The neurological correlates of language acquisition

Stephen Krashen
Cerebral dominance

Explain in a few words the main theme of the 1st paragraph entitled cerebral dominance

The two sides of the brain perform different functions concerning language

Summarize the role of each hemisphere

<table>
<thead>
<tr>
<th>Functions</th>
<th>Left hemisphere</th>
<th>Right hemisphere</th>
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<tbody>
<tr>
<td>language</td>
<td>Dominant</td>
<td>Involved in prosody</td>
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<tr>
<td>Perception of time</td>
<td>Judgment of temporal order</td>
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<td>Sequence of stimuli</td>
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<td>Estimation of numbers</td>
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<td>Gestalt</td>
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<td>Part to whole judgment</td>
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<tr>
<td>Music perception</td>
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<td>Fully involved</td>
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Cerebral dominance

What is the main hypothesis put forward by Bogen?

There are 2 different cognitive modes

Propositional (analytic, digital) appositional (analogic, synthetic)

Which hemisphere is involved in each mode?

Propositional: Left hemisphere Appositional: Right hemisphere

How are the 2 cerebral hemispheres connected?

By the corpus callosum, that is why we have the illusion to have one mind
Cerebral dominance

List the variety of techniques which allow to know where things are in the brain? Summarize the main results

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Laterality can be studied by presenting two stimuli, one to each ear, so as to investigate the ability to accurately identify the sounds.
Cerebral dominance

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<td>AER Average Evoked Response</td>
<td>Verbal stimuli yield a higher evoked response in LH, greater activity</td>
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Development of cerebral dominance and language acquisition

Lenneberg hypothesized that
a. before puberty, the 2 hemispheres are functionally equal
b. it is impossible to recover language after 10 in case of stroke
c. after puberty, cerebral lateralization is achieved
d. the native language is left lateralized

Since 1967, new research reports have put forward that
a. puberty is not as important as previously thought
b. biological explanations are the most important ones to account for differences between children and adults
c. cerebral dominance for language does not exist
d. other explanations can account for child-adult differences
So how DO we learn our first language?
Development of cerebral dominance and language acquisition

L1 acquisition

- Sound production/babbling
- Phonological acquisition
- Morphological/Syntactical acquisition
- Semantic development
Development of cerebral dominance and language acquisition

Acquisition of phonetics

- Few weeks: cooing and gurgling, playing with sounds. Their abilities are constrained by physiological limitations.
- 4 months: distinguish between [a] and [i], so their perception skills are good.
- 4-6 months: children babble, putting together vowels and consonants. This is not a conscious process!
- 7-10 months: starts repeated babbling.
- 10-12 months, children produce a variety of speech sounds. (even ‘foreign’ sounds)
Acquisition of phonology

- Early stage: Unanalyzed syllables
- 15-21 months: words as a sequence of phonemes.
- Mastery of sounds differing in distinctive features (e.g., voicing)
- Duplicated syllables: *mama, dada* - CV is main syllable structure. They reduce = *banana* $\rightarrow$ [na.na] 2 syllable words
- Early mastery of intonation contours (even in non-tone languages)
- Perception comes before production (‘fis’ or ‘fish’?)

Phonological Processes
Lexicon

• Begin with simple lexical items for people/food/toys/animals/body functions

• **Lexical Achievement:**
  - 1-2 years old: 200-300 words (avg)
  - 3 years old: 900 words
  - 4 years old: 1500 words
  - 5 years old: 2100 words
  - 6-7 years old: 2500 words
  - High school grad: 40,000 – 60,000 words!

