

Grey Matter: Learning and Teaching Science with the Brain in Mind

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Goals

- ▶ Provide information how neuroscience research supports the principles found in *How People Learn* and other publications.
 - ▶ Provide strategies that can be implemented in the classroom to enhance long term memory.
 - ▶ Provide instructional sequence examples to support the K-12 Framework for Science Education principles for instructional design.
 - ▶ Provide information for your own personal understanding
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Activating Prior Knowledge (APK)

- ▶ Recall what you believe to be the most effective science lesson you've delivered to students.
- ▶ Provide three reasons why you think the lesson worked so well



Agenda

- ▶ Brain-Compatible Science Lesson
- ▶ Major Findings for the Classroom
- ▶ Application to History of Science Education principles
- ▶ Application to K-12 Framework for Science Education



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- ▶ You have been hired by the Center Grove Day Care Center because of your expertise in laundry detergents and knowledge of Jello. The day care has been barraged with questions from parents on how to get the Jello stains out of their children's clothing. It seems that this day care center loves to serve Jello to the boys and girls. The day care center wants to make the parents happy and needs your help and advice on what to recommend to the parents.
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Graphic Organizer

KNOW

WHAT

LEARN

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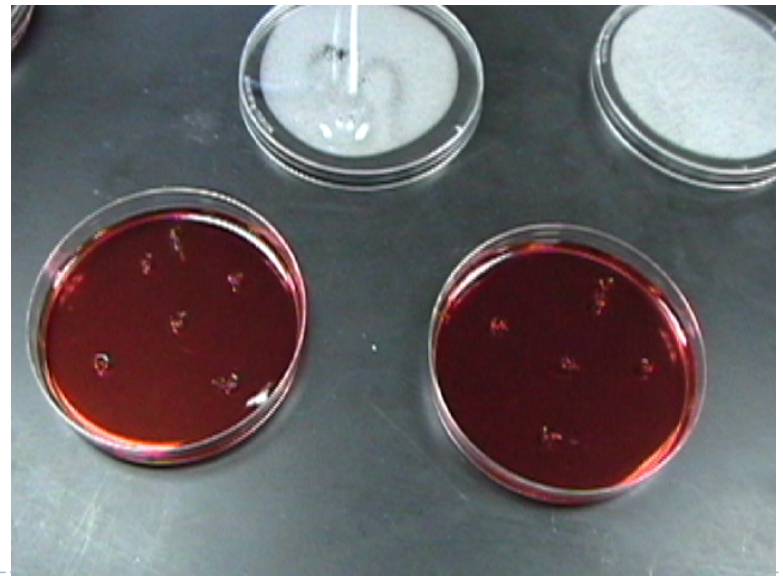


Next Steps

- ▶ Ideas to answer questions?



I JUST HAPPEN TO HAVE:



Explore

1. If given the following materials (...), how would you go about designing an experiment to find an answer to the problem statement?
 2. As you look at the examples of experimental designs, do you see any conflicting procedures, information, vagueness, or any steps that are left out?
 3. How would you go about changing any of the designs?
 4. What is the hypothesis for these experimental designs?
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Data Analysis

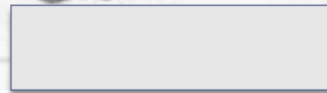
- ◆ Collect data, analyze data, share results
- ◆ Determine the cause of the results
- ◆ Research other information to help interpret results
- ◆ Assessment - Construct concept map to explain what is happening to the Jello and why and write a letter to the daycare center.



Center Grove Daycare Center,

After running several tests, we have decided that Tide Free liquid can best remove Jello Stains. The enzymes in the detergent attach on to and then break apart the proteins in gelatin, found in Jello. I would also recommend that the water used in the cycle should be warm and not hot. Extreme heat can change the shape of the enzyme. The shape of the enzyme determines what job it will do and is very specific to that job. Tide liquid seems to have the enzymes best suited for gelatin.

Sincerely,
Sarah



New Questions:

- ▶ Grease stains
- ▶ Chocolate milk stains
- ▶ Recombinant Detergent – *Bacillus* bacterium



Why successful?

- ▶ List three reasons why you think this lesson series was successful.

