The Use of FM Technology in school-aged children with Autism Spectrum Disorder
The Use of FM Technology in School-Aged children with Autism Spectrum Disorder

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Background

- **Autism Spectrum Disorder (ASD)**
  - neurodevelopmental disorder affecting ≈ 1 in 120 children

- **Behavioural symptoms**
  - social interaction impairment
  - communication deficit
  - restricted, repetitive and stereotyped patterns of activity/interest

- **Sensory deficits (particularly auditory)**
  - consistently reported speech perception in noise deficits (Ornitz et al. 1989; Alcantara et al. 2004)
  - inability to use brief gaps in noise to gain release from masking (Groen et al. 2009)
Study Aims

- Characterize the pattern of auditory deficits in children with ASD

- Determine whether FM-listening devices can improve speech understanding/general communication
Study Design

- Initial test session
  - Psychophysical & formal speech perception testing
  - FM device fitting (Inspiro device / iSense micro receiver)
  - Comparison of aided (FM) and unaided scores
Study Design

◆ 6 week FM trial

» 1. Period of non-use (prior to fitting)
» 2. Two week period wearing the device
» 3. Another two week period wearing the device
» 4. Two week period of non-use

– Subjects completed a hearing disability questionnaire at the end of each period (APHAB)
– Teacher survey at end of trial (LIFE)
Subjects

- 20 children with ASD
  - **Diagnosis:** Childhood Autism Rating Scale (CARS)
  - **Intelligence/Cognitive Profile:** Wechsler Intelligence Scale for Children (IQ>80)
  - **Education**
    - All in mainstream settings: secondary N=10, primary N=10
    - **Age range:** 8 to 15.4 yrs

- 20 controls matched for age/gender/hearing level
  - Identical test battery (apart from the FM trial)
Psychophysical Protocol

◆ Audiogram (4-freq average)
  - ASD: 12.6±6.4 dBHL
  - Control: 10.4±8.3 dBHL

◆ Temporal Resolution
  - Ability to detect changes in stimuli over time
  - Temporal modulation transfer function (TMTF)
Temporal Modulation Transfer Function (TMTF)

- Determines the listener’s ability to perceive rapid amplitude changes in a continuous signal

- Variables
  - Modulation rate
  - Modulation depth

100% (0dB)
50% (-6dB)
10% (-20dB)
Temporal Modulation Transfer Function

Mod. Depth 20\log M (dB)

Modulation Rate (Hz)

○ Control

● ASD
Temporal Modulation Transfer Function

Mod. Depth $20\log M$ (dB) vs. Modulation Rate (Hz)

- Control
- ASD
Spatial Processing
Binaural Speech Perception

- Listening in Spatialized Noise Test (LiSN-S)
- Speech in background noise
- Measures the listener’s ability to use spatial cues to improve perception

- Spatial Advantage
  - Difference in speech reception threshold (SRT)
  - 2 test conditions:
    - Target speech and noise presented from the same direction (i.e. no spatial cues available)
    - Target and noise spatially separated (90°)
LiSN-S Spatial Advantage

- **Age (Years)**
- **Spatial Advantage (dB)**

- **Control**
- **ASD**
LiSN-S Spatial Advantage

![Graph showing LiSN-S Spatial Advantage with Age (Years) on the x-axis and Spatial Advantage (dB) on the y-axis. The graph compares Control (circles) and ASD (filled circles).]
Hearing Disability Survey

- Abbreviated Profile of Hearing Aid Benefit (APHAB)

- Self-assessment survey examining various aspects of everyday listening and communication

- Evaluation categories
  - Ease of communication
  - Listening in background noise
  - Effect of reverberation
  - Aversion to sound
APHAB (unaided)

Control (N=20)  ASD (N=20)

Perceived Difficulty (%)
Management of speech in noise problems

Personal FM systems
FM Test Setup: Free Field Speech in Noise

- Speech: CNC words - 65 dB SPL
- +0 dB S/N ratio (at the subject's head)

(noise)  (speech)  FM lapel microphone
Results: Free-field Speech in Noise

Control Group (N=20)
- unaided: 78.9 ± 8.4%
- aided (FM device): 89.1 ± 4.0%

ASD Group (N=20)
- unaided: 68.9 ± 11.7%
- aided (FM device): 85.6 ± 5.1%
6 Week FM-Device Trial

- Secondary School Children: 13-15 yrs (N=10)
  - All rejected
    - Resistance from the child
    - Inconsistent teacher support

- Primary School Children: 8-12 yrs (N=10)
  - 5 completed
    - 3 mid-trial: all consistent users at this stage
    - 2 rejected
      - Both had significant behavioural problems
APHAB: unaided v aided (ASD)

Perceived Difficulty (%)

- Communication
- Noise
- Reverberation
- Aversiveness
- Total

Unaided (N=5)
Communication Noise Reverberation Aversiveness Total
Perceived Difficulty (%)

APHAB: unaided v aided (ASD)

Unaided (N=5)  FM-aided (N=5)
Educational Impact

- **Listening Inventory For Education (LIFE)**
- Completed by classroom teacher at the end of the FM-trial
- Aims to determine the efficacy of device usage

- **16 questions**
  - 1. “Focus on instructions has improved”
  - 2. “Appears to understand instructions better”
  - 14. “Socially more involved with other children”

- **Agree** | **No Change** | **Disagree**
  - (2) | (1) | (0)
  - (-1) | (-2)

- Maximum score = 35
Listening Inventory For Education (LIFE)

ASD Participants
Listening Inventory For Education (LIFE)

ASD Participants
Conclusions

- ASD participants showed monaural & binaural auditory processing deficits

- Impaired speech perception (in noise) and a greater degree of everyday listening/communication difficulty

- All ASD subjects showed better speech perception in noise when wearing the FM device
  - teenagers failed to complete the FM trial
  - most of the younger participants (8-12 yrs) were still enthusiastic device users 6 weeks post-fitting
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