The Neural Basis of Infant Linguistic and Non-Linguistic Sound Processing Seen Through the New Light of FNIRS

2-096

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INTRODUCTION

From birth, babies have the capacity to discriminate categorically the smallest "building blocks" of language—*the phonetic units such as in [ba] [da]*—from any of the world's languages. By 10-12 months, they lose this universal capacity, and, instead, hone in on the phonetic inventory of their native language with increased precision[1-2]

What brain mechanisms support the remarkable infant capacity of phonetic discrimination so important for human language acquisition?

Equivocal Answers from Behavioral Data

Auditory-general[3-4]

Language-dedicated[5-8]

NEW QUESTIONS, NEW TECHNOLOGY

New views into the human brain help adjudicate long-standing behavioral controversy

What, When, How…

What brain tissue underlies language (phonetic) processing?

When does it come on line in human development?

How does it changes over time?

HYPOTHESIS LANGUAGE-DEDICATION will be evidenced by brain activation in tissue classically associated with the processing of native language phonetic units, involving specific sites in the human Left Hemisphere (e.g., Superior Temporal Gyrus, STG)[9], but not other sounds

METHODS

PARTICIPANTS

AGE GROUP	N	Language Background	Language Milestone
Young (2 – 6 Months)	4	English Only	Universal Phonetic Perception
Older (10 – 16 Months)	4	English Only	Native Phonetic Perception

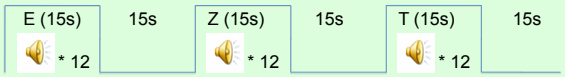
STIMULI (Equated for duration, mean pitch, mean intensity)

English (E, Native) /ta/ – /pa/

Zulu (Z, Non-Native)[10] /la/ - /lla/

Tone (T, Non-Linguistic)

Block-Design



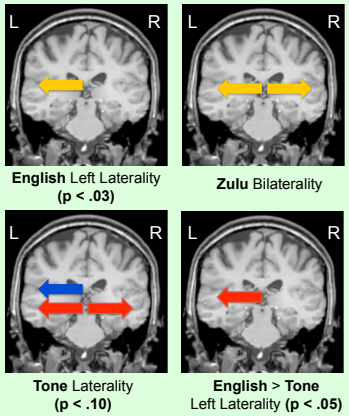
RESULTS

LEGEND - STG Activity

All infants

Young infants

Older infants

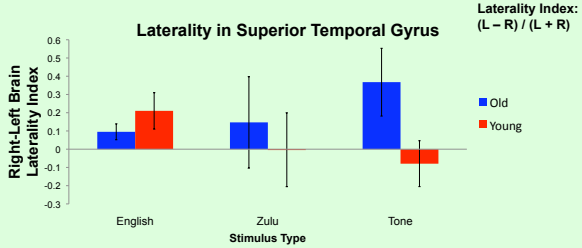


English Left Laterality **(p < .03)**

Zulu Bilaterality

Tone Laterality **(p < .10)**

English > **Tone** Left Laterality **(p < .05)**



NEUROIMAGING

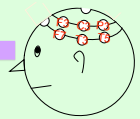
FUNCTIONAL NEAR-INFRARED SPECTROSCOPY (fNIRS)

fNIRS – ADVANTAGES OVER FMRI

CHILD-FRIENDLY NEUROIMAGING METHOD
Closer measure of hemodynamic change (HbOxy, HbDeoxy, HbT)
Used with INFANTS, and up (Quiet, tolerant of movement)
Excellent spatial (~4 cm) and temporal (10 Hz) resolution

Hitachi ETG-4000

Bilateral temporal probe placement



10 x 20 Coordinates[11]

CONCLUSIONS

Do infants recruit language-dedicated or auditory-general brain tissue for the processing linguistic sounds?

Language-dedicated, and from an early age!

Young infants recruited classically language-dedicated left hemisphere brain tissue[5-9,12-13], suggesting that these neural mechanisms come online early

Do infants show the same developmental trajectories for their responses to linguistic and non-linguistic sound processing?

Different trajectories based on linguistic status!

Infants showed developmental change in their recruitment of brain tissue when processing non-linguistic Tones, suggesting that there is a developmental shift in the recruitment of auditory-general brain tissue

ADVANTAGES IN SCIENCE FROM fNIRS

fNIRS has provided a window into the developing baby's brain, allowing us to look inside the human brain's developmental trajectory for processing linguistic and non-linguistic sounds over early life

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