Thinking Skills
(produce learning skills)

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"The purpose of an educational institution is to lead the students, who initially believe the educational institution is there to educate them, to the realization that they must educate themselves."

"They must …learn how to learn [*integratively*]…"

From Willis Hurst, MD, Medscape

[*and Pelley*]

They must educate themselves!

- But, why?
  - Expectations of advanced degree graduates
  - People who lack the ability to educate themselves are terrible problem solvers
  - Self-regulated learners are more effective in research direction and application
- Well then, how *do* we educate ourselves?
  - Retrain your brain by learning about how it works
  - Metacognition – thinking about thinking

What is metacognition and why is it important?

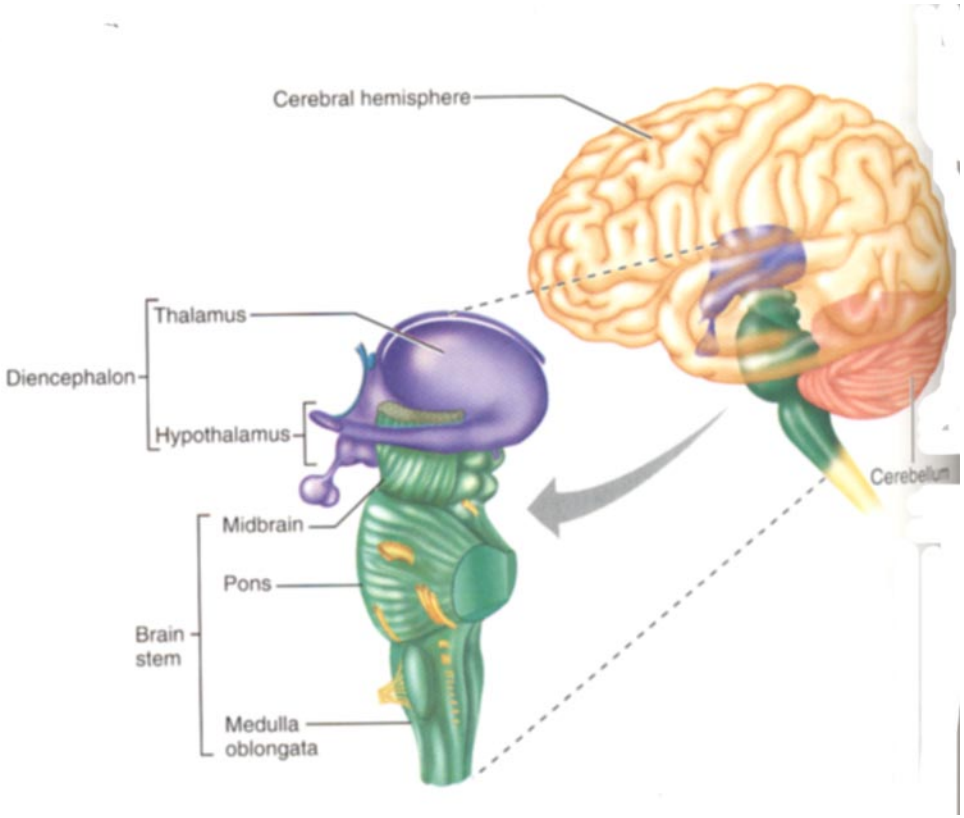
- Research shows applied metacognition increases both intelligence and academic performance
- It is an absolute requirement for understanding cause-and-effect.
- Examples of effects:
  - Grades on exams
  - Successful experiment design
  - Successful grant proposals
  - Any skill development

Main Points Today

1. Students need to transform themselves from *receiver* role to *producer* role.
   - Receiving information vs producing understanding
2. Deliberate Practice produces skilled thinking.
   - You study for the teacher but you learn for yourself.
   - Responsibility for learning lies with student.
3. The brain is wired to predispose thinking/learning “styles.”
   - Learning style tells you how to do Deliberate Practice

Your Thalamus Distributes My Biochemistry Lectures To Your Cerebral Cortex

Thalamus volume setting is high or low (gain control)



Prefrontal Pause
(1 minute)

Getting In Touch With Your Thalamus

- Thalamus
  - Base of brain; top of spinal cord
  - Distributes all sensory information to higher centers
  - Thinking requires both sensory input and memory

Talk with a neighbor about how you do your best thinking:

- Talk it out or,
- Think it through

Low Gain vs. High Gain

- Talk it out – “low gain” thalamic activity; seeking more input; more active
  - Extraversion; low arousal level – too quiet
  - Lower cerebral blood flow, augmentation of “evoked response,” lower doses of sedatives
- Think it through – “high gain” thalamic activity; reducing input; more reclusive
  - Introversion; high arousal level – too loud
  - Higher cerebral blood flow, reduction of “evoked response,” higher doses of sedatives

Extraverson vs Introversion

- Everybody does both; one is easier and more comfortable
- Normal behavior is adaptable
- Preference only describes what is easier, not what is limited
- You can develop the opposite as a skill and be good at both
- Professionals are good at both

Mindset Comparison

Fixed Mindset

- IQ is fixed
- Success based on innate ability
- Failure is dreaded, feared.
- Least likely to succeed

Growth Mindset

- IQ can increase
- Success based on working smart
- Failure is a challenge to adapt.
- ***Most likely to succeed***

Mindset goals are different

Fixed Mindset

- Look smart at all times – and all costs
- Effort is a bad thing.
- Setbacks reveal your deficiencies

Growth Mindset

- Learn at all times – and all costs
- Effort activates abilities.
- *Setbacks happen!*

Mindset is a *cause!*

So, what do you have to do to get the growth mindset?

- Learn about deliberate practice
- Learn about metacognition
  - Learning styles and cortical specialization
  - Sleep processing
  - Learn how to spend time

Deliberate Practice Characteristics

- Applied to limitation in skill
- Focused effort; demanding
  - Not much fun; motivation critical
  - Learn to avoid automated behavior (=Loss of focus and attention, esp. while reading)
- Highly demanding mentally; tiring
- Not aimed at minimum standards
  - Goal is continuous improvement in skill

Myers-Briggs Personality Types And Learning Style

- Preferences influence how you learn.
- Self awareness critical first step in deliberate practice
- Affects academic performance
- Describes effective learning practices

Myers-Briggs Personality Type – What It Is

- Normal differences between people
- Persistent tendencies (choices)
  - Do not change once established
  - e.g. Folding your arms
- Comfort zone for thinking;
  - Requires less effort than the opposite
  - Use of opposite is a conscious effort
  - Use of opposite is also normal in everyday thinking

Myers-Briggs Personality Type – What It Isn't

- Not a measure of intelligence
- Not a "limitation"
- No negative aspects
- No psychopathology
- No stereotype

Figure 8.3 Comparison of aptitude and achievement of the sixteen types in liberal arts

