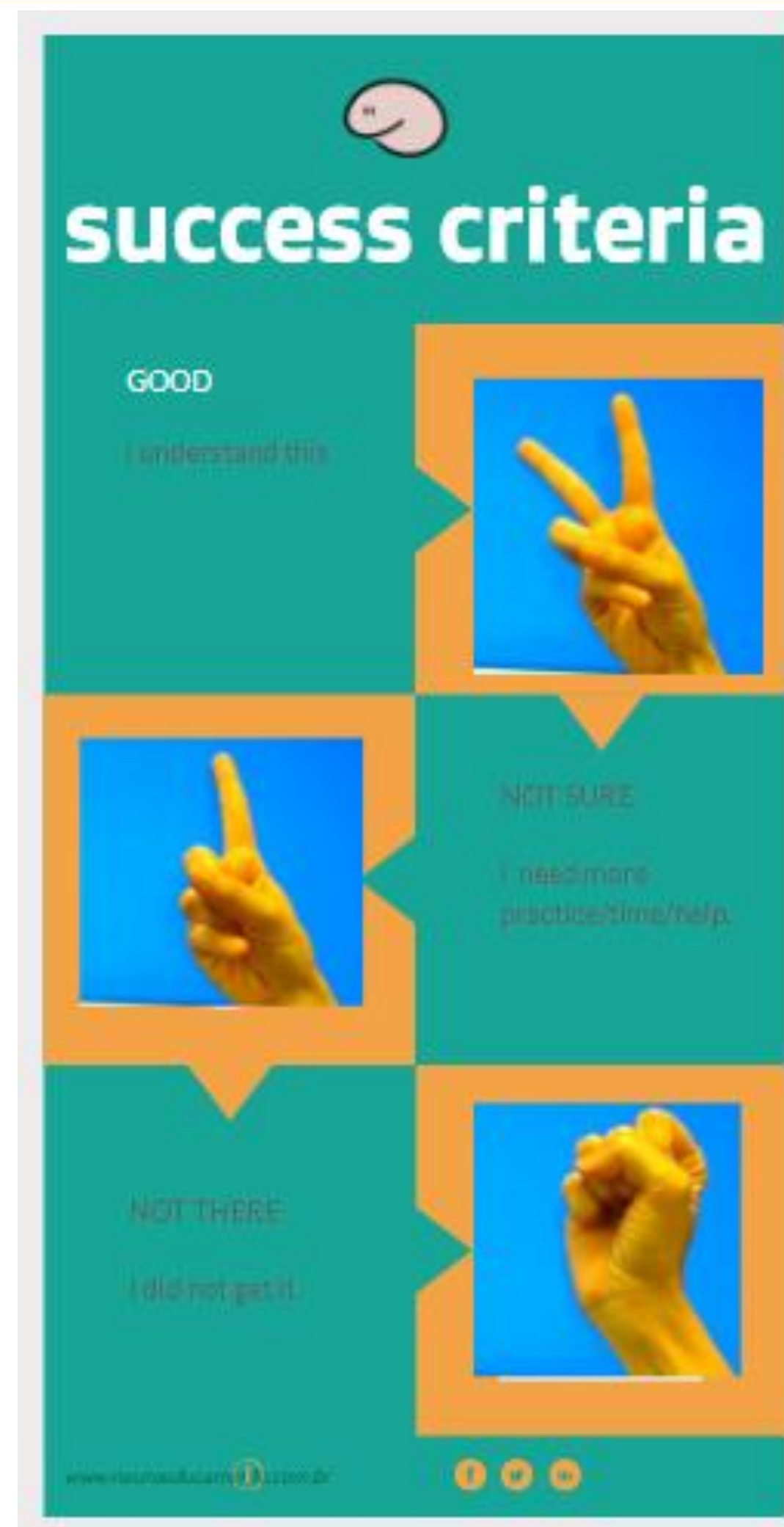
1. Self-esteem (=self-efficacy)
2. Social Cognition
3. Student-teacher relationship
4. Motivation

LEARN TO READ → READ TO LEARN

Feedback

MEANINGFUL ENVIRONMENTS EXPERIENCE

- BRAIN DEVELOPMENT & EXPERIENCE
- PATTERN SEEKER/FINDER
- PRIOR EXPERIENCE
- SAME/DIFFERENT
- RECEPTIVE SKILLS
- READING NEURAL NETWORKS



OBJECTIVES

1. Challenges
2. Meaningful environment
3. Cognitive and metacognitive strategies
4. Evidence-based: principles and best practices



