Communicating Brains: Autism and Neurodevelopmental Disorders

12/6/12

Elysa Marco, PhD

BIOGRAPHY:

Dr. Marco is the director of research for the UCSF Autism and Neurodevelopment Program (ANP). In addition to the founding and directing research efforts for the UCSF ANP, Dr. Marco directs the cognitive and behavioral child neurology clinic and participates in the neurology, psychiatry, and genetics multidisciplinary autism clinics at UCSF. Dr. Marco’s research laboratory applies her clinical expertise in cognition and behavior to understanding the neural mechanisms of neurodevelopmental disorders related to autism, agenesis of the corpus callosum, sensory processing disorder (SPD), ADHD, and brain injury. Her laboratory is focuses on how individuals with neurodevelopmental differences process basic sensory information from perception to action. Her NIH funded research investigates how children with autism process sensory information using magnetoencephalographic imaging and her expanding treatment projects are targeting computer training as a tool for augmenting positive brain plasticity.

BIBLIOGRAPHY:


Nina F. Dronkers, PhD

BIOGRAPHY:

Nina F. Dronkers is a VA Research Career Scientist and Director of the Center for Aphasia and Related Disorders with the Department of Veterans Affairs Northern California Health Care System. She is also an Adjunct Professor at the University of California, Davis in the Department
of Neurology and a consultant to the UCSF Memory and Aging Center. She received her interdisciplinary Ph.D. degree in Neuropsychology from the University of California, Berkeley in 1985, and has since specialized in the mapping of speech, language, and cognitive disorders that occur after injury to the brain.

Using numerous methodologies, Dr. Dronkers and her colleagues have isolated numerous brain regions that play critical roles in the processing of speech and language, as well as how these relate to other cognitive skills. Her latest work involves analyzing the structural and functional connections that contribute to language and cognitive processing through advanced work with diffusion and resting state functional neuroimaging.

BIBLIOGRAPHY:


**Communicating Brains: From Autism and Dyslexia to Progressive Aphasia**

**Maya L. Henry, PhD, CCC-SLP**

**BIOGRAPHY:**

Dr. Henry is an Assistant Adjunct Professor and speech-language pathologist working with the language team at the Memory and Aging Center at UCSF. She is also an Assistant Professor in the Communicative Disorders Program at San Francisco State University. She received her master’s degree and PhD from the University of Arizona, studying the nature and treatment of
acquired neurogenic communication disorders. She has conducted NIH-funded studies examining the neural bases of spoken and written language in primary progressive aphasia (PPA) and also examining the utility of speech and language treatment in the three variants of this disorder. Her broad research interests include the neural and cognitive bases for speech and language, rehabilitation of speech and language in individuals with aphasia, and ways in which neuroimaging can inform treatment research in individuals with stroke and neurodegenerative disease. Dr. Henry runs a monthly support group for individuals with PPA in the Bay Area.

BIBLIOGRAPHY:


Communicating Brains: Autism and Neurodevelopmental Disorders

Elysa Marco, MD
12.6.12
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Communication begins with sensory perception and processing:

Review basics of sensory processing from a neuroscience perspective
How does this differ in children with autism and neurodevelopmental disorders?
What are we doing at UCSF to help?

The first question is:
Are there sensory differences in autism at the bedside?… all you need to do is ask!

Or read…

Emergence (pgs 21 & 28)

• Even today, sudden loud noises such as a car backfiring, will make me jump and a panicky feeling overwhelms me. Loud high pitched noises such as a motorcycle’s sound, are still painful to me.

• Tactile stimulation for me and many autistic children is a no-win situation. Our bodies cry out for human contact but when the contact is made, we withdraw in pain and confusion.

Grandin, T. Publisher: Warner Books (September 1, 1996) Emergence: Labeled

Sensory Processing Disruption is Ubiquitous in Autism

• Sensory behavioral differences occur in over 90% of individuals with autism
• Children with autism are more likely to have multiple domains affects than controls (70% vs. 13%)

Sensory Symptoms in Autism

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Children with Developmental Disabilities and Language Impairment also have sensory symptoms

Leekam et. al. (2007) Describing the Sensory Abnormalities of Children and Adults with Autism

Leekam et. al. (2007) Describing the Sensory Abnormalities of Children and Adults with Autism
Sensory Processing Disruption has long-term impact

- Sensory symptoms often persist into adulthood
- Sensory processing is the basis for all learning and behavior

Leekam et al. (2007) Describing the Sensory Abnormalities of Children and Adults with Autism

What do I mean by sensory processing-bringing together neuroscience & behavioral sciences?

