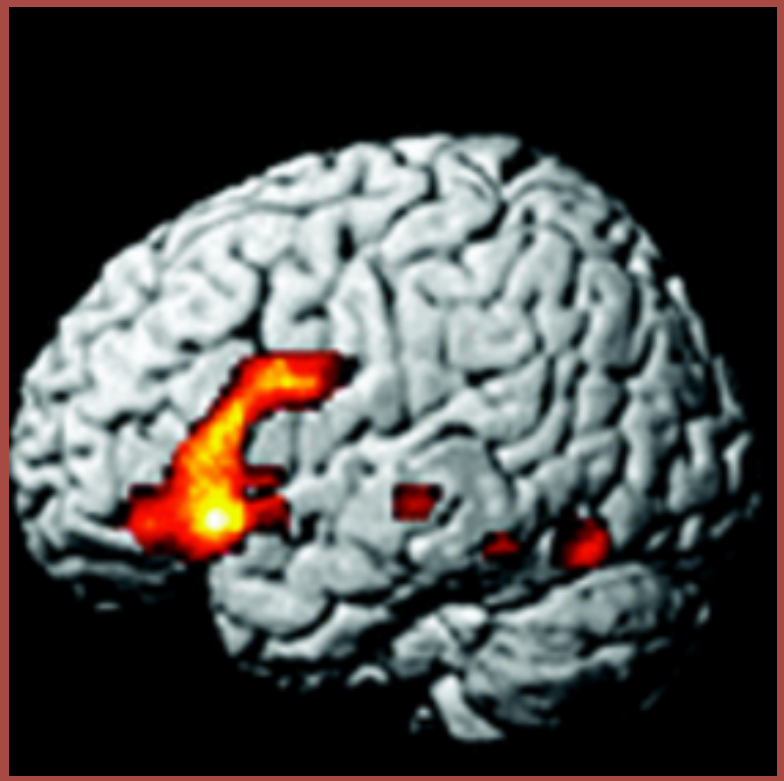
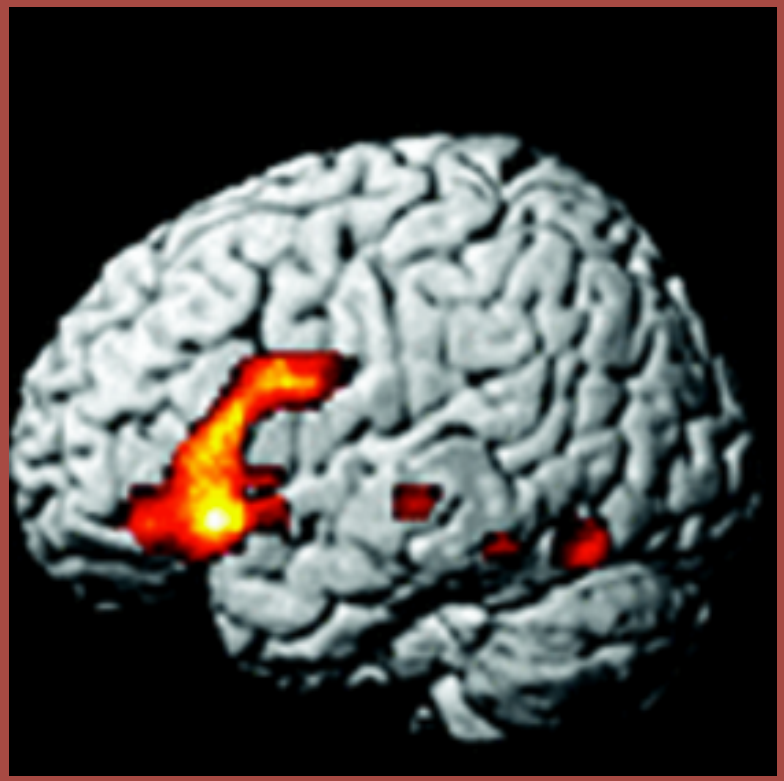
Bridging education and neuroscience: towards a meaningful dialogue



Bridging education and neuroscience: language as a connection

Brain mechanisms of

- language impairment
- general cognitive skills (e.g., attention)



Listen! Students' Attentional Focus Shapes Language Expertise in the Brain

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Molloy College

NEW YORK UNIVERSITY CHILD STUDY CENTER

Reading

- Complex skill
  - **Language**
  - **Cognition**

Reading

Complex skill

- **Language**
  - Phonology (e.g., speech perception)
  - Orthography (e.g, decoding letters)
  - Morphosyntax (e.g., inflectional endings)
  - Syntax (e.g., sentence grammar)
  - Lexical semantics (e.g, words and meanings)

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- **Cognition**
  - Memory (e.g., working memory)
  - Attention (e.g., selective attention)
  - Reasoning (e.g., inferencing)
  - Visual-spatial processing (e.g., processing text)

Reading

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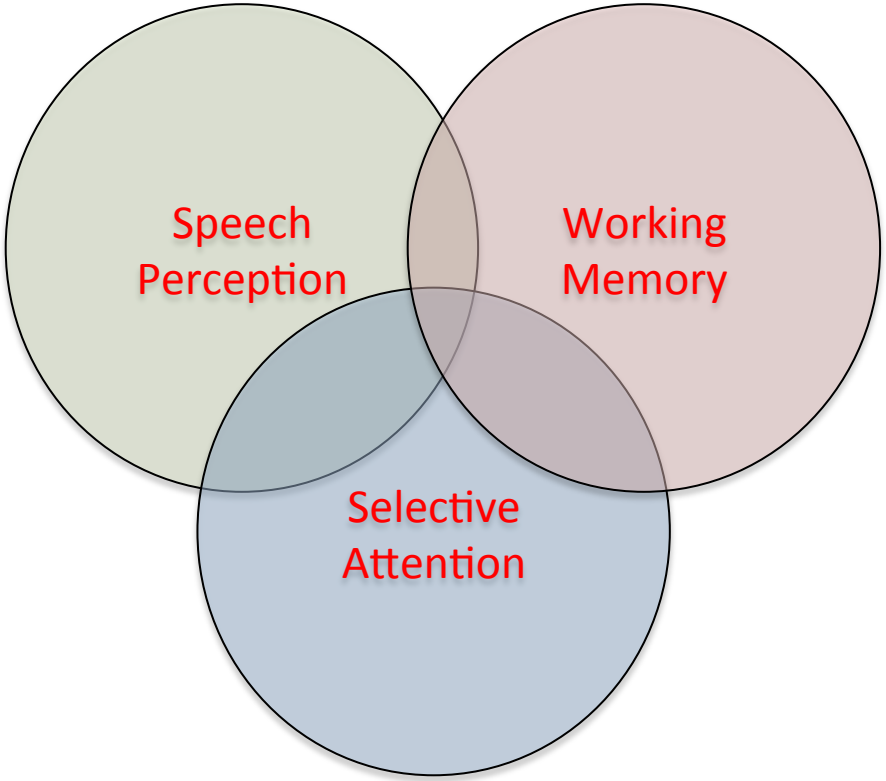
Reading



Reading impaired children

- Language impairments
  - Poor speech perception
  - Poor phonological skills
  - Poor phoneme-grapheme correspondence
  - Poor language comprehension

- Cognitive impairments
    - Differences in attention skills
    - Differences in working memory

Brain correlates of speech perception in language impaired children

Hia Datta, Ph.D.

Assistant professor & Undergraduate Director

Communication Sciences and Disorders

What does language impairment have to do with reading?

Everything!