(META)- COGNITIVE STRATEGIES

DEFINITIONS & DIRECTIONS

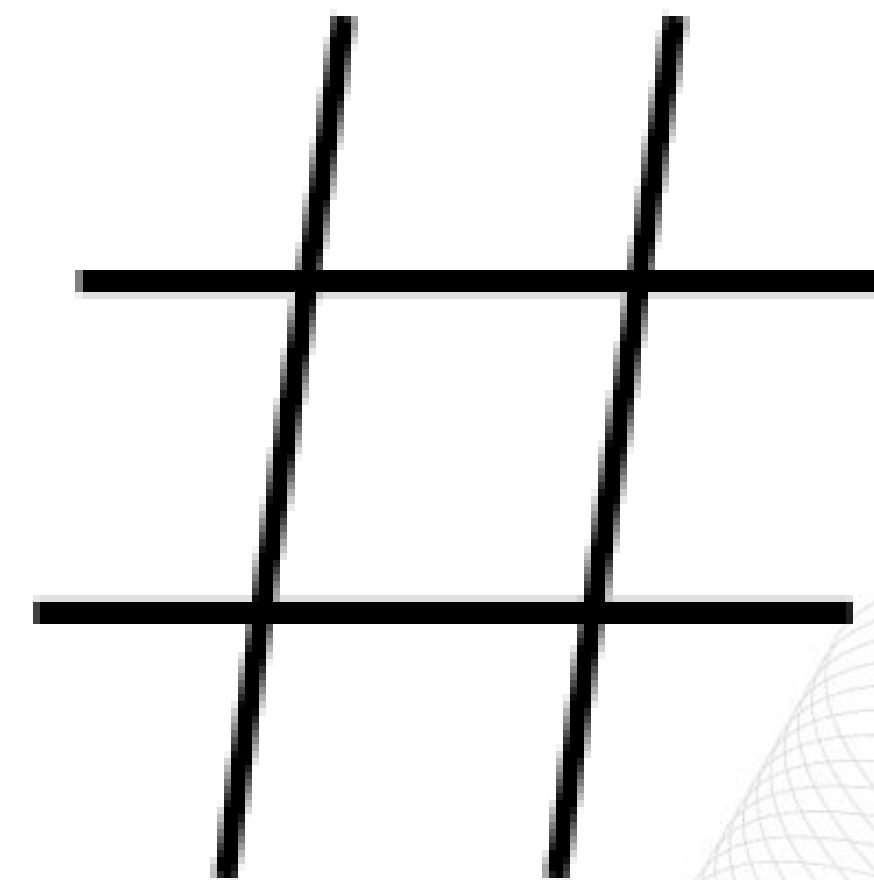
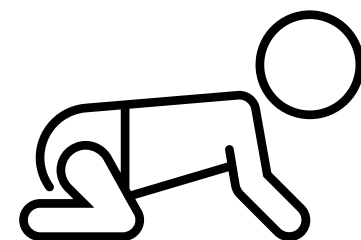
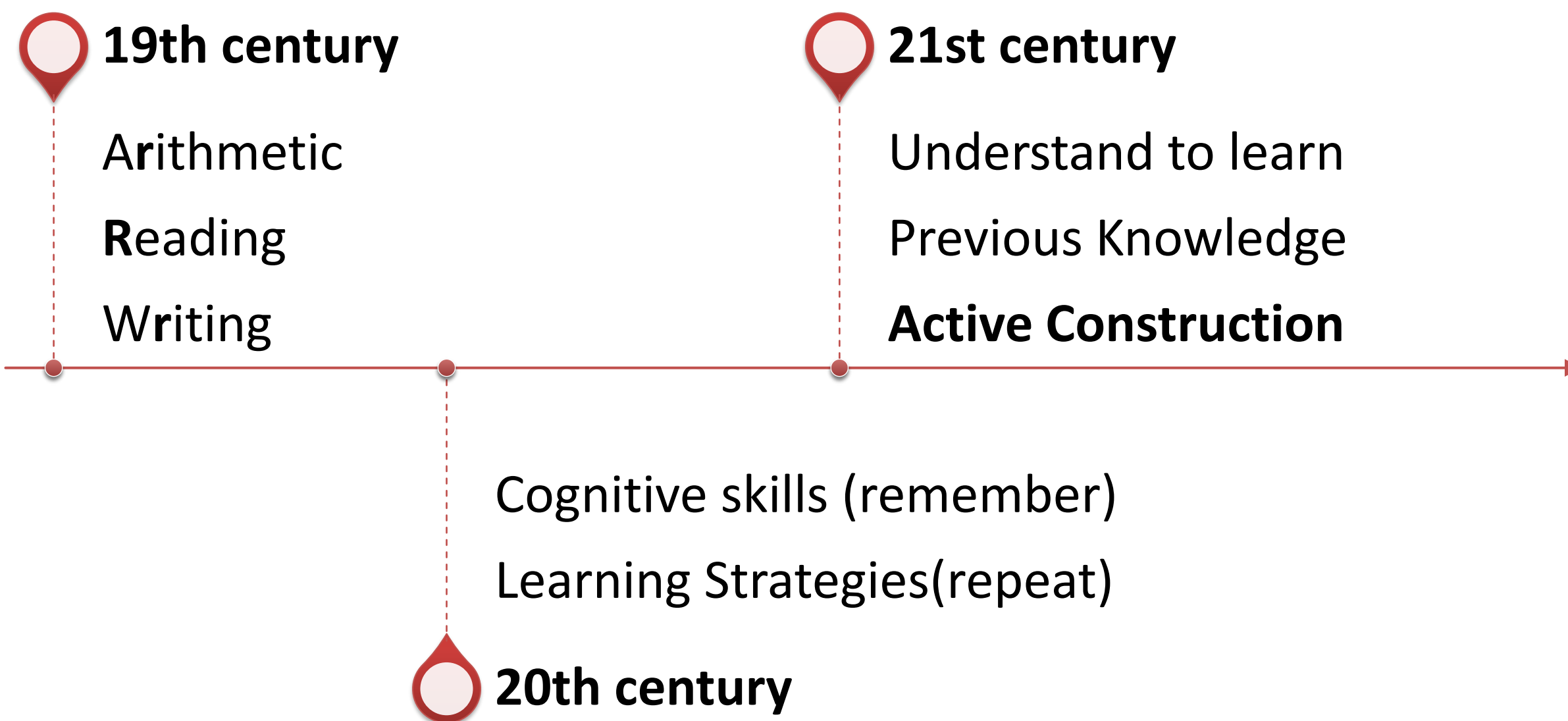


