Central Auditory Development and Language Outcomes in Children with Hearing Loss Receiving Aural Habilitation: Case Studies

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Introduction

- 2-3 in 1,000 babies are born with hearing loss.[1]
- 73% of Colorado's 64 counties are rural; 13% or 697,748 people reside in rural counties in Colorado.[2]
- Families living in rural areas do not always have access to specialized therapy services for their children. Telemedicine is emerging as an option to provide health services for patients living in rural areas.[3]

P1 CAEP Biomarker

- The P1 cortical auditory evoked potential (CAEP) is a non-invasive electroencephalographic (EEG) response to auditory stimulation.
- The P1 response reflects refinement in the efficiency of sound transmission along the central auditory pathways at the level of the primary auditory cortex and the thalamus.[4-6]
- Because the P1 response varies systematically with age, it can can be used to objectively assess central auditory maturation in clinical populations with hearing loss.[7-12]
- Our laboratory has established 95% confidence interval norms for P1 CAEP latency, consistent with evidence of a 3.5 years in which the central auditory system is maximally plastic.[7]

Goals

In 2 children with cochlear implants, we assessed central auditory maturation using the P1 CAEP biomarker and the relationship with speech and language outcomes during the course of aural habilitation.

Design of the Clinical Trial

Study Population: Children with bilateral sensorineural hearing loss <age 7 years who have hearing aids or cochlear implants.

Baseline speech & language testing and P1 CAEP testing before therapy. → **Weekly in-person therapy or telemedicine aural habilitation therapy via videoconference software (Zoom™)** → **Repeat speech & language testing and P1 CAEP testing after 6-9 months of therapy to assess development over time.**

Case Study 1

Case History: Male child born at 38 weeks gestation with no complications with birth or delivery. The child referred on his newborn hearing screening bilaterally. Hearing loss was confirmed at age 1.5 months. The child received bilateral simultaneous cochlear implants at age 13 months.

