The views of professionals on the fitting of RM/FM systems to pre-school children

"A study submitted in partial fulfilment of the requirements for the degree of Master of Science of the University of Hertfordshire"

D. Bevington. B.Ed (Hons) Dip SEN Hearing Impairment

University of Hertfordshire
Hatfield
Hertfordshire

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Abbreviations

ANSD	Auditory Neuropathy Spectrum Disorder
BAA	British Academy of Audiology
BMLD	binaural masking level differences
BSA	British Society of Audiology
CI	cochlear implant
CIC	Cochlear Implant Centre
dB	decibels
EA	Educational Audiologist
FM	Frequency Modulation (transmitter/receiver)
FM + M	Frequency Modulation + Microphone (HA/CI mode)
HA	hearing aid
HI	hearing impairment
HL	hearing loss
ILD	interaural level difference
IPD	interaural phase difference
ITD	Interaural time difference
LEA	Local Education Authority
MCHAS	Modernising Children's Hearing Aid Services
NHSP	Newborn Hearing Screening Programme
NDCS	National Deaf Children's Society

P	participant
PA	Paediatric Audiologist
RM	Remote Microphone
RT	Reverberation Time
SALT	Speech and Language Therapist
SNHL	Sensori-neural hearing loss
SNR	Signal to noise ratio
TEF	The Ear Foundation
TOD	Teacher of the Deaf
UK	United Kingdom

Abstract

In identifying the importance of early identification and subsequent amplification for children with hearing loss (HL) there has been little attention given to how advanced RM/FM (remote microphone/frequency modulation) technology may improve outcomes. Listening in noise is more challenging for children than for adults and distance; noise and reverberation remain considerable challenges for individuals using hearing aids (HAs) and or cochlear implants (CIs).

The purpose of this research was to explore the attitudes of professionals to the fitting of RM/FM to pre-school children, for use in the home, with reference to those aged 3 years and below and those aged 4 years and above. The research includes both quantitative and qualitative analysis. A questionnaire was distributed by TEF (The Ear Foundation) and 177 professionals, from a mixture of educational and health backgrounds, responded. The study qualitatively explores their views and experiences on their use of RM/FM technology.

Thematic content analysis for those in favour of fitting RM/FM to children aged 3 years and below sought to acknowledge three main themes; 'carer perspective', 'child development' and 'technological practicalities' and was analysed separately for HA and CI users. A further two main themes; 'child competency' and 'detrimental to the child' were explored for those not in favour of fitting RM/FM. The thematic content for those aged 4 years and above was more general in approach, identifying a number of main themes categorised for those in favour and those not in favour of fitting RM/FM.

Overall, the analysis highlighted the potential benefits, barriers and challenges to the use of RM/FM with pre-school children and identified the training needs of participants. The study concludes by discussing the findings and implications and highlighting areas for future research. The current study provides a unique contribution to the existing literature and together with future research can be integral to the provision of RM/FM technology as standard for pre-school children.

Chapter 1 Introduction

1.1. Background

It is necessary to consider every link in the auditory chain from the source to the nature of the sound signal being delivered to the ear canal when discussing auditory access (Ross, in Smaldino and Flexer, 2012). Early access to amplification plays a major role in laying the foundations for spoken language which is a critical component of normal development for deaf and hearing children (Marschark and Hauser, 2011, Davis et al, 1997). It is well documented that difficulties in acquiring spoken language stem directly from limited access to auditory information (Marschark and Spencer, 2006).

HAs/CIs provide early technological intervention. However, distance from a speaker, reverberation, and reduced opportunities for overhearing and background noise remain an issue for children using HAs/CIs. Combining sophisticated amplification such as HAs and CIs can be effective in improving signal to noise ratio (SNR) and speech perception in noise for children with HL.

Whilst initially infants may remain close to their primary care giver, distance from the speaker can be created by walking away from a child or as an infant begins to crawl and walk. For a child with a HL, early interactions are therefore potentially compromised. Additionally, the home and daily routines can be far from acoustically friendly (Berg, 1997). It would therefore seem logical to consider the use of RM/FM amplification.

