Developing effective interventions for children with brain injuries

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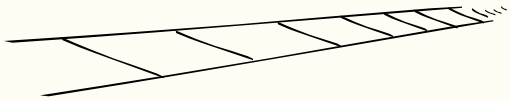
1

"I seek not the answer,
but to understand the question"
(Confucius)



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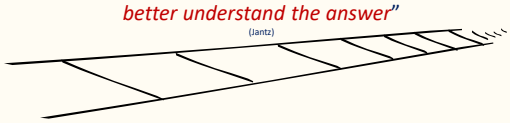
"I seek not the answer,
but to understand the *individual's brain injury,*
as…
to understand the injury is to
better understand the answer"
(Jantz)



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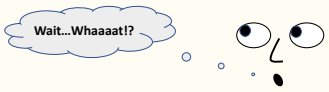
Spoiler alert…

We understand more about how a computer processes “1+1” than we do about how the brain processes “1+1”



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Assumptions for today…

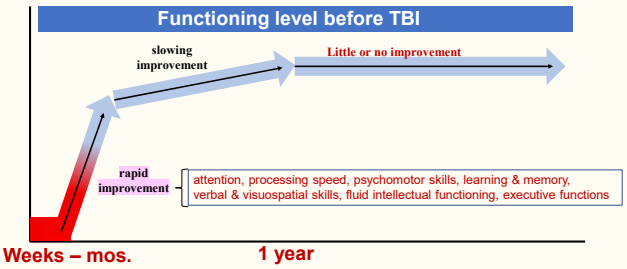
- helpful interventions will
  - target specific behaviors and activities, rather than “discrete” neurological impairments or assessment scores
  - apply to all settings in which the behavior/activity is likely to occur, and
  - include practice opportunities outside the classroom environment

5

Old-school view: recovery following a TBI

6

Recovery



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Contemporary view

- For many, TBI recovery is a chronic (ongoing) condition

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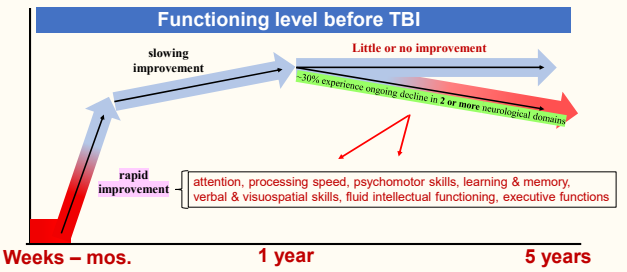
Frasca, et al., 2013 - Metanalysis
Christiansen et al., 2008 - longitudinal)

Recovery



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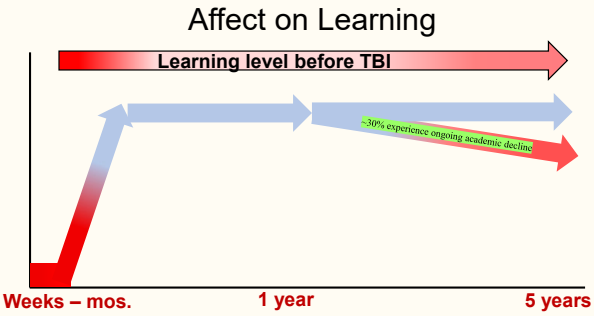


10

Translation: re-assess often and systematically…

- When? Where? How often?
- Need not be standardized testing…
  - Work samples
  - Classroom observations
  - Tchr/parent/child report

11

What does any type of assessment instrument or observation of behavior really measure?

- Already acquired knowledge & skills (i.e., past learning)
- Current ability to access/retrieve [knowledge & skills acquired in the past]

12

What does neurological damage affect?

