

CEREBRAL LATERALIZATION & LANGUAGE (p.1)

1. Historical Introduction to CL/Hemispheric Specialization

Aphasia = difficulties in producing/comprehending speech

Dr. Marc Dax (1836)

40+ of his patients who had various speech problems all turned out to have damage to their left brains (not one with damage on the right)...no one paid any attention to his research finding

Dr. Paul Broca (in 1860s)

Noticed that his speech problem patients (N=9) all had damage to the inferior prefrontal cortex on the left side of the brain, an area that has come to be called “Broca’s area”

Dr. Hugo-Karl Liepmann (early 1900s)

Found that *apraxia* (patient had difficulty performing movements on command, out of context, although could still do the movement spontaneously) is also associated with left brain damage

So...left hemisphere came to be thought of as the “dominant” hemisphere,
And the right hemisphere as the “minor” hemisphere

2. Modern Tests of Cerebral Lateralization

a. Wada Test (sodium amytal)

b. Dichotic Listening Test (Doreen Kimura)

c. Functional Brain Imaging (PET or fMRI)

92% of R-handers show greater activity in L brain for language

69% of L-handers/ambidextrous Ss also

early L brain damage in L-handers/ambidextrous Ss decreased % of persons with greater activity in L brain for language

So...left hemisphere does seem to be the brain half that controls language (especially speech) in most persons, assuming no early L brain damage, no matter what handedness

Note: differences in degree of lateralization in males vs. females

3. Split Brain Subjects (p.2)

Corpus callosum – 200 million axons

When sever the CC --- “split brain” preparation...behavior “normally”

Note: **complete or partial agenesis of the CC**

50% also have epilepsy, but degree of epilepsy is not correlated with degree of agenesis...so seizures are likely not caused by loss of CC per se

more frequent in males than females

also correlated with intellectual impairments (50%), and/or various psychiatric disorders (depression, psychosis, anxiety, etc.)(33%)

can occur in a completely normal S...but is harder to detect

estimated overall incidence is 0.07% (7/10,000)

Cats with surgically severed CC (Dr. Myers & **Dr. Sperry**)

Also severed the optic chiasm, so visual input is all ipsilateral

Can train eye/hemisphere #1 to do task X, naïve eye/hemisphere #2 shows no “savings”

Can train eye/hemisphere #1 to do task X (circle is “+” and square is “-“), while simultaneously training eye/hemisphere #2 to do task Y which is just the opposite

Humans with surgically severed CC

Commissurotomy is performed to limit uncontrollable seizures to only one hemisphere (when anti-seizure drugs have not worked), rare present unique opportunity to study what one hemisphere can do vs. the other hemisphere

L brain can talk to us; R brain cannot talk but can read, can comprehend spoken language

e.g. show R brain the word “keys”, and ask S to pick out the object

e.g. show R brain the word “keys”, and ask S what word he/she saw

e.g. show R brain “keys” and L brain “pencil”, using R vs. L hand

“Cross-cuing” behaviors

the “helping-hand” phenomenon

“hemispheric conflicts” observed in some patients

the “left-brain interpreter” effect

4. Differences between L and R Hemispheres (p.3)

the “glib” description:

Left – visual perception of letters & words

- auditory perception of language sounds
- complex/precise movement control, more ipsilateral involvement
- verbal memories, “greater significance” of memories
- spoken/written speech, reading, calculations (math)

Right – visual perception of faces, geometric patterns, emotional Expression

- auditory perception of nonlanguage sounds, melodies, music
- tactual patterns, including Braille reading
- movement in spatial patterns, less/no ipsilateral involvement
- nonverbal memory, perceptual aspects of memories
- emotional content of language
- spatial ability (mental rotation of shapes, geometry, direction, distance perception)

But...these are often slight biases toward one side or the other, and not an absolute distinction into one or the other side

The above list makes too broad a set of labels...each of these behaviors is really made up of many more discrete abilities, some of them controlled by L and some by R hemisphere

Besides, most of us are not “split-brained”...thus, we use both hemispheres all the time, simultaneously, while information freely passes from one hemisphere to the other via the CC

It is, thus, neurologically absurd to describe someone as being either “left” or “right” brained!

5. Evolution of Hemispheric Specialization (p.4)

What would we expect? We would expect to see **precursors** to CL/HS in nonhuman primates, precursors to hand preferences, etc.

What do **nonhuman primates** show us?

Handedness data – R handed preference for certain tasks (precise movements)

So R hand preference began before human tool use

Note: nonhuman primates do make & use “tools”

Left hemisphere (and not right) is used more for production of and discrimination between communicative vocalizations
the “Wernicke” area is larger on left brain (vs. right)

Right hemisphere is used more for facial identification & emotional expression (as it also is in humans)

6. Wernicke-Geschwind Model

Broca’s area (speech production), located near face/tongue/lips/fingers motor cortex (precentral gyrus)

Wernicke’s area (language comprehension), located near auditory primary projection area & visual primary projection area

“expressive” vs. “receptive” aphasias

current thinking, while accepting some of this model, is becoming more and more precise

e.g. specific language abilities are now being located in specific regions for *phonological analysis* of sounds, for *grammatical analysis* of words (e.g. word order), and for *semantic analysis* (of the word meanings)

e.g. areas of the brain that are involved in language-related behaviors are often also involved in other behaviors as well (e.g. STM)

e.g. areas of the brain that are involved in language-related behaviors are likely to be small, widely distributed, and specialized (e.g. assign meaning to verbs, but not nouns)