The steps of sensory processing:
- Unimodal Perception (Auditory, Somatosensory, Visual, Olfactory)
- Multimodal Integration
- Attaching Meaning (Linguistic & Emotional)
- Creating Response
- Performing Response (Verbal/Motor)

Some basic neuroanatomy

- Early Auditory Processing
  - CN II synapses at bilateral cochlear nuclear complex (medulla)
  - Only from one ear & gets spectral and temporal information
  - Superior olivary complex
  - Bilateral input
  - Sound localization (delay & intensity)
  - Inferior colliculus
  - Medial geniculate nucleus
  - Auditory cortex
  - All neurons tonotopically organized
  - More frequency specific as you go up
  - Information goes up and down

http://brainconnection.positscience.com/med/medart/anat/996705.jpg

Central Auditory Processing

Can we measure auditory processing in the scanner?

Yes!

EEG
MEG
fMRI
How do neurons talk to each other?

How can you measure electrical activity?

Using magnetoencephalographic Imaging

- Milli-second & millimeter cortical activity resolution (w/MRI co-registration)
- Non-invasive
- Well tolerated

Let's use auditory processing as an example.

We find early primary auditory cortex processing differences

- Faster: Ferri (1000 hz, 100ms tone), Martineau (1000 hz, 4ms tone), Marco et. al. (1000 hz, 80ms)
- Slower: Bruneau (750khz, 200ms), Oram Cardy (1000hz, 300ms), Roberts (delay RH, 200, 300, 500, 1000)

But, it depends on who you ask…
Audiovisual Integration-McGurk Effect

A Congruent
B Non-McGurk Incongruent
C McGurk Incongruent

Percept: "ba" Percept: "ga" "da" in perceivers "ta" in non-perceivers

Whole-brain regression of fMRI responses and McGurk susceptibility–
The more you integrate, the more activity you show in the yellow region below

A Axial B Sagittal C Coronal

Do children with autism show a McGurk effect?

What about other neurodevelopmental disorders?

High Risk Infants may not process AV mismatch

Images courtesy of Dr. Elliott Sherr

Absent
Atypical Auditory Behavior in AgCC:

What does brain activity look like during communication in AgCC?

How are we planning on helping: Our goal is to build both areas of strength and areas of challenge

Kids and video games: if you can’t beat em, join em…

NeuroRacer: What happens when Neuroscience meets Video Gaming in the bay area
Autism and SPD kids have trouble staying in the center of the road

Drive w/ Irrelevant signs

% of time at road center

Decades of Life

Autistic Children (n=mg)
Sensory Processing Disorder (n=mg)

Gazzaley Lab Unpublished data

Autism and SPD kids take longer to shoot: with visual distraction

RT (msec)

Decades of Life

Autistic Children (n=mg)
Sensory Processing Disorder (n=mg)

Gazzaley Lab Unpublished data

Can we improve accuracy with practice?

Multi-tasking index (d')

Decades of Life

Training Study

Single-task train
Multi-task train
No-contact control

Gazzaley Lab Unpublished data

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- Suzanne Homma
- Joaquin Anguera
- Adam Gazdaley
- Cammie Rolle
- John Gibbons
- Shivani Desai*
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- John Gibbons
- Shivani Desai*
- Ashleigh Antovich
- Julia Harris*
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- Richard Hill

Thank you!

Speech and Language Deficits After Injury to the Adult Brain

Nina F. Dronkers, Ph.D.

VA Northern California Health Care System
University of California, Davis
Why do we study communication abilities in the injured brain?

- The more we understand about the injured brain, the more we can help patients toward a more rapid and effective recovery.
- Individuals with brain-injuries teach us a great deal about how the normal brain processes language; understanding how language breaks down tells us a lot about it normally functions.

