

REVOLUTIONS IN EDUCATION & LANGUAGE

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**Lecture for the
Office of English Language Acquisition
U.S. Department of Education
December 4, 2003**

HISTORIC TIMES NEW DISCIPLINE

Educational Neuroscience

Goals

Basic Research

Principled Translation into Reality

NEW

Teachers

Caretakers

**State & Local
Policy Makers**

Research



Medical

Clinicians

NEW

Teachers

Caretakers

**State & Local
Policy Makers**

Research



Medical

Clinicians

Research Whole Child

- Language & Cognition**
- Social, Moral & Emotional**
- Scientific Reasoning**
- Math & Numeracy**
- Reading & Literacy**
- Motivating & Learning**
- Teaching & Teachers**

NEW

Teachers

Caretakers

**State & Local
Policy Makers**

Research

Impact Whole Child

Children “Ready to Learn”
Age Appropriate Programs
Child Screening & Referrals
Parent Education & Support
Training Medical & Clinical Staff
Policy Impact
Student Internships
Teacher Burnout - School
Partnership Program



Medical

Clinicians

NEW

Local

National

International

Teachers

Caretakers

**State & Local
Policy Makers**

Research



Medical

Clinicians

400th ACADEMY OF SCIENCES



NEW RESEARCH WITH PRINCIPLED APPLICATION

Discovery of Tissue Key
for Successful Language
& Reading Development



LANGUAGE DEVELOPMENT

Monolingual & Bilingual

Previous Findings

New Findings

Relevance to Education

QUESTION

How is Language possible?

Brain & Environment

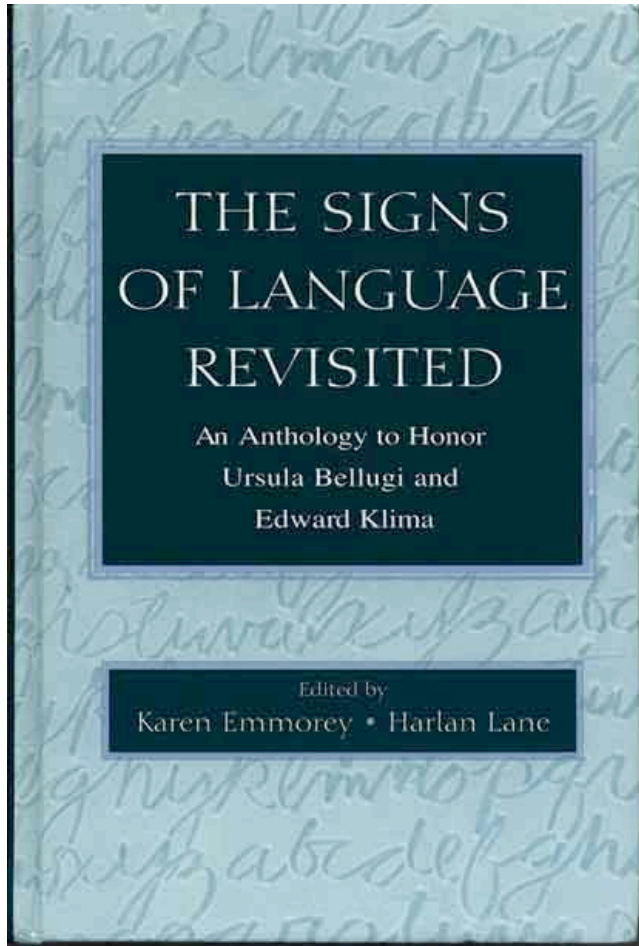
Is there a dedicated neural basis for Language?



ANSWER

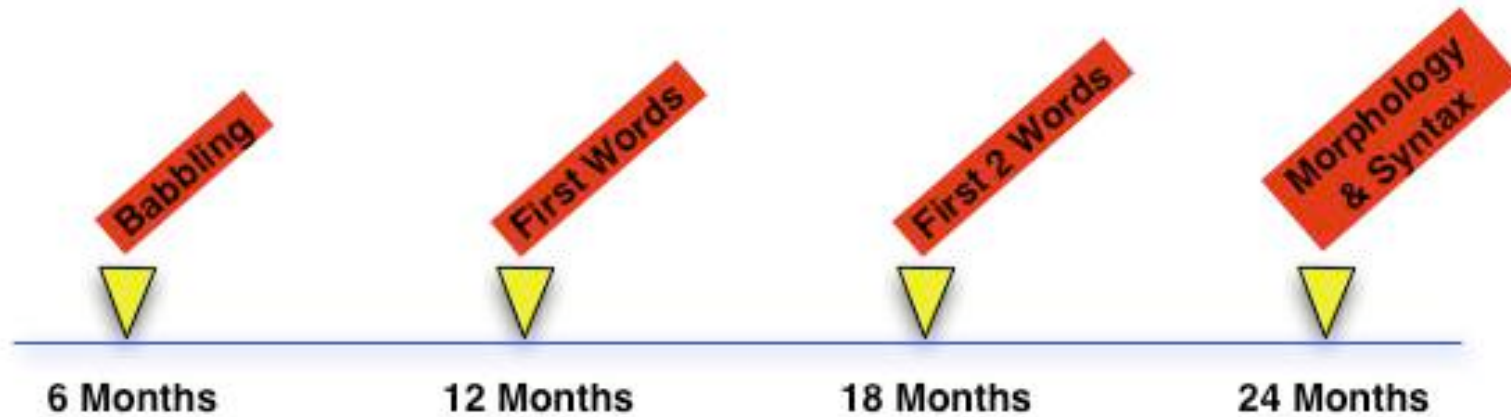
**Tissue in the human Brain dedicated to
detecting & processing highly specific
rhythmical patterns in Language
*Phonological Patterns***