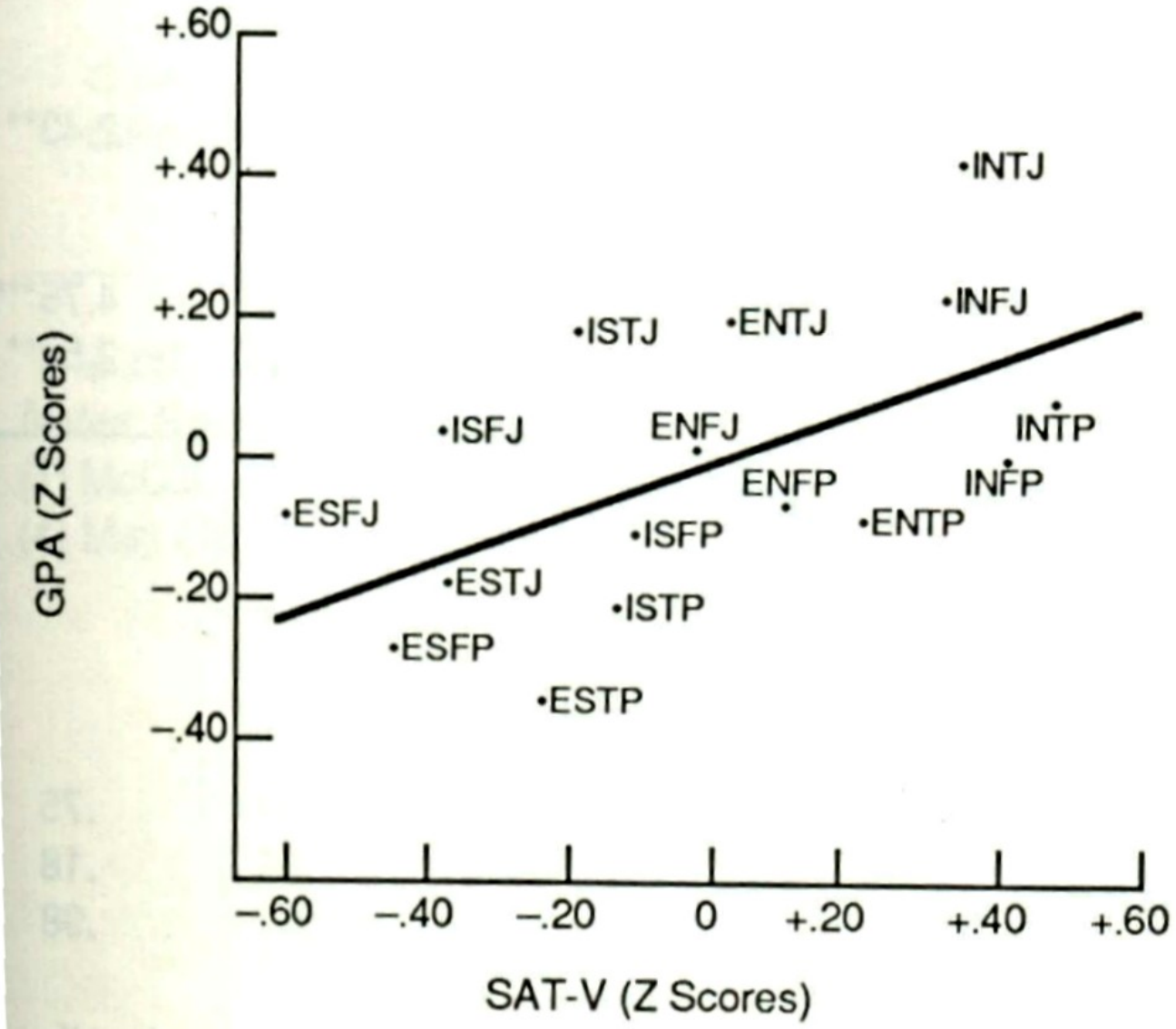
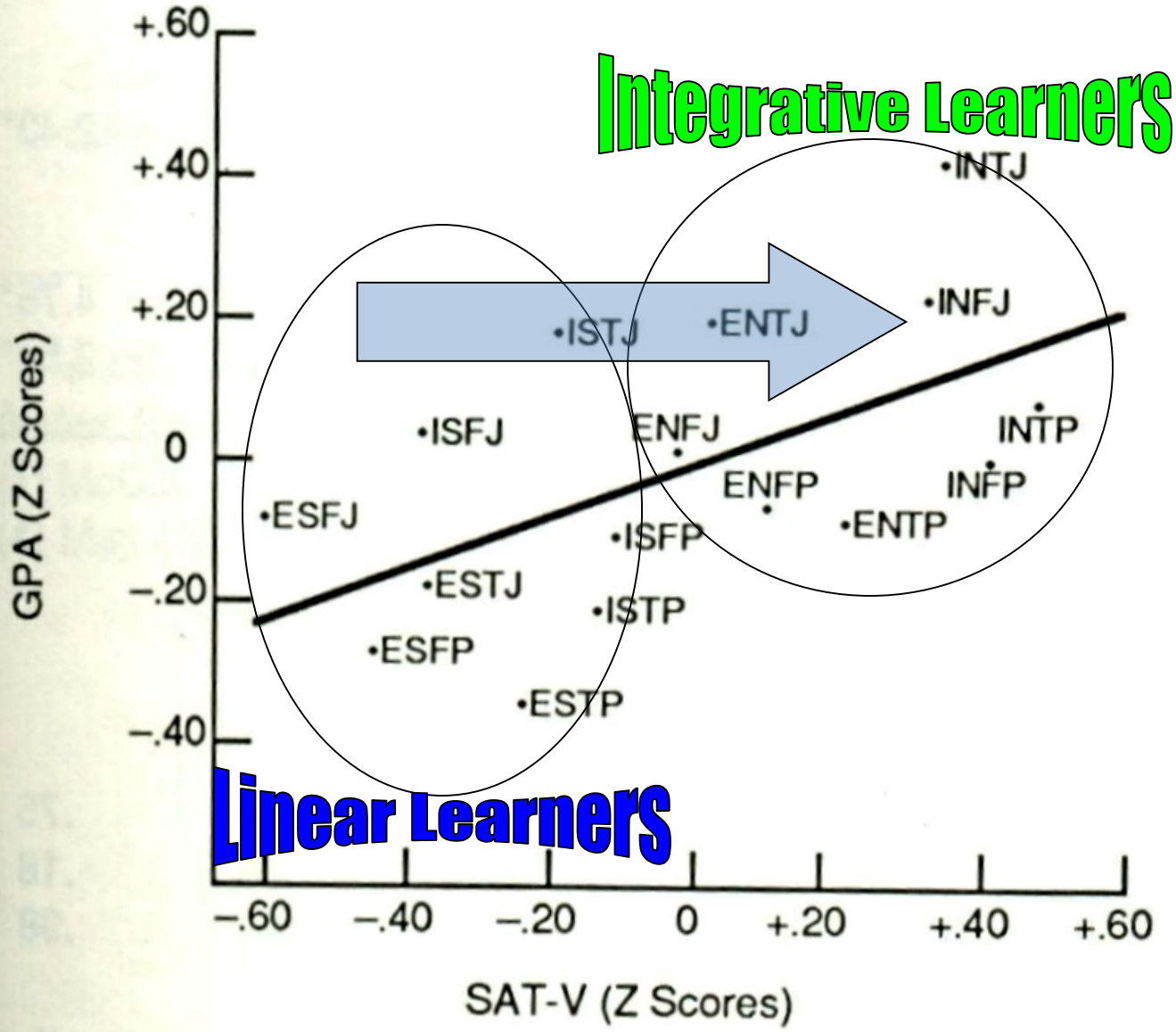


Figure 8.3 Comparison of aptitude and achievement of the sixteen types in liberal arts



What Do Those Letters Mean?

- Four dimensions of preferences

  Extraversion (E) vs. Introversion (I)*

  Sensing (S) vs. Intuition (N)*

  Thinking (T)* vs. Feeling (F)

  Judging (J) vs. Perceiving (P)*

*Pelley's type

Prefrontal Pause
Sensing Type vs Intuitive Type

- Talk for a minute with your neighbor about what your preference might be:
  - Think better with “facts and specifics”
  - Think better with “big picture and connections”
- Try to give an example
- Does it worry you that there is another way to think?

