

Lexical and Grammatical Development in
Children with Early Hemisphere Damage: A
Cross-sectional View from Birth to
Adolescence

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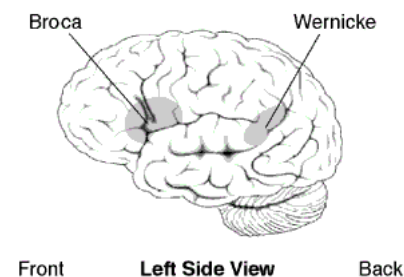
Gist

- A complete acquisition of language requires the normal functioning of both hemispheres right from the start of development.
- Experimental proofs from studying development and recovery of language functions in children with early hemisphere damage.

Aphasia

- A language disorder which impairs both expression and understanding of language.
- Caused by injury to brain due to head injury, stroke, brain tumor or bacterial infection.
- Injury to temporal or frontal regions result in different manifestations of the disease

Aphasia (Contd.)



Picture from: <http://www.nidcd.nih.gov/health/voice/aphasia.asp>

- Damage to frontal lobe results in Broca's aphasia in which a person speaks in small meaningful phrases with great effort without small words like the is etc.. (accompanied by body weaknesses/paralysis). Understanding of speech to varying degree
- E.g. Speaks "Walk Dog" means "I want to take the dog for a walk"
- Damage to temporal lobe results in Wernicke's aphasia in which person speaks long meaningless sentences often with unnecessary and created words. Great difficulty in understanding speech.
- E.g. "You know that smoodle pinkered and that I want to get him round and take care of him like you want before," means "The dog needs to go out so I will take him for a walk."
- Global aphasia: Damage to extensive language areas. Extremely limited ability to speak and comprehend language.

Subject in the study

- Children and adolescents with unilateral brain lesions i.e. affected region limited to one hemisphere of the brain.
- Comparisons between normal, left hemisphere injury and right hemisphere injury subjects in different age groups on emergence of gestural, lexical and grammatical abilities.

Study limited to children with nonaphasic language disorders that persist beyond the acute stage.

Introduction

- Brain and Language: Evidence from acquired aphasia.
- Neural plasticity and specialization in the context of development.

The first points elaborates the relation between brain and language. Language organization is tightly knit in the brain which is revealed by the various language disorders caused by brain injury.

Infants suffering from brain injury show a remarkable recovery compared to adults due to plasticity of infant brain. This becomes more challenging when language acquisition is taken into account.

Brain and Language

Issues concerning the neural basis for language focus primarily on two questions:

- At what level do functional units of language share meaningful neurological correlates.
- To what extent can these units of language be localized to various regions of the brain.

Brain and Language (2)

- The study of adult aphasia has revealed the potentially selective nature of language disturbances resulting from left hemisphere damage.
- Adult aphasia selectively impairs phonological, lexical, syntactic and semantic aspects of language performance

Neural Plasticity & Specialization

Childhood aphasia

- Normal and lesion-induced mechanisms of neural plasticity allows a child's brain to recover from neural insult substantially.
- At the beginning of language development both hemisphere seem to be equally involved.

Neural Plasticity & Specialization(2)

- The dominant phenomenon seems to come through a progressive decrease in involvement of the right hemisphere.
- If the left hemisphere is not functioning properly, the physiological activities of the right hemisphere persist in their earlier function.

Early Language Development in Children with Focal Lesions

Child Language Acquisition

- Various stages in CLA in a normal child
 - Onset of perception (0;0 – 0;10)
 - 0;3 Cooing
 - 0;7 Babble
 - 0;10 Reduplicative Babble
 - Single word stage (1;0 – 1;6)
 - Early sentence stage (1;6 – 2;0)
 - Short sentence stage (2;0 – 2;6)
 - Full sentence stage (2;6 – 3;6)
 - Complete Language (by 5;0)

Period between birth and 5 years of age marked with rapid growth. Synaptic density peaks within the first 2 years and by 5 reaches nearly the adult values

Gestural Development

- Gestural communication consists of nonverbal communication signs such as waving, nodding, pointing etc.
- Limited knowledge in this field.
- 3 studies quoted, each reporting gestural delays in infants with LL and RL injuries.
- Gestural delays accompanied by production and comprehension of first words.

Involves transformation of abstract mental representation into real world referent.
Communicative development inventory for infants consisting of 64 communicative gestures divided into early gestures (pointing, giving, showing, nodding) and Late gestures (actions with common objects, pretense and imitation).