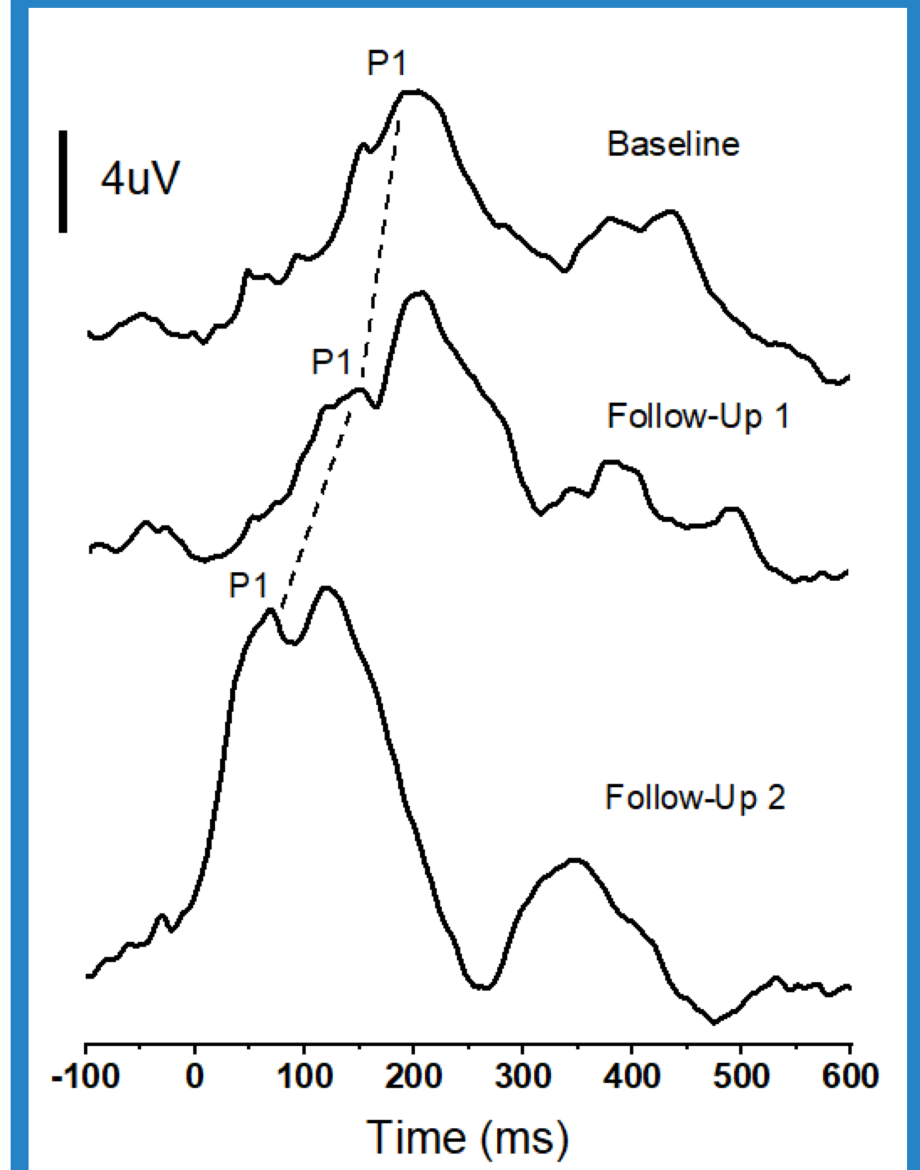

FIGURE 1. Longitudinal Development of P1 CAEP Responses. P1 CAEP responses were evaluated at age 5.25, 6.44, and 6.89 years. Decrease in P1 CAEP latency, increase in P1 amplitude, and changes in waveform morphology are observable during the course of aural habilitation.

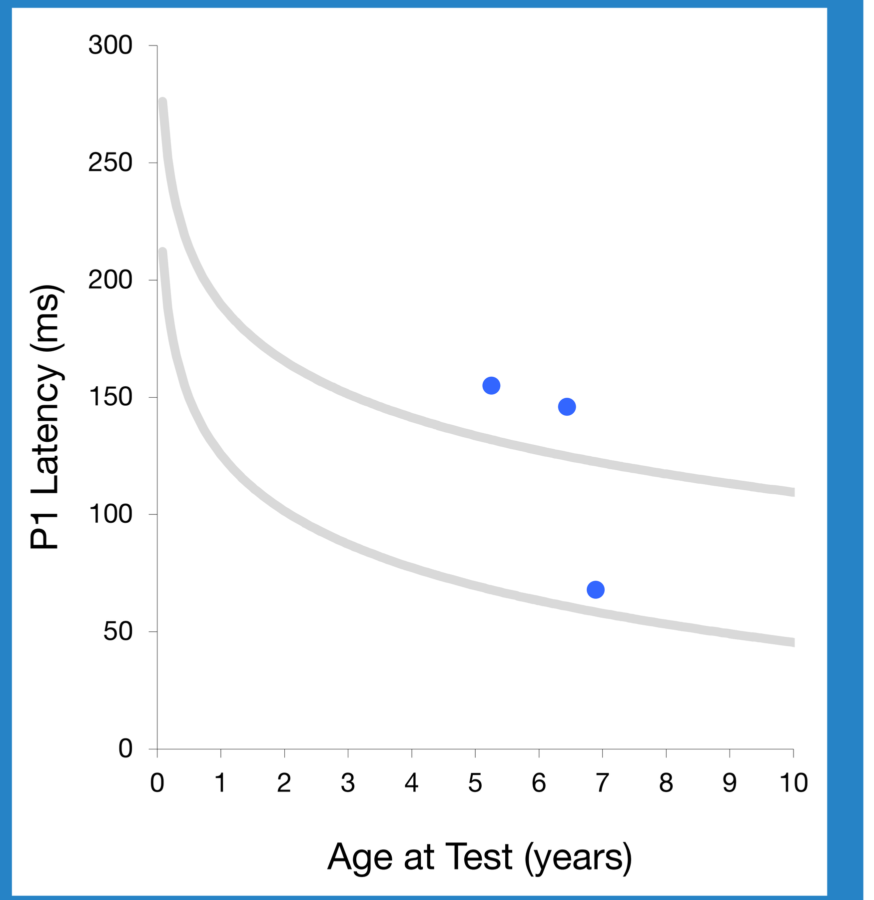

FIGURE 2. P1 CAEP Responses plotted against 95% Confidence Interval. Decreases in P1 CAEP latency are observed over the time course of aural habilitation.

	Baseline	Follow Up 2
Words Correct	92%	100%
Phonemes Correct	92%	100%

FIGURE 3. Performance on the Multisyllabic Lexical Neighborhood Test (MLNT). Improvement in speech perception abilities are observed from baseline to follow-up testing.

