FM Technology: When to Introduce to Children

Imran Mulla PhD
Audiologist, Research Co-ordinator
Nottingham, UK

www.earfoundation.org.uk  +44 (0) 115 942 1985
The Ear Foundation®
What do we know?

• Younger children (5-6 years) with normal hearing require significantly higher SNR values (>15dB) and reduced reverberation times for speech recognition compared to older children and adults
  
  

• Effects of reverberation and noise have a far greater impact on hearing aid users compared to normal hearing individuals
  
What does this mean for really young children with hearing loss?
Overarching Questions

How parents and carers of pre-school hearing aided children incorporate the use of FM technology into their daily routines?

What were the potential benefits of FM technology use with pre-school hearing aided children?

What were the views and experiences of parents and carers using FM technology?

<table>
<thead>
<tr>
<th>Age (months)</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
<th>P6</th>
<th>P7</th>
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<tbody>
<tr>
<td>Hearing loss (R-L)</td>
<td>Sev-Mod</td>
<td>Sev-Sev</td>
<td>Mod-Mod</td>
<td>Sev-Sev</td>
<td>Sev-Sev</td>
<td>Prof-Sev</td>
<td>Mod-Mod</td>
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<td>Naida SP</td>
<td>Naida UP</td>
<td>Nios</td>
<td>Naida SP</td>
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<td>Nios</td>
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<tr>
<td>FM Receivers</td>
<td>MI11i</td>
<td>MI10i</td>
<td>MI12i</td>
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<tr>
<td>FM Transmitter</td>
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QUANTITATIVE
FM LEC (De Conde Johnson, C.)
Scores: listening in quiet, noise, distance, auditory only and total.
Trend scores improved by 12-15% overtime (after 1 month of FM use compared to end).
Significant improvements in noise and distance.

LDS (Gilkerson and Richards, 2008)
Assesses expressive and receptive language skills.
No significant change in LDS scores for children who started off "Within Normal Limits".
Significant improvements in LDS scores for children who started off "At Risk".
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<th>P4</th>
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<th>P6</th>
<th>P7</th>
<th>Total</th>
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<td>Age in months</td>
<td>21</td>
<td>17</td>
<td>11</td>
<td>24</td>
<td>11</td>
<td>15</td>
<td>32</td>
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<tr>
<td>Days in study</td>
<td>251</td>
<td>232</td>
<td>104</td>
<td>187</td>
<td>111</td>
<td>142</td>
<td>171</td>
<td>1198</td>
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<tr>
<td>Days FM used (%)</td>
<td>232</td>
<td>162</td>
<td>14</td>
<td>151</td>
<td>33</td>
<td>98</td>
<td>162</td>
<td>81</td>
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<tr>
<td>Total use</td>
<td>723:15</td>
<td>681:00</td>
<td>23:15</td>
<td>598:00</td>
<td>58:15</td>
<td>244:20</td>
<td>546:10</td>
<td>2874:15</td>
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<tr>
<td>Benefit</td>
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<td>676:30</td>
<td>19:10</td>
<td>582:55</td>
<td>42:20</td>
<td>239:20</td>
<td>544:10</td>
<td>2801:00</td>
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<tr>
<td>No Benefit</td>
<td>0:15</td>
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<td>0:00</td>
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<tr>
<td>Not sure</td>
<td>35:10</td>
<td>4:30</td>
<td>3:05</td>
<td>12:35</td>
<td>15:25</td>
<td>0:00</td>
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<td>70:45</td>
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FM LEC (De Conde Johnson, C.)
Scores: listening in quiet, noise, distance, auditory only and total
Total scores improved by 12-48% overtime (after 1 month of FM use compared to end)
Biggest improvements in noise and distance

LDS (Gilkerson and Richards, 2008)
Assesses expressive and receptive language skills
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Assesses expressive and receptive language skills

No significant change in LDS scores for children (n=4) who started off “Within Normal Limits”

Significant improvements in LDS scores for children (n=3) who started off “At Risk”
QUANTITATIVE
QUALITATIVE

Sought to acknowledge parents and carers as the experts and place them in the centre of knowledge generation

8 weekly diaries, 7 semi structured interviews:
Overall 8 ‘cases’ (7 diary & interview, 1 diary only)

Thematic content analysis was carried out using NVivo 9

Codes generated independently and compared in an iterative process. Codes collapsed and clustered into themes
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Codes generated independently and compared in an iterative process. Codes collapsed and clustered into themes
Main themes: 6
(sub themes: 27)

Access to speech (5)
Listening (7)
Language (2)
Wellbeing (4)
Ownership (4)
Practicalities of FM use (5)
Access to speech

Child position: car, pram, walking

P6: “I can talk to him whilst we are walking and point to things and tell him what they are... In the morning on the way in to school we saw a rabbit and I was talking to him about it. He loved it... I also taught him stop, look and listen at the road today”.

Reduced access to HA microphones: winter hats, horse riding and cycling helmets etc.