SIGN LANGUAGES



Petitto 2000

MONOLINGUAL MILESTONES SAME



BABBLING STRUCTURE SAME



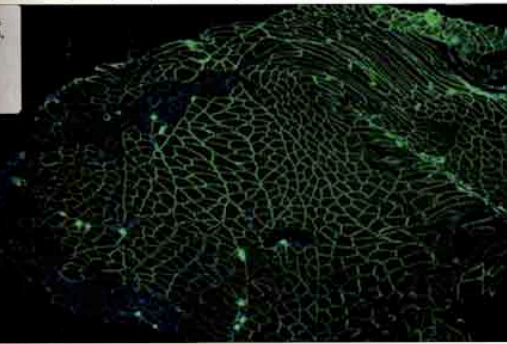
**Petitto &
Marentette 1991**



BRAIN STRUCTURES SAME

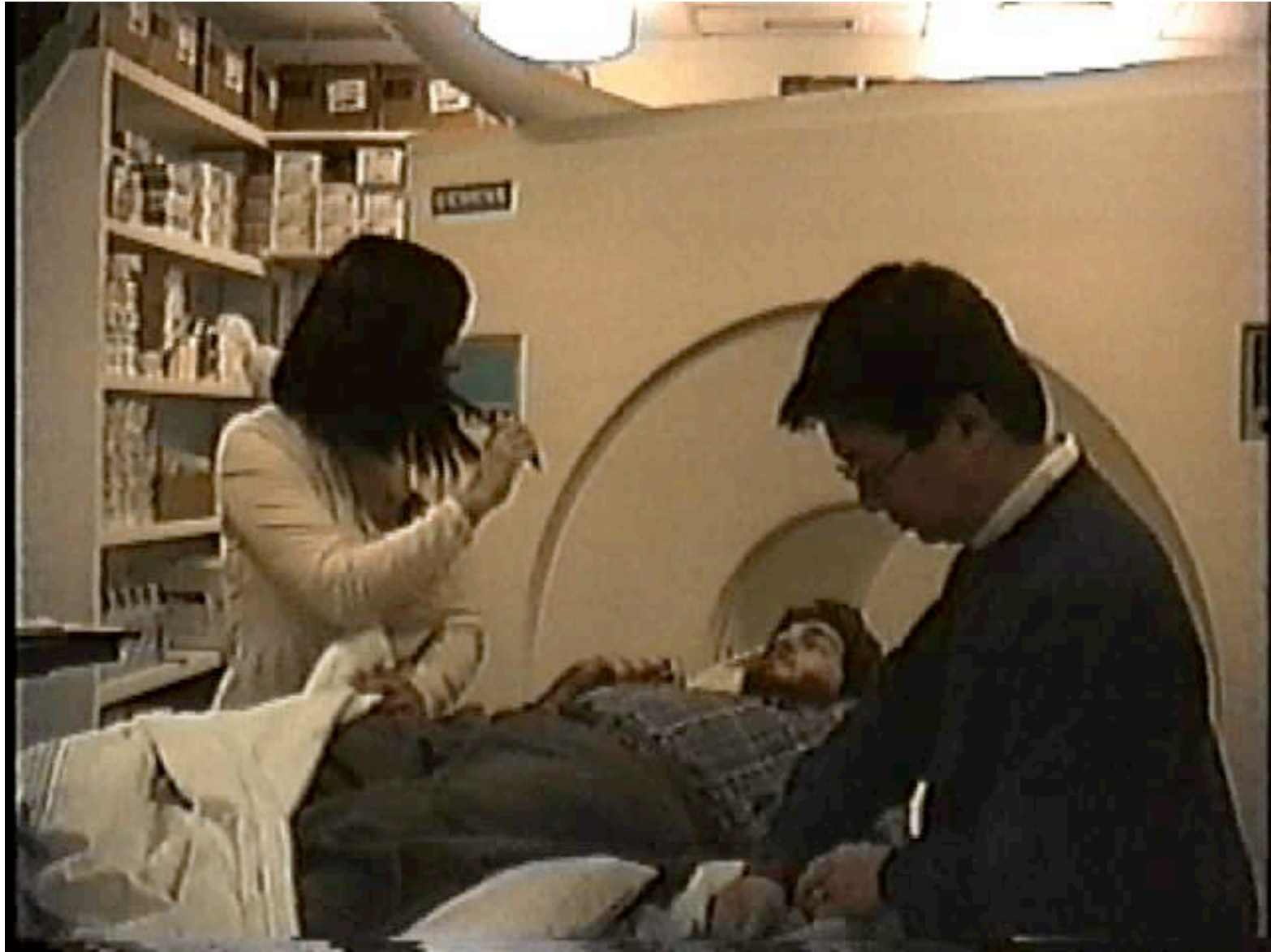
PNAS
Proceedings of the National Academy of Sciences
of the United States of America

December 5, 2000 | vol. 97 | no. 25 | pp. 13461-14016 | www.pnas.org



Minidystrophin gene delivery ameliorates muscular dystrophy
Measuring crystalline elasticity under pressure
How rivers dictate species distribution
Microarrays and bacteria-host contacts
Sign language triggers speech-like cerebral activity

