

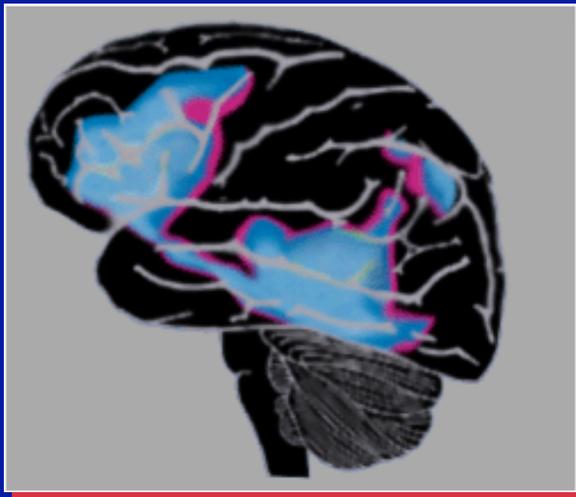
The Scientist in the Crib: Language and the Infant Brain

Dr. Patricia Kuhl, Co-Director,
Institute for Learning and Brain Sciences
University of Washington



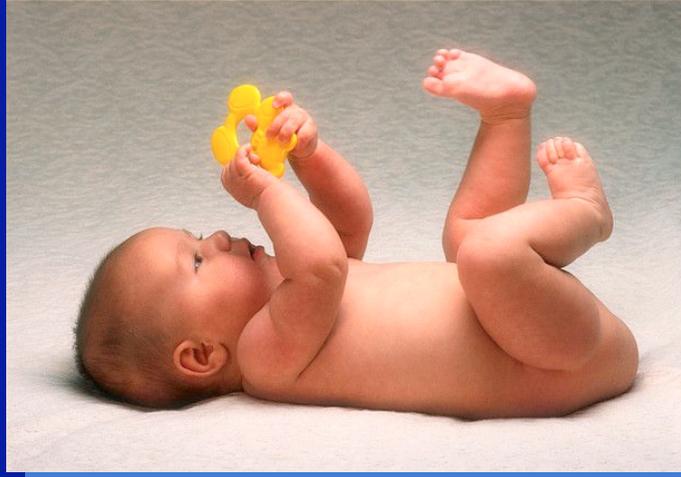
Business

Academic

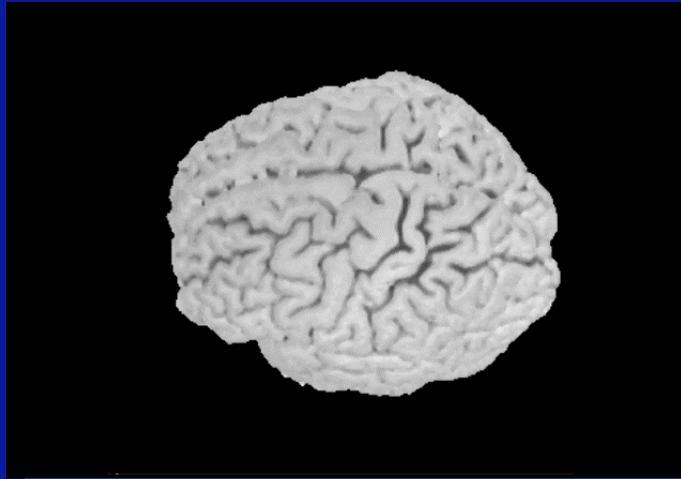


Society

Early Learning



Reading



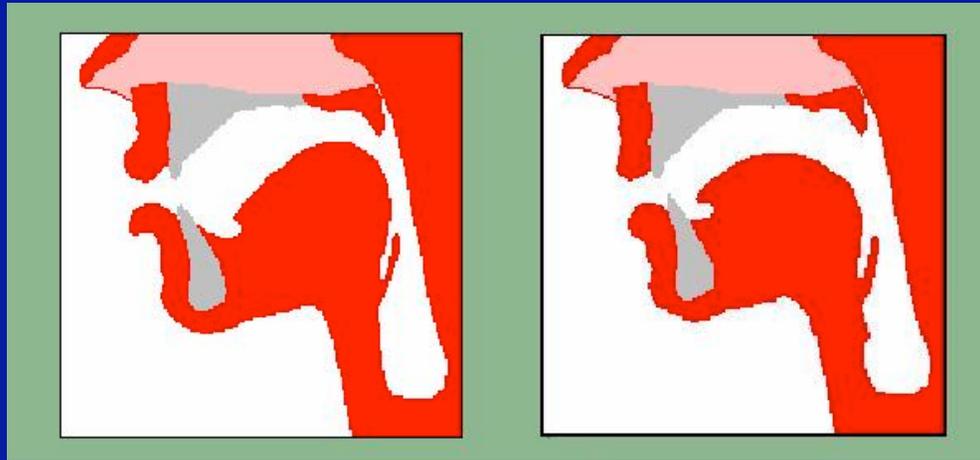
Institute for Learning & Brain Sciences
University of Washington

The Brain

Partnerships

Vocal Tract Configuration

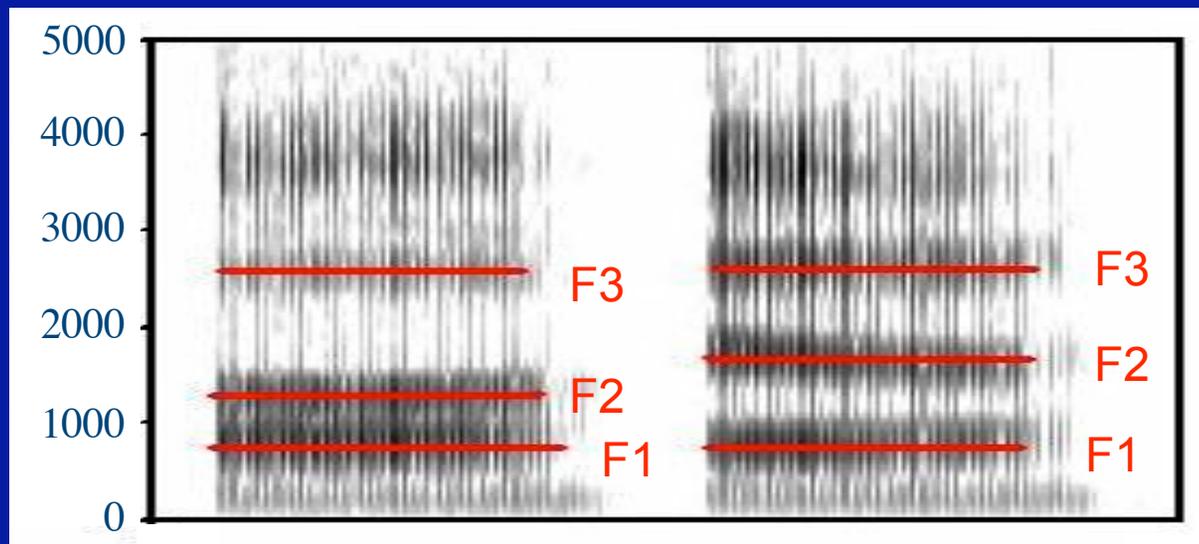
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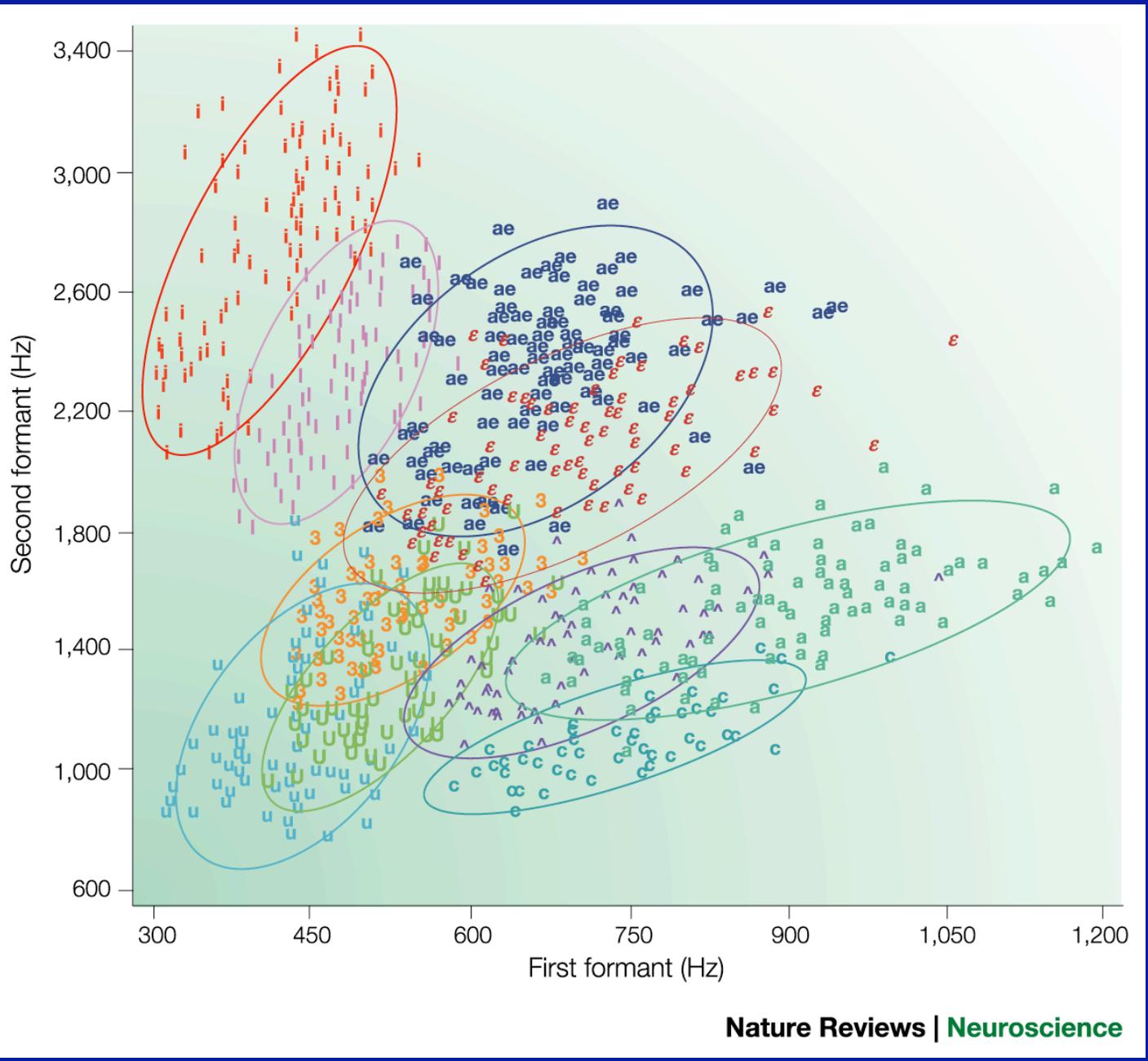
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Formant Frequency Configuration

Frequency (in Hz)



Time (in sec) →



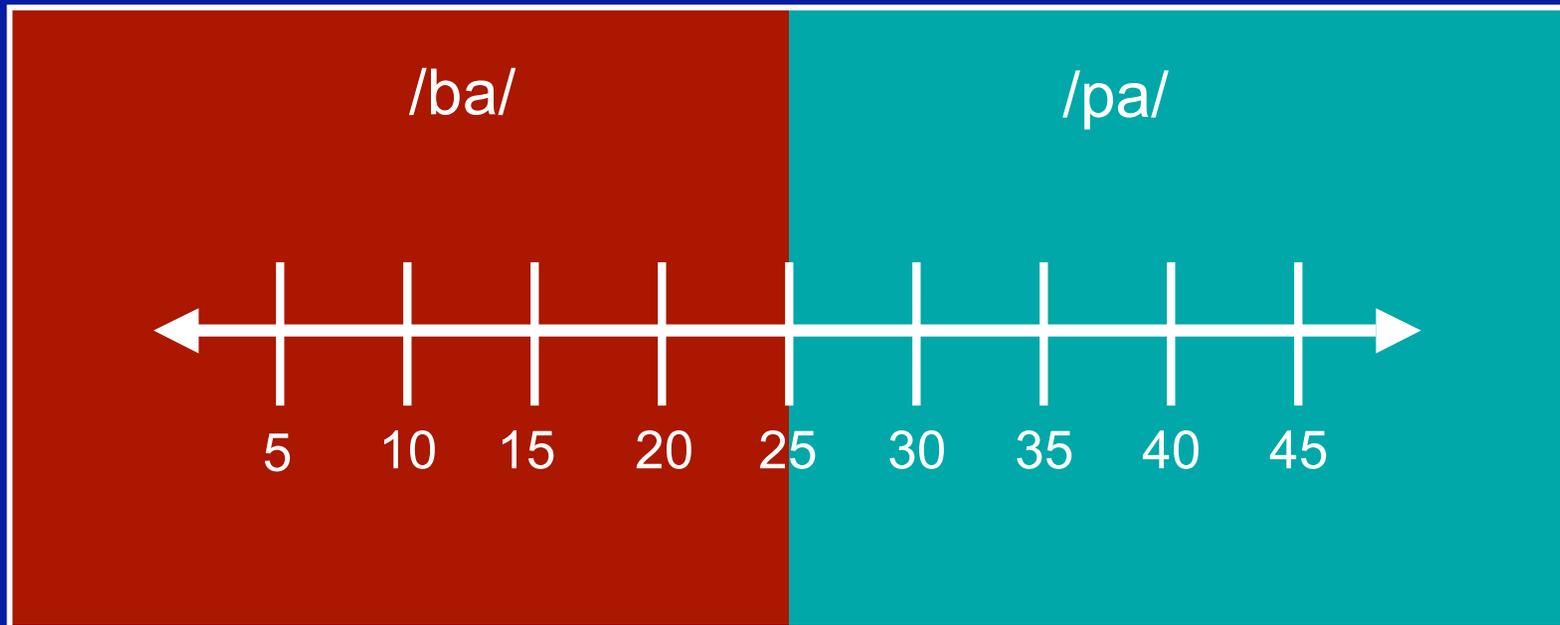
Kuhl, *Nature Reviews Neuroscience*, 2004

Kuhl • International Dyslexia Association • 2007





Phonetic Boundary

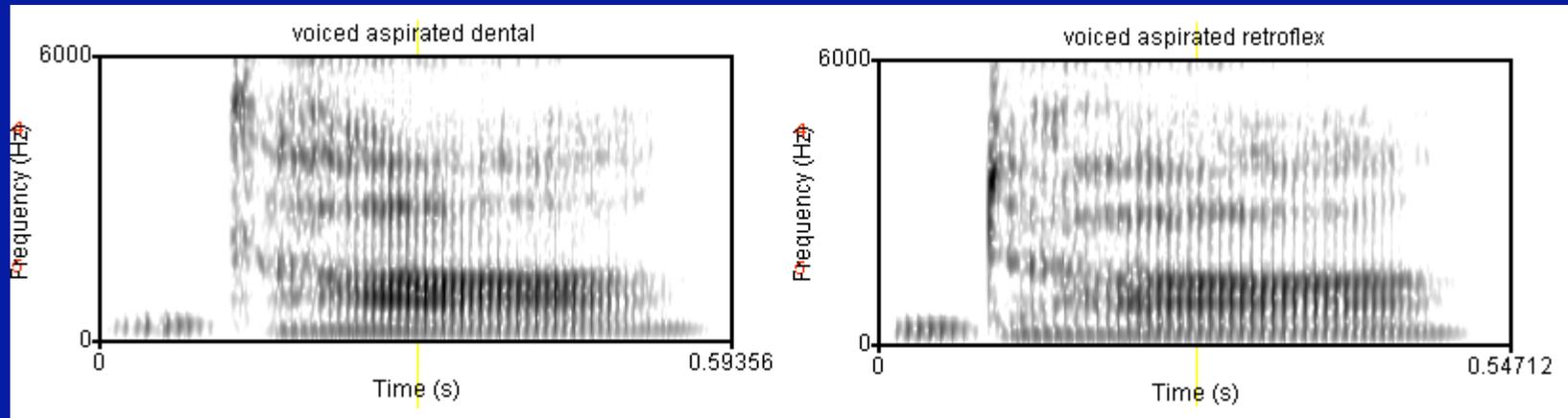


Critical cue — Voice onset time

Infant data -- Eimas et al, *Science*, 1971

Animal data -- Kuhl & Miller, *Science*, 1975

Hindi place contrast: dental vs. retroflex stop



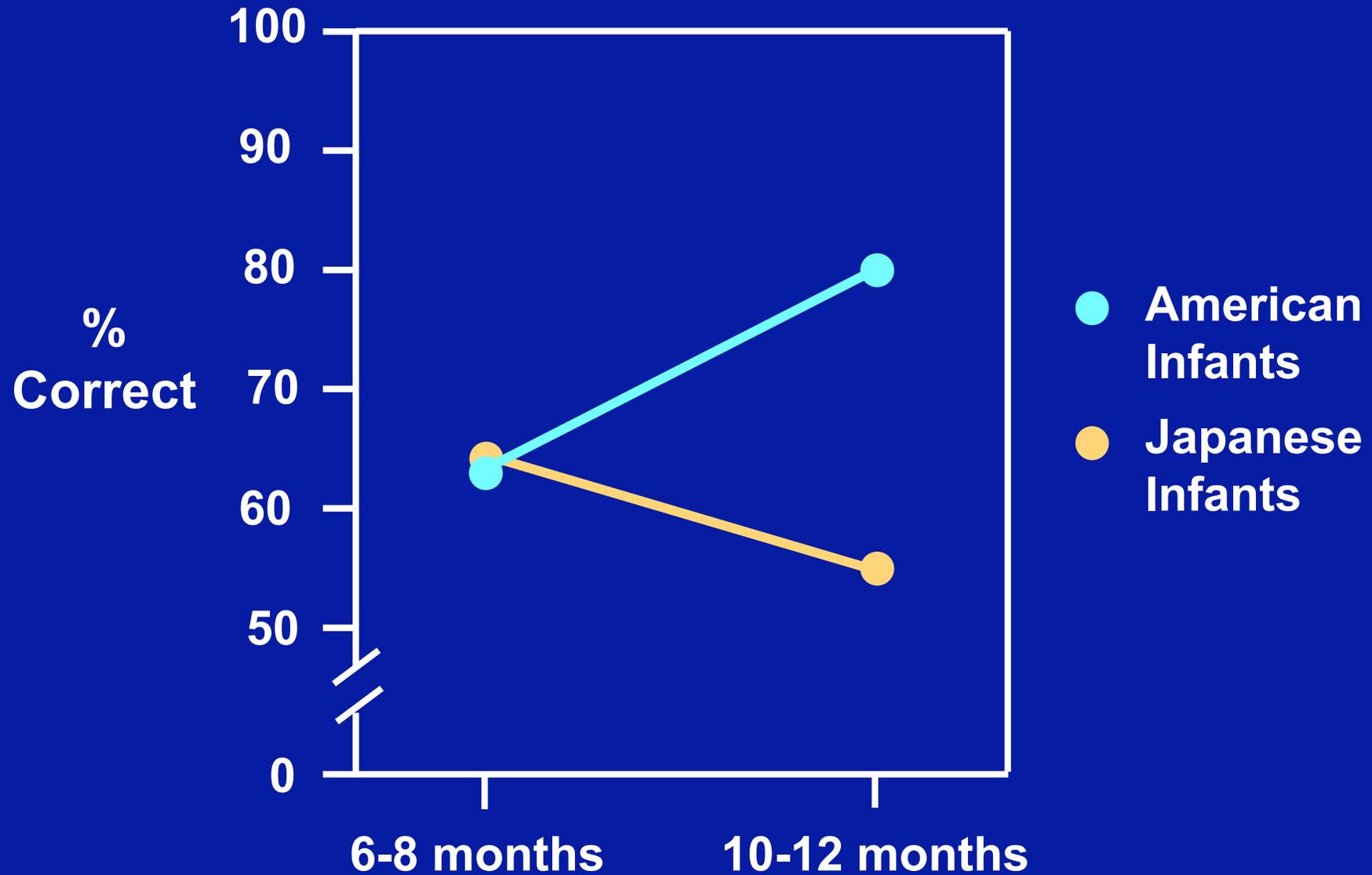
- high frequency energy in burst
- transitions falling into the vowel
- similar to English alveolar stop /d/