Specific Language Impairment (SLI)

- Oral language deficits
- Reading/Writing deficits

Specific Language Impairment (SLI)

- Oral language deficits
  - Syntactic/morphosyntactic
  - Word recognition & production
  - Narrative discourse

- Reading/Writing deficits
  - Mapping phoneme to grapheme
  - Oral reading skills
  - Reading comprehension

SLI: what leads to language and reading impairments?

- Deficits in the following underlying processes
  - Speech perception
  - Morphosyntactic
  - Attention
  - Inhibition
  - Working memory

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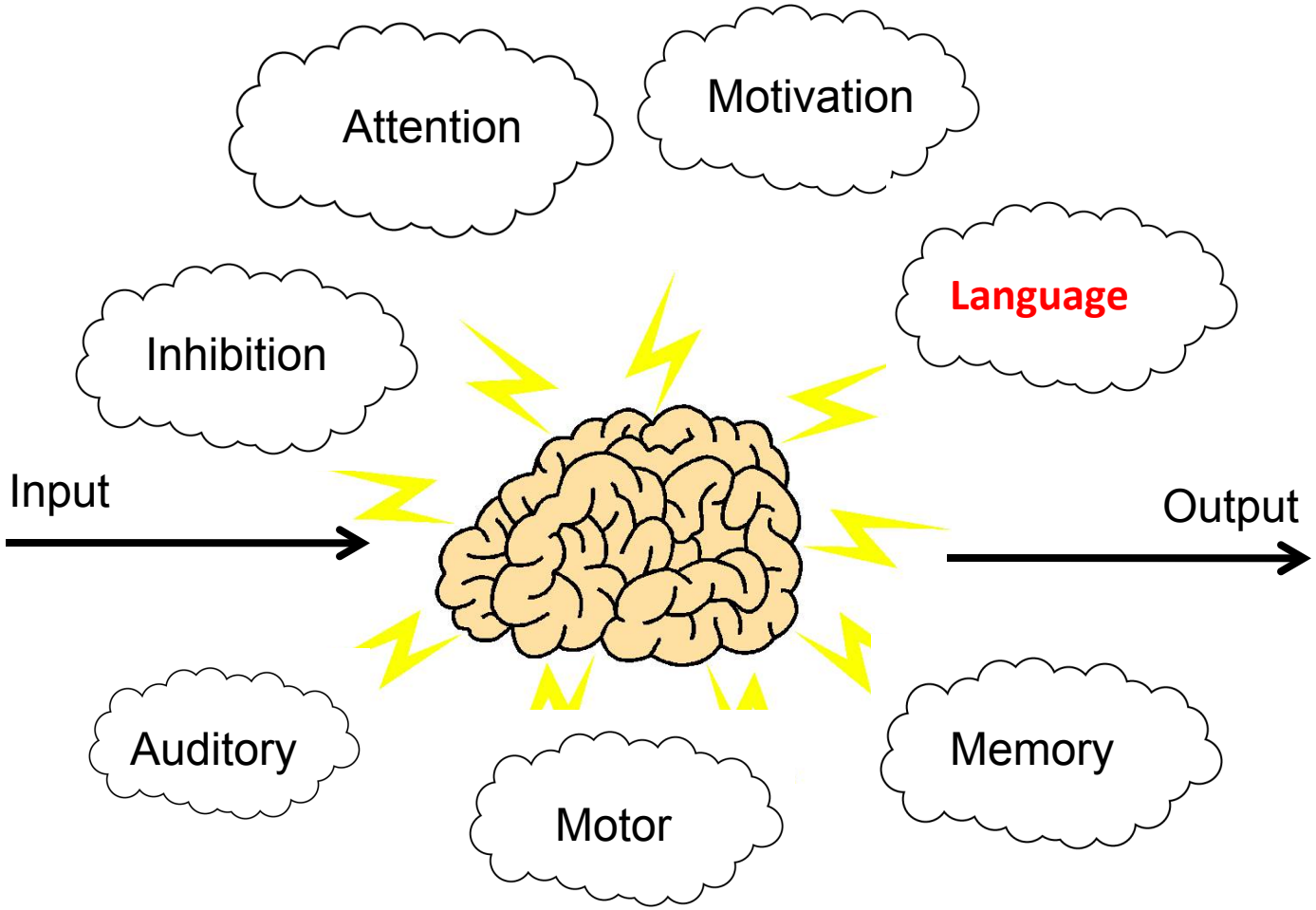
What is a good way to measure speech processing in these children?

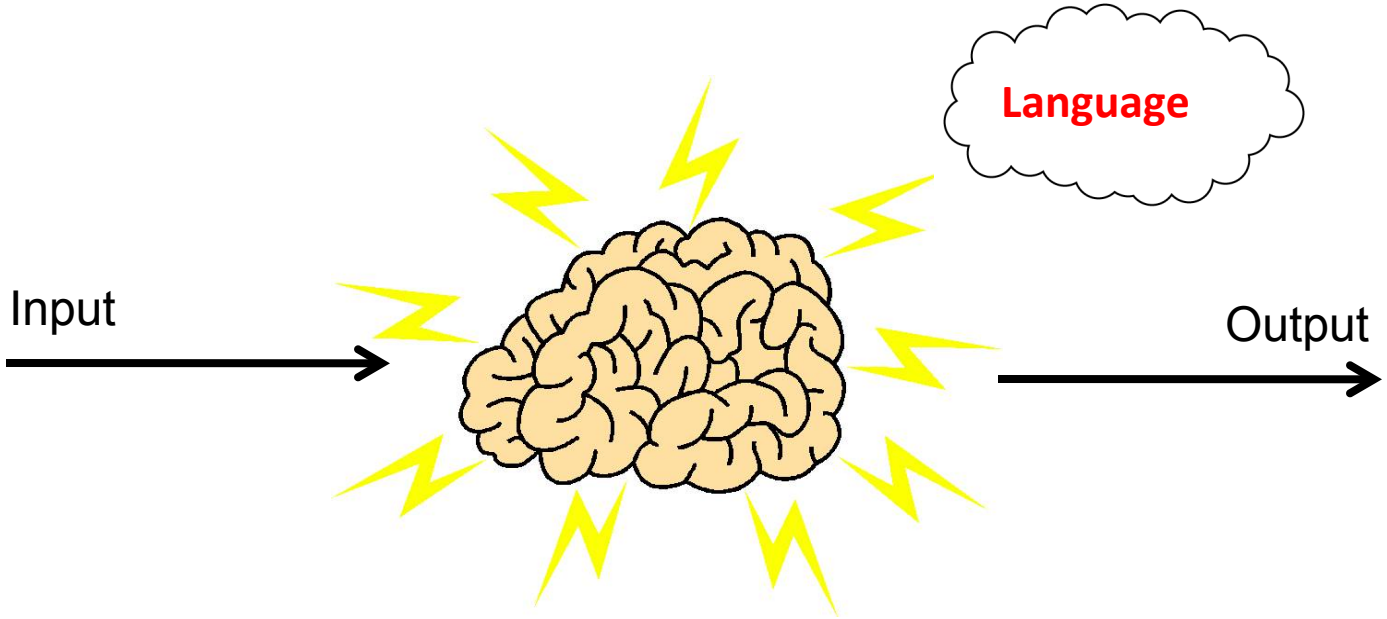
- Traditional behavioral methods:
  - Standardized tests

  - Laboratory button press experiments

Traditional behavioral methods



Neurophysiological method: ERPs



What is a good way to measure speech processing in these children?

