


Mild TBI Impact on Language



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Objectives

- **Define** communication/language & brain-language relationships
- **Differentiate** left & right hemisphere language processes
- **Discuss** pathophysiology of mTBI
- **Describe** mechanism of connections between language centers of the brain & the impact of mTBI on those connections
- **Outline** language/communication consequences of mTBI
- **Discuss** language/communication consequences of mTBI in two patients
- **Outline** a language/cognitive syndrome secondary to mTBI injury

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Outline

- **General Persp/Definitions**
 - Commun/Lang/Speech
 - Hist Persp – Prop/Affec Lang
 - Aphasia/Aprosodia
 - Communication – Whole Brain
- **Pathophysiology of TBI/DAI**
 - DAI - Imaging
 - DAI – Blasts
 - DAI – Language
- **Brain-Lang Relationships**
 - Fleschig/Functional Zones
 - LH – Types of aphasia & Wernicke's Model of Language & the Brain
 - RH – Affective Lang & Aprosodias
 - Other Language Related Problems
- **Case Study – mTBI/Blast**
 - Conduction Aphasia
 - Conduction Aprosodia
 - Other Lang/Cog Dysfunction
 - Tractography
 - Treatment/Tractography
 - Implications re: Neurobiologic Recovery Patterns
- **mTBI Lang/Cog Syndrome**
- **Case Study – mTBI/MVA**
 - Visual Percep/Rela to Conduc Apha & Aprosodia
 - Constr Apraxia/Rel to Dyslexia & Dysgraphia
 - Rel to Other Cog Functions

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Definitions

Communication • *Transfer* of an idea, feeling or information from one person to another. Can also be from inanimate objects, animals or the environment.

Language • A "*symbol system*" where a word, sound, or written symbol stands for something else. Language symbols are *arbitrary* and agreed on by a general language community (e.g. "dog" is "perro" is Spanish)

Speech • The *oral-verbal* representation of language or "talking"

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Language & Communication 1865 - 1879

1865 Broca • *Language/speech* mediated by LH, focal lesions result in specific problems, described syndrome of aphasia associated w frontal lesion

1875 Wernicke • Described syndrome of aphasia associated with temporal lesion & proposed a *model* of language organization in the brain

1879 H. Jackson • *Affective* lang/speech mediated by R Hemis - pt lost propositional speech but could express emotion/sing; and possibly *figurative* language mediated by R Hemis

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Language & Communication 1865 - 1879

Propositional

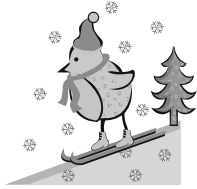


Affective

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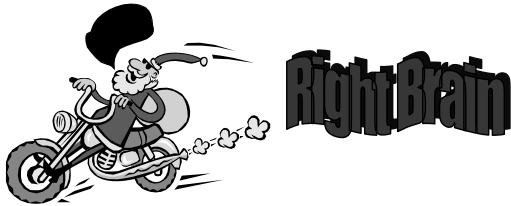
Concrete Language - Cool

Left Brain



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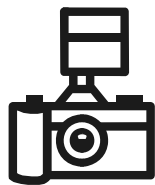
Figurative Language - COOL



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Concrete Language - Flash

Left Brain



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Figurative Language - Flash



Right Brain

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Definitions

Aphasia

- A non-functional impairment in the reception, manipulation and/or expression of **symbolic** material (or **language**). Results from organic damage to relatively central brain structures. Can occur in reception or expression of auditory, visual (graphic) or gestural modalities.

Aprosodia

- A disturbance in the processing of **affective** or emotional components of language. Can include problems in recognition or production of emotional tone of voice, facial expression, gesturing or matching one area to another (e.g. tone of voice with facial expression).

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Communication - Whole Brain

Left Brain



Right Brain

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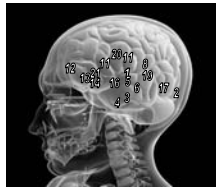
Communication - Whole Brain

- Left Brain/ Right Brain*
- **Focal Lesions** – can evaluate specific syndromes relative to specific hemisphere/lobe; for 100 yrs after Broca emphasis on lang/LH focal lesion relationships; 1970's expansion of affective lang/RH relationships
- Whole Brain*
- **TBI** – often more than one lesion site requiring evaluation of multiple areas of brain function (left & right, cortical & subcortical, anterior & posterior in same hemisphere) to identify consequences.

