Bamford Lecture
Auditory Skill Development of Children Who are Deaf and Hard of Hearing from Birth: Validating Amplification Fit, Cochlear Implant Candidacy and Mapping

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http://www.mariondowns.com/our-research/pediatric
Relationship Between Toneburst ABR and Behavioral Thresholds

Verification-Validation in the first year of life

- **Audibility:**
  - Physiological thresholds – first month of life
  - Prescription for HA fitting (DSL, NAL)- second month of life
  - SII > 65
  - Under-amplification-Over-amplification – Ling 6 sounds in first few weeks of life- within weeks of initial HA fitting- behavioral validation
  - Physiological measures: CAEP P1 presence or absence – specific sounds reach the cortex

- **Discrimination:**
  - VRISD (6 mo+)
  - Cortical Evoked Potentials –possible but not ready yet (MMN, ACC) (<6 mo)

- **Auditory Skills – Identification/Comprehension**
  - Parent Questionnaires
  - Parent Interviews
VALIDATING AUDIBILITY ACROSS THE SPEECH SPECTRUM
Newborns can be observed to respond to speech sounds
Ling 6 sounds: Validation of audibility

Parents should be taught from initial hearing aid fitting to stimulate their infants with the Ling 6 sounds and to look for observable responses such as head turns, eye gaze shifts, eye widening, body movements.

Instruct parents to stimulate the child at ear level, but not so close that the child feels the breath flow. They may use varied intensity and inflection.
Ling 6 sounds: Validation of audibility

Put the hearing aids on in the morning after the child wakes

Turn them on and stimulate with one of the Ling 6 sounds – observe the child to determine if there is a response

Socially reinforce the child’s response with voice, hugs, and smiles

Each day choose a different sound so that within a week the parent can report back to the audiologist the sounds that the child responds to

Within weeks of the first amplification fit, it is possible to tweak the hearing aid settings and begin to observe responses for phonemes that are not yet audible
Validation that sound is reaching the cortex- Cortical auditory evoked potentials CAEP

P1 is a physiological indicator that sound has reached the cortex (presence/absence) – but it is not hearing

HearLab – FRYE Electronics

Clinical tool to determine whether sound is reaching the cortex across the speech frequencies: ma (low), ga (mid), ta (mid-high)
VALIDATION OF SPEECH DISCRIMINATION IN THE FIRST YEAR OF LIFE
Validation of detection of difference: Visual Reinforcement Infant Speech Discrimination

Intelligent Hearing Systems: VRA system

If a child can provide reliable VRA thresholds, the child can do the VRISD task

Rarely does the child need to be conditioned first, most children turn their head as soon as the stimulus changes
Clinical tool: Individual child score – stopping criteria

Reliable score – replicable at repeated sessions – criterion 90

Conditioned head turn response

Half hour sessions

5-6 contrasts per session

Typically no more than 15 trials

Trials include both change and no-change

Can set minimum of head-turn responses to reach criterion – e.g. 2 correct or 3 correct
Stimuli

• Theoretically can be almost any paired contrast – can be used with any spoken language

• Technique can be used with deaf adults who have not had previous auditory experience and with adults from non-English backgrounds – have recorded 15 different languages

• Can be used in habilitation/rehabilitation using social reinforcement

• Must be ‘short’ duration – no phrases or sentences
Oddball Paradigm

\text{a a a a a a i i i i i a a a a a a a}

(background) (target) (background)

_________________________head turn ___________
Duration makes a difference: 500 msc
(shortening duration to 400, 300, 200, 100 msc results in an increasing number of children with normal hearing who are not successful with the task)

Intensity level makes a difference: 60 dB HL
Can reduce duration and intensity with experience
Theoretically can do speech discrimination in noise

Phoneme contrast makes a difference - Hierarchy of difficulty
Most commonly used speech contrasts: a/u, a/i, u/i, sa/sha, ta/da, pa/ka, ba/da
vowels easiest (u/i most difficult)
place next - sa/sha and voicing most difficult but demonstrable with HAs about 9 months
VALIDATION OF IMPROVED AUDITORY SKILL DEVELOPMENT

PARENT QUESTIONNAIRE: CINCINNATI AUDITORY SKILLS CHECKLIST

35 ITEMS – 70 TOTAL POINTS
Children with normal hearing

Average Total Scores

Detection | Discrimination | Identification | Comprehension

- Birth - 1 Year
- 1 - 2 Years
- 2 - 3 Years
Average Total Scores: 2-3 Year Olds

- Normal hearing
- High freq hearing loss
- Mild hearing loss
- Moderate hearing loss
- Moderate-Severe hearing loss
- Severe hearing loss
- Severe-Profound hearing
- Cochlear Implant users

Total Score (out of 70)
Average Scores: Children with Hearing Loss

- Comprehension
- Identification
- Discrimination
- Detection

Categories include:
- Max Possible Score
- Normal Hearing
- High Frequency
- Mild
- Mild-Moderate
- Moderate
- Moderate-Severe
- Severe
- Profound
Average Scores: Normal Hearing vs. CI Users (Ages 2-3)
Item 34: Does your child obtain information incidentally through audition/hearing alone?