**PETITTO
ZATORRE
GAUNA
NIKELSKI
DOSTIE &
EVANS 2000**

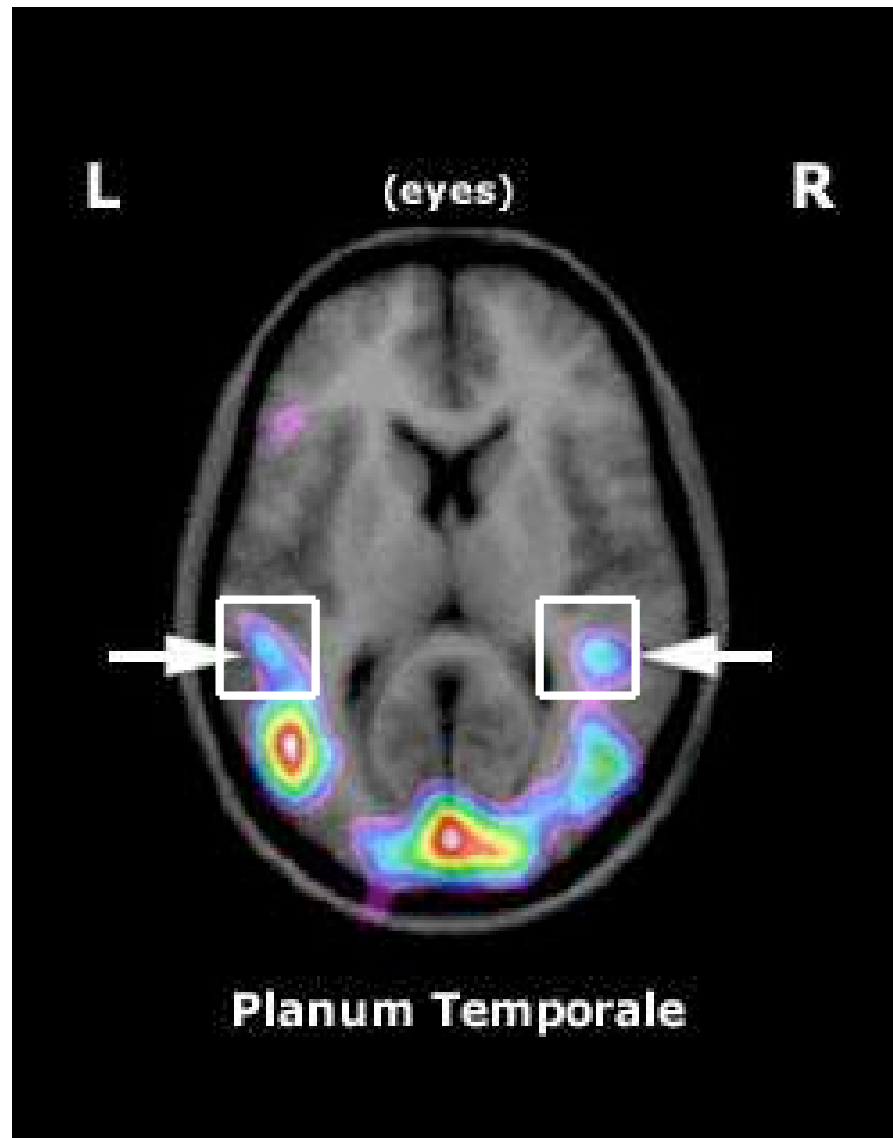


PARTS OF SIGNS & PARTS OF WORDS SAME

Parts of Signs
=Phonetic Hand
Shapes

Processed in Same
Sound &
Phonology
Brain Tissue

Superior
Temporal
Gyrus
"STG"



LANGUAGE PATTERNS SAME



**Petitto, Holowka
Sergio & Ostry
2001**

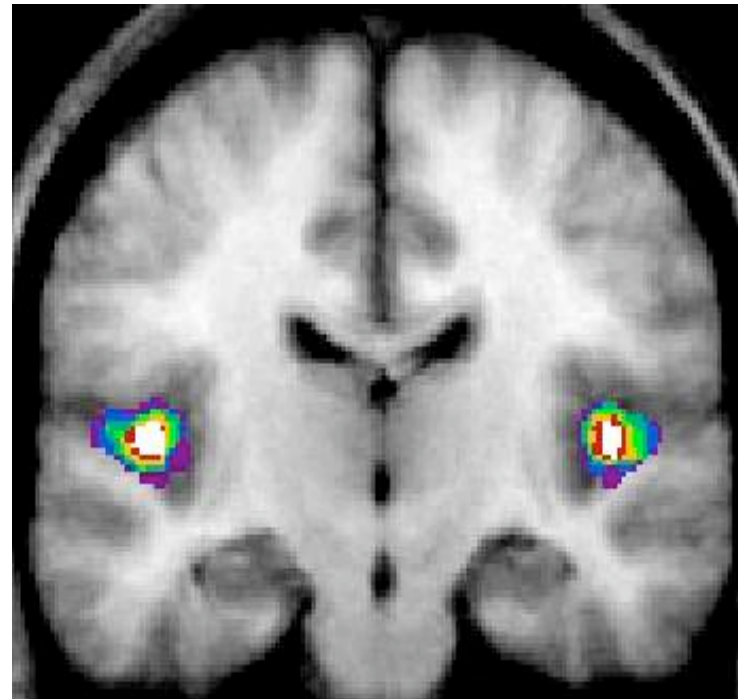
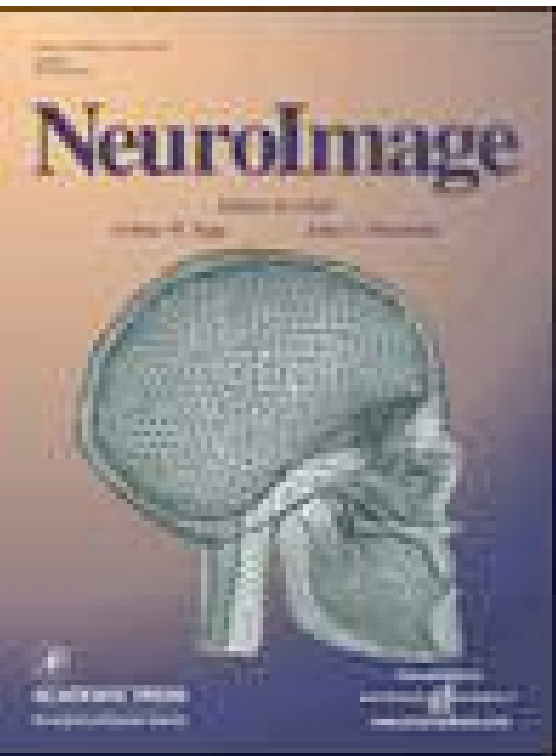
LEFT BRAIN & LANGUAGE EARLY

Babies From 5 months-old
Use mouth differently

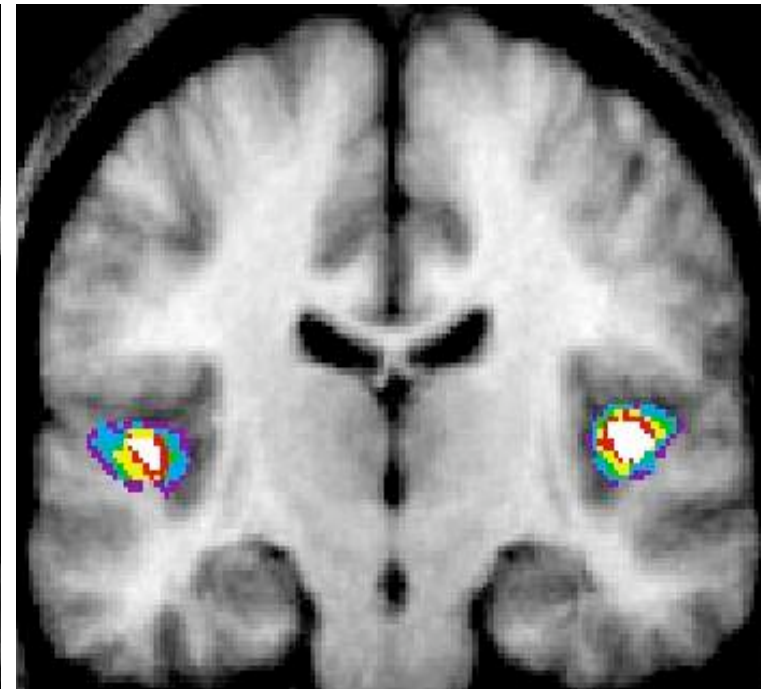


Holowka & Petitto
August 30 2002

BRAIN VOLUMES IN AUDITORY TISSUE SAME



Deaf



Hearing

Penhune, Cismaru,
Dorsaint-Pierre,
Petitto & Zatorre
2003

HOW IS IT POSSIBLE?