Sensing (S) vs. Intuition (N)

- What information do you give the *most* attention to?
  - Sensing types give their attention to specifics
  - Intuitive types give their attention to the “big picture”
- Everyone does both, but only *one* is preferred.
  - Use of opposite is *deliberate*; not automatic

Test Taking Style

- N style
  - Seek answer that matches big picture
  - Rule out answer choices
    - Don’t fit pattern
    - Big picture learning establishes patterns
- S style
  - Seek answer that matches memorized knowledge
  - Re-read question to stimulate recall
  - Memorization learning relies on recognition

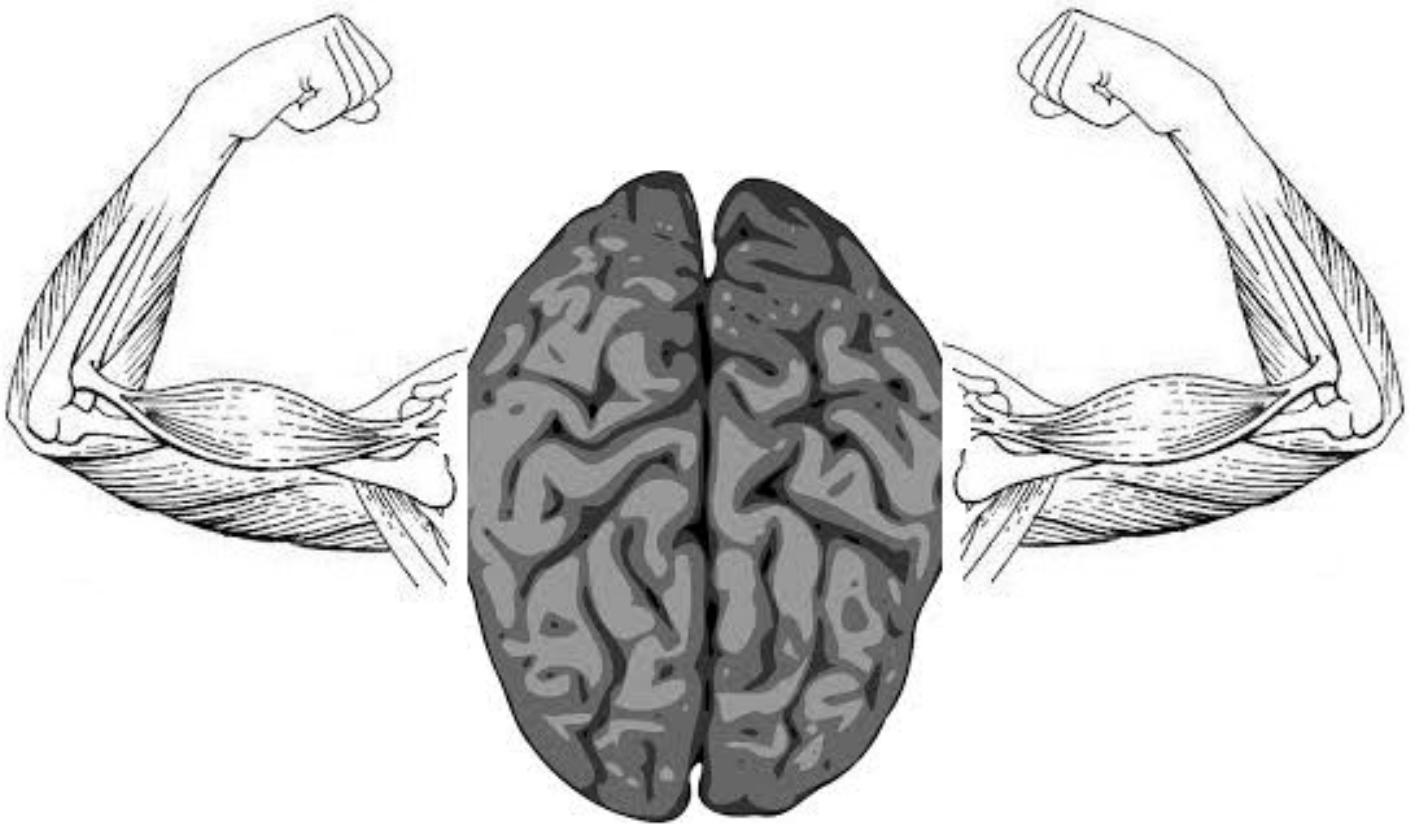
Memorization vs. HOTS

- Memorization
  - Recall: remembering facts/details and their "organization" (list the symptoms of heart attack)
  - Preferred by sensing types
- Higher Order Thinking Skills (HOTS)
  - Grouping: "organizing" facts into patterns
  - Comparing: relationships between patterns (explain the causes of chest pain)
  - Preferred by intuitive types

How Do Preferences Relate To Learning?

- Extraversion: Good at initiating
  - think out loud and then think alone
- Introversion: Good at reacting
  - think alone and then think out loud
- Sensing: Enjoy using what already learned
  - bring details but neglect relationships
- Intuition: Enjoy learning new things
  - bring patterns and relationships but missing some details

Can We Change Our Own Brain?



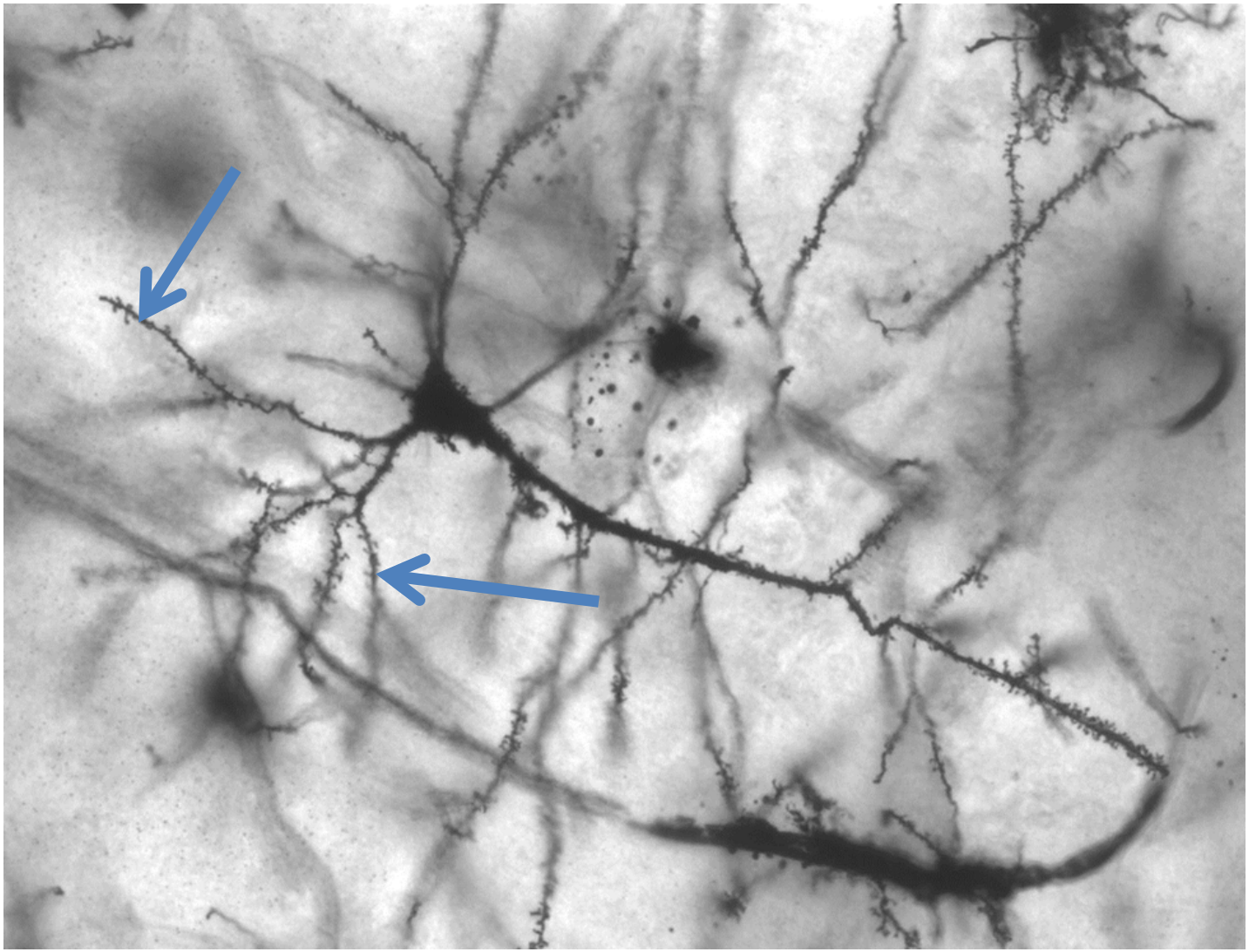
Developing Expert Skills – Transforming The Brain