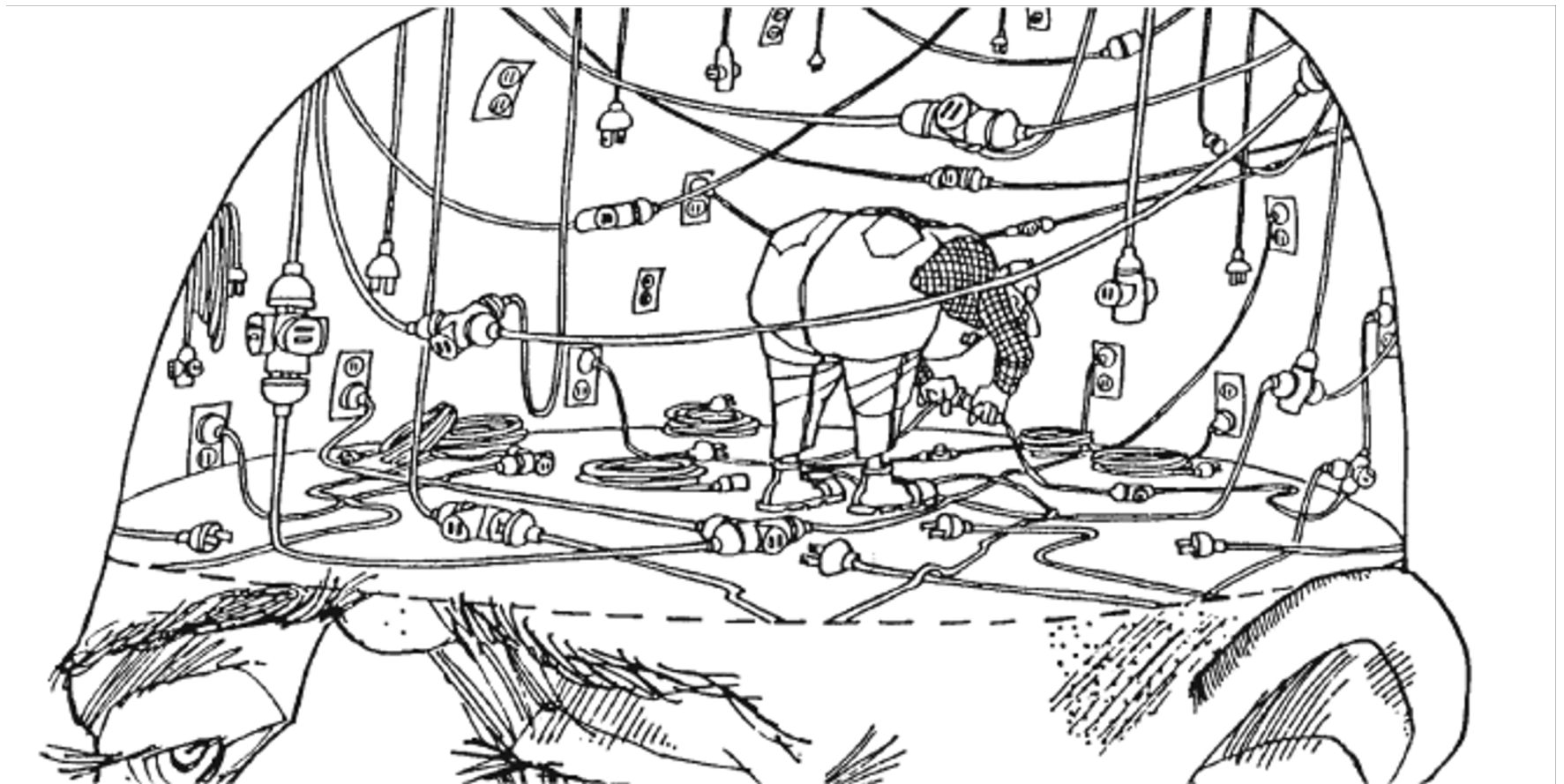


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How the Brain Works



Mind, Brain, and Education Science

MBE Science joins the knowledge of:

- ▶ How neurons change (neuroscience)
- ▶ How behaviors are modified (psychology) with
- ▶ How students learn (education)

– Tokuhamma-Espinosa (2010)