SAME

Milestones

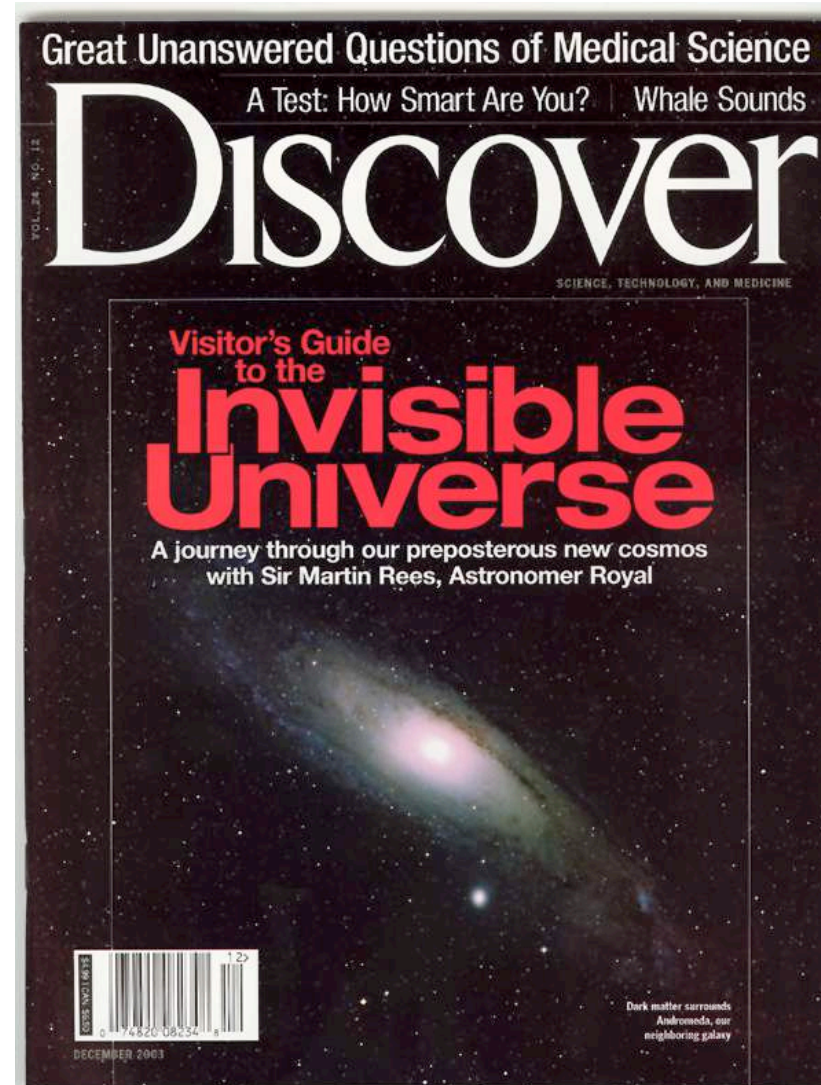
Structures

Brain Tissue

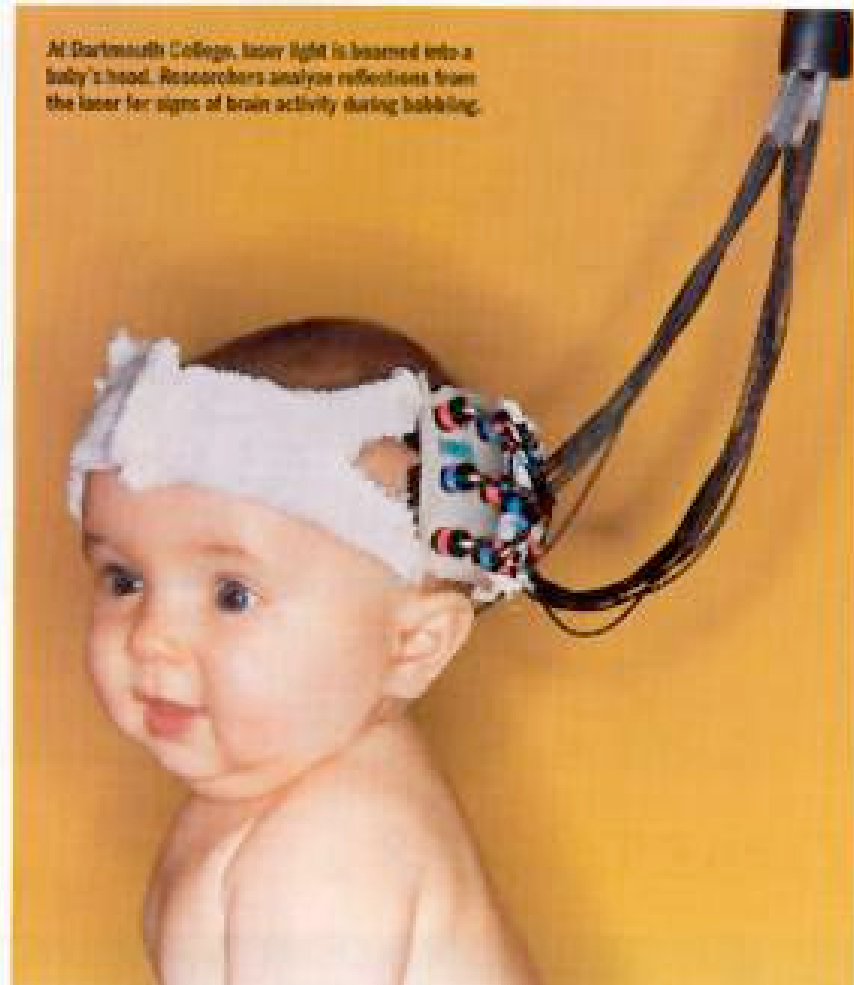
ANSWER

**Tissue in the human Brain dedicated to
detecting & processing highly specific
rhythmical patterns in Language
*Phonological Patterns***

NEW - PHONETIC PERCEPTION IN MONOLINGUAL BABIES



December 2003



Near-Infrared Spectroscopy
(NIRS)

NEW - PHONETIC PERCEPTION IN MONOLINGUAL BABIES

FOCAL Neuroanatomical Analyses of Focal Language Tasks in Babies, Children & Adults