AGE RANGE 8-42 months

Production delays in LL and comprehension delay in RL

Gestural Development (Contd.)

- Hypothesis A:
 - Gestural and language delays outcome of damage to motor cortex.
 - Refuted due to
 - Presence of gestures and children having frank hemiparesis (weakness of body parts due to damage to motor cortex) and
 - Absence of gestures from infants having brain lesions but motor involvement , and also the lesion area were outside motor cortex.

Gestural Development (Contd.)

- Hypothesis B
 - Delay in gestural communication is due to delayed emergence of certain form of mental representation.
 - Accounts for the association in gestural delay and early word learning.
 - Does not prove a continuity from gesture to language development.

Delays in gestural when present consistently predicted delays in either production or comprehension of first words but delays in lexical development not always accompanied by gestural delays.

Debate “whether language and gestures arise from a common set of representational abilities. **Derivation from same set of shared representation VS language as modular entity, independent from more general forms of cognitive representation.**

Phonological Development - babble

- Important milestone in language development.
- Free-play session recordings taken at 3 stages longitudinally. Analysis based on vocalization frequency and length, consonant production and syllable structure.
- Limited evidence suggest that phonological development is adaptive towards early hemispherical damage.

Lesion children did not babble any less, nor did their vocalization differ qualitatively from controls. However at ‘zero word’ production stage lesion children produced greater number monosyllabic vocalizations and fewer consonants. Persisted in 2 LL children for 22 months.

Interactions between LL and RL damaged children with age 2-3 and a half years old revealed that these children produced age appropriate phonological simplifications.

Delayed emergence of consonant production and prolonged use of phonological simplifications associated with delayed emergence of first words.

Lexical Development

- Different courses for development in word comprehension and word production.
- Wide degree of individual variations observed for each of them.
- Disparity reflects maturational differences in the neural substrate mediating these two modalities of lexical performance.

Mean 57.9 words comprehended at 10 months. With range from 8-183.

First true word from 11-13 months. 3.6 (10), 11.9 (12), 79 (16) and 317 (24).

No specific region marked to particular language functions but changes happen during language development.

Vigorous brain transformations near transitory phases.

Utter First words -> peak in metabolic activities in frontal lobes. (0;8-0;10 first word comprehension). Maturation of corticosubcortical fibers of the pyramidal tract, the motor system for speech (50-90% of adult values) by one and a half years (early sentence stage).

Lexical Development (Cont.)

- No clear evidence whether early brain damage selectively impairs the two modalities of lexical development or just delays the onset.

Lexical Comprehension

- Semantic representations are thought to be most widely distributed in neural representation.
- Adult aphasic results show damage to particular regions of left or right hemisphere disrupt semantic feature association with individual words.
- Infant study confirming continuous involvement of both hemispheres in mediating lexical-semantic knowledge

Semantic representations mediate between comprehension of individual word meanings.

Right hemisphere damage (adult aphasic studies) associated with lack of sensitivity to subtle aspects of semantic meaning (metaphorical or nonliteral aspects of meanings)

Lexical Comprehension (Contd.)

- Significant delays were observed in the onset of word comprehension in both LL and RL.
- Greater percentage of RL subjects showing delays in comprehension than LL subjects.
- Novel word learning skills (nonsensical nouns and verbs) required greater number of teaching presentations for lesion subjects VS controls

12-22 months

Lexical Productions – first words

- Adult aphasic result: greater frequency of disturbances observed in left hemispherical injury VS right hemispherical injury subjects.
- Contrary to above infant studies show requirement of healthy left as well as right hemispheres for normal onsets and functioning.

Disturbances => spoken output of individual phonemes to grammatically well formed sentences.

Lexical Productions – first words (Contd.)

- Also the delays in the expressive vocabularies of LL and LR children became more pronounced with age.
- Three studies
 - First word (More LL than RL)
 - Expressive naming skills (almost equal)
 - Expressive deficits/ Vocabulary size (Significantly poor performance by LL VS RL)

Complete lateralization ruled out due to presence of delay in RL subjects.

Early Grammatical Development

- Significant delays in lesion subjects (both RL and LL).
- Delay measured by usage of morphological inflections and presence of functional words.

