

The Social Brain and Early Language Learning: Connecting the Dots!

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The Social Brain: Neural Synchrony!

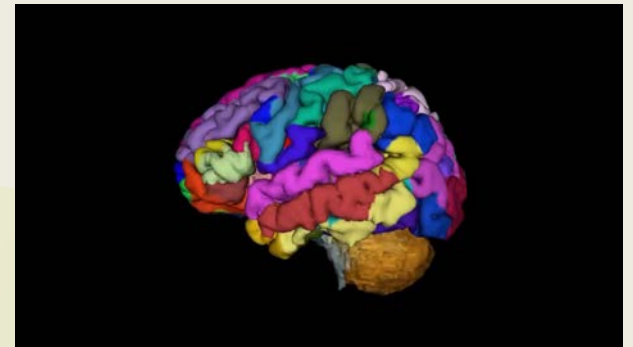


Image Credit: agsandrew/Shutterstock



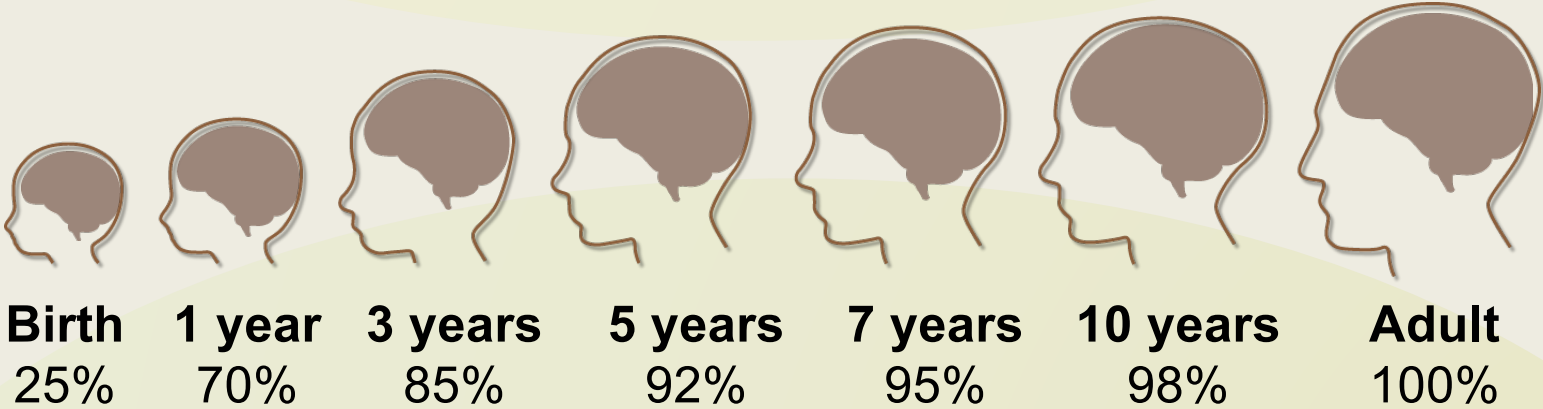
Brain Function

Brain Structure



Evidenced-based
interventions
parents and
teachers that work!

Brain Growth: Birth to Adulthood

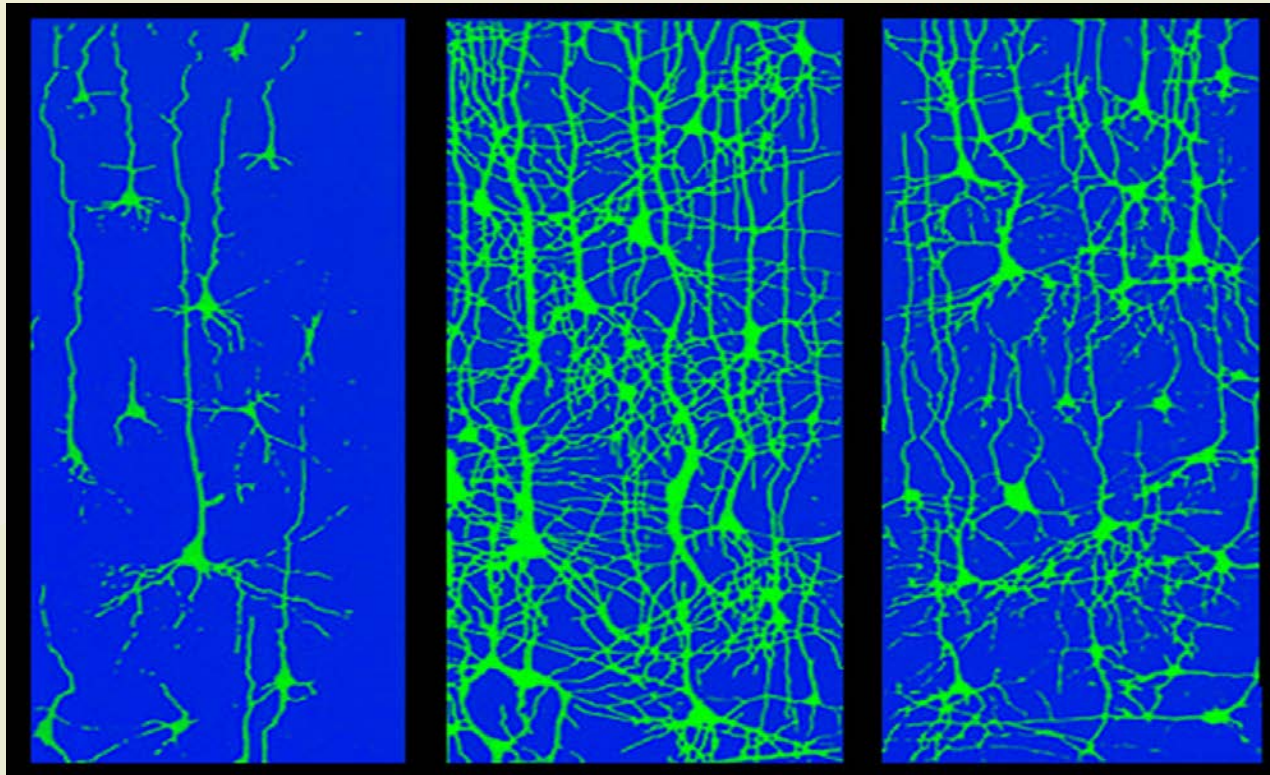


Building Connections : 1 Million/sec!

Birth

3 Years

14 Years



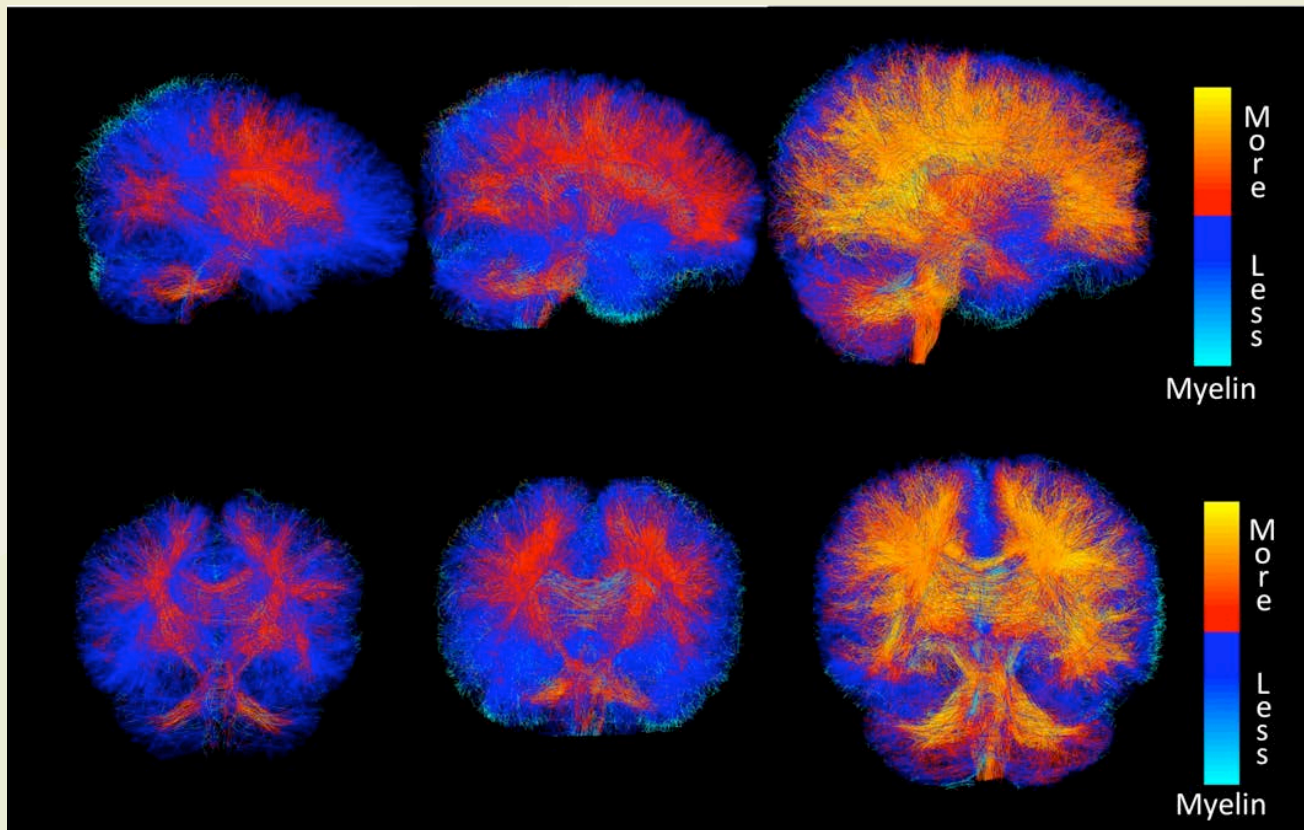
Synapses proliferate, and then are “pruned”!

Growth of Baby Brain Connections

7 month old

11 month old

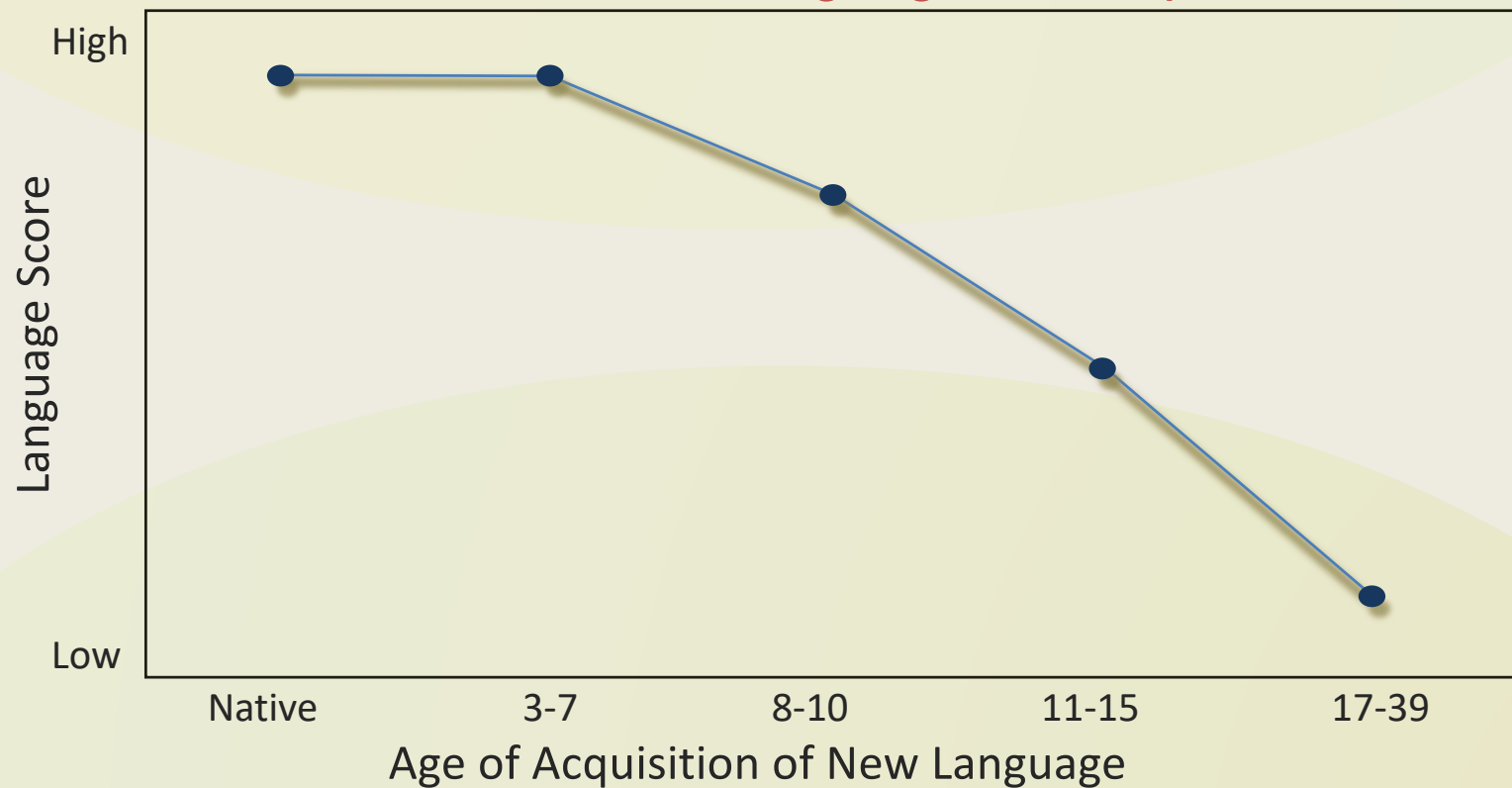
26 month old



Institute for Learning & Brain Sciences, University of Washington

Why Focus on Early Development?