STRATEGIES

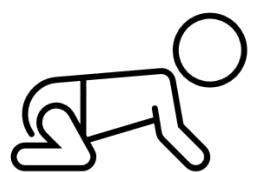
Plans for action

In what direction?

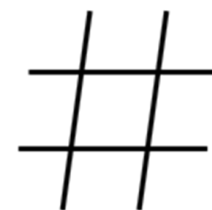
Evolution of Knowledge



From Constructivism to Neuroconstructivism



Piaget: Children build their own cognitive structures (1937)



Kandel: functional brain organization is a progressive, activity-dependent process (2000)



Knowledge



world



self

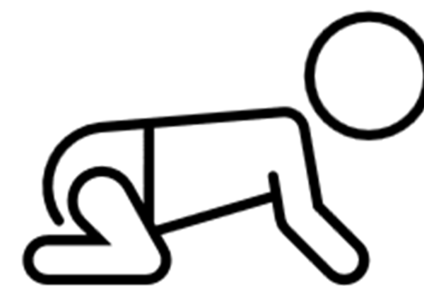


YOU KNOW ABOUT THE WORLD



TO KNOW ABOUT YOURSELF

Ways to learn about yourself



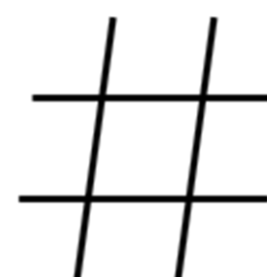
instrospection