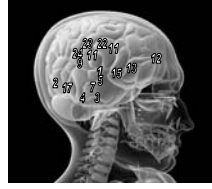
Particularly important in mTBI since signs are subtle & can be confused or co-exist with problems producing similar symptoms

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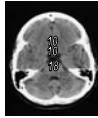
Communication & the Brain



- 1-Hearing
- 2-Vision
- 3-Concepts
- 4-Memory
- 5-Aud Recognition
- 6-Prop Underst
- 7-Affect Underst
- 8-Naming-Prop
- 9-Naming-Figur
- 10-Inter Hem Trans
- 11-Intra Hem Trans



- 12-Motor Initiation
- 13-Motor Planning
- 14-Motor Prop Speech
- 15-Motor Affect & Singing
- 16-Aud Component Reading
- 17-Vis Component Reading



- 18-Rt-L Info Transfer
- 19-A-V Integ Reading
- 20-Grapheme Transfer
- 21-Writing
- 22-Pragmatics/Non-Verbal Rules
- 23-Higher Lang-Presup/Infer, Rel/Irrel
- 24- Fig Lang-Metaph,Idiom,Proverb

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Other Functions Subserving/Supporting Language

- Finger Recognition* ➤ LH
- Spatial Orientation* ➤ RH
- Motor Coord/Tone* ➤ Cerebellum/Basal Gang
- Visual Perception* ➤ Both Hemispheres
- Memory/Atten/Conc* ➤ Both , Brain Stem
- Sensory Integration* ➤ Thalamus

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Pathophysiology of TBI

- Rotational forces & skull fractures
- Subdural Hematomas
- Contusions
- Diffuse Axonal Injury - mTBI

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Diffuse Axonal Injury

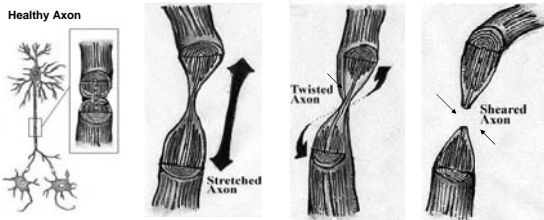
- Axon can be detached
- Axon can be stretched
- Increased permeability
- Calcium influx
- Damage to cytoskeleton
- Impaired axoplasmic transport
- Axonal swelling
- Detachment

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Diffuse Axonal Injury



Do **NOT** see this with common imaging

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Imaging Studies

➤ Fewer than 10% mTBI pts have acute intracranial lesions identified on imaging

- CT
- MRI
- SPECT Scan

➤ Blast & mTBI – no difference

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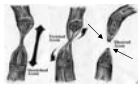
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DAI & Blasts

- *Overpressure wave* of 1,600 ft/sec strikes *twice* – initial wave followed by “*secondary wind*” or air flooding back into the vacuum under high pressure
- Sudden & extreme pressure changes are *1,000x greater* than atmospheric pressure - helmets nor armor protect the body from being set into motion
- Nerve cells & axons – contain different concentrations of fluid & fat so when set into motion they move at *different speeds*
- *Potential Impact* – blasts set nerve cells & axons into motion at different speeds resulting in a shearing effect

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Impact of mTBI On Language

Understanding mTBI impact on language requires understanding:

- Cortical zones mediating lang components & functions subserving those components (e.g. spatial perception & reading)
- How those zones connect with each other

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Fleshig's Primary Zones



Primary Zones - myelinate first in each lobe. Have a "primary" motor or sensory function (receive sensory-motor information only).

- No other part of the brain can assume their function
- Cannot assume function of any other part of the brain.

•**Frontal Lobe** - motor

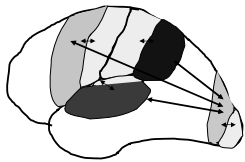
•**Parietal Lobe** - somatosensory

•**Temporal Lobe** - auditory

•**Occipital Lobe** - visual

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Fleshig's Secondary (Association) Zones



Association Zones - myelinate second in each lobe. Surround & process information of primary zones.