P4: “we had it in the winter, we started off in the winter. Very useful with the hats on. [My daughter] has hats that cover her ears... so we notice a big difference using the FM outside. She could still hear you.”
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Listening

Wellbeing

Attending: improved responsiveness

"Parents/carers' diary entries described the child as being: “more responsive”, “joins in more”, “turns quicker”, “quicker reactions”, “answered more”, was more “interactive”/“communicative”, had more eye contact”/“looking”, going “quiet” and “pausing”, overall being “more alert” when the FM was in use.

Locating FM user: Parents and nursery staff all commented on their positive observance of how “accurate”, “quick” and “instant” the child was able to locate the FM user:

Nursery: “I said [child’s] name from across the room. He was sat down on a chair. He turned to look at me. As it was dinner time there were a lot of other noises going on in the room”

P4: “My mum was very impressed how instant she was to look round at her whilst outside playing”

Mason and Bracken (1995). FM-Himulation at normal background levels, when no FM, required greatly increased volume.

Overhearing

Floor and Naiker (2008) found children as young as 15 months could learn new words whilst distracted without any form of scaffolding.

Reduced opportunities for overhearing with HEP

P4: “I was taking my oldest daughter off whilst driving to school when from the back seat [child] said “Shut up, shut up”.”
Attending: improved responsiveness

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“more responsive”,
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Maxon and Brackett (1989): FM+M localisation at normal conversational levels; when no FM, required greatly increased stimulus
Overhearing

Floor and Akhtar (2006) found children as young as 16 months could learn new words whilst distracted without any form of scaffolding.

Reduced opportunities for overhearing with HA’s

P4: “I was telling my eldest daughter off whilst driving to school when from the back seat [child] said “Shut up, shut up”.”
Wellbeing

Social: increased engagement

P1: "At the nursery (my daughter) never plays in with anyone. She never sits in the crunch just stands and watches from a distance. She just claps, as her play worker who now takes the nursery into a

P2: "At play group it's very noisy, a lot of children knowing my daughter's

P1: "At nursery it's very noisy, a lot of children knowing my daughter's

Safety

P1: "It was quiet but I didn't have to look at her. Both really we didn't have to have eye

P2: "It was quiet but I didn't have to look at her. Both really we didn't have to have eye

Ownership

Control of own listening (children):

P2: "If I didn't listen then she wouldn't

Increase in consistency of HA use::

P1: "It was quiet but I didn't have to look at her. Both really we didn't have to have eye

P2: "If I didn't listen then she wouldn't

Increase in consistency of HA use::

P1: "It was quiet but I didn't have to look at her. Both really we didn't have to have eye

P2: "If I didn't listen then she wouldn't
Social: increased engagement

P4: “At the nursery [my daughter] never joins in with singing. She never sits in the circle just stands and watches from a distance. She sat next to her key worker who was wearing the microphone and joined in”.

P1: “At play centres its very noisy, a lot of children shouting so [my daughter] was struggling whereas with the FM she can hear me even though she can’t necessarily always see me which means she’s a bit more confident at playing on her own or playing with the other children there doing the activities.”
P7: “It meant that I didn’t have to look at her, both really we didn’t have to have eye to eye contact, like in the car really it’s dangerous to turn round and look at her, so for me personally it was a lot easier so I could speak to her and she could still hear me and we could still chat”
Ownership

Control of own listening (children):
P3: "I don't have the FM on when I would park the car at my hearing aid and say 'silently for now' to let my child know she wanted the FM on/".
P3: "If the FM was on and it was on a little bit older she will get on the FM, I don't want you to keep that up. I have found when we don't wear it as much it still benefits them because we are using it when we want to use it, it is very aware of it.

Increase in consistency of HA use:
P3: "After Sue used, [my son] seems to be keeping his hearing aids in more. It was the first time he has ever kept his hearing aids in whilst in the car.
P3: "He has always gone through stages pulling them out and then when we got the FM he started leaving them in/"
P3: "My daughter] has begun to ask for her hearing aids to be put in now/"

Ease of use:
P3: "Same as mobile phones, so it is not too hard... was quite easy/"
P3: "It was easy enough to use, quite self-explanatory, you know the up and down and obviously the volume."

Barriers to FM use:
P3: "[My son] started with an ear infection on the Sunday so we haven't used it since... Not used as [my son] isn't keeping aids in long enough, only 10 minutes at a time as ear moulds are too small... the problems we have had is with availability, whether there able to/"

Remembering to mute:
P3: "Remembering to mute it at the times you are supposed to mute it, if you went into another room, the telephone rang/"

Acknowledged: Overheating
Control of own listening (children):

P7: “If I didn’t have the FM on she would point at her hearing aid and say “Mummy can’t hear” to let me know she wanted the FM on”.

P2: “as he has got a little bit older and he will tell us ‘oh, I don’t want you to wear that’ and we have noticed we don’t wear it as much but it still benefits him because we are using it when he wants us to use it, he is very aware of it.”
Increase in consistency of HA use:

P6: “After Day one, [my son] seems to be keeping his hearing aids in more. It was the first time he has ever kept his hearing aids in whilst in the car.