- Traditional behavioral methods:
  - Standardized tests
  - Laboratory button press experiments
- Neurophysiological methods:
  - Event Related Potentials (ERPs)

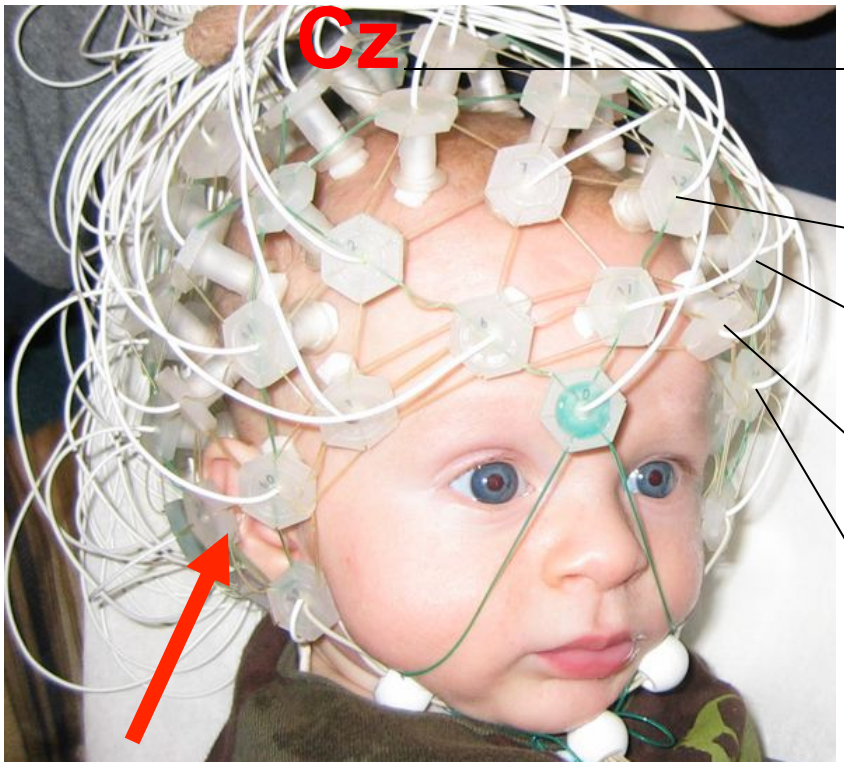
Event Related Potentials

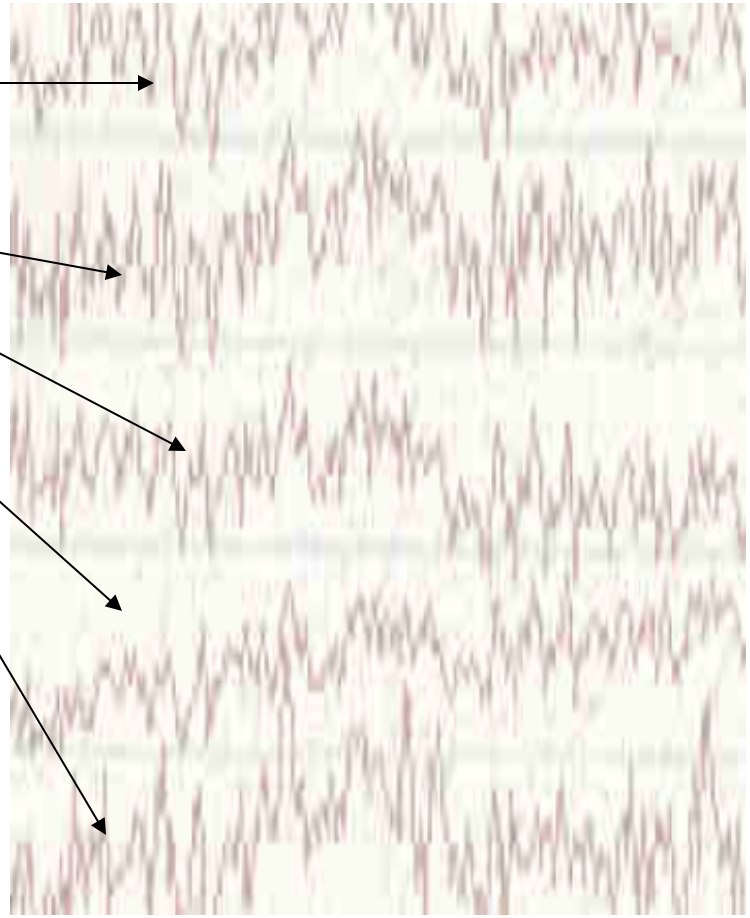
ERPs

Event Related Potentials: ERPs

- Response potentials related to events
  - Events:
    - Any information (stimulus) presented in the environment
      - Sounds/ words
      - Pictures
- Experimental Paradigms for ERPs
  - Passive or Attention driven paradigms
    - ERPs reflect automatic processes
    - Directed attention
  - Repeating stimuli (sounds, words or pictures)

Electroencephalogram (EEG)