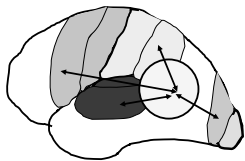
- Frontal Lobe** - secondary motor
- Parietal Lobe** - second somatosens
- Temporal Lobe** - secondary auditory
- Occipital Lobe** - secondary visual

•Called association because are the only areas that communicate with responding primary zones

•Communicate with each other

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Fleshig's Tertiary Zones



Tertiary Zones - myelinate last in each lobe. Have "integrative" higher cognitive functions.

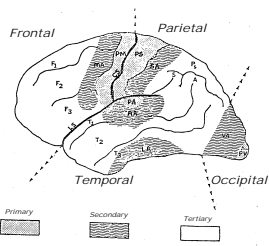
•**Frontal Lobe** - "prefrontal" tertiary deals with personality, motivation, initiation.

•**Temporal Lobe** - temporal tertiary mediates "interpretive" responses, "concepts" etc.

•**Parietal Lobe** - infraparietal lobule (supramarginal & angular gyri) is the "association zone of association zones."

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Fleshig's Zones

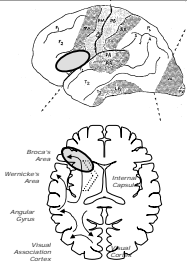


- **F1, F2, F3** - first, second, third frontal gyri
- **T1, T2, T3** - first, second, third temporal gyri
- **CS, LS** - central sulcus (Rolando), lateral sulcus (Sylvius)
- **PM, PS, PA, PV** - primary motor, somesthetic, auditory visual cortex
- **MA, SA, AA, VA, LA** - motor, somesthetic, auditory, visual, limbic association areas
- **S, A** - supramarginal gyrus, angular gyrus

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Description of Problems Broca's Aphasia 1865

(+ = No Problem, "-" = Problem)



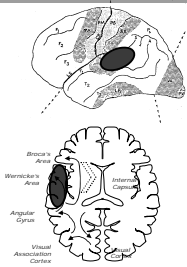
Lesion: Post Portion of 3rd frontal convolution, adjacent subcortical white matter

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- Physical -
- Auditory Comp +
- Fluency -
 - Speech Rate -
 - Ease of Production -
 - Articulatory Agility -
 - Motor Initiation -
 - Phrase Length -
 - Melody -
 - Syllable Transitions -
 - Rhythm -
- Grammar -
- Naming +/-
 - Content +/-
 - Paraphasias +
- Reading -
- Writing -
- Singing/Autom Speech +
- Repetition -

Description of Problems Wernicke's Aphasia 1875

(+ = No Problem, "-" = Problem)



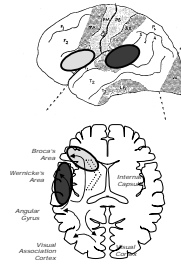
Lesion: Post Portion of superior, transverse temporal gyri

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- Physical +
- Auditory Comp --
- Fluency + + +
 - Speech Rate +
 - Ease of Production +
 - Articulatory Agility +
 - Motor Initiation +
 - Phrase Length +
 - Melody +
 - Syllable Transitions +
 - Rhythm +
- Grammar +
- Naming --
 - Content --
 - Paraphasias --
- Reading -
- Writing -
- Singing/Autom Speech +
- Repetition -

Comparison of Problems Broca's & Wernicke's

(+ = No Problem, +/- = Problem)



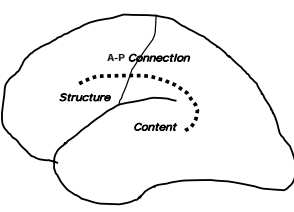
Broca's Area
Wernicke's Area
Angular Gyrus
Visual Association Cortex

- Physical
- Auditory Comp
- Fluency
 - Speech Rate
 - Ease of Production
 - Articulatory Agility
 - Motor Initiation
 - Phrase Length
 - Melody
 - Syllable Transitions
 - Rhythm
- Grammar
- Naming
 - Content
 - Paraphasias
- Reading
- Writing
- Singing/Autom Speech
- Repetition

	Broca	Wernicke
Physical	-	+
Auditory Comp	+	- -
Fluency	-	+++
Speech Rate	-	+
Ease of Production	-	+
Articulatory Agility	-	+
Motor Initiation	-	+
Phrase Length	-	+
Melody	-	+
Syllable Transitions	-	+
Rhythm	-	+
Grammar	+/-	+
Naming	+/-	- -
Content	-	-
Paraphasias	+	-
Reading	-	-
Writing	-	-
Singing/Autom Speech	+	+
Repetition	-	-