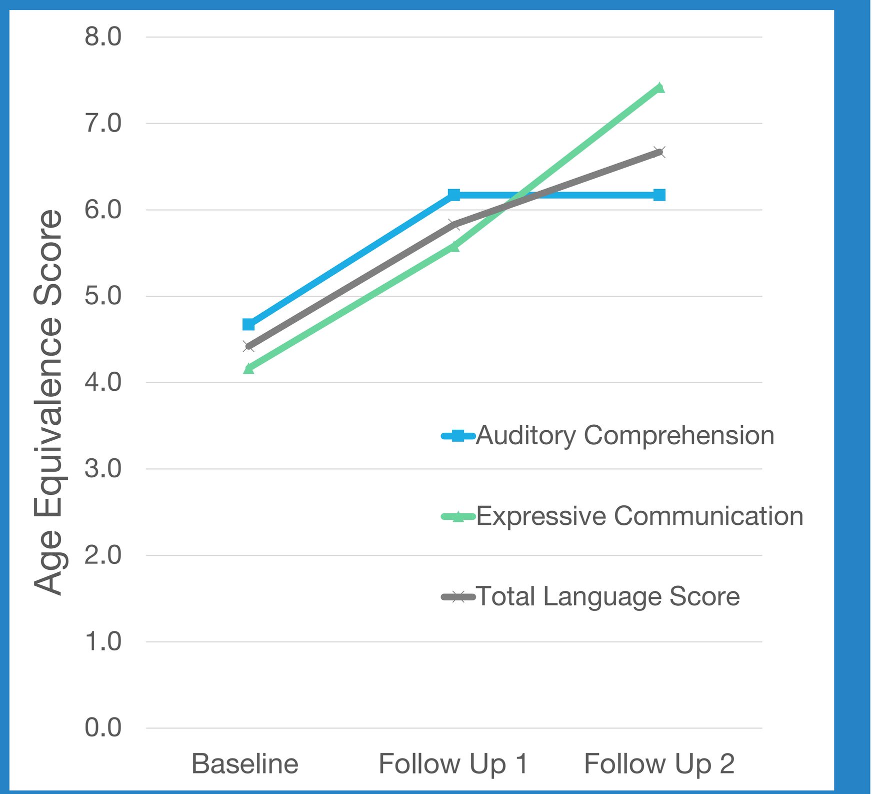

FIGURE 4. Age Equivalence Score on the Preschool Language Scale (PLS-5). Improvements in language outcomes are observed over the time course of habilitation.

Case Study 2

Case History: Male child born at at 41 weeks gestation. Complications included perinatal hypoxia and subsequent fetal distress, Referred on his newborn hearing screening bilaterally. Hearing loss was confirmed at age 7 months. The child received bilateral simultaneous cochlear implants at age 19 months.