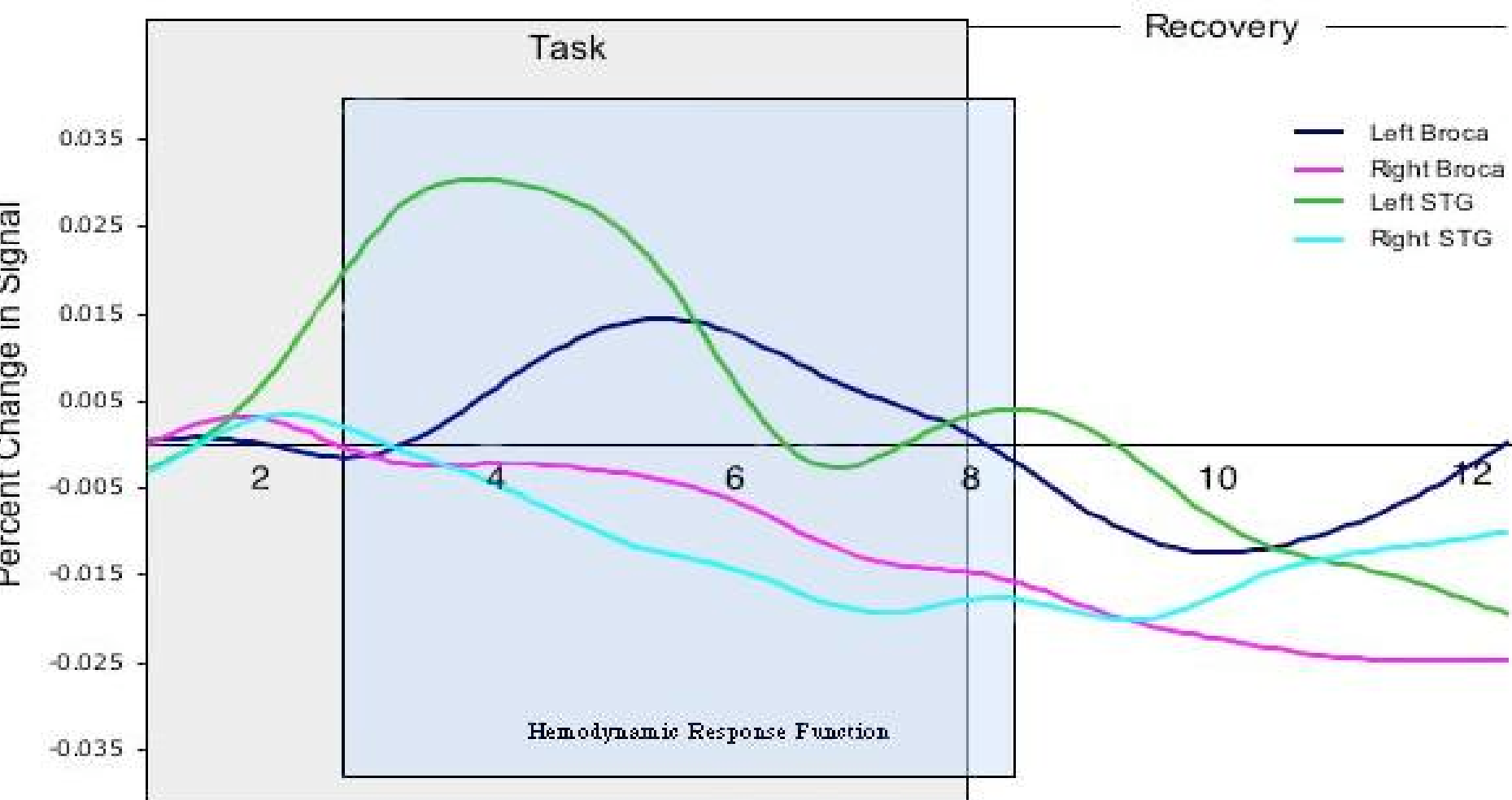
Abigail Baird, Stephanie Baker, Elizabeth Norton Laura-Ann Petitto



PHONETIC PERCEPTION PRELIMINARY PILOT



Discrimination of Phonetic Contrasts - Phonetic Hands Similar to PET study ASL, 6 Infants, mean age 3 months 39



WHAT ABOUT TWO LANGUAGES?



THE BILINGUAL PARADOX

Effortless

Effortful *Delayed & Confused*

Strategies

Parents *Hold back*

Educators (& Countries) *Hold back*

Scientists *Hold back*

BILINGUAL CHILDREN DELAYED & CONFUSED?

Children

Signed & Spoken

Children

Spoken & Spoken



Petitto et al. (2001). *JCL*

BILINGUALS DELAYED & CONFUSION?

Bilingual children **SAME** milestones

Bilingual children **DO** mix their Languages **YES**

Language Mixing (vs Code Switching)

Are they Confused? **NO**

Mixing related to adult mixing

Mixing is rule-governed, systematic



BILINGUALS SEMANTIC CONFUSION?



**Word Meanings are Not
Confused & Grow Equally**

Holowka, Brosseau-Lapr e & Petitto
2002 *Language Learning*

WHEN IS BILINGUAL EXPOSURE OPTIMAL?

Birth

age 3

age 5

age 7-9

age 9-12

Home, Intensive Community, Classroom

Five Language Pairs (R-F , S-F, F-E, E-F, S-F)

RESULTS - The earlier the better BUT not in all contexts!

Kovelman & Petitto, 2002, *SFN*

OPTIMAL EXPOSURE?