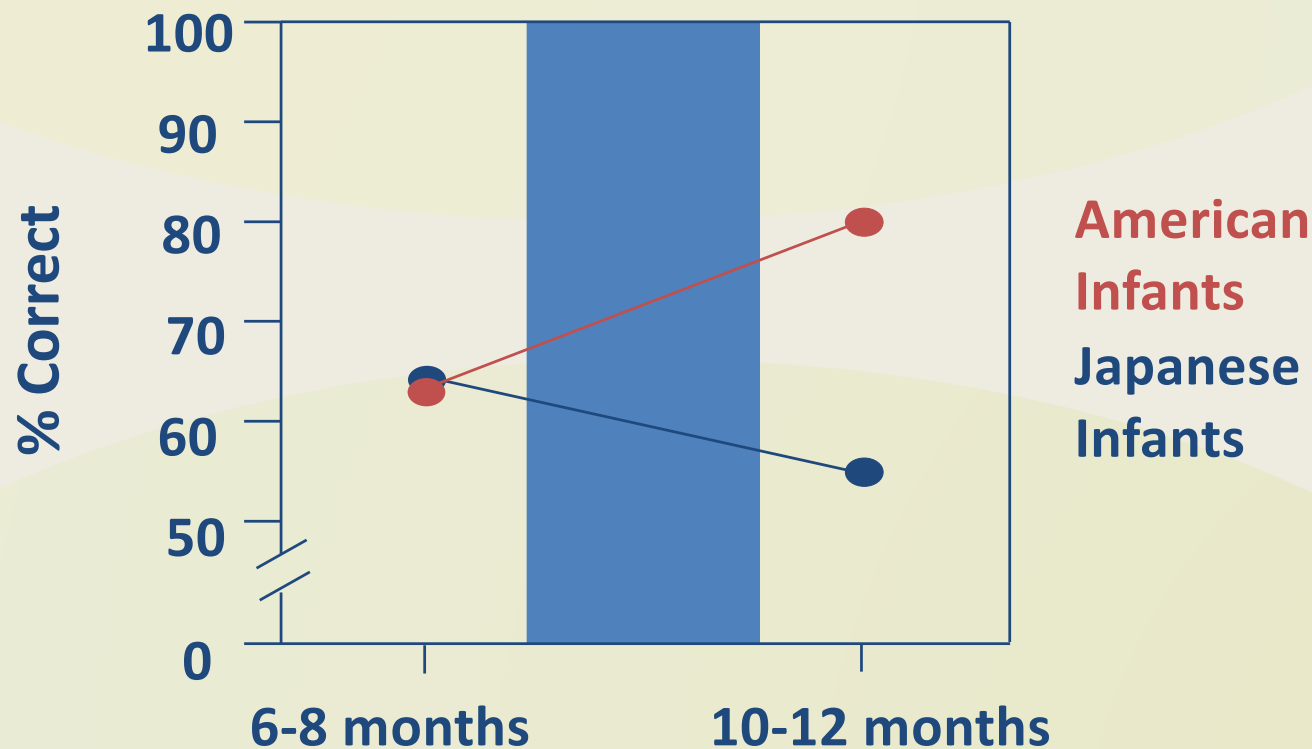
Sensitive Period for Language Development





A 'Sensitive Period' for Speech Learning

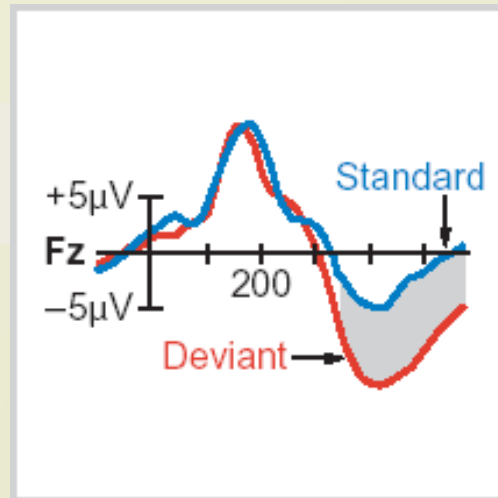
Infant discrimination of /ra/ vs. /la/



Kuhl et al., *Developmental Science*, 2006

Neural Signatures of Speech Learning

Event-related Potential (ERP): Mismatch Negativity (MMN)



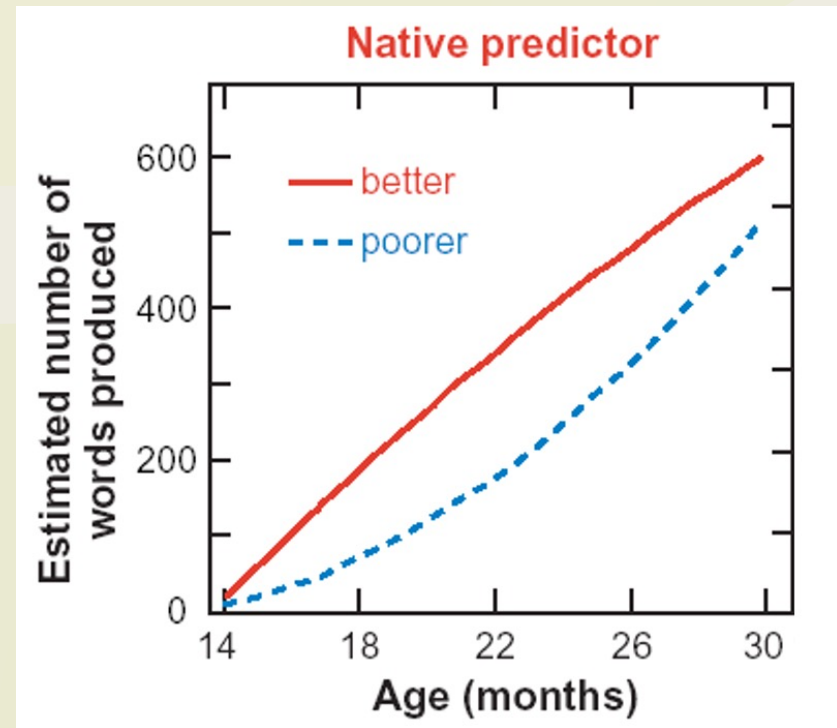
Mismatch Negativity (MMN)

Early Learning Predicts Language Outcomes

A



B

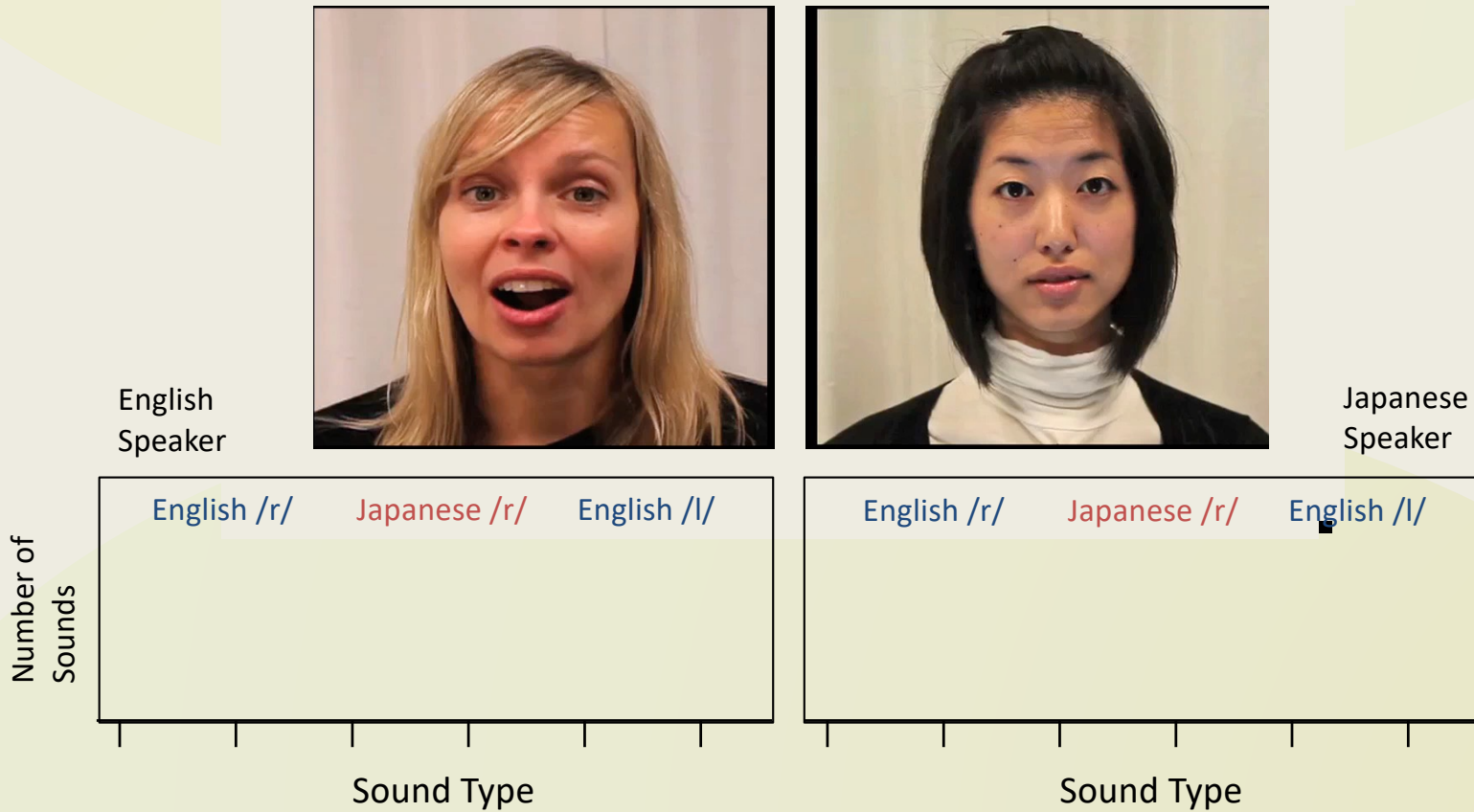


Kuhl et al., *Phil. Trans. of the Royal Society*, 2008

What Drives Learning During the Critical Period?

Statistics and the Social Brain!

Infants Take Statistics



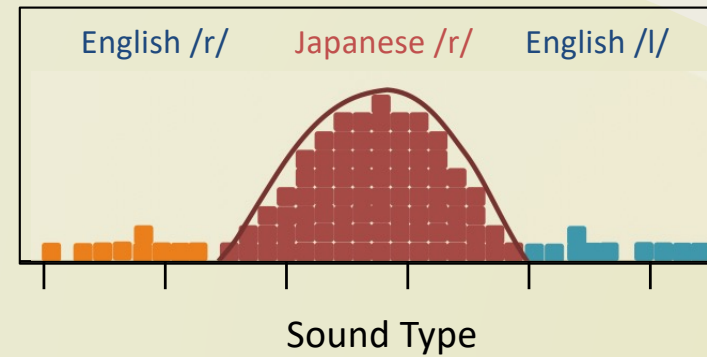
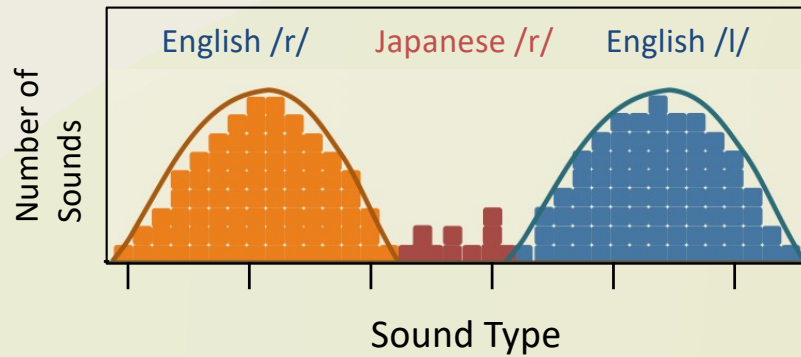
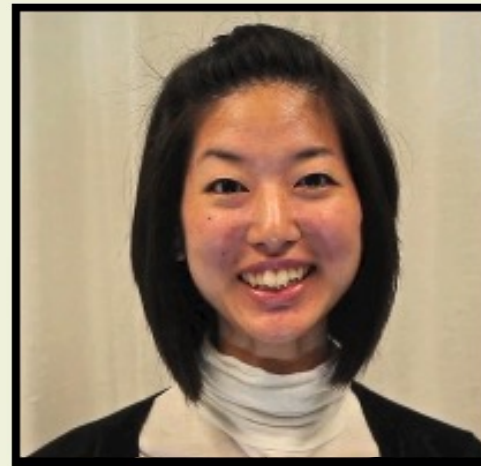
Kuhl et al., *Science*, 1992; TED.com, 2011

Infants Take Statistics

English Speaker



Japanese Speaker

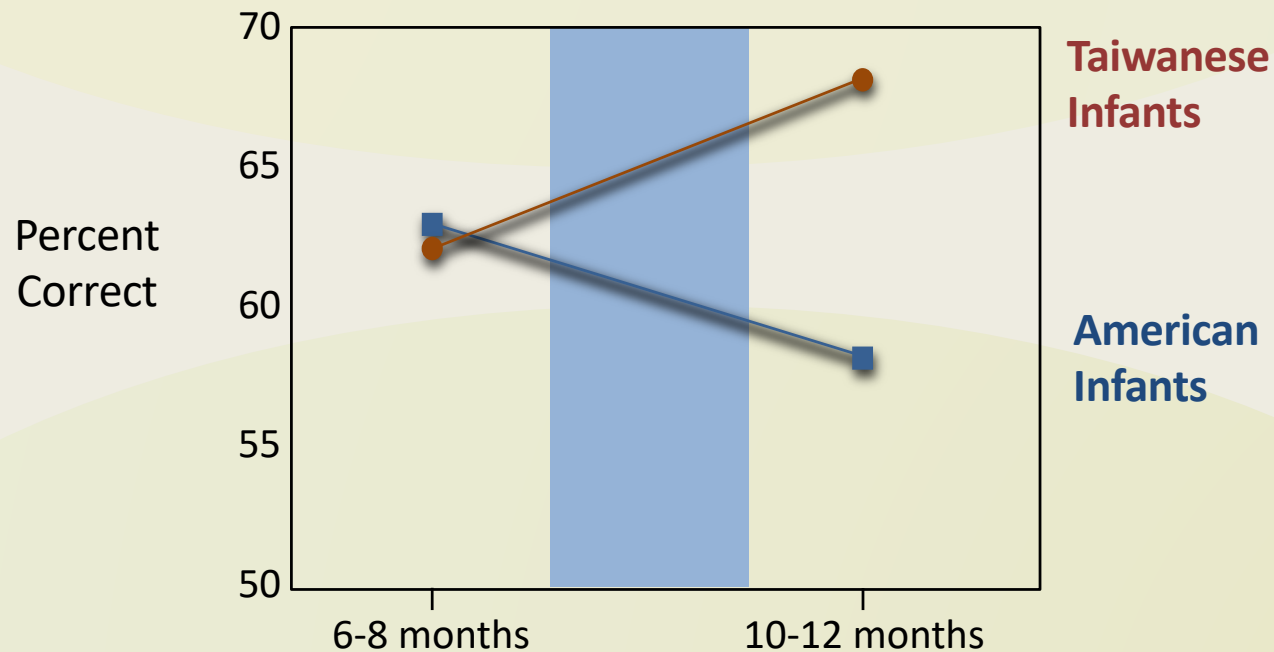


Kuhl et al., *Science*, 1992; TED.com, 2011

The Social Brain is Essential!