- Ability to access/retrieve [knowledge/skills]

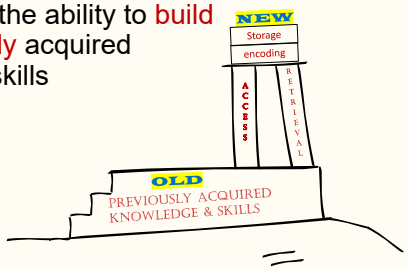
…and/or

- Ability to encode/store [new knowledge & skills]

This leads to difficulties acquiring new knowledge and skills

13

Acquisition of new knowledge & skills requires the ability to build upon previously acquired knowledge & skills



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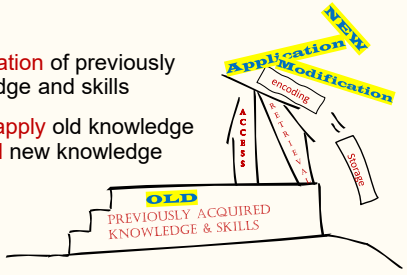
Difficulty encoding/storing/retrieving new information :

- prevents modification of previously acquired knowledge and skills
- affects ability to apply old knowledge and skills to build new knowledge and skills



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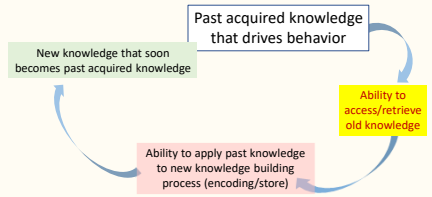
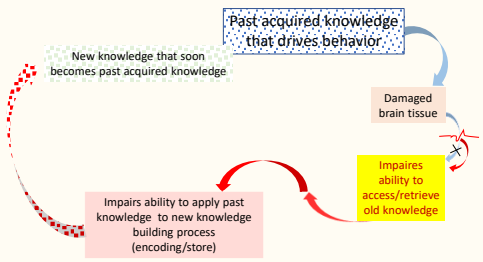
Healthy brain



16

TBI



17

The best way to develop a good intervention?

Know the child, not the label

and

Understand the neurological outcomes and the broader related issues

18

Said differently…

19

- Paul is not a "child with a TBI" (a label)
- Paul is a "child who has difficulties with…

20

When viewed as a label

- "Paul is a child with a TBI"

21

- increased risk of using
  - "prescriptive" (e.g. FL damage? Use…XXX)
  - "one-size-fits-all" interventions (e.g., memory aids)
- easy to ignore actual neurological difficulties and focus on preconceived outcomes

22

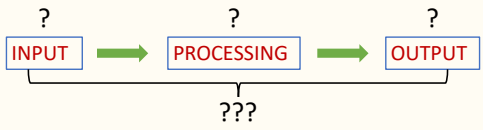
- Ex. Commonly heard statement about TBI
- "Students with a TBI" (a label) often have difficulty remembering information that may include trouble recalling information from minute to minute, or may involve forgetting information over time"
  - If Paul, a "child with a TBI (lable)" forgets something, the "forgetting" is often presumed to be a memory problem resulting from a TBI and is treated by giving him a memory aid (prescriptive intervention)

23

- Commonly recommended prescriptive memory interventions found in TBI intervention resources:
  - Provide all information in writing — What if the neurological mem. deficit is for visual information?
  - Repeat important information — What if the deficit is for auditory information?
  - Ask student to repeat back important information — What if the deficit is for long-term (not short term) retrieval of information?
  - Inform a parent about homework due dates to assure completion — What if the deficit is forgetting to take work to school?

24

- How do any of these interventions help Paul remember information?
- How do these interventions help you understand where the neurological breakdown is occurring?



25

When viewed in terms of neurological outcome….

- Paul is "a child who has difficulties with…

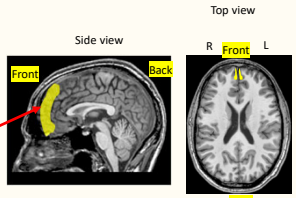
26

- Paul is "a child who has difficulties with… subtracting double digit numbers, because he has difficulty with "A-B, A-C" learning associations; and this difficulty is the neurological outcome of a fall off the porch at age 4, during which, a piece of iron rebar sticking out of a broken concrete step, penetrated his upper forehead resulting in bilateral damage to the medial prefrontal cortex (MPFC) of his brain"

27

Paul has damage in this yellow area of the brain on both hemispheres (bilateral)

*medial prefrontal cortex (MPFC)



*involved in creating and storing contextual memories of interrelated (what & where) memories received from hippopcampi (in medial temporal lobe)

- Paul has no damage to his **hippocampus (involved in memory formation) in either temporal lobe