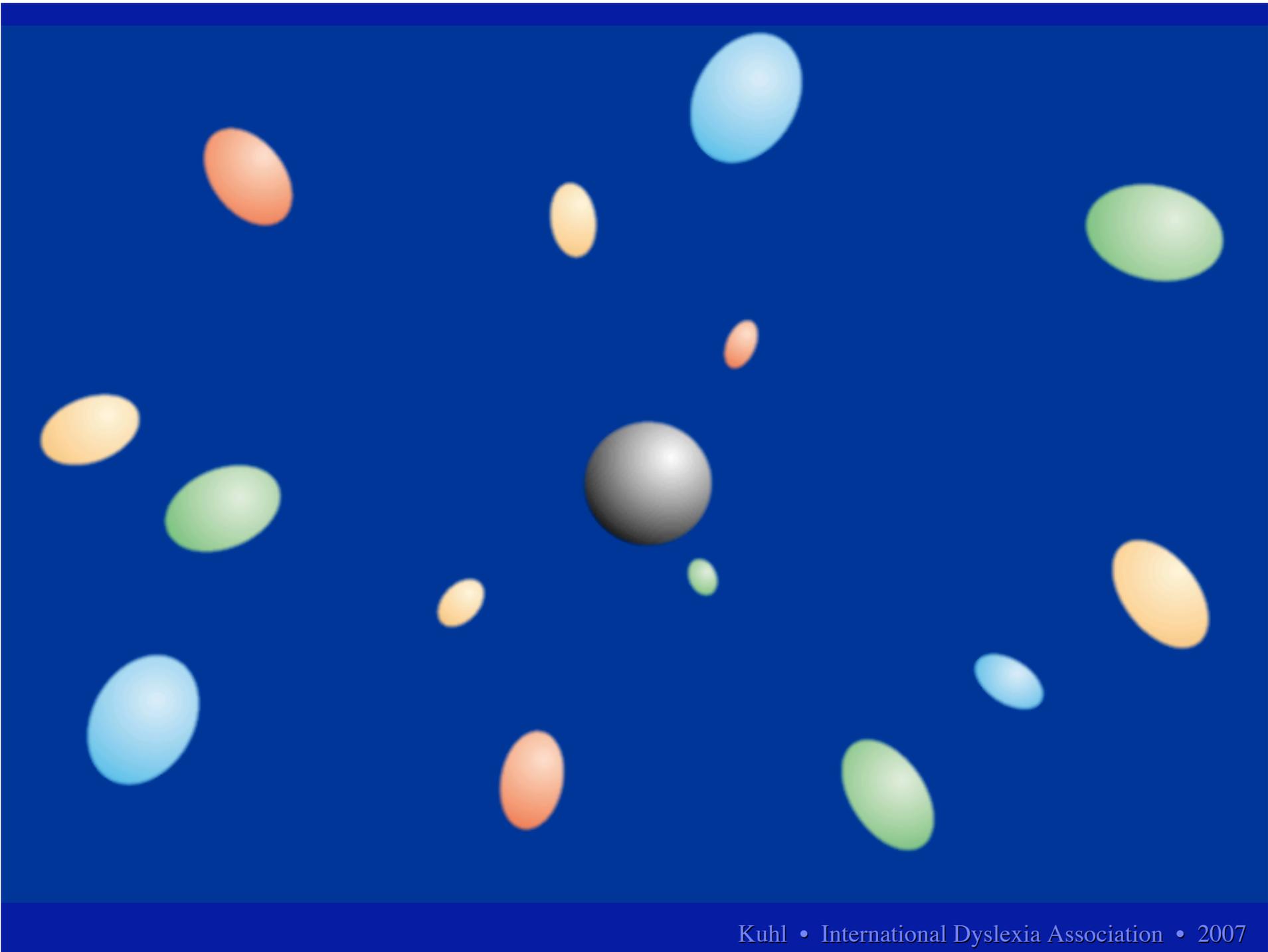


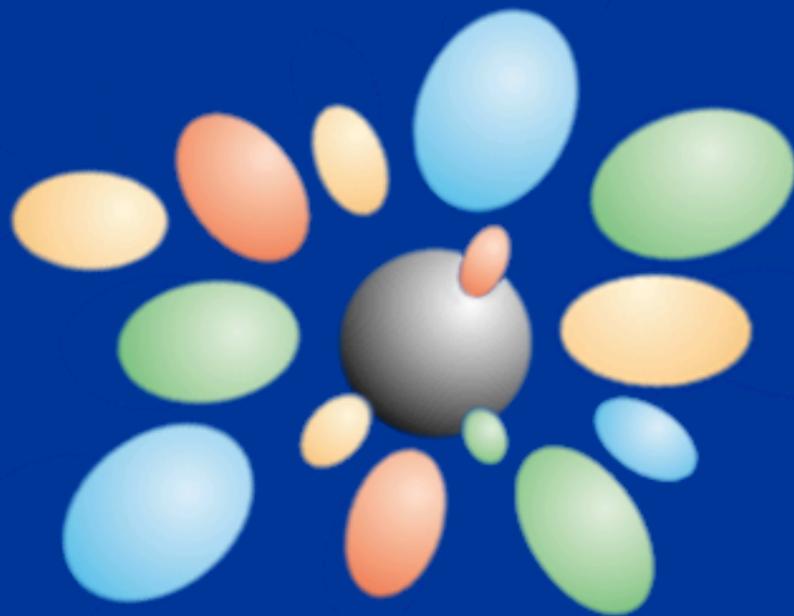
- burst has more central energy intensity
- flatter F3 and F4 transitions

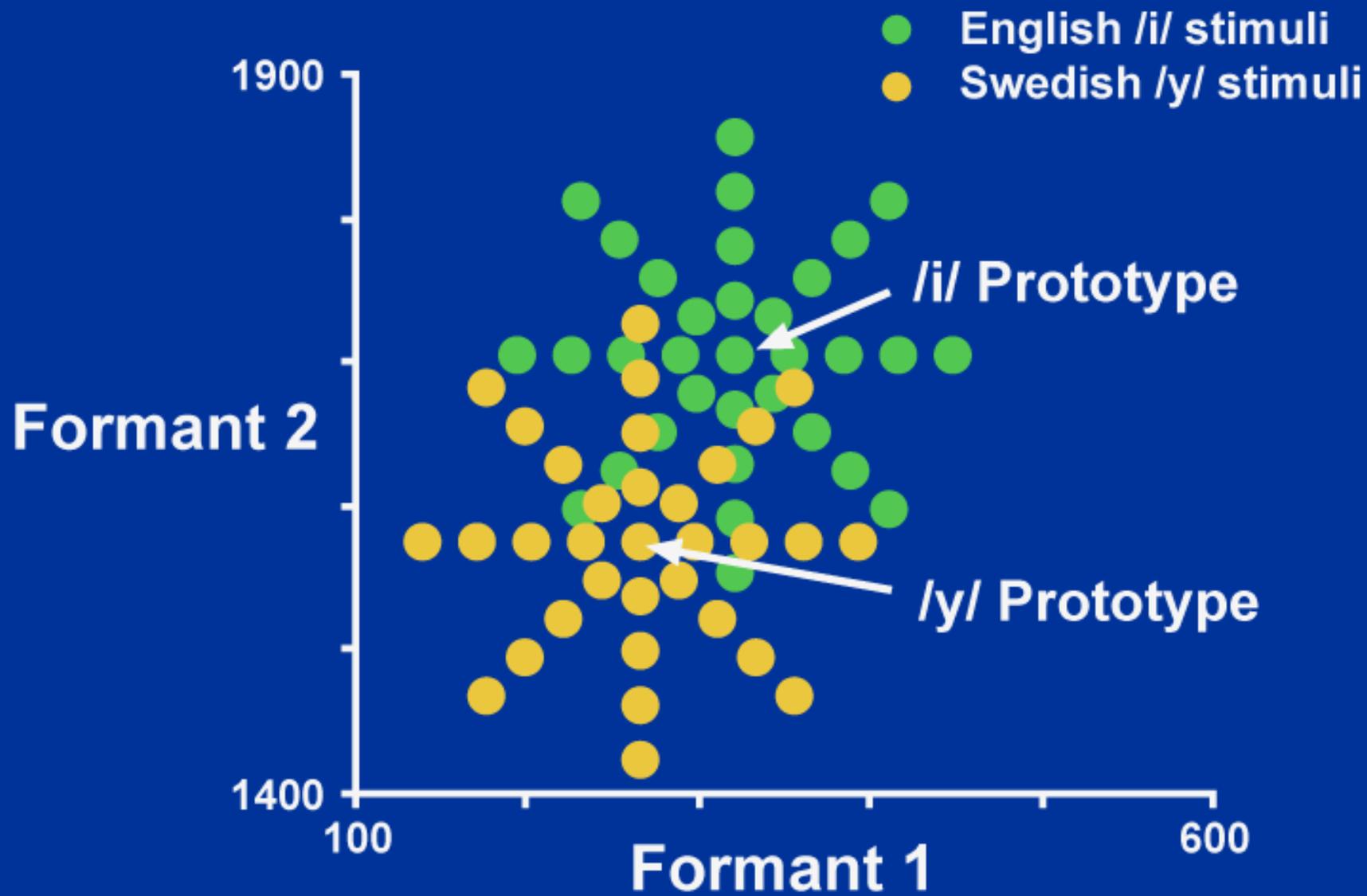


Cross-language perception of /ra/-/la/

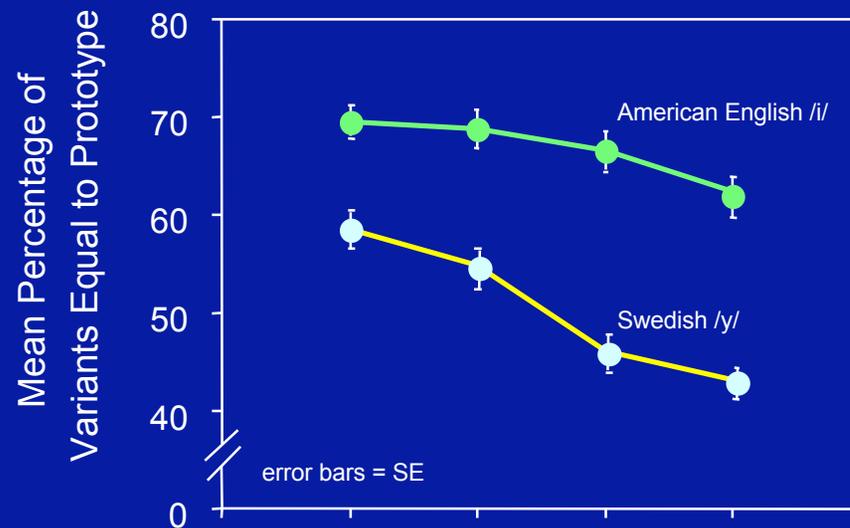




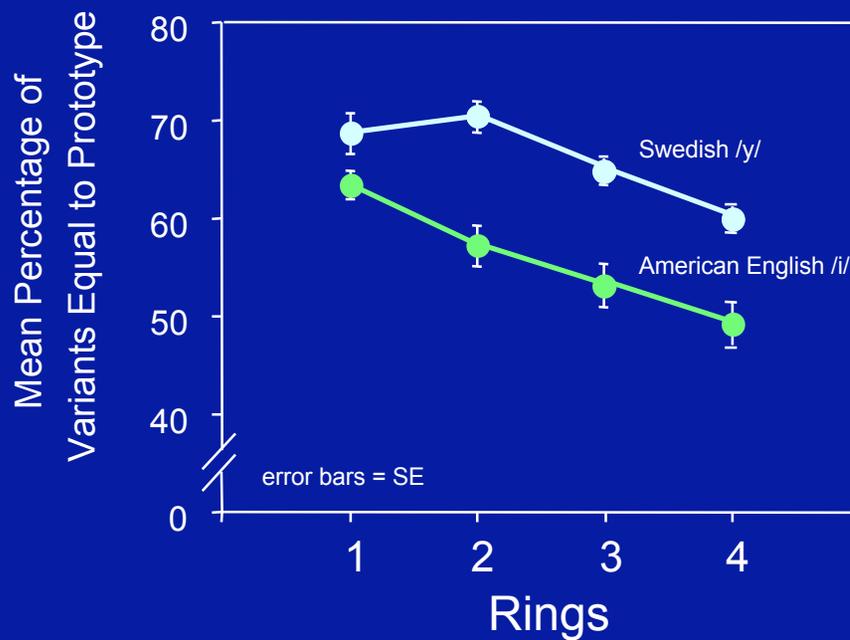




American Infants



Swedish Infants

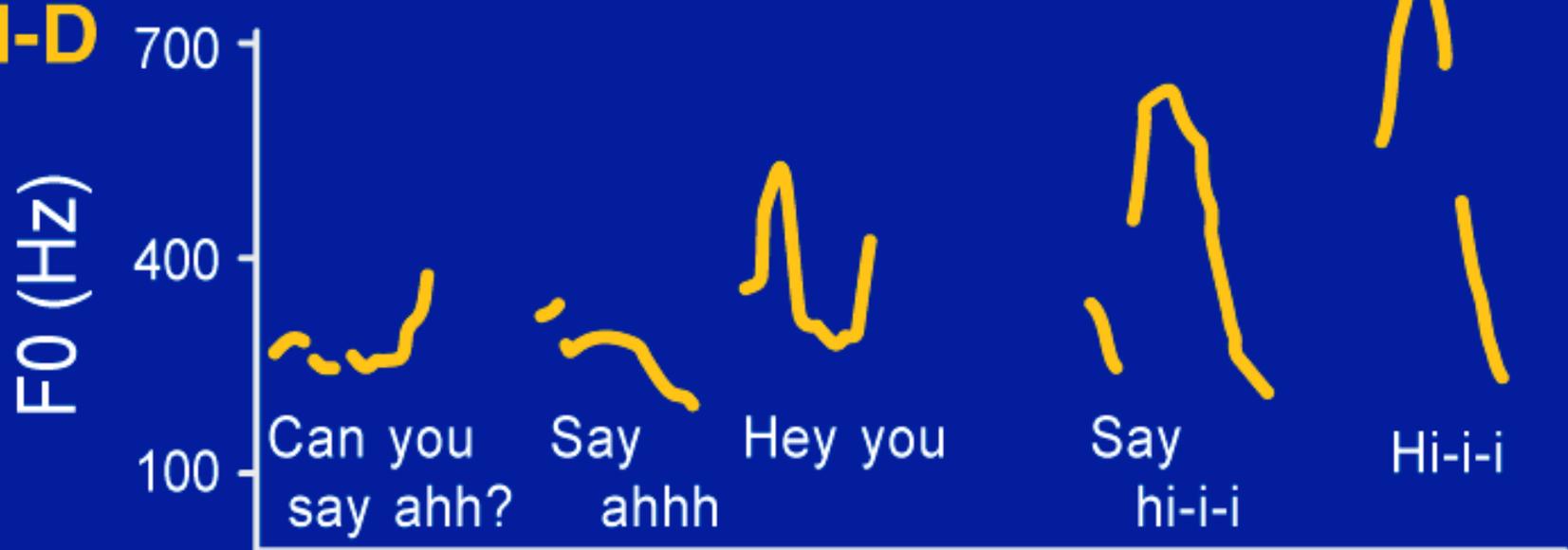




A-D

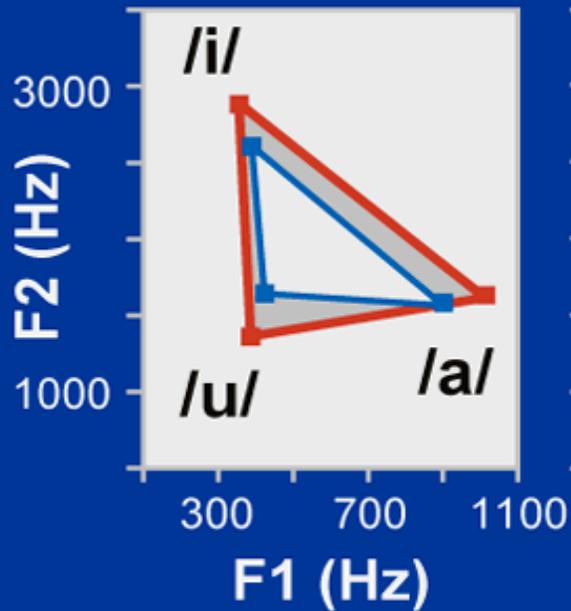


I-D

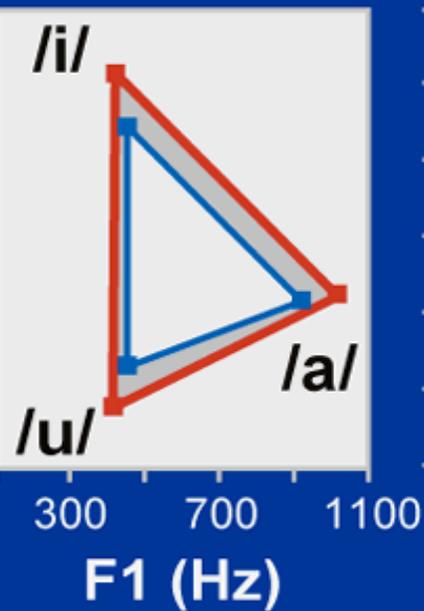


Time →

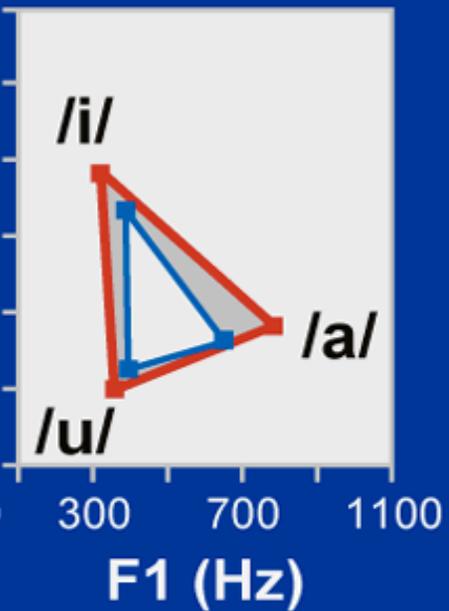
English



Russian

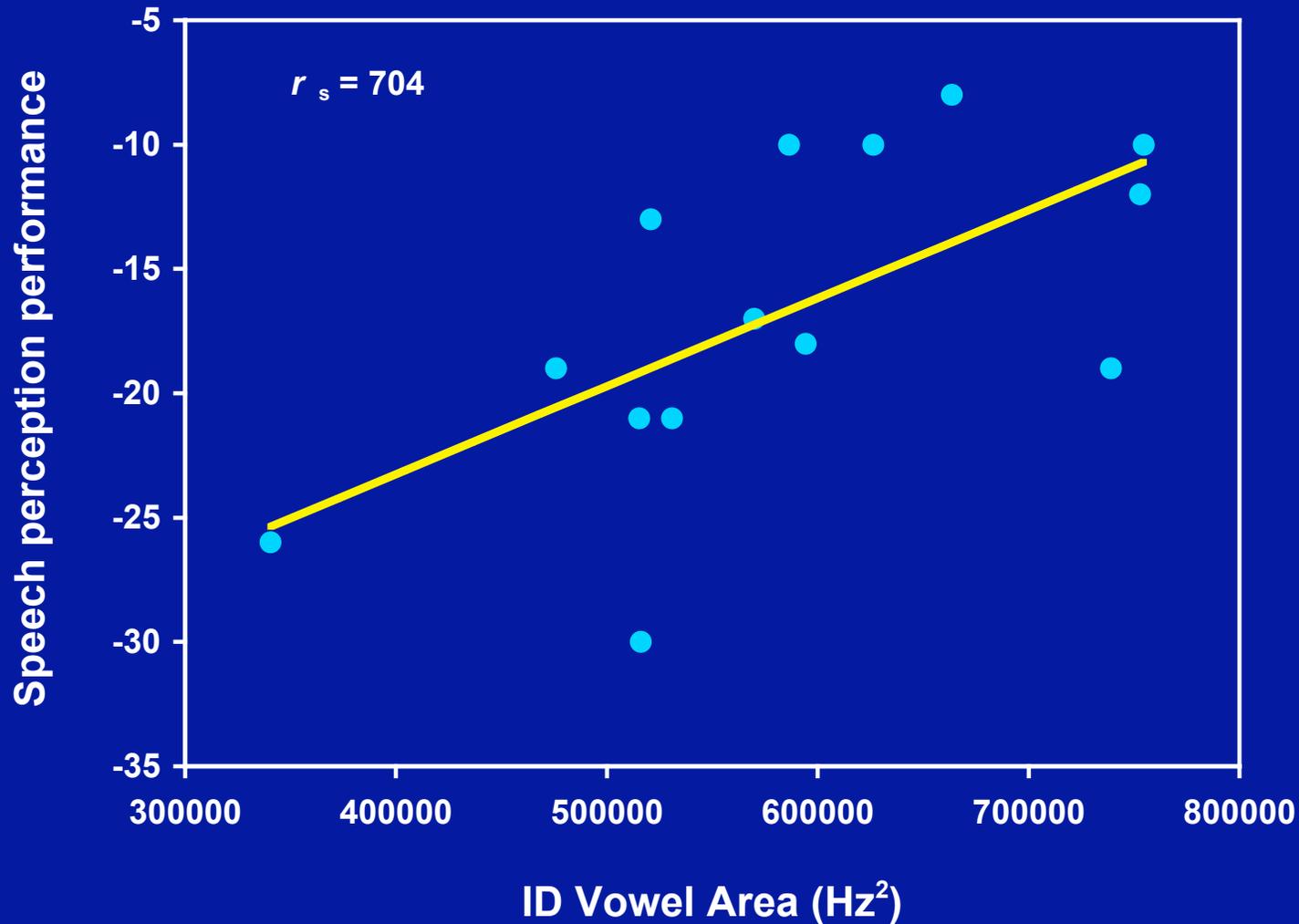


Swedish



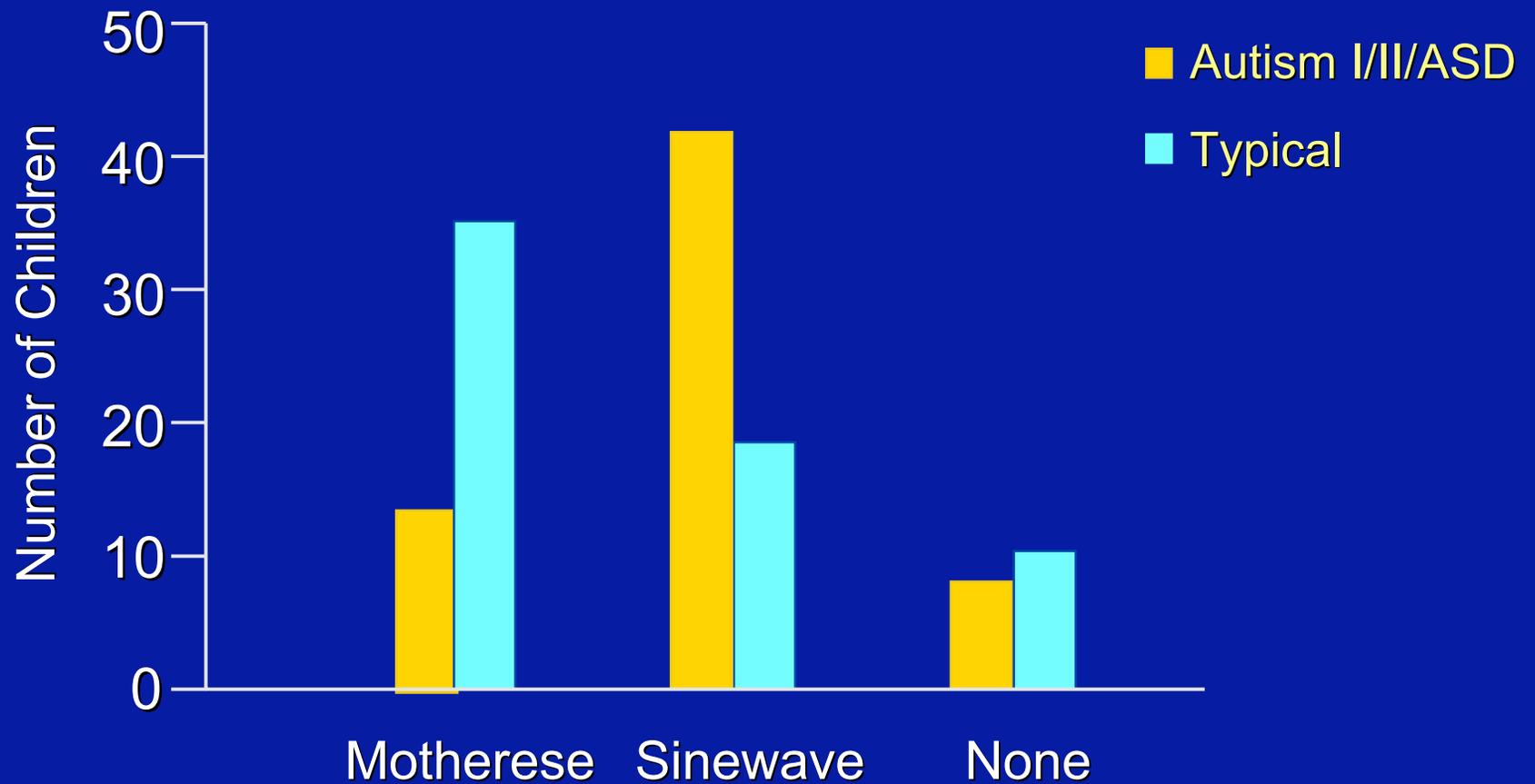
Key
— adult directed
— infant directed

Relationship between Mother's speech clarity and infant's speech perception abilities at 7 months