Perception of Mandarin Chinese Sounds

Intervention: 12 sessions, 25 minutes each,
4 different talkers (mean # of syllables = 33,000)



Kuhl, Tsao & Liu, *Proceedings of the National Academy of Sciences*, 2003

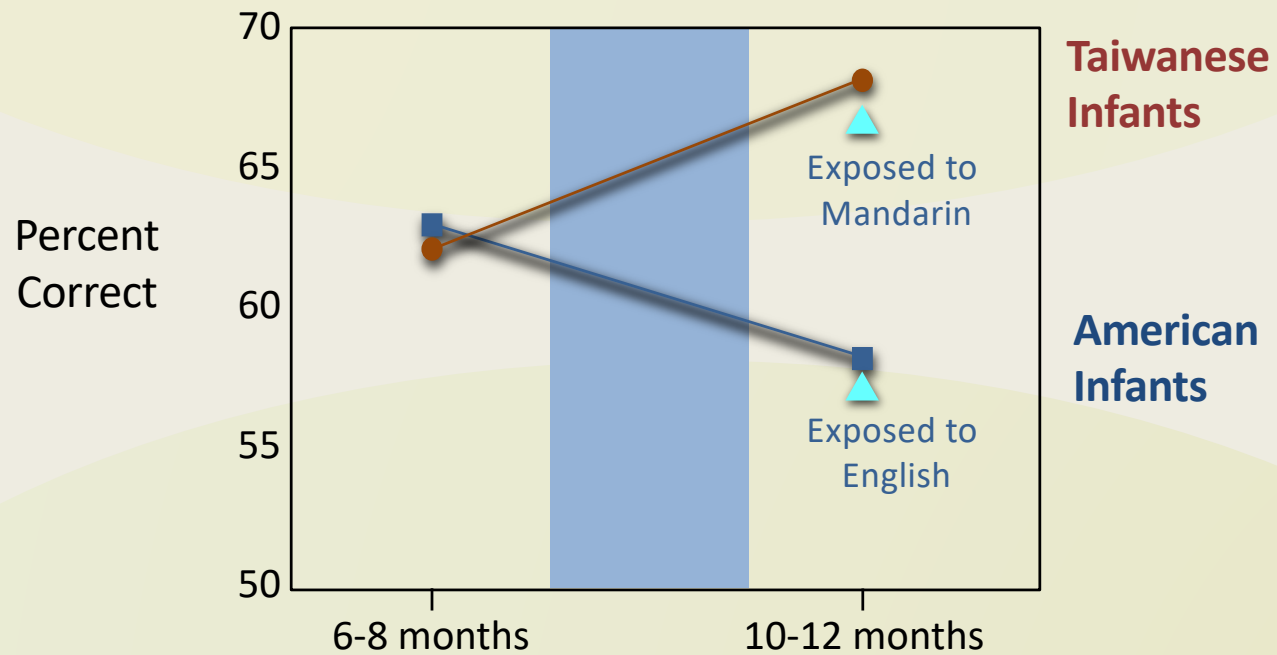
Mandarin Chinese Exposure

12 sessions between 9 and 10.5 months of age



Kuhl, Tsao & Liu, *Proceedings of the National Academy of Sciences*, 2003

Did Infants Learn?



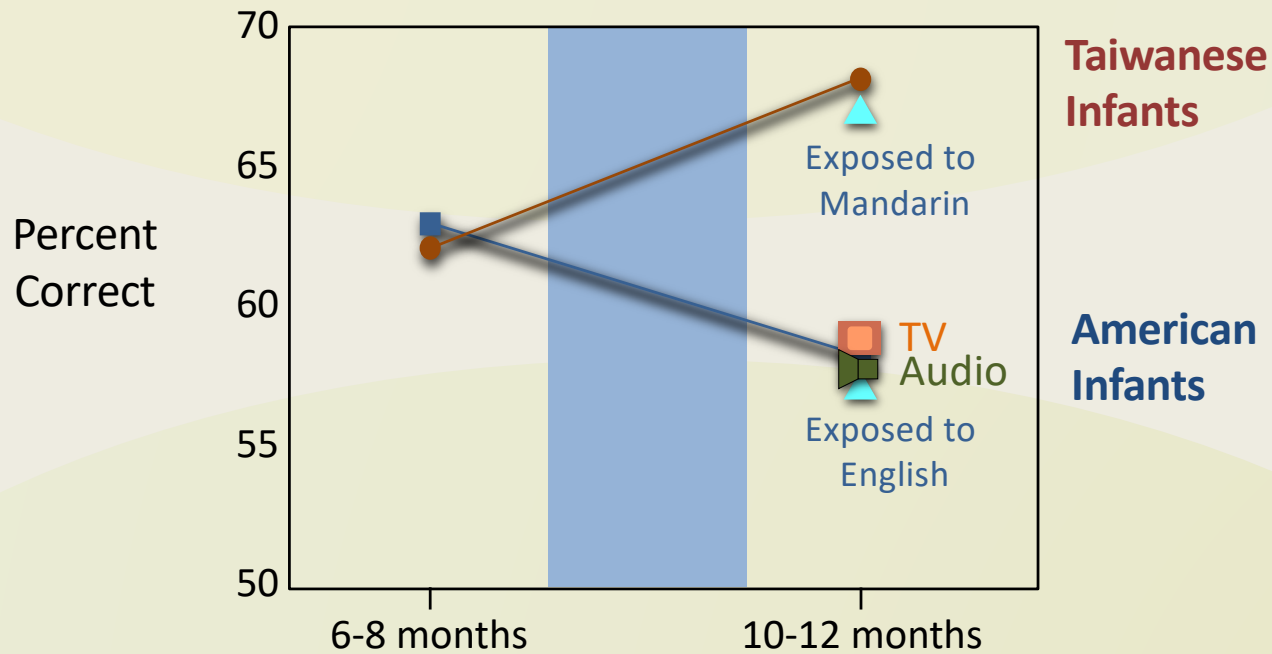
Kuhl, Tsao & Liu, *Proceedings of the National Academy of Sciences*, 2003

Do Infants Learn From a Screen?



Kuhl, Tsao & Liu, *Proceedings of the National Academy of Sciences*, 2003

Do Infants Learn Language From Video?



Kuhl, Tsao & Liu, *Proceedings of the National Academy of Sciences*, 2003

Spanish Exposure Experiments



Conboy & Kuhl, *Developmental Science*, 2011

Infants' Social Skills

Eye-Gaze Following



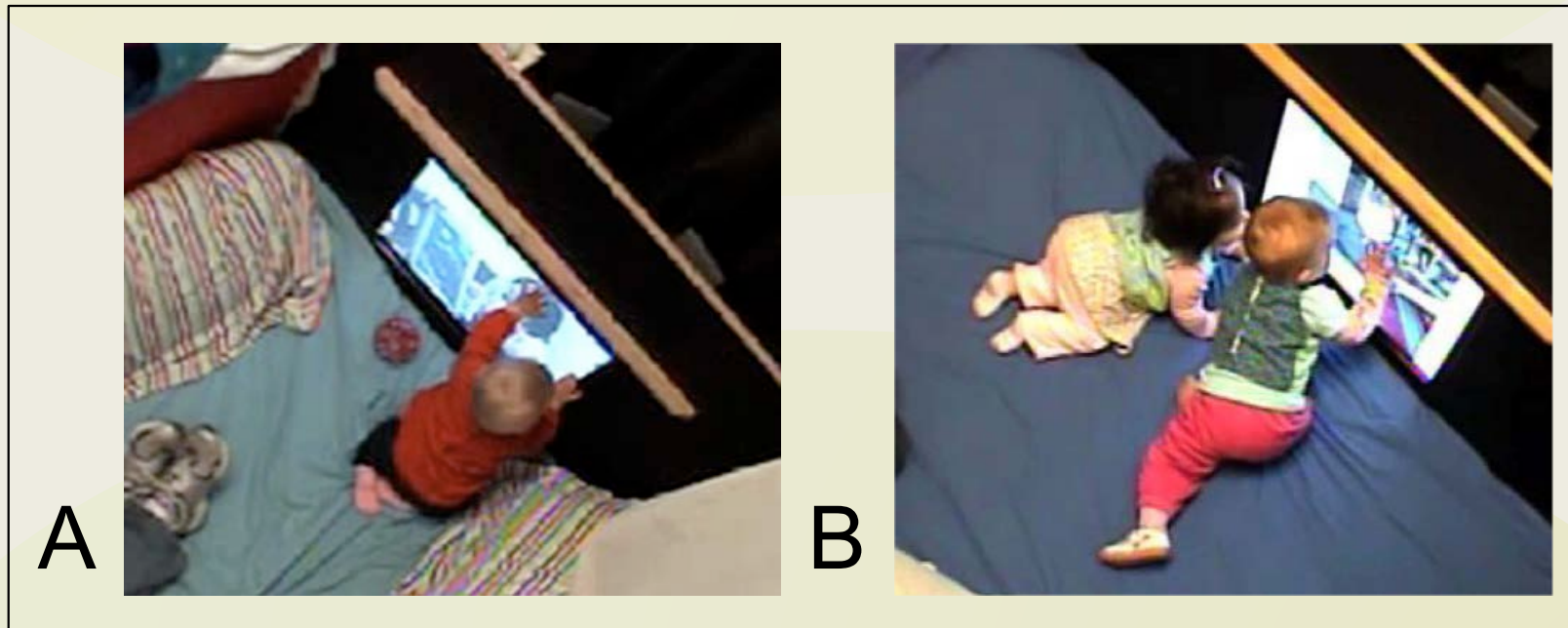
Conboy, Brooks, Meltzoff, & Kuhl, *Developmental Neuropsychology*, 2015

The Mere Presence of Another Baby Increases Learning



Lytle, Garcia-Sierra, & Kuhl, 2018, *PNAS*

Babies Learning in Pairs



Roseberry Lytle, Garcia-Sierra & Kuhl, 2018, *PNAS*



The Bilingual Brain Studies

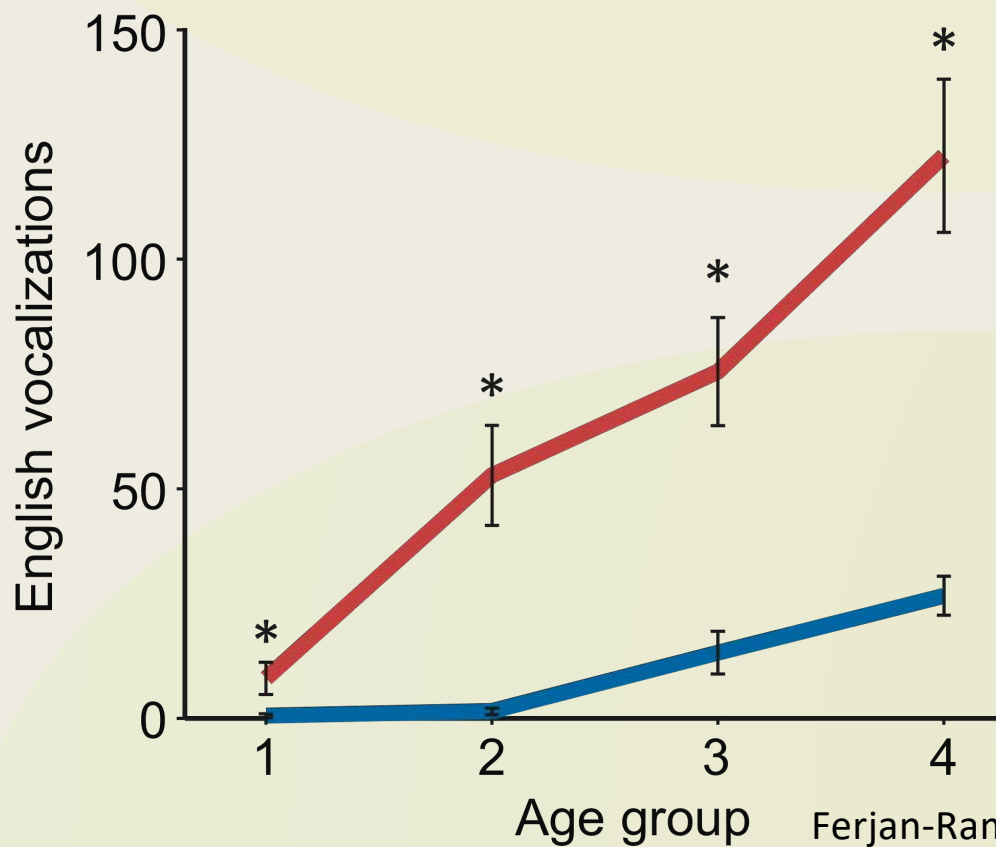


SparkLing Bilingual Intervention: Madrid!



Naja Ferjan-Ramirez & Kuhl, *Mind, Brain, and Education*, 2017

I-LABS bilingual learning in school: 18 weeks, 1hr/day

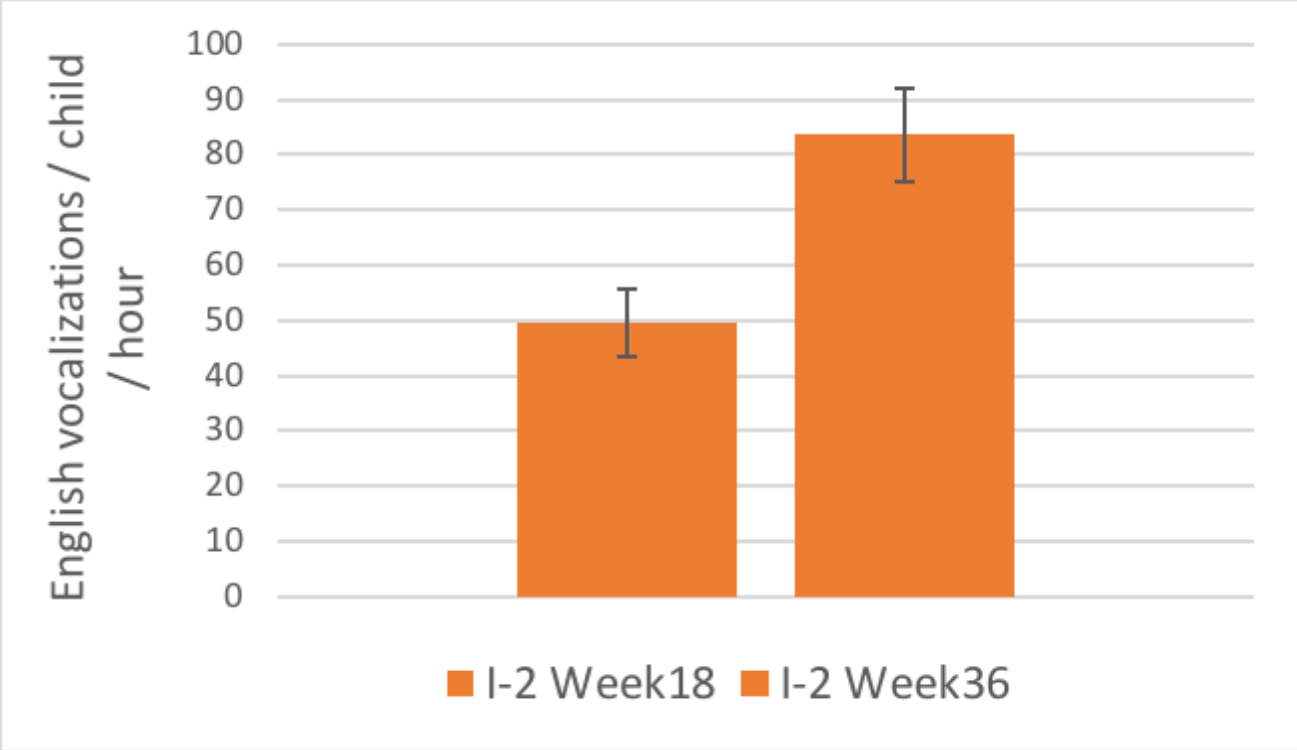


— Intervention	Age Group
— CPC	1 - 7-14 months
	2 - 14-20.5 months
	3 - 20.5-27 months
	4 - 27-33.5 months