• “5,000 per year, 13 words a day” -- *Miller & Gildea*
The acquisition of morphosyntax

- At about 12 months, children begin producing words consistently.
- **One-word stage** (holophrastic stage):
  - Name people, objects, etc.
  - An entire sentence is one word
- **Two-word stage**:
  - Approximately 18-24 months
  - Use consistent set of word orders: N-V, A-N, V-N…
  - With structure determined by semantic relationships
    - agent+action (baby sleep)
    - possessor+possession (Mommy book)
- **Telegraphic stage** (only content words)
Word Inflections

• Function word sequences:

1. -ing
2. Plural –s
3. Possessive –’s
4. 3rd person singular –s
5. Past marker –ed
6. Verb ‘to be’ (is, are)

Plurals:
1. All singular
2. Some irregulars
3. Regular ‘s’ overgeneralized
4. [-ez] for all
5. Only irregulars remain problematic
6. Irregulars memorized
Question Formations

• 1\textsuperscript{st} stage – wh- word placed in front of rest of sentence: \textit{Where} daddy go?
• 2\textsuperscript{nd} stage – addition of an auxiliary verb: \textit{Where you will} go?
• 3\textsuperscript{rd} stage – subject noun changes places with the auxiliary: \textit{Where will you} go?
Acquisition of Semantics

• **Concrete before abstract:**
  – ‘in/on’ before ‘behind/in front’

• **Overextensions:**
  – Using ‘moon’ for anything round
  – Using ‘dog’ for any four-legged animals

• **Underextensions:**
  – The word ‘bird’ may not include ‘pigeon’, etc
Reviewing Linguistic Stages

- **6-12 weeks**: Cooing (googoo, gurgling, coocoo)
- **6 months**: Babbling (baba, mama, dada)
- **8-9 months**: Intonation patterns
- **1-1.5 years**: Holphrastic stage (one word)
- **2 years**: Two-word stage
- **2.5 years**: Telegraphic stage
- **3,4 – 11 years**: Fluent speech w/ errors
- **12 years+**: Fluent speech
Summarize the main results obtained from DL in your paper

**Right Ear Advantage at « birth » (left hemisphere):**

Witelson (1977)
- 30 experiments out of 36
- Young children (from 3 to 7)

**Other studies**
- Lateralization firmly established before puberty

**Increasing REA:**
- Few studies
- Different stimuli from those used by studies reporting no change with age
Dichotic listening

Right Ear Advantage at « birth » (left hemisphere):
Stimuli: ba vs. ga
Short term memory load: easy

Increasing REA:
2 or 3 sets of digits, subjects had to recall digits
Short term memory load: difficult

In summary
2 different processings:
one early in life, before puberty (low short term memory load)
one later in life, around puberty (high short term memory load)
Dichotic listening tasks: Right-ear advantage for verbal stimuli in 2-year-olds

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.
Summarize the experiment about motor skills in babies

Introduction
Assess the development of motor skills in babies and their lateralization

Materials and Methods
21 infants (mean age, 21 months 21 days)
A rattle holding by each infant

Results
Average duration of grasp: 62 seconds for the right hand
41 seconds for the left hand

Discussion
Early propensity for unimanual performance in motor skills
May reveal that a cerebral dominance is established very early
Brain damage

Summarize what is said about brain damage

After 5, lesions to the LH result in aphasia, like in adults
Before 5, lesions to the RH can result in aphasia

Laterlization seems to be complete before puberty
Summarize what is said about hemispherectomy

Early removal of the LH does not result in aphasia
After age 5, this surgical procedure is extremely rare

The RH participates in language functioning in early years
Summarize what is said about AER and EEG

AER: 2 weeks old children

verbal stimuli AER greater in the left hemisphere
musical stimuli AER greater in the right hemisphere

EEG results are similar
Anatomical differences between Left and Right hemispheres

Summarize what is said about anatomical differences

Slight differences between the 2 hemispheres in the adult brain
Confirmed in the infant brain and even in the pre-natal brain
Development of cerebral dominance

Summarize what is said in the text about cerebral dominance

Lateralization by 0:
EEG, AER, anatomical studies, dichotic listening studies, experiments with unimanual skills

Lateralization by 5:
clinical data on brain damage and hemispherectomy

Lateralization by puberty:
Dichotic studies using complex stimuli
Development of cerebral dominance

How can these discrepancies in results be explained?

Predisposition for language in the left hemisphere, enough to be detected at birth

Degree of lateralization increases by 5

Even after puberty, certain aspects of language are not fully lateralized. Particularly, complex stimuli

What’s the conclusion?