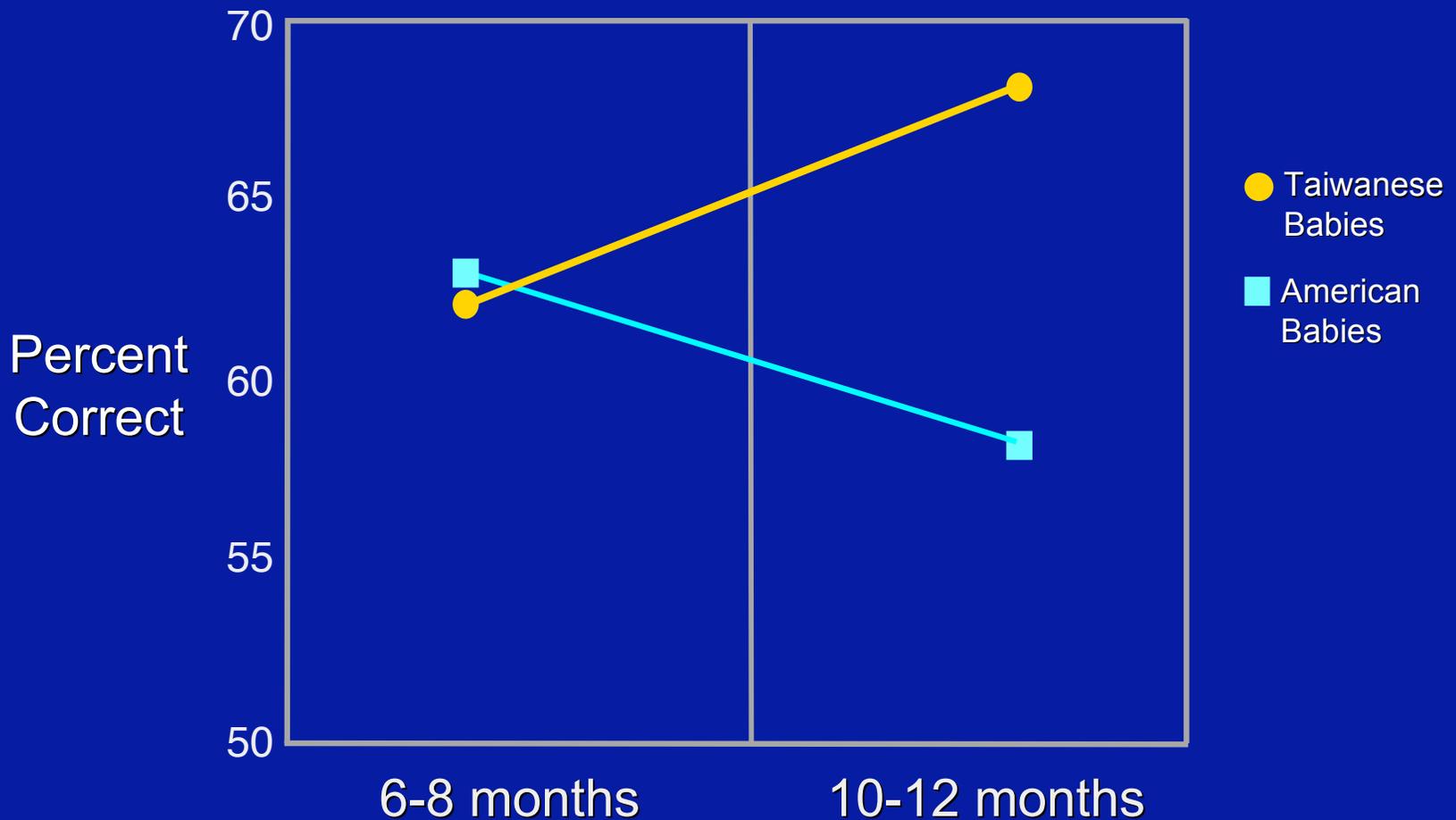


Liu, Kuhl & Tsao, 2003, *Developmental Science*

Auditory Preference Tests with Toddlers

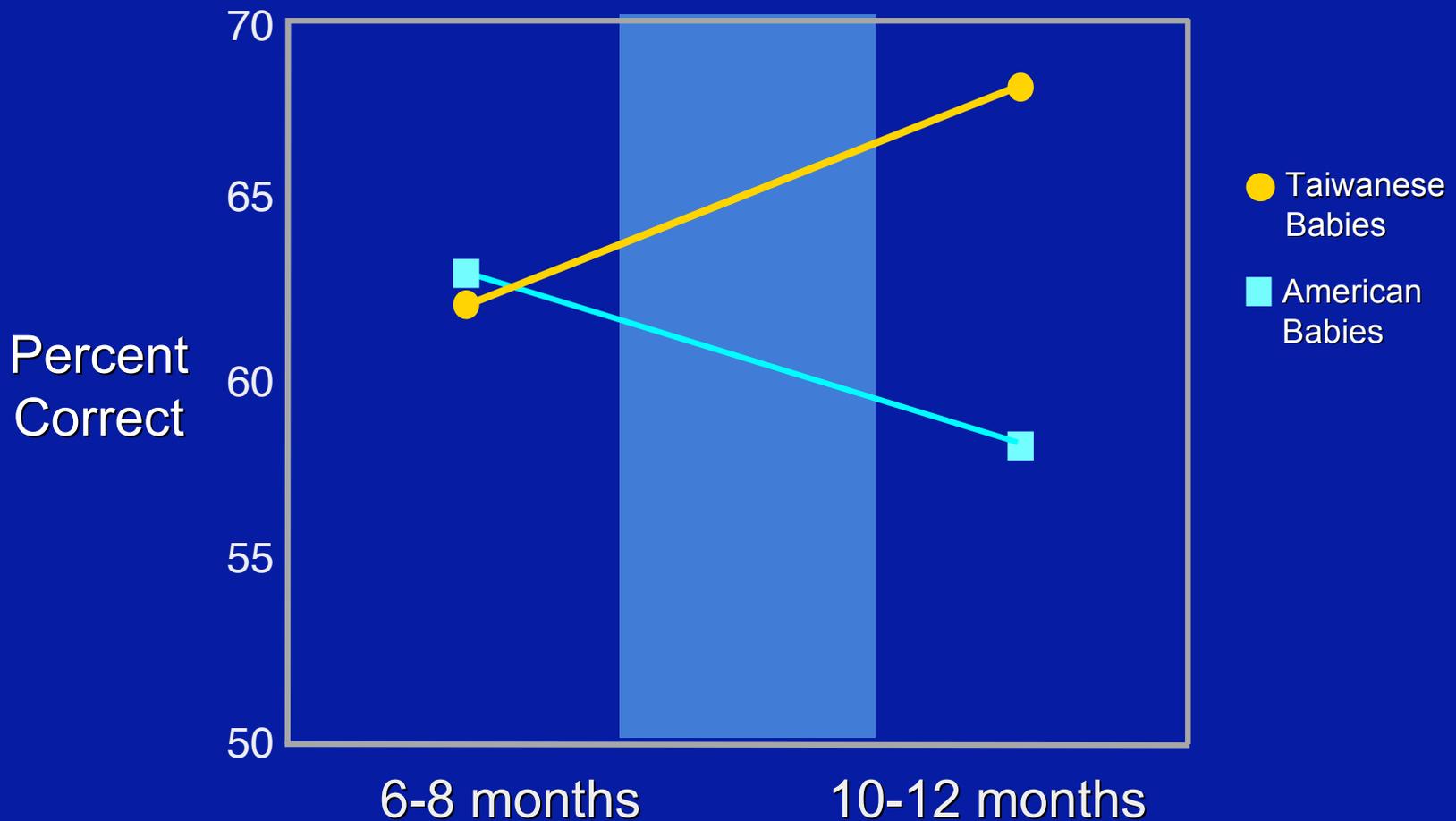


Second-language learning: Can American infants learn phonetically from exposure to Mandarin Chinese at 9 months?



Expose infants to Mandarin Chinese in a natural setting:

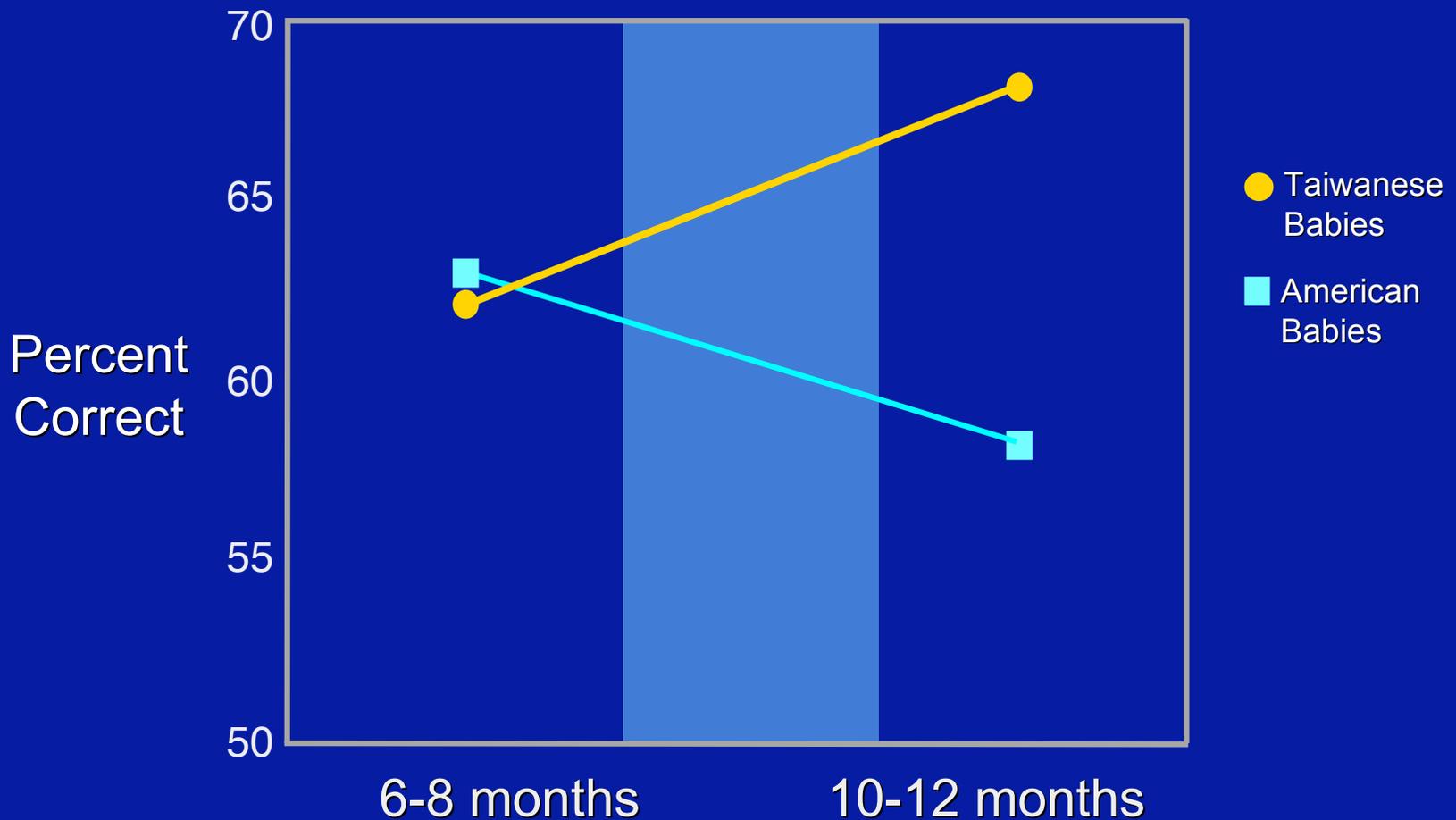
- 12 sessions, 25 minutes each
- 4 different talkers (mean # of syllables = 33,000)



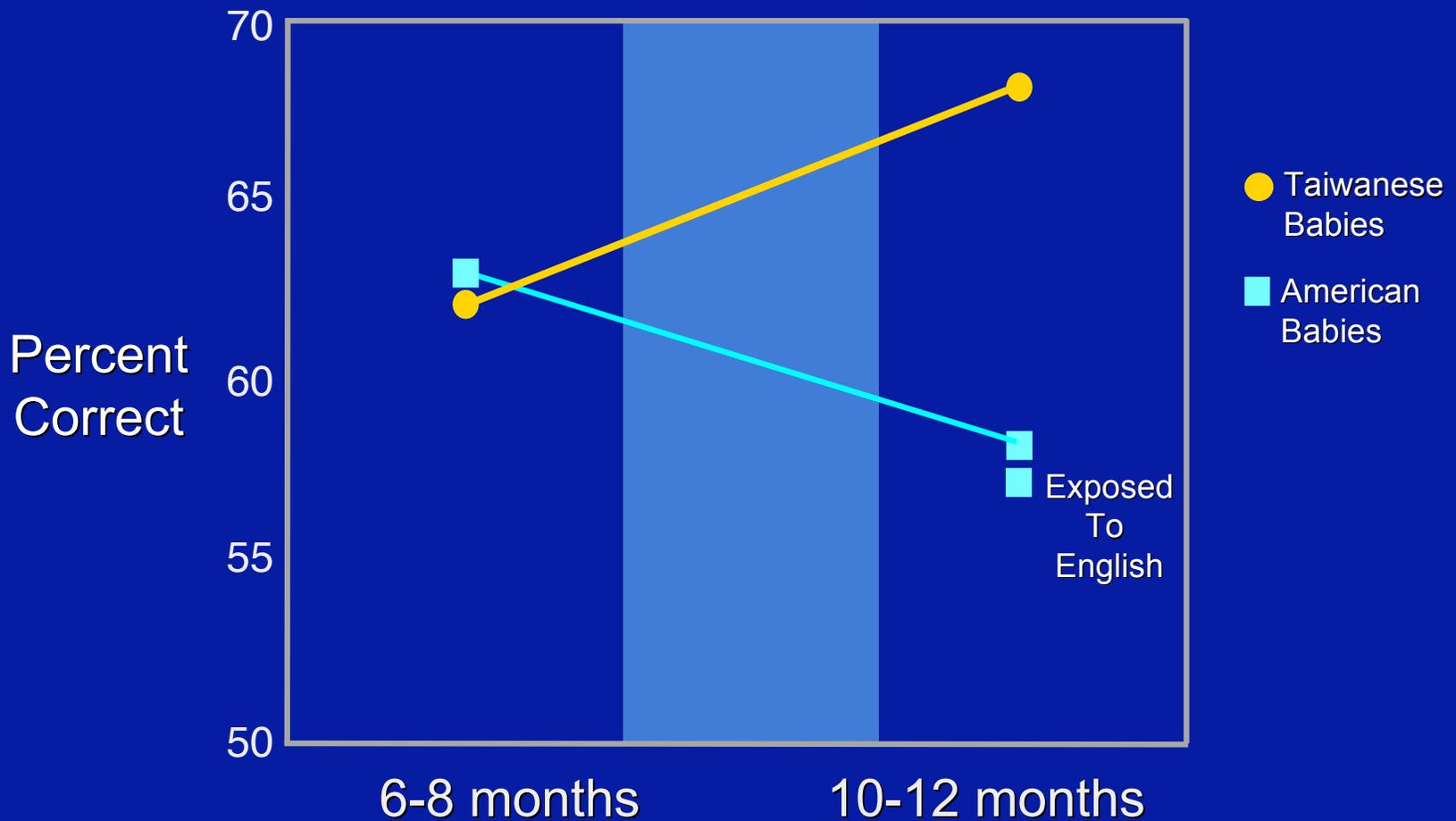




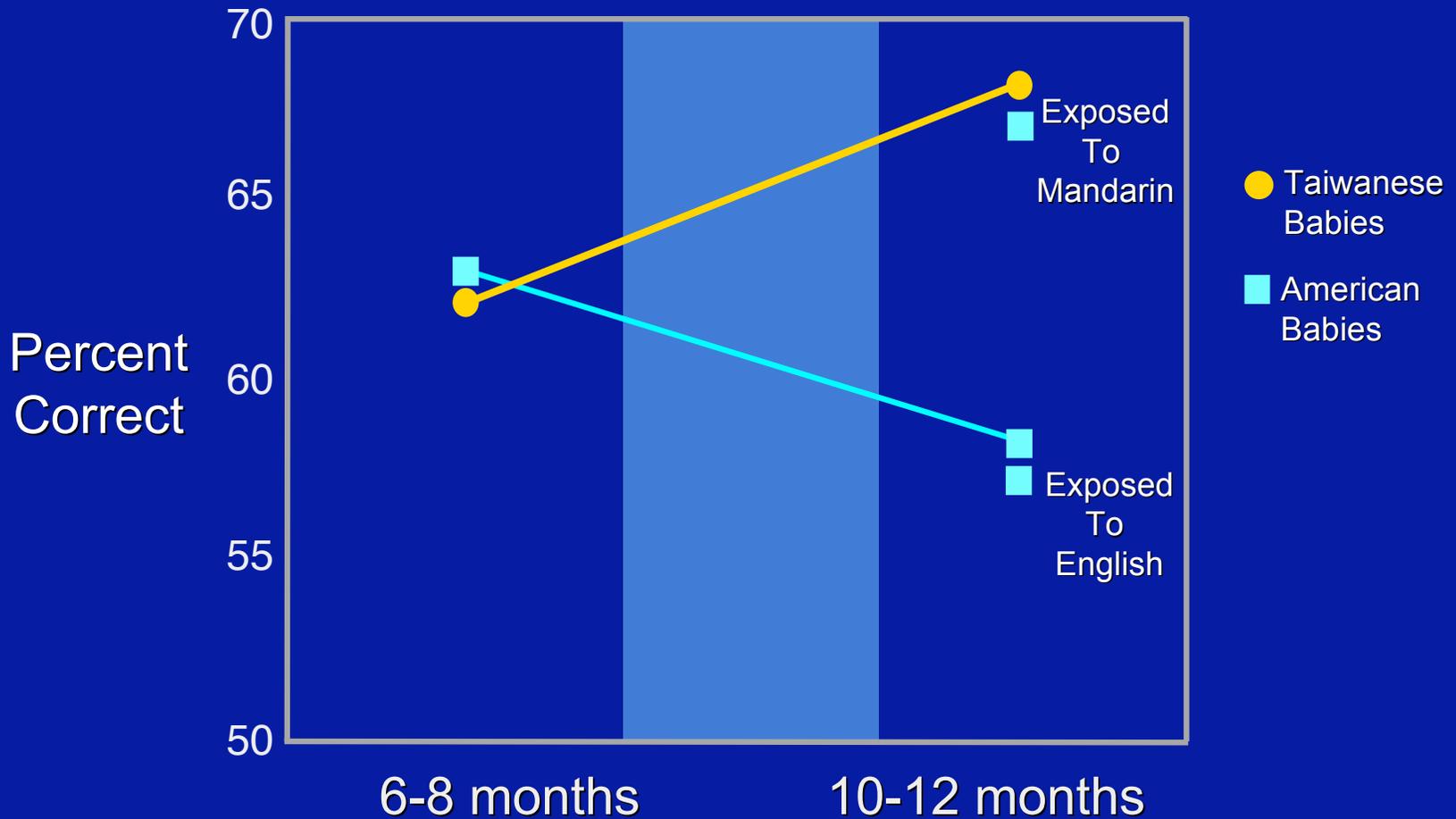
Test Mandarin-exposed and Control infants on the Mandarin affricate-fricative contrast after completion of exposure sessions