feedback



BOTH MUST BE EXPLICITLY TAUGHT



Metacognitive self-questioning

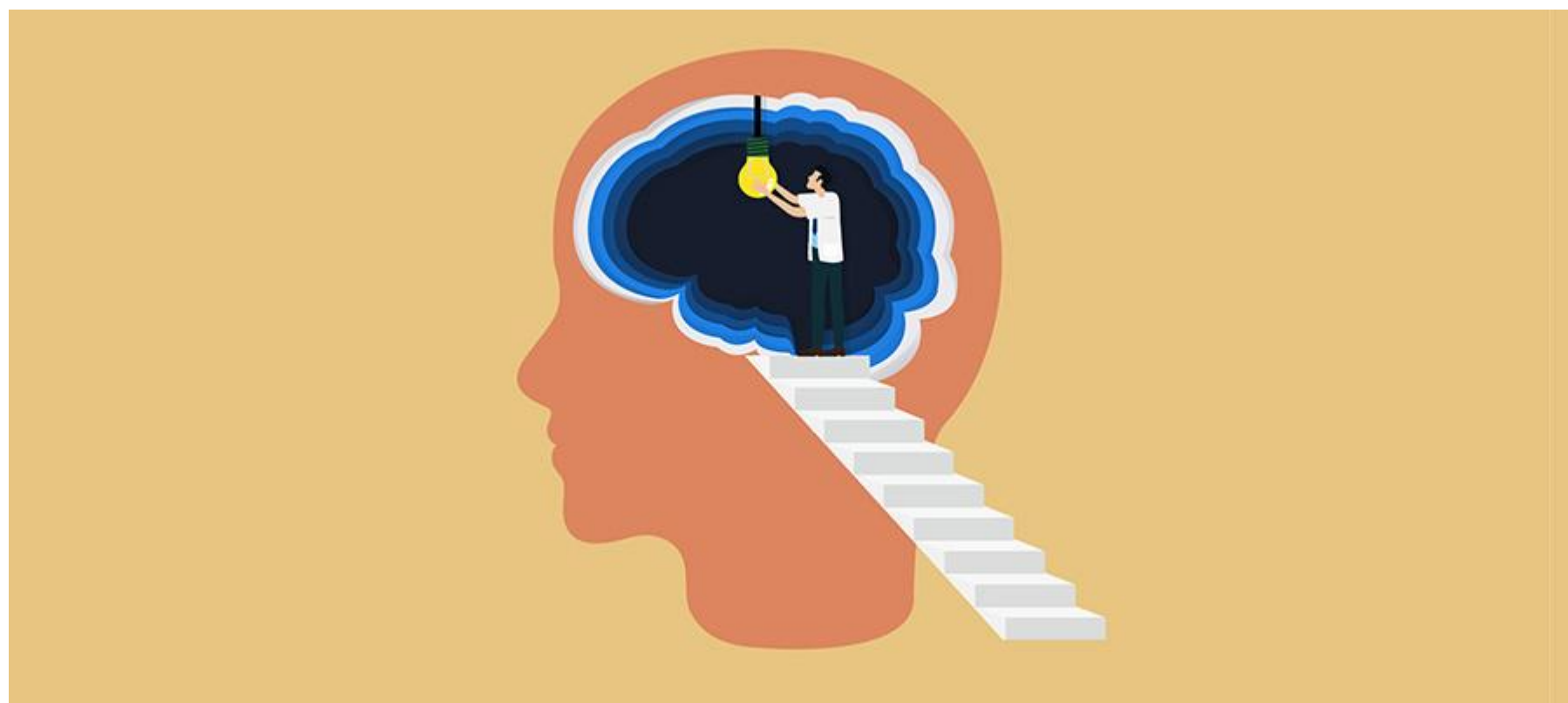


Image from <https://knowledgeone.ca/metacognition-101/>

1. What do I already know about this?

2. What do I need to know about this?

3. How can I fill this up?

4. Where do I start?



Self-Evaluation

Dopamine Mechanisms (modulation)

Optimal Stimulation

two distinct functions:

- invigorates current behavior (motivation)
- influences future behavior (learning) by reward prediction errors

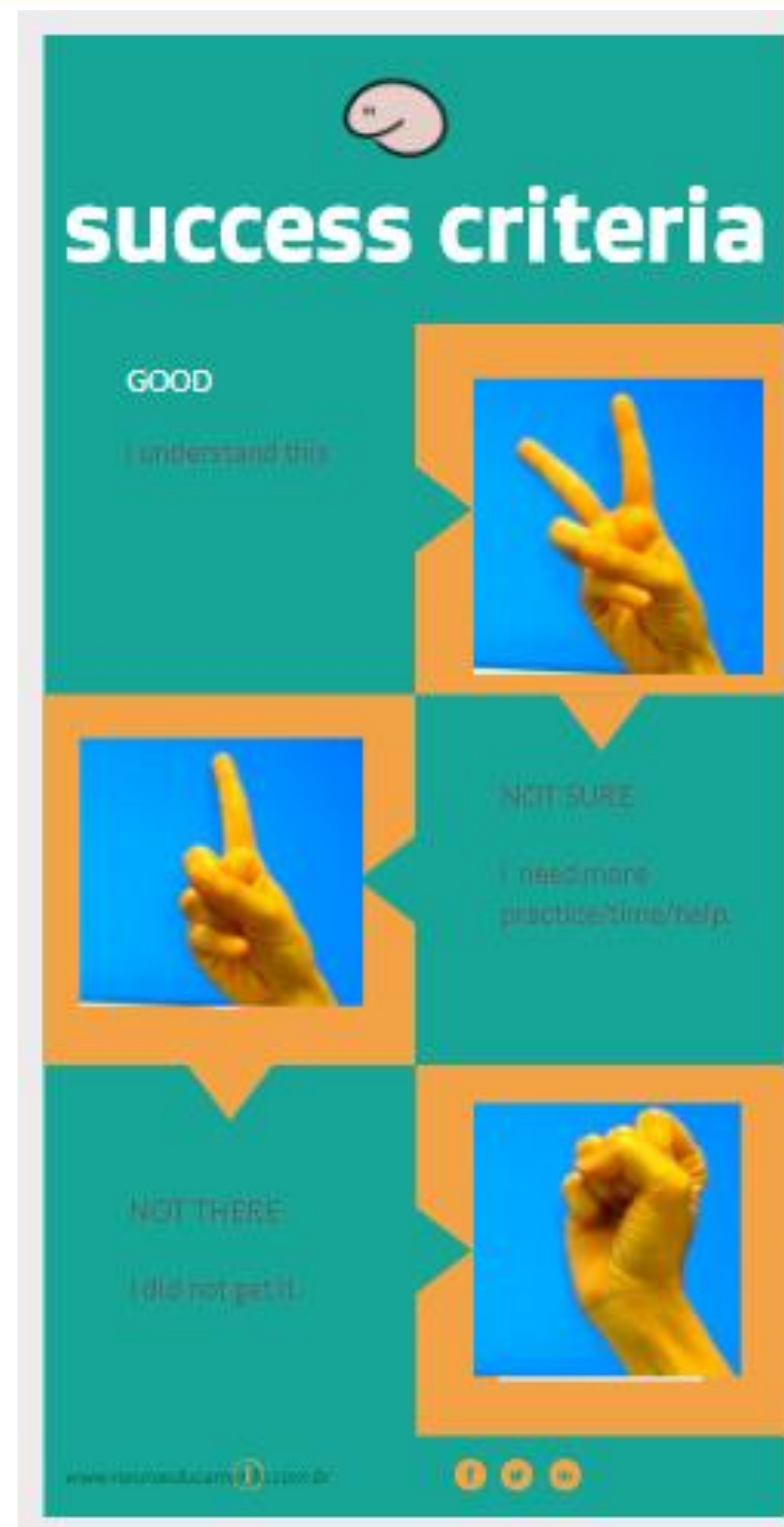
(Mohebi & Berke, 2020)



