Brain Science: How Early Experiences Shape the Brain

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Language interventions for parents and schools
Brain Growth: Birth to Adulthood

- Birth: 25%
- 1 year: 70%
- 3 years: 85%
- 5 years: 92%
- 7 years: 95%
- 10 years: 98%
- Adult: 100%
Building Connections in the Brain: 1 Million/sec!

Synapses proliferate, and then are “pruned”!
New Measures: Growth of Connections in the Baby Brain

I-LABS, work in progress
The ‘Critical Period’ for Language

- Native
- 3-7
- 8-10
- 11-15
- 17-39

The graph shows the language score for different age groups of acquisition of a new language. The x-axis represents the age of acquisition (Native, 3-7, 8-10, 11-15, 17-39), and the y-axis represents the language score, with High and Low levels. The graph indicates a decrease in language score as the age of acquisition increases.
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

Rivera-Gaxiola, Silva-Pereyra, & Kuhl, Developmental Science, 2005
Powerful Learning Mechanisms

Statistical Learning + Social Learning
Infants Take Statistics


<table>
<thead>
<tr>
<th>Number of Sounds</th>
<th>Sound Type</th>
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<tbody>
<tr>
<td></td>
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</table>
Infants Take Statistics

Kuhl et al., Science, 1992; TED.com, 2011
New Question:
Can infants ‘take statistics’ on a new language during the sensitive period?
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 Machine?

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

![Graph showing language learning in infants exposed to English or Mandarin through TV or audio](image)
Magnetoencephalography (MEG)
Baby Brain ‘Rehearses” a Response to Speech

Kuhl et al., *Proceedings of the National Academy of Sciences*, 2014
Brain measures of the reward system in response to social (faces) vs. nonsocial (arrows) stimuli

The Bilingual Brain
MEG Results on Monolingual and Bilingual 11-month-old Infants

Ferjan-Ramirez, Ramirez, Taulu, Clark & Kuhl, *Developmental Science*, 2017
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 (2017)
Tests of Executive Function: 11-Month-Old Bilingual Child

Conboy, Sommerville & Kuhl, 2017
Classroom Activities

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

Naja Ferjan-Ramirez & Kuhl, *Mind, Brain, and Education*, 2017
I-LABS bilingual learning in school: 18 weeks, 1hr/day

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
Bilingual Graduates

Ferjan-Ramirez & Kuhl, 2017, *Mind, Brain & Education*
Cognitive Influences: Music Exposure
Does Music Intervention Affect the Brain?

- The “waltz”
- Social environment
- 12 sessions over one month’s time
- Brain tests after exposure
- Track language development until 30 months of age

Zhao & Kuhl, *Proceedings of the National Academy of Sciences*, 2016
MEG Tests of Rhythmic Processing for Music and Speech

Zhao & Kuhl, *Proceedings of the National Academy of Sciences*, 2016
‘Parentese’
Fernald & Kuhl, 1997

A-D

F0 (Hz)

I had a little bit and uhh the doctor gave me Ben-dectin for it

I-D

F0 (Hz)

Can you say ahh? Say ahhh Hey you Say hi-i-i Hi-i-i

Time
‘Parentese’ Exaggerates Acoustic Differences Between Phonetic Units

Kuhl et al., Science, 1997
‘Parentese’ One-to-One Associated with Advanced Later Language Skills, regardless of SES

Parentese Speech

Standard Speech

$r = .491^*$

$r = -.167$

Ramirez-Esparza, Garcia-Sierra, & Kuhl, Developmental Science, 2014; Child Development, 2017
Parent ‘Coaching’ at 6 and 10 Months Enhances Infant Language at 14, 18, and 24 Months

Ferjan-Ramirez, Lytle, Fish & Kuhl, *Developmental Science*, 2018
Thank You!

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