Control group exposed to English shows no learning

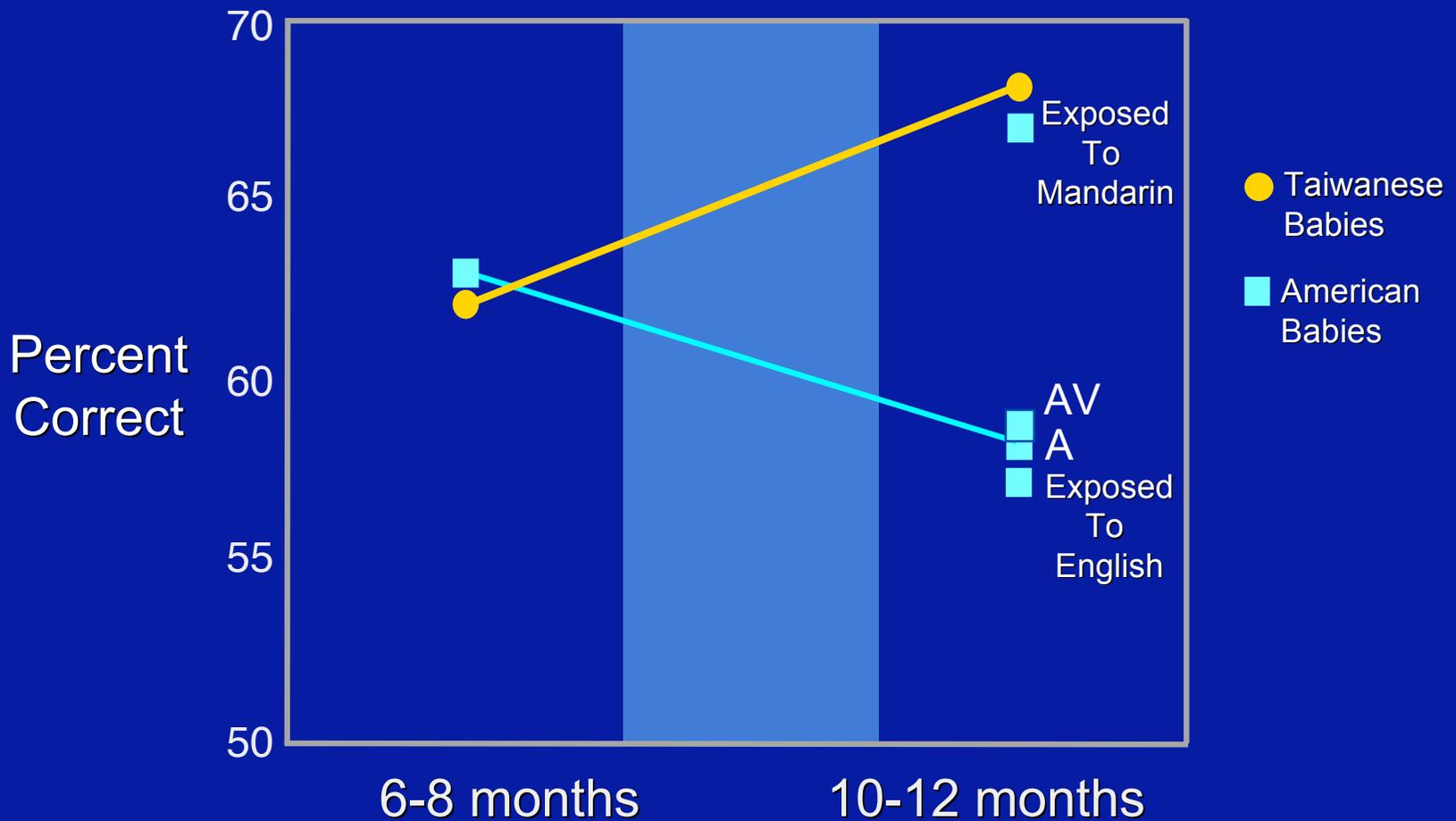


Experimental Group exposed to Mandarin Chinese shows learning

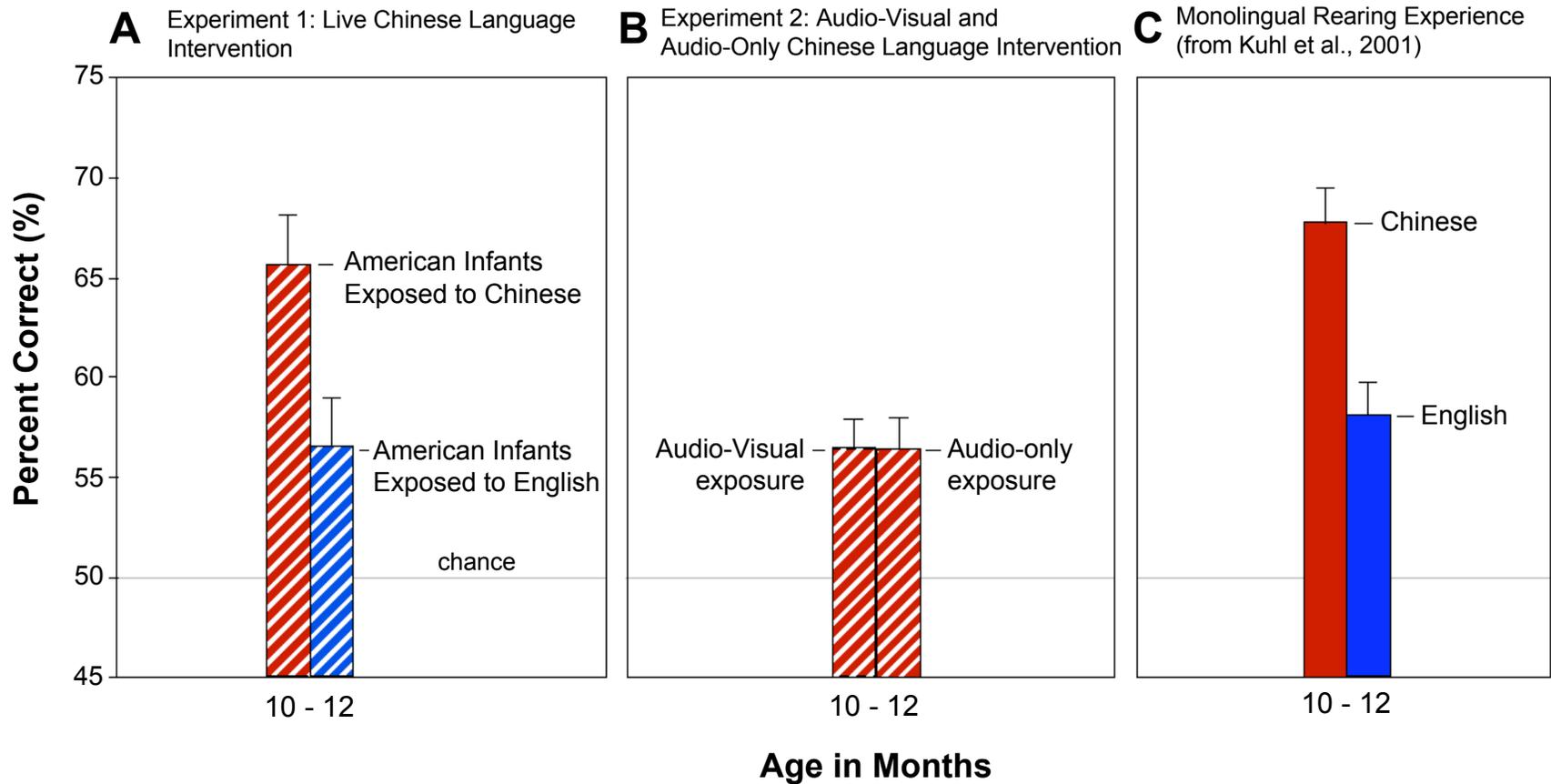




Exposure to Mandarin Chinese via TV or audio-only does not produce learning



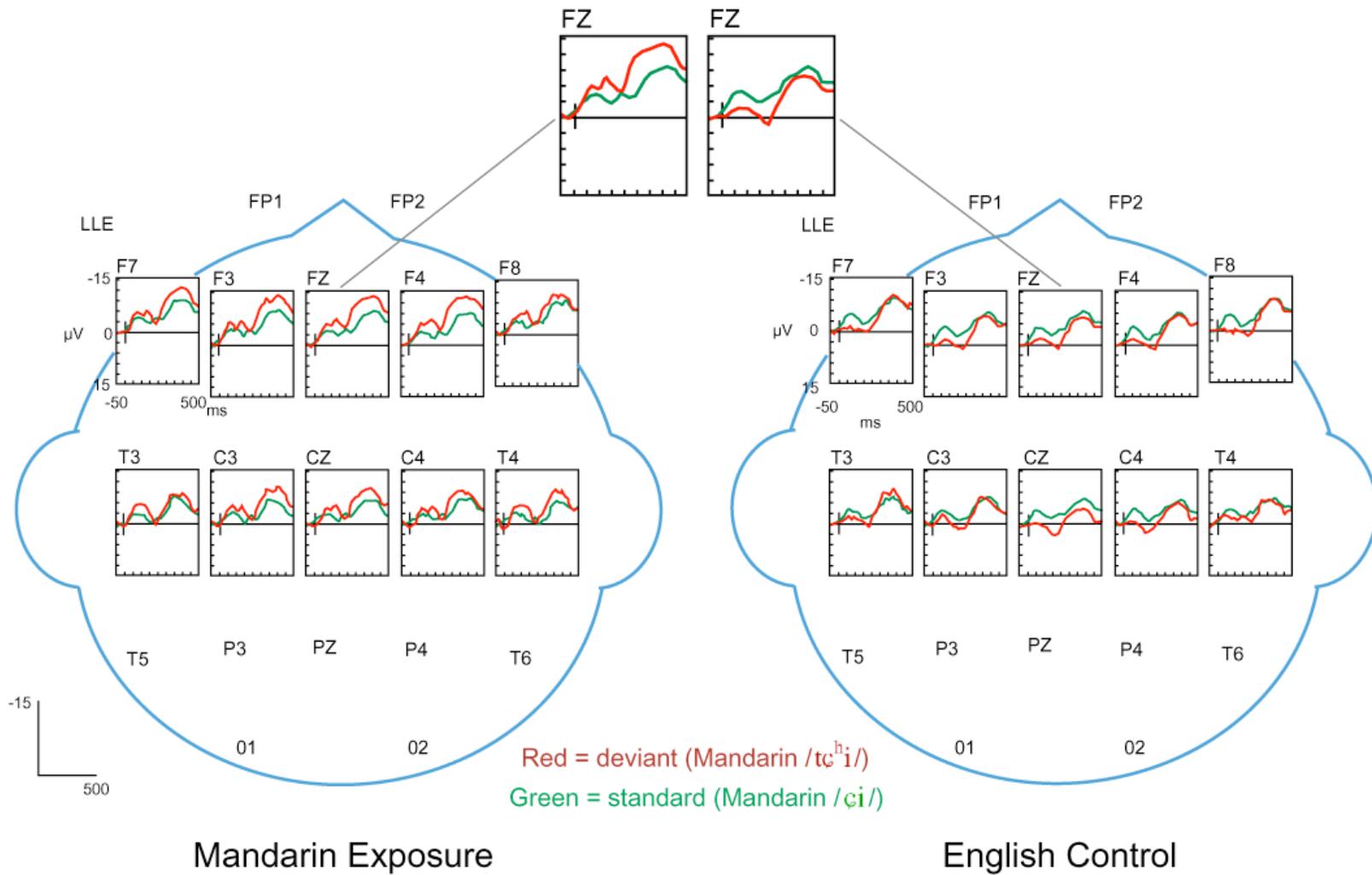
Mandarin Chinese Phonetic Discrimination



Baby Brainwaves



Mandarin Chinese Phonetic Discrimination: Brain Measure

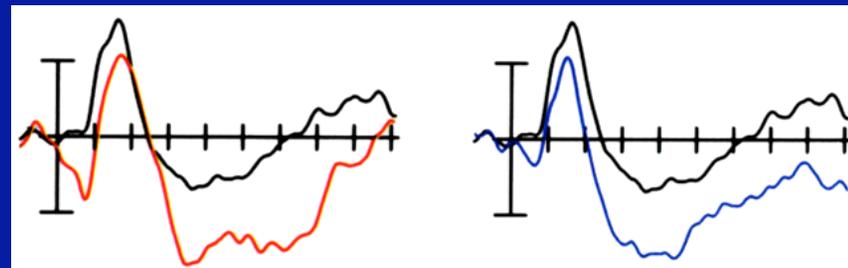


Spanish exposure experiment: Phonetic and word learning, social interaction analysis, cognitive tests



Spanish Exposure Learners

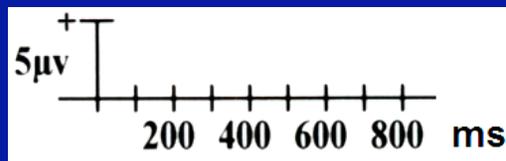
Enhanced negativity, measured by the Mismatch Negativity (MMN) response, indicates discrimination



Spanish

English

ta-ta-ta-ta-da-ta-ta-t^ha
ta-ta-ta-da



— Spanish target [da]
— English target [t^ha]

Conboy & Kuhl, *Society for Neuroscience*, 2006

Kuhl • International Dyslexia Association • 2007

What enhances infant language learning?

Cognitive hypothesis: Cognitive skills (means-ends, inhibitory control, executive function) will affect or be affected by exposure to a second language.

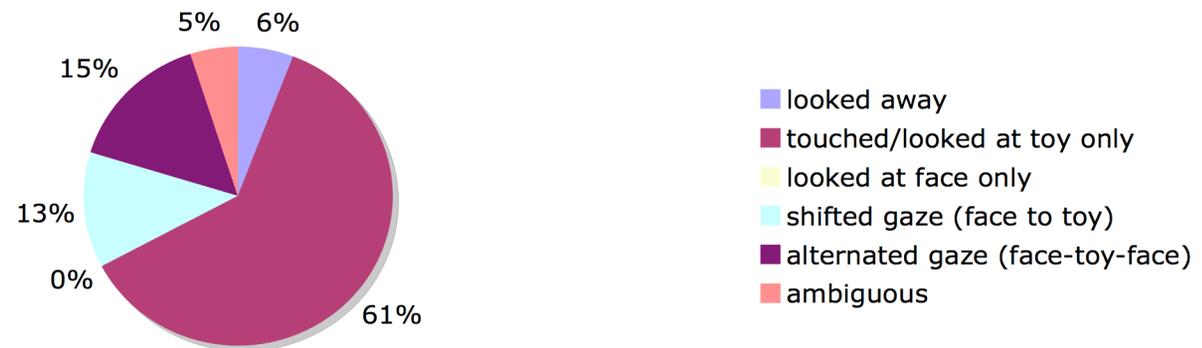
- Infant pre-test scores **do not** differ; learning in the exposure experiment was not related to initial cognitive skills
- Infant post-test scores **do** differ; infants who learned show higher cognitive skills after the exposure (not all skills, but specific ones thought to reflect mental flexibility) ✓

Social hypothesis: Infants with more sophisticated social abilities will show greater learning

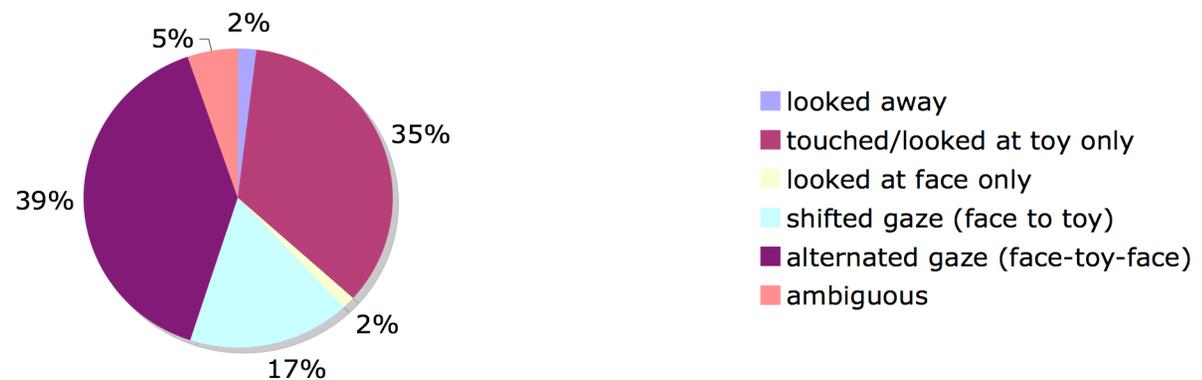
- Global attention and arousal 'gates' learning: Motivational explanation ✓
- Socially-delivered cues (eye-gaze) increase learning: Informational explanation ✓

Analyses of visual attention

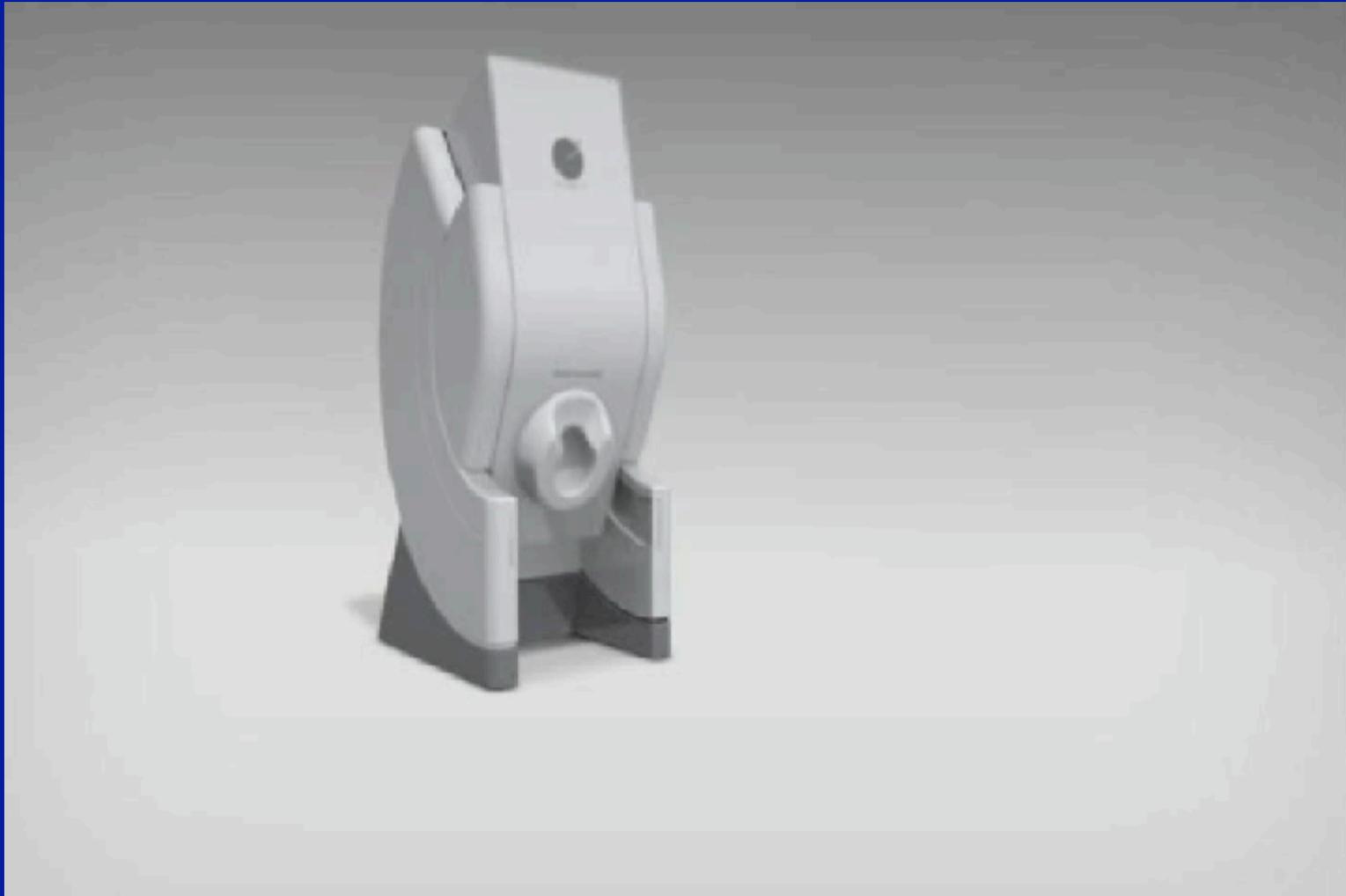
Lower Group (8 children with less negative 11m N250-550 effect to Spanish)



Higher Group (9 children with more negative 11m N250-550 effect to Spanish)