Personal FM systems have been used for the benefit of the hearing impaired for many years (Katz et al, 2009). A personal FM system can improve the listening environment by delivering a clear signal directly from the speaker to the HAs or CIs, therefore reducing the negative effect of noise or distance (Nelson et al, 2013).

The Newborn Hearing Screening Programme for England (NHSP-England) achieved full implementation in March 2006 (Wood et al, 2015). The vision being to improve outcomes and provide early intervention for children with HL and the aim of the programme to screen all eligible babies within the first few weeks of life. As a result, there have many developments in early support services and this has been matched by rapid technological development in the field of audiology. Modernising Children's Hearing Aid Services (MCHAS) was introduced, enabling children identified with HL by the NHSP, to have access to the latest digital amplification systems within the first few months of life.

The aims of this study were to qualitatively and quantitatively investigate the views of professionals on the fitting of RM/FM technology to pre-school children and provide an insight into current practice. Thus, a mixed methodological approach was employed to ensure that a holistic view of professional attitudes was gained. This research builds upon earlier research by Mulla (2011) into the early use of FM amplification with pre-school children.

Chapter 2 Literature Review

2.1. Auditory perception and speech development

Eimas et al, (1971) explored the capabilities of speech discrimination. Their findings demonstrated that infants as young as one month had some capacity to discriminate speech sound contrasts. Research in recent years has supported this and shown that infants innately possess the ability to process speech from birth. Studies indicate that infants begin with a general language capacity but following prolonged exposure to their native language show a decline in discrimination of many non-native distinctions and an enhancement of sensitivity to native ones (Werker and Yeung, 2005).

2.2. Binaural Hearing

When listening to sounds in the environment the auditory system needs to determine what the sound is, and its location. This is accompanied by challenges; including being able to suppress echoes in reverberant environments and combining or grouping sounds that belong together (Litovsky, 2008).

Real listening, more often than not, involves binaural processing of auditory information (Durrant and Lovrinic, 1995). Sound is delivered to both ears as opposed to monaural which refers to sound delivered to one ear only (Moore 2013). Binaural hearing is particularly useful for our ability to localise sounds and determine the content of sounds (Litovsky, 2008).

Mason (2011) discussed the importance of binaural hearing. Using Figure 2-1 he was able to demonstrate how sound inputs from each ear travel up ipsilateral and contralateral brainstem pathways, are then compared and processed at various nuclei before reaching the auditory cortex. Binaural hearing allows the listener to benefit from a range of auditory cues such as interaural level and time differences.

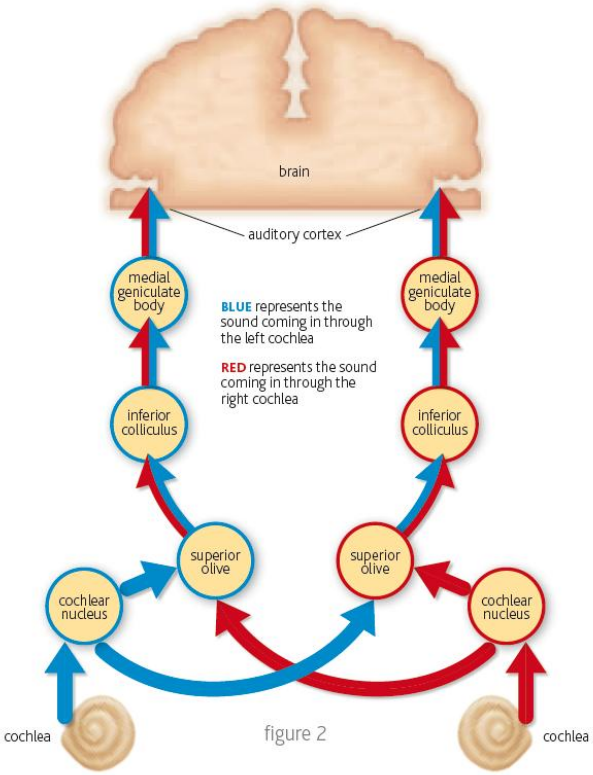

Figure 2-1: The auditory pathway that the sound takes from the cochlea and then through the brainstem to reach the auditory cortex in the brain. (Source: Mason, 2011)

Moore (2013) outlines three reasons to support the advantages of binaural hearing. Firstly, subtle differences in the intensity and the timing of the arrival of sounds at the ears provide cues that enable localisation of a sound source. Secondly, it is easier to detect and discriminate the signal in noise when the signal and background noise come from different directions. Thirdly, when listening in the presence of background noise the SNR may be higher at one ear than the other. This is useful when trying to hear speech against a background of noise.