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Wernicke's Model of Language/Brain

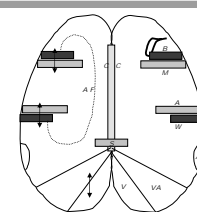


A-P Connection
Structure
Content

- Structure
- Content
- Anterior-Posterior Connection

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Wernicke's Model Intrahemispheric Connections

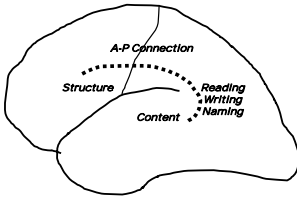


Route
A - W Primary Auditory to/from Secondary Auditory (Wernicke's area)
M - B Primary Motor to/from Secondary Motor (Broca's Area)
W - AF - B Secondary Auditory thru Arcuate Fasciculus to/from Secondary Motor

- B - Broca's Area (Motor Association)
- M - Motor Cortex
- A - Auditory Cortex
- W - Wernicke's Area (Auditory Association)
- AG - Angular Gyrus
- VA - Visual Association
- V - Primary Visual Cortex
- CC - Corpus Callosum
- S - Splenium
- AF - Arcuate Fasciculus

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Extension to Wernicke's Model

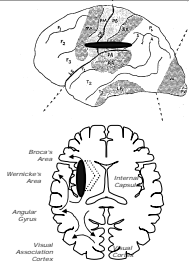


- Structure
- Content
- Anterior-
Posterior
Connection
- Reading
Writing
Naming

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Description of Problems Conduction Aphasia 1965

(+ = No Problem, "+" = Problem)



Lesion - Arcuate fasciculus, a lesion deep to supramarginal gyrus or insula

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- | | |
|------------------------|----|
| • Physical | + |
| • Auditory Comp | + |
| • Fluency | + |
| • Speech Rate | + |
| • Ease of Production | + |
| • Articulatory Agility | + |
| • Motor Initiation | + |
| • Phrase Length | + |
| • Melody | + |
| • Syllable Transitions | + |
| • Rhythm | + |
| • Grammar | + |
| • Naming | - |
| • Content | -- |
| • Paraphasias | -- |
| • Reading | + |
| • Writing | - |
| • Singing/Autom Speech | + |
| • Repetition | -- |

Tractography/Left Hemisphere Arcuate Fasciculus Normal 25y/o



- Corpus Callosum – deep orange
- Arcuate Fasciculus – light orange
- BA - Broca's Area Insertions
- WA - Wernicke's area Insertions

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Comparison of Problems

Broca's-Wernicke's-Anomic-Conduction

+ = No Problem, "-" = Problem)

	Broca	Wernicke	Anomic	Conduction
• Physical	-	+	+	+
• Auditory Comp	+	- -	+	+
• Fluency	-	+	+	+
- Speech Rate	-	+	+	+
- Ease of Production	-	+	+	+
- Articulatory Agility	-	+	+	+
- Motor Initiation	-	+	+	+
- Phrase Length	-	+	+	+
- Melody	-	+	+	+
- Syllable	-	+	+	+
- Transitions	-	+	+	+
- Rhythm	-	+	+	+
• Grammar	-	+	+	+
• Naming	+/-	-	-	-
- Content	+/-	-	-	-
- Paraphasias	+	-	+	-
• Reading	-	-	-	+
• Writing	-	-	-	-
• Sing/Autom Sp	+	+	+	+
• Repetition	-	-	+	- - -

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Right Hemisphere Language

Historical Perspective

1879 - H. Jackson

1950 - Denny-Brown

1977 - Heilman et al

1978 - Larsen

1979 - Ross & Mesulam

- **Affective** speech mediated by R Hemis (pt lost propositional speech but could express emotion)
- Described alterations in **expression** of emotion in pts with R Hemis lesions
- **Emotion** mediated by R Hemis - pts can't recognize &/or produce happy, sad, angry, indifferent
- R hemis **blood flow** patterns for automatic speech similar to L hemis patters for propositional speech
- R hemis mediates "prosody" & emotional gestures - proposed **functional anatomic relationship**