Feedback

(META-)COGNITIVE STRATEGIES

- DEFINITION
- EVOLUTION OF KNOWLEDGE
- TYPES
- DIRECTION
- EFFECTIVENESS
- (NEURO-)CONSTRUCTIVISM
- SELF-QUESTIONING/EVALUATION
- MOTIVATION/DOPAMINE



OBJECTIVES

1. Challenges
2. **Meaningful environment**
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EVIDENCE-BASED PRACTICES

PRINCIPLES

BEST PRACTICES (BASED ON TOKUHAMA-ESPINOSA, NOURI, & DANIEL, 2020)

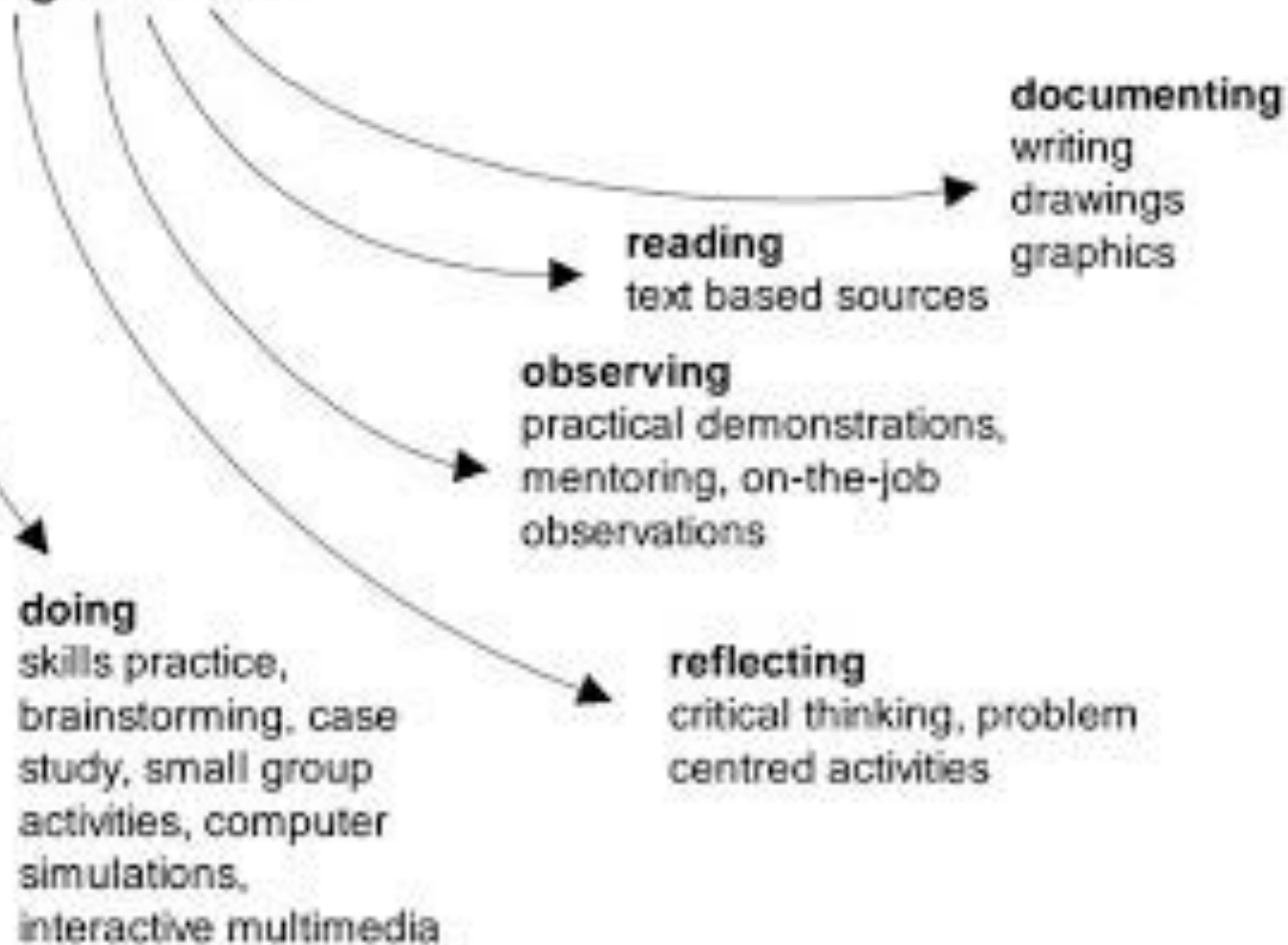


Principle #1 Uniqueness

Use multiple
approaches &
methodologies

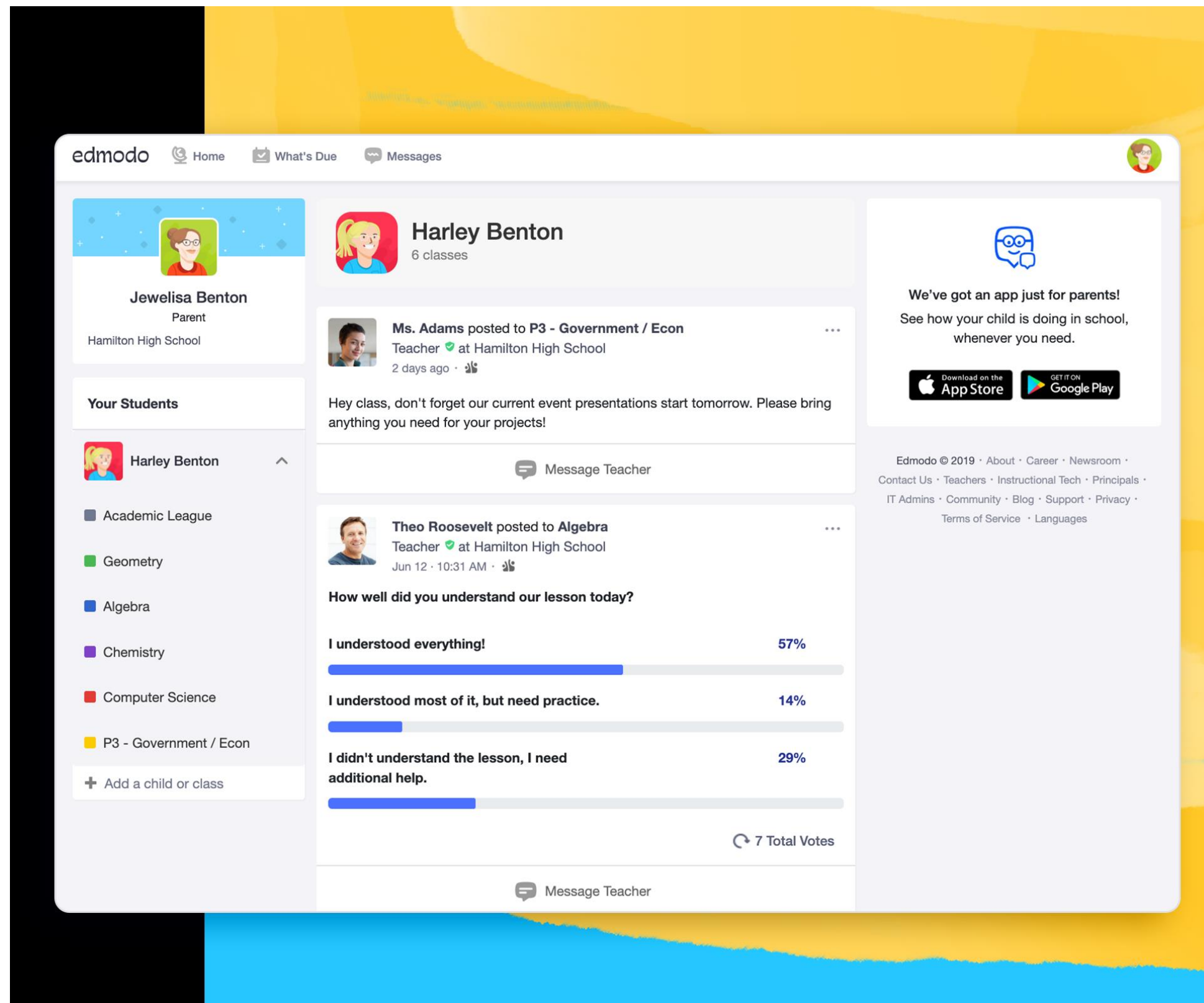
(Karmiloff-Smith et al., 2014)

Learning activities



Principle #2 Different Potentials

Manage learning at the individual level:
selective attention
(Seit et al., 2019; Stevens & Bavelier, 2012)



The screenshot displays the Edmodo web interface. At the top, navigation links for Home, What's Due, and Messages are visible. The main content area is divided into three columns:

- Left Column:** Profile for Jewelisa Benton (Parent, Hamilton High School) and a 'Your Students' list for Harley Benton. The list includes: Academic League, Geometry, Algebra, Chemistry, Computer Science, and P3 - Government / Econ.
- Middle Column:** Profile for Harley Benton (Teacher, 6 classes). A post from Ms. Adams (Teacher) asks students to bring materials for presentations. Below is a poll by Theo Roosevelt (Teacher) titled 'How well did you understand our lesson today?' with the following results:

| Response | Percentage |
|---|------------|
| I understood everything! | 57% |
| I understood most of it, but need practice. | 14% |
| I didn't understand the lesson, I need additional help. | 29% |
- Right Column:** A promotional banner for a parent app with 'Download on the App Store' and 'GET IT ON Google Play' buttons. Below is a footer with copyright information and various links.