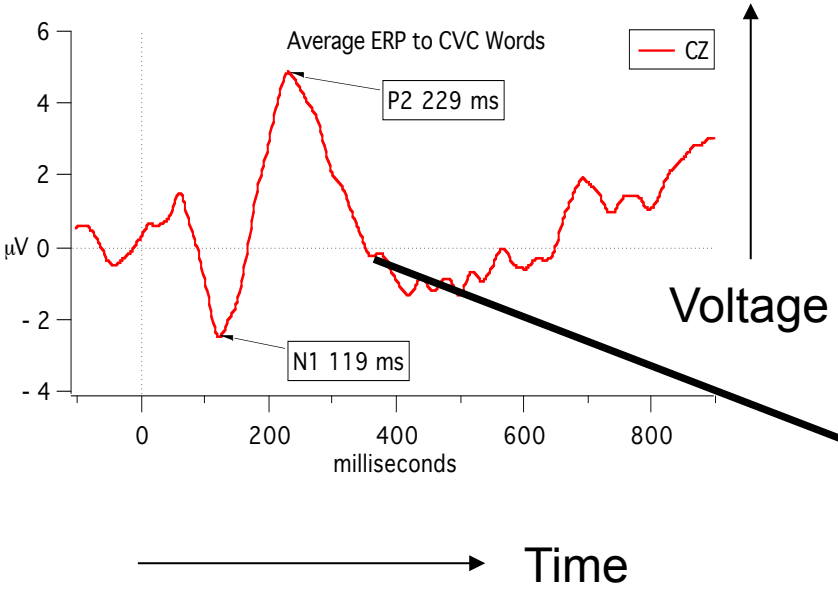
Voltage

Time

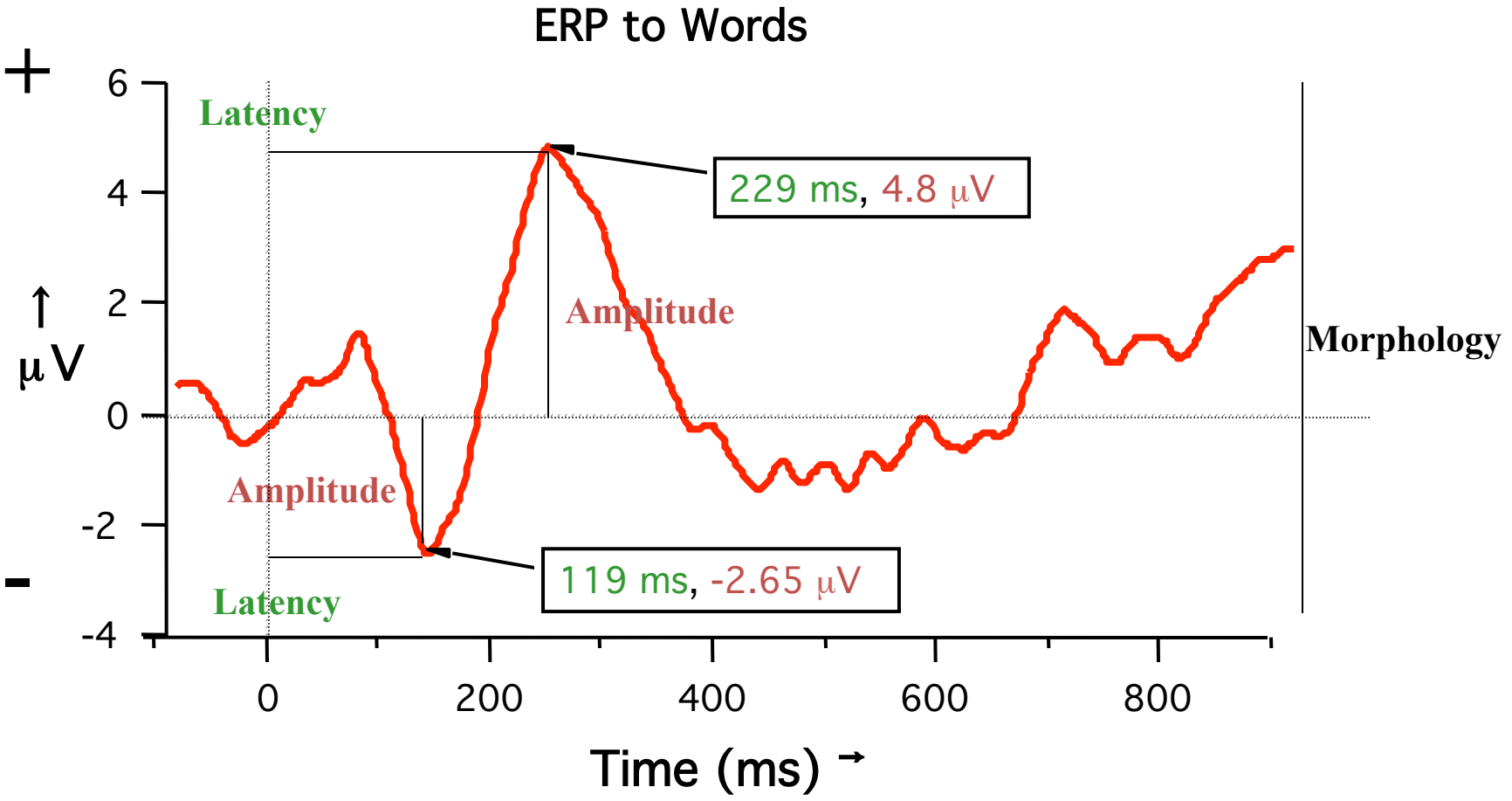
S

\+ ENVIRONMENT

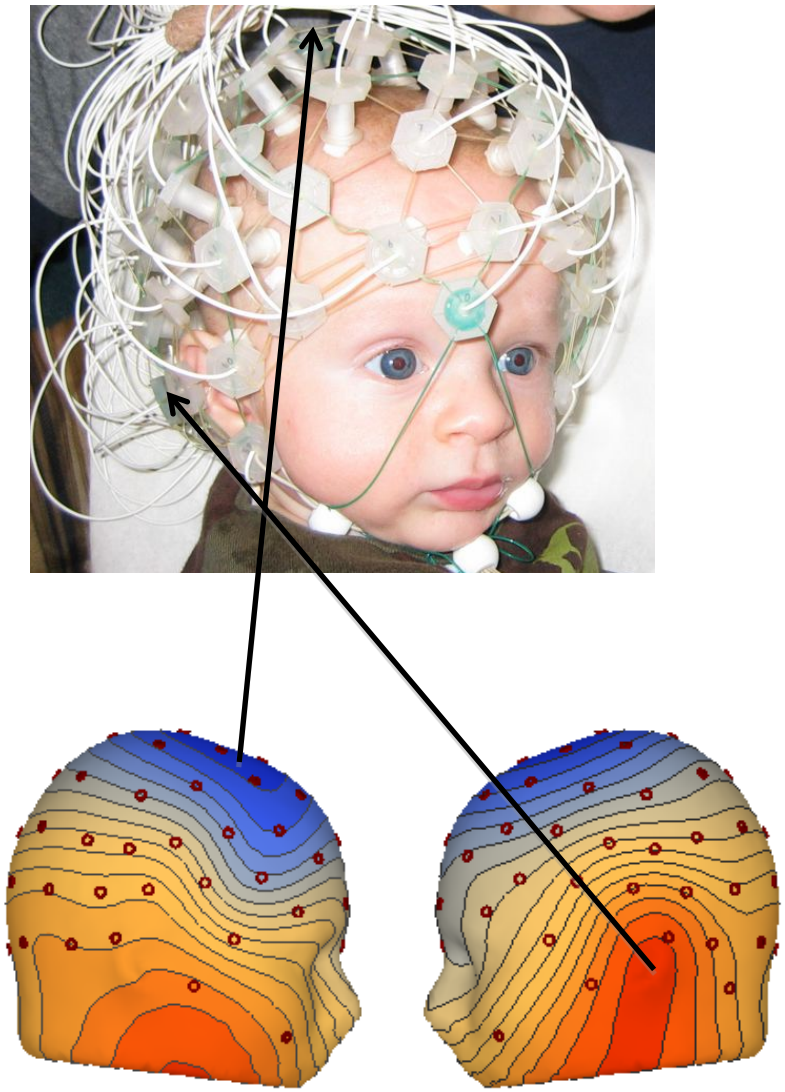
ERP


Average ERP to CVC Words
CZ
P2 229 ms
N1 119 ms
6
4
2
μV 0
- 2
- 4
0
200
400
600
800
milliseconds
Voltage
Time

Latency, Amplitude, Morphology



Topography



Latency: 226 ms

Study

Perception of **long** & **short** vowels
in children with SLI

with & **without attention**

Research Question

- Do children with SLI demonstrate differences in
  - processing short vs long vowels
  - when they are paying attention relative to when they are not?