Left hemisphere dominance for language before puberty
No relationship between second language learning and cerebral dominance
Development of cerebral dominance

What explanations can be put forward to explain that there is no relationship between cerebral dominance and second language learning?

Some cognitive and affective changes occur around puberty, they may boost language learning while limiting language acquisition.

The teen becomes an abstract thinker, allowing him to create an abstract theory of the second language.
What are the 2 different ways of learning a foreign language?

Formal operations:
They allow conscious grammar, reflection on the rules

Subconscious language acquisition

How do formal operations interact with subconscious acquisition?

They can induce a fossilization of progress in subconscious learning. Affective changes which occur during adolescence: shame which prevents from interacting with others

Subconscious learning is the most important factor in learning A second language
Second language acquisition

Krashen's theory of second language acquisition consists of five main hypotheses (1980):

1. the Acquisition-Learning hypothesis

2. the Monitor hypothesis

3. the Natural Order hypothesis

4. the Input hypothesis

5. the Affective Filter hypothesis
Second language acquisition

1. the Acquisition-Learning hypothesis

The 'acquired system' or 'acquisition' is the product of a subconscious process very similar to the process children undergo when they acquire their first language. It requires meaningful interaction in the target language - natural communication - in which speakers are concentrated not in the form of their utterances, but in the communicative act.

The 'learned system' or 'learning' is the product of formal instruction and it comprises a conscious process which results in conscious knowledge 'about' the language, for example knowledge of grammar rules.

According to Krashen 'learning' is less important than 'acquisition'.
2. The Monitor Hypothesis

The Monitor hypothesis explains the relationship between acquisition and learning and defines the influence of the latter on the former. The monitoring function is the practical result of the learned grammar. According to Krashen, the acquisition system is the utterance initiator, while the learning system performs the role of the 'monitor' or the 'editor'.

The 'monitor' acts in a planning, editing and correcting function when three specific conditions are met: that is, the second language learner has sufficient time at his/her disposal, he/she focuses on form or thinks about correctness, and he/she knows the rule.
3. the Natural Order hypothesis

The Natural Order hypothesis is based on research findings (Dulay & Burt, 1974; Fathman, 1975; Makino, 1980 cited in Krashen, 1987) which suggested that the acquisition of grammatical structures follows a 'natural order' which is predictable. For a given language, some grammatical structures tend to be acquired early while others late. This order seemed to be independent of the learners' age, L1 background, conditions of exposure, and although the agreement between individual acquirers was not always 100% in the studies, there were statistically significant similarities that reinforced the existence of a Natural Order of language acquisition. Krashen however points out that the implication of the natural order hypothesis is not that a language program syllabus should be based on the order found in the studies. In fact, he rejects grammatical sequencing when the goal is language acquisition.
4. the Input hypothesis

The Input hypothesis is Krashen's attempt to explain how the learner acquires a second language. In other words, this hypothesis is Krashen's explanation of how second language acquisition takes place. So, the Input hypothesis is only concerned with 'acquisition', not 'learning'.

According to this hypothesis, the learner improves and progresses along the 'natural order' when he/she receives second language 'input' that is one step beyond his/her current stage of linguistic competence.

For example, if a learner is at a stage 'i', then acquisition takes place when he/she is exposed to 'Comprehensible Input' that belongs to level 'i + 1'.

Since not all of the learners can be at the same level of linguistic competence at the same time, Krashen suggests that natural communicative input is the key to designing a syllabus, ensuring in this way that each learner will receive some 'i + 1' input that is appropriate for his/her current stage of linguistic competence.
the Affective Filter hypothesis, embodies Krashen's view that a number of 'affective variables' play a facilitative, but non-causal, role in second language acquisition. These variables include: motivation, self-confidence and anxiety. Krashen claims that learners with high motivation, self-confidence, a good self-image, and a low level of anxiety are better equipped for success in second language acquisition. Low motivation, low self-esteem, and debilitating anxiety can combine to 'raise' the affective filter and form a 'mental block' that prevents comprehensible input from being used for acquisition. In other words, when the filter is 'up' it impedes language acquisition. On the other hand, positive affect is necessary, but not sufficient on its own, for acquisition to take place.
Second language acquisition

- Second language acquisition is a lifelong process with many parallels to first language acquisition.