**involved in forming and storing cohesive memories of individual events within the context in which they occurred ("what we remember" & "where in space events occur")

28

- With damage to the MPFC, Paul
  - …will have no difficulty with standard tests of memory (a hippocampal memory formation function)
    - "Here learn this list of 5 words" - hippocampi undamaged
    - 2 min later: "tell me the 5 words" → no problem remembering
  - …will have difficulty when memory for target information must be obtained under conditions of memory interference or distraction (a MPFC function) — MPFC is damaged
    - Ex: the concept of "borrowing" in subtraction

29

Pre-injury: Paul "learned a math rule":

Rule: in column subtraction(condition A), subtract the smaller number from the larger number (condition B) - this is known as an "A-B" association

Paul is given this problem to solve:

(A) 8
- 4 (B)
?

← Learned A-B association

"The procedure for subtracting numbers in a column"

Target information to be learned

hippocampus/mpfc functioning ok

30

Paul gives the correct answer "4" because: he learned the A-B association and can remember the rule (target information): "In column subtraction (A), subtract the smaller number from the larger number (B)"

$$\begin{array}{r} 8 \\ -\ 4 \\ \hline ? \end{array} = \begin{array}{r} \overset{\text{(A)}}{8}\ \text{(B)} \\ -\ 4 \\ \hline 4 \end{array}$$

column subtraction (A) is associated with subtracting smaller number from larger number (B)

hippocampus/mpfc functioning ok

31

Post injury - Math teacher teaches the class the concept of "borrowing" – a new "A-C" association

Hippocampus ok mpfc broken

New target information to be learned

In column subtraction (A), subtract smaller number from larger number unless the top number is smaller than the bottom number, then you must borrow 10 from the next column's number and add it to the first column's number, then subtract the smaller number from the larger number(C)

32

Old A-B association

column subtraction (A) is associated with subtracting smaller number from larger number (B)

$$\begin{array}{r} \overset{\text{(A)}}{8}\ \text{(B)} \\ -\ 4 \\ \hline 4 \end{array}$$

New A-C association

In column subtraction (A), subtract smaller number from larger number unless the top number is smaller than the bottom number, then you must borrow 10 from the next column's number and add it to the first column's number, then subtract the smaller number from the larger number(C)

column subtraction (A) has a new association (C)

$$\begin{array}{r} \overset{\text{(A)}}{\overset{4}{\cancel{5}}\ \overset{14}{\cancel{4}}}\ \text{(C)} \\ -\ 29 \\ \hline 25 \end{array}$$

33

Paul learns this new A-C association because he has no problem with "remembering" what he is taught (hippocampi intact)

Hippocampus ok
mpfc broken
but A-C being
taught without
memory
interference or
distraction
simply being taught
"if this, do this"

a single
"what"- "where"
context

New "A-C" relationship

In column subtraction (A), subtract smaller number from larger number unless the top number is smaller than the bottom number, then you must borrow 10 from the next column's number and add it to the first column's number, then subtract the smaller number from the larger number(C)

$$\begin{array}{r} 54 \\ -\ 29 \\ \hline ?? \end{array} \qquad \begin{array}{r} {\scriptstyle +10} \\ 54 \\ -\ 29 \\ \hline 25 \end{array}$$

34

On test

$$\begin{array}{r} 8 \\ -\ 4 \\ \hline ? \end{array} \qquad \begin{array}{r} 54 \\ -29 \\ \hline ?? \end{array}$$

correct answer

$$\begin{array}{r} 8 \\ -\ 4 \\ \hline 4 \end{array} \qquad \begin{array}{r} {\scriptstyle 4\ 14} \\ \not{5}\not{4} \\ -\ 29 \\ \hline 25 \end{array}$$

35

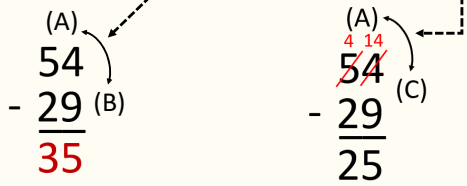
his answer

$$\begin{array}{r} 8 \\ -\ 4 \\ \hline 4 \end{array} \qquad \begin{array}{r} 54 \\ -\ 29 \\ \hline 35 \end{array}$$