Principle #3 Prior Experience

Let students
elaborate

(Alloway & Alloway, 2010;
Baddeley, 2012)



Principle #4 Constant Changes

Give constant
qualitative feedback
to improve learning

(Hattie, 2016)



Principle #5 Plasticity

Treat expectations
well

(Fields, 2015; Glasper & Neigh,
2019; Kolb & Muhammad, 2013)



Principle #6

Memory +
Attention =
Learning

Depth before Width

(Schwartz, Sadler, Sonnert & Tai, 2009)



Verification

| Principle | Best Practice |
|-----------------------------------|--|
| #1: Uniqueness | A. Treat expectations well |
| #2: Different Potentials | B. Let students elaborate |
| #3: Prior Experience | C. Give constant, qualitative feedback to improve learning |
| #4: Constant Changes | D. Use multiple approaches and methodologies |
| #5: Plasticity | E. Depth before Width |
| #6: Learning = memory + attention | F. Manage Learning at the individual level |

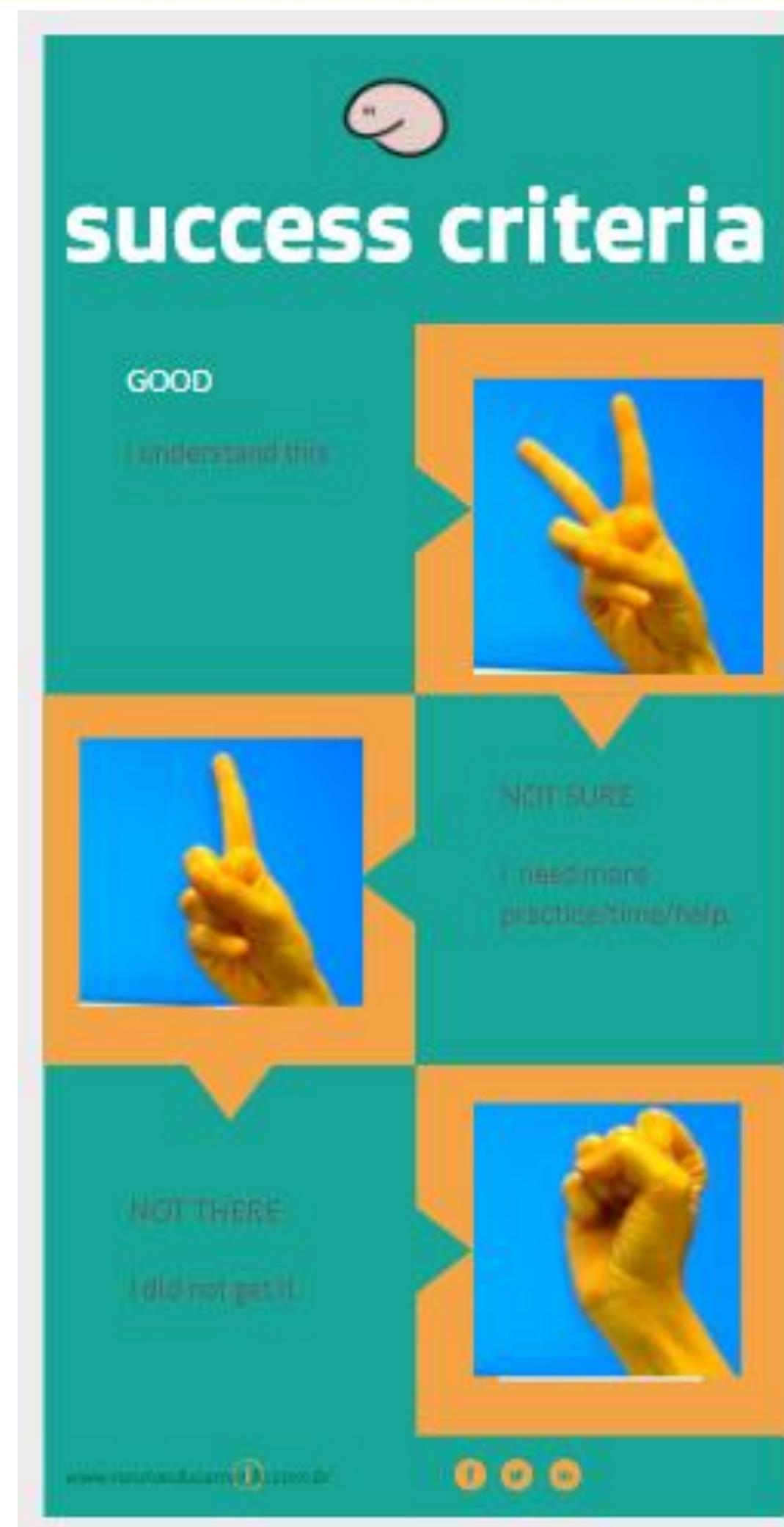
Verification: feedback

| Principle | Best Practice |
|-----------------------------------|--|
| #1: Uniqueness | D. Use multiple approaches and methodologies |
| #2: Different Potentials | F. Manage Learning at the individual level |
| #3: Prior Experience | B. Let students elaborate |
| #4: Constant Changes | C. Give constant, qualitative feedback to improve learning |
| #5: Plasticity | A. Treat expectations well |
| #6: Learning = memory + attention | E. Depth before Width |