2.2.1 Localisation

2.2.1.1. Interaural timing differences

The directions of sound sources in space are usually defined as relative to the head (Blauret, 1993, in Moore, 2013, p266). Depending upon the location of a sound source there can be a difference in the arrival time between the two ears, this is called the interaural time difference (ITD). The highest ITD will be present when the sound is located directly to right or the left ear. For sound sources in the median plane the ITD will be zero and this can be seen in Figure 2-2.

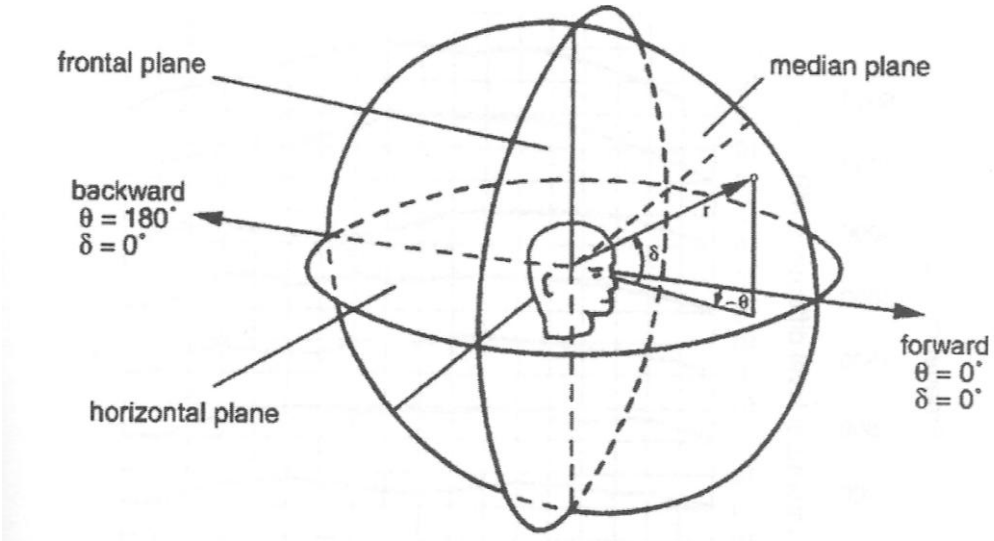

Figure 2-2: Illustration of the co-ordinate system used to define the positions of sounds relative to the head. The azimuth is given by the angle θ, and the elevation by the angle δ. (Source: Blauert, 1993, in Moore, 2013, p247)

Each location in space around the head will create a different set of ITDs (Litovsky, 2008). ITDs show some variation with sound frequency and are the most important cues for sound location when low frequency components are present (Schnupp et al, 2011 and Moore, 2013).

Moore (2013) argues that for a sinusoidal tone, an ITD is equivalent to a phase difference between the two ears and this is termed interaural phase difference

(IPD). For example, if a 200Hz tone is delayed at one ear by 100 microseconds, this is the equivalent to a phase shift of one tenth of a cycle.

For high frequency tones the IPD becomes an ambiguous cue as the peak in the waveform at one ear can coincide with the minimum in the other, so the auditory system has no way of knowing which is the leading ear. However, for low frequency sounds this provides important information about location.

An ITD shift of between 0 and 10 microseconds results in the location of the sound source changing by approximately 1^{o} degree in the azimuth. This is considered accurate in terms of the resolution. It can be inferred that information about when time sounds occur is maintained in the auditory system at least to the superior olivary complex where inputs from two ears are combined (Moore, 2013).