LIFE Baby MEG Studies: Helsinki, Finland



6-Month-Old Baby in MEG Device



Imada, Zhang & Kuhl, *NeuroReport*, 2006

Kuhl • International Dyslexia Association • 2007

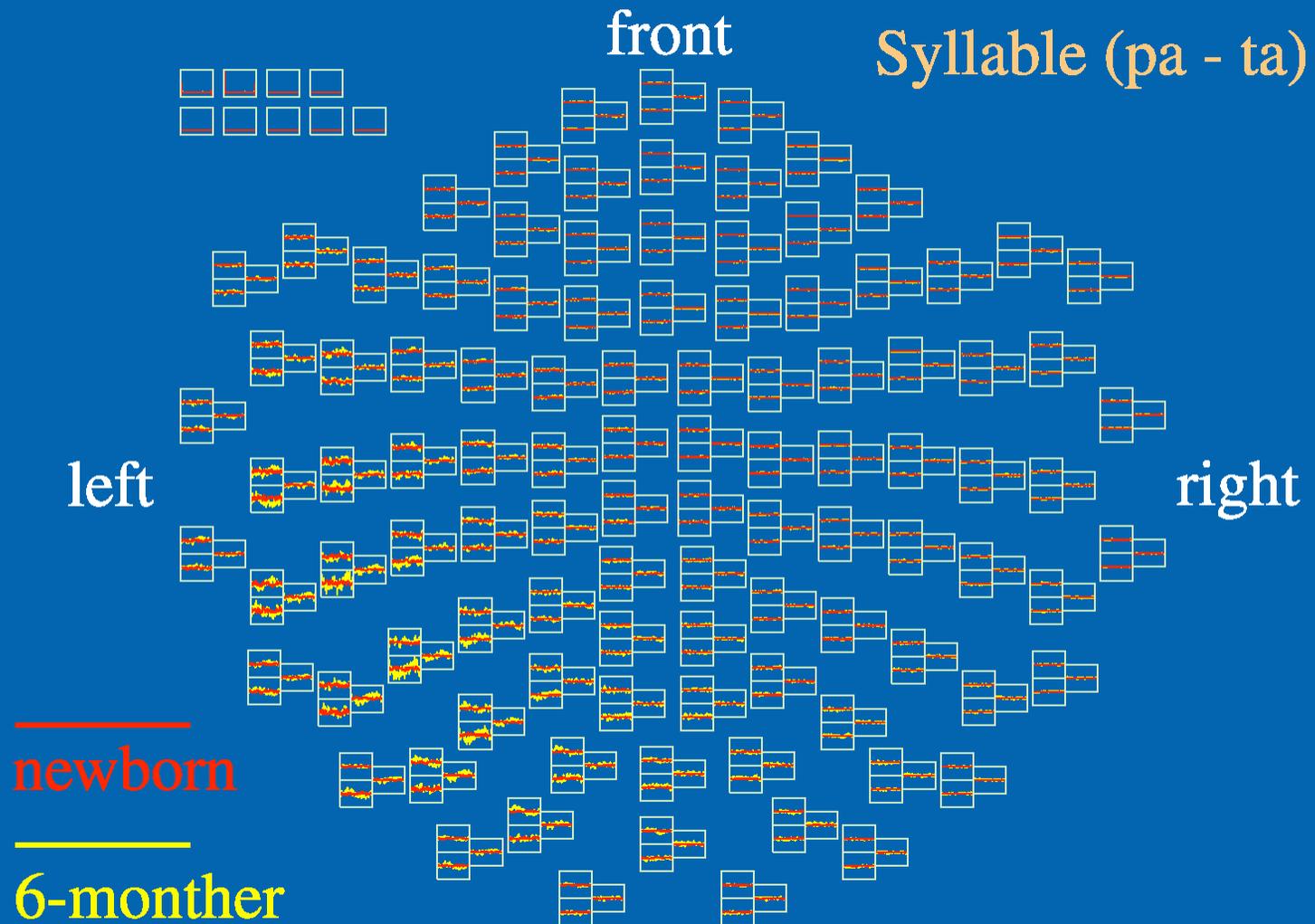
Entertainment During Language Stimulation



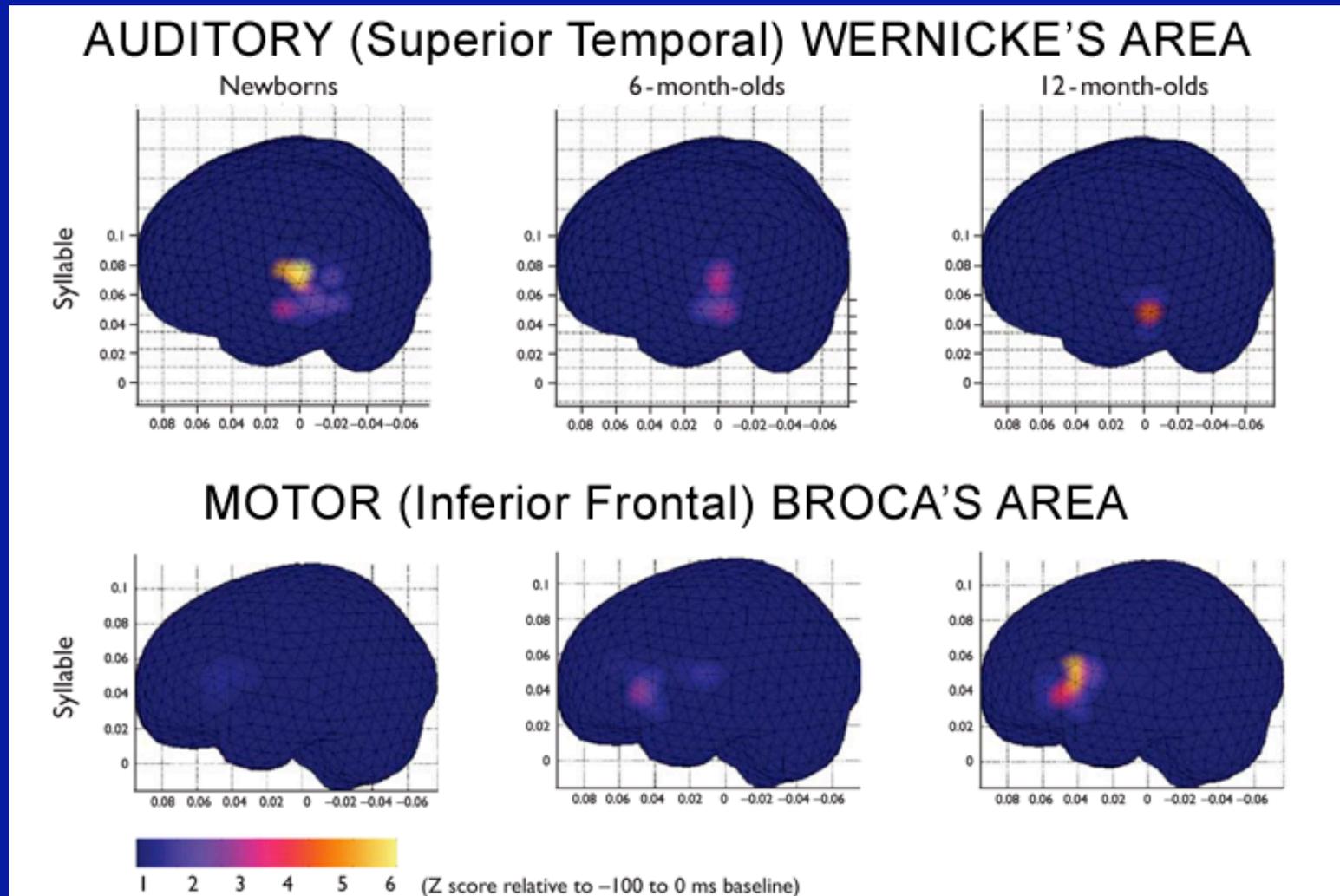
Imada, Zhang & Kuhl, *NeuroReport*, 2006

Kuhl • International Dyslexia Association • 2007

Waveform from 306 channels



Developing coordination between brain areas as infants (newborn, 6- and 12-month) listen to syllables



Infant Head-Start Learners: Brain and
Behavioral Measures and
Family Assessments
UW LIFE CENTER & UTSA
NIH-NSF LIFE Supplement

Maritza Rivera-Gaxiola
University of Washington
I-LABS

&

Harriett Romo
University of Texas at
San Antonio



Early Brain Measures of Phonetic and Word Processing and 5-yr Follow-up

Brain and behavioral measures:

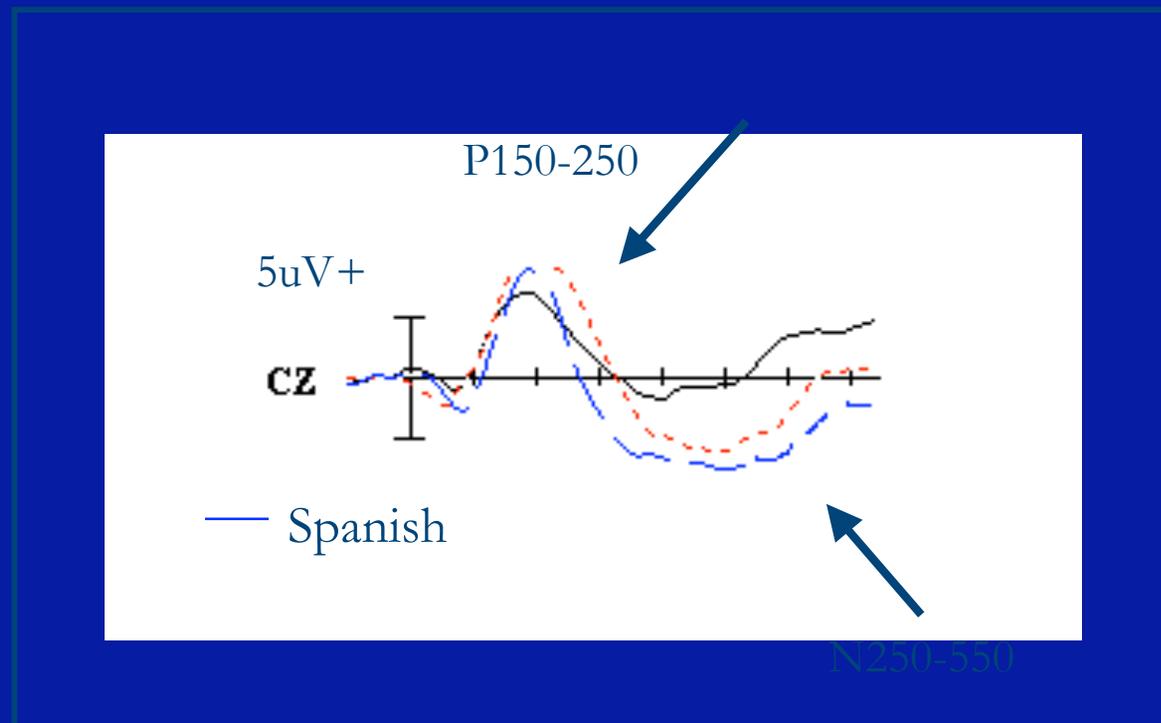
- Language
- Cognition
- Family assessments (SES, language, parental support systems)

- 55 families enrolled in San Antonio
- Head-Start Bilingual Learners
- Single parent (teen-age mother) families
- Home visits



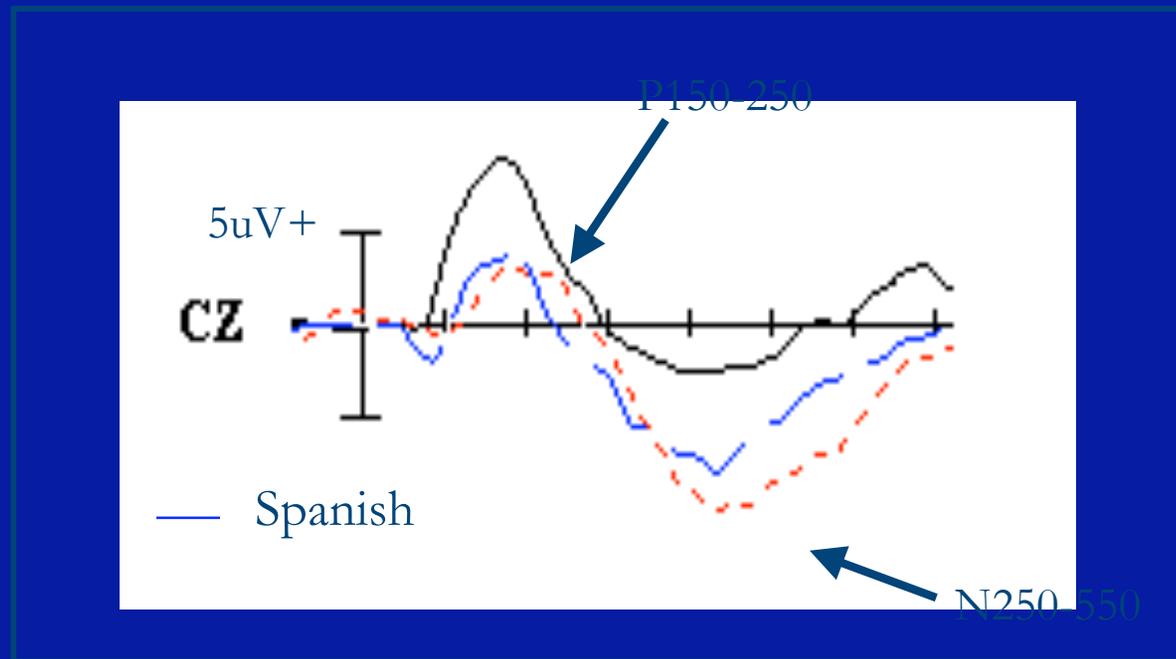
Year 1 Results

6-8 month old infants ERPs: Discrimination of both English and Spanish sounds



Year 1 Results

10-12 month old infants: Enhanced discrimination of both Spanish and English sounds



Comparisons underway: Data on monolingual vs bilingual infants in 4 countries (Finland, Sweden, Japan, and the Seattle cohort)

LIFE NSF-NIH Supplement Grant

Year 2 Measures:

Barbara Conboy (UW, now at UTSA)

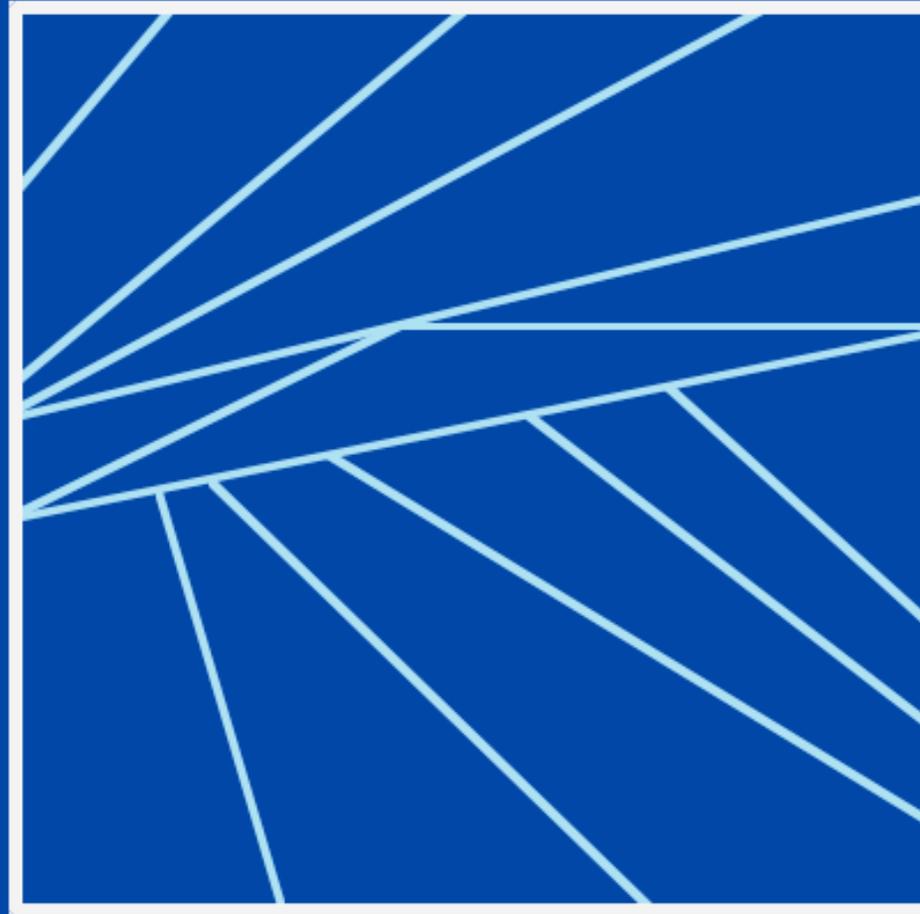
- ERP measures of English and Spanish word learning
- Cognitive measures: executive function & inhibitory control
- Follow-up language assessments every 3 months

Harriett Romo:

- HOME assessments
- Language input
- Cultural views
- SES

Infants' Natural Auditory Boundaries

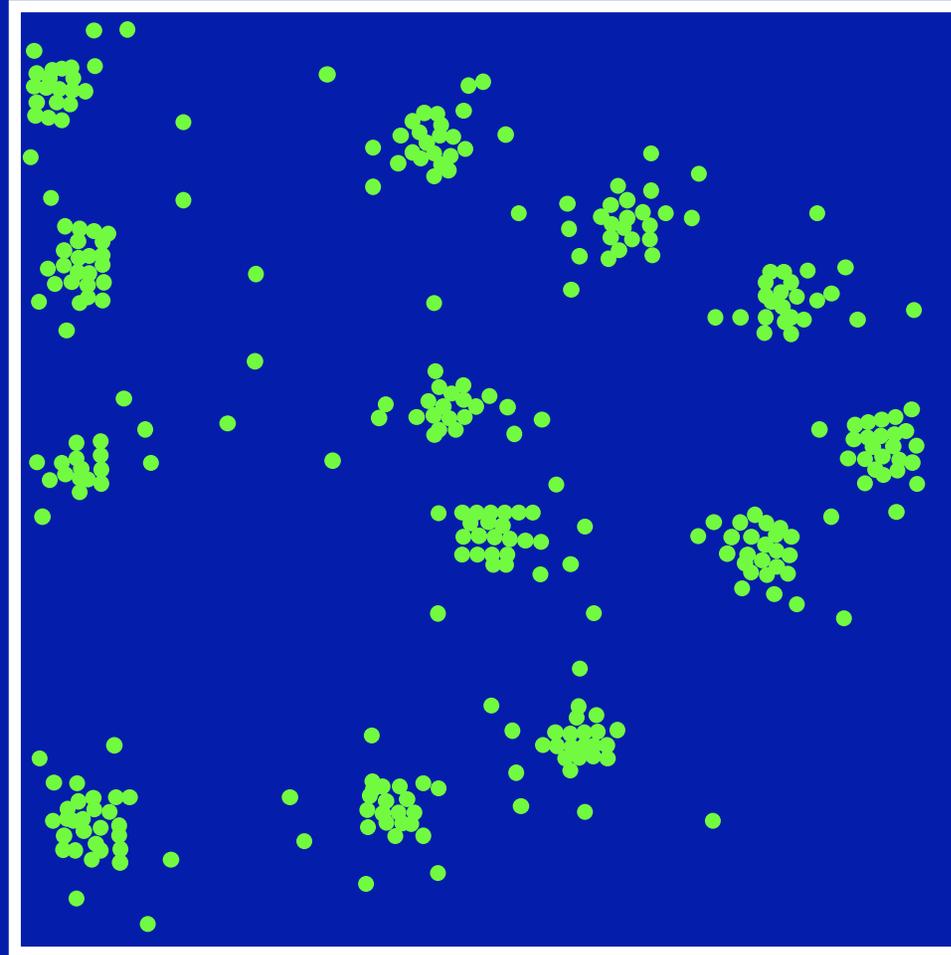
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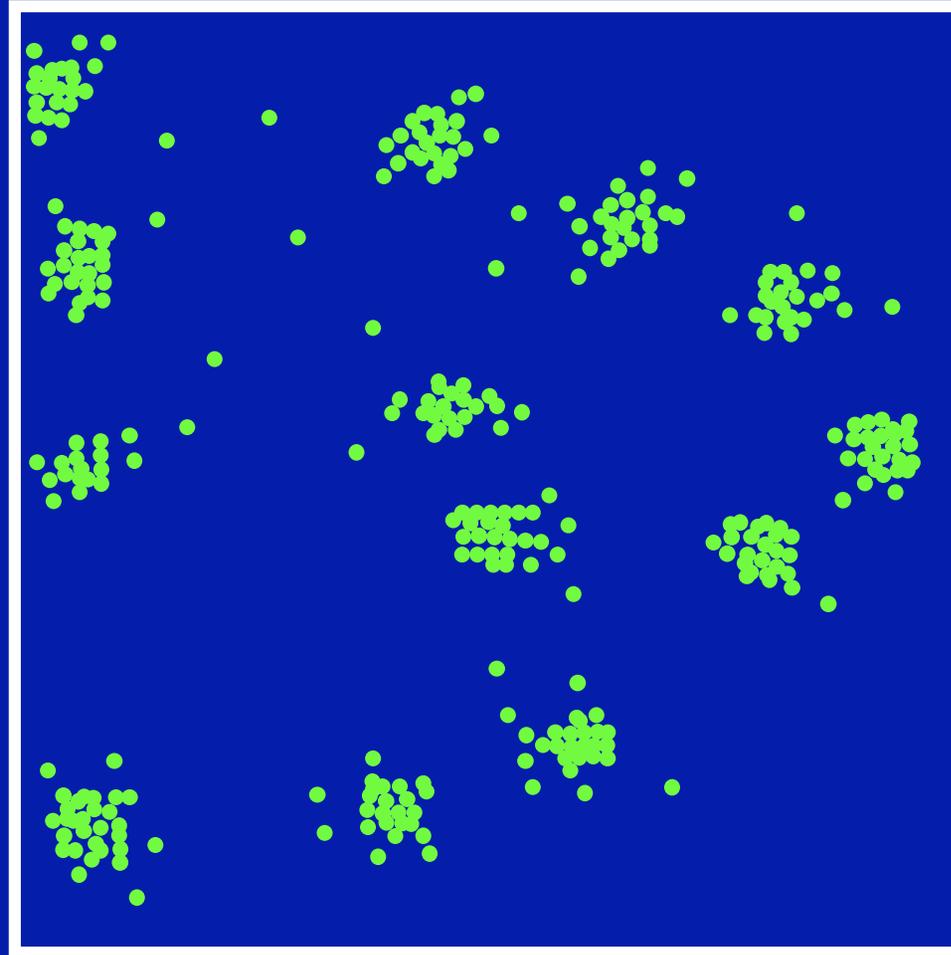
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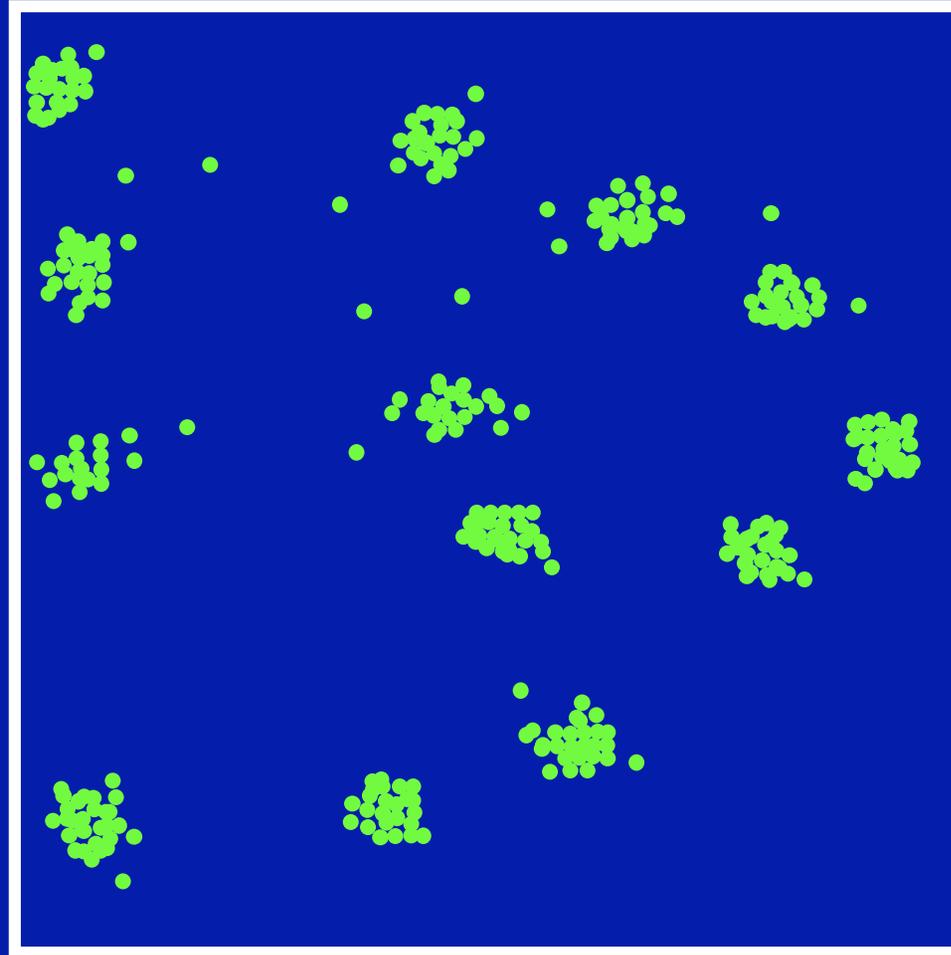
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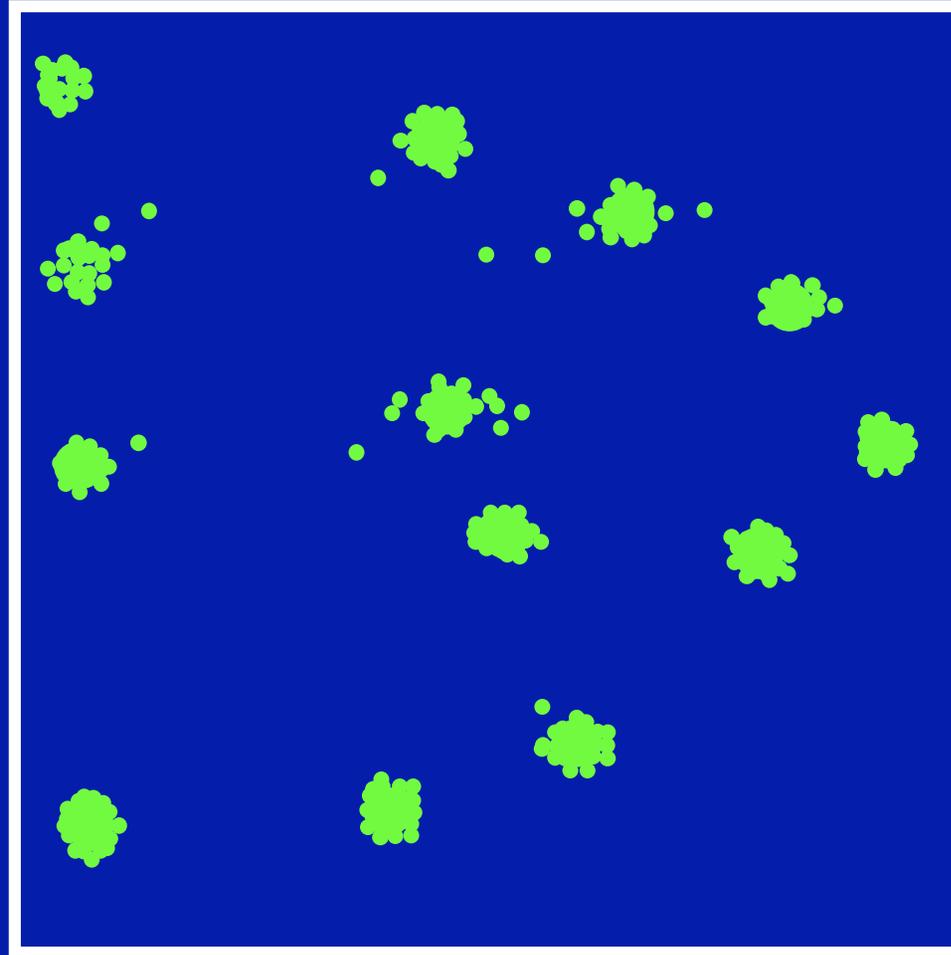
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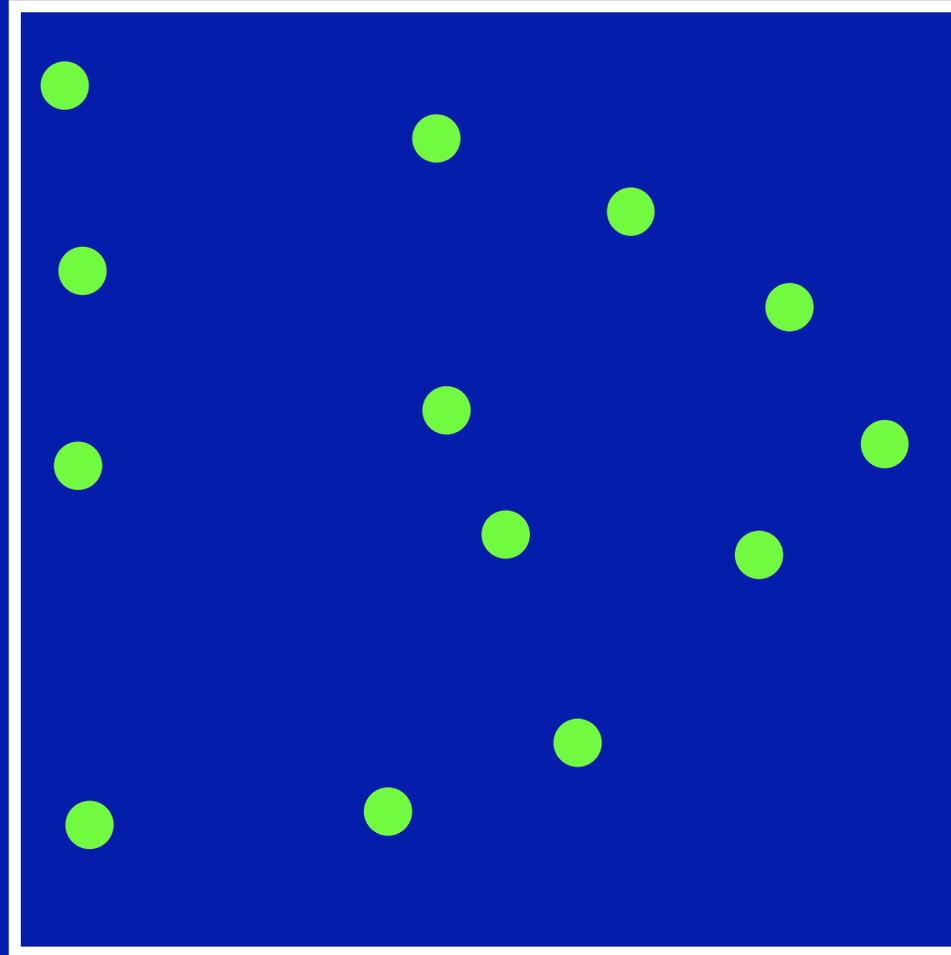
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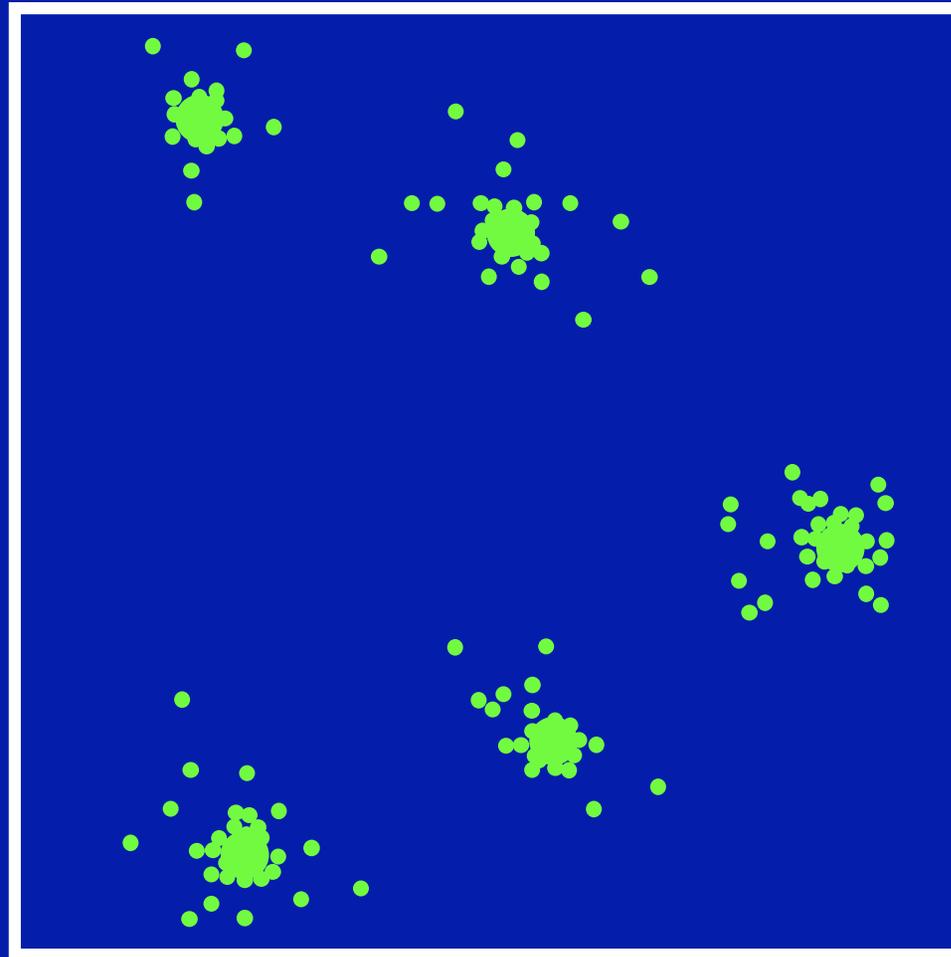
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Japanese

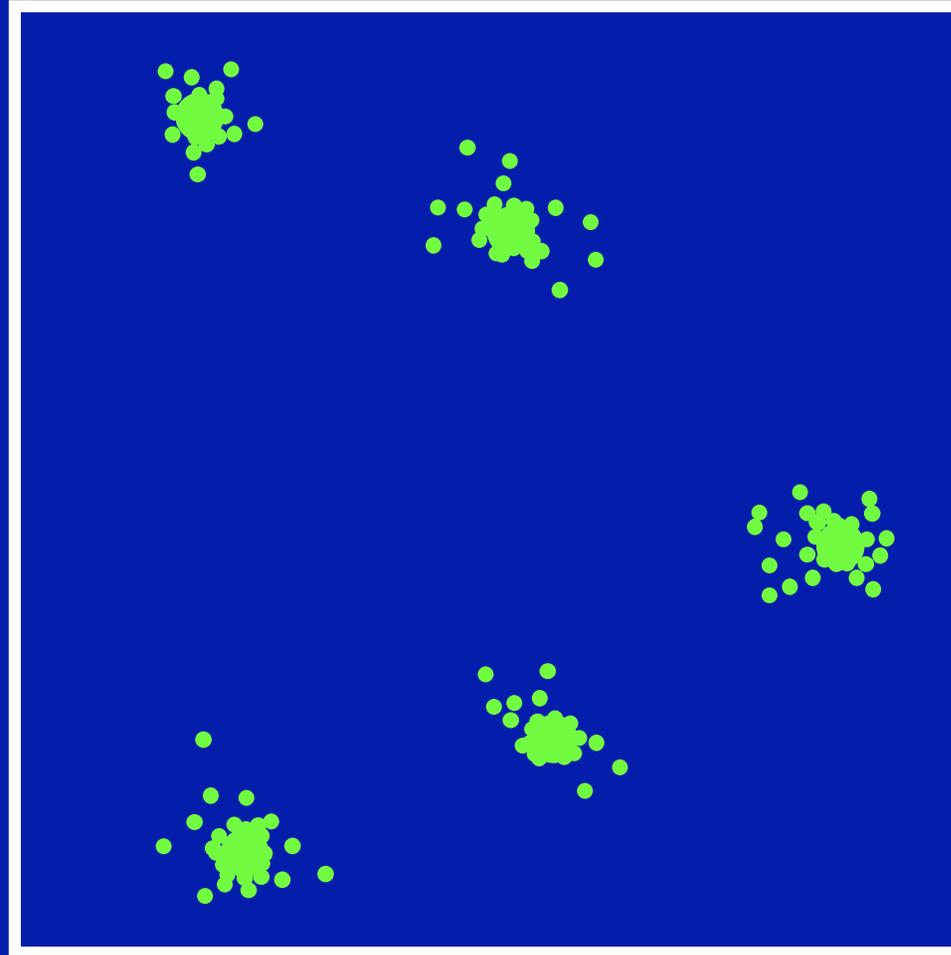
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Japanese

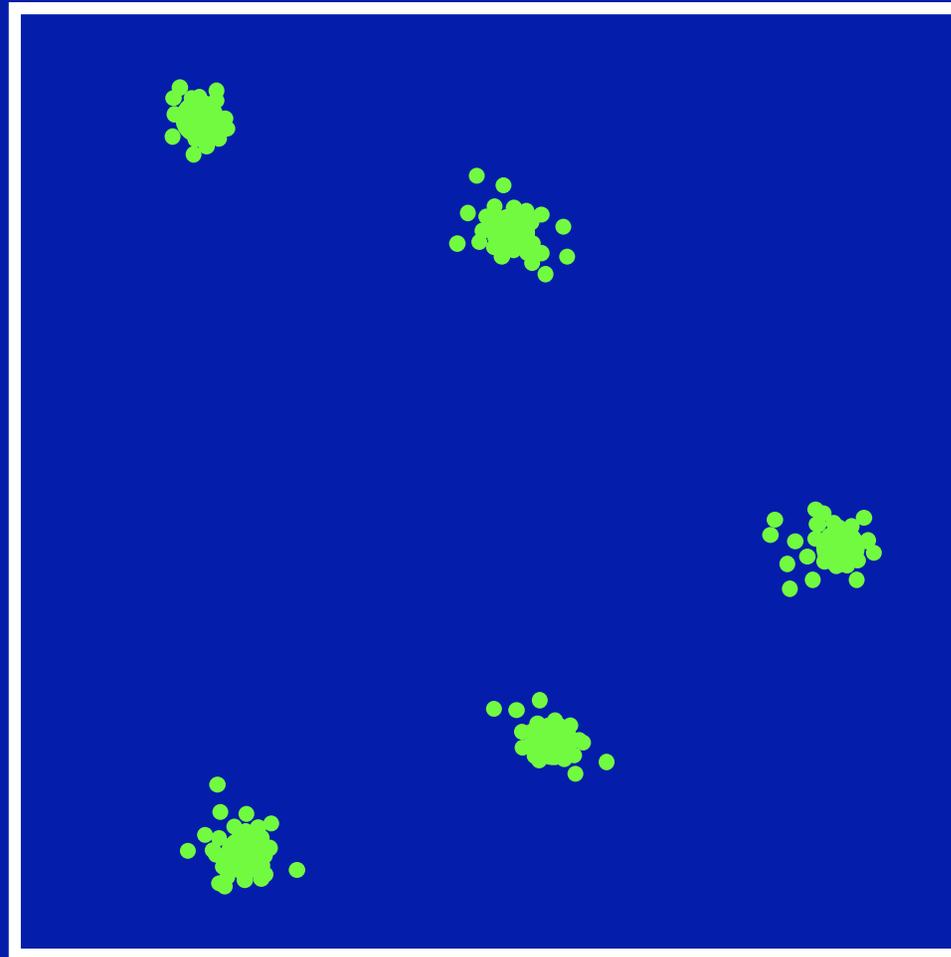
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Japanese

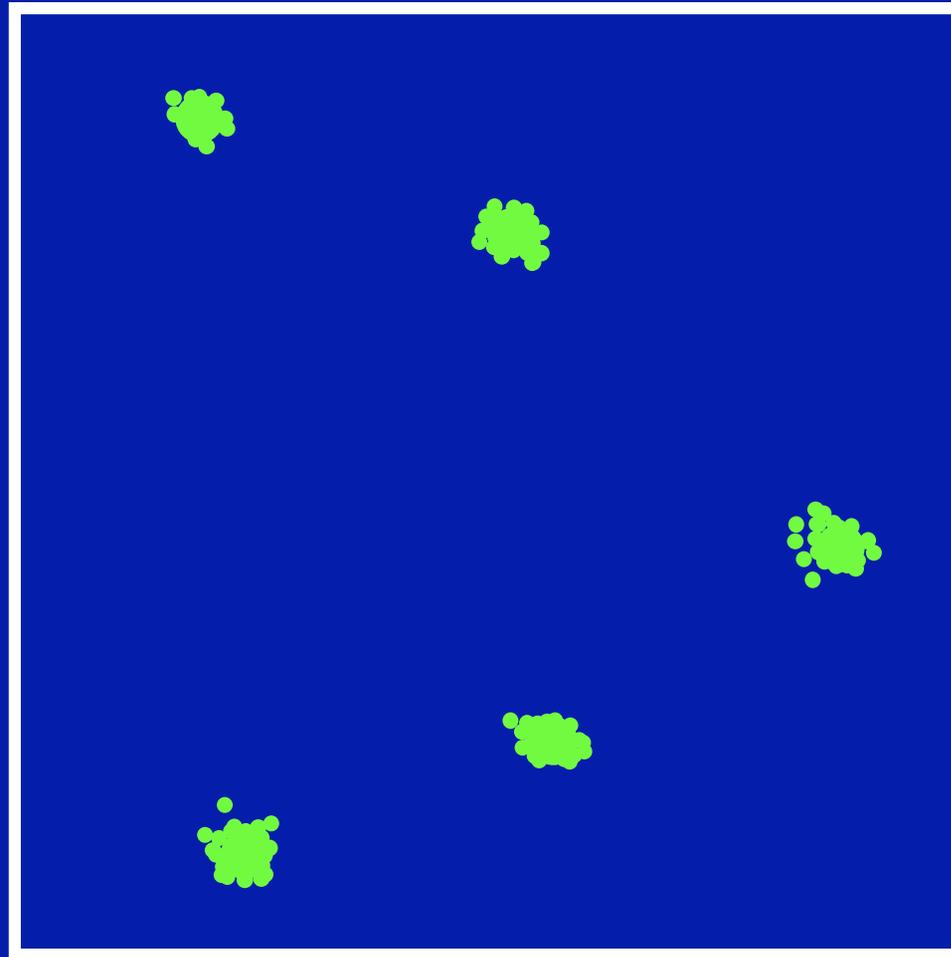
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Japanese