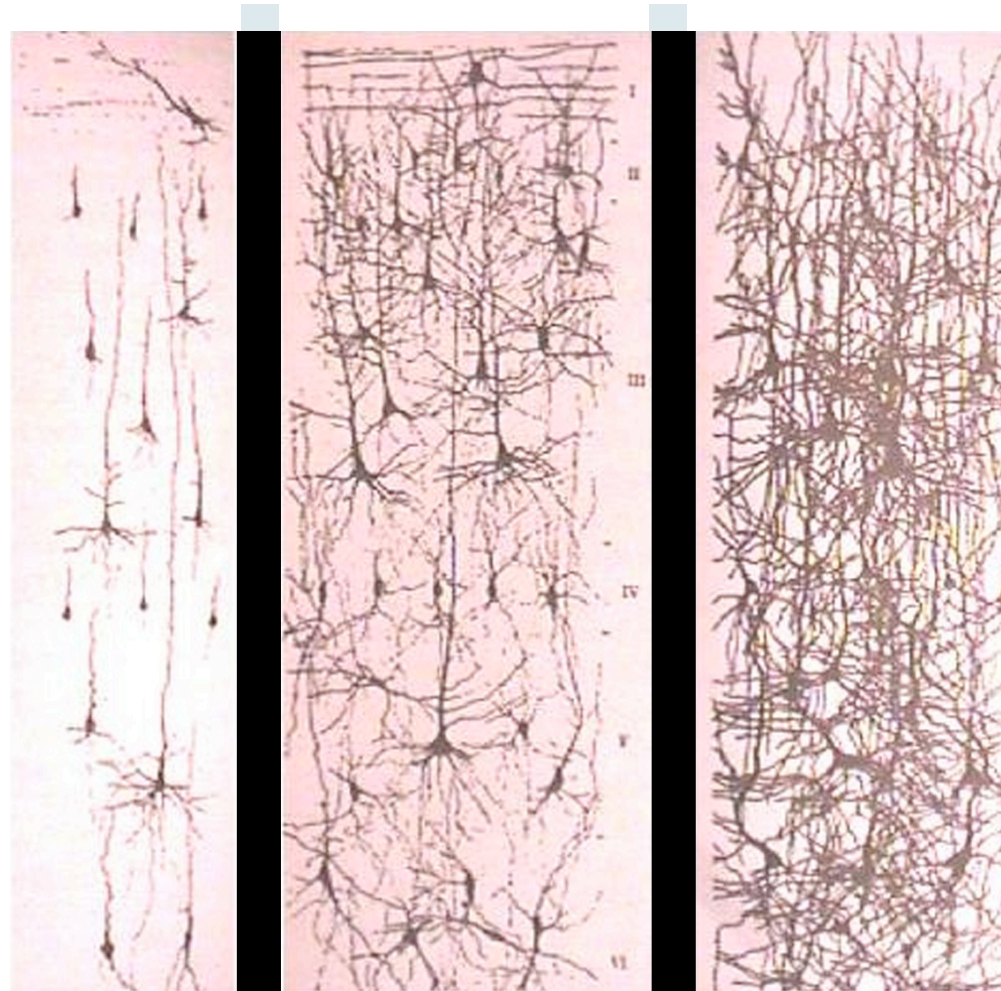
1. Experience sculpts the brain.

- ▶ Application: Students learn what they experience.