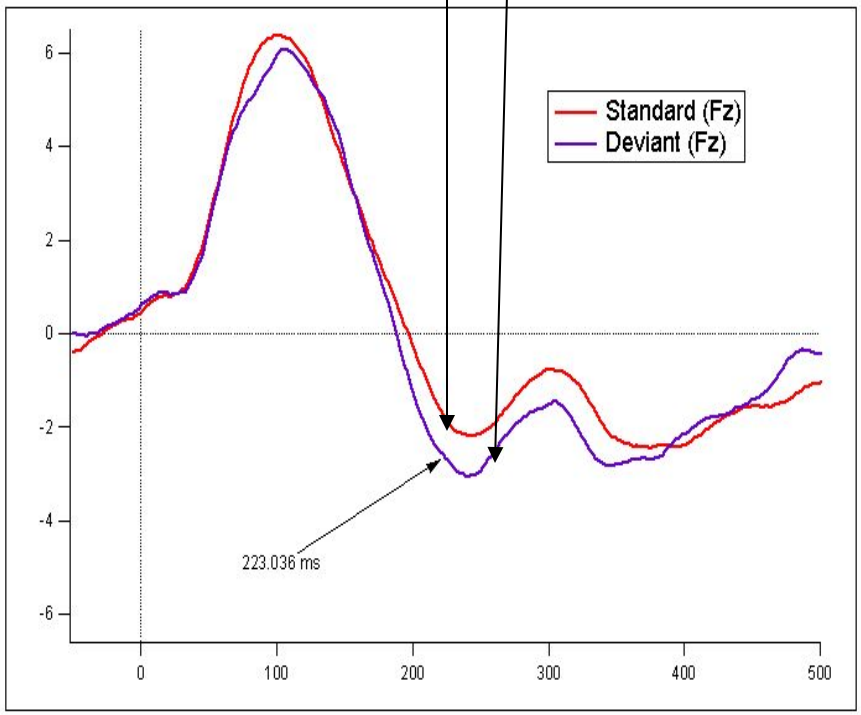
ERP measures in this study

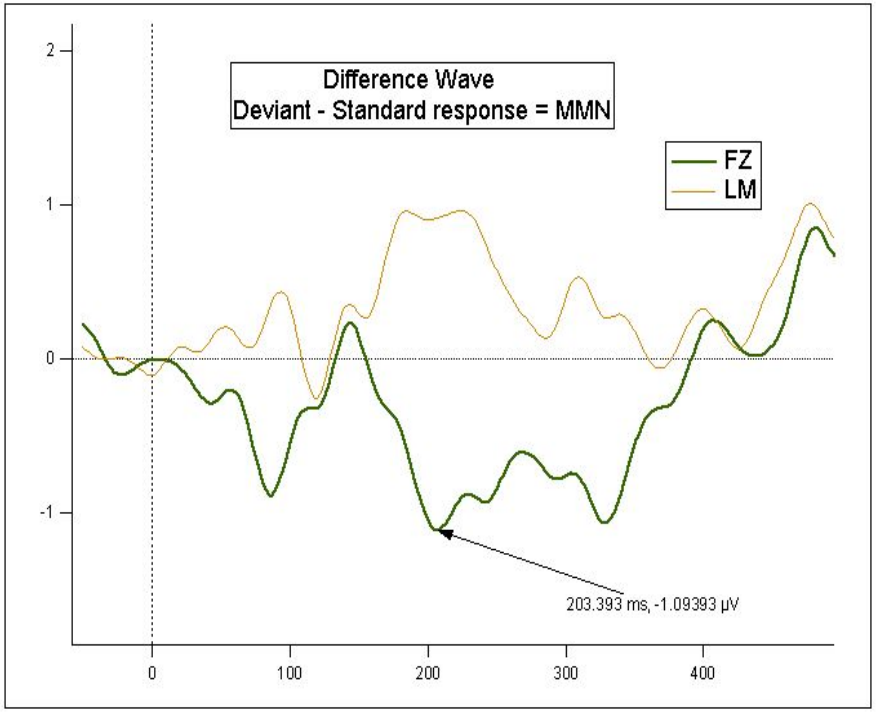
- **Mismatch Negativity (MMN)**
  - Automatic discrimination of sounds
  - In a oddball paradigm
  - Influenced by templates of sounds in the brain

An oddball paradigm

Sound discrimination

ɛ ɪ ɛ ɛ ɛ ɛ ɪ ɛ ɛ ɛ ɛ ɪ ɛ ɛ ɛ ɪ ɛ ɛ ɛ ɛ ɛ ɪ ɛ ɛ ɛ



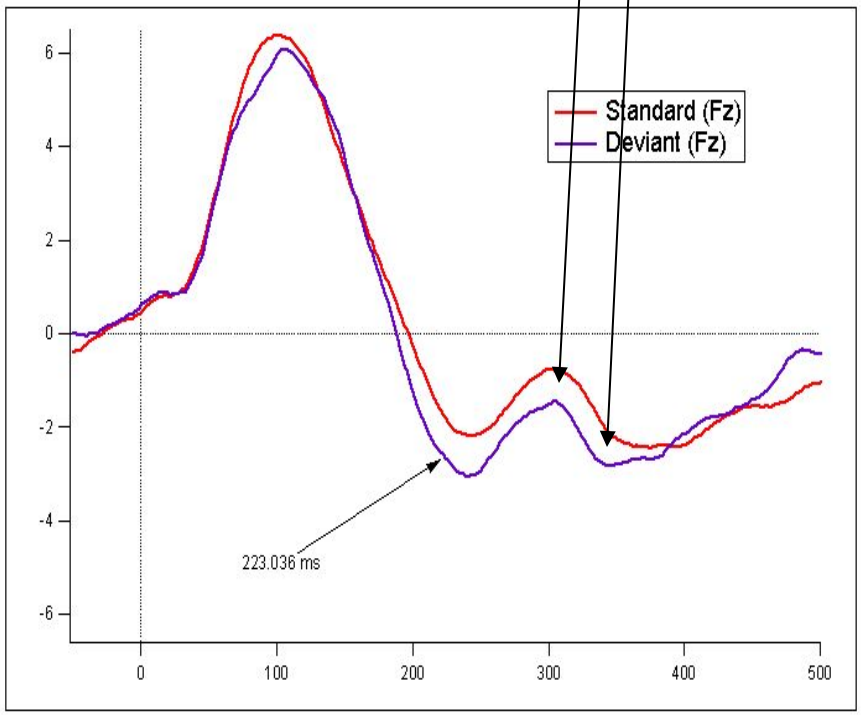


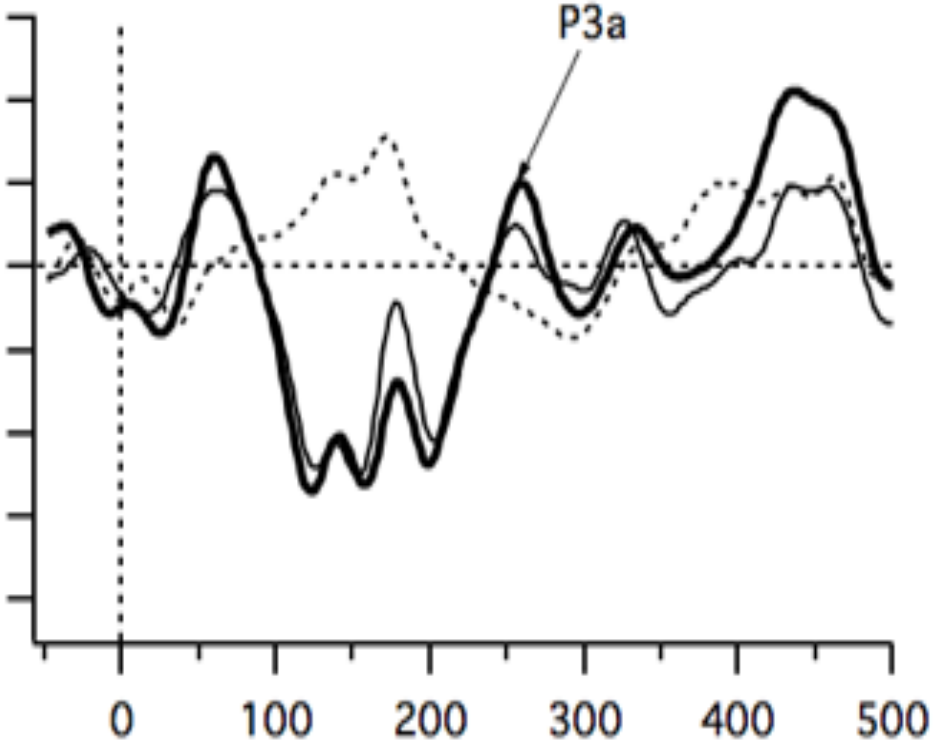
ERP measures in this study

- **Mismatch Negativity (MMN)**
  - Negative peak around 200 ms
  - Automatic discrimination of sounds
  - In a oddball paradigm
  - Influenced by templates of sounds in the brain
- **P3a**
  - Positive peak around 300 ms
  - Indexing automatic allocation of attention