Feedback

EVIDENCE-BASED PRACTICES

- PRINCIPLES
- BEST PRACTICES



OBJECTIVES

- Challenges
- Meaningful environment
- Cognitive and metacognitive strategies
- Evidence-based: principles and best practices



NEUROSCIENCE
&
LEARNING



IF I HAVE SEEN FURTHER,
IT IS BY STANDING
ON THE SHOULDERS
OF GIANTS.

- ISAAC NEWTON



success criteria

| | |
|---|--|
| GOOD
I understand this | |
| NOT YET
I need more practice/time/help | |
| NOT THERE
I did not get it | |

FEEDBACK

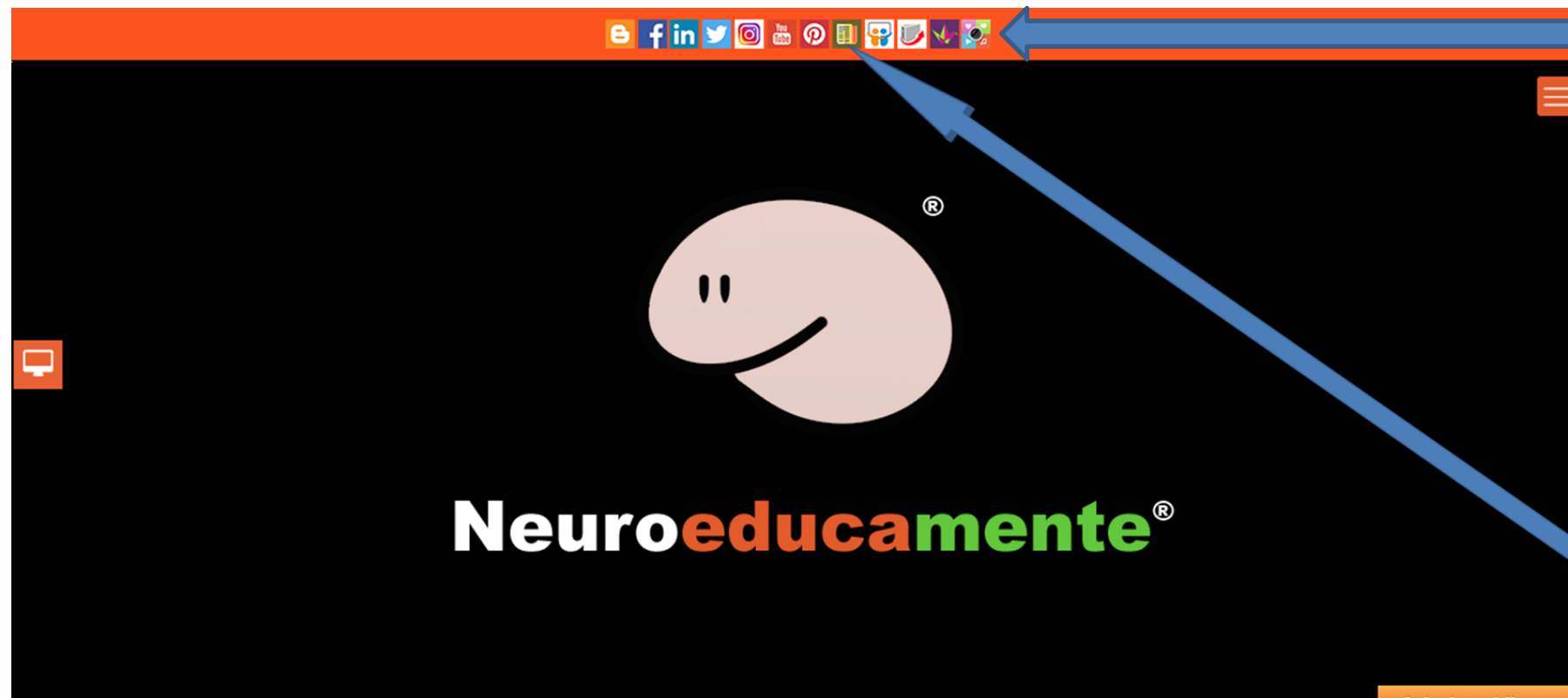
AFTER EACH OBJECTIVE



Keep Learning

www.neuroeducamente.com.br

<https://open.spotify.com/show/0UALWrRndoJstrqedJv41u>



<https://www.mindbrained.org/>

<https://essia.com/@oficinadigital/aprender-entendendo-o-cerebro>



Contact, Conflict & Copyright



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- Ramacciotti, M. (September 26th, 2020). Neuroscience and Learning. Cambridge Experience, 2nd edition. Porto Alegre, Brazil.



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