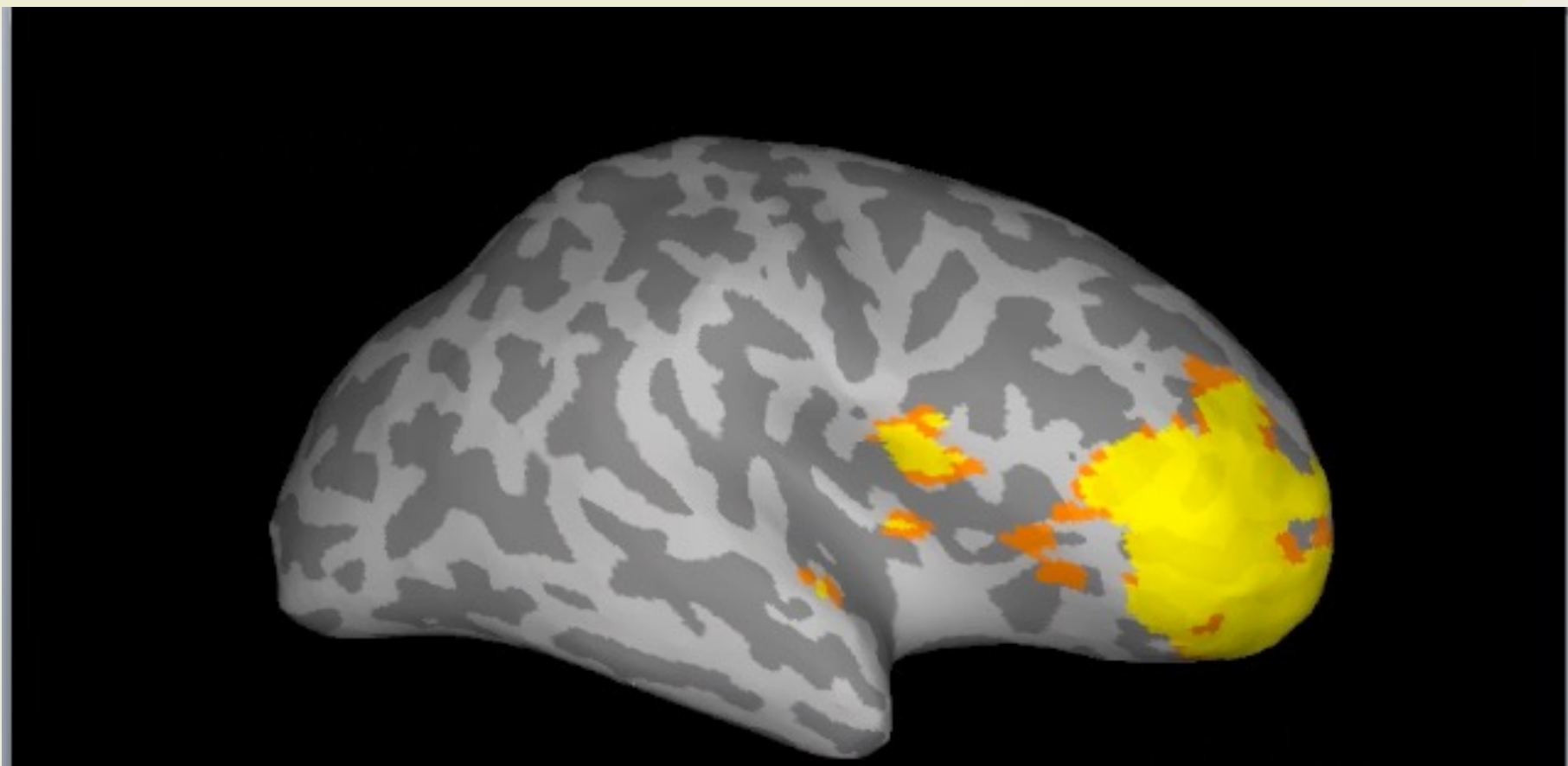
Children who experienced I-LABS Bilingual Baby method and curriculum show extraordinary gains compared to children who experienced current bilingual teaching methods in use in Madrid.

Ferjan-Ramirez & Kuhl, *Mind, Brain, and Education*, 2017

Half-Year vs. Entire Year: Learning Nearly Doubles



Bilingual Babies Show Prefrontal Activation: Greater Cognitive Flexibility



Ferjan-Ramirez, Ramirez, Taulu, Clarke, & Kuhl, *Developmental Science*, 2017

Tests of Executive Function: 11-Month-Old Monolingual Child



Conboy, Sommerville, & Kuhl, in progress)

Tests of Executive Function: 11-Month-Old Bilingual Child



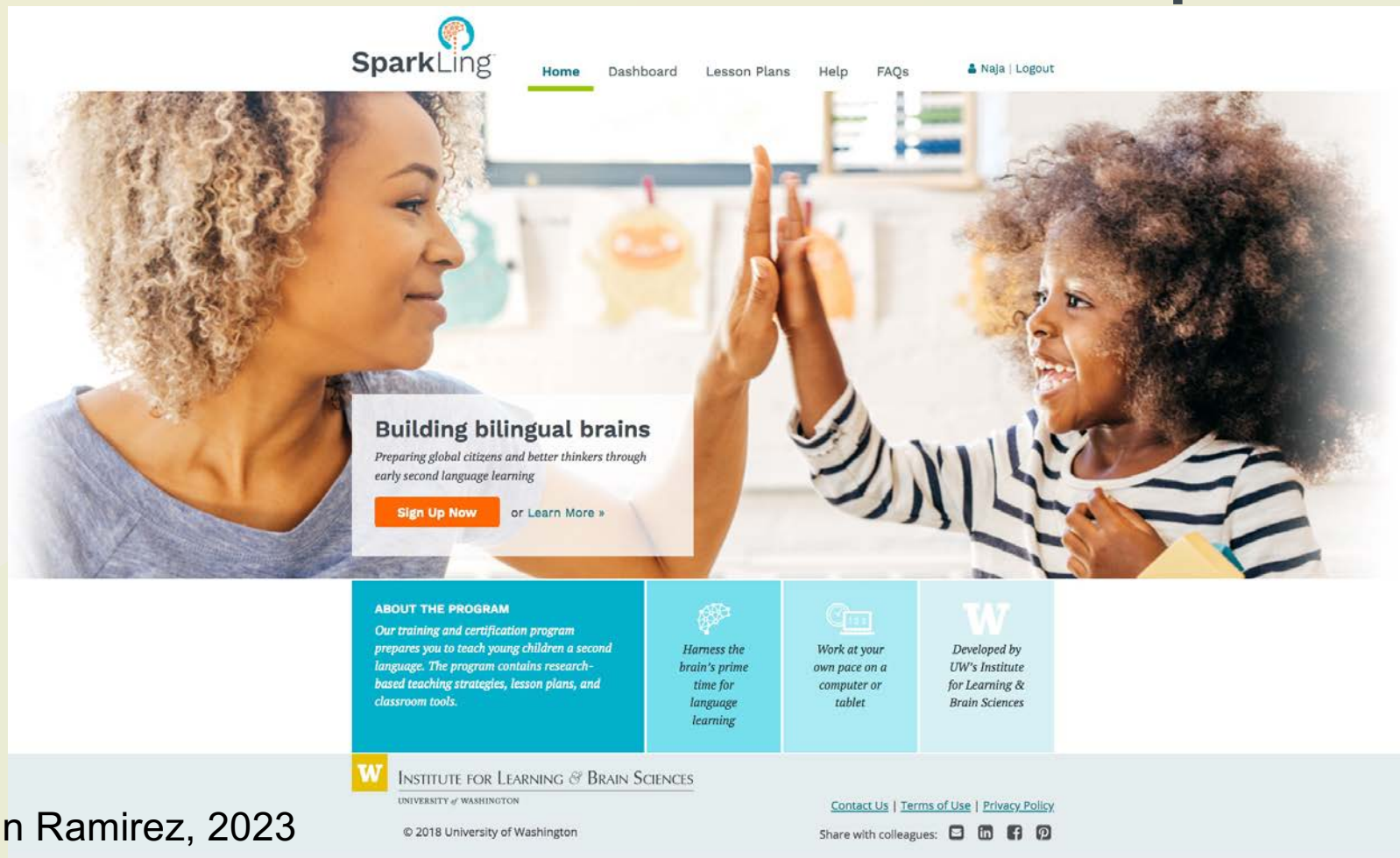
Conboy, Sommerville & Kuhl, in progress

SparkLing Bilingual Graduates In Madrid



Ferjan-Ramirez & Kuhl, *Mind, Brain & Education*, 2017

SparkLing Teachers Trained Online!



The screenshot shows the SparkLing website homepage. At the top, the SparkLing logo is on the left, and navigation links for Home, Dashboard, Lesson Plans, Help, and FAQs are in the center. On the right, there is a user profile for "Naja" with a "Logout" link. Below the navigation is a large hero image of a teacher and a young girl high-fiving. A white call-to-action box is overlaid on the image with the text "Building bilingual brains" and "Preparing global citizens and better thinkers through early second language learning". Below this is a "Sign Up Now" button and a link "or Learn More >".

Building bilingual brains
Preparing global citizens and better thinkers through early second language learning

[Sign Up Now](#) or [Learn More >](#)

ABOUT THE PROGRAM
Our training and certification program prepares you to teach young children a second language. The program contains research-based teaching strategies, lesson plans, and classroom tools.

Harness the brain's prime time for language learning

Work at your own pace on a computer or tablet

Developed by UW's Institute for Learning & Brain Sciences

W INSTITUTE FOR LEARNING & BRAIN SCIENCES
UNIVERSITY OF WASHINGTON


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Kuhl & Ferjan Ramirez, 2023

SparkLing Trains and Certifies Bilingual Teachers



Home Dashboard Lesson Plans Help FAQs | Logout


Unit 2 | 2C | Concept 2: Teaching Language through Playful Learning

Progress: ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ✓


How to Teach Responsively

Click on the video below to watch an example of responsive teaching. As you watch, think about the tutor's role during the experience:

- How does the tutor let the children take the lead?
- How does the tutor make the interaction fun, relevant, and responsive?



< Previous Next Step >



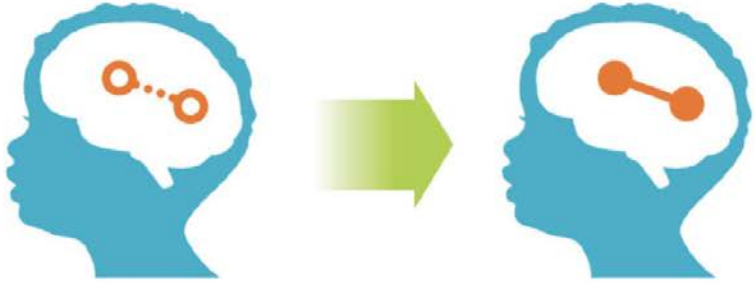
Home Dashboard Lesson Plans Help FAQs | Logout

Unit 2 | 2B | Concept 6: Active Language Learning

Progress: ① ② ③ ④ ✓

Wiring the Brain for Language

To speak a language, our brains must wire together many different areas. Particularly important are the speaking and the listening areas. Young children activate these regions of their brains while they listen to you talk. You can support this process by speaking to them often with rich language, parentese, and encouraging them to "talk" back – whether using words, sounds, their eye gaze, gestures, or other responses.



< Previous Next Step >

Ferjan-Ramirez & Kuhl, *Mind, Brain, and Education*, 2017, 2020


SparkLing Bilingual

- Online training and certification for early educators
- Trains teachers on an evidenced-based 6-point method of teaching
- 32 -week play-based curriculum
- 0-3 and 3-5 year old programs
- Bright Horizons teachers advising!

Progress: 1 2 3 ✓

Examples of Scaffolding - Part 1

Read through and click on the panels below for ideas and examples of strategies that you can use in scaffolding young children's second language learning. You will find three more video examples of scaffolding on the next page.

LET THE CHILD LEAD ✕ Children learn a new language best if you are able to follow their lead in play. In this video, notice how the adult guides the children in play, but lets them make choices within the activity. How does she follow their lead? Notice how interactive she makes the activity.	ASK QUESTIONS + Asking open-ended questions is a great way to have a conversation, even if the child doesn't  hand is when using the puppet.	BREAK TASKS INTO STEPS ✕ Help children sound out a new word by breaking it into steps. Then praise them for completing each step to boost confidence. Next, try to sound out a more difficult word! For example, hippopotamus could be broken down into "hip-po-pot-ah-mus", as in this video.
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Parent Coaching Studies

