The Importance of Evidence Based Habilitation
maximizing the potential of technology
Service Models & Therapies
Remote therapy at RIDBC: Teleschool
Blended Service
What do we know of predictors of outcomes....

- Geers (2012): 112 children
  - Age at implantation
  - Generation of speech processor
  - Aided PTA thresholds
  - Non-verbal IQ

- Ching (2014) 450 children (70% HA 30% CI)
  - Additional disability (30%): AN about 10%
  - Gender
  - Maternal education
  - Cognitive ability
  - Age at fitting for ci children
Changing educationally?
Sue Archbold: Ear Foundation

• The majority are going to mainstream schools....

• The majority of deaf children are using spoken language

• In England (2013/14: CRIDE report... ndcs.org.uk)
  – 79%/90% using spoken language only
  – 2%/1.8% using BSL
  – 6%/7% using Sign with spoken language
However........

- Nearly three quarters of children with hearing loss arrive at primary school (aged 4) having not achieved a good level of development in the early years. (NDCS, 2016)

- In 2015, 44% of deaf children left primary school (aged 10) - without having achieved the expected benchmark in reading, writing and mathematics, compared to 10% of children with no Special Educational Needs. (Department for education, January 2016)
Early Intervention
Increasing Expectations
for all children
(Up to 40%......have another difficulty)

The Newborn Hearing Screening Programme was introduced in order that outcomes for deaf children could be improved by early identification of hearing loss and effective, early intervention (Yoshinagol-tano, 1998).
Maximising Potential
Early Intervention

Bonding/attachment
Development of the listening brain
Pre-verbal skills

By the age of three and a half, the human brain has completed 85% of its physical growth. Suskind, 2015
Developing the Musical Brain!

- Musical processing activates multiple areas of the brain important for language development (Tervaniemi, 2009)

- Structural changes as a result of experiences (Shaw & McEachern, 2001)

- Musical experience boost implicit learning of both musical & linguistic structures (Franciois, C., Schon, D., 2011)

- Immersion in consistent musical experiences allows developing brains to absorb sound, supporting development of communication & cognitive abilities (Patel, 2003)
A growing body of evidence suggests that musical activities can:

Enhance the listening brain (Francois and Schön, 2011; Shaw and McEachern, 2001; Tervaniemi, 2009)

Provide a foundation for later music and language inter-related development (Besson et al., 2011; Chobert et al., 2014; White et al., 2013)

Naturally developing the areas of attachment, listening, language, and cognition (Chandrasekaran and Kraus, 2010; Patel, 2003a, 2003b)
Using music can enhance the development of literacy skills

- Welch, G. (2015). Literacy through music
What are they listening to?

Specific musical characteristics of everyone’s speech & singing

Discriminate voice features
- Timing patterns: slow versus fast
- **Pitch:** high versus low
- Intensity: soft versus loud
- Voice quality: happy, angry, neutral
- **Emotional Inference**
- **Emotional Literacy**

DeCasper & Fifer, 1980
Listening, Language & ......Music leading to Literacy (reading & writing)

It’s more about the ‘musical’ ears than the eyes!!
Traditionally are nursery songs just for Rhythm & Auditory closure?

• Consider: ‘musical auditory closure’
  (Bharucha, 1987, 1994)

• Musical information is primed during the listening time. Emerges through exposure (Bharucha 1987)

• Veridical Memory…..what do we expect the next note to be?
Learning induced neural plasticity of speech processing before birth.

Proceedings of the National Academy of Sciences, 110(37), 15145-15150.


In the study in the infants listened to a slightly modified version of “Twinkle twinkle...”, and the brains of the infants who were exposed to the original piece during the third trimester reacted strongly to the modified melody.