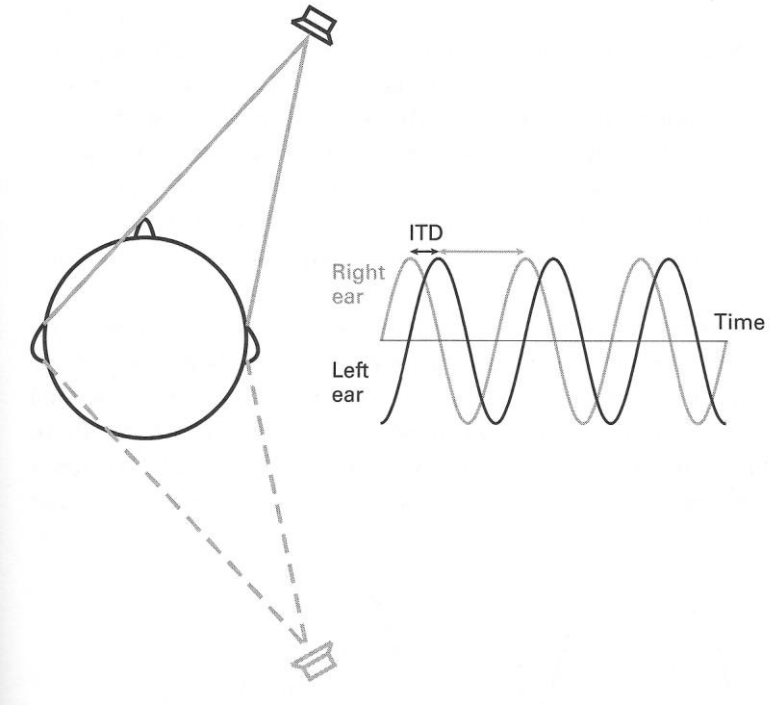

Figure 2-3: Illustration of the ITD results in a phase shift between signals at each ear (Source: Moore, 2013)

2.2.1.2. Interaural level differences (ILD)

Another binaural cue to sound location is the difference in the level of sound at the two ears and this is called the ILD.

These differences arise for two reasons. Firstly, a sound originating from a particular side of the ear will be more intense at that side and the sound intensity or level decreases as it travels away from the source to the other ear. However, in many situations the effect of distance in relation to the ears is a minor factor as the width of the head is comparatively small compared to the distance between the sound source and the ear. Secondly, the head has a 'shadowing' effect on the sound as it will prevent some of the sound energy reaching the left ear when the sound source is on the right, as it is diffracted by the head to the opposite ear which lies within the acoustic shadow of the head (Schnupp et al, 2011). The wavelengths of low frequency sounds are long, compared with head size, therefore they bend round the head easily producing little or no shadow. However, high frequency sounds have short wavelengths compared to the head and so a 'shadow', almost like that produced by an obstacle in a beam of light, occurs (Moore, 2013).

ILDs are negligible below 500Hz (Moore, 2013), therefore at low frequencies, apart from when the sound source is very close to the head. On the other hand, at high frequencies ILDs can be 20dB or greater.

2.2.1.3. Binaural lateralization.

Durrant and Lovrinic (1995) suggest the sounds perceived by two ears are not heard independently but combine into a single auditory image. For example, if a sound in the right ear is greater in intensity or leading in time or phase, the sound appears to be in the right side of the head, the sound is lateralised, an effect called binaural lateralization (Durrant and Lovrinic, 1995). Ching et al, (2004) are of the view that the same SNR benefits exist for adults using bimodal hearing devices when listening to spatially separated speech and noise.

2.2.1.4. Binaural squelch.

Gray et al, (2009) describe the binaural squelch as a centrally mediated segregation of a signal from noise when that signal and noise are differing in location, producing temporal and intensity differences at the two ears. Resulting in better speech intelligibility in noise, due to the addition of a second acoustic input at the contralateral ear, with the poorer SNR than the first ear.

Binaural squelch is the process of suppressing the signals that are unimportant when both ears and brain receive both speech and environmental noise. The brain has the ability to use the differences in SNR between the ears and identify what is not wanted; important for understanding speech in noise.