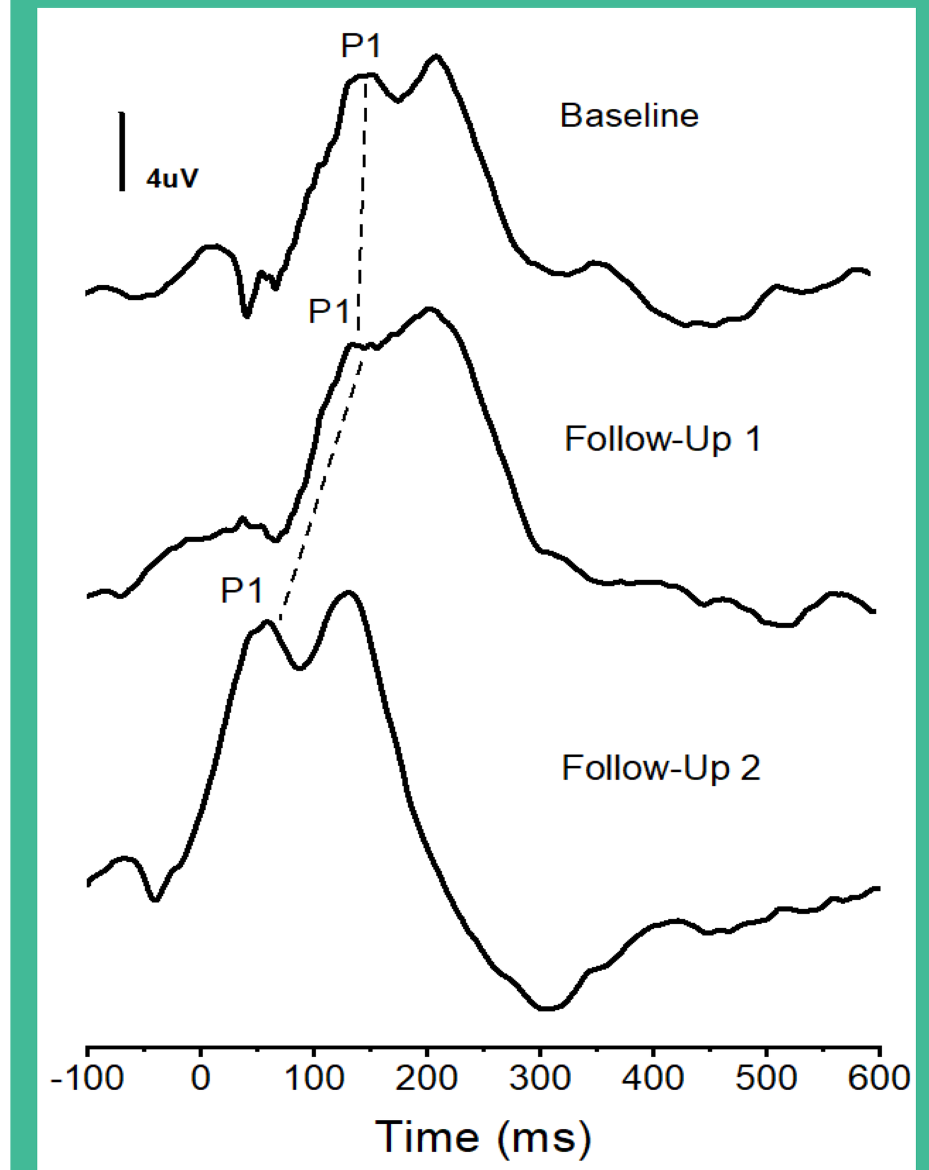

FIGURE 5. Longitudinal Development of P1 CAEP Responses. P1 CAEP responses were evaluated at age 4.82, 5.78, and 6.16 years. Decreases in P1 latency, increase in P1 amplitude, and changes in waveform morphology are observable over time.