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Right Hemisphere Language

Historical Perspective

1981 - Ross

1983 - Hughes et al

1984 - Brownell et al

1984 - Weintraub & Mesulam

- Tested Pts - supported anatomic relationship/R hemis affective lang is organized in analogous fashion to L hemis propositional lang/termed **APROSODIA**
- Showed R hemis lesioned Chinese (**tonal lang**) pts had problems with affect but not propositional lang
- R hemis pts reduced in "**connotative**" processing & L hemis pts in "denotative" processing of same words
- Described "**developmental R Hemis problems**" (like develop dyslexia in L hemis) - consisted of chronic emotional difficulty, (partic in expression) & disturb of interpersonal skills

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Aprosodia

Classification

- The functional-anatomic organization of affective lang in R hemis mirrors L hemis organization for propositional lang. So, aprosodias are classified in a fashion **analogous to aphasia** (e.g. motor aprosodia is analogous to Broca's)

Lesions

- Aprosodia lesion sites are **analogous to L hemisphere** lesion sites causing aphasia

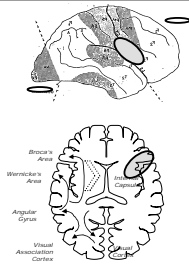
Patients - Functional Appearance

- Expressive**
 - May appear depressed (doesn't initiate interaction)
 - May appear uninterested (doesn't look at speaker)
 - May display no emotion on face or incongruous signals (smile when describing sad situation)
- Receptive**
 - May misperceive jokes or miss "in-jokes" with family & friends
 - May appear confused &/or respond "concretely" to specific words instead of message carried by tone of voice ("you look awful" used teasingly to express compliment)

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Description of Problems Motor Aprosodia

(+ = No Problem, "-" = Problem)



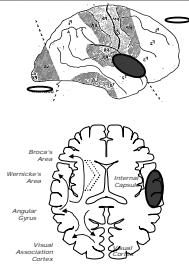
Lesion - Post Portion of 3rd frontal convolution, adjacent subcortical white matter

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- Physical -
- Comp of Emot Tone +
- Comp of Emot Gest +
- Prod of Prosody in Lang -
- Match Affect Tone to Semantic Output -
- Repetition -
- Prod of Affect Facial Exp & Gestures -
- Match Facial Express/ Gest to tone of voice -
- Match Facial Exp/Gest to Semantic Content -
- Appearance -
 - Flat Affect/Depressed -
 - Confused/Inappropriate -
 - Labile -
- Other Problems +
 - Hemianopsia/Neglect +
 - Slurred speech +
 - Disoriented +

Description of Problems Sensory Aprosodia

(+ = No Problem, "-" = Problem)



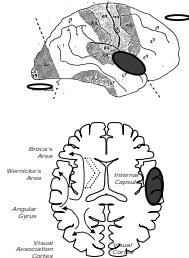
Lesion - Post Portion of superior, transverse, adjacent subcortical white matter

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- Physical +
- Comp of Emot Tone -
- Comp of Emot Gest -
- Prod of Prosody in Lang +
- Match Affect Tone to Semantic Output -
- Repetition -
- Prod of Affect Facial Exp & Gestures +
- Match Facial Express/Gest to tone of voice +
- Match Facial Exp/Gest to Semantic Content -
- Appearance +
 - Flat Affect/Depressed +
 - Confused/Inappropriate -
 - Labile +
- Other Problems -
 - Hemianopsia/Neglect -
 - Slurred speech +
 - Disoriented -

Description of Problems Conduction Aprosodia

(+ = No Problem, -- = Problem)



Lesion - Post Portion of superior, transverse, adjacent subcortical white matter

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- Physical +
- Comp of Emot Tone +
- Comp of Emot Gest +
- Prod of Prosody in Lang -
- Match Affect Tone to Semantic Output ---
- Repetition ---
- Prod of Affect Facial Exp & Gestures --
- Match Facial Express Gest to tone of voice --
- Match Facial Exp/Gest to Semantic Content -
- Appearance +/-
 - Flat Affect/Depressed
 - Confused/Inappropriate
 - Labile
- Other Problems +
 - *Heianopsia/Neglect*
 - Stunned speech
 - Disoriented

Aprosodia Functional Problems

- Family reports "personality" change & pt is **"not the same person"**
- Family/friends/staff report pt is purposefully being **"difficult"**
- Pts often end up in **divorces** due to changes in relationships
- Pts may **insult others** by attempting inappropriate "in-jokes" or using inappropriate tone of voice
- Pts appear **"concrete"** because they react to the linguistic components of messages vs emotional components
- Pts feel **"disconnected"** because they cannot produce or understand non-verbal messages (carry up to 90% of meaning)
- Pts appear **"uninterested"** due to lack of eye contact or facial expression - can result in reduced stimulation or cessation of interaction
- Audience becomes **"suspicious"** because pt sends confusing messages (e.g. sad story with smile on face)
- Pts appear & can become **depressed** &/or be diagnosed as having primary psychiatric problems because of the above

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Case of A.L.