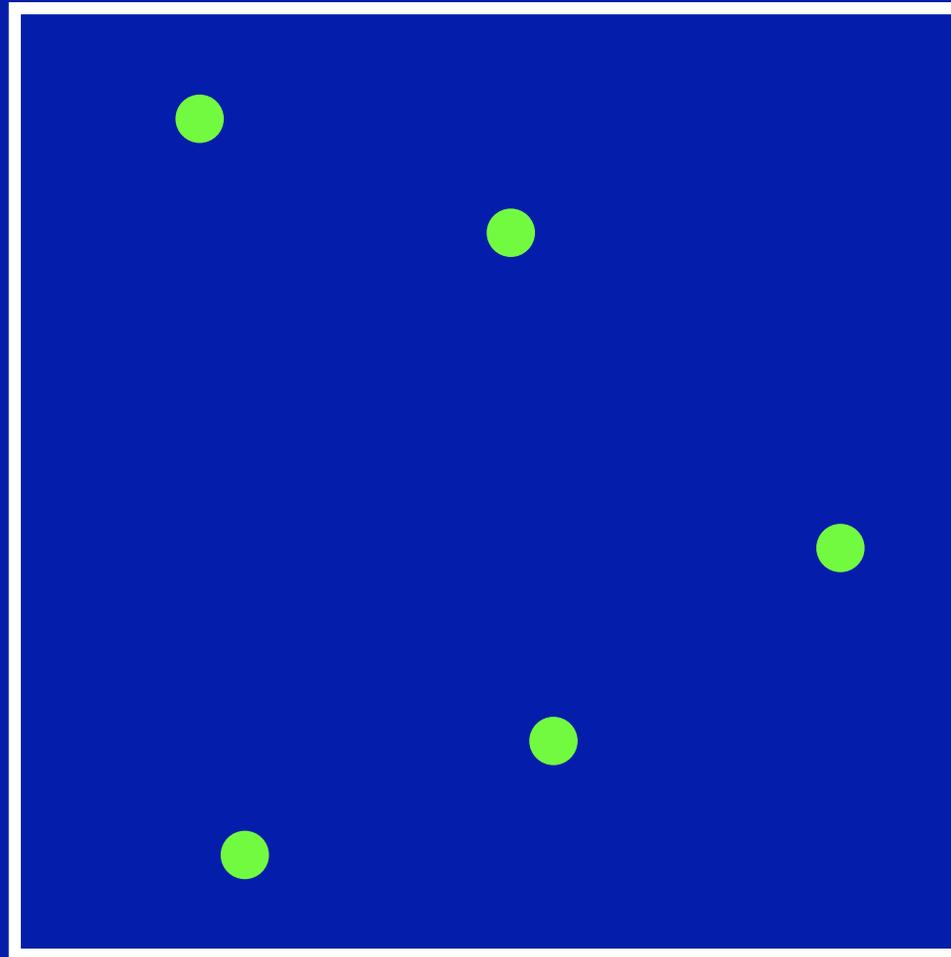
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Japanese

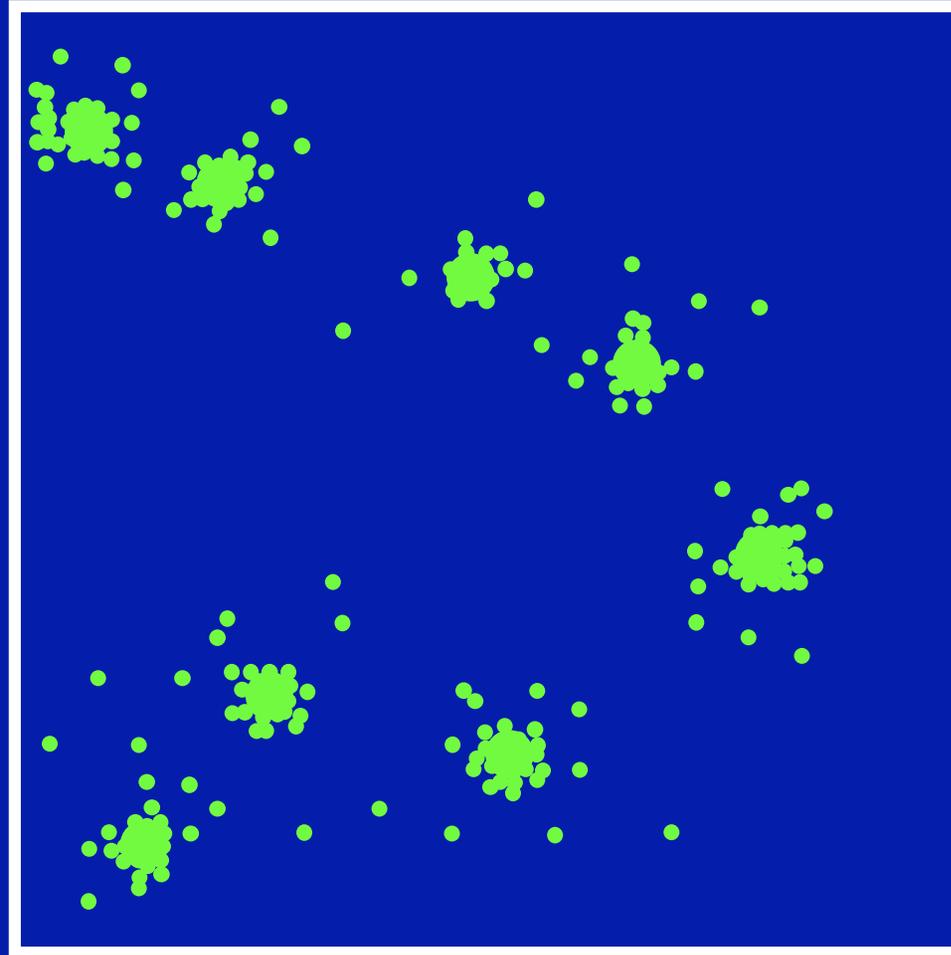
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Formant 1

English

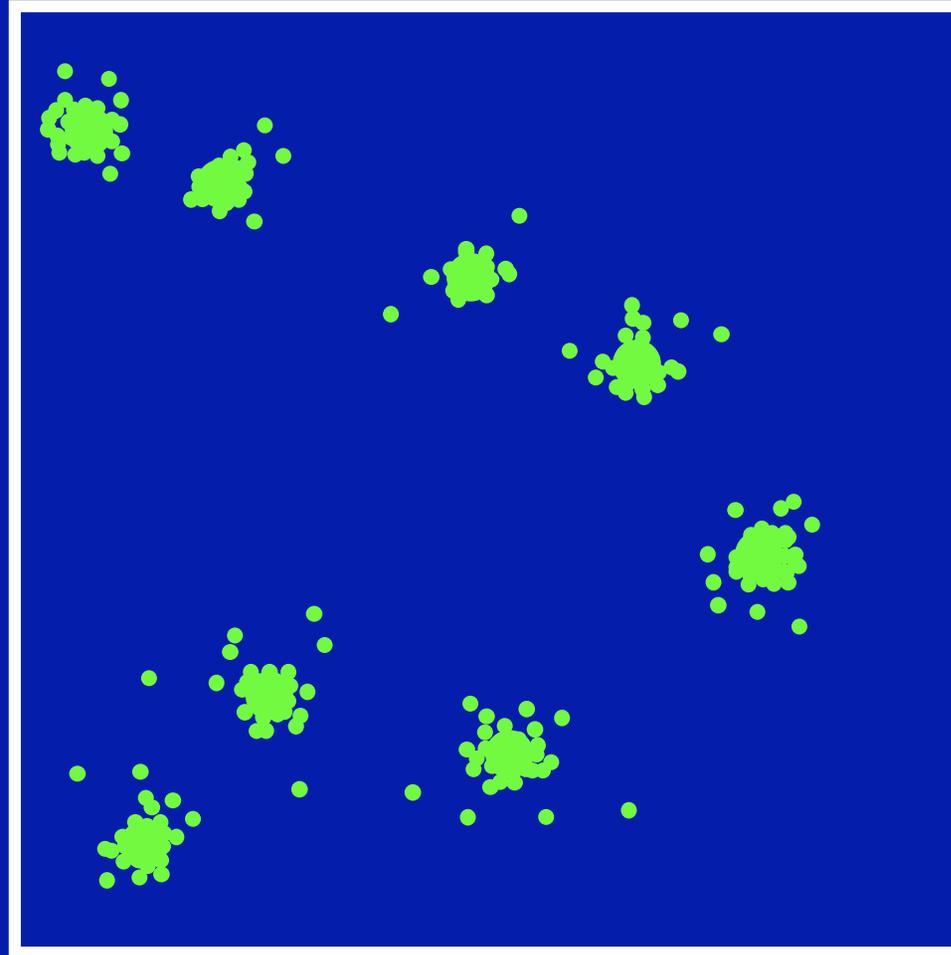
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English

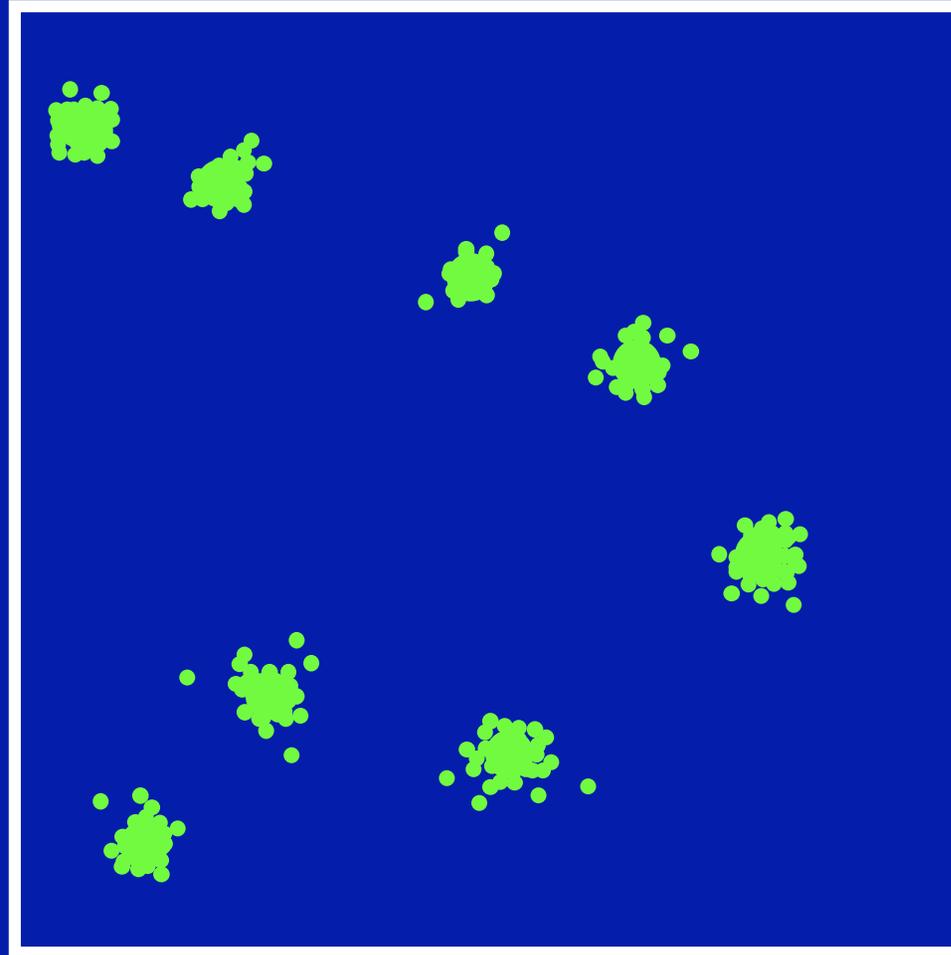
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English

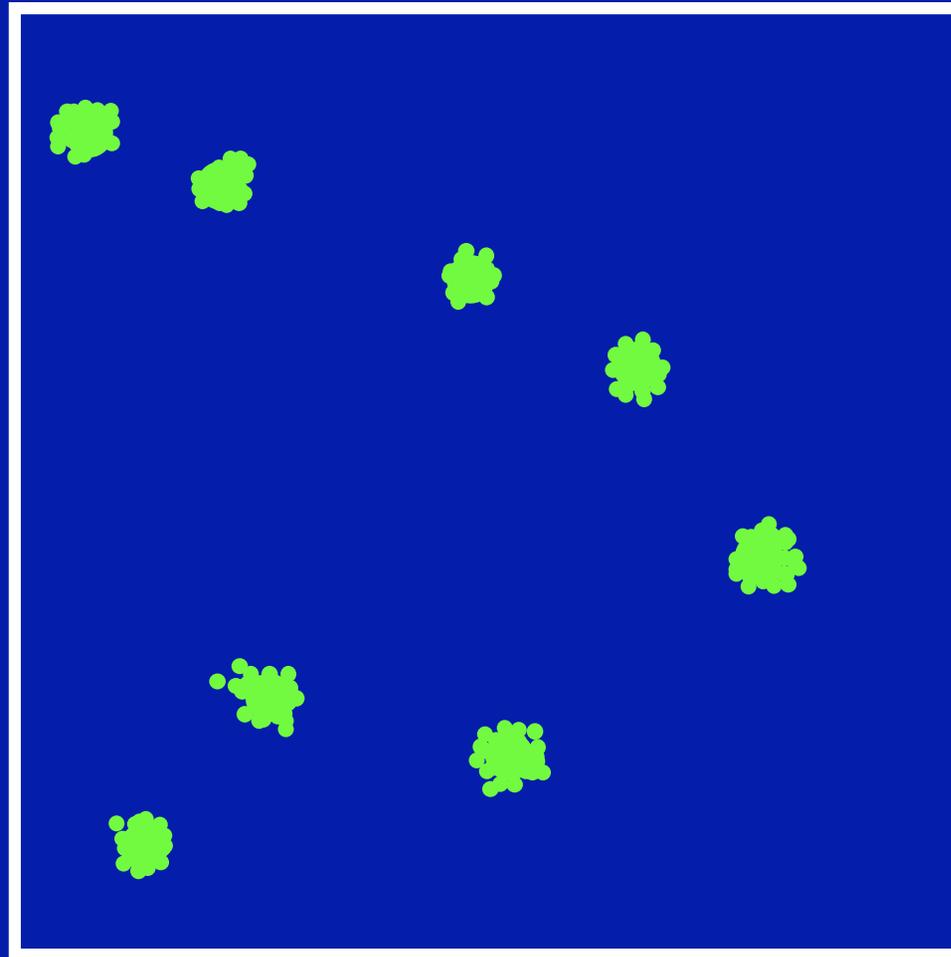
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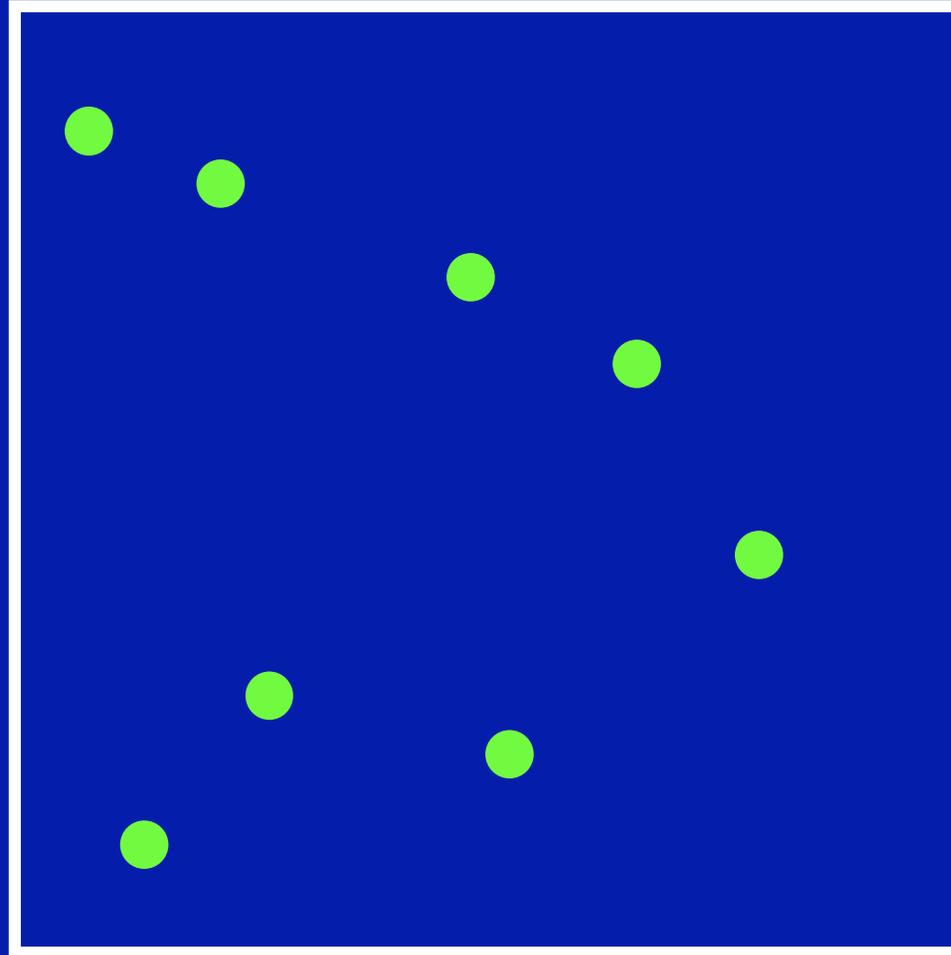
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English