Paul applies the old A-B association
– i.e., "in column subtraction (A), subtract the smaller number from the larger number (B)"

36

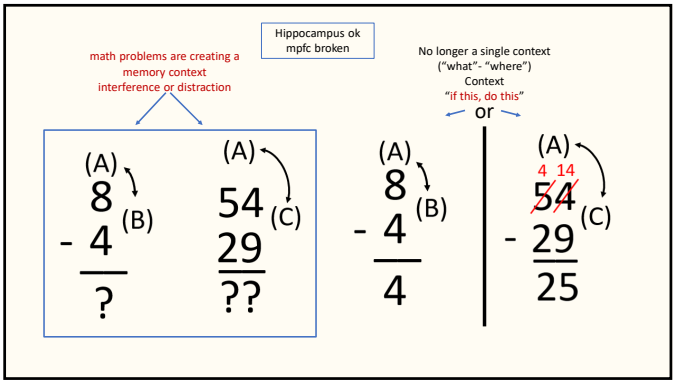
Why does Paul do this not this



37

- It is not a memory problem, it is a context (column subtraction) application violation, in which, ongoing task rules that govern multiple memory decisions are interfered with and an incorrect memory (A-B) is retrieved and applied (A-B vs. A-C assoc.)
- i.e., given the possible column subtraction contexts, he has difficulty retrieving the correct context-appropriate memory and then applying it (a MPFC function)

38



39

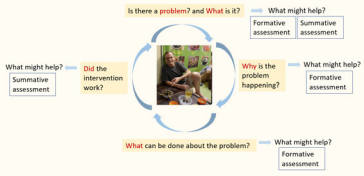
Intervention?

- Teach Paul to use a phone/watch calculator for all math involving subtraction Give practice opportunities in real world (at store, etc.)
- Give him a list of math rules to choose from
- Watch/assess for other paired A-B, A-C association errors
  - e.g., "the federal government issued a statement" vs "The U.S. Federal Government issued a statement" (intervention? – use a grammar checker on computer)

40

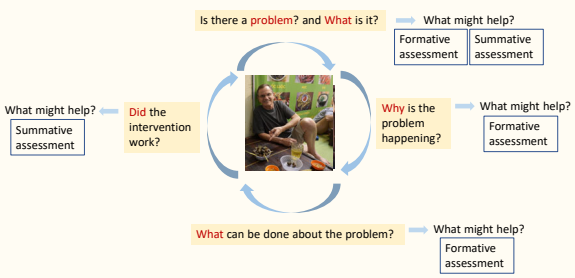
Brain injury interventions

- Begin with good problem-solving



41

Problem solving as a guide to TBI intervention development



42

Remember…

- Most educational problems are brought to light when student performance deviates significantly from teacher expectations in classrooms

43

Make the intervention be useful…

- Does the intervention "accommodate" (enable) or "remediate/compensate" (build skills)?
  - Ex: memory deficits…
    - Typical: "Write down assignments from whiteboard"
    - Better?: teach self-talk strategy:
      - "Think about whether or not you want or need to remember information. Should you do something to remember? What can you do to help yourself remember?

44

- Brain injury interventions should
  - include an educational component to help the child
    - learn about brain injury
    - set realistic, obtainable life/career goals
    - recognize/accept their neurological limitations
      - understand how these impede educational progress

45

- - address mental health issues
- - help compensate for damaged brain tissue
- - develop/strengthen new brain connections
- - teach new problem-solving strategies
- - provide real-world *practice* opportunities

46

Avoid cookie cutter interventions

- For example, the all-too-familiar memory aid intervention for memory deficits:

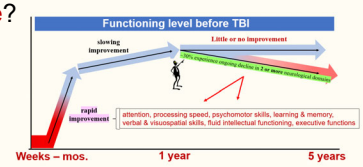
  "writing assignments in a notebook"

  ("provide all information in writing")

47

Educational intervention

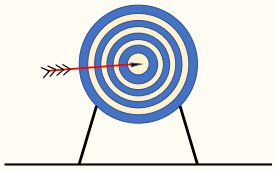
- Focus on the chronic neurological conditions
  - What has stabilized? What continues to decline?