- Iraq 3/03 to 6/04 – exposed to 2 roadside bomb blasts
- First - 10 ft from blast, no reported consequences
- Second – April 2004, 5 feet from blast
 - No obvious physical injuries
 - LOC – unknown amt of time, estimated a "few minutes"
 - Reported "slow" vision; hearing problems; impaired memory; stuttering; mumbling
 - No obvious "physical" injuries – was "looked over" w no other med tx

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Case of A.L.

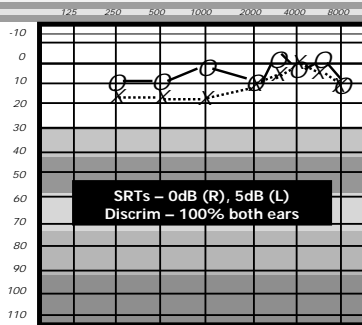
- > 2 ½ Yrs Later Sept 2006 – seen in Palo Alto PNS clinic; reported continuing problems with above issues, *reduced hearing*, tinnitus, concentration problems, reduced family interactions, social withdrawal, headaches
- > Tests
 - > Speech Pathology – positive on screen, referred for indepth speech & language evaluation
 - > Neuropsych – WNL cognitive; PTSD, referred to Mental Health
 - > Audiology – *normal* peripheral hearing (see audiogram); no CAP testing conducted

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Audiogram of Pt A.L.

9-29-06



Case of A.L.

- > **In-depth Speech-Language Eval** – revealed multiple problems suggesting bilateral, sub-cortical etiologies
 - > Mild *conduction aphasia* (LH arcuate fasciculus)
 - > Mild *neurogenic stuttering* 2dary to conduction aphasia
 - > Moderate *conduction aprosodia* (RH arcuate fasciculus)
 - > Moderate attention deficits (sustained)
 - > Reduced speed of cognitive processing
 - > Visual *visual-perceptual* functioning
 - > Constructional apraxia
 - > Reduced spatial orientation
- > Other – **reduced pragmatics, flat affect**

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Case of A.L.

- **Auditory Processing Findings** – areas of the speech-language exam suggested auditory processing problems
 - **Auditory comprehension** – 100th percentile except for complex ideational material (BOth) suggesting auditory concentration or memory component
 - **Test of Everyday Attention** – worst scores on
 - 20th percentile - Elevator Counting with Distraction
 - 1-3rd percentile - Visual Elevator (also suggests attention prob)
 - 1-3rd percentile - Sustained Auditory Lottery (listening for targeted numbers presented in combination with letters & other numbers in various sequences)
 - **Results** – reduced speed of processing auditory information, concentration, memory, & sustaining auditory attention indicate auditory processing problems

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Case of A.L.

- **Treatment** – enrolled in therapy; early in tx complained of sleep problems & referred to Mental Health
- **Serendipity** – reviewed by Dr. Ashford (psychiatrist) and Dr. Rosen MD (neuropsychologist); read our report implicating arcuate fasciculus lesion; aware UCSF obtained new tractography technology; referred; A.L. one of first pts
- **Tractography MR** – new technology which permits identification of a magnetic resonance image of specific nerve tracts

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Anterior Posterior



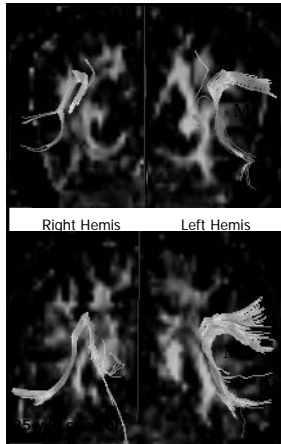
Radiologist – Normal limits?
Neurologist – Interpretation

Lateral View – arcuate fasciculus light orange

Anterior termination at Broca's area – the pt's is stumped without dispersion of its terminals