Language Input in Infancy

Quantity

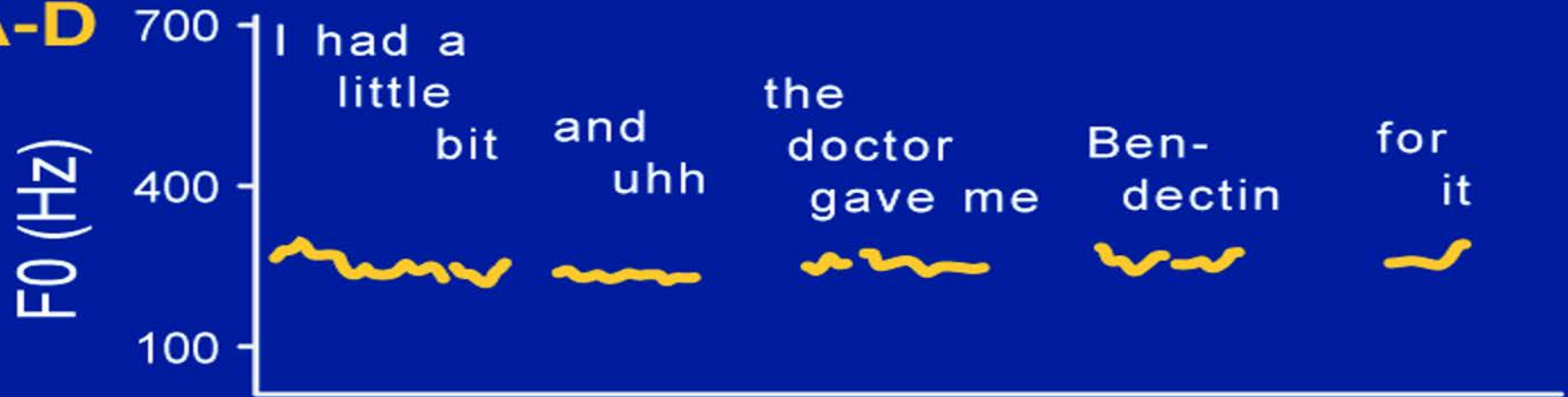
Number of words



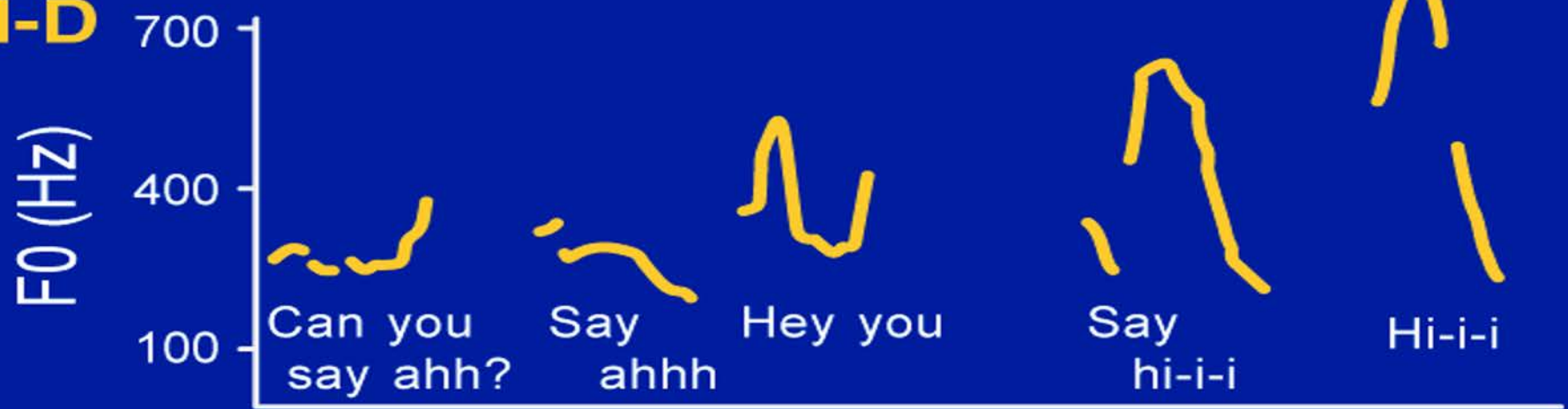
Quality

'Parentese'

A-D



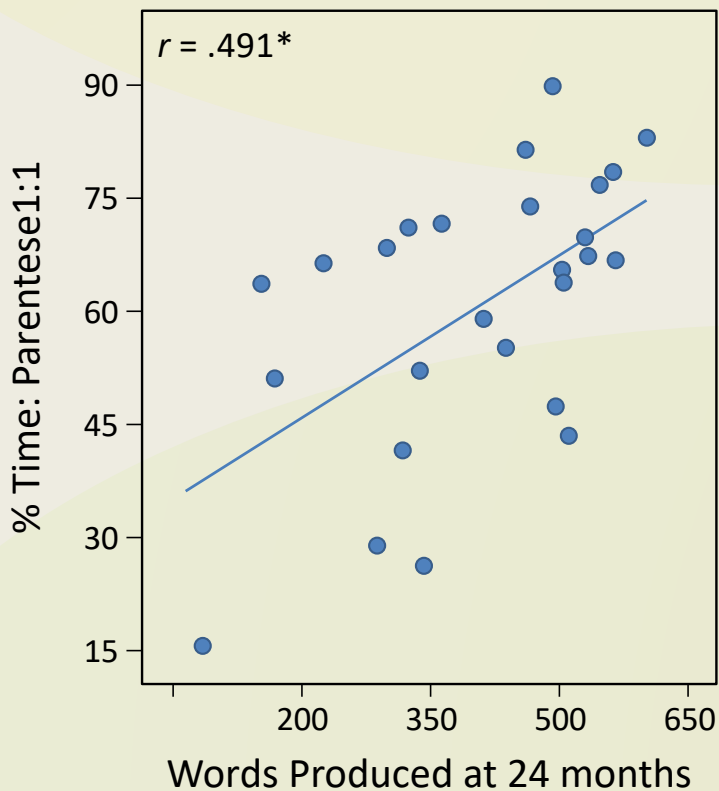
I-D



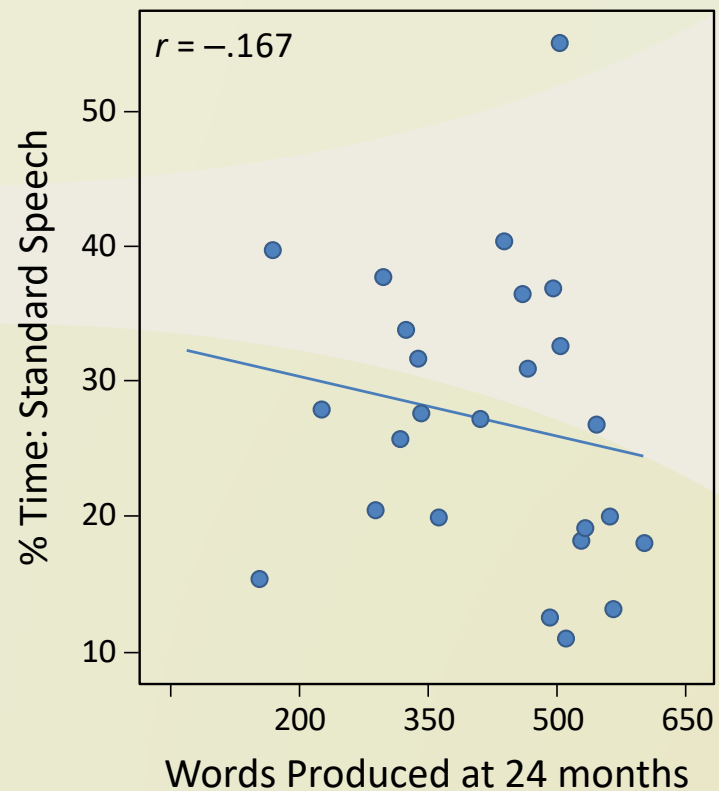
Time →

'Parentese' Associated with Advanced Later Language Skills, regardless of SES

Parentese Speech



Standard Speech



Ramirez-Esparza, Garcia-Sierra, & Kuhl, *Developmental Science*, 2014; *Child Development*, 2017

Parent Coaching Study: Questions

- Can parents be coached to enhance the amount of parentese they use with their child?
- If so, does this have an impact on child language outcomes?



Ferjan Ramírez, Lytle, Fish, & Kuhl, *Dev Sci* 2018;
Ferjan Ramírez, Lytle, & Kuhl, *PNAS* 2020

Randomized Control Study: Parent Coaching at 6, 10, 14, 18 months

- 45-min individual coaching session, following a 4 step format:
 - Feedback on LENA measures (adult word count, conversational turns, parentese & parentese 1:1)
 - Listen to audio samples (parentese vs standard, turn-taking, contingency, child vocs)
 - Discuss upcoming language milestones
 - Discuss book sharing, suggest concrete interactive activities



Suggested Age Range
9 - 18 months

Meal Time Feeding Memories

When loved feeding or giving your child a bottle, use that time to tell them a story of something happy you remember from your childhood. When your child has finished eating and responds to your voice, respond by making the same sound face to them.

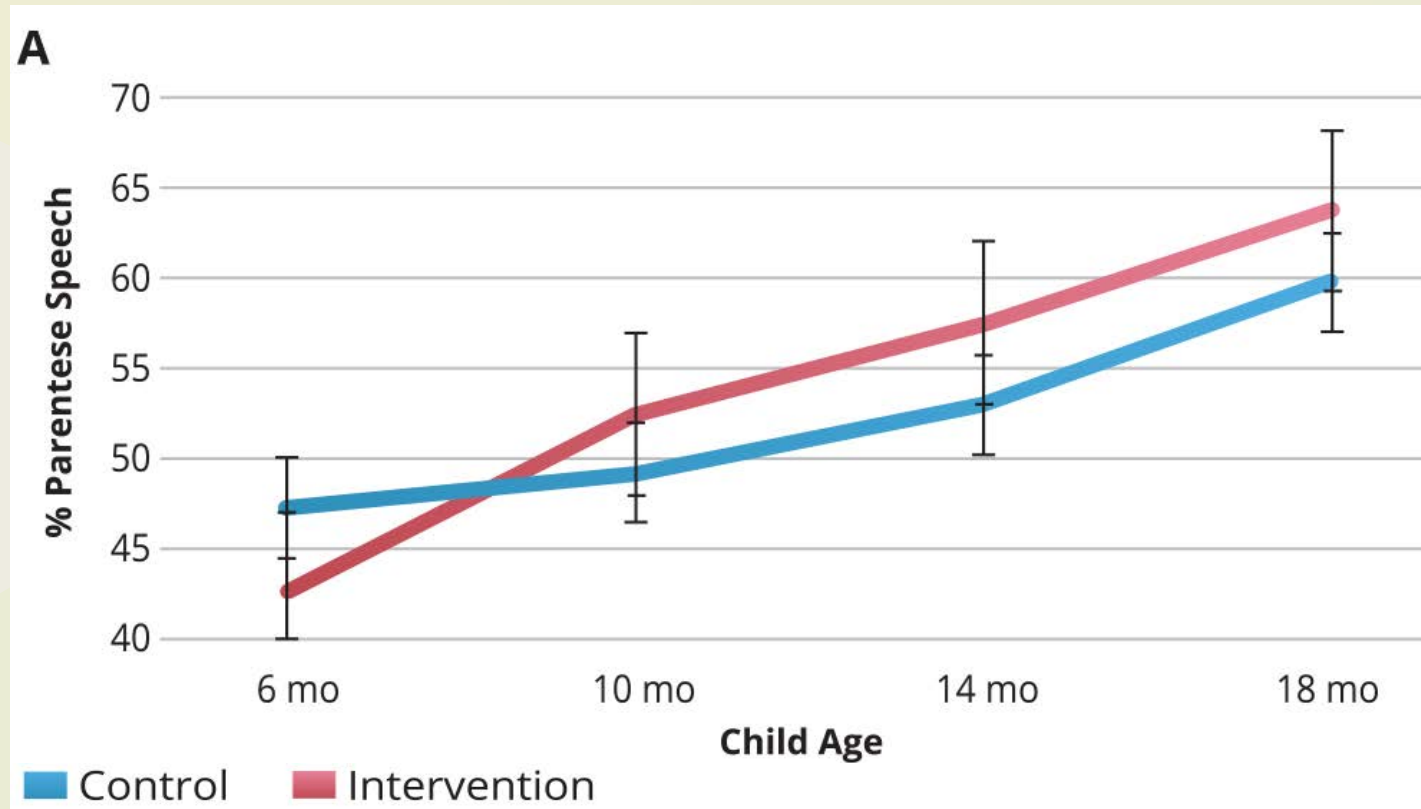


Suggested Age Range
9 - 18 months

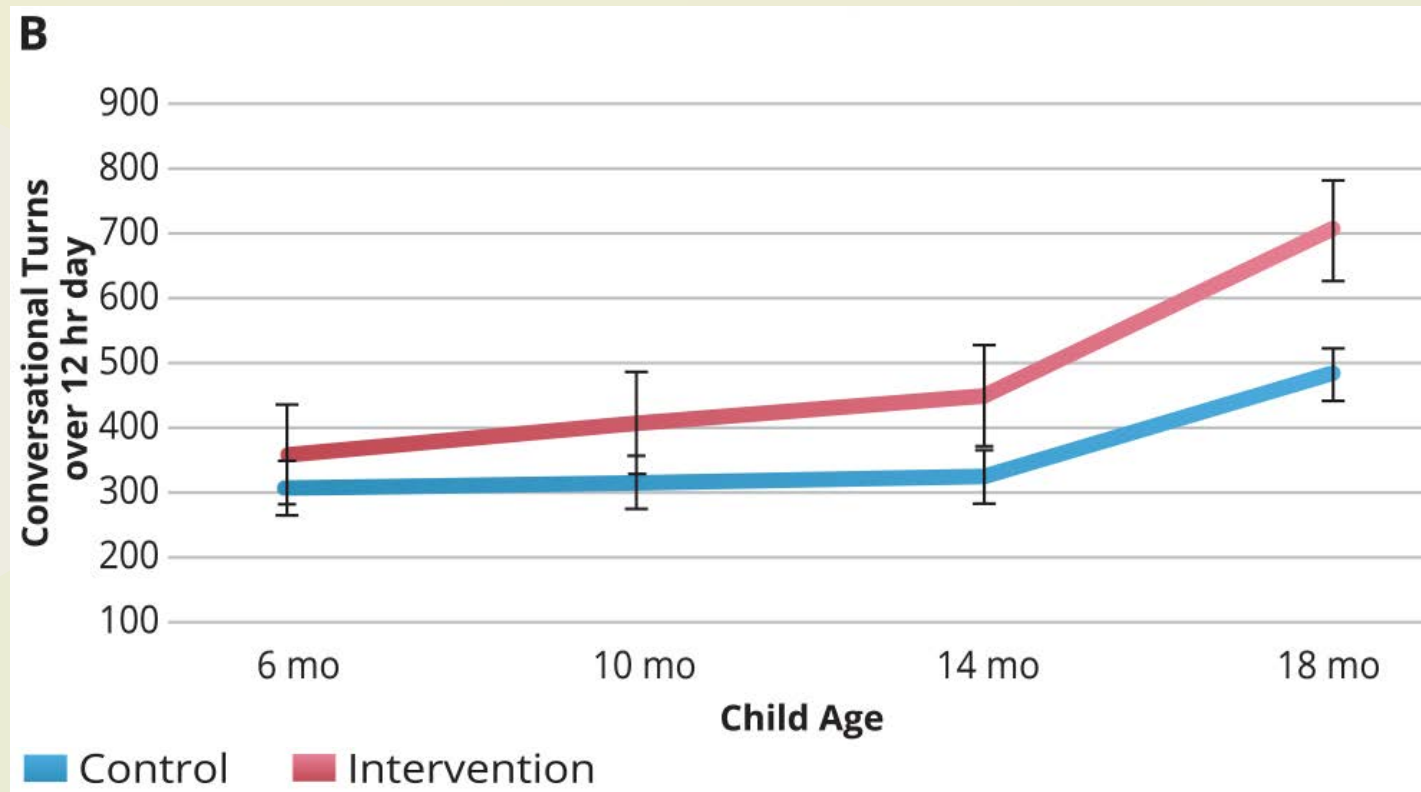
Breing Background Feeding Memories

Your voice is your child's favorite sound. Even though they can't say words yet, they're listening and working what sounds go together in words, which is an important foundation for language later on.