The fetus’s brain had formed a memory trace of the song in the womb and was later able to pick up slight anomalies in the song.
A Different Musical Perspective

Improving Outcomes in Music through Habilitation, Education, and Training for Children with Cochlear Implants/Hearing Aids
A dynamic new opportunity!
Objective
Design a musical habilitation resource
Maximise Early Intervention – an integral element of therapy

- Engage in parent-child interactions early
- Establish listening behaviors early
- Establish early communication skills
- Encourage social & emotional development

- Confident families - Can start during the “wait time” after receiving hearing aids and waiting for cochlear implants
- Confident, consistent use in the Clinic & Home
Multi-sensory

During the first 6 months of life touch is critical to mother–baby interaction (Kaye and Fogel, 1980; Tronick, 1995)

the baby’s communicative skills (Lamb et al., 1987).
Early Influence of Music
what do babies innately listen for?

• **Mother’s voice:** Querleu et al., 1984, DeCasper, 1980
• A particular prosodic sequence when sung by the mother during the last weeks of her pregnancy: Mehler, 1988
• **A musical sequence:** Trehub, 2001
• **Sensitive to the rhythmic prosodic features of language:** Mehler, 1988
• **A given language (maternal)**


Early Musical features within the babies voice

- Babble sounds at around the age of 8 weeks
- Phrased vocalisations by 2 months
- By 5 months discriminate adjacent pitches
- 8-11 months perceive/recall melodic contour
- ID speech guides vocalisations/melodic phrasing through musical vocal play


Winkler I et al. Newborn infants can organize the auditory world. Proceedings of the National Academy of Science 2003; 100 (20): 11812 – 11815
Nurturing -

Communicative intent


Communicative Musicality (Malloch, 1999)


Innate Musicality


Pre canonical:
Precursor to canonical babble & speech
Doesn’t possess well formed qualities C’s or V’s
Before 6 months hearing babies
Not transcribed phonetically

Canonical
• Full, well formed, vowel like sounds
• At least 1 consonant sound
• Rapid transition between C & V
• Repeatedly contrast sounds
7-8 months and reliably at 10 months in hearing children
Onset of real words follow few months after onset canonical babble
Canonical babble ratio: number of utterances increases with age

Good measure of progress
Good measure of speech like quality
Parents hearing children-95% accurate identifying onset canonical babble-less easy to determine with deaf babies

Reference:
What about babies with a hearing impairment?

• Moderate/severe loss-canonical same time or slightly later than hearing children

• Profoundly deaf-canonical babble significantly later than hearing babies (except CI)

• More glottal sequences than hearing babies

• Age amplification positively correlated to canonical babble

Vocal language development in deaf children-new challenges - D. Kimbrough Oller- In Advances in the spoken language development in deaf and hard of hearing children-Spencer & Marschark 2006
Babies with cochlear Implants

- Ref: Schauwers et al 2004
- Babble=First appearance of multiple articulatory movements/Stage 5/Canonical babble-usually at 7-10 months
- Canonical babble ratio of 0.2 or higher
- Babbling started 1-4 months following implantation
- Babbling corresponded with age implantation-earlier implantation, closer to normal development of babble
- Better results if implanted within first year

Attachment

A play of closeness and distance

‘At the level of the mind, attachment establishes an interpersonal relationship that helps the immature brain to use the mature functions of the parent’s brain to organise its own process’

Aim through Early Multi-Sensory Musical interaction
Parental Engagement & Influence

- Given that parents of special needs children often experience excess stress, they may be susceptible to negative outcomes (Asberg et al 2008)

- Post-diagnosis mothers of deaf babies may have difficulty coping with the fact of the child’s impairment
- Mourning process
- Feelings of anger, grief, guilt & helplessness

Evolutionary necessity for bonding... critical... biologically programmed part of infant and parent functionality
(Dissanayake, 2000)
consider the key Musical components in relation to children with an hearing impairment

- **RHYTHM**

- **TIMBRE**

- **PITCH**

- **HARMONY**

- **Listening in noise!**
  Kraus N, Chandrasekaran B. Music training for the development of auditory skills. Nat Rev Neurosci 2010;11:599-605
Basic Beat & Imitation of rhythmic patterns, sequences

- Left auditory cortex: groupings, rhythm
- Underpins all Speech and Musical development
Nina Kraus

- The first to provide biological evidence linking the ability to keep a beat to the neural encoding of speech sounds which indicates significant implications for reading.