Attention allocation

ɛ ɪ ɛ **1000 Hz** ɛ ɛ ɪ ɛ ɛ ɛ **1000 Hz** ɛ ɛ ɛ ɪ ɛ ɛ ɛ ɛ ɛ ɪ ɛ ɛ ɛ





Methods

Overview of design

- 2 Groups of school-aged children:
  - Typically developing children (TLD)
  - Children with Specific Language Impairment (SLI)
- Stimuli
  - Long 250 ms vowels
  - Short 50 ms vowels
- Task
  - Ignore all stimuli/watch a video
  - Attend to tone targets in auditory stream
- Dependent ERP measure
  - MMN & P3a

Participants

- Age:
  - 8-10 years
  - No hearing/neurological/oral physiology impairment
  - Scores in typical range for *Test of Nonverbal Intelligence-3*
- Participants with SLI
  - 1 standard deviant below typical scores on the *Clinical Evaluation of Language Fundamentals-3*

Sounds & Task

Without Attention

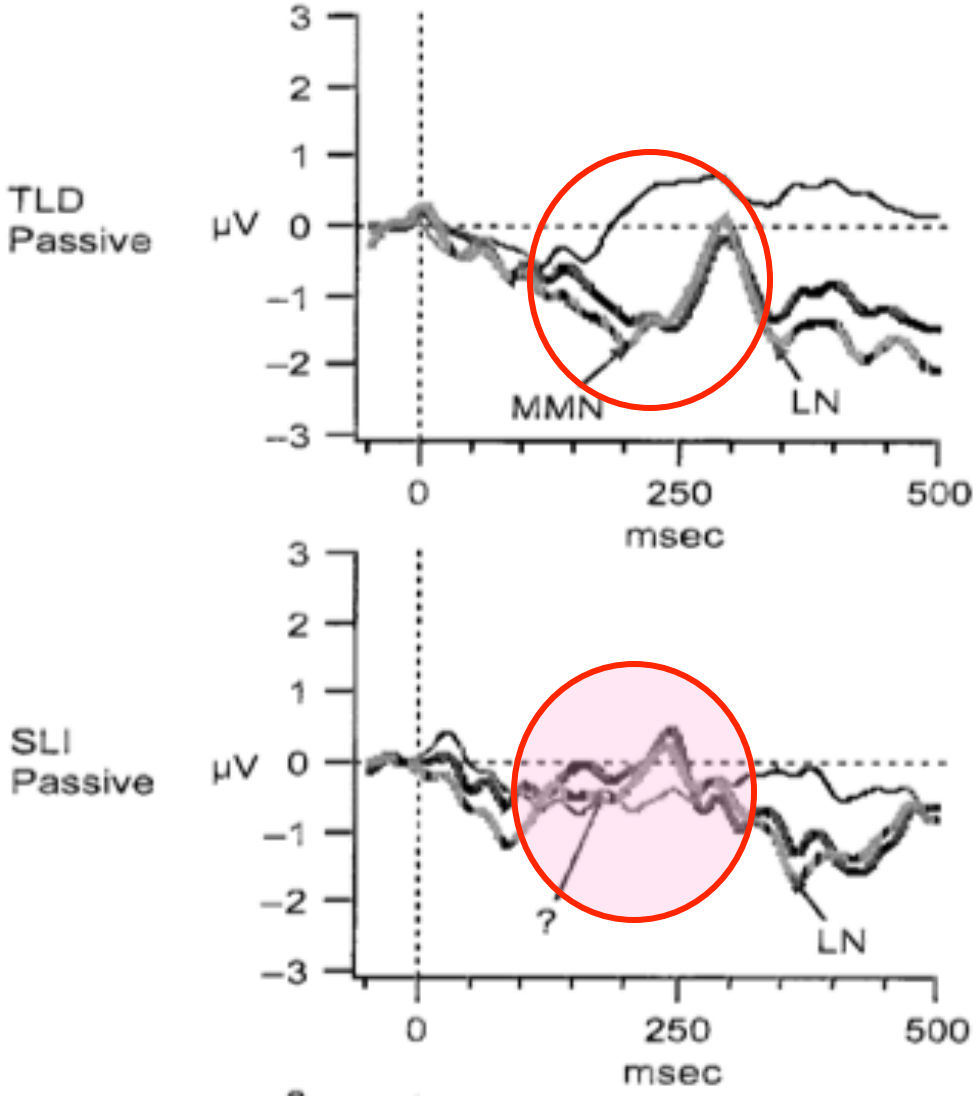
ɛ ɪ ɛ ɛ ɛ ɪ ɛ ɛ ɛ ɛ ɪ ɛ ɛ ɛ ɪ ɛ ɛ ɛ ɛ ɪ ɛ ɛ ɛ ɛ ɪ ɛ

With Attention to **tones**

ɛ ɪ 1000 Hz ɛ ɛ ɪ ɛ ɛ ɛ ɛ ɪ ɛ ɛ ɛ ɪ ɛ ɛ 1000 Hz ɛ ɛ ɪ ɛ 1000 Hz

Results

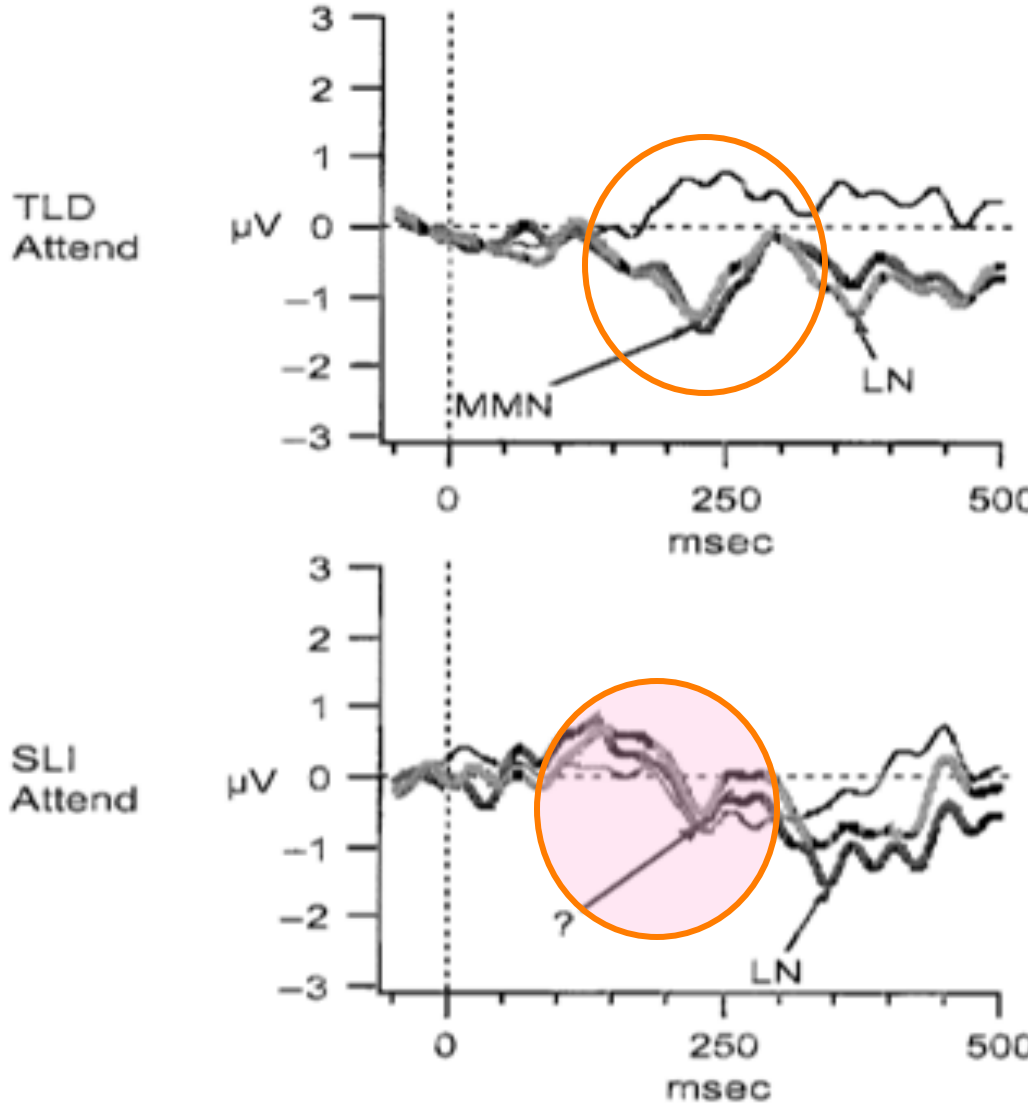
Short vowels: Sound discrimination without attention