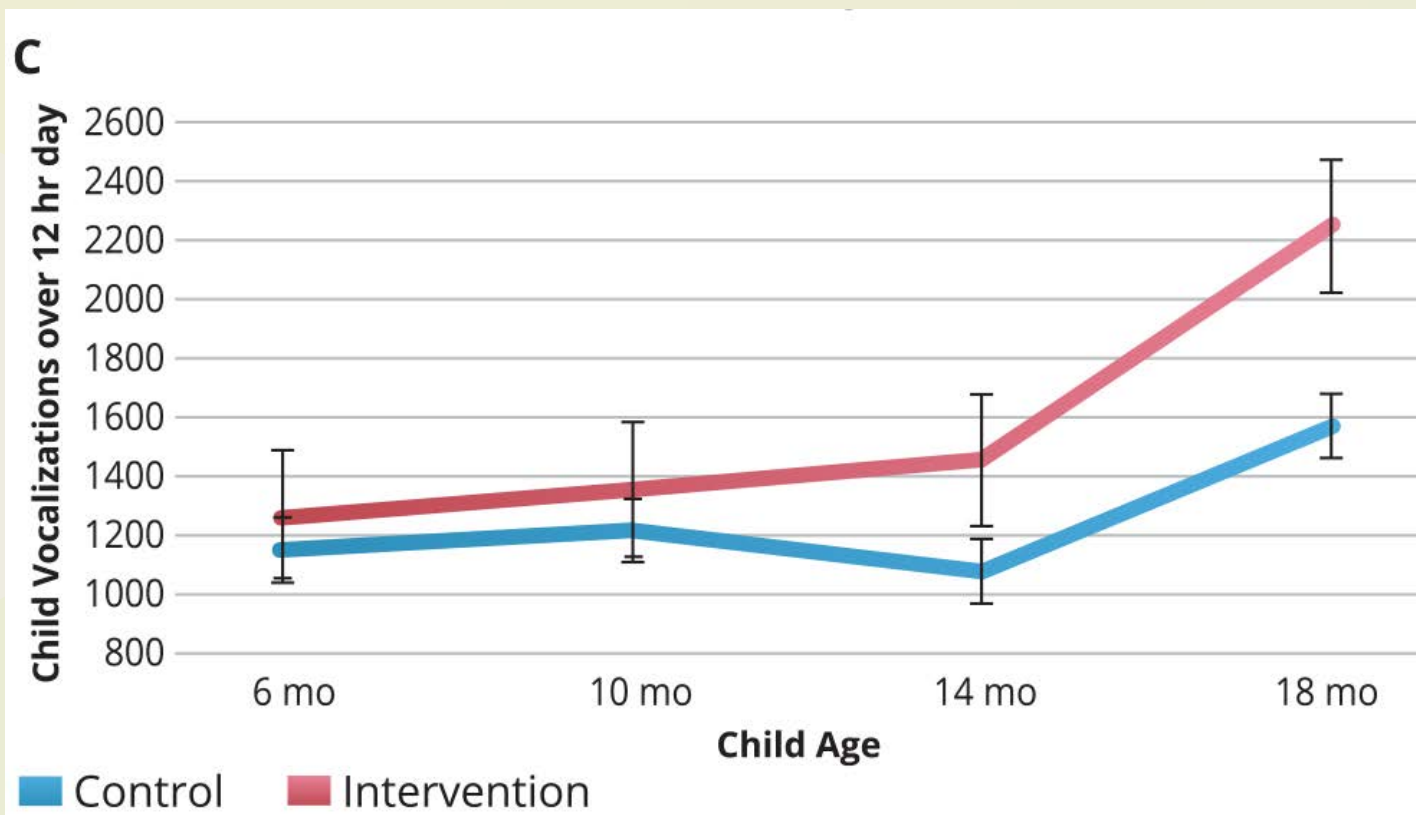
Parentese Speech



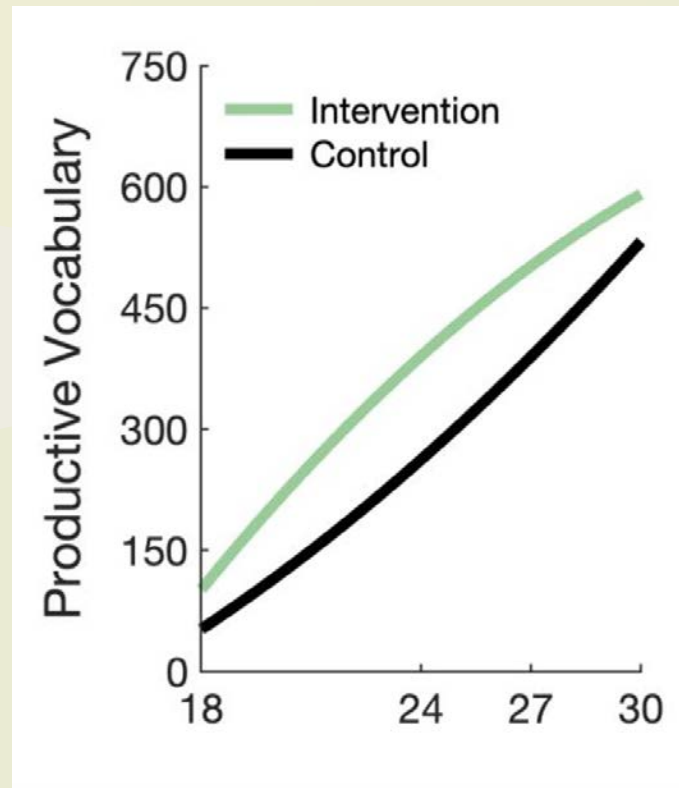
Conversational Turns



Child Vocalizations



Lasting Effects of Parent Coaching: Age 3



Huber, Ferjan Ramirez, Corrigan, & Kuhl, *Developmental Science*, 2023

What About Longer-Term Outcomes: Age 5?



At Kindergarten entry (age 5), children of parents who used more parentese in infancy:

- Produced longer sentences
- Used a more diverse set of lexical items
- Took more conversational turns with their parents

Ferjan Ramírez, Weiss, Sheth, & Kuhl, 2023

What About Fathers?

- Not as “chatty,” but all produce parentese
- Different beliefs & attitudes than mothers
- Beliefs & attitudes predict paternal parentese
- Paternal parentese predicts child language



Shapiro, Hippe, & Ferjan Ramírez, 2021 (*JSLHR*); Ferjan Ramírez et al., 2022 (*Infancy*)
Ferjan Ramírez, 2022 (*Language & Linguistics Compass*)



Does Brain Science Explain These Effects?

Magnetoencephalography (MEG)

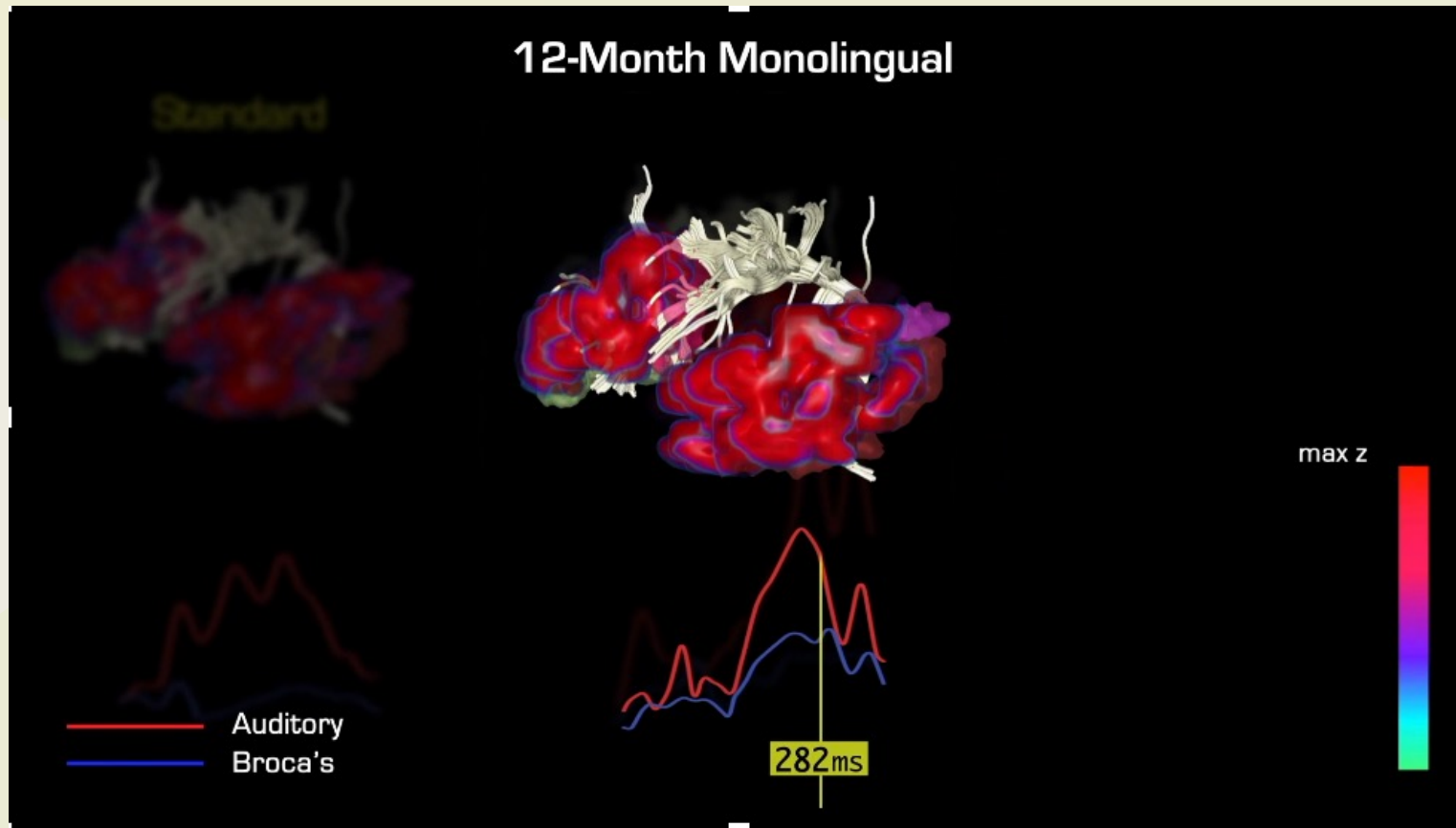


Baby MEG



Imada, et al., *NeuroReport*, 2006; Kuhl, et al., *PNAS*, 2014

Speech Activates Auditory and Motor Brain Areas



Kuhl et al., *Proceedings of the National Academy of Sciences*, 2014

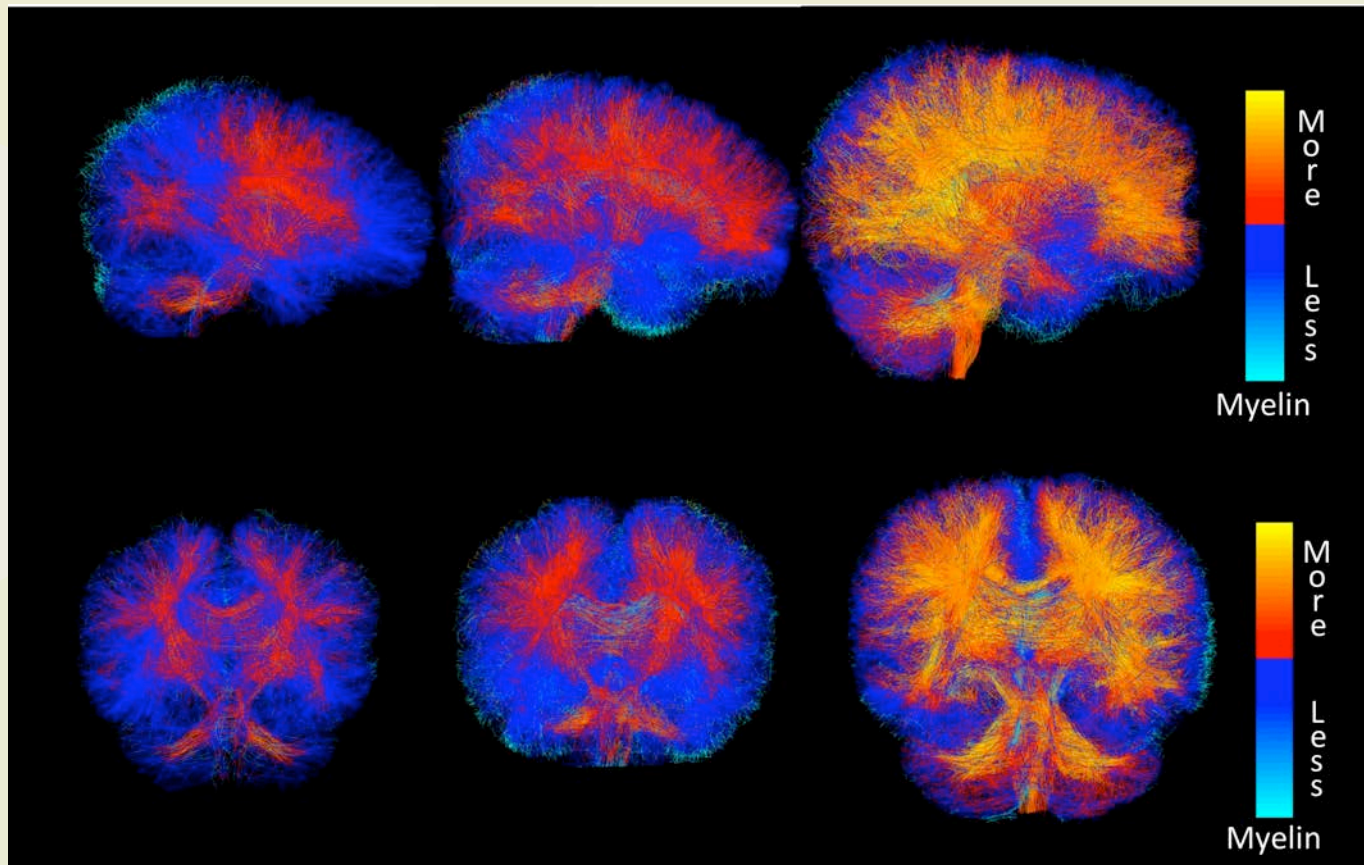
What Does Structural Imaging Add?