CLASSROOM-ONLY EXPOSURE HARDEST HIT

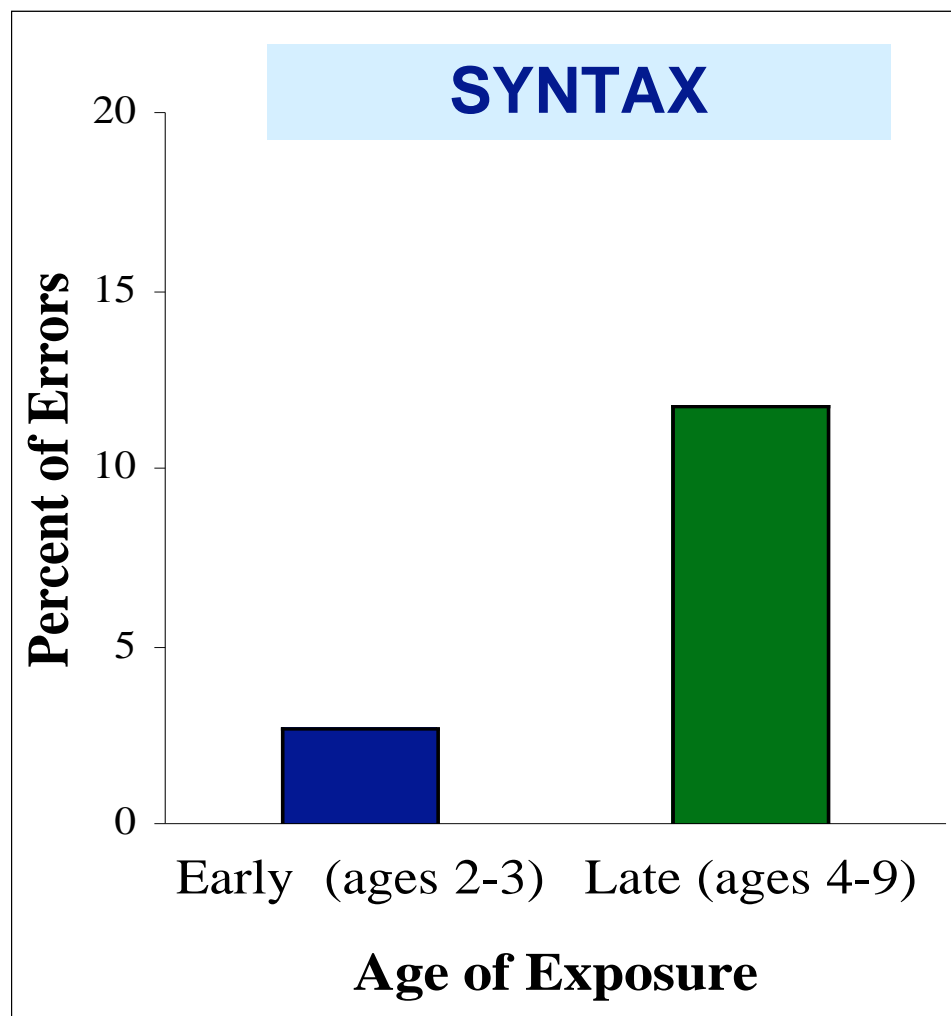
PHONOLOGY

Accent, Pronunciation

Vowel Lengthening
Syllabification
Stress

HIGHLY sensitive to
Age of Exposure

EARLIER (>7) better than
LATER



OPTIMAL EXPOSURE?

**HOME & COMMUNITY EXPOSURE CAN
YIELD...**

NO damage to either Language

**Even relatively late bilingual exposure is
fine if from either home/intensive
community, but NOT CLASSROOM
ONLY**

OPTIMAL EXPOSURE? EARLY IS BEST

- *Unsupported View*

Teach second language later when child has “cognitive base”

- *Strongest Formula* = Native Fluency in BOTH Languages

Early exposure

Across multiple & rich contexts

Systematic input

NEW BILINGUAL CHILDREN SMARTER?

Bilingual children
perform **BETTER**
than monolinguals
on select cognitive
tasks



Baker, Kovelman, Bailystok & Petitto *IN PROGRESS*

BILINGUALS SMARTER?

Theoretical Accounts

Modality Competition

Linguistic Competition

BILINGUALS SMARTER?

26 Participants

Bilingual



French



**Langue des Signes
Québécoise/LSQ**

Monolingual

French


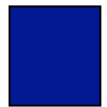

English

Matched

Age, Language, Memory

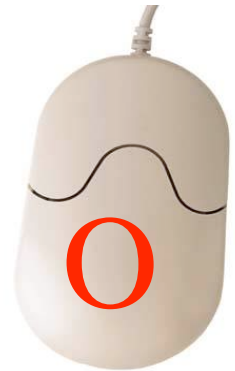
BILINGUALS SMARTER?

Simon Task

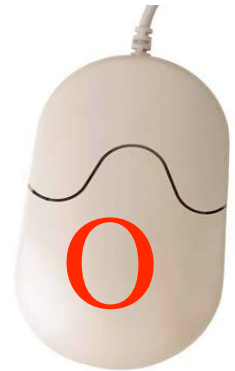
Control	Congruous	Incongruous
		



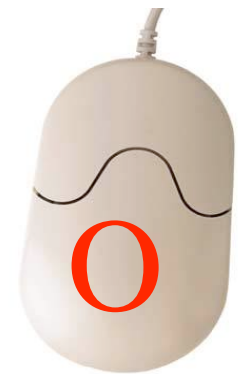
CONTROL



CONGRUOUS



INCONGRUOUS



BILINGUALS SMARTER?

PREDICTIONS

Modality Competition

Bilinguals & monolinguals SAME

Linguistic Competition

Bilinguals BETTER

BILINGUALS SMARTER?

PRELIMINARY PILOT DATA

Bilinguals had an overall lower error rate than monolinguals

+ Lower error rate on the most attention-demanding types of trials (incongruous)

NEW SIMULTANEOUS OR SEQUENTIAL READING?

How best to teach bilinguals to read?



Wilson-Orkamura

**Kovelman, Baker, Peacock-
Villada, Norton, Petitto
*IN PROGRESS***

SIMULTANEOUS OR SEQUENTIAL READING?

5 Simultaneous

4 Sequential

6 Monolingual English

2nd Grade (ages 7-8)

Simultaneous (Spanish at Home)

Sequential (Spanish first, 1-2 yrs)

SIMULTANEOUS OR SEQUENTIAL READING?