Research at our Aphasia Center

- We conduct extensive speech, language, and neuropsychological evaluations of aphasic stroke patients to determine the specific deficits they are experiencing.
- We also scan participants in an MRI scanner to see which part of the brain was affected by the stroke.

Some Causes of Brain Injury in Adults

- Stroke
- Tumor
- Head Trauma
- Severe Epilepsy
- Neurodegenerative disease (e.g., Alzheimer’s Disease)
- Anoxia
- Infectious disease
- Toxicity

What is a Stroke?

- Blood Clot Lodged in Artery
- Bleeding into the Brain

Strokes and Aphasia

- Strokes can lead to speech and language disorders that severely disrupt one’s ability to communicate.
- A disruption of core language functions as a result of injury to the brain is called “aphasia”. 

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Strokes Can Affect Language in Different Ways

Strokes in the front regions of the brain can lead to non-fluent speech.

Broca’s Aphasia

- Halting, telegraphic, agrammatic speech with reliance on content words and a paucity of function words
- Impaired comprehension for complex grammatical structures
- Repetition of sentences reflects agrammatic style
- Word finding difficulty
- Almost always accompanied by dysarthria and/or apraxia of speech
- Reading and writing also impaired

Written Picture Description: Moderate Broca’s Aphasia

3-D MRI of an Individual with Broca’s Aphasia

Lesion Overlapping of 36 Patients with Broca’s Aphasia

The injuries tend to involve more anterior areas.

Strokes Can Affect Language in Different Ways

Strokes in posterior regions of the brain leave the person with fluent speech, but which is hard to understand.

(video of individual with Broca’s aphasia - not available for distribution)

(video of individual with Wernicke’s aphasia - not available for distribution)
Severe Wernicke’s Aphasia

- Reflects extreme disruption of language system without encumbrance of motor speech deficits
- Chronic Wernicke’s aphasia occurs very rarely
- Acute Wernicke’s aphasia typically evolves into milder forms of aphasia

Lesion Overlapping of Patients with Wernicke’s Aphasia

The injuries tend to involve more posterior areas.

Strokes Can Affect Language in Different Ways

Larger strokes can leave patients with only automatic sounds, words or phrases with which to communicate

(video of individual with severe Broca’s aphasia - not available for distribution)

Tips for Communicating with Individuals with Aphasia

- Keep the sentences simple, but avoid talking down.
- Reduce your rate of speech; emphasize key words.
- Make sure you have the person’s attention.
- Try writing, drawing, or gestures in addition to speech.
- Give them time to talk.
- Ask yes/no questions if the aphasia is severe.
- Provide practice trials and give positive feedback.

Things to Remember

- On the other hand, individuals with aphasia have not lost their intelligence.
- They may find it more difficult to process incoming information or to solve difficult problems; they may have lost some of the language that would normally help them.
- Though they may have difficulty expressing their thoughts with words, their thoughts and ideas are not typically affected.

What has research with aphasic individuals taught us about language processing in the normal brain?
What Have We Learned?

The areas of the brain that support language are far more extensive than previously thought.

Language Areas in Older Models

Examples of Additional Language Areas from Recent Research

What Have We Learned?

- Brain areas do not work in isolation.
- The fibers that connect them help these regions to interact with each other to support complex functions such as language.

Fiber Bundles in Dissection

Visualization of Fiber Tract Data with Diffusion MRI
Visualization of Language Tracts with Diffusion MRI

Visualization of the Arcuate Fasciculus with Constrained Spherical Deconvolution Tractography

Visualization of Language Tracts in Stroke

What Have We Learned?

- These techniques have taught us a lot about how the brain processes language and what happens when the brain suffers an injury.
- With this information, clinicians know that strokes affecting certain brain structures will cause a loss of specific functions, and that these will require special training.
- At the same time, brain structures that were spared can be recruited to help take over the functions that were lost, or, develop new strategies to compensate for the dysfunction.

Summary

- A complex system such as language requires an extensive and interactive network of brain regions.
- Understanding this network provides us with the tools for assisting our patients in their recovery from brain injury, and, for understanding how language is processed in the normal brain.