Growth of Baby Brain Connections

7 month old

11 month old

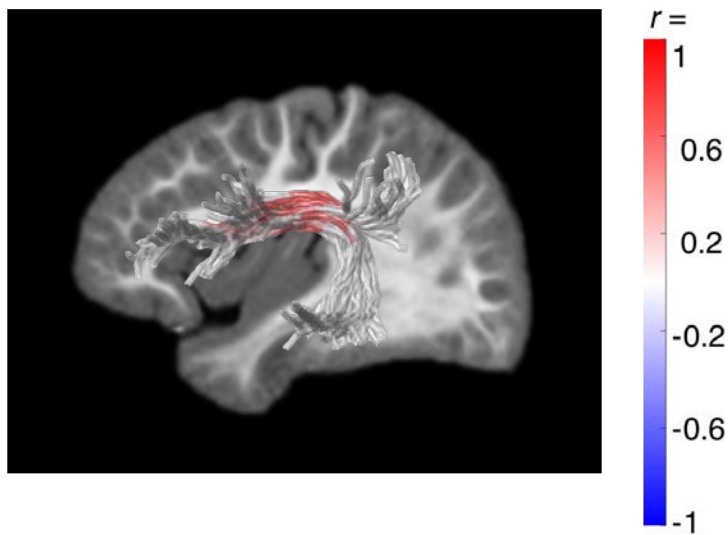
26 month old



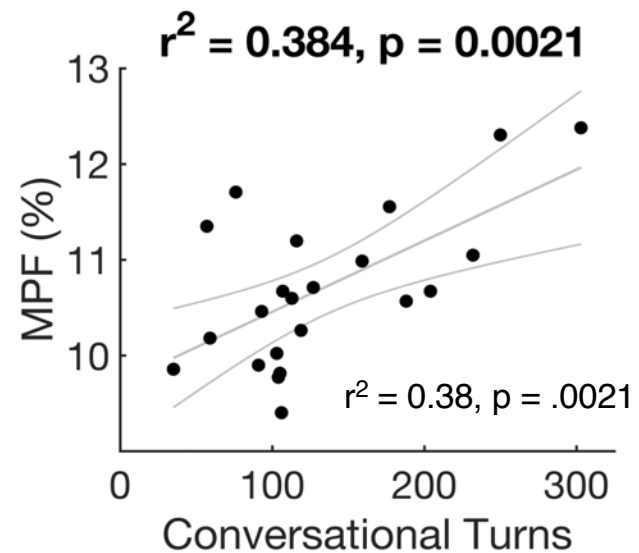
Kuhl, Institute for Learning & Brain Sciences, University of Washington

Early Language Input Linked to Initial Growth of the Arcuate

Conversational turns at 6 months predict myelin density in the arcuate

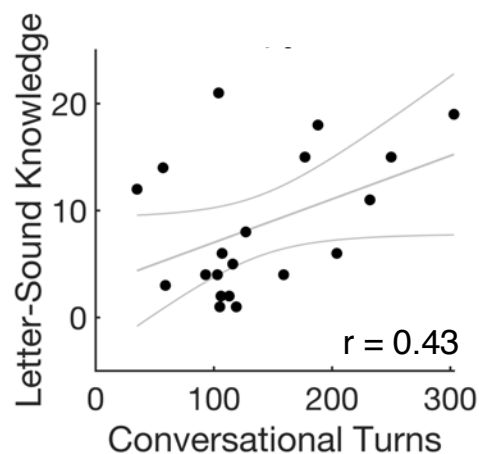


Myelin density in the arcuate fasciculus and CTs

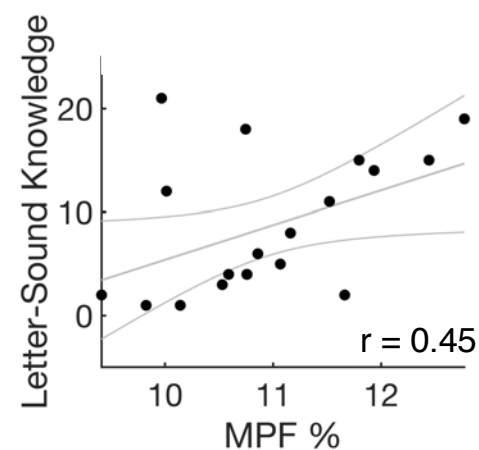


Do Language Input and Brain Structure Predict Reading Readiness at Age 5?

Parent-infant **conversational turns** predict 5-year letter-sound knowledge

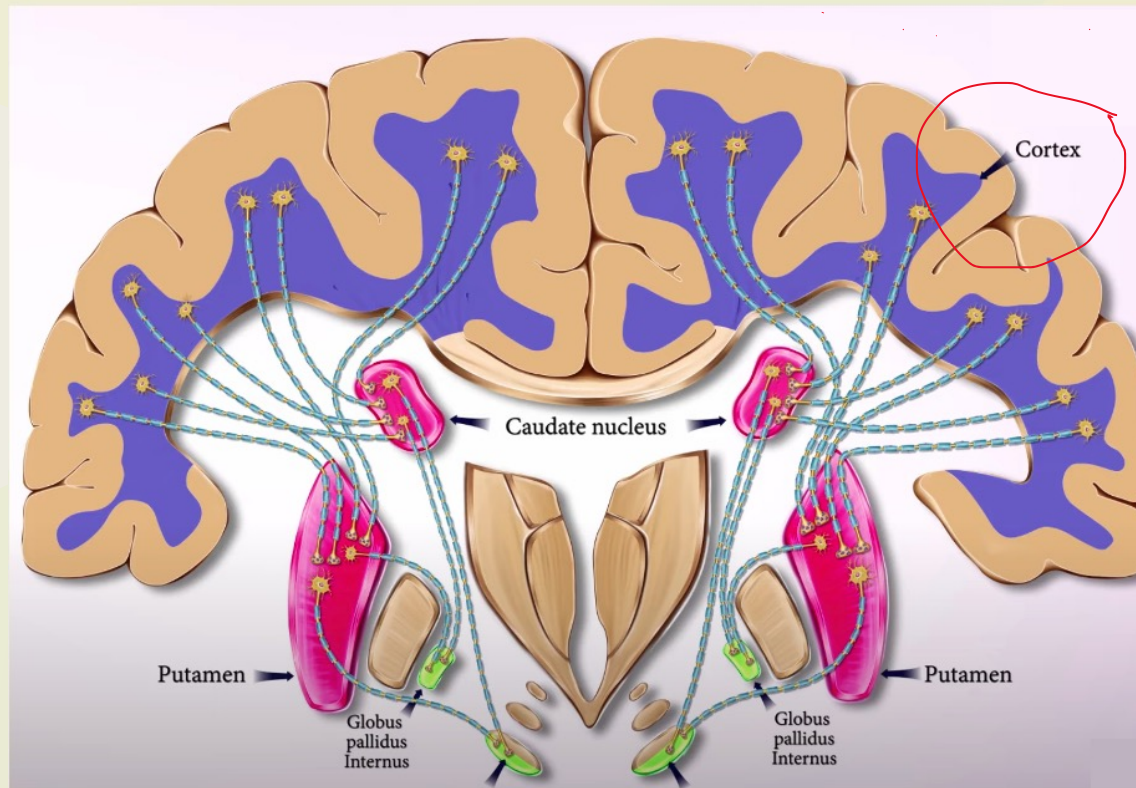


Arcuate myelination at 2 years predicts 5-year letter-sound knowledge



How did the Pandemic Affect Brains?

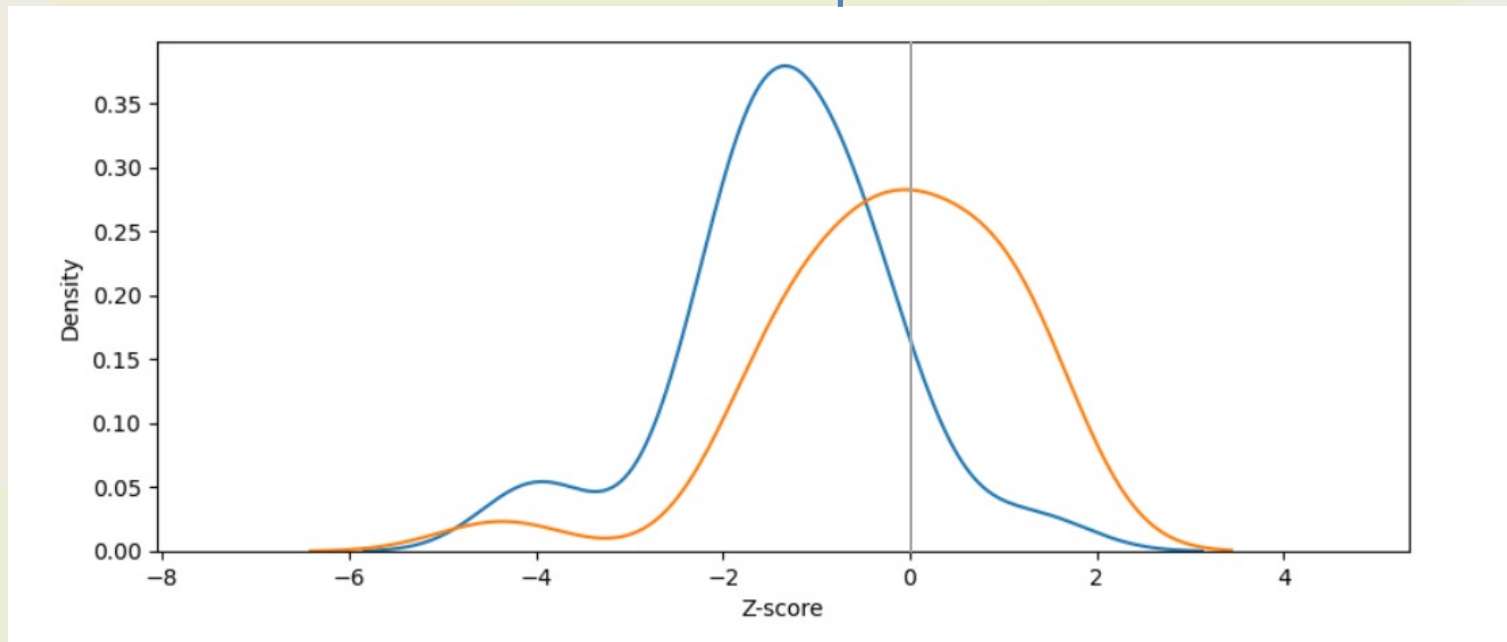
Teen Brains Before and After the Pandemic: Cortical Thickness Measures



The human cortex gets thinner as we age, even in the teenage years.

Teen Brains Aged Faster (Cortical Thickness was Reduced) During the Pandemic

The effect is much more profound in females!



Blue = Females

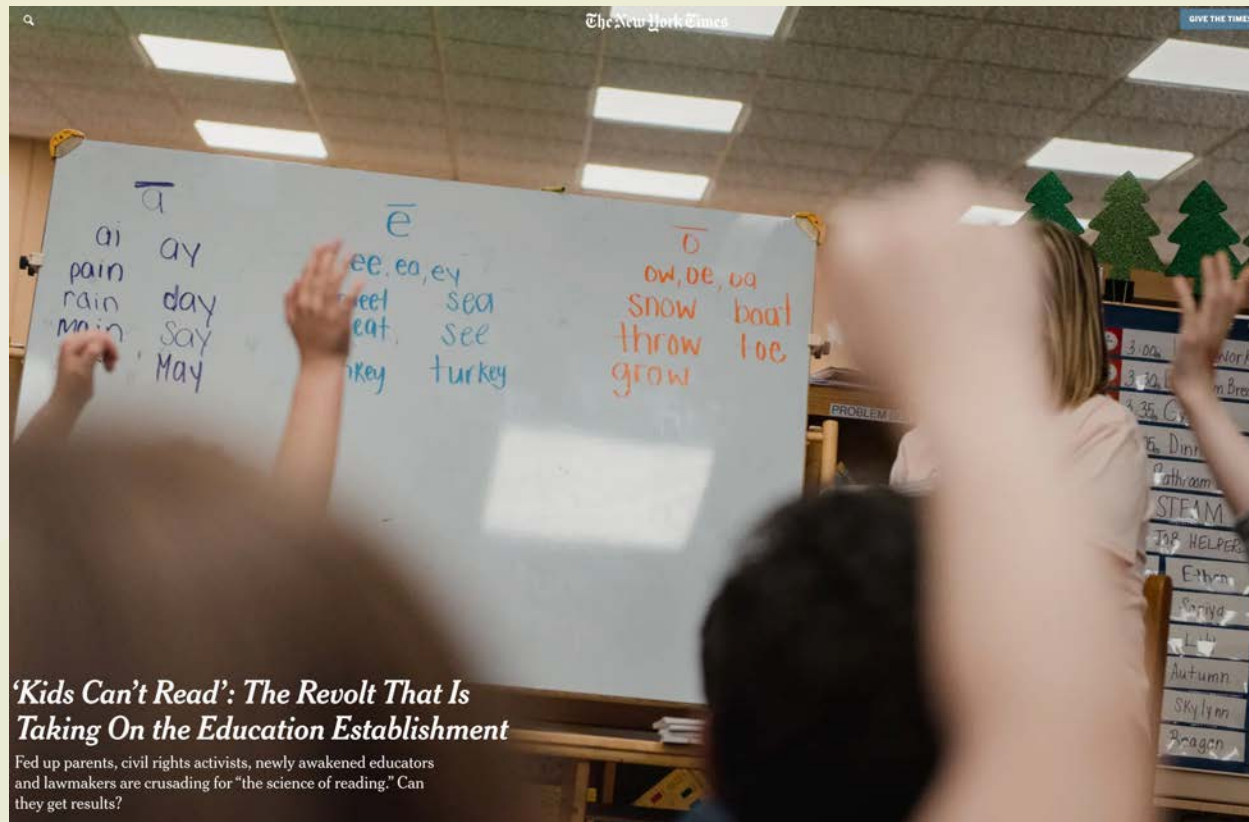
Red = Males

Kuhl et al., Work in progress, 2023



A Pandemic Intervention for 5-Year-Olds: Online Reading Camp

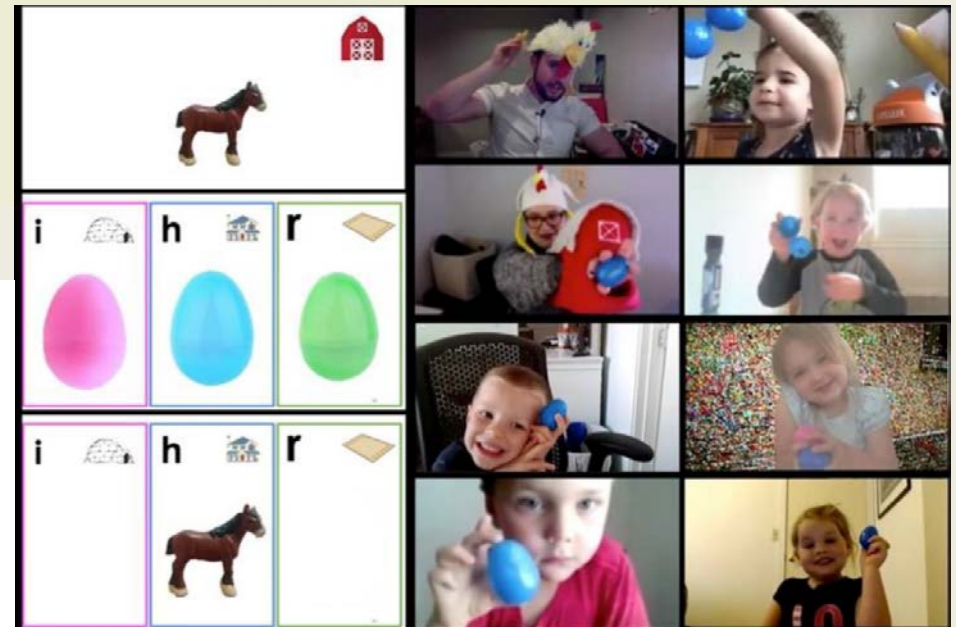
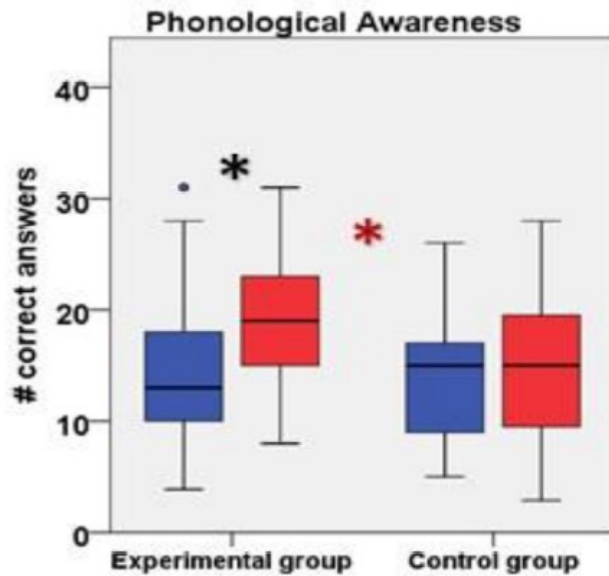
The Reading Crisis in America



New York Times, April 16, 2023

New Approaches: Can 5-Year-Olds Learn to Read Online?

