KIPA Presentation

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An association between early screen time experience and auditory awareness in young children

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Chear

Children's Hearing Evaluation & Amplification Resource

Chear has been helping children with hearing loss since 2001

Chear is an independent hearing centre for children and adults in UK for hearing assessment and hearing aids – privately or via health insurance.

Opportunity to review the last 30 years of paediatric audiology

- Newborn hearing screening introduced in 1990s in UK
- Now early identification and management of hearing transforming outcomes for children with hearing impairment
- Technology of amplification, auditory implants, remote microphones give new options and achievements
- Support for families in providing aided audibility and linguistic input
- Understanding of the critical importance of auditory or sensory experience in the early years of life for neural network development
- All of this is predicated on the plasticity of the neural systems in the first 2 or 3 years of life, a critical period for communication development

Behavioural testing of children from 6 months to 5 years at Chear

- Over the past 22 years hearing assessments have been carried out by the same tester (JM) – Clinical scientist
- As parents book appointments directly with Chear - the socioeconomic characteristics may be skewed, (slightly higher) when compared to the general population.
- Our sample population has a wide range of ethnic heritage groups and cultures and come from around the UK and Europe

Two main types of behavioural testing in pre-school age children

1

Visual reinforcement audiometry (VRA):

- From 6 months to 2 years developmental age
- The child is conditioned to turn their head to an audible signal (warble tone) by pairing it with a visual reward

2

Conditioned play audiometry (CPA):

- The child is taught to make a response on hearing a warble tone, e.g. put figure in a boat
- CPA typically used from around 2 years developmental age

Over past five years we have observed a change in children's hearing behaviours

Increase in proportion of children (1-3 years) who don't respond to simple sounds, warble tones (WT) or narrow-band noise (NBN)

These children are difficult to test as they do not condition to WT or NBN in VRA, but they often do respond if familiar tunes are used, *eg* Peppa Pig or Baby Shark

These children often have inconsistent responses to their own names or their parent speaking

These children may have delayed or absent spoken language development and often have no words

Subsequent testing shows that they have normal or near-normal peripheral hearing.
All these cases had passed newborn hearing testing.

Video showing VRA test protocol, lack of response to WT sounds, response to music

What we see in the video

Classical conditioning paradigm. Warble tone is presented with the visual reward (the bug).

Child's attention is drawn to the toy in the box twice (or more).

Acoustic signal is presented alone. The child has not learned to associate the sound with the lighted toy reward.

Further acoustic signals are presented. No responses are made by child to the sound alone. Nor to narrow band noise.

The signal is changed to cartoon theme without the visual reward, the child turns their head towards the sound. Visual reward is given

Video showing VRA test protocol, lack of response to WT sounds, response to music

Audit of Chear data over past 6 years: proportion of children needing “adapted” behavioural testing

Sample taken of pre-school age children seen in month of July over past 6 years.

Includes: All new cases seen at Chear, aged between 1 and 3 years
Exclude: All cases with known permanent SNHL hearing loss, or complex medical needs, i.e., Down syndrome, visual impairment, cleft palate or identified genetic syndrome

What constitutes “adapted testing”: using music rather than WT, or VRA rather than CPA if > 2 years of age

Year seen:	2016	2017	2018	2019	2020	2021
Adapted test:	20%	23%	33%	19%	78%	53%

Chi-square (X^2 = 10.4, p=0.001) between 2020-21 and the previous 4 years.

← COVID-19 lockdowns →

Confirms significant increase in the proportion of children needing adapted testing over last two years

Multiple factors that contribute to development and rate of spoken language / communication

Possible factors underlying atypical listening behaviours?

Hearing loss:

But these children have normal or near normal peripheral hearing

Genetic susceptibility:

Genetic factors may contribute 50-80% risk in ASD

But genetic risk unlikely to vary markedly over a few years

Environmental:

Pollution or COVID-19 illness factor

Nurture / Communication:

Shaped by adult caregivers, could have been reduced during COVID-19 i.e. less spoken communication at home [1]

Experiential:

Less interaction with other people and less day-care attendance. Increase in entertainment screen time (EST)

1.(Gordon et al, 2021)

Children have increased exposure to moving visual images on screens

Increased use of television, mobile phones, laptops and tablets for passive screen watching

Screen use causes the release of neurotransmitters affecting the frontal cortex. Sets off pleasure/reward cycle and addiction behaviours in older children

Cohort study by Heffler et al (2023) reports changes in sensory behaviours for toddlers and children with higher early screen experience (TV and video)

Population study by Kushima *et al.* (2022) reports that increased screen time at one year is associated with the significant increase in autism spectrum disorder (ASD) at 3 years of age in boys

Romeo *et al*. (2018) reports adult-to-child language exposure correlates with connectivity in the left hemisphere, regardless of SEG or sheer amount of speech. There is a change in brain architecture arising from sensory inputs.