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- Our patients and research participants who taught us all we know
PROGRESSIVE IMPAIRMENTS OF SPEECH AND LANGUAGE: WHEN APHASIA ISN’T CAUSED BY A STROKE

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Communicative Disorders Program, San Francisco State University

Language and normal aging

- Most common complaint: “I just can’t remember the name…..” (especially proper names)
- Word-finding does decline with age
  - Difficulty with access rather than a deterioration of knowledge
  - Older adults outperform younger adults on vocabulary tests
  - Semantic memory (conceptual knowledge) is preserved into old age (Burke & Shafto, 2008)

When is language decline not normal?

- When the decline is more rapid than would be expected and changes are observed at ages <60 years
- When cognitive processes not typically affected by age are noticeably impaired
  - Motor control for speech
  - Ability to speak in complete sentences
  - Conceptual knowledge, word meaning
  - Ability to “hold on to” heard information (e.g., a phone number)

Primary progressive aphasia (PPA)

- Slowly progressive aphasia caused by neurodegenerative disease
- Language processes are affected first and foremost (Mesulam, 2008; Gorno-Tempini et al., 2011)
- There must be no focal lesion (e.g., stroke)

Regional cortical atrophy
Primary Progressive Aphasia (PPA)

PPA affects core speech-language processes

- Like aphasia resulting from stroke, progressive aphasia may involve
  - Syntax (grammar)
  - Motor speech (articulation/voice)
  - Semantics (meaning)
  - Phonology (sound system)
  - Orthography (written language)
Deficits tend to arise in patterns: 3 variants of PPA (Gorno-Tempini et al., 2011)

- Nonfluent variant
  - Impaired syntax (sentence processing) and/or motor speech (articulation/voice)
- Semantic variant
  - Impaired semantic processing (conceptual knowledge)
- Logopenic variant
  - Impaired phonological processing (sound system for language)

These variants linked to underlying patterns of atrophy caused by different diseases

- Nonfluent variant
- Semantic variant
- Logopenic variant

Wilson et al., 2010

HOW CAN PPA PATIENTS CONTRIBUTE TO OUR UNDERSTANDING OF BRAIN-BEHAVIOR RELATIONS FOR LANGUAGE?

- Converging and complementary evidence regarding brain-behavior relations for language
  - PPA involves some areas rarely damaged in stroke
  - Anterior temporal regions implicated in semantic processing

What can PPA tell us about core language domains?

- Semantics
- Phonology
- Orthography (written language)

Language tasks

- Semantic tasks

What is this? Which item goes with the picture on top?

Pyramids and Palm Trees Test (Howard and Patterson, 1992)
Language tasks

- Phonological tasks
  - Blend these sounds together /bl/ /oi/ /l/ → “boil”
  - Say “fat”...now take away “f” → “at”
  - Say “mouth”...now change “th” to “s” → “mouse”

Written language tasks
- Different word types require different types of processing

<table>
<thead>
<tr>
<th>Irregular Words</th>
<th>Nonwords</th>
</tr>
</thead>
<tbody>
<tr>
<td>yacht</td>
<td>flig</td>
</tr>
<tr>
<td>circuit</td>
<td>hoach</td>
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<td>doubt</td>
<td>sanse</td>
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<td>glope</td>
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<tr>
<td>sword</td>
<td>boak</td>
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<tr>
<td>island</td>
<td>cheese</td>
</tr>
<tr>
<td>debt</td>
<td>member</td>
</tr>
</tbody>
</table>

Semantically-derived
Phonologically-derived

Spoken language

Written language

Neural bases of semantic vs. phonologic processing

Treatment for speech and language impairments in PPA
- Treatments similar to those applied in stroke aphasia appear promising (Henry et al., 2008; Beeson et al., 2011; Newhart et al., 2009)
- Treatment effects can be substantial and lasting
- Behavioral therapy can result in changes in language behaviors and also in imaging findings
Treatment results in PPA

- Semantic PPA: impaired meaning system (semantics)
  - Therapy for naming: take advantage of spared sound system

- Logopenic PPA: impaired sound system (phonology)
  - Therapy for naming: take advantage of spared meaning system

In sum

- PPA is a slow decline in speech and language caused by neurodegenerative disease
- Semantic, phonologic, and motor systems can be selectively impaired
- Treatment for speech-language can have lasting benefits, taking advantage of spared cognitive and neural systems

QUESTIONS?