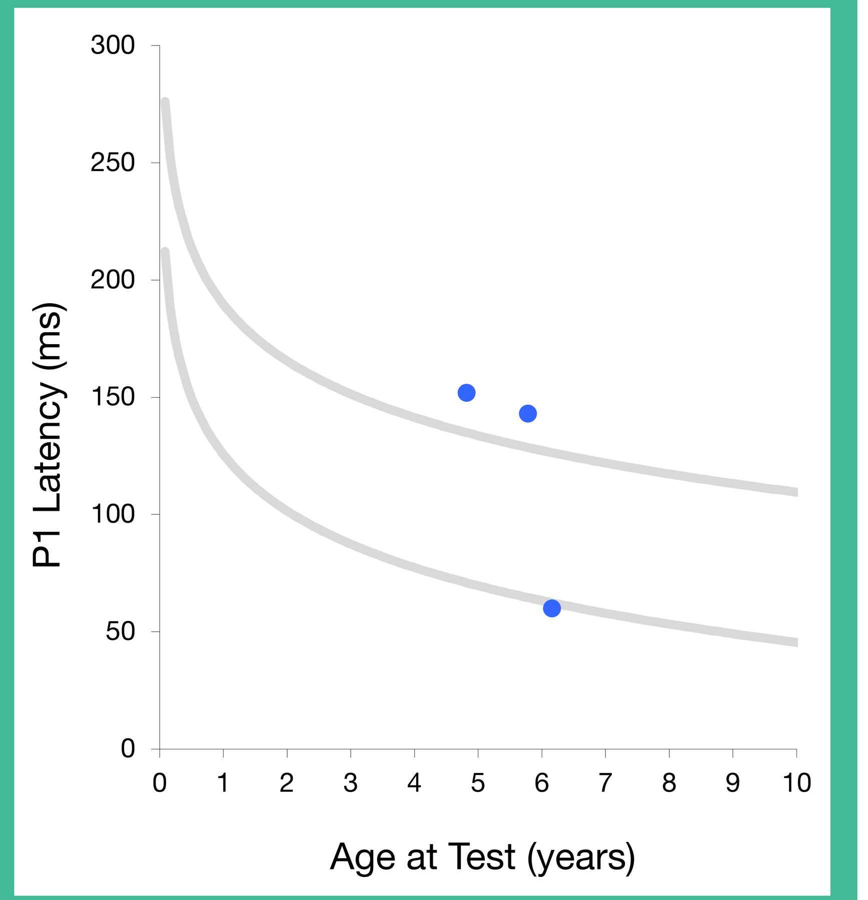

FIGURE 6. P1 CAEP Responses plotted against 95% Confidence Interval. Decreases in P1 CAEP latency are observed over the time course of aural habilitation.

	Baseline	Follow Up 2
Words Correct	25%	83%
Phonemes Correct	84.7%	97%

FIGURE 7. Performance on the Multisyllabic Lexical Neighborhood Test (MLNT). Improvement in speech perception abilities are observed from baseline to follow-up testing.

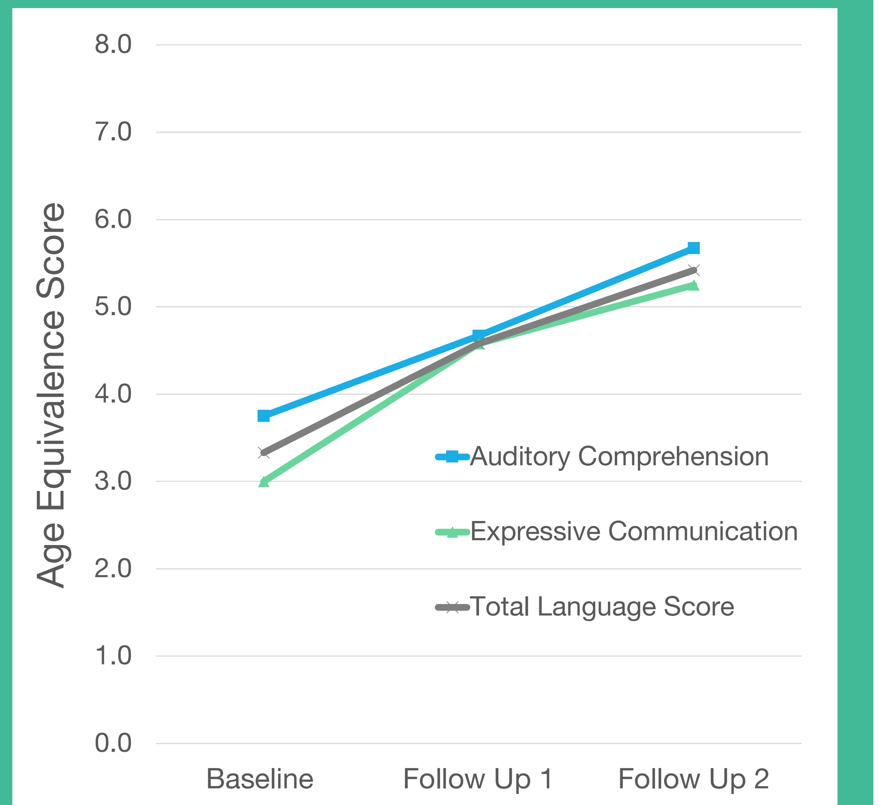

FIGURE 8. Age Equivalence Score on the Preschool Language Scale (PLS-5). Improvements in performance are observed across test sessions.

Discussion

In these both case studies of children with bilateral cochlear implants, we can see that the P1 CAEP biomarker (which reflects central auditory maturation), shows changes over time from initial enrollment in the study (Figure 1, 5). Latencies of the P1 CAEP response (which reflect synaptic propagation through the central auditory pathways) appear to decrease in latency (Figure 2, 6), reflecting refinement in maturation of the central auditory pathways. These results are consistent with improvements in speech and language development in both children over the time course of habilitation (Figure 3, 4, 7, 8).

We are currently recruiting children with hearing aids under the age of 7 years to participate in this study. If you are interested in referring patients, please contact:

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This project is funded by the National Institute on Deafness and other Communication Disorders (U01DC013529). The authors would also like to thank Listen Foundation for their involvement in this study, as well as the families who have so generously agreed to participate.