- How do we change our brains?
- Learning efficiency: What is the “illusion of memory?”
- What does brain anatomy tell us about how we learn?
- Clinical skill areas of the brain

Sleep Helps Us Forget - or, Learn

- Forgetting Can Be A Good Thing
  - Neurologic protection: no cluttering with irrelevant information.
- The brain is designed to forget.
  - New synapses form during the day.
  - Unneeded synapses pruned overnight; saves energy
  - Valuable synapses strengthened into long term memory (= consolidation)

“Grow Baby, Grow”



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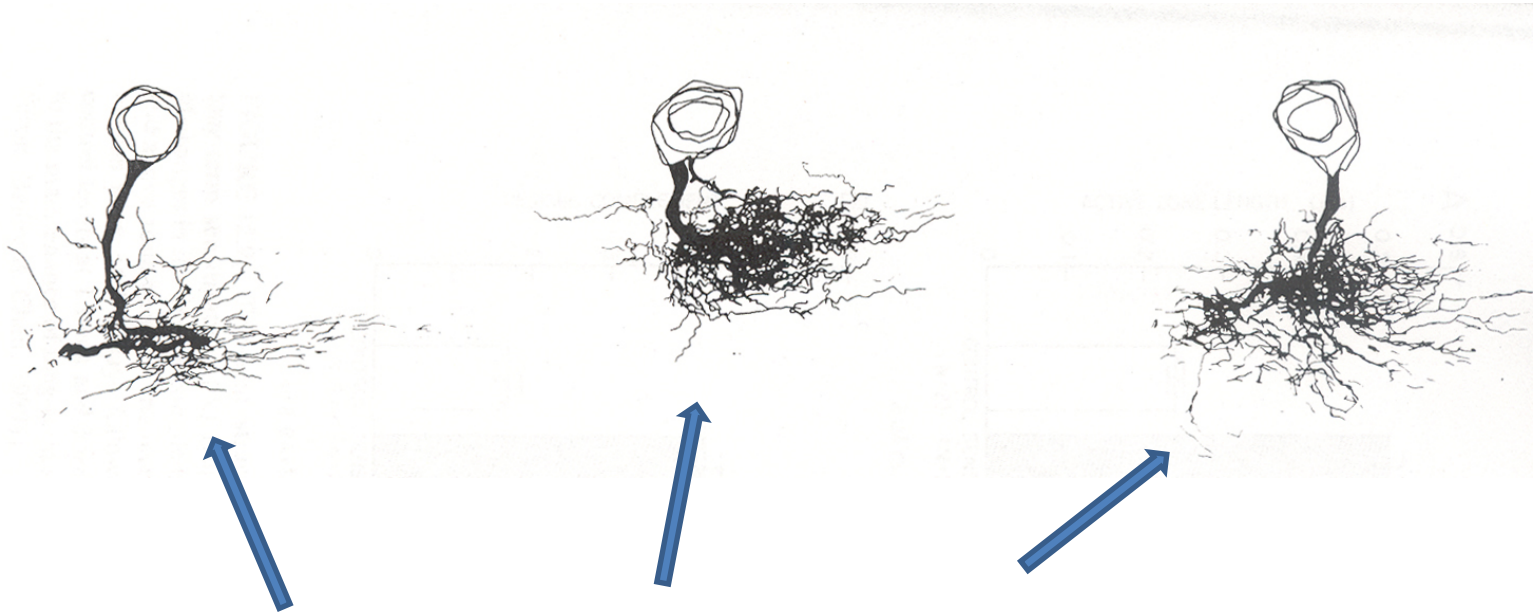
To Sleep, Perchance To Replay

- Replay of activity
- Non-dreaming deep sleep
- Emotional only
- Pruning of unimportant experience
- Valuable experience consolidated

Can You Find The Sittin' And Readin' Dendritic Tree?



Sittin' and readin'

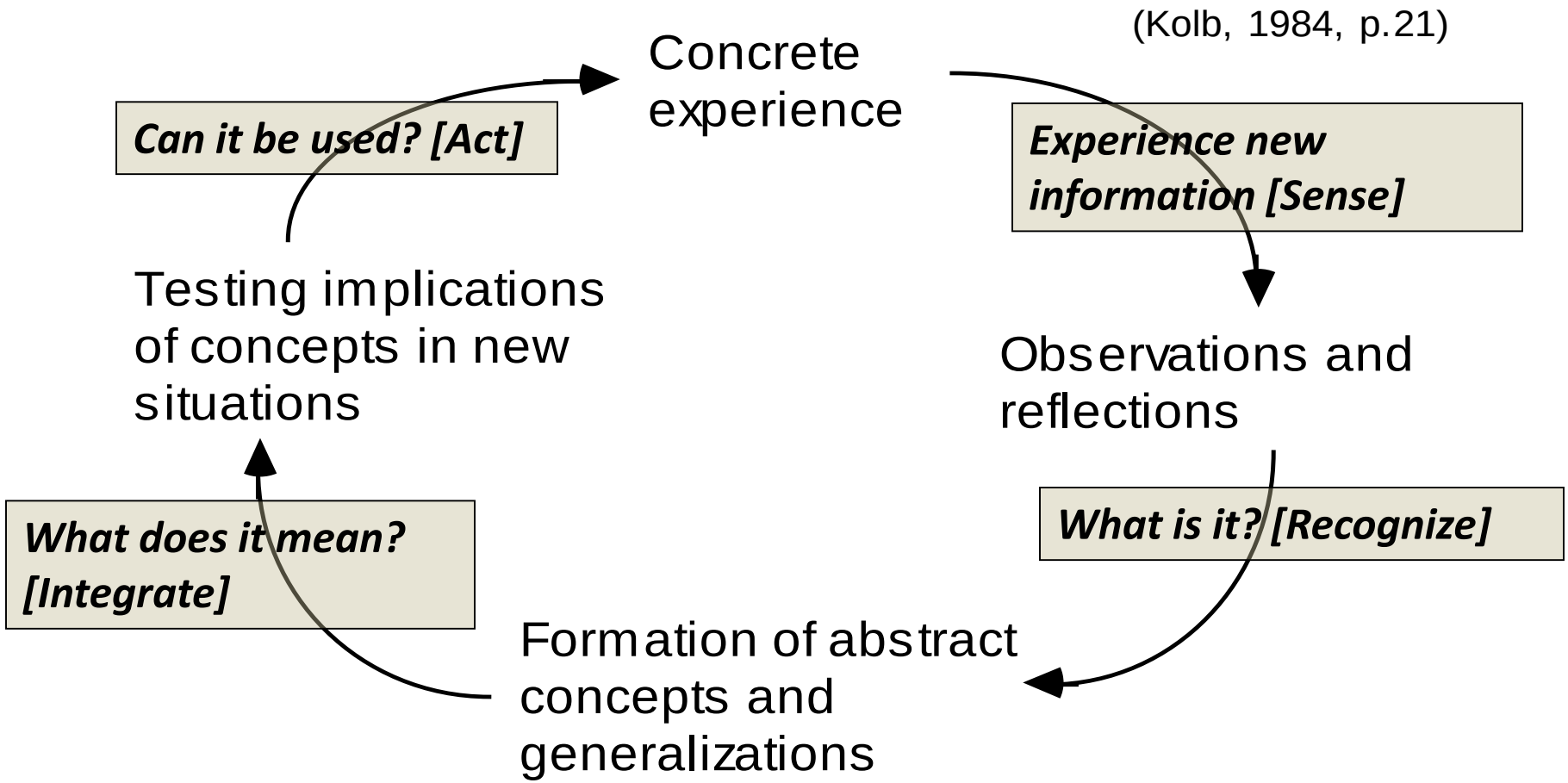
1. Complete learning cycle
2. Sleep (5 REM cycles)