Children with SLI
cannot discriminate
short vowels
automatically without
attention

Shafer, Morr, Datta, Kurtzberg & Schwartz 2005

Short vowels: Sound discrimination with attention

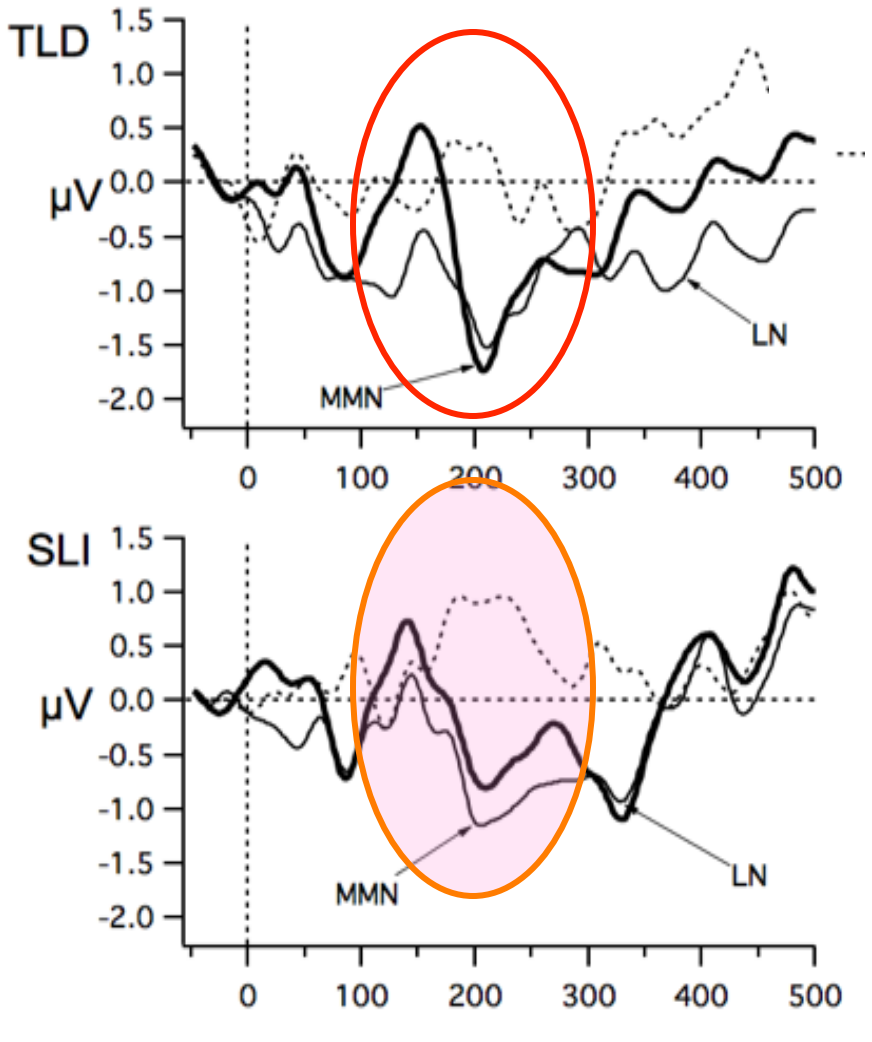


Children with SLI cannot discriminate short vowels automatically with attention either

msec

Shafer, Morr, Datta, Kurtzberg & Schwartz 2005

Long vowels: Sound discrimination without attention



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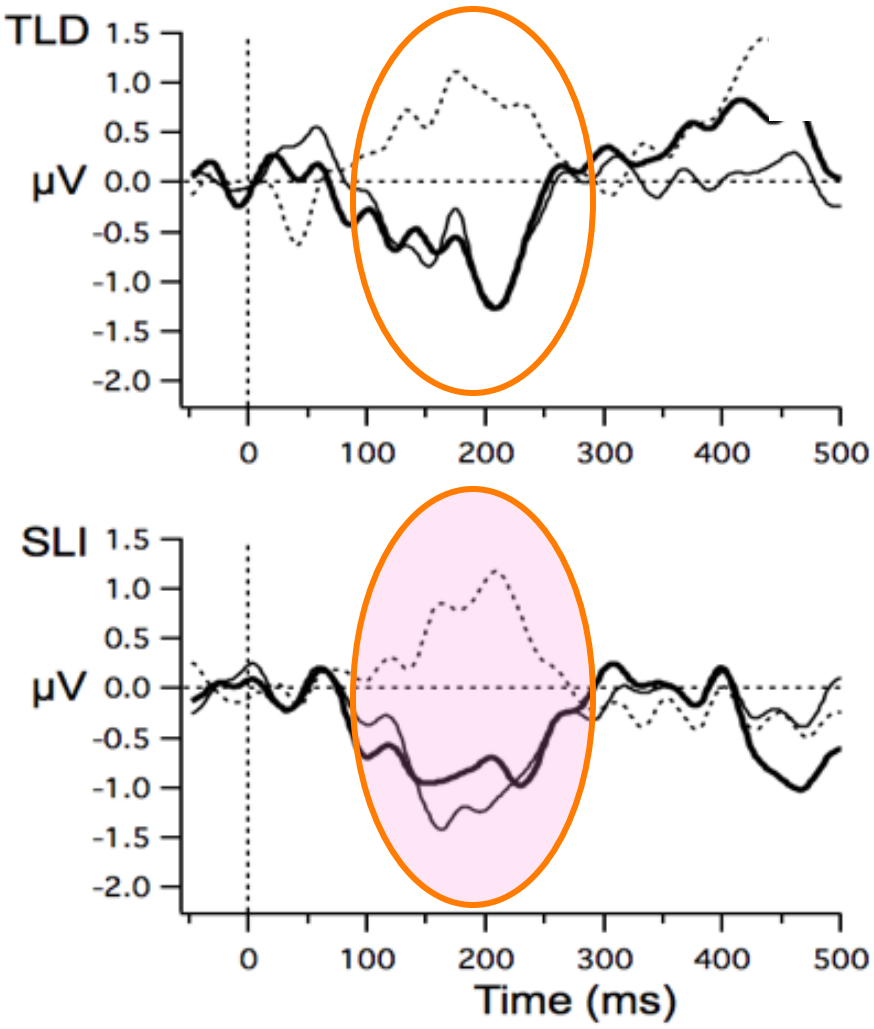
Datta, Shafer, Morr, Kurtzberg & Schwartz 2010

