Psych 56L/ Ling 51: Acquisition of Language

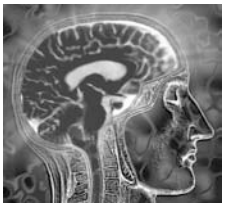
Lecture 4

Biological Bases of Language II

Announcements

Be working on HW1 (due 1/21/10)

Language Localization



Why the left hemisphere?

Left hemisphere may process information more analytically.

Trained musicians process music in the left hemisphere.
Normal (untrained) people process it on the right.

Left hemisphere may be better at executing well-practiced routines, while right is better at responding to novel stimuli.

Language, for adults, is a well-practiced routine.

Where is language located? Not-just-left hemisphere evidence

Sometimes, aphasia doesn't result when there is left hemisphere damage.

Sometimes, aphasia results when there is right hemisphere damage.

In some people (usually left-handed people), language is controlled by the right hemisphere.

Where is language located? Not-just-left hemisphere evidence

Right hemisphere contributions to language: tone contour, emotional tone, jokes, sarcasm, figurative language interpretation, following indirect requests

(much of this falls under pragmatics)

Evidence: right hemisphere lesion patients

Right hemisphere activated by semantic processing, while left hemisphere activated primarily by syntactic processing

Evidence: ERP studies

Evidence: late language learners who aren't as proficient with syntax, and have language located primarily in right hemisphere

How does a left hemisphere specialization for language develop?

Equipotentiality hypothesis: left and right hemispheres have equal potential at birth

Prediction: dichotic listening and brain injury in children show less specialization for language than adults

Invariance hypothesis: left hemisphere specialization available at birth

Prediction: dichotic listening and brain injury data from children should look like the corresponding data from adults

How does a left hemisphere specialization for language develop?

fMRI studies: newborns and 3-month-old infants show greater left-hemisphere than right-hemisphere activation in response to speech stimuli (as do adults)

- But also greater left-hemisphere activity in response to non-speech sounds, suggesting general bias to process sounds in left hemisphere (older children [10-month-olds] and adults process non-speech sounds with right hemisphere)

How does a left hemisphere specialization for language develop?

Dichotic listening tasks: Right-ear advantage for verbal stimuli in 2-year-olds

Speech vs. non-speech?

Best (1988): right-ear advantage for consonants but not for vowels. Consonants have rapidly changing acoustic properties compared with vowels. Could tie in to left-hemisphere specialization for serial processing.

How does a left hemisphere specialization for language develop?

Summary from experimental studies:

Language processing appears to be specialized to the left hemisphere as early as researchers can test it.

But the infant brain is not the same as the adult brain - specialization/lateralization continues to increase as the brain matures.

How does a left hemisphere specialization for language develop?

Childhood aphasia: Aphasia nearly always results from left hemisphere damage and rarely from right hemisphere damage (Woods & Teuber 1978)

However, immature brain is not organized the same way as the mature brain.

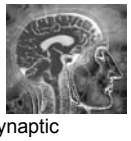
- children more likely to suffer Broca's aphasia (non-fluent aphasia) than Wernicke's
- children tend to recover better from brain damage, with younger children recovering better than older children

Neural plasticity in children

Plasticity: the ability of parts of the brain to take over functions they ordinarily would not serve - ex: right hemisphere taking over language functions if left hemisphere is damaged.

However, plasticity isn't the perfect solution - ex: subtle syntactic impairments in these cases suggest that the right hemisphere isn't as good at parts of language as the left hemisphere is.

Neural plasticity in children



How plasticity works:

The child's brain has much redundancy (extra synaptic connections.)

Maturation = pruning unnecessary connections

What's necessary: what gets used (where child's brain activity is).

Once connections are pruned, redundancy is lost and particular functions become localized.

Neural plasticity in children

But wait - young children use their right hemisphere (somewhat) for language. Since there's language activity, why does the right hemisphere lose its language functionality?