Development of children with normal hearing by item and age

Development of children who are hard of hearing by hearing loss and age – forthcoming - Marion Downs website
LittlEars - Percent in Normal Range by Hearing Category
VALIDATION OF AUDITORY TO SPOKEN LANGUAGE

PARENT INTERVIEW: IMP INFANT MONITOR OF VOCAL PRODUCTION

ROBYN CANTLE MOORE, RIDBC, UNIVERSITY OF NEWCASTLE
Three interviews in first year – 15 minutes average

• 3 to 4 months -- Reflexive vocalization -- auditory feedback loop not impacting vocal production

• 6 to 7 months - auditory feedback loop influencing vocal production

• 8 to 9 months - auditory feedback- language comprehension begins – from sound to meaning
Stages of Infant Vocal Production

Typical Stages of Infant Vocal Production

Adapted from Oller (2000)
Adapted from Nathani, Ertmer & Stark (2006)
Cantle Moore, 2005
3. Does the infant produce sounds other than crying?

*Ask parent:* What sounds do you hear him make with his voice?

(Are sounds described as guttural, squealing, cooing? What is the infant doing? Does parent ascribe meaning?)

Comment: ......................................................................................................................

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13. Does the infant vocalize freely during independent play?

*Ask parent:* Do you hear him use his voice to comment /‘talk’ when he is playing alone? What does he do?

(Does he produce rhythmic open & close of jaw CV patterns? (e.g. a-ba... a-ba... a-ba)

Are CV vocalizations polysyllabic? (e.g. di-di-di-di-di-di-)

Are CV vocalizations prolific in number? (4-5 strings per minute)

[Mark each example CV production on chart below Q 16]
IMP scoring & evaluation
Cantle Moore

Baseline: .......months age/corrected age: 2^{nd} .......months HA/CI: 3^{rd} .......months HA/CI: 4^{th} .......months HA/CI

SCORE: Assessment Date: ...........................................
Child's Age: .......yrs .......mths.

Chronological Age (Corrected)

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Hearing Age (HAE) (CI)

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% Ranking

| 20 | 50 | 80 | 76 |

CONSONANT-VOWEL QUADRILATERAL

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<tbody>
<tr>
<td>low [i]</td>
<td>shoe [i:]</td>
<td>book [u]</td>
</tr>
<tr>
<td>bad [æ]</td>
<td>bid [i]</td>
<td>bell [ɛ]</td>
</tr>
<tr>
<td>cat [ɪ]</td>
<td>can [e]</td>
<td>cat [o]</td>
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Audition Q4 Q12 Cognition Q2 Q9

Raw communicative score: 100 %
Ceiling total score: 

Total % Ranking = 76
IMP – Typical hearing infants

Cantle Moore

Kuhl et al., 2006
IMP – Infants (ANSD) using HAs (Cantle Moore)

PROGRESSIVE SCORING:

Child: Hearing Status: Change in Status:

Chronological Age (Corrected)

Question ceiling

Hearing Age (HAs) (CI)

PROGRESSIVE SCORING:

Child: Hearing Status: Change in Status:

Chronological Age (Corrected)

Question ceiling

Hearing Age (HAs) (CI)
IMP – Infants (ANSD) using HAs
(Cantle Moore)

PROGRESSION SCORING:

Child: Hearing Status: Change in Status:

Chronological Age (Corrected)
Question ceiling

Hearing Age (HAS) (CI)

31% 50% 62%

Pre 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

68% physiological 65%

24 months

18 months
IMP – Infants (ANSD) using Has (Cantle Moore)

PROGRESSIVE SCORING:

Child: ............... Hearing Status: ............... Change in Status: ...............
Registration
This training is free of charge, however you are required to register before you can access the training modules. We also ask that you share data collected using the IMP via the online form, available in the training website.
Go to http://www.ridbcrenwickcentre.com/imp to register. Once registered, you will receive an email containing your login credentials.

Robyn Cantle Moore, PhD
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CRYSTAL BALL: CAEPs + improved behavioral procedures

• Kristin Uhler & Phillip Gilley (University of Colorado, Boulder)

• **Discrimination:** Mismatched negativity - MMN
  – Stay tuned --
  – Measuring speech discrimination cortically with hearing aids or cochlear implants
  – Some labs using Acoustic Change Complex (ACC)

• **Efficacy of auditory habilitation** - the assessment may result in newly developed potentials (Tremblay – adults)