Middle tract of AF – pt's is clearly smaller & seems to be thinned with individual fibers apparent, suggesting loss of fibers in between

Posterior termination at Wernicke's area – again the pt's termination does not have dispersion of terminals & elongation appears to be abnormal growth of some fibers looking for a place to terminate



Right Hemis Left Hemis

**Radiologist – Normal limits?
Neurologist – Interpretation Below**

Anterior Posterior View –
arcuate fasciculus light orange

A-P View – left hemisphere
appears on right of slide

Anterior/Middle/Posterior
– as on prior slide

AP View – features shown on lateral view also apparent on A-P view particularly the branching at Broca's area/control subject has profuse branching, pt's appears sheared

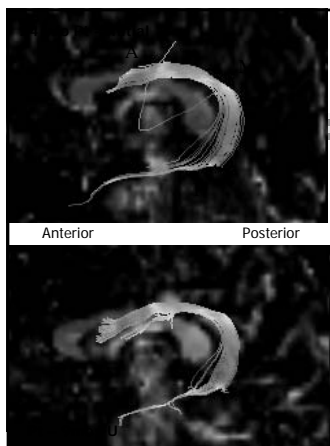
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Case of A.L.

- Treatment – emphasis on conduction aphasia, neurogenic stuttering, aprosodia & auditory attention
- Repeat Tractography – referred for 2nd tractography evaluation 4-6 mo after the first
- Repeat Testing
 - Speech Path – significant improvement in all tx areas
 - Distraction Subtest – 1-3rd to 30-43rd percentile
 - Sustained Auditory – 1-3rd to 30-43rd percentile
 - Aprosodia/Emotional Production – 25% to 87%
 - Aprosodia/Repetition – 0% to 80%
 - Audiology Peripheral Hearing – stable
 - Audiology Central Testing – SSW, SCAN-A

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Anterior Posterior

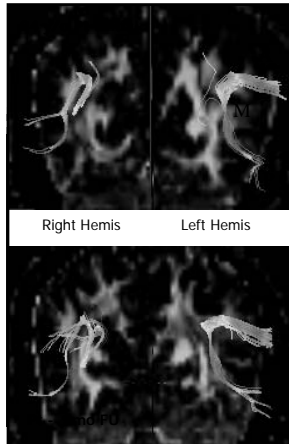
**Radiologist – No change?
Observation – Interp Below**

Anterior termination at Broca's area – no longer a "stumped" appearance/new terminal growth

Middle tract of AF – appears to have new branching

Posterior termination at Wernicke's area – appears denser with more branching

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Right Hemis Left Hemis

Radiologist – No change?

Observation –Interp Below

Anterior Posterior View –
arcuate fasciculus light orange

A-P View – left hemisphere
appears on right of slide

Anterior termination at Broca's area – no longer a "stumped" appearance/new terminal growth

Middle tract of AF –
appears denser

Posterior termination at Wernicke's area – appears denser & larger with more branching

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Therapy - Tractorgraphy

- **Tractorgraphy** – although there are no "normative" data yet, appears to be potentially powerful tool
- **Images** – pt seen 2½ yrs post blast, initial imaging showed what looked like "shearing" effect, 2nd imaging clearly shows changes after 9mo that look like **new terminal growth**
- **Therapy** – image changes 9mo into tx suggests tx works & functional changes correlate with brain structure changes

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Stages of Neurobiologic Recovery

- Rapid Physiologic Changes**
 - **1-7 Days After Injury**
 - **Reduction of edema** - results in decreased intracranial pressure & in
 - **Improved oxygenation** - of cells around injury & analogous contralateral regions of brain (Benson & Geschwind)
 - **Passage of diaschisis** - or neural shock (Finger & Stein)
- Intrahemispheric Reorganization**
 - **1-6 Months After Injury**
 - **Reconnection** - of damaged pathways/new synaptic connections to intact systems denervated by lesion (Jacobson, Bachy-Bita)
 - **Transfer of Function** - reorganization or "unmasking" of intact pathways that were underutilized (Carter & Henri)
 - **Reduction of Disinhibition** - release of influence of damaged areas resulting in maladaptive behaviors, such as perseveration, lability, distractibility (Wil & Echlancher)
- Interhemispheric Reorganization**
 - **Months to Years After Injury**
 - **Reconnection** - transfer of function to analogous contralateral regions (Smith - recovered aphasics became aphasic again after R. hemis lesion)
 - **Alternate Strategies** - use of processing strategies of intact functions to aid damaged areas (phonic vs sight reading)

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Stages of Neurobiologic Recovery??????