- Control left, long-term potentiated (LTP) cells sensitized right
- Tree of LTP markedly increased (hippocampus "rehearsal").
- Dendritic trees are "processing power."
- Prefrontal dendritic growth increases analytic skill.

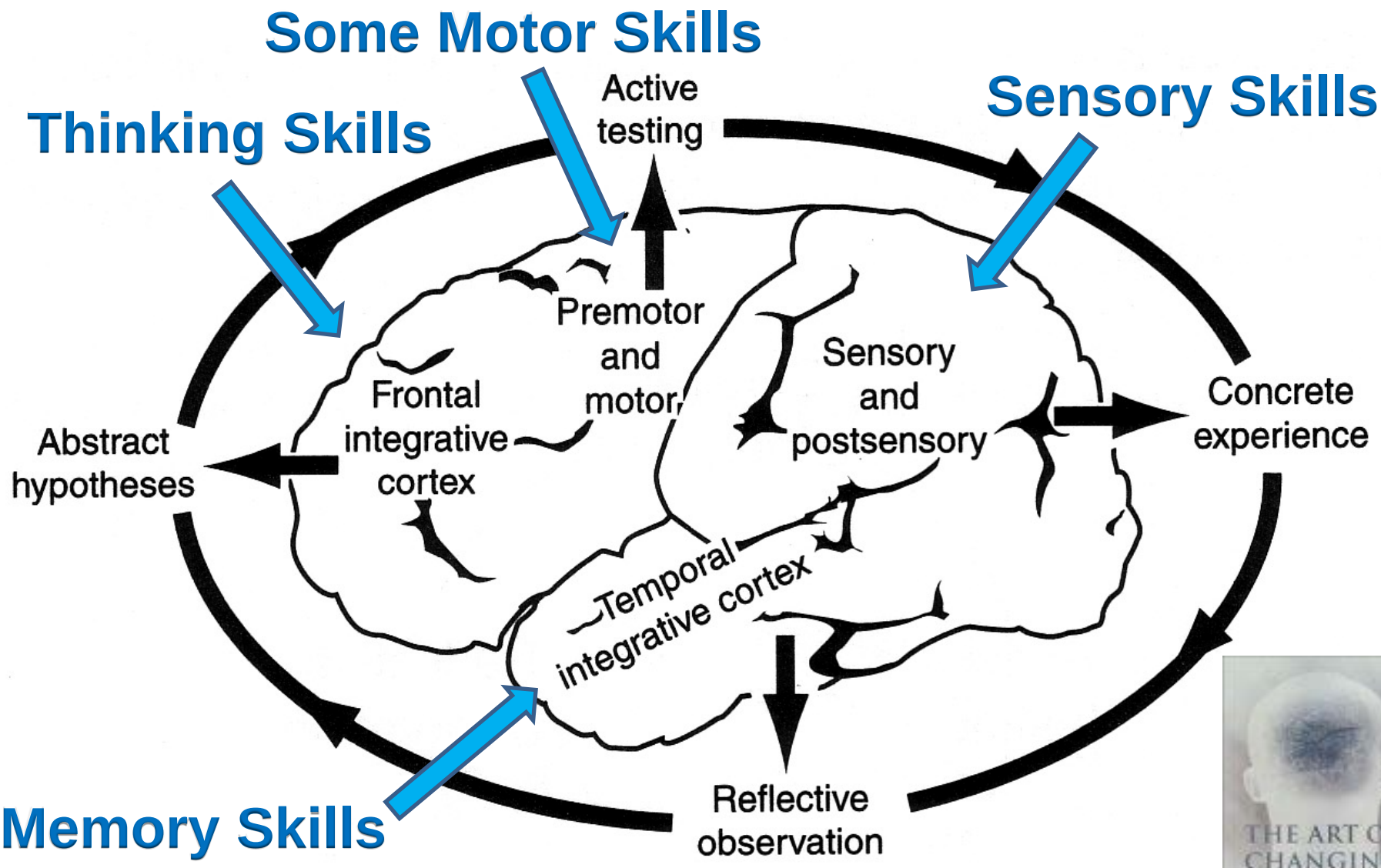
Where Do Dendrites Grow?

Everywhere

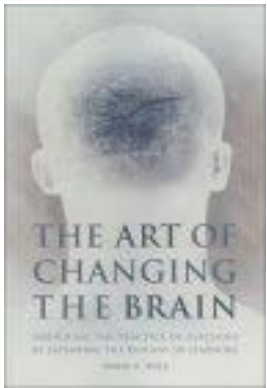
Experiential Learning Cycle
Achieving Long Term Potentiation