- Error patterns are predictable across all learning regardless of the student’s L1 or formal instruction in L2.

- Language acquisition is not a linear process; formal instruction does not speed up the process.

- Sequential materials (mastery of each discrete point before moving on to the next point) are disastrous for second language learners.
Stages of second language acquisition

• Pre-Production; Silent Period

• Early Production

• Speech Emergence

• Intermediate Fluency
Stages of second language acquisition

- **Preproduction/Comprehension Stage**
  - Silent period
  - Can respond non-verbally
  - Will be able to understand more than they can produce
Stages of second language acquisition

- **Early Speech Production** Characteristics

  - Can understand more than can produce
  - Can produce one or two words at a time
  - Will make lots of errors
  - Interlanguage occurs (a mixture of vocabulary and structures from both languages)
Stages of second language acquisition

✓ **Speech Emergence** Characteristics

  - Will be able to understand more than they can produce
  - Interlanguage continues to occur
  - Longer utterances
  - Decreases in errors
Stages of second language acquisition

✓ **Intermediate Fluency Characteristics**

- Appear orally fluent

- Errors are same errors native speakers make

- Struggle with content area reading and writing.
Stages of second language acquisition

- ESL students are faced with many phonological, syntactical, and semantic differences in going from L1 to L2.

- The less proficient a student is in English, the more the student will rely on L1 cues.
Second language learners are doing twice the cognitive work of native speakers during reading instruction because they are

- acquiring new literacy concepts and skills and
- attending to the sounds, meanings, and structures of a new language.
oral language development and phonological/phonemic awareness are critical components for the second language learner.

ESL students must develop these areas in order to succeed in reading development in English… They need to have the phonology of L2 before they can make connections between letter and sound.
Stages of second language acquisition

ESL Strategies:

*Songs *Chants * Rhymes * Stories * Modeling

Minimal Pairs

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<th>vat</th>
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Proficiency in second language

✓ Grammatical Competence
  • Mastery of language code
    Pronunciation rules
    Lexicon
    Word formation rules
    Sentence formation rules
    Spelling

✓ Sociolinguistic Competence
  • Mastery of appropriate language use in different contexts
Proficiency in second language

✓ Discourse Competence
   Mastery of how to combine meanings and forms to create a text in different modes

   Examples: telephone inquiry, argumentative essays, recipes

✓ Strategic Competence
   Mastery of verbal and non-verbal strategies to compensate for breakdowns in communication
How long does it take?

To Think About:

If you wanted to learn a second language, how long do you think it would take you to speak and understand that language? How long would it take you to read and write?
Proficiency in second language

✓ BICS (Basic Interpersonal Communication Skills)

2 to 3 years

Ability to converse and understand every day discussions

✓ CALP (Cognitive Academic Language Proficiency)

5 to 7 years

Ability to read, write, speak, and listen at an academic level
The role of the right hemisphere in L2 learning

The text says that even if the right hemisphere plays a role in native language acquisition, it has no role in second language learning. What do you think about that?

It’s false. It is said the right hemisphere is involved in second language learning in the same way that it is involved in native language acquisition.

Summarize information coming from aphasia investigation

A study has revealed that a higher incidence of aphasia was reported in bilingual subjects when the RH was damaged.
Bilingualism and aphasia

• L1 and L2 seem to be able to recover independently

• It appears to sometimes make a difference whether the language was learned by reading or speaking (implicit vs. explicit long term memory?)