Two weeks, 3-hr/day fun-filled learning activity works!



Yael Weiss Zruya et al., *Frontiers in Human Neuroscience*, 2022

Social Foundations of Learning



The 'Social Ensemble': Effects on the Brain

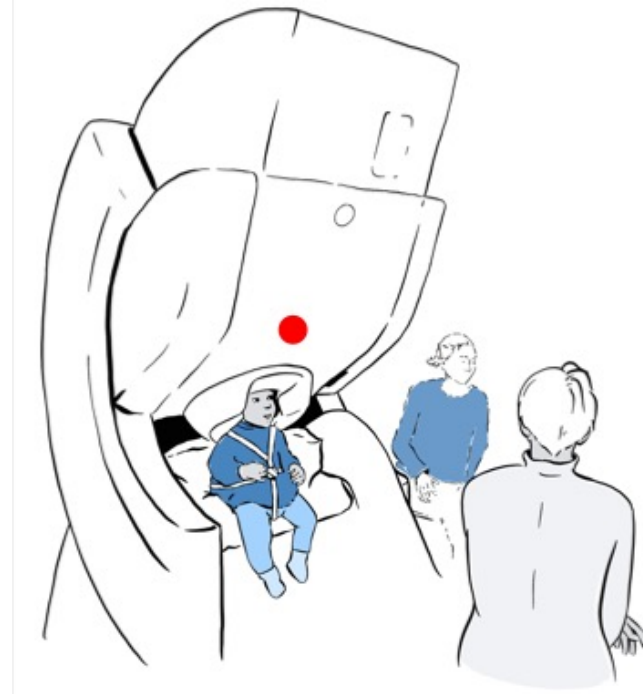
A)

SOCIAL

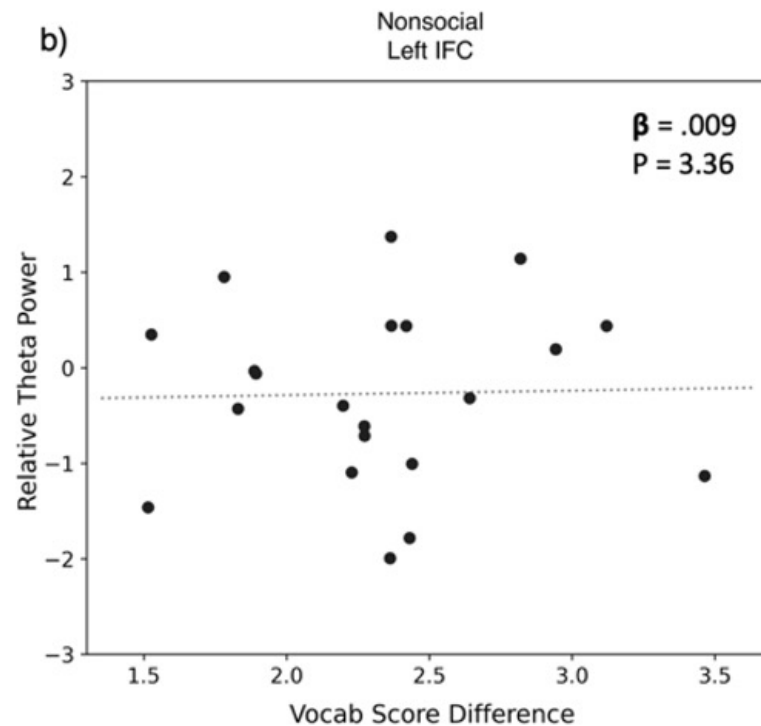
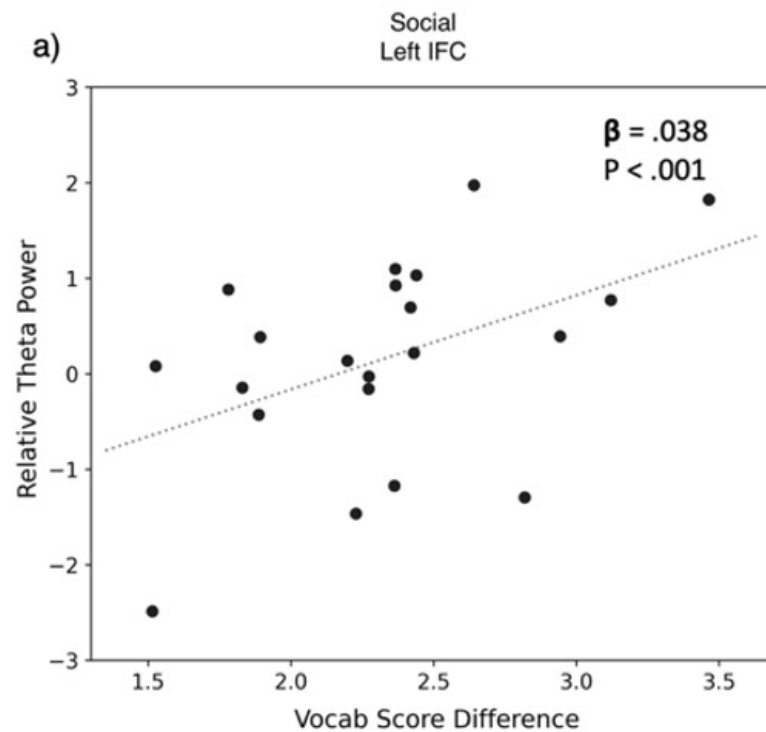


B)

NONSOCIAL



Social Interaction Activates Motor and Attention Areas—Predict Future Language



Bosseler, et al., Submitted for publication

Two Person Neuroscience in a Dual-MEG Setup

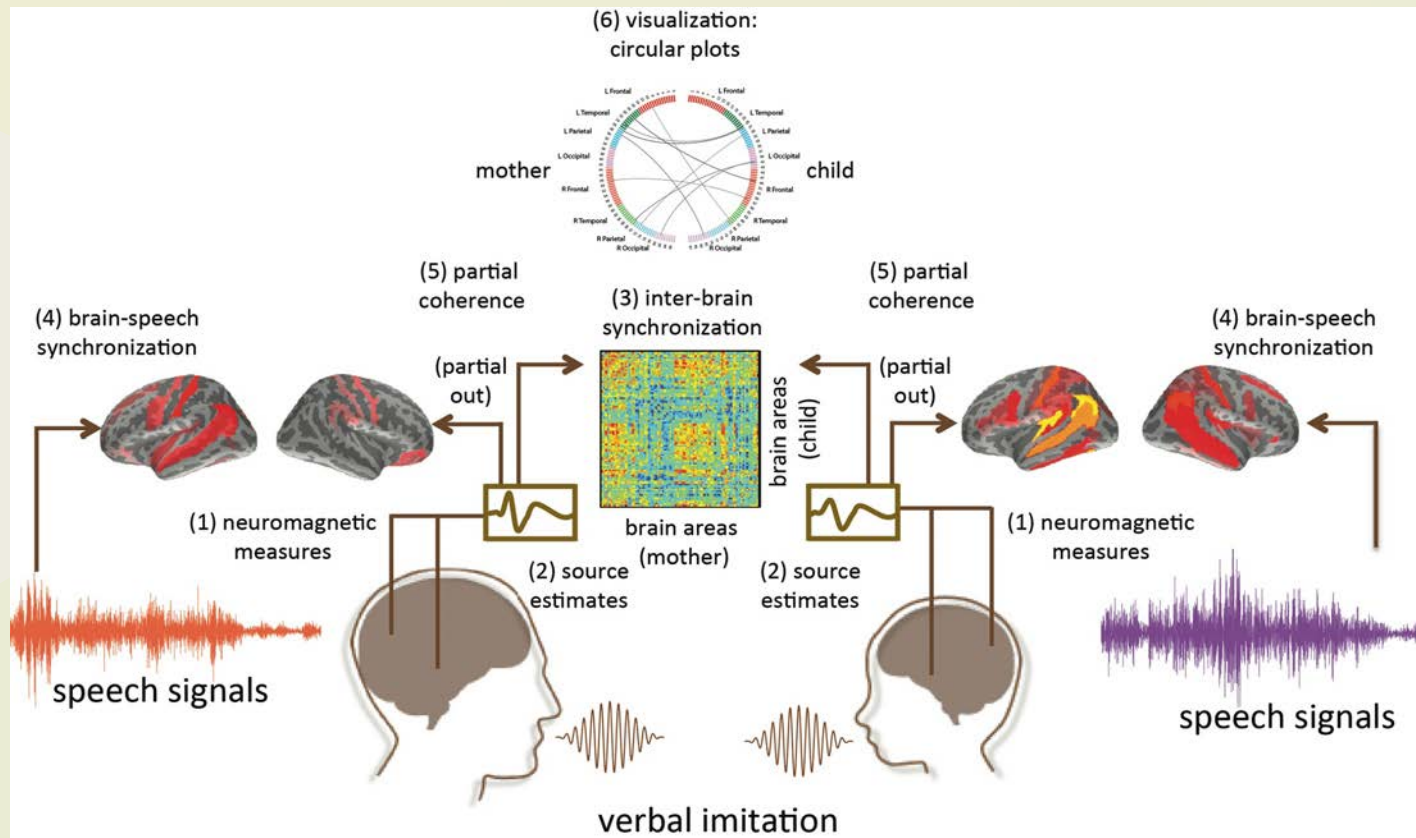
NEURAL SYNCHRONY!

- Two brains, both monitored
- Identical brain areas in the 2 brains
- Neurons firing at the same exact rate!

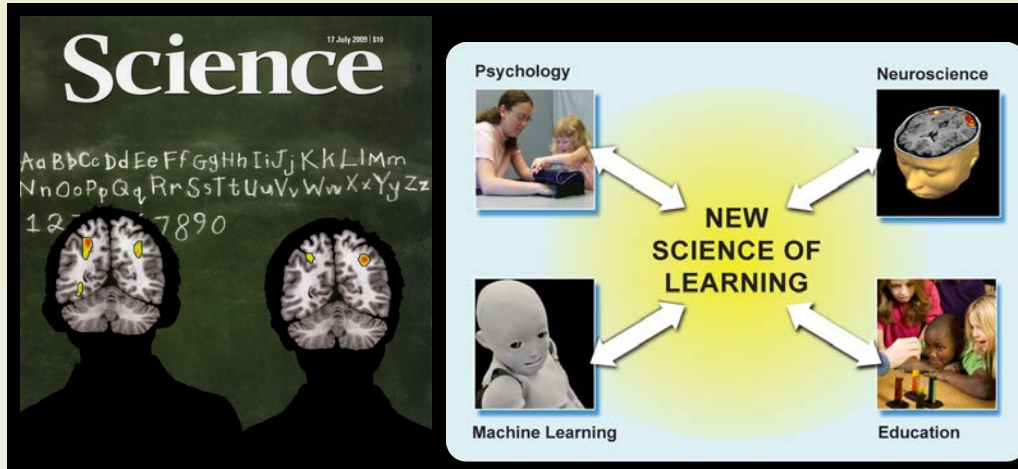


Lin et al., *Cerebral Cortex*, 2022

Dual-MEG Verbal Interaction Between Mother and Her 5-Year-old: “Neural Synchrony”



The Science of Learning



The image features the cover of the July 17, 2003 issue of *Science* magazine, which displays two human brain silhouettes with highlighted regions. To the right is a diagram with a central yellow circle labeled "NEW SCIENCE OF LEARNING". Four white arrows point towards this center from four surrounding boxes: "Psychology" (top-left, showing a woman and child), "Neuroscience" (top-right, showing a brain scan), "Machine Learning" (bottom-left, showing a robot head), and "Education" (bottom-right, showing children at a table).

Foundations for a New Science of Learning

Andrew N. Meltzoff,^{1,2,3*} Patricia K. Kuhl,^{1,3,4} Javier Movellan,^{5,6} Terrence J. Sejnowski^{5,6,7,8}

Human learning is distinguished by the range and complexity of skills that can be learned and the degree of abstraction that can be achieved compared with those of other species. *Homo sapiens* is also the only species that has developed formal ways to enhance learning: teachers, schools, and curricula. Human infants have an intense interest in people and their behavior and possess powerful implicit learning mechanisms that are affected by social interaction. Neuroscientists are beginning to understand the brain mechanisms underlying learning and how shared brain systems for perception and action support social learning. Machine learning algorithms are being developed that allow robots and computers to learn autonomously. New insights from many different fields are converging to create a new science of learning that may transform educational practices.

Meltzoff, Kuhl, Movellan, & Sejnowski, *Science* (2009)

CONCLUSIONS

Powerful social learning turns “citizens of the world” into “culture-bound” listeners, and predicts future language skills to the age of 6 years!

Bilingual Language learning can be ignited in all children via SparkLing Bilingual

Language is malleable and Parentese increases children’s skills

Infants are born learning, but require “opportunities” to learn – their brain processing of language is experience dependent

MEG and MRI brain measures reveal mechanisms of social learning, and implicate sensorimotor brain machinery that underpins ‘social understanding’

Implications for education – early learning matters, the social brain matters

Kuhl Laboratory Supporters:

- Bernard van Lear Foundation
- Bezos Family Foundation
- Gates Foundation
- Kaiser Foundation
- Nadella Foundation
- National Institutes of Health
- NSF Science of Learning Center Grant
- Overdeck Foundation
- Paros Foundation
- Simms-Mann Foundation
- WA State Life Sciences Fund

Thank You!

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