Neuronal Branching

Dendrites
& Synapses



BIRTH

3 MONTHS OLD

2 YEARS

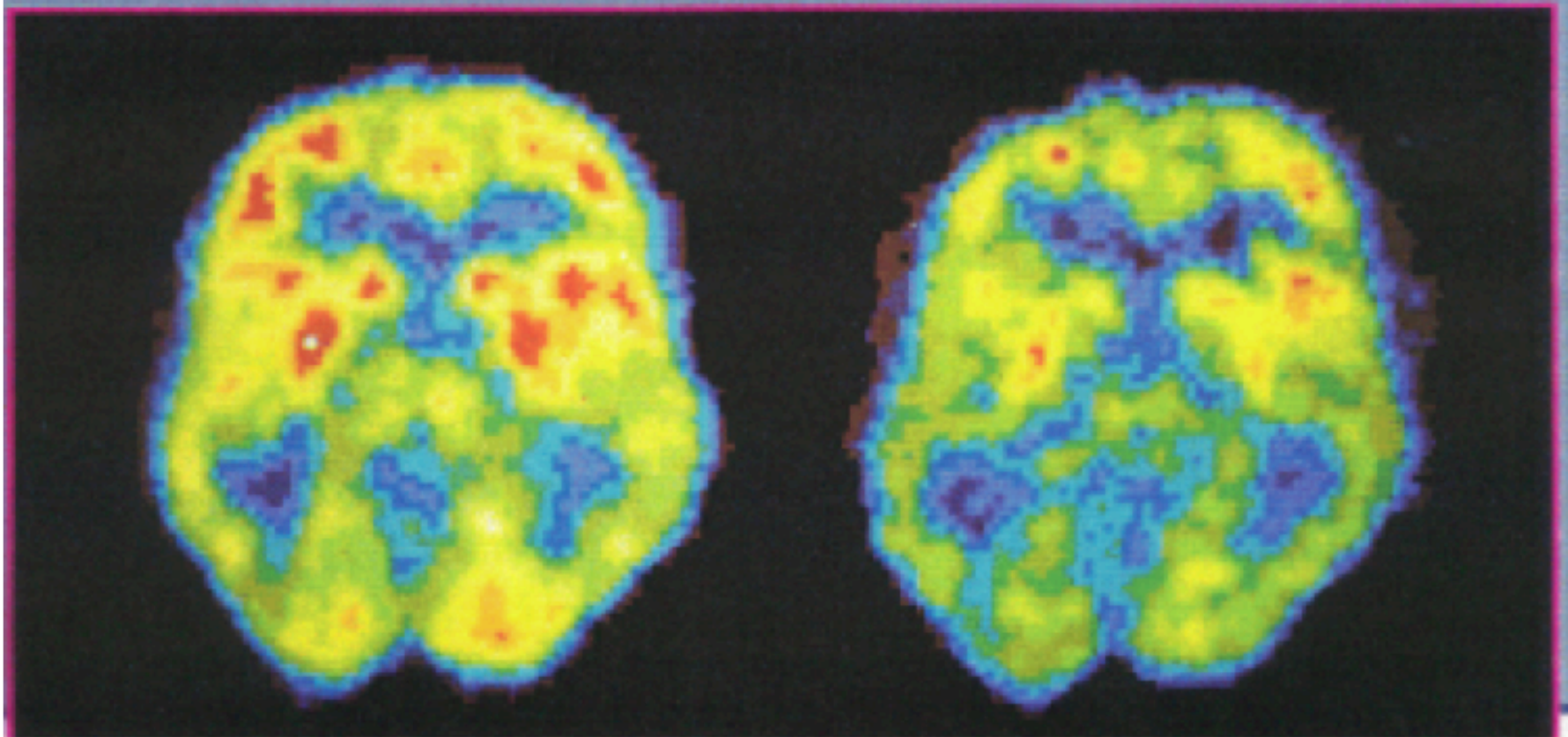
1. Experience sculpts the brain.

- ▶ Application: Students learn what they experience.
- ▶ Neuroplasticity:



PET images depict levels of activity in the brains of two people playing a computer game. With red and yellow indicating high levels of activity, the scans reveal that an experienced player (below, right) burns significantly less energy than a novice (be-

low, left). Learning, then, seems to be a function not of greater effort but of increased neuronal efficiency. Indeed, players who score high on standard IQ tests show the most precipitous drop in mental exertion while learning the game.



1. Experience sculpts the brain.

- ▶ Application: Students learn what they experience.
- ▶ Neuroplasticity:
- ▶ Strategies:



Strategies - Experience

- ▶ Designing experiments
- ▶ Field Trips
- ▶ Simulations
- ▶ Role Play



2. The brain seeks meaningful patterns.

- ▶ Application: Find or construct links between new information and previously stored information.