• Cases so far: recovering non-communication languages first, differential effects from the same lesion
Bilingualism and aphasia

Child aphasia

• Acquired aphasia during childhood is almost never fluent (mutism), but they recover rapidly (lasting effects generally only slight word-finding and vocabulary difficulties)

• Recovery is faster, better than in adult acquired aphasia, but not complete

• Early enough, right hemisphere can take over language functions after a serious loss in the left hemisphere
Bilingualism and aphasia

Translation

- Aphasic deficits in translation capabilities suggest that translation too might be a separate system

- Reported cases of loss of ability to translate (though retaining some abilities in each language)

- Other reported cases of loss of ability not to translate;

- **Case:** Perecman (1984): patient would always spontaneously translate German (L1) sentences uttered into English (L2) immediate afterward, yet could not perform translation task on request.
Translation

- Sometimes this can happen even without comprehension;

**Case:** Veyrac (1931): patient (English L1, French dominant L2), could not understand simple instructions in French, but when instructed in English would spontaneously translate them to French and then fail to carry them out.
Gomez-Tortosa et al. (1995)

- 22 years, a woman raised until 10 in Bolivia (Spanish L1), in US for past 12 years (fluent English L2). Had a brain problem which required surgery in a language area. Wada test in English showed LH dominance.
- 2 months later: Had trouble finding words in Spanish, frequently used nonwords approximating Spanish words. No noticeable problems with English. Tests confirmed.
- Conclude: both languages in dominant hemisphere. Each language in different area?
Bilingualism and aphasia

• The fact that L1 and L2 can recover independently implies that they are at least in part differentially represented in the brain

• Case: Dimitrijevic (1940)
  Woman grew up in Bulgaria, Yiddish home language, moved to Belgrade at 34 and spoke Serbian (and Yiddish) from then on, “forgetting” Bulgarian. A brain injury at 60, after two months for recovery, resulted in her only being able to speak Bulgarian and Yiddish; she could no longer speak Serbian (though she could understand it), despite it having been her dominant language for 25 years
Bilingualism and aphasia

• Almost 1/3 of reported multilingual aphasics do not recover their L1, but their L2 (L3, ...)

• **Case: Minkowski (1928)**
  Patient’s L1 was Swiss German, learned standard German in school, moved to France for 6 years, became fluent in French, then moved back to Switzerland (using SG, though still reading French). 19 years later, had a stroke. After 3 days for 3 weeks spoke only (increasingly fluent) French, then started recovering German, but for 6 months was incapable of using SG. Around Christmas, suddenly SG returned (to the detriment of French)
Bilingualism and aphasia

Recovery of non-communication languages

- **Case: Grasset (1884)**
  Patient knew only French (never studied other languages), but then had a stroke and after a few days, began speaking only Latin (single words only, primarily prayer-related)

- **Case: Pötzl (1925)**
  Professor who knew several modern languages as well as classical Greek and Latin. After a stroke, he was only able to express himself in the dead languages, which he only knew through reading
Bilingualism and aphasia

Recovery of non-communication languages

- **Case:** Gelb (1937).
  WWI officer acquired aphasia. Pre-war had been a professor of classical languages. Post-injury he could no longer speak, but could still read and could express himself correctly in Latin. Facilitated his rehabilitation by communicating thus: he’d build a Latin sentence corresponding to what he wanted to say, then translate it into German.

- **Suggests?** Perhaps implicit/automatized knowledge was lost more readily in the aphasia, whereas the consciously learned languages were spared, in explicit memory. (connection to learning by writing)
Bilingualism and aphasia

Selective crossed aphasia

• Case: Paradis & Goldblum (1989).
  L1 Gujarati, from Madagascar (spoke Malagasy), learned French in school. After brain surgery, tested fine in French but was having trouble with Gujarati at home—fairly classic Broca’s aphasia symptoms. Malagasy was fine. Over following months, Gujarati was recovered, but at the expense of Malagasy. 2 years later, Gujarati was fine, Malagasy was impaired. 4 years later, both were fine.