48

Targeted, task-specific and skills-specific interventions

- Typical "go to" TBI interventions
- What are they?
- Do they work?



49

Examples…

- Teaching strength-based compensatory skills [e.g., how to use a calculator]
- Providing targeted evidence-based instruction [e.g., direct instruction]
- Providing accommodations that remove barriers to educational opportunities [extended time to complete assignments]

50

Benefits

- Generally *improve* cognitive composite scores on assessment instruments that measure attention, speed of processing, memory and executive function
- Generally *improve* task-specific performance on task-specific outcome measures

51

- Provide norm-referenced results
- Provide goal attainment accountability
- Legally defensible when sued

52

Disadvantage

- *Do not generalize* to everyday, real-world settings

53

Targeted, task-specific and skills-specific interventions

- Are a necessity and should be used, AND…

…they must be supplemented with varied general stimulation and environments that are meaningful to the child

54

Non-specific general interventions and meaningful environments

- Research has shown that varied general stimulation and meaningful environments (meaningful to the individual) result in better generalizability, significant functional neurological gains, and help prevent cognitive decline during the chronic period of TBI recovery

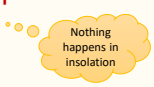
55

Generalizability…the missing link

- How do you develop an intervention that is most likely to generalize outside the classroom?

56

- The environment needs to be meaningful and contain intellectually challenging activities
- The stimulation must be varied within a complex environment that has multiple opportunities for social participation



57

- The intervention(s) must
  - be relevant to real-world events/circumstances found inside and outside the classroom environment
  - present a variety of novel, intellectually challenging teaching, learning and practice activities within multiple diverse, complex, stimulating environments

keystone

- The child must be motivated and encouraged to participate

58

Putting it all together example…

- As a result of her TBI, Misha has convergence insufficiency

Trouble moving eyes inward toward the nose when moving from far vision to close vision

- Manifests as difficulty copying information from the whiteboard/ppt to a piece of paper on the Mish's desk

one or both eyes which are focused on distant object (letters on ppt screen) have trouble moving inward to focus on close object (paper/pencil on desk)

59

Intervention…

- Targeted task-specific/skills-specific intervention: Pencil push-ups administered once weekly by OT/PT, with instructions to practice multiple times a week at home

60

- Results:
  - *If* the child does them correctly, multiple times a week at home – a measurable difference will be noted by the OT/PT at school, YAY…
  - Let's consider a supplemental intervention likely to increase compliance and new neuronal connections resulting in less eye drift, and an increased efficiency in reading ability (i.e., a generalization of skill)

61

- If the child finds the game of chess to be highly interesting, a qualified individual at school could regularly engage the child in a chess game
- During said game, the individual could instruct the child that, prior to making the next move on the game board, the child is to look the individual in the eye and state what that next move will be

62

- Alternately…

the game could be played in the lunchroom at noon and, in-between moves, prior to looking downward at the game board to move a piece, the child could be instructed to locate known friends in the lunchroom and point them out to the qualified individual

- This sort of "practice opportunity activity" could easily be written into an educational plan

63

Another practice session:

- Go to grocery store
- Have child look at prices on shelf for: a can of chopped tomatoes, spaghetti sauce, pasta, 1 lb. of hamburger, a bunch of basil leaves, celery, and parsley and enter each item and its price into smart phone
- Then add up the total cost for meal using phone's calculator app and check against sales receipt

64

More about generalizability

- during the intervention teaching/learning phase
  - include teaching individually-designed strategies that apply to a broad range of settings

65

- provide multiple opportunities for the application/practice of these individually designed strategies within the context of a variety of settings

66

- Ex. high school student identified as having difficulties with reading comprehension after sustaining a significant brain injury
  - the student could be taught to use
    - external memory aids (e.g., guided notes),
    - diagrams that facilitate a deeper understanding/ encoding of information
    - self-questioning (e.g., 'Do I understand what I just read?', 'How does what I just read fit what I already know?').