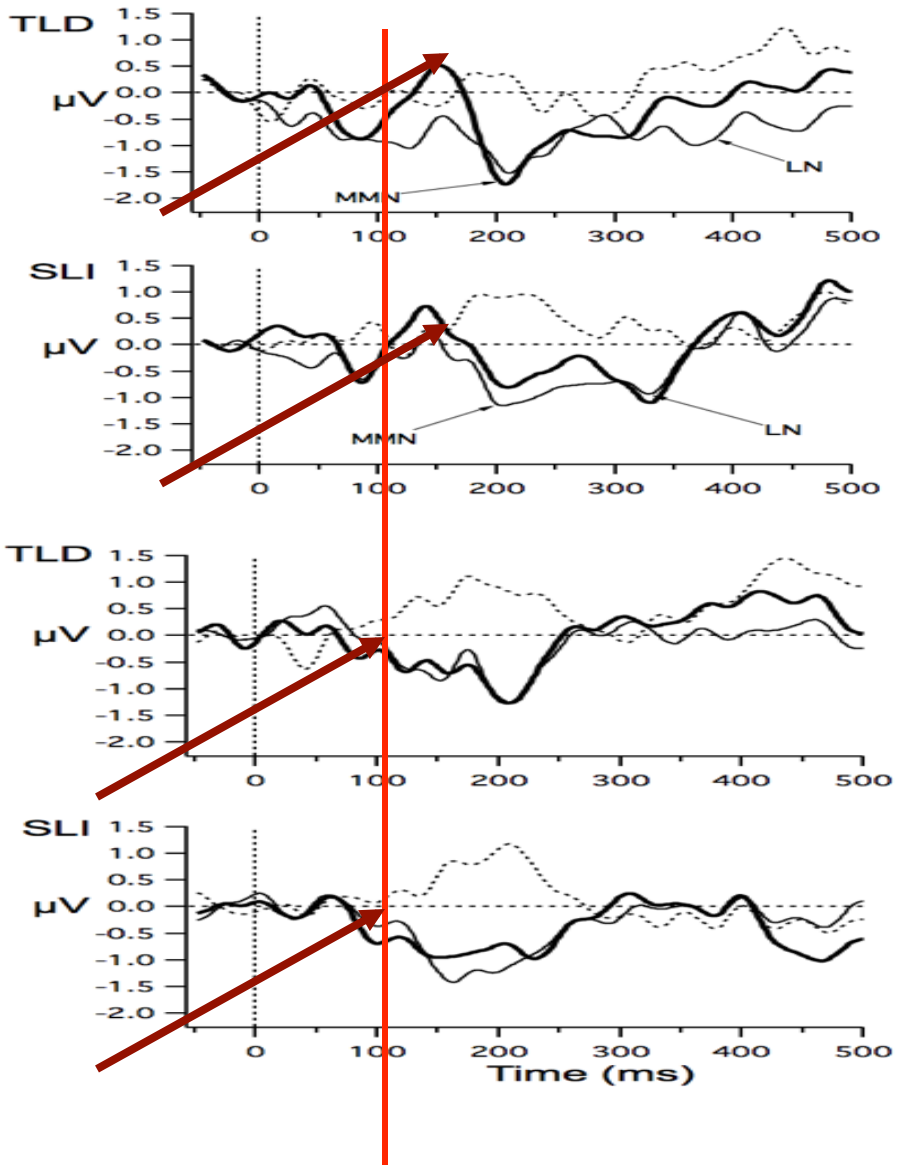
Long vowels: Sound discrimination with attention



Children with SLI can discriminate long vowels automatically with attention as well

Datta, Shafer, Morr, Kurtzberg & Schwartz 2010

Long Vowels: Earlier discrimination: with attention

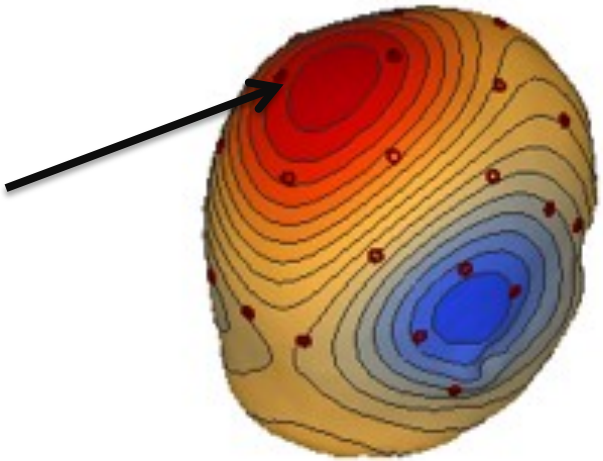


Passive

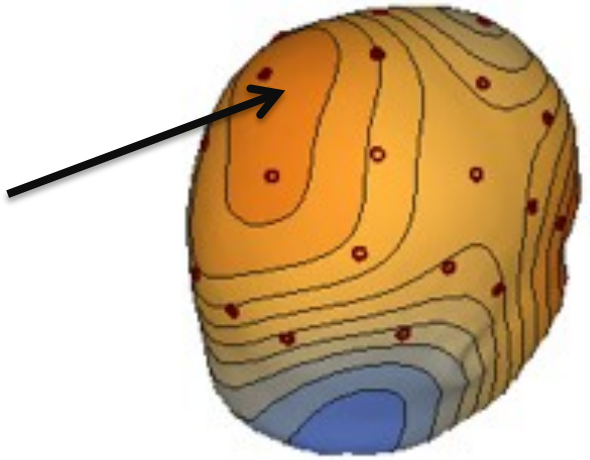
Attend

Both groups the discriminated long vowels faster in the attend condition

Long vowels: Attention allocation



TLD



SLI

Both groups automatically attended to the vowel differences in the attention condition for the long vowels

What does it all mean?

Implications

- Children with language impairment show difficulties with vowels sounds
  - Especially when they are very short, like in continuous speech
  - Easy for them to miss teacher's instructions in class
  - Create poor sound templates in their brains
    - Poor phonological maps
  - Leading to poor reading skills

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  - Easy for them to miss teacher's instructions in class
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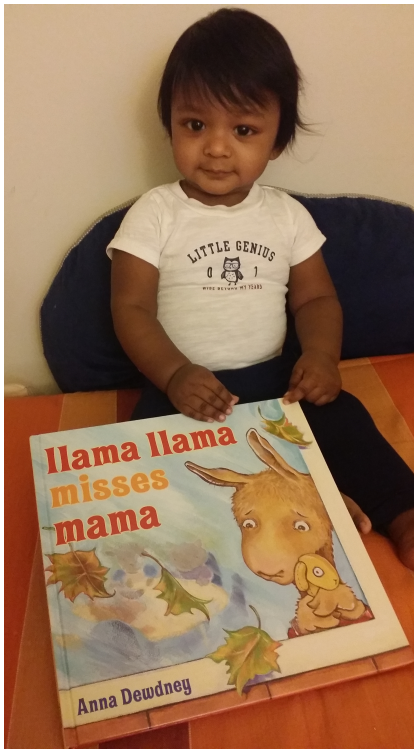
- How to help?
  - Speaking slowly and clearly may lengthen vowels in continuous speech
  - Attention can help


LITTLE GENIUS
llama llama
misses
mama
Anna Dewdney

LITTLE GENIUS
llama llama
misses
mama
Anna Dewdney

LITTLE GENIUS

LITTLE GENIUS

Thank you!