

Assessing Speech Perception in Infancy

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Our overall goal is to examine the relationship between infant speech perception and later language development; and to bridge our research with translational and clinical applications to improve the assessment and treatment of infants & children with hearing loss.



Learning Objectives

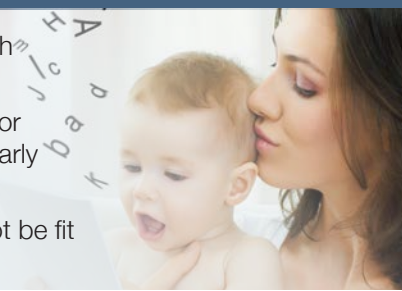
Learn about novel approaches to the analysis and interpretation of EEG for translational and clinical applications.

Describe the relationship between evoked potentials and behavioral measures of infant speech perception & discrimination.

Examine potential uses of electrophysiological and behavioral measures as tools for predicting language outcomes in children with hearing loss.

Key Issues

- Early language exposure fine tunes speech perception skills.
- Children with any hearing loss are at risk for missing essential sound patterns during early learning.
- Up to 50% of children fit with HAs may not be fit to optimal targets.



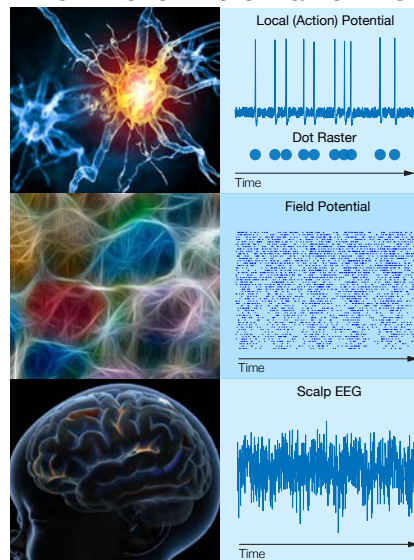
Assessment Tools

1 - 4 Months	7 - 9 Months	16 - 36 Months
Electrophysiology (EEG, EPs, ERPs)	Behavioral Assessment (VRISD)	Questionnaires & Language Sample

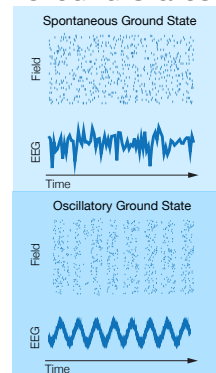
Electrophysiology

The scalp recorded EEG represents a volumetric sum of multiple underlying electrical currents generated at different spatial scales: microscopic (local action potentials and field potentials), mesoscopic (field potentials and EEG), and macroscopic (EEG and behavior). When the brain is “at rest”, neurons may fire spontaneously or become rhythmically entrained; that is, they begin to oscillate en masse creating a “ground state”. Perturbations of these ground states may be reflected in the scalp EEG as evoked or event-related potentials, or as oscillatory synchronizations and desynchronizations.

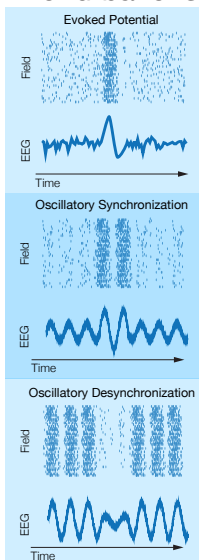
From Action Potential to EEG



Ground States



Perturbations



1. University of Colorado School of Medicine, PM&R
2. University of Colorado, Boulder, Institute of Cognitive Science

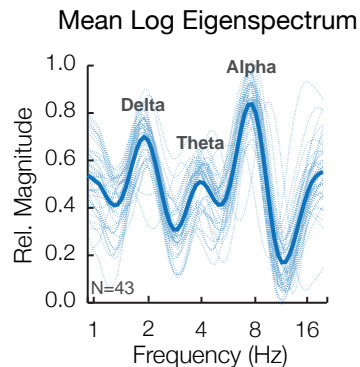
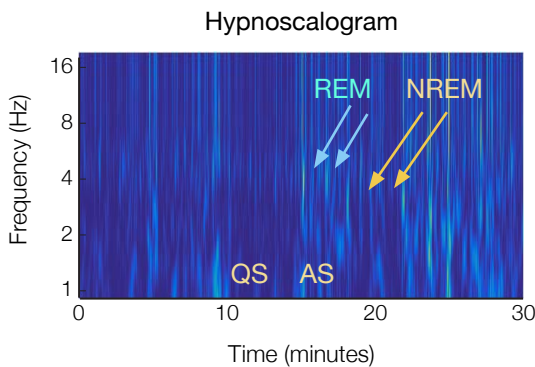
Infant EEG & Sleep

Infants spend up to 75% of their time asleep...however, the brain is still “listening” and processing information!

- Infant sleep cycles are dominated by “active sleep” (AS) and “quiet sleep” (QS).
- Active sleep accounts for up to 80% of all infant sleep.
- Two basic sleep stages, REM and NREM (or, non-REM) account for about 50% each of all active sleep.

Band	Hz	REM	NREM	QS	Sleep stages are recognized by spatial patterns in the EEG frequency bands. Typical sleep staging does not appear until about 4 to 5 months.
K-Complex	0.5 - 1.5				
Delta	1 - 3				
Theta	3 - 8				
Alpha	8 - 12				
Beta	12 - 30				

The hypnoscogram is a spectral-temporal representation of the EEG during sleep. Eigendecomposition of the normalized frequency scales in the scalogram reveals the “eigenspectrum”, which represents the mean contribution of each EEG scale over time.



