Examples of lateralization

- Language
- Spatial abilities
- Examples of children with brain damage

Big questions:
- What cognitive abilities show lateralization?
- What are the subtleties of these differences?
- What can development teach us about lateralization of functions?

Language - a classic example of lateralization

- An example of some language that we understand in everyday life

Linguistics basics

- Pragmatics - meaning within a social context
  "We are sinking!" (SO SEND A RESCUE SHIP!!!!)

- Semantics - meaning based on words and sentence structure
  "We are sinking!"

- Syntax - structure of phrases and sentences
  "We are plural _______ing"

- Morphology - small units of meaning (words, prefixes, suffixes, etc.)
  "think-ing"

- Phonology - sounds of a particular language
  "s" vs. "th"

Aphasia

- Paul Broca (1861)
  - Non-fluent aphasia
  - Syntax? Production?

- Karl Wernicke (1871)
  - Fluent aphasia
  - Semantics?
  - Comprehension?

Broca’s/non-fluent Aphasia

- M.E.: Cinderella...poor...um ‘dopted her...scrubbed floor, um, tidy...poor, um...’dopted...Si-sisters and mother...ball. Ball, prince um, shoe...
- Examiner: Keep going.
- M.E.: Scrubbed and uh washed and um... tidy, uh, sisters and mother, prince, no, prince, yes. Cinderella hooked prince. (Laughs.) Um, um, shoes, um, twelve o’clock ball, finished.
- Examiner: So what happened in the end?
- M.E.: Married.
- Examiner: How does he find her?
- M.E.: Um, Prince, um, happen to, um...Prince, and Cinderella meet, um met um met.
- Examiner: What happened at the ball? They didn’t get married at the ball.
- M.E.: No, um, no...I don’t know. Shoe, um found shoe...
Wernicke's/Fluent Aphasia

- C.B.: Uh, well this is the /dodu/ of this. This and this and this and this. These things going in there like that. This is /sen/ things here. This one here, these two things here. And the other one here, back in this one, this one /gesh/ look at this one.
- Examiner: Yeah, what's happening there?
- C.B.: I can't tell you what that is, but I know what it is, but I don't know where it is. But I don't know what's under. I know it's you couldn't say it's ... I couldn't say what it is. This shu-- that should be right in here. That's very bad in there. Anyway, this one here, and that, and that's it. This is the getting in here and that's the getting around here, and that, and that's it. This is the getting in here and that's the getting around here, and that, and that's it. This one and one with this one. And this one, and that's it, isn't it? I don't know what else you'd want.

Right Hemisphere Brain Damage

- Reduced sensitivity to listener
- Talk more per turn
- May be too detailed or too vague
- Inappropriate
- Disjointed
- Difficulties with non-literal language
- Pragmatics?

RHD and Language

A teenager is being interviewed for a summer job. "You'll get $50 a week to start off," says his boss. "Then after a month you'll get a raise to $75 a week."
(a) "That's great! I'll come back in a month."
(b) "I'd like to take the job. When can I start?"
(c) "Hey boss, your nose is too big for your face!"

Let's look at each hemisphere

- Wada test
- Handedness
  - 96% of right-handers have left-hemisphere language
  - 70% of left-handers have left-hemisphere language
- Split-brain patients
  - Treatment for severe epilepsy

* over 200 million axons! (as many as 10x more than the spinal cord)

* anterior fibers connect anterior areas of cortex (frontal lobes), posterior fibers connect occipital and parietal cortex
commissurotomy - surgically cutting nerve fibre tracts which connect the two hemispheres

Name that object (picture in RVF)

Patient says: “Spoon!”

Name that object (picture in LVF)

Patient: (says nothing)
Researcher: “Did you see anything?”
Patient: “Nope.”

Pick up the object displayed

**Left Hand:** Pulls out Spoon!
Right hand does nothing
Summary

• Language
  – Left hemisphere: production, better word knowledge, structure
  – Right hemisphere: some word knowledge, conversational implications, social appropriateness
  – Think back to our German coast guard…

Spatial cognition

• Right-hemisphere damage is typically described as causing spatial deficits
• Right parietal brain damage can cause people to ignore the left side of their world
• More split-brain studies…

Face perception -- chimeric faces
Patients will choose the face which matches the left half of the chimera

Brain damage and spatial abilities

• Right hemisphere is important for face processing
• Block arrangements
• “Hierarchical figures”
Heirarchical figures

Target Figure Left Hemisphere Damage Right Hemisphere Damage

(Deha et al, 1986)

Summary

• Language
  – Left hemisphere: production, better word knowledge, structure
  – Right hemisphere: some word knowledge, conversational implications, social appropriateness

• Spatial cognition
  – Left hemisphere: small elements, “local”
  – Right hemisphere: faces, broad contours, block arrangement, “global”

Why would there be lateralization?

• A processing strategy
  – Local (featural/analytic) vs. Global (holistic/synthetic) processing

• Pre-programming/genetics
  – Language acquisition device
  – Williams Syndrome
  – FoxP2

• Input characteristics

• A combination of several of these things?

What can development teach us about localization of function?

• Is lateralization of function observed in children?

A special population
  – Unilateral brain damage
  – Acquired pre- and peri-natally

Language

• Casual personal stories (5-8 years old)
  – Amount of speech, complexity, errors
  – RHD, LHD and controls: amount and complexity of language is equal
  – RHD, LHD: make more errors than control children
  – him lost it, two shoe, I kicks the ball

• Frog Story

Frog Story

Frog, where are you? (Mercer Mayer, 1969)
“The dog is looking in the frog bowl.”

“In the night when the girl is sleeping, the frog jumped out of its bowl.”

“Oh, it’s a boy instead. When the boy woke up next morning he looked that the frog was gone.”

“Then the boy, and the boy, was looking in his hat and the dog was going in the, in the frog bowl.”

“Then he looked outside the window and the dog has the bowl on his head.”

“Then the dog jumped out with the bowl on his head.”
**Language**

- Casual personal stories (5-8 years old)
  - RHD, LHD and controls: amount and complexity of language is equal
  - RHD, LHD: make more errors than control children
- Frog story (4-11 years old)
  - RHD, LHD: more morphological errors, shorter sentences, difficulties with narrative, fewer complex sentences
- Comprehension
  - RHD, LHD: some trouble with syntactically complex sentences

**Spatial**

- Block creation
  - LHD: accurately finished figures; used different techniques
  - RHD: had more trouble; were able to adapt at older ages (6-8 years old)

**Adult vs. Children Lateralization**

- Language
  - Left hemisphere: production, better word knowledge, structure
  - Right hemisphere: some word knowledge, conversational implications, social appropriateness
- Spatial cognition
  - Left hemisphere: small elements
  - Right hemisphere: faces, broad contours, block arrangement

**Summary**

- Language and spatial cognition are processed by both hemispheres
- Hemispheres have different primary abilities
- HOW lateralization happens (and WHY?) is the result of a complex developmental system - details to be determined!!