- The study shows that accurate beat keeping involves synchronisation between the parts of the brain responsible for hearing and movement.

- She focussed on the auditory component whereas previous research highlighted the motor component.

  Journal of Neuroscience (2015)
Why Use Backing Tracks?

• Baby hears your voice and their voice
• **Baby separates their mothers voice from accompanying background music**
• Develops listening with definition of melody, harmony, bass
• Supports rhythmic impetus
• Baby learns to listen and understand the musical context
• **Listening in noise**


Kraus N, Chandrasekaran B. Music training for the development of auditory skills. Nat Rev Neurosci 2010;11:599-605
Design

• Hierarchically structured musical activities
• 4 “musical trails”
• Not songs – language independent

Babies from 3 months

Infants up to 2 years
Evidence based research: Movement & Music

• Infants sense & perception of rhythm linked to their body movements (Bergeson & Trehub, 2006)

• Basic beat foundation of both music & communication

• Most caregivers move while singing to their infants, making the connection between rhythm and movement

Rhythm influences our perceptual processes related to cognition, affect and motor function

Movement influences the auditory encoding of rhythmic patterns in infants and children
India
Exploring Instruments

Babies Pre-Implantation

Toddlers Post implantation
Developing Timbre & Pitch


• Listen for sound & silence

• Explore the different sounds & tactile feel of the instruments

• Detection, discrimination and identification of instrumental timbre

• Responding to changes in the tempo, rhythm & phrases

• Language independent
Input dynamic range (IDR) 80dB
Ocean Drum

• Use the Ocean Drum.
• Listen to the music.
• When the music changes, what will you do?
Development of listening for the changes in the sections
Early Symbolic Sounds
Animal fun
Instrumental & Vocal Timbre, Pitch, Harmony

• Discriminating music from voice (symbolic animal and transport sounds)

• Opportunity for imitation of actions and vocalisations

• Association of symbolic sounds to an object/picture (toddlers)

• Anticipation - cause and effect
Exploring Transportation
What did they hear?
Hearing the Symbolism or Meaning in Music!

What do we listen for?

- Rhythm – tempo?
- Melody – pitch & intervals, phrases?
- Character of the music – timbre, dynamics?
- Emotional inference – harmony?

We don’t listen to isolated musical elements ..... **We Learn to listen to simultaneous layers of musical experience**
Exploring Transportation:
Link to Listening, Language & Music for Literacy

Extend: Rhythm, Rhyme, Repetition
• Dynamics
• Tempo
• Rhythmic flexibility
• Memory span
• Cognitive development
• Motor control

Auditory sequential memory:
• Integrating early symbolic sounds & text
• Integrating instrumental timbre
• Integrating movement
• Integrating short backing tracks- & symbolic music

Vocabulary e.g. Johnson and Goswami 2010; Hermans et al 2008; Kyle and Harris 2010

Word formation – morphology – Nunes et al 2010

Word order – syntax – Miller (2010), Kelly 1996

Awareness of print – orthography – see Miller 2010 for refs
Daily Routine

Children Acquire language in context of their daily experiences and specifically, through the caregiver and family interactions (Hoff, 2000)

- Meal time
- Nappy changing
- Going up stairs
- Washing

- happen many times each day and every day.

These routines are the perfect opportunity to provide appropriate, repetitive language to link with the action and activity
A feasibility study was conducted on families from the UK

- 10 babies
- <12 months old, with a varying degree of severe to profound hearing loss

- 12 infants
- >12 months old, implanted with bilateral cochlear implants

Data were collected based on a simple parental and professional feedback questionnaire, completed at the end of an 8-month trial.
Outcomes for pre-implant group

Graph showing the percentage of the 20 parents and 9 professionals in the pre-implant group who recorded seeing a change or improvement in their child’s responses whilst using BabyBeats after 6 months of use.