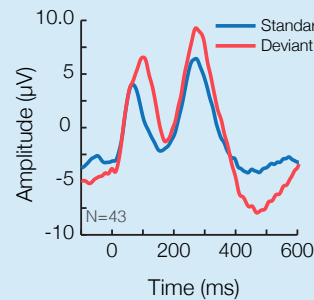
Auditory Processing During Sleep

Can we measure auditory perceptual processes from the EEG of sleeping infants?

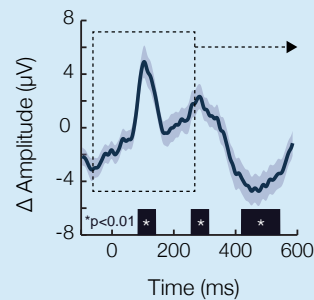
Mismatch Response (MMR)

Auditory evoked and event-related potentials can be estimated from the EEG of sleeping infants with a non-parametric, bootstrapping procedure that randomly permutes the trials without regard to sleep stage. This procedure can be extended to computed responses, such as the mismatch response (MMR), as seen below.

Standard & Deviant Responses

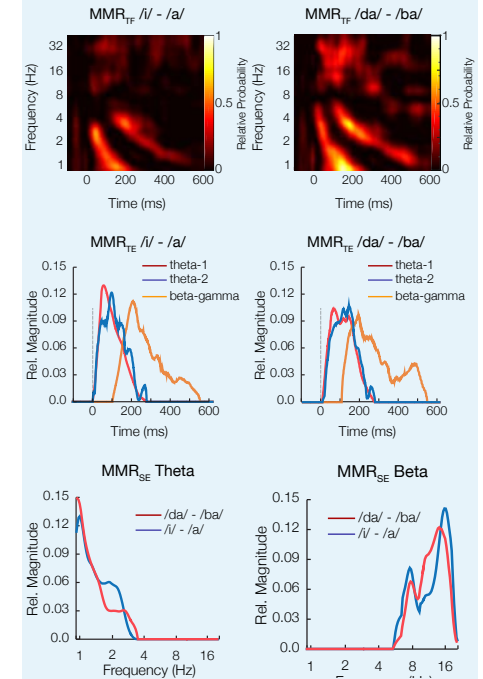


Mismatch Response (MMR)



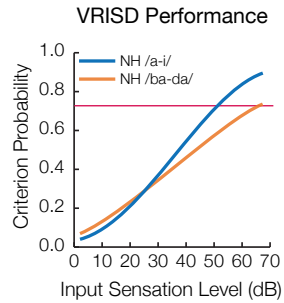
Time-Frequency MMR (MMR_{TF})

When further extended to the time-frequency domain, bootstrapping and permutation procedures provide a probabilistic estimate of a response. These probabilities represent dynamical modulations (event-related spectral perturbations) during auditory processing, and inform us about the probability of discriminating two sounds.



Behavioral Discrimination

VRISD allows us to assess an infant's ability to discriminate pairs of speech sounds with a statistically validated procedure.



Advantages

Language not required

Verbal responses not required

Prior knowledge not required

Challenges

Time intensive / Fatigue

Balancing reinforcement & distraction

Cognitive demands

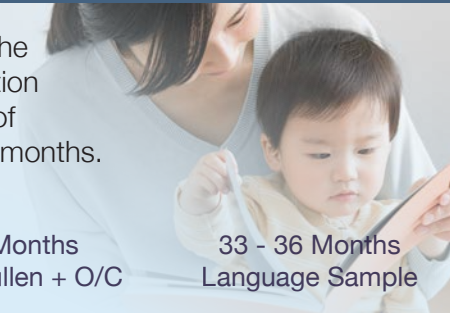
Language Emergence

Language development, including the emergence of gestural communication and syntax, is assessed by a series of questionnaires between 16 and 36 months.

16 & 24 Months
MDCD & CSBS-CP

16 - 30 Months
MDCD & Mullen + O/C

33 - 36 Months
Language Sample

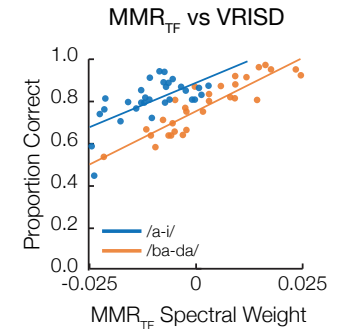


MMR_{TF} & VRISD

Can electrophysiological responses at 1 - 4 months inform us about later behavioral responses?

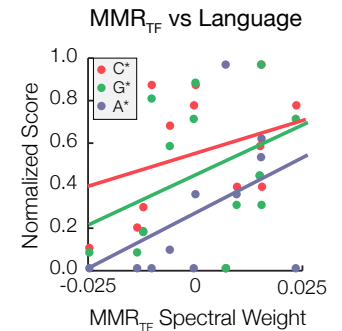
MMR_{TF} & Behavioral Discrimination

The "spectral weight", or spectral coherence factor, for each infant and contrast was used as the independent variable in a linear correlation analysis with the VRISD proportion correct scores. Although preliminary, we observe a mild correlation between the MMR_{TF} spectral coherence factor and VRISD proportion correct scores on the same contrasts.



MMR_{TF} & Language

Although preliminary, an early analysis from a small sample (n=14) suggests a similar, mild correlation between the MMR_{TF} spectral coherence weights for at least three scored variables from the MDCD and CSBS questionnaires.



MMR & Assessment of Hearing Aid Fittings



We have begun testing a modified MMR_{TF} procedure for assessing the effects of amplification (i.e., hearing aid fittings) on the detection of discrimination responses. The temporal envelopes for each eigenspectra provide a convenient method for measuring discrimination responses (MMR_{TE}), and allow for the selection of latency and relative magnitude values, which can be compared to age-matched latency shifts from a cohort of NH infants, for example as shown to the right (N=43).