When ITDs and ILDs arise under conditions of spatial separation of signal and noise, the auditory system can potentially combine the sound information to form a better central representation (Litovsky et al, 2006).

2.2.1.5. Binaural summation.

When identical sounds arrive simultaneously at both ears this is referred to as diotic, sounds that are different are termed dichotic (Moore, 2013). Improvements in hearing sensitivity and increased loudness when sounds are presented binaurally are referred to as examples of binaural diotic summation. This can also be termed binaural redundancy or bilateral summation (Durrant and Lovrinic, 1995, Moore, 2013).

Binaural diotic summation refers to the auditory system's ability to centrally combine and derive benefit from duplicate representations of the same signal to the two ears when speech and noise originate from the same location (Litovsky et al, 2006).

One implication of this can be seen when a stimulus is presented via headphones. The binaural threshold is better than the monaural threshold with a binaural

advantage around 3dB. In addition, a sound presented binaurally sounds louder than one presented monaurally by a ratio of 2:1 (Durrant and Lovrinic, 1995).

Dillon (2001) argues that loudness of a sound is greater binaurally for an individual with typical hearing. This loudness increase occurs at all levels but not to the same degree. For near threshold sound, binaural summation is equivalent to an increase of 3dB in one ear; at a comfortable level it is equivalent to a 5-6dB increase with some studies finding a difference of 10dB.

Studies have shown that binaural summation can improve speech recognition in quiet as well as in noise for bilateral CI users (Nittrouer et al, 2013). Litovsky et al, (2006) study suggests that the improvement is seen even when speech and noise come from the same location. However, Nittrouer et al, (2013) argue that there is evidence to suggest the binaural summation effect is greater for hearing impaired people than those with typical hearing, as one ear may compensate for errors in the other.

2.2.1.6. Binaural masking level differences (BMLDs).

An ability to detect signals in adverse conditions is an important sensory function. The masked threshold of a signal can be significantly lower when listening binaurally as opposed to monaurally (Moore, 2013).

The BMLD is a psychoacoustic phenomenon that reflects sensitivity to IPD. Whereby a signal that is identical at each ear, masked by a noise that is identical at each ear, can be made 12–15dB more detectable by, inverting the waveform of either the tone or noise at one ear (Bornstein, 1994, Moore, 2013, Gilbert et al, 2015). In hearing, spatial separation can lead to a dramatic improvement in signal detectability. BMLD is a measure of this ability and is different for the various frequencies. Ranging from 15dB at low frequencies to 2-3dB for frequencies above 1500Hz. For children this can be developmental as BMLD’s become larger

until the child reaches the age of 5 or 6 where, they reach adult levels ranging between 8 and 15dB (Bornstein, 1994).

In experimentally controlled environments, a listener can use IPD cues to increase detection of the signal when presented in the presence of a binaural masking noise. This takes place when the signal is changed from in-phase to out-of-phase at the two ears. This occurs when the signal and masker are spatially separated and differ in position leading to increased detection and discrimination of signals (Moore, 2013). An illustration of this can be seen in Figure 2-4. The first illustration shows poor detectability and the second, where the interaural relations of the signal and masker are different, providing good detectability.

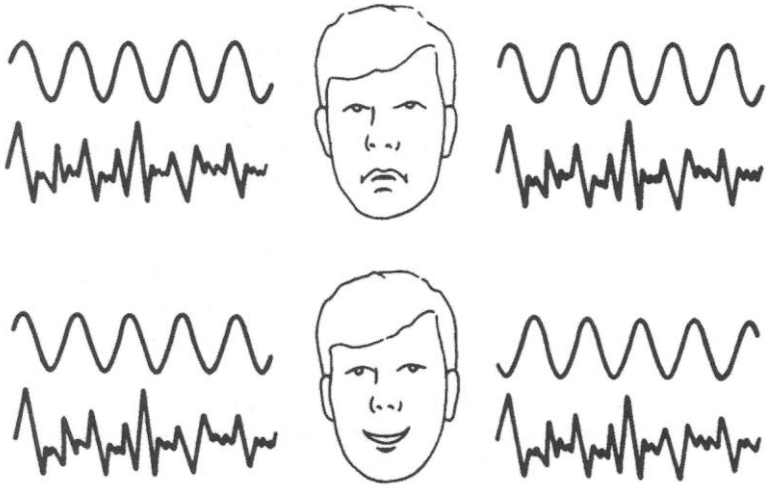

Figure 2-4: Illustration where BMLD's occur (Source: Moore, 2013 p272)

The effect of BMLD has also been observed for complex tones, clicks and speech sounds and is not restricted to pure tones and white noise (Moore, 2013).