- A.L Injuries**
 - 2 ½ yrs before eval

- Intrahemispheric Reorganization**
 - ??? Tractography suggested the normal A-P pathway was compromised; ??? if spontaneous reconnections occurred; limited if they did

- Therapy**
 - Changes suggested after 6 mo of treatment

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Summary - mTBI Lang/Cogn Syndrome

- Conduction Aphasia
- Conduction expressive Aprosodia
- Neurogenic Stuttering 2ndary to conduction aphasia
- Visual-spatial Perceptual Problems/constr apraxia re: reductions in reading speed, writing/spelling
- Pragmatics reductions related to aprosodia
- Reduced speed cognitive processing
- Reduced attention w distractions

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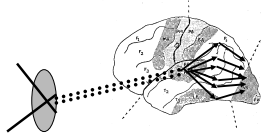
Case of M.S.

- **Background** – 56 yr old SP 2 mTBIs; very bright, 2 degrees, 8yrs Air Force (4 active/4 reserve); pilot/worked in intelligence in AF/plotted bombing targets in Vietnam
- **History** – head hit windshield in MVA; immediate nausea & vomiting w “reduced speed of thinking” which did not last. Sustained 2nd MVA 7 yrs later.
 - Hit from behind while stopped w head turned, rt side of head hit windshield hit windshield
 - Immediate bloody taste in mouth, electric-like shocks down legs, nausea, vomiting, incontinent
 - Persistent nausea & headache for 7 days
- **Evaluation** – received no eval because there was no LOC
 - 3 yrs later - sought eval for persistent symptoms particularly w memory/concentration. Neuropsych findings included reduced processing speed but “emotional functioning was most likely cause of perception of reduced intellectual efficiency” & referred to Mental Health.
 - 3 yrs after that – again sought eval. neuropsych reported “w exception of processing speed no sig impairment in any domain of cognitive functioning.
- **Sp/Lang** – referred during routine audiology eval bc: complaints of continuing attention problems

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Visual Pathways Lateral View



- **Retina** - images inverted & reversed
- **Optic Nerve** - from retina
- **Optic Chiasm** - inside fibers cross @ pituitary
- **Optic Tract** - same eye outside fibers & opposite eye inside fibers travel to thalamus
- **Lateral Geniculate Bodies** - optic tract fibers connect in thalamus
- **Optic Radiation (Geniculocalcarine)** - fibers from LGB course cortical zones to primary visual cortex
- **Upper Quadrant Fibers** - course through temporal lobe
- **Lower Quadrant Fibers** - course through parietal lobe
- **Left Primary Visual Cortex** - info from inside field of L eye & outside of R eye

M. S. - Where's the Lesion



M. S. - Where's the Lesion



NOTE

Center first
 Abnormal Pattern - LR quadrant next
 Resumes Normal Pattern - UL
 then circling to right
 DELAY - LL quadrant petals delayed
 and then LL design quadrant delayed
 DISTORTION - LL quadrant leaves
 are equal in number but show
 significant size distortion

Summary

- *Whole Brain* – even though propositional “language” is mediated by the LH, communication is mediated by virtually the whole brain
- *mTBI* – re: in DAI with SQL difficult to predict & potentially multiple sites
- *Pt Complaints* – virtually all complain of initial “stuttering” or mumbling, “hearing” problems even in the context of normal tested hearing, “slowed” thinking, difficulty thinking of or saying words, memory or concentration problems, changed social relationships
- *DO NOT COMPLAIN* – of difficulty understanding or producing emotions, visual perceptual problems because they are unaware
- *mTBI Communication Syndrome* – VERY DIFFICULT TO DIAGNOSE bc symptoms can be mild in formal testing and complaints are consistent with other problems (PTSD), but careful analysis reveals a syndrome consistent with multiple subcortical dysfunction sites including *Conduction Aphasia, Conduction or Expressive Apraxia, mild neurogenic stuttering, visual-spatial perceptual problems, pragmatics reductions*
- *Tractography* – potentially powerful tool for laboratory confirmation of clinical findings & response to tx
- *Treatment* – both functional outcome (repeat testing, vocational) & potentially tractography suggest tx is effective even YEARS after injury

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