PRELIMINARY PILOT DATA

English Tasks

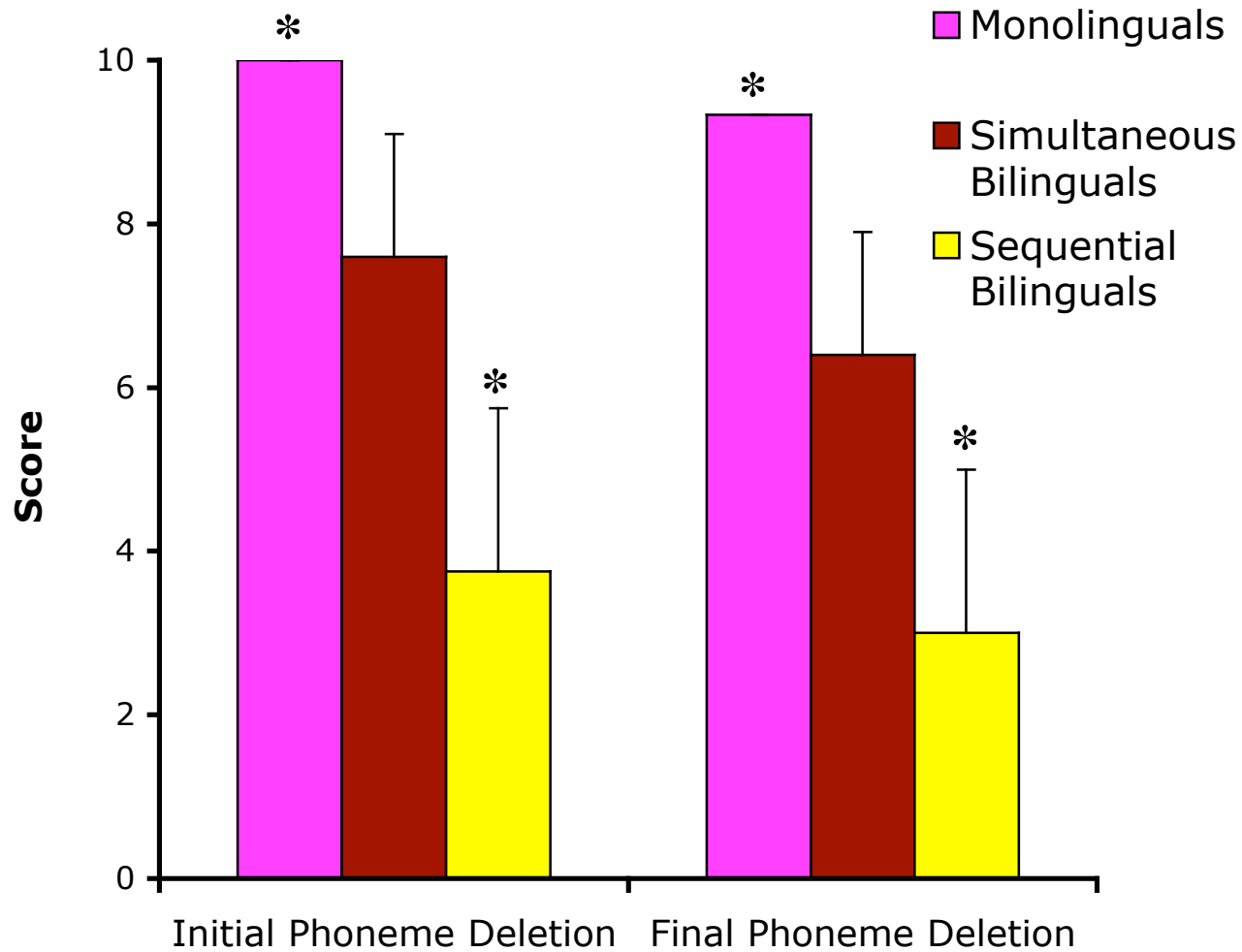
Simultaneous same as monolinguals

Sequential worse than monolinguals (Phoneme Deletion, Passage Comprehension)

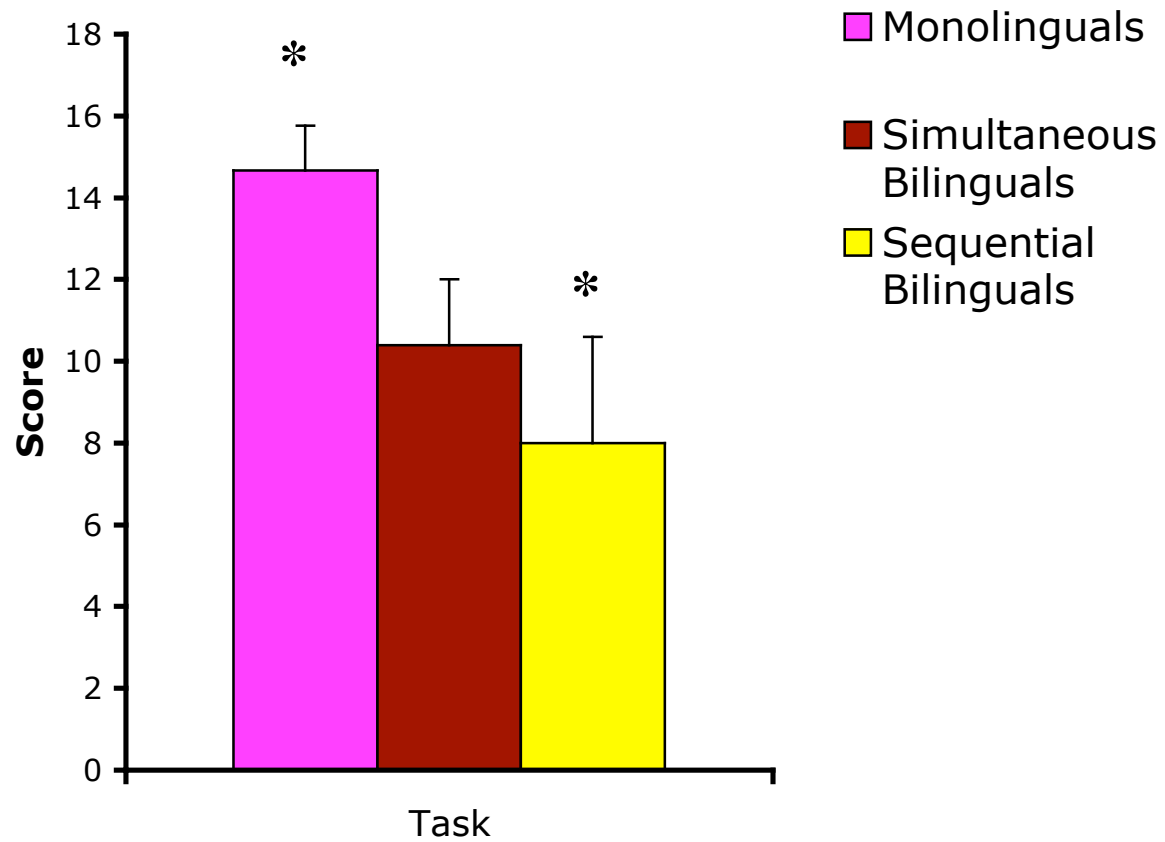
Spanish Tasks

Sequential + formal schooling in Spanish outperformed simultaneous bilinguals on Word Attack task only