P6: “he has always gone through stages pulling them out and then when we got the FM he started leaving them in”.

P4: “[My daughter] has begun to ask for her hearing aids to be put in now”.
Practicalities

Ease of use
- P3: “I was easy enough to use... quite self-explanatory. You draw the up and down and obviously the soundtrack.”
- Nursery: “Heard of it on a holiday but the other staff in the room are much more confident with it now.”

Barriers to FM use
- P3: “If any issues come up with our solution we will ask the council if they haven’t used it since. Not used as it only isn’t stopping ears in long enough. Only 1h where as it is in the room. The problems we have had so far were getting them back up to speed enough.”
- P3: “At the time more busy and the mould is going, and for not ensuring the hearing aids. We also have a lot of guests staying over and sometimes we would keep the aids in until they left the hotel after a minute or two and we would think what is the use.”

Increase in consistency of HA use
- P3: “After the first time, 22% want to be using the hearing aids in voice. A lot the first time he has ever been here hearing aids is unheard of this.”
- Nursery: “He has always gone through stages of doing them and then when we get the bid we would start learning them in.”
- P3: “(Light laughing) has begun to ask for her hearing aids to be put in once.”

Remembering to mute
- P4: “Remembering to mute it at the town or you are supposed to mute it. If you want to move into another rooms, the telephone song.”

Acknowledged + Deafhearing
Ease of use

P5: “same as mobile phones, so it is not too hard... it was quite easy”

P3: “It was easy enough to use..., quite self-explanatory, you know the up and down and obviously the soundcheck”.

Nursery: “Head of room is on holiday but the other staff in the room are much more confident with it now”.
Barriers to FM use

P3: “[My son] started with an ear infection on the Sunday so we haven’t used it since... Not used as [my son] isn’t keeping aids in long enough, only 10 minutes at a time as ear moulds are too small... the problems we have had is with earmoulds, getting them back to us quick enough,

P5: “At the time more her age and the moulds going, and her not wearing the hearing aids – that would be the main thing that would stop us and sometimes she would keep the aids in and then take the aids out after a minute or two and we would think what’s the use”.
Remembering to mute

P4: “Remembering to mute it at the times you are supposed to mute it, if you went into another room, the telephone rang”

Acknowledged + Overhearing
Monitors and provides automatic analysis of large amounts of natural child language environment data


Language environment basic reports: AWC, CV, CT
Characterisation of language/acoustic environments: Meaningful, Distant, TV, Noise and Silence & Background

LENA: with vs without FM
Four families participated in this sub-study
Four recordings each: two at home and two outdoors (with and without FM)

Home situation:
No clear trends in AWC’s, CV’s or CT’s

Outdoors:
3 of the 4 showed some increase with AWC’s and CV’s with FM
Clear pattern of increase with CT’s

Language Environment Percentiles
Comparison with normal hearing peers:
AWC’s and CV’s all recordings above 50th percentile

Characterisation of Language-Acoustic Environment
Average of all 16 recordings:

<table>
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<tr>
<th>Acoustic Category</th>
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<tr>
<td>Meaningful</td>
<td>31</td>
</tr>
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<td>Distant</td>
<td>42</td>
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Language Environment Percentiles

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CT Percentiles

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<tr>
<th></th>
<th>With FM at Home</th>
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<th>With FM Outdoors</th>
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<th>Average</th>
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<tr>
<td>P1</td>
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<td>P2</td>
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Comparison with normal hearing peers: AWC's and CV's all recordings above 50th percentile

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INFANT SNR's

Batten, A. (2013) SNR's in typical infant listening environments, MSc Dissertation, University of Manchester
Supervisors: Dr Tim Wilding & Dr Imran Mulla
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<table>
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<tr>
<th>Scenario</th>
<th>Value</th>
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<tr>
<td>Bus</td>
<td>3</td>
</tr>
<tr>
<td>Busy road away facing</td>
<td>8</td>
</tr>
<tr>
<td>Busy road towards facing</td>
<td>7</td>
</tr>
<tr>
<td>Residential street away facing</td>
<td>12</td>
</tr>
<tr>
<td>Residential street towards facing</td>
<td>15</td>
</tr>
</tbody>
</table>

The difference in dB values is +14 dB.
The chart shows the comparison of noise levels in different shopping centers under peak and off-peak conditions.

- **Peak Shopping Centre Away Facing**: A-SR 9 dB, I-SR 13 dB, Difference +4 dB
- **Peak Shopping Centre Towards Facing**: A-SR 7 dB, I-SR 0 dB, Difference -7 dB
- **Off-Peak Shopping Centre Away Facing**: A-SR 4 dB, I-SR 10 dB, Difference +6 dB
- **Off-Peak Shopping Centre Towards Facing**: A-SR 7 dB, I-SR 11 dB, Difference +4 dB

The overall improvement is indicated by the +10 dB text box.
INFANT SNR's

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Young children need improved SNR’s
FM can considerably improve SNR’s
Carers can make effective use of FM
What age? As soon as possible!

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Phonak: equipment + support throughout
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Thank you for listening!