2. The brain seeks meaningful patterns.

- ▶ Application: Find or construct links between new information and previously stored information.
- ▶ Attention:
- ▶ Meaning
- ▶ Emotional component



Using Analogy to Understand Large Numbers

- ▶ Draw a line approximately 4 inches long
- ▶ Label the left end of the line “one million dollars”
- ▶ Label the right end of the line “one trillion dollars”
- ▶ Make a mark on the line indicating where one billion dollars would fall



2. The brain seeks meaningful patterns.

- ▶ Application: Find or construct links between new information and previously stored information.
- ▶ Attention:
- ▶ Meaning
- ▶ Emotional component
- ▶ Strategies:



Strategies - Meaning

- ▶ KWL
- ▶ Metaphor, Analogy, Simile
- ▶ Brain Storming
- ▶ Thinking Maps
- ▶ Project/Problem Based Learning



3. Emotions are a primary catalyst in the learning process.

- ▶ Application: Provide a physically and psychologically safe environment. Provide emotional hooks.



Question

- ▶ What was your most favorite learning experience from either K-12 school or graduate school?



Question

- ▶ What was your most favorite learning experience from either K-12 school or graduate school?
- ▶ Turn to you neighbor and share the learning experience and identify why you think it was your favorite based on your knowledge of the brain.



3. Emotions are a primary catalyst in the learning process.

- ▶ Application: Provide a physically and psychologically safe environment. Provide emotional hooks.
- ▶ Strategies:



Strategies - Emotion

- ▶ Rhyme, song, rap
- ▶ Story-telling
- ▶ Mnemonics
- ▶ Role play/Simulations
- ▶ Student journals



4. There are two distinct types of memory.

- ▶ Application: Long Term Memory can be enhanced by the use of elaborative rehearsal strategies or in-depth processing.
- ▶ Two Types of Memory
 - ▶ Procedural Memory (*Implicit*) – How
 - ▶ Declarative Memory (*explicit*) – What



Memory is not static and decays rapidly

- ▶ Rehearsal:
 - ▶ Rote:
 - ▶ Elaborative:
- ▶ Strategies:



Strategies – Memory/Rehearsal

- ▶ Reciprocal/Peer teaching
- ▶ Walk and Talk
- ▶ Reflect and Write (one-minute paper)
- ▶ Simulations
- ▶ PBL
- ▶ Compare and contrast
- ▶ Foldables
- ▶ Quick Write/Quick Draw



Revisit “The Enzyme Story”

Where would we use these findings?

1. Experience shapes the brain
2. The brain seeks meaningful patterns
3. Emotion is a catalyst for the learning process
4. Two distinct types of memory



Reflection

- ▶ Find an elbow partner
- ▶ Introduce yourself and decide who is A and who is B
- ▶ A will start and share something that he/she has learned so far. B listens
- ▶ After 1 minute switch roles
- ▶ B will next share something that he/she has learned so far. A listens.



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How Students Learn Science

- ▶ Addressing preconceptions
- ▶ Knowledge of what it means to “Do Science”
- ▶ Meta-cognition



K-12 Framework for Science Education

- ▶ Integration of three dimensions:
 - ▶ Scientific and engineering practices
 - ▶ Crosscutting concepts
 - ▶ Disciplinary core ideas
- ▶ *Integrated Instructional Design*
 - ▶ Improve mastery of subject matter
 - ▶ Develop scientific reasoning
 - ▶ Cultivate interest
 - ▶ Effective for diverse groups of students
 - ▶ Apply BSCS 5E Instructional Model (Engage, Explore, Explain, Elaborate, Evaluate)



Application to K-12 Framework

- ▶ Integration of instructional sequence – 5 E Learning Cycle
 - ▶ Engage – Get attention of the brain
 - ▶ Explore – Allows brain to interact with content
 - ▶ Explain – Provides meaning and patterns
 - ▶ Elaborate – Source of rehearsal
 - ▶ Evaluate – Assess to match context of learning



Revisit Your Effective Science Lesson

Using the following code, identify the four major findings to the reasons why lesson was effective.

1. Experience shapes the brain
2. The brain seeks meaningful patterns
3. Emotion is a catalyst for the learning process
4. Two distinct types of memory/rehearsal strategies



Based on your new learning,
what might you:

- **stop** doing?
- **continue** doing?
- **start** doing?



Better learning will
come not so much
from finding better
ways for the teacher
to instruct...



But



From giving the
learner better
opportunities to
construct.

*Adapted from
Seymore Paper, 1990*

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References:

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