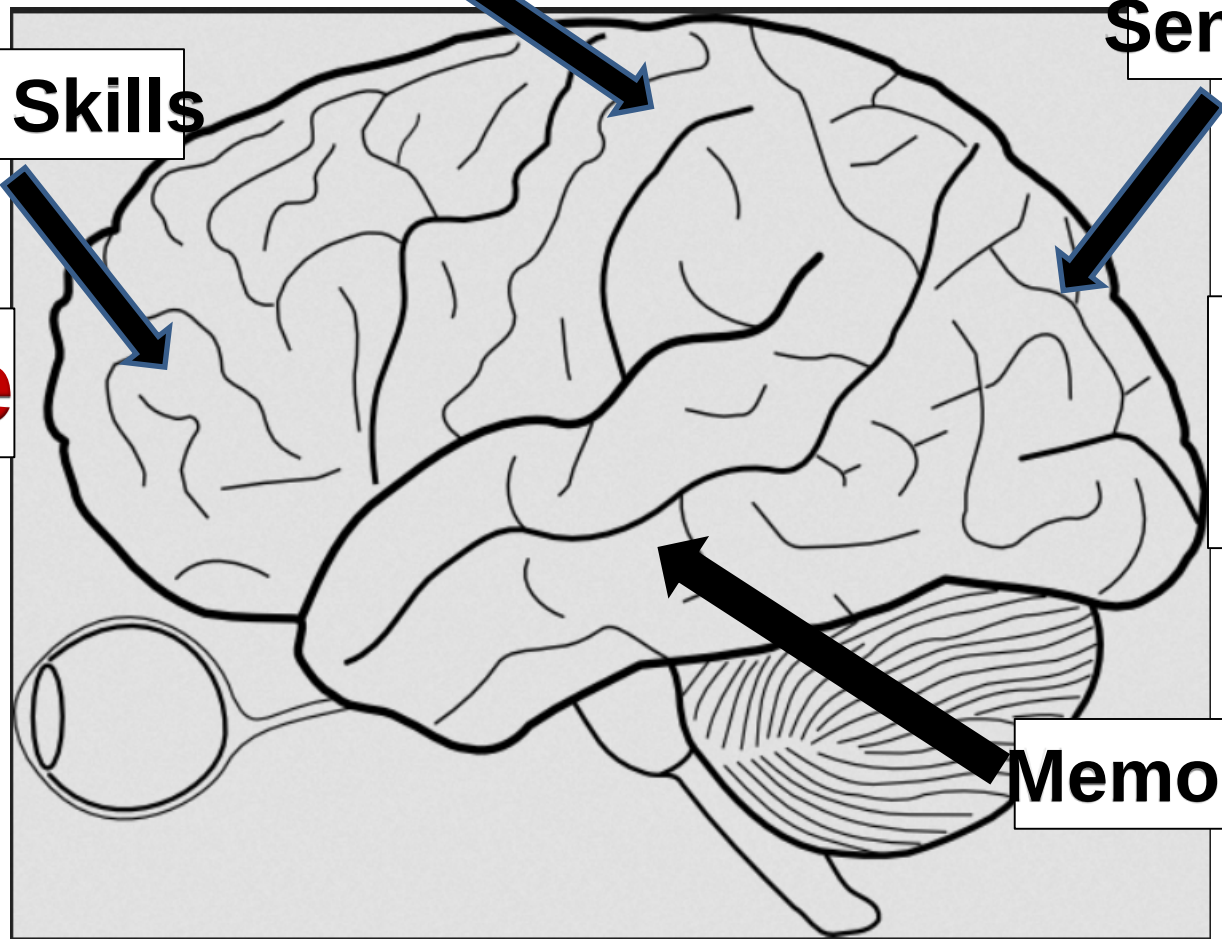
Experiential Learning By The Brain



Adapted from Zull, 2002, The Art of Changing the Brain



Back To The Future



Short Circuits

Experiential Learning Cycle

- It is easy to bypass frontal processing
- Frontal processing = decision making + action

Complete Processing

- Concept mapping and question analysis (group study) prevent "short circuits."

- Short Circuit Examples
  - "Looking at" reading: occipitotemporal activity
  - "Hearing": parietotemporal activity

- Complete Circuit
  - "Looking for" reading
  - "Listening for" in lecture
  - Increased attention; informed decisions

Recap – Back To The Future

- Temporal (back) processing
  - Facts, grouping, memorized patterns
  - From lectures, books, other resources
  - Information resource for prefrontal decision making
- Pre-Frontal (future) processing
  - "Discovered" patterns, inferences, evaluation of options
  - Dialog requires a decision based on a rationale, Broca's area is integrative
  - ALWAYS BE MAKING A DECISION!

Neurobiological Effects of Concept Mapping

- First, a look at concept mapping
- Neurobiology of learning with concept maps
- Deliberate Practice and concept maps

Which one is “what works for you?”

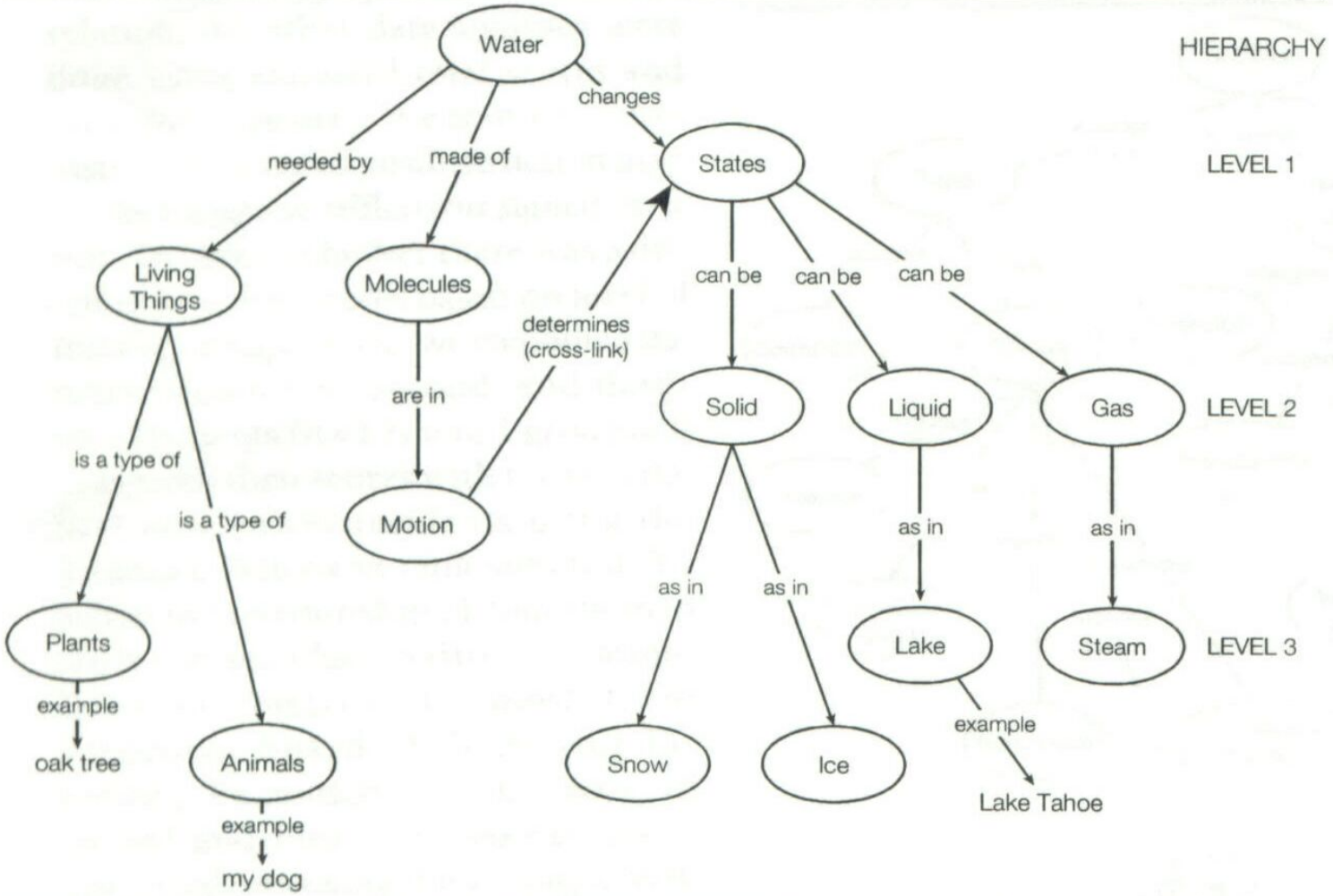
1. Inspectional (analytical) reading
   - “Looking for”
2. Outlining
3. Paraphrasing
4. Cluster construction
5. Comparing
6. Verbalizing (group or individual)

- All of these develop the prefrontal cortex.
- All of these are found in ESPeak Mapping.