Individual Dissociations in Comprehension and Production

- Dissociation in lexical production and comprehension was observed to occur in both LL and RL infants.
- Nature of dissociation was different based on the laterality of the lesion and appeared right from the earliest point in development
- Delayed expression in RL subjects suggested a potentially greater role of right hemisphere in mediating acquisition of expressive grammar.

LL children showed significant delays in lexical production, which pronounced with passage of time coupled with a fixed set of comprehension vocabularies. RL children on the other hand had expressive vocabularies and delayed comprehension.

Continuities and Discontinuities Across Development

- Longitudinal studies support the existence of modality-specific and domain-specific deficits in the periods of language acquisition.
- Delays in language development shown to cut across discrete points in time
 - Selectively impairing lexical but not gestural delays
 - Production and not comprehension of first words and vice versa.
 - Onset of babbling and production of first word.

Continuities and Discontinuities Across Development (Contd.)

- Continuity in language development shown in terms of transition from first word production and onset of grammar.
- Data supports the view that before onset of stages of grammatical development children need to achieve a critical mass in vocabulary development.

Later Language Development in Older Children and Adolescents

- Here the lexical and grammatical skills of children from six years of age to early adulthood is discussed.
- Subtle deficits in linguistic performance will persist well beyond the initial phase of recovery.

Later Language Development in Older Children and Adolescents (Contd.)

- Disorders of lexical production in older children with focal lesions.
- Disorders of lexical comprehension in older children with focal lesions.
- Disorders of syntactic comprehension in older children with focal lesions.
- Disorders of syntactic production in older children with focal lesions.

Disorders of Lexical Production in Older Children with Focal Lesions

- Significant naming deficits were observed in the age group 6 to 17 years.
- Higher incidence of naming disorders following left than right hemisphere damage.
- LL children made significant errors in response to rhyming cues and responded slowly to semantic and visual signs as compared to the RL children.

Disorders of Lexical Comprehension in Older Children with Focal Lesions

- Disorders of lexical comprehension are frequently noted in the later language abilities of left and right hemisphere injured children.
- The disorders of comprehension appeared just as likely to occur following left or right hemisphere damage.
- Both RL and LL group showed a similar pattern of performance on a semantic related task.

Disorders of Syntactic Comprehension in Older Children with Focal Lesions

- Selective deficits in syntactic comprehension are present following a early left hemisphere damage.
- Right hemisphere has a important role in mediating certain aspects of sentence meaning.
- The syntactic comprehension disorders are evident in noncanonical passive and relative clause structure.

Disorders of Syntactic Production in Older Children with Focal Lesions

- Reduced verbal output has been a predominant feature of acquired childhood aphasia.
- Disorders of expressive syntax occur more frequently and are more persistent following early left than right hemisphere damage.
- Imitation deficits were more pronounced in LH children than the RH children.
- LL children have the greatest difficulty in imitating coordinate and passive sentence types.

Conclusion

- The study challenges the simplistic view of language lateralization and shows the requirement of contributions from both the hemispheres.
- The nature of language deficit however seems to differ in subtle ways for LL and RL subjects.
- Gestural delays translated more naturally to delay in production of first word in LL than RL infants.

Conclusion

- Left hemispherical damage more strongly associated with delay in first word production and word combinations and later in syntactic production.
- Right hemispherical damage frequently associated with delay in first word comprehension. They also reported greater failures in comprehend presuppositions and implications of truth associated with lexically negative verb 'forget'.

Conclusion

- Recover from early hemispherical damage is characterized by wide degree of variability within and across children.
- Attempts to characterize this variability in terms of lesion specific regions have met with failure.
- Factor of age at lesion onset has not emerged as a consistent predictor for recovery.

Our Input

- The authors tried to argue that language functions are not completely lateralized in the brain.
- Some functions seem to be more easy to learn by one hemisphere of the brain than the other.
- Limited data availability

- Proof comes from the fact that both LL and RL subjects had developmental delays happening to them at different stages.
- Difference in the production and comprehension error rates and delays shown in infants. Also the fall of success rate of RL subjects below chance for interpreting inferences associated with lexically negative verb "forget" show some form of specialization of hemispheres for specific tasks.
- The nature of study limits the availability of large population of lesion affected children simultaneously

Our Input

- Novelty of experiment designs
- Field still open for further research

- Difficulty in gathering data in infant related studies. Indirect ways required.
- As the facts are not conclusive nor the researcher go for strong claims about the nature of language faculty inside human brain.