67

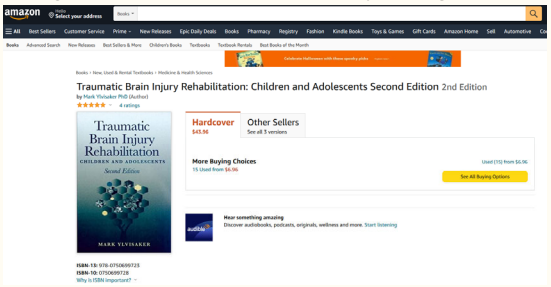
- Following mastery (as part of the educational plan)
  - student could
    - be accompanied to various potential employment settings where these strategies could be practiced while completing a job application
    - join/start a book club in an area of his or her interest
  - student's parent(s) could
    - provide the opportunity to apply these strategies at home
      - having the student prepare a complex recipe (e.g., baking a cake)

68

A great resource for understanding TBI rehabilitation…

69

A great $6.96 investment and an easy reading book



70

General brain areas & functions

Brain Area	Involved in
Anterior cingulate cortex (ACC)	Coordination of cognition, emotion, and behavior; redirecting attention to/from appropriate stimuli, empathy; interpretation of voice tone/inflection, physical gesturing, and facial expression
Basal ganglia/orbitofrontal cortex (OFC)/ caudate nucleus (CN)	Regulation of behavior, impulse, mood; cognitive flexibility; obsessive thinking; compulsive behavior
Brain stem	Sensory impairment
Broca's Area	Expressive language, prosody word production/articulation
Wernicke's Area	Receptive language, language processing, written language

71

Brain Area	Involved in
Cerebellum	motor coordination
Corpus callosum (CC)	Processing speed
Fusiform facial area (FFA)	Modulation of language, emotions, executive functions; sensory responses, shifting attention, memory; facial recognition and processing, predicting and imitating actions
Occipital lobe (OL)	Vison; visual identification of "what" an object is and "where" an object is
Limbic system (LS)	Assignment of fear and anxiety; interpretation and recognition of emotions in self; emotional response to stimuli, affect, mood, memory consolidation, empathy

72

Brain Area	Involved in
Prefrontal cortex (PFC)	Shifting, dividing, maintaining attention; generalization of learning; concrete thinking, theory of mind, control of anger/irritability/impulse
Right hemisphere	Novel problem solving; shape interpretation. Communicates with left hemisphere primarily via corpus callosum
Left hemisphere	Storage of learned material, primarily language-based (e.g, words, labels, facts). Communicates with right hemisphere primarily via corpus callosum
Right insula (RI)	Empathy; theory of mind; affect interpretation

73

Brain Area	Involved in
Right premotor anterior cortex (PMC)	Gesture production, voice prosody production/ intonation
Medial prefrontal cortex (MPFC) Ventral medial prefrontal cortex (VMPFC) Dorsal medial prefrontal cortex (DMPFC) Posterior parietal cortex (PPC) Inferior parietal lobule (IPL) Ventral anterior cingulate cortex (VACC) Posterior cingulate cortex (PCC) Temporal pole (TP) Medial posterior parietal cortex (MPPC) Lateral parietal cortex (LPC) Medial temporal cortex (MTC) Angular gyrus (AG) Temporoparietal junction (TPJ) Hippocampal formation (HF) Parahippocampal cortex (PHC) Retrosplenial cortex (RC) Precuneus	Perspective taking/theory of mind; self-knowledge, self-reflection, self-monitoring, self-concept (how people perceive themselves), social self-concept (how people believe others perceive them), referencing information to the self, episodic memory (i.e., personal experiences); emotional processing, moral decision-making; thinking about the past, present, and future, autobiographical memory; moral reasoning; use of memory and category knowledge to develop a mental model of the past, present, and future; judging abstract concepts that involves others; judgments involving first person embodiment; goal-oriented attention-demanding tasks or stimulus-driven cognitive processing; spontaneous, stimulus-independent, introspective, and adaptive mental activities; when an individual is disengaged from the external world and thinking (mentalizing) about the self; when engaged in introspective, internal narrative involving judgments about self-worth and self-concept, and contemplations about past, present, and future behaviors

74

Brain Area	Involved in
Superior temporal sulcus	Difficulties interpreting facial expression
Thalamus	Challenges with memory retrieval, emotion regulation, and visual-spatial processing.

75

As they say in Texas…
"all y'all have a good day"

Texas female garden spider

76