Improvements seen in:
- Attention
- Eye contact
- Vocalisations
- Anticipation
# BabyBeats™ Audit

## Elizabeth Foundation

### Results: Rating the Musical Trails

<table>
<thead>
<tr>
<th></th>
<th>Movement</th>
<th>Instruments</th>
<th>Animals</th>
<th>Transport</th>
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<tbody>
<tr>
<td>Parent Group</td>
<td>Enjoyed greatly</td>
<td>Enjoyed greatly</td>
<td>Enjoyed greatly*</td>
<td>Enjoyed – Enjoyed greatly*</td>
</tr>
<tr>
<td>Professional Group</td>
<td>Enjoyed greatly</td>
<td>Enjoyed greatly</td>
<td>NA*</td>
<td>NA*</td>
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</tbody>
</table>

![Image of a baby enjoying musical instruments](image1.png)

![Image of an adult and child playing musical instruments](image2.png)
Outcomes showing the percentage of the 12 parents in the implanted group and nine professionals who reported on questionnaire that they had seen a change or improvement in their child’s responses at other times of the day after 8 months use of BabyBeats™.
• Audits continuing in USA, UK, India
  – endorsed by AG Bell.

1. Increased **joined and sustained attention**: both groups of children participated in the activities for long periods of time (up to 45 minutes and more, even for the youngest in Group 1).

2. Increased **parent-child interaction**: the parents were more relaxed when playing with their infant, displayed more non-verbal communication, were engaged in more face-to-face interaction (because they observed the response of their child - parent feedback: “I feel hope when I see my child respond”).

3. Increased **parent confidence**: the parents felt more confident to interact with their infant and increasingly use their voice during the vocal play activities.

4. Increased **vocalisation**: both groups of infants starting vocalising more (in Group 1 this was more in response to the tactile/sensory input from the activities, movements and instruments).

• **Build on positive professional & parental feedback**
• **Monitoring progress of children with cochlear implants and an additional need; including complex needs**
Using the BabyBeats NOTES to empower parents and help develop the listening, language and communication skills of their deaf baby

ESPCI, 2015

Jane Gallacher

1 Speech and Language Therapist, Scottish Cochlear Implant Team, Crosshouse Hospital, Kilmarnock KA2 OBE, United Kingdom
**Aim:** To assess the usefulness of the BabyBeats™ resource, combined with BabyBeats™ NOTES as a tool to enhance parent’s understanding of listening and language development.

**Method:**

- Parents rated BabyBeats™ using an in-house designed questionnaire
- NOTES was demonstrated to parents and they continued using it at home, independently for several weeks
- Re-assessment using same questionnaire

<table>
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<tr>
<th>Description</th>
<th>Mean</th>
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<tbody>
<tr>
<td>Age Range (6 – 50 months), n=18</td>
<td>25 Months (SD +/- 12 mths)</td>
</tr>
<tr>
<td>Age started using BabyBeats™</td>
<td>17 Months (SD +/- 13 mths)</td>
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<td>Aiding - 7 HA, 11 CI</td>
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</table>
Results

I know what stage my child is at and what the next steps will be

I am confident about doing musical activities with my child
Parent Comments

“It is particularly interesting to me as a parent to understand the specific reasons and benefits of the music.”

“If I know what I’m trying to achieve, I’ll do the activity more.”

“It’s given us ideas on the areas to work on next.”

“It is important for me that the language and terms used aren’t in ‘professional speak’.”
HiRes Fidelity 120

- **Fine structure preservation**
  - HiRes preserves the temporal coding of sound information

- **Simultaneous current steering**
  - Fidelity120 improves spectral resolution by “current steering” between electrodes.
BabyBeats
Movement & Music Section
Building BabyBeats as part of Daily Routines
Making a case for Music as an integral part of evidence-based Habilitation

• Supports functional use of Early Appropriate Amplification

• Supports development of Communication & emerging Pre-verbal skills

• Supports parent/care-giver Bonding/attachment
Regular music-making strengthens nonmusical brain functions

- speech in noise
- reading
- language
- memory
- vocal emotion
- attention

Reviewed in:
Kraus and Chandrasekaran (2010) *Nature Reviews Neuroscience*
Strait & Kraus (2013) *Hearing Research*
Great way to learn to listen, develop communication & enjoy activities together as a family
Thank you to the organisers - & to Phonak – music matters!