Anatomy Of A Concept Map

- Key terms enclosed in “bubbles”
- Fact = two connected bubbles
- Connections can contain verbs
  - describes concept relationship
- Branch points represent groupings and organization
- Cross-links are comparisons and cause-and-effect; integrative thinking

Figure 1. Example Concept Map



Example map of *water* demonstrating the basic components of hierarchical concept maps. Note the cross-link (bold arrow) between the concepts *motion* and *states*. Reproduced with permission from Cambridge University Press.[14]

Overview of ESPeak Mapping

List – **Group** – **Compare** - **Share**

1. **List** important terms
2. **Group** by major topic
3. **Compare** by drawing cross-links
4. **Share** by speaking your map as a lecture

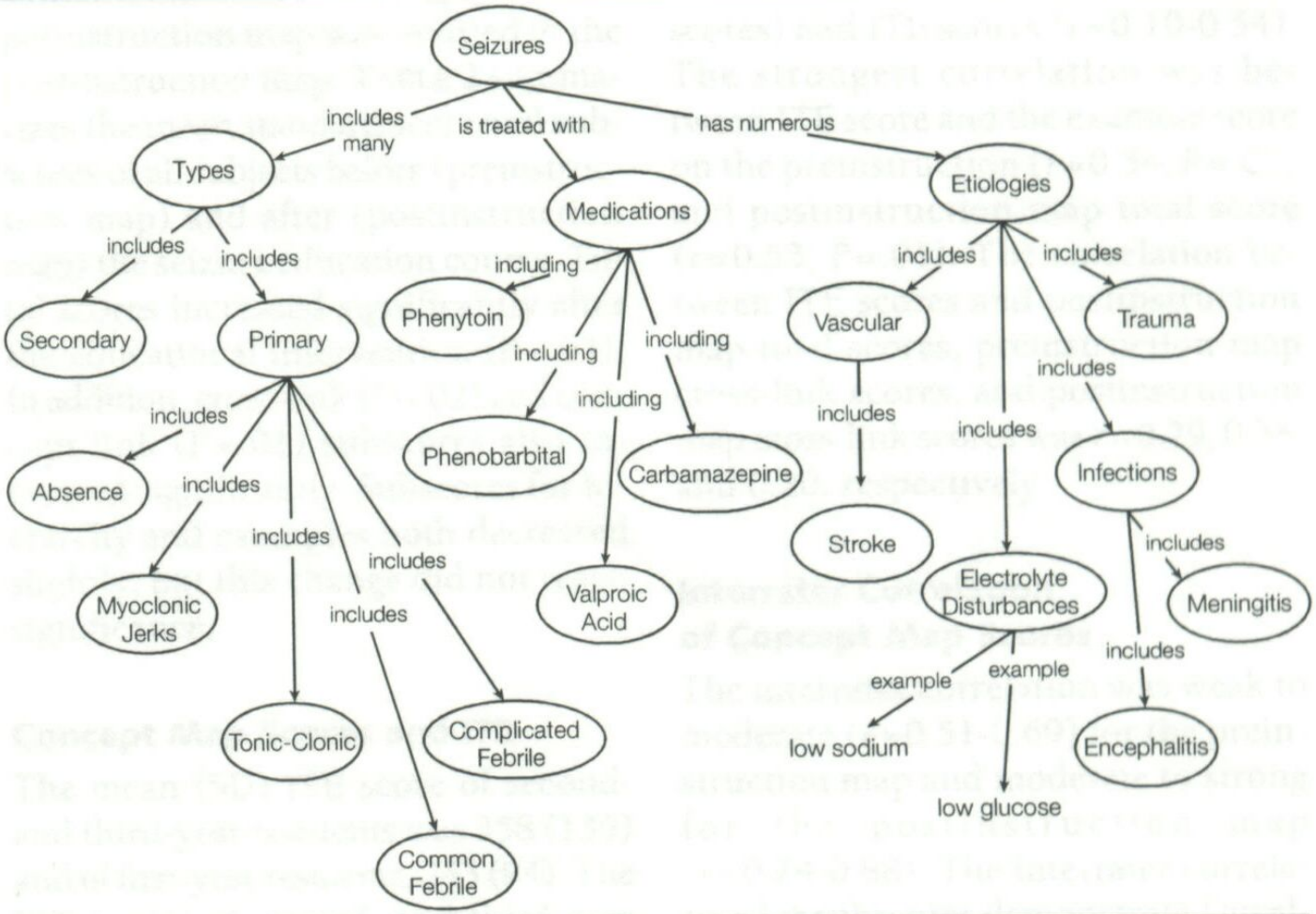
All four steps require use of Deliberate Practice during reading

Cells and Organelles

I. General Definitions
II. Cell Membranes
  A. Composition of cell membranes: Lipids
  B. Composition of cell membranes: Proteins
  C. Classifications and functions of cell membrane proteins
  D. Glycocalyx
  E. Freeze fracture
III. Nucleus
  A. Chromatin
  B. Nucleolus
  C. Nuclear envelope
  D. Nuclear pores
IV. Endoplasmic Reticulum
  A. Smooth ER (sER)
  B. Rough ER (sER)
V. Polysomes
VI. Golgi Apparatus (Complex)
  A. Function
  B. Structure
  C. Regions of Golgi apparatus
  D. Sorting in the trans-Golgi network (TGN)
VII. Proteosome
VIII. Lysosomes
  A. Contents
  B. Morphology

1. List of the most general categories (terms, topics
2. Early grouping of subtopics
3. Subtopics will have sub-subtopics in the notes – look for them!
4. You can add to groups later on when they are discovered

Figure 2. Low-Scoring Concept Map



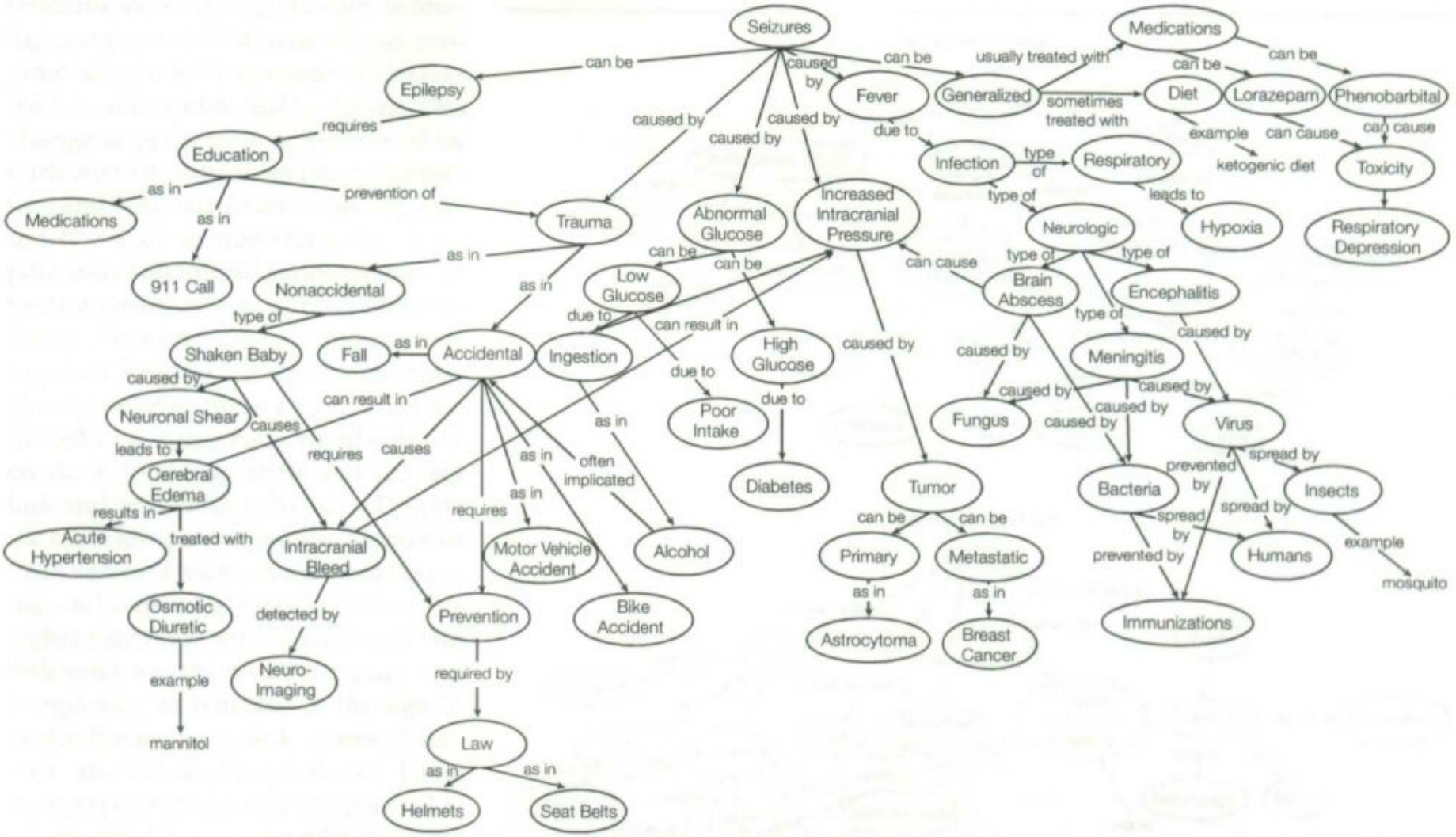
Reproduction of a hand-written concept map of *seizures* by a first-year resident. Note the absence of cross-links and the consistent use of 2 to 3 levels of hierarchy, resulting in a low score.