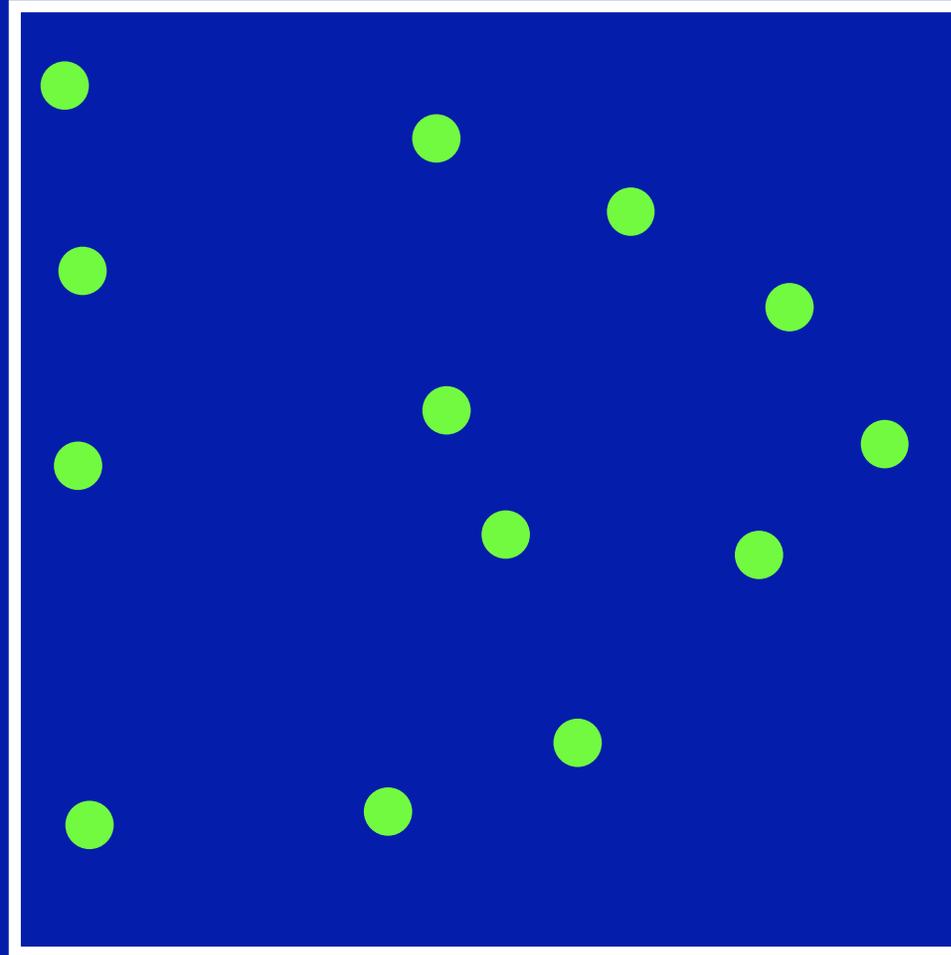
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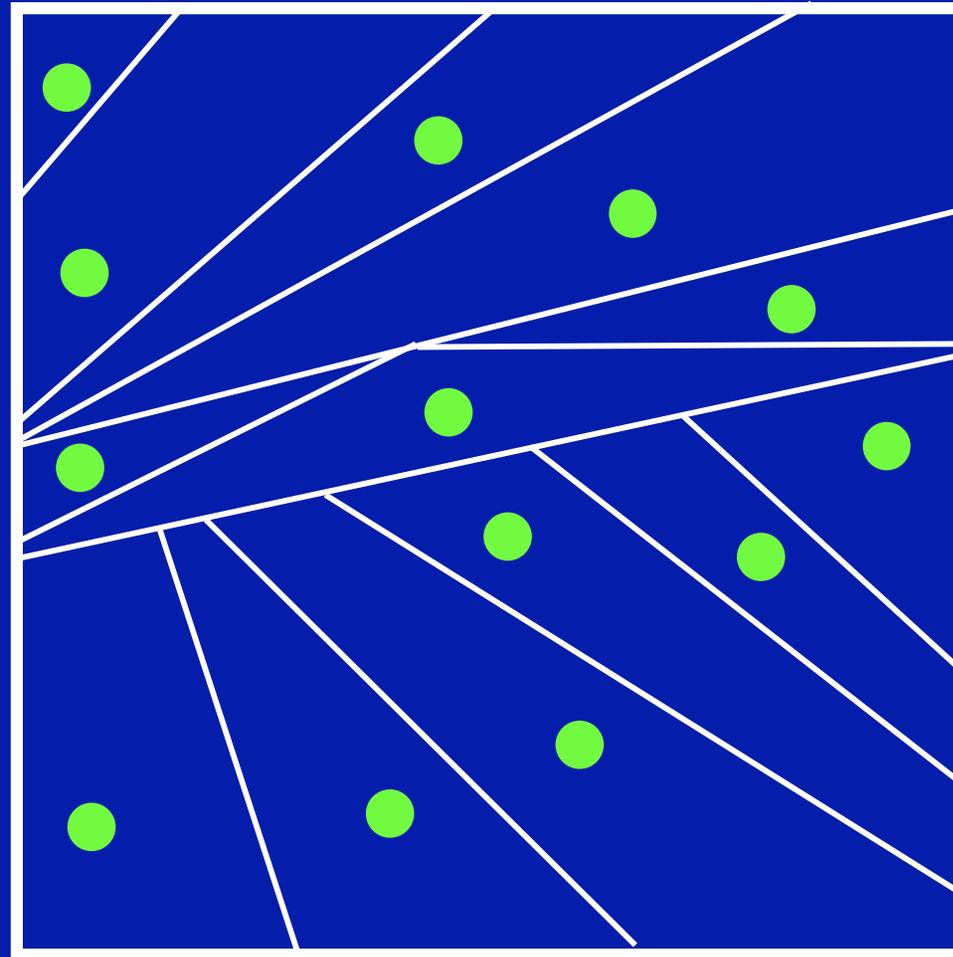
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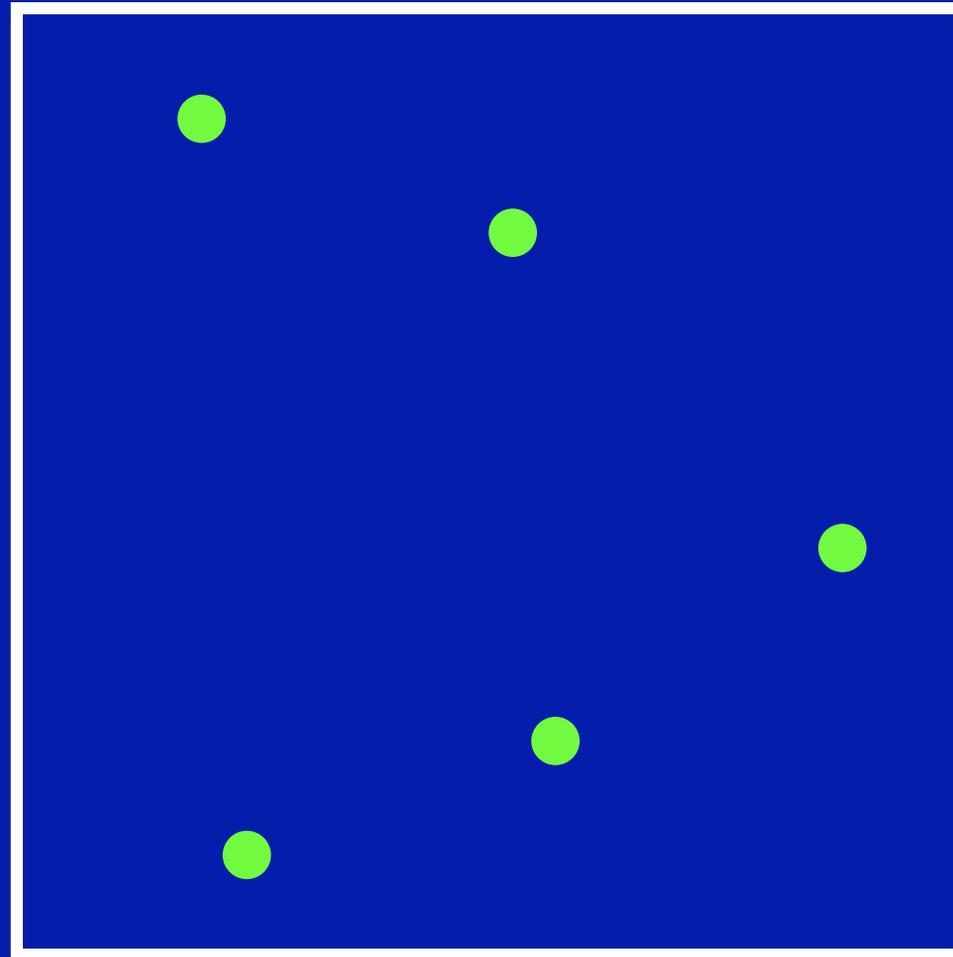
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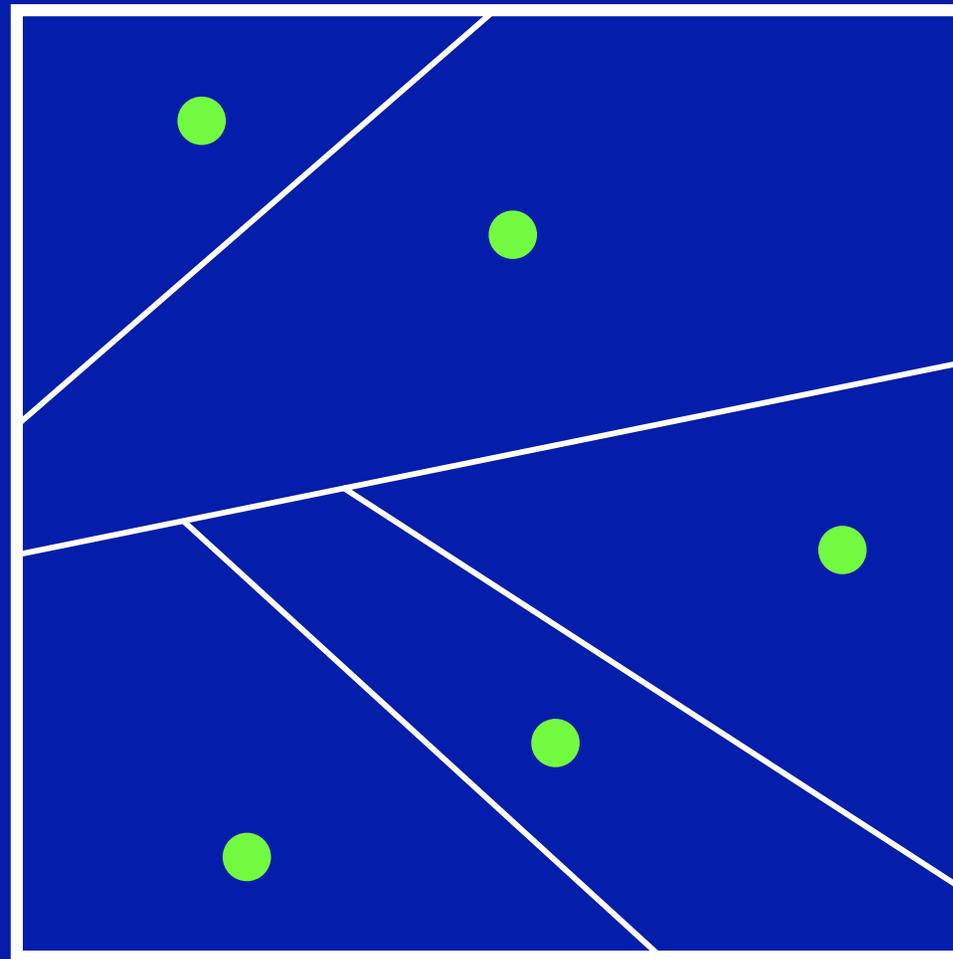
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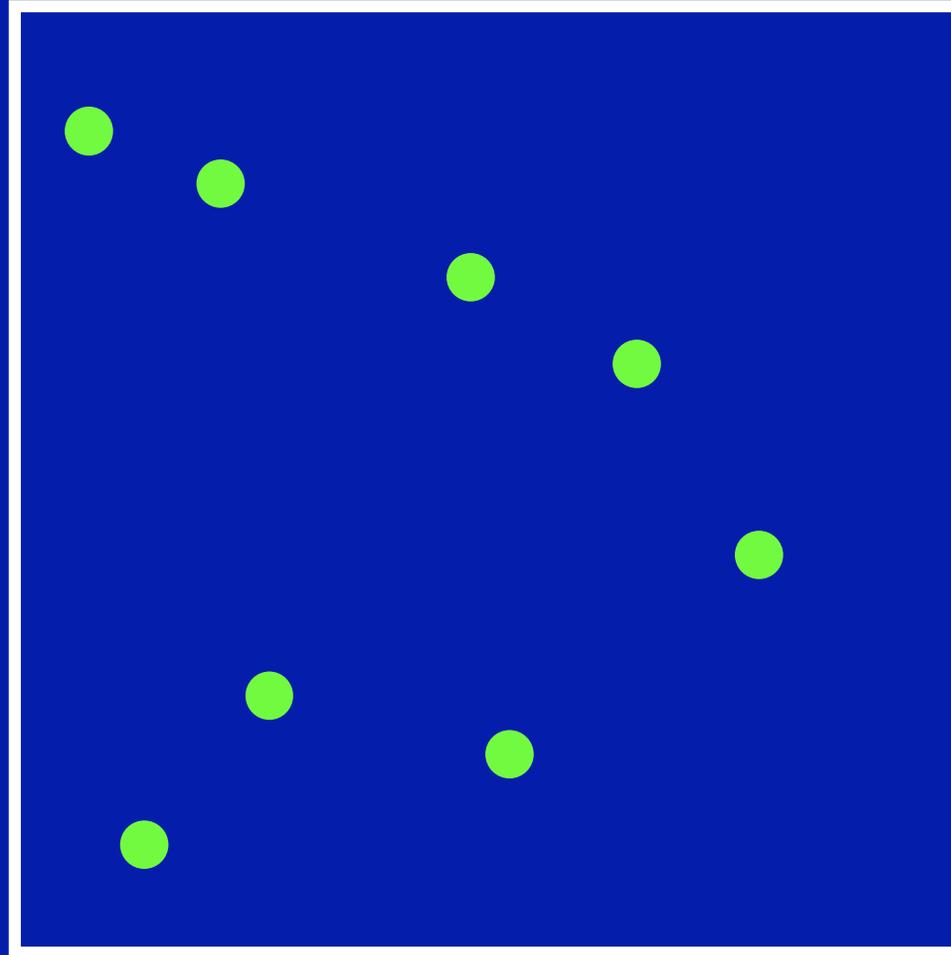
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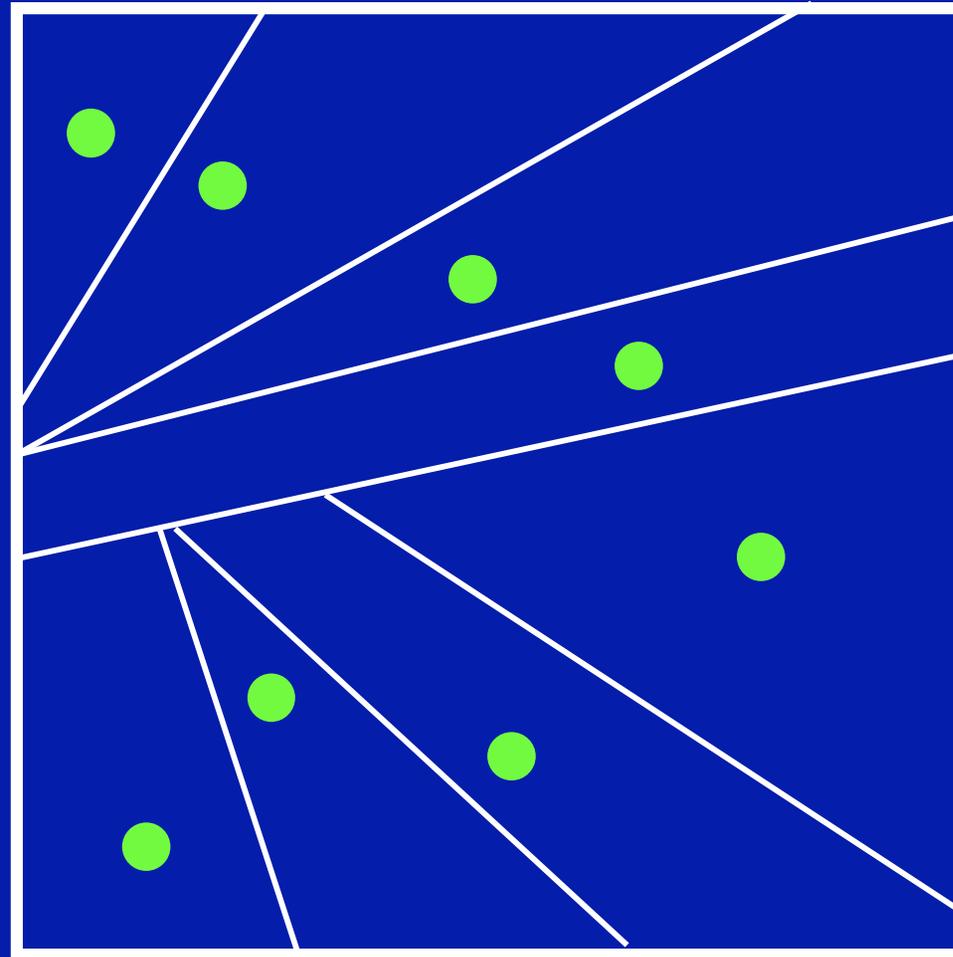
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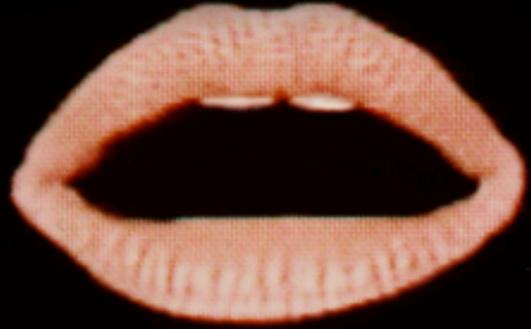
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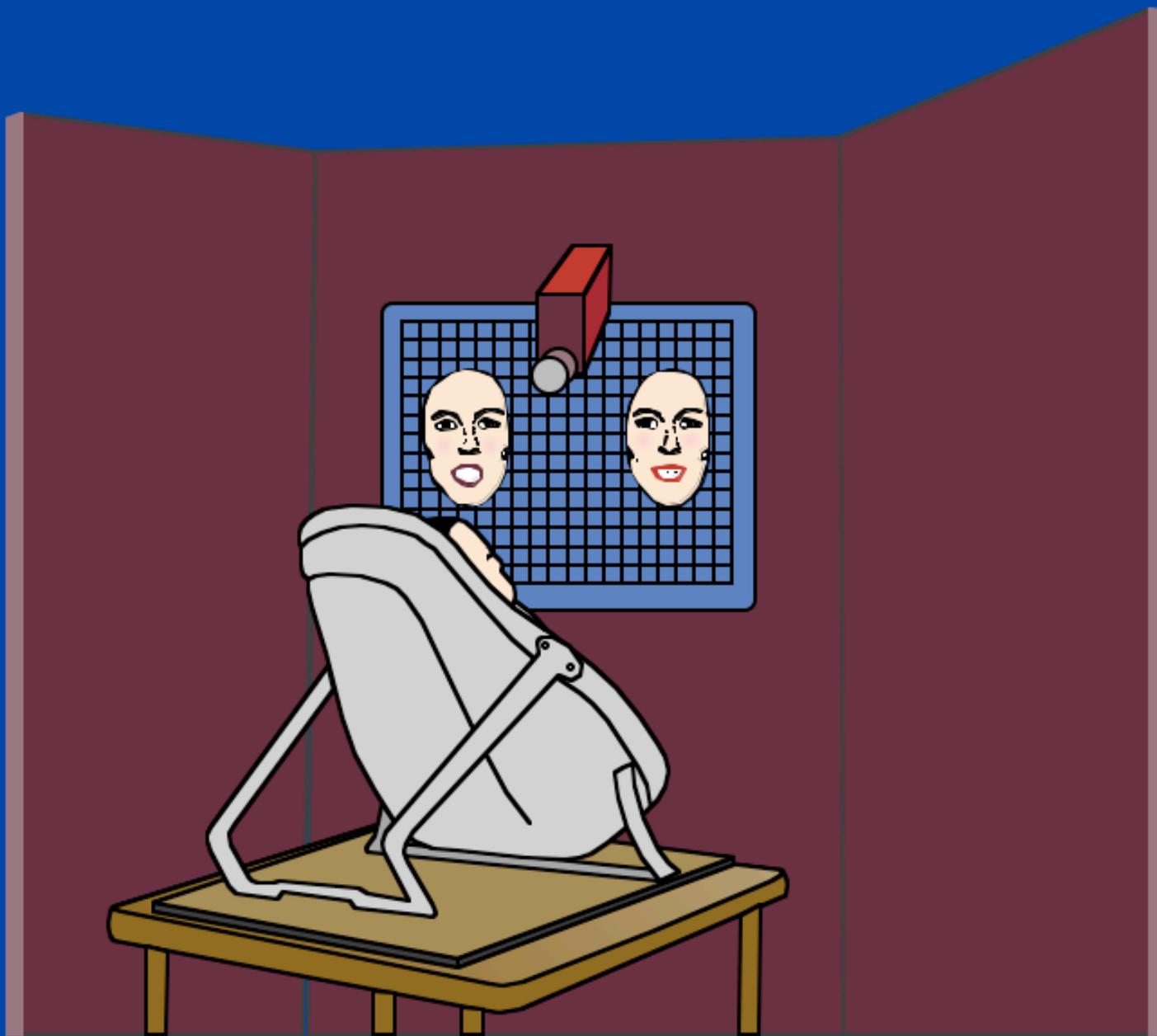
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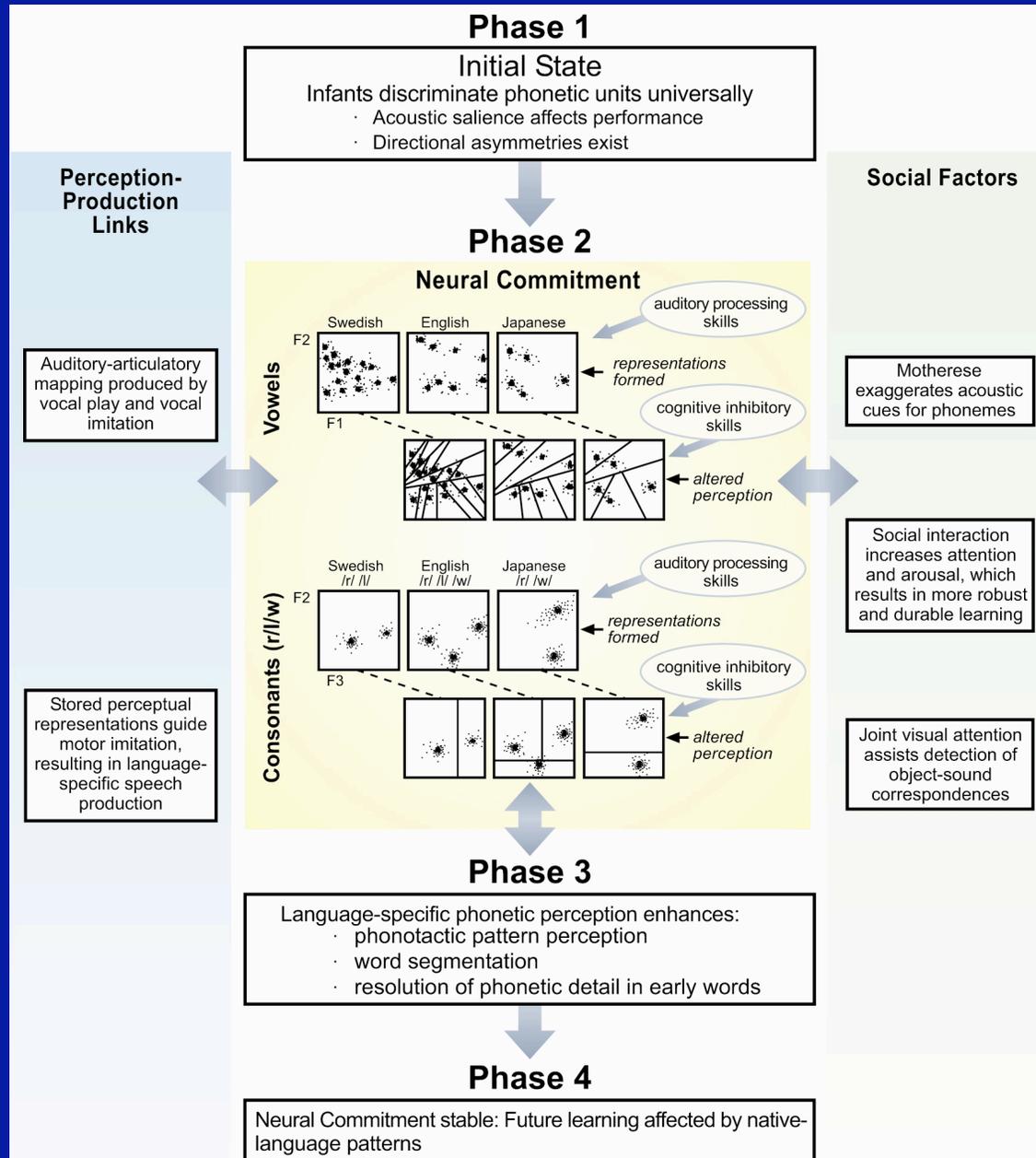
Formant 1







NLM-e



THE SCIENTIST IN THE CRIB

MINDS, BRAINS, AND
HOW CHILDREN LEARN



Alison Gopnik, Ph.D.,
Andrew N. Meltzoff, Ph.D.,
and Patricia K. Kuhl, Ph.D.

Neuroscience to Education:

Is the Neuron to the Chalkboard a Bridge too Far?



Thank You!!