• Suggests differential inhibition (rather than localization); languages differentiated at a functional level, but not necessarily neuroanatomical.
Differential aphasia

- **Case: Albert & Obler (1975).**
  Hungarian L1, Lived variously in France, England, and US, moved to Israel at 16, then had brain surgery to remove a tumor at 35. 10 days later, exhibited Broca’s aphasia in Hebrew and Wernicke’s aphasia in English (understood but could barely speak Hebrew, couldn’t understand English but spoke it fluently). Deficits in Hungarian and French were mild.

- If this is same lesion having differential effects on two languages, suggests that the two languages do have some spatial differences in localizations—still fairly hotly debated, though.
Bilingualism and aphasia

Bilingual representation

- A number of dissociated phenomena in bilingual aphasia studies.
  - Sometimes only one language returns, not always the L1
  - Production and comprehension and translation seem to be separable, and even by language.
  - Monolingual aphasia studies seem to correlate lesion localization with function.
  - Not much evidence for localization differences between multiple languages per se.
  - Some evidence for localization differences between types of learning? (written, conscious vs. unconscious, implicit vs. explicit memory?)
The role of the right hemisphere in L2 learning

Summarize experiments using dichotic listening and tachistoscopic exposure

No difference between L1 and L2: LH dominance for both languages

L2 less LH lateralized (greater RE advantage for L1)

L2 RH processing
The role of the right hemisphere in L2 learning

Summarize Obler’s experiment and Gaziel’s experiment

**Obler’s experiment**: dichotic listening
Hebrew-English bilinguals, RE advantage for L1 and L2, greater REA for L1
English dominant: REA for English (L1)
Hebrew dominant: REA for Hebrew (L1)

**Gaziel’s experiment**: tachistoscopic experiment
Hebrew learning English: LH advantage for Hebrew (L1)

For English, depends on the proficiency, the more proficient, the more left lateralized
The role of the right hemisphere in L2 learning

Define the “stage hypothesis” by Obler

the “stage hypothesis” refers to the fact that the right hemisphere participates in L2 learning at an early stage of the acquisition. This is reinforced by studies from aphasia which reveal that aphasia can occur in L2 following a RH damage. Moreover, Obler states that both L1 and L2 involve the right hemisphere participation.

Describe one counter-example of the “stage hypothesis”

The study by Carroll (1978)
English: L1, Spanish: L2. Method: Dichotic listening
REA for Spanish (L2) greater than for English (L1)
Possible explanation: Conscious grammar more important in L2 than in L1, so a REA more important

Note: TESOL: Teachers of English to Speakers of Other Languages
The role of the right hemisphere in L2 learning

What’s the problem with the grammar explanation?

DL uses words in isolation, and does not require grammar. So, the grammar explanation may be erroneous.

Find another problem with Carroll’s experiment

The study by Carroll (1978) reveals that Subjects who had a more natural exposure to L2 before age 6 present a less important REA, consistent with the stage hypothesis BUT Another group of informal learners reveal a strong REA for L2 Age is an important factor, which may account for discrepancies in results
The role of the right hemisphere in L2 learning

Describe another counter-example of the “stage hypothesis”

Rogers et al EEG experiment

Hopi (L1) English (L2)
Greater LH lateralization for L2
Explanation: Hopi involved RH, English involved LH
Children have overcome the RH stage in their learning of English
The role of the right hemisphere in L2 learning


Electroencephalographic (EEG) recordings were obtained from electrode placements over the left and right frontal and parietal lobes of the brain in sixteen Hopi Indian children listening to tape recorded children's stories in the Hopi and English languages. Spectral analysis of the EEG data revealed that, for the parietal leads, alpha desynchronization was relatively greater over the right hemisphere for listening to Hopi than for listening to English, which indicates a greater right hemisphere participation in the processing of the Hopi speech. The results of the experiment are directionally consistent with our hypothesis, and imply that linguistic relativity may exist on a neurolinguistic level, such that languages can differ in the relative degree to which they serve as instruments of thought in a propositional, left hemisphere mode, or in an appositional, right hemisphere mode
The role of the right hemisphere in L2 learning

What is exactly the role of the Right Hemisphere in language?

RH presents a rich comprehension lexicon and an understanding of basic semantic relationships. It may be less involved in syntax than LH.