Concept Mapping and DP

- One of the following will be harder to do than the others

1. **Focus and attention**
   - (sensory/temporal/prefrontal)
2. **Identifying the grouping terms**
   - (prefrontal/temporal)
3. **Identifying subtopics**
   - (prefrontal/temporal)
4. **Organizing relationships**
   - (prefrontal/temporal)
5. **Drawing the map**
   - (prefrontal/motor)

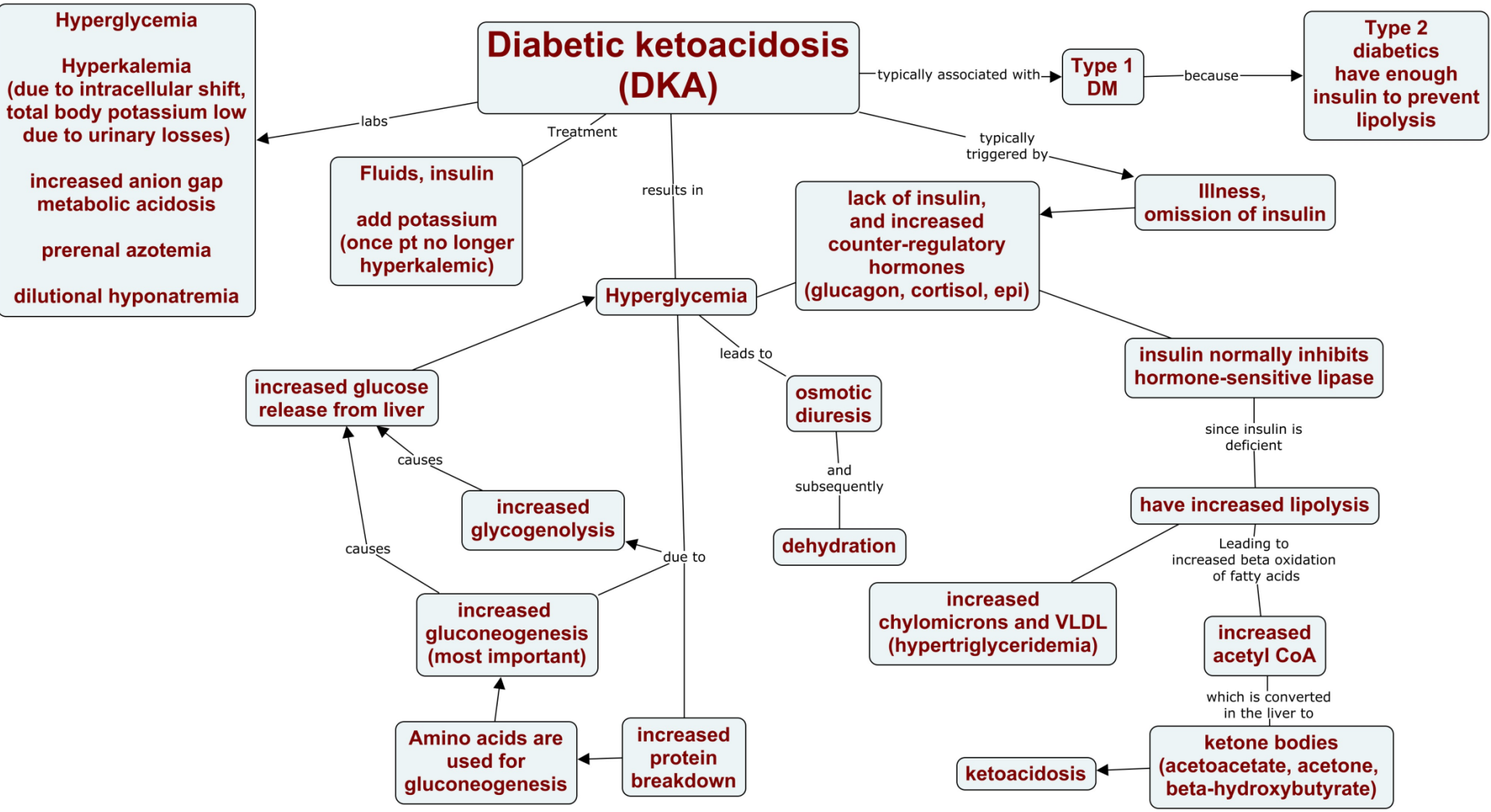
Figure 3. High-Scoring Concept Map



Reproduction of a hand-written concept map of *seizures* by a resident in the second- and third-year group. Note the complexity of the map as manifested by frequent cross-links and the consistent use of 5 to 7 levels of hierarchy, resulting in a higher map score.

DP Outcomes From Concept Mapping

- Slow at first as most-limiting brain function undergoes development
  - Limiting function is identified and practiced
- Faster processing during consolidation of skill areas
  - Capacity to make decisions faster
  - Capacity to access long term memory faster
- Capacity to retain fact (declarative) memory increased
- Transfer of skill to other problem solving venues


Diabetic ketoacidosis (DKA)
labs
Hyperglycemia
Hyperkalemia (due to intracellular shift, total body potassium low due to urinary losses)
increased anion gap metabolic acidosis
prerenal azotemia
dilutional hyponatremia
Treatment
Fluids, insulin
add potassium (once pt no longer hyperkalemic)
results in
Hyperglycemia
typically associated with
Type 1 DM
because
Type 2 diabetics have enough insulin to prevent lipolysis
typically triggered by
Illness, omission of insulin
lack of insulin, and increased counter-regulatory hormones (glucagon, cortisol, epi)
leads to
osmotic diuresis
and subsequently
dehydration
insulin normally inhibits hormone-sensitive lipase
since insulin is deficient
have increased lipolysis
Leading to increased beta oxidation of fatty acids
increased acetyl CoA
which is converted in the liver to
ketone bodies (acetoacetate, acetone, beta-hydroxybutyrate)
ketoacidosis
increased chylomicrons and VLDL (hypertriglyceridemia)
increased glucose release from liver
causes
increased glycogenolysis
causes
due to
increased gluconeogenesis (most important)
Amino acids are used for gluconeogenesis
increased protein breakdown

More About Maps

- Remember that maps are living documents; they grow as you learn
- Maps don’t have to include everything
- Maps are the best study notes
- Maps allow you to compare your thinking
  - …and improve it!

Recap

- Experiential learning “flows” through the cortex
  - Always completed through action
  - Personality type reflects time allocation.
- Experiential learning develops both:
  1. Cognitive memory
  2. Critical thinking skills
- Long-term memory is external evidence of dendritic tree growth (temporal cortex).
- Critical thinking (analytic) skill is external evidence of dendritic tree growth (prefrontal cortex).