Maturation hypothesis: adult language brain structures develop in the left hemisphere and take over (specialization is genetically determined)

Process change hypothesis: children change the way they process language, and the new way is more in line with the left hemisphere natural capacities. (specialization is by-product of process change)

The Critical Period Hypothesis

Critical & sensitive periods

"critical period for language" = biologically determined period during which language acquisition must occur in order for language to be learned fully and correctly

Other biologically determined deadlines:

- imprinting: chicks & ducklings follow first thing they see forever (it's likely their mommy)
- visual cells in humans: if cells for both eyes don't receive visual input during the first year or so of life, they lose the ability to respond to visual input

"sensitive period": biologically determined period during which learning must occur for development to *most likely* happen correctly

Critical & sensitive periods

How do we test for a critical period for language acquisition?

Critical & sensitive periods

How do we test for a critical period for language acquisition?

Ideal experiment: deprive children of all linguistic input during the purported critical period and see how language development occurs.

Problem: ideal experiment isn't so ideal ethically or logistically (just ask the Egyptians)

Critical & sensitive periods

How do we test for a critical period for language acquisition?

Some historical cases that have unintentionally provided lack of linguistic input to children:

"wild children": like Victor of Aveyron

Problem: the lack of language may be due to other reasons

Critical & sensitive periods

How do we test for a critical period for language acquisition?

Some historical cases that have unintentionally provided lack of linguistic input to children:

> Lenneberg (1967): "the only safe conclusions to be drawn from the multitude of reports is life in dark closets, wolves' dens, forests, or sadistic parents' backyards is not conducive to good health or normal development"

Critical & sensitive periods

How do we test for a critical period for language acquisition?

One success story for lack of linguistic input with a young child: Isabelle

1930s: 6-year-old Isabelle discovered hidden away in a dark room with a deaf-mute mother as her only contact.

She was taught to speak and by age 8, appeared to be normal. Potential implication: Isabelle discovered before critical period was over.

Critical & sensitive periods

How do we test for a critical period for language acquisition?

A more thorough study: Genie

1970s: 13-year-old Genie brought by her mother to social services after escaping mentally ill father; until mother's escape, had no language input (and very horrific living conditions)

By age 17, she had a 5-year-old's vocabulary, and could express meanings by combining words together.

Critical & sensitive periods

How do we test for a critical period for language acquisition?

A more thorough study: Genie

However…syntactic skills lagged far behind - deficient in both production and comprehension.

"Mama wash hair in sink." "Like go ride yellow school bus."
"At school scratch face." "Father take piece wood. Hit. Cry."
"I want Curtiss play piano."

Dichotic listening tasks showed language was a right-hemisphere activity for her.

Critical & sensitive periods

How do we test for a critical period for language acquisition?

A more thorough study: Genie

Potential Implication: Genie discovered after critical period was over.

However, Genie may have had other cognitive disabilities…

Critical & sensitive periods

How do we test for a critical period for language acquisition?

Late acquisition of sign language (ASL): deaf-of-hearing children whose parents don't know sign language. Children are eventually exposed to sign language when they encounter other deaf children.

Good: individuals have normal early childhood experience, except for lack of language input

Critical & sensitive periods

How do we test for a critical period for language acquisition?

If critical period is true, children who learn from infancy should be better than children who learned later - this is what Newport (1990) found. Children who were 4-6 when first exposed were far superior in their sign language ability to children who were exposed after age 12.

Critical & sensitive periods

How do we test for a critical period for language acquisition?

Late acquisition of sign language (ASL): deaf-of-hearing children whose parents don't know sign language. Children are eventually exposed to sign language when they encounter other deaf children.

Also important: not just about how long sign language speakers had known the language. Speakers who had been signing for more than 30 years showed this same difference: those exposed younger were far superior in their language skills to those exposed when they were older.

Critical & sensitive periods

How do we test for a critical period for language acquisition?

Second language learning. Why? Children who learn a second language when they are young often become indistinguishable from their native-born peers.

Critical & sensitive periods

How do we test for a critical period for language acquisition?

Testing age differences in second language acquisition:

- Oyama (1976): testing Italian immigrants learning English age of arrival was better predictor of accent than how many years the immigrant had been speaking English

- Oyama (1978): age of arrival was better predictor of comprehension than number of years speaking the language (not just about motor skill learning ability)

Critical & sensitive periods

How do we test for a critical period for language acquisition?