What factors are impacting on reduced auditory responsivity? Two hypotheses:

1. Are the children experiencing a decrease in their social experience?

2. Has there been an increase in entertainment screen time (EST) as a factor in reduced auditory responses?

To test these hypotheses, we set out to look at EST and social factors using a questionnaire for children being seen at Chear.

Questionnaire completed by parents of all new children aged 1-3 years, seen from Jul-Dec 2022

1. **Q.** What is child's preferred song or tune and how does child listen to this tune?
   How easy was it to settle your child when upset or distressed in first year of life?

2. **Q.** How many times per week did your child meet up with children outside the family in:
   a) first 12 months of life
   b) between 13 -24 months of life

3. **Q.** How many words did your child have:
   a) at 12 months of age
   b) at 24 months of age (or now)

4. **Q.** How much screen time per day did your child have:
   a) in first 12 months of life
   b) between 13-24 months of life

- Maternal age and profession/role
- Post code (used to estimate socio-economic group)

Completed MoSAIC (Monitoring of Social Attention Interaction and Communication) from observations in Chear appt (respond to name, eye contact, following and using a point, other gestures, response to sounds)

Analysis of Questionnaire data and MoSAIC Categorised into 2 groups- based on type of testing used at appointment

Group 1
If child needed adapted testing (tested using VRA rather than CPA when over 30 months), **or** music needs to be used because unresponsive to WT/N

Group 2
Children tested using age-appropriate test technique, and children responsive to warble tones or NBN and could be conditioned to these signals.

Preliminary T-tests between-group results (SD in brackets): Aiming for total of 50+ cases in each group

	Group 1 (Unresponsive to WT/NBN) N = 52 cases 39m/13f (3:1)	**Group 2 (Responsive to WT/NBN)** N = 66 cases 45m/21f (2:1) Wilcoxon RS	P Value
Age of group:	28.1 months (8.3)	29.7 months (8.9)	p=0.58 (NS)
Ease of settling	2.04 (1.2)	2.28 (1.1)	p=0.099 (NS)
Meet up in Yr 1:	1.7 times (2.3)	2.2 times (2.28)	p=0.26 (NS)
Meet up in Yr 2:	4.4 times (2.8)	4.3 times (2.8)	p=0.93 (NS)
Maternal education:	2.04 (0.88)	2.39 (0.76)	p=0.043 (sig*)
No. words @12months:	3.2 (4.5)	5.6 words (5.0)	p=0.0013(sig**)
No. words @24 months:	11.2 (13.9)	31.7 words (16.4)	p=0.00063 (sig***)
Hours EST in Yr 1:	2.34 hours (1.6)	1.05 hours (1.0)	p=0.00016 (sig***)
Hours EST in Yr 2:	2.81 hours (1.56)	1.77 hours (1.1)	p=0.00027 (sig***)
MOSAIC Score	2.19/6 (1.5)	5.8/6 (0.5)	p=0.0001 (sig ***)

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Box plots of scores:

Group 1: “Unresponsive” to simple sounds

Group 2: “Responsive” to simple sounds

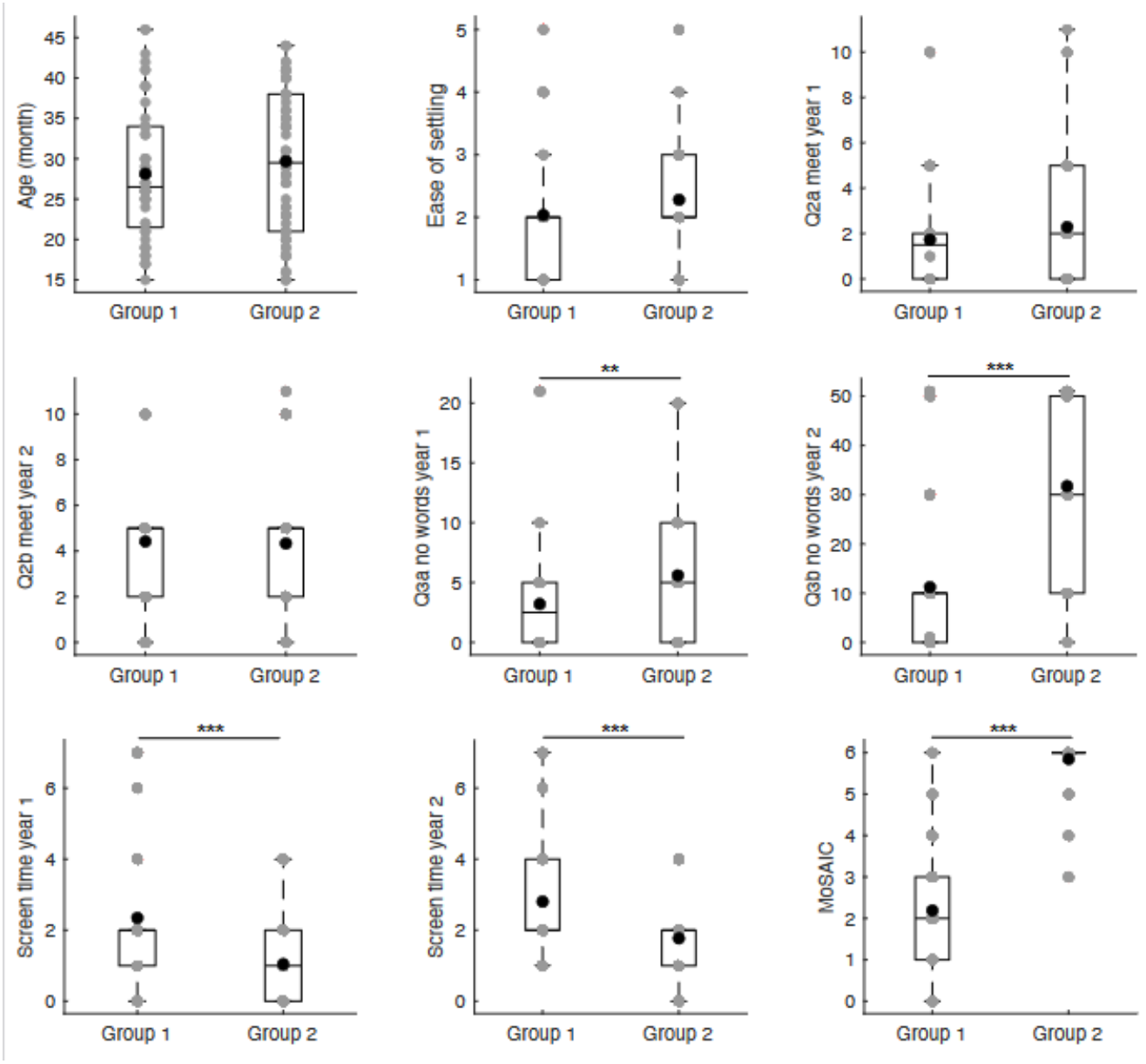
Horizontal line = median

Upper and lower edges of boxes = quartiles

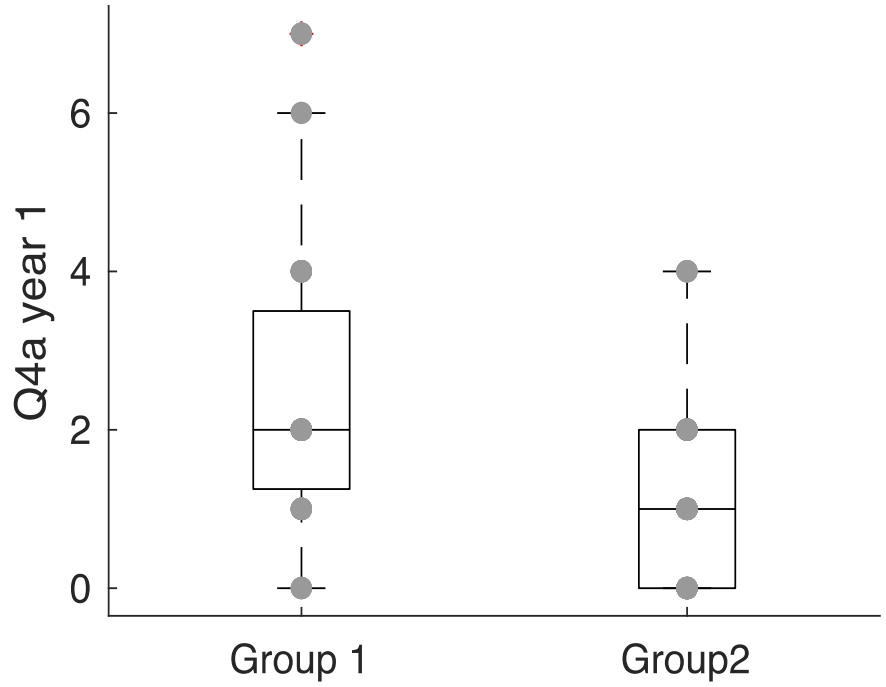
Black filled circles = mean

Significant differences between groups are indicated by:

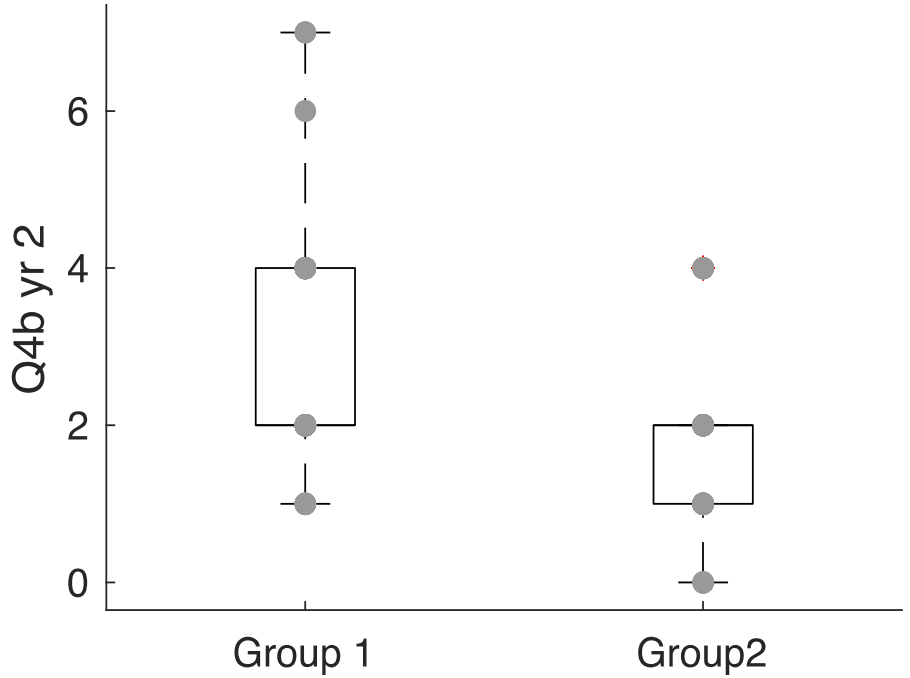
** (p< 0.01)
*** (P<0.001)



Significantly more screen time (EST) for Group 1 than for Group 2 in both the first and second years of life



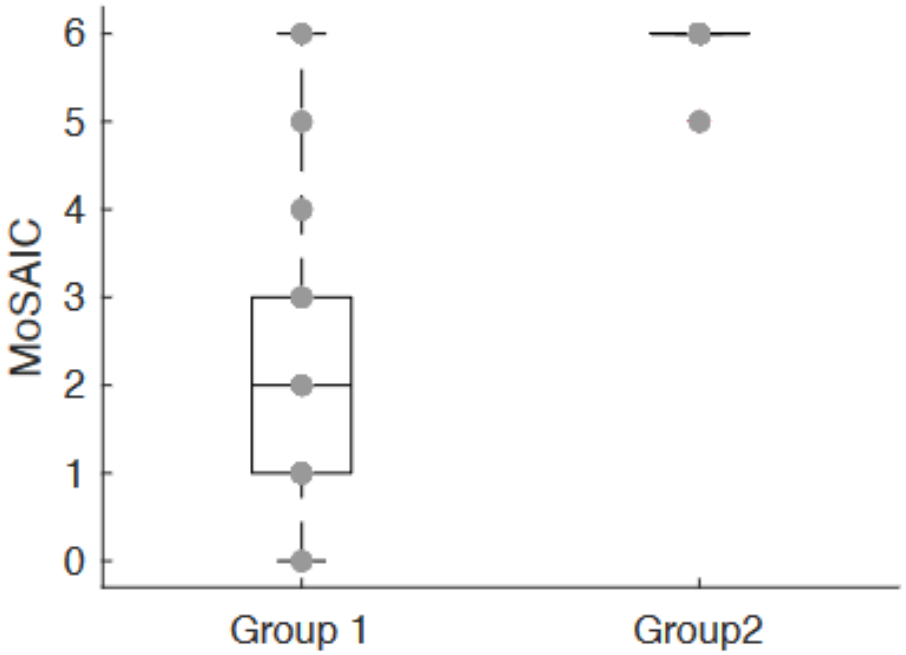
P = 0.00016



P = 0.00027

MOSAIC: Spontaneous eye contact, pointing, following a point, using gestures and response to name

Group 1 have lower scores on social and visual behaviours than Group 2



MoSAIC scale includes visual communication:

- Why are children not responsive to visual information? Eg visual hyperconnectivity
- Visual and auditory communication are disordered
- Discussion with Prof Andrej Kral:

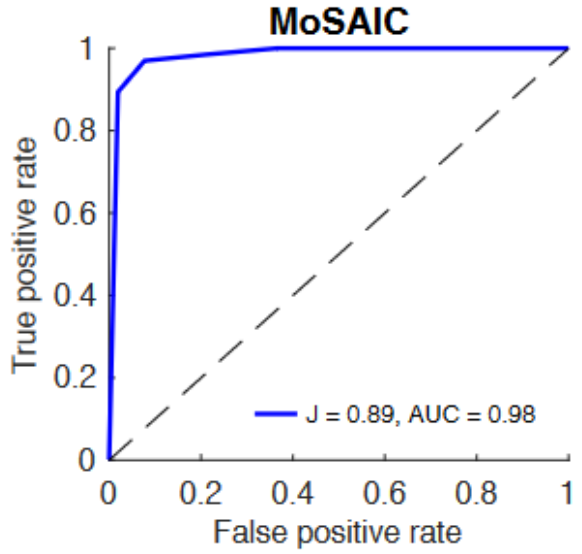
There are sensitive periods in development of sensory systems and for language development

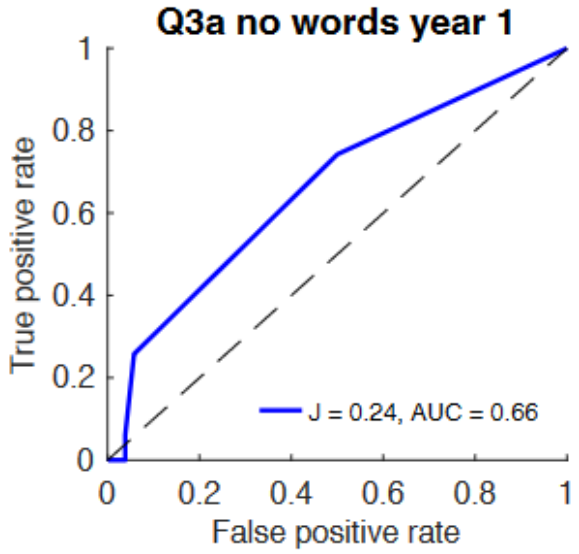
Steps in cortical development are dependent on sensory experience

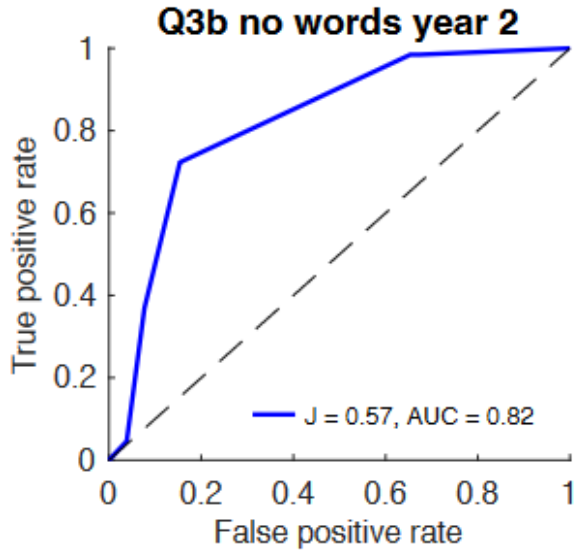
For transformation of naïve cortical networks to a network capable of categorization of auditory objects

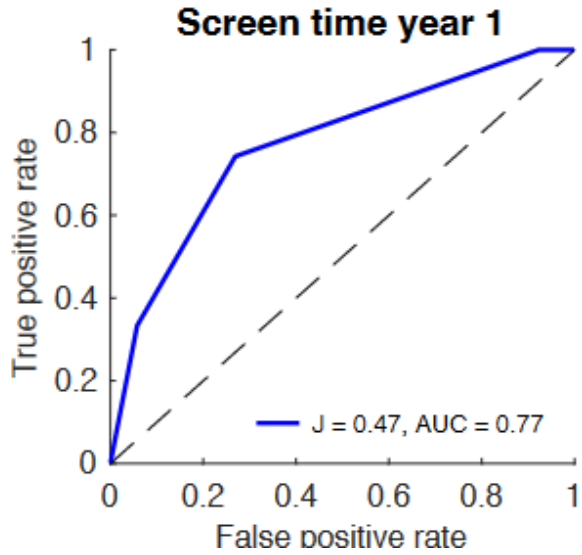
Need cortical measures of auditory and visual detection and discrimination for this grou

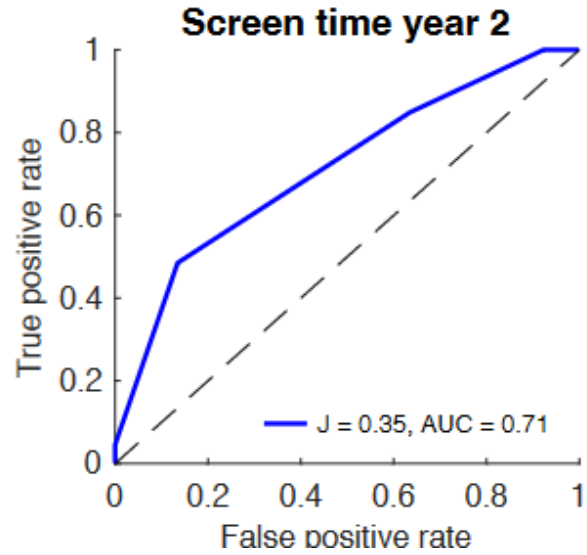
ROC curves: Area under curve (AUC,0.5 – 1) and Youden's Index, J, indicating best cut-off point











Results and Conclusions:

1. There has been a change in the proportion of children who do not respond to simple sounds traditionally used in hearing assessment.
2. This is particularly noted over COVID-19 lockdowns and is also reported by NHS departments in UK
3. There is no significant difference in opportunities to meet with other children for Unresponsive and Responsive groups, or ease of settling
4. There are significant differences in the number of words at a year, and at two years. Also the amount of EST in first and second years for the two groups
5. High EST is associated with poor auditory and social skills

Future Aim: to understand the mechanism for neural plasticity changes and to limit EST in young children in line with WHO guidance. No screen time in children of <2 years

There is an urgent priority to provide information and services for these families

However, there are barriers that need to be addressed:

1. Long waiting times for NHS SLT provision in UK
2. Many SLT providers do not offer services to pre-verbal children (“too young for speech therapy” or “SLT offered at over 2 years of age”)
3. Long waiting times for developmental paediatrics and variable intervention strategies for unresponsive children with little evidence-based practice.
4. Criteria for diagnosis of “autistic spectrum disorder ASD” are now so wide that it has little specific meaning for families looking for therapy services. Unresponsive to simple sounds in audiology maybe a biomarker for later ASD
5. WHO guidance is no screen time for children of 2 years and under

Next steps:

Study of Auditory change in children

Audit of proportion of children (1-3) years needing adapted behavioural testing

Data on screen time and interaction opportunities for children (1-3) years seen at Chear n=100 Grp 1 and Grp 2

Development of paediatric music-stimulation VRA system supported by UK Innovation Biomedical Catalyst Grant 10037793. Audio 3 Ltd. Guys & St Thomas' Hospital, Xed Ltd., London Southbank University and Cheer Ltd.

Use of Cortical auditory (CAEP) and Cortical Visual responses. Discussion with Karolina Kluk and Jason Smalley

Phase 1&2: Feasibility (yr 1)
Phase 3: Prototype & Clinical evaluation (yr 2)
Phase 4: Verification & Validation for release (yr 3)

Audit of Cheer data (2016-2021)

Manchester/Aston STP student projects
Audit of children in NHS departments (1-3 years)
+ students own research questions

JW	HM	KO	KN
Manchester	Cambridge	Reading	So'ton
M vs F*	Referral paths*	Effective tests*	Developmental delay

Thank you for your attention. Questions and comments?

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