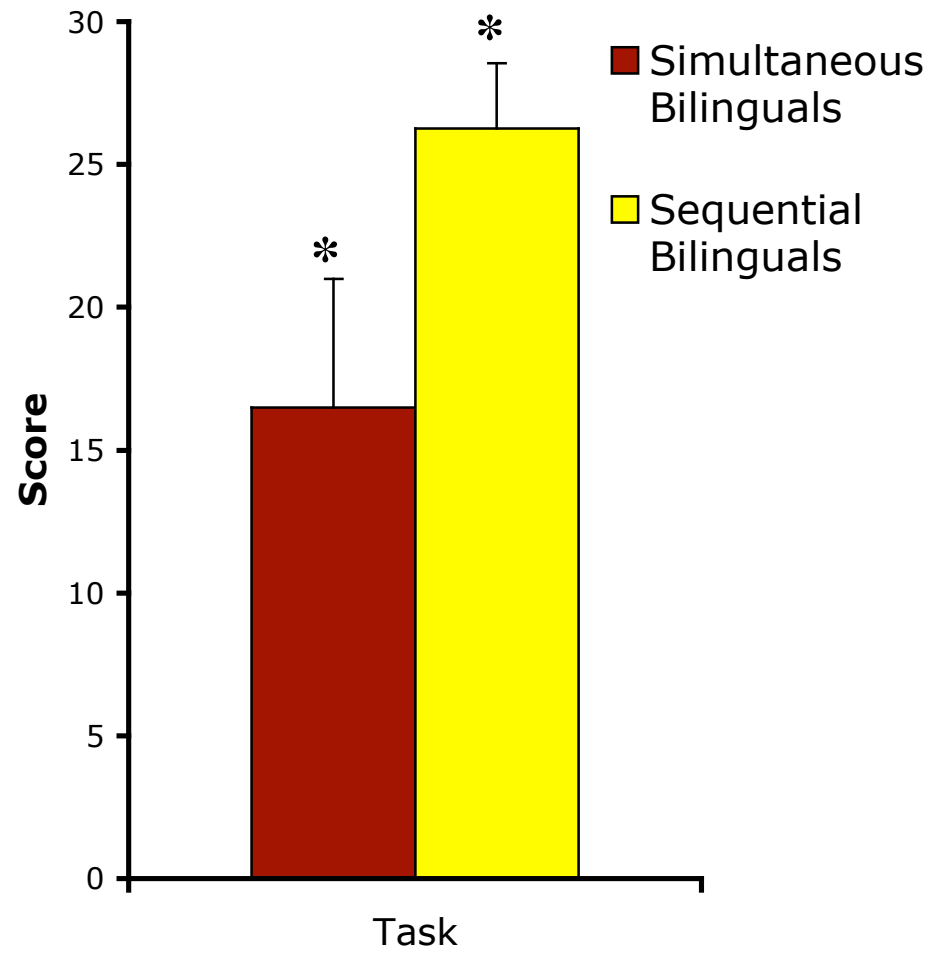
English Tasks: Phoneme Deletion



English Tasks: Passage Comprehension



Spanish Tasks: Non-words



NEW PHONETIC PERCEPTION IN BILINGUAL BABIES



Five HEARING
Babies

Two 4 MTH

Three 14 MTH

Norton, Baker & Petitto, *IN PROGRESS*

NEW PHONETIC PERCEPTION IN BILINGUAL BABIES

PRELIMINARY PILOT DATA

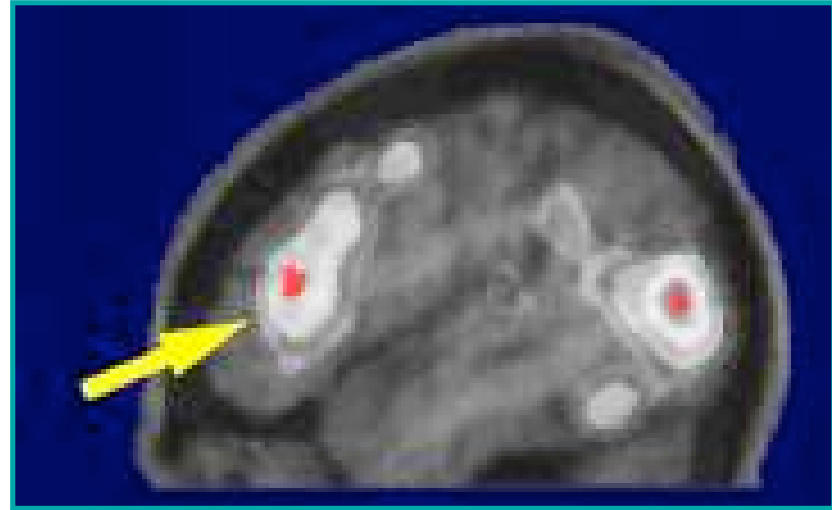
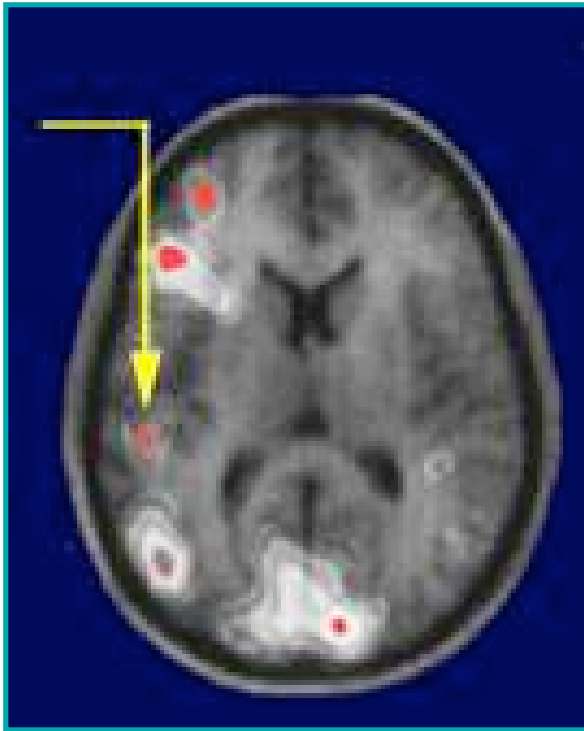
4-month-old bilinguals= monolinguals

- brain not set to discriminate one language

14-month-old bilinguals= sensitivity to all novel phonetic units

- a greater & extended sensitivity to linguistic contrasts

NEW Bilingual brains



Early exposure yields
same brain sites &
course

Kovelman, Baker & Petitto, *IN PROGRESS*

SUMMARY

WHAT I HAVE COVERED

• **Monolingual Milestones**

• **Bilingual's Language Development**

Milestones, Delay/Confusion, Semantic Confusion

Optimal Age of exposure

***New* Cognitive Advantage in Bilinguals**

***New* Bilingual Reading- Behavioral (& NIRS)**

***New* Phonetic Perception in Mono/Bilinguals-Infan**

Habituation & NIRS

***New* Bilingual Adult Brain Organization- fMRI**

SUMMARY - FINDINGS

- The earlier a child is exposed to two languages, the stronger they are in each language
- Not the reverse

CONCLUSIONS

- Tissue in brain sensitive to specific language patterns, phonological patterns, which helps children learn ALL language (one, two, or more)
- Developmentally sensitive to age of exposure
- **Discovery is a good thing**
Helps us know how to give children what they need & when

BILINGUAL Teachers **EDUCATION**

Caretakers

**State & Local
Policy Makers**

Research



Medical

Clinicians

THANK YOU

Ioulia Kovelman



**The Spencer Foundation
Dartmouth College**

Dr. Stephanie Baker



Elizabeth Norton



Paola Peacock-Villada

“Los Patitos de Petitto”