Testing age differences in second language acquisition:

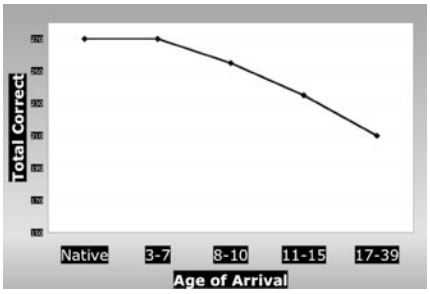
- Singleton & Newport (1989): testing grammatical competency of Chinese & Korean natives living in the US

Heard recorded voices speaking sentences, and had to judge whether they were correct or not.

"The farmer bought two pig at the market."

"Tom is reading book in bathtub."

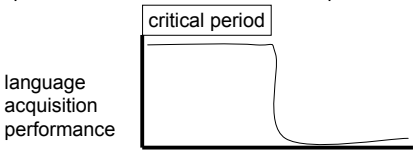
Second-language proficiency dependent on age of arrival



Critical vs. sensitive, revisited

If there is a truly a critical period of language acquisition, people learning language after this period should not succeed very well at all while people within the critical period should do very well.

Expectation: discontinuous function of performance



Critical vs. sensitive, revisited

However, experimental evidence (Hakuta, Bialystok, & Wiley 2003) suggests that there is a smoother drop-off, and also a relation to education-level. (support for sensitive)

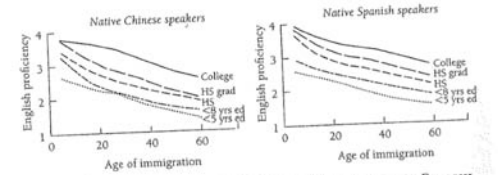


FIGURE 2.6 | THE RELATION BETWEEN AGE OF IMMIGRATION AND ENGLISH PROFICIENCY FOR NATIVE CHINESE AND SPANISH SPEAKERS WHO IMMIGRATED TO THE UNITED STATES

So why are younger children better?

One idea: genetically determined critical/sensitive period

Another factor: dominant language switch hypothesis
Younger children are better able to make the new language their dominant language (better at new language than old language)

Another factor: self-consciousness about making errors & identification with the new language

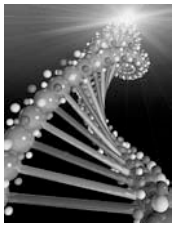
So why are younger children better?

"Less is more" hypothesis: Newport (1991)

Children can remember less than adults (and have other cognitive limitations, like less attention). Perhaps language is actually easier to figure out if the input is limited to smaller chunks. Adults remember more and can store longer chunks, which makes their analytical task harder.

Studies supporting a limitation on children's input leading to better learning performance: Pearl & Lidz, 2009, Pearl 2008, Pearl & Weinberg 2007, Dresher 1999, Lightfoot 1999, Lightfoot 1991

Genetic Basis of Language Development



Heritability of individual differences

Twin studies: assess how similar/different monozygotic (identical) and dizygotic (fraternal) twins are

Stromswold (2001): heritable factors account for 25-50% of variance in normal children's language abilities; 50-60% of variance in impaired children's language abilities

Heritability of individual differences

Twin studies: assess how similar/different monozygotic (identical) and dizygotic (fraternal) twins are

Difference between grammatical and lexicon development:

genetic factors account for 25% of syntactic differences and 5% of variance among vocabulary (Stromswold 2006). In general, biological contribution to syntactic development is greater than biological contribution to lexical development.

Genetics of language impairment

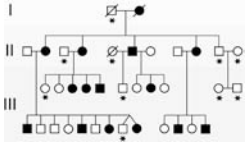
Language impairment runs in families.

- language-impaired children are far more likely to have language-impaired family members
- monozygotic twins are more likely to share a language impairment

Genetics of language impairment

Language impairment runs in families.

- KE family (16 of 30 members had language impairment)
  - affected members had poor language abilities and severe difficulties with the motor skills involved with speech production
  - single dominant gene appeared to be the cause: mutation on gene that affects encoding of protein FOXP2 (Fisher 2006)

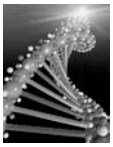


…however, this is only one genetic part of language development

In summary…

There does seem to be a strong biological/genetic component of language development - but it's certainly not the only factor involved.

Moreover, while at least one specific genetic component involved with language development has been discovered, it's still unknown how this component interacts with the rest of the genetic makeup of an individual to produce normal linguistic development.



Questions?