2.3 Listening in Noise

In real environments, background noises are invariably present and can mask cues in speech messages affecting speech recognition (Yang et al, 2012). Even for typical adult listeners, background noise can be challenging. Studies have shown there needs to be a 2dB SNR to understand 50% of words (Killion, 2000).

For adults with a hearing impairment, a greater SNR is required. Plomp (1994 in McFarland, 2000) researched speech perception in background noise. His findings showed that for people with a SNHL there needs to be an increased SNR between 2.5dB for mild HL and 7dB for moderate to severe losses. Additionally, when there was a fluctuation in noise the SNR increased to between 9dB and 25dB (Baer and Moore, 1994; Eisenberg and Dirks, 1995). KIllion (1997 in McFarland, 2000) illustrates the increase in SNR averaged for different levels of HL in Figure 2-5.

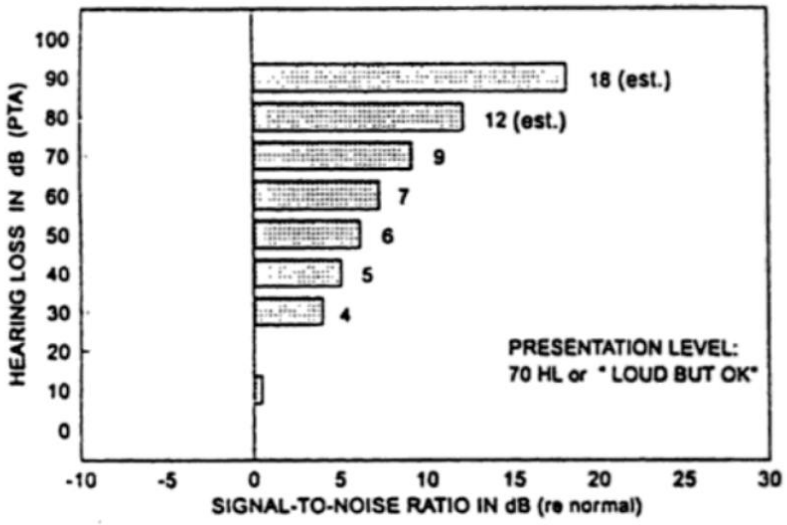

Figure 2-5: Smoothed-average SNR versus HL data (Source: Mc Farland, 2000 p45)

2.3.1 Listening in noise for children with typical hearing

It is well recognised that children do not have the same auditory perceptual abilities as adults (Johnson, 2000, Lewis et al, 2014). Children require better SNRs to achieve comparable speech recognition scores (Nittrouer et al, 2013, Wroblewski et al, 2012). Paradoxically, children spend much of their lives functioning in environments much noisier than those in which adults live (Nittrouer et al, 2013).

For children there can be a reliance on context independent processing (bottom up processing). This is especially true when learning new concepts where the context is unfamiliar (Wroblewski et al., 2012). As a consequence it becomes more challenging for a child to understand speech as they are unable to fill in gaps in their understanding. On the other hand, for adults who have a greater reliance on context-dependent processing (top-down processing) and can therefore fill in missing information, it becomes less demanding.

A study by Johnson (2000) found that children's consonant identification abilities may not reach adult like performance until they reach mid to late teens as children require more acoustic energy than adults.

2.3.2. Listening in noise for children with hearing loss

Children with HL have an even greater disadvantage listening in noise as they are hampered by their HL and age (Nittrouer et al., 2013). Research shows that there is a significant impact on the development of speech and language when children have insufficient access to sound (Nelson et al., 2013).

There is however, evidence to show that many children with SNHL can achieve language abilities similar to hearing peers as a result of intense early intervention (Moeller, 2000). Indeed, early detection and intervention are believed to be critical steps toward proactive management. The first 3 years of life are a critical learning period. For a child with a HL there are reduced opportunities for overhearing and intervention is needed to provide this.

A key part of this early intervention is the consistent use of appropriate amplification (Nelson, 2013) such as HA or CI. Golos and Moses (2013) state that even with NHSP and the increased availability of amplification some deaf children are still at risk and it becomes paramount for a child to receive a clear and consistent signal across environments.

In a study Yang et al, (2012) found that children with CIs performed better than children with HAs and the accuracy of speech recognition at SNR 10dB was about 50% for CI children and 33.33% for HA children.

2.4. Reverberation time (RT).

Reverberation is an acoustic phenomenon resulting from multiple reflected sounds arriving at a point with minimal sound delays between them. It is quantified as the necessary time for the sound pressure at the observation point to decay. RT is defined as the time (in seconds) it takes for the sound from a source to decrease in level by 60dB after the source has stopped (Boothroyd, 2012. Crandell and Smaldino, 2000. International Organization for Standardization, ISO 3382, 1997. Klatte et al, 2010).

RT is a major factor of room acoustics dependent directly on the room volume and the absorption of the boundaries or objects within the environment (Durrant and Lovrinic, 1995). Klatte et al, (2010) state that long RT's reduce the clarity of speech intelligibility due to the fact that speech signals reaching a listener are a mixture of direct energy and time-delayed reflections. Additionally, when RTs are too long, undesired sounds remain longer in the room and as a consequence, noise levels increase.

In a normal listening environment some sounds arrive by a direct path but a great deal of sounds reach the ear after one or more reflections from the surfaces in the room (Moore, 2013). When sounds reach the ear in close succession they are not heard as two separate events, but as a single sound. This is known as echo

suppression where the interval between them is sufficiently short (Litowsky et al, 1999, in Moore, 2013).

A sound is determined largely by the location of the first sound when successive sounds are heard as fused and this is the precedence effect (Moore, 2013). This plays an important role in our perception of everyday sounds (Moore, 2013) and is helpful for localisation and for the suppression effects of reflections arriving soon after the direct sound. If the early reflections were not integrated with the direct sound, these reflections would interfere with the perception of the direct sound and in particular with speech intelligibility.

For children with HL speech intelligibility is hampered in reverberant environments (Crandell and Smaldino, 2000). The reverberant speech energy reaches the listener after direct sound, and overlaps with that direct signal, resulting in a "smearing" or masking of speech. This has a similar affect to noise, in that reverberation tends to affect consonant perception, particularly those in word final positions. However, the masking effect of reverberation is more noticeable for vowels as they exhibit greater overall power and are longer in duration than consonants. This means that in highly reverberant environments, words may overlap with one another, causing reverberant sound energy to fill in temporal pauses between words and sentences.

2.5. The use of RM/FM Technology

Norrix et al, (2015) explain how hearing assistive technology systems can improve SNR as a result of an active microphone at the signal source rather than at the microphone of the HA. When using FM, speech is detected by a remote microphone situated close to a talker. The signal is converted to an FM signal by a transmitter, which in turn is detected by a receiver (Nelson, 2013) and is injected into the HA signal path after the HA microphone and converted back to an acoustic signal. As a result the speech signal is at a higher-level and suppresses the background noise and overcomes the problem of distance.

For HA and CI wearers, distance and the presence of background noise is challenging and a listener would be less likely to access intensity and timing cues. The understanding of speech in the presence of background noise and reverberation is difficult (Marrone et al., 2008). The use of RM/FM raises the SNR making listening in noise or at a distance much easier.

2.5.1. Pre-school use of FM technology

FM systems have been used widely in classrooms to enhance SNR for pupils (John et al, in Smaldino and Flexer, 2012) and research has shown the benefits for children with HL. Research has validated the benefit of this but few studies have investigated use with pre-school children.

HAs alone do not provide sufficient benefit if the infant and primary talker are more than a few feet apart. With early diagnosis and coming to terms with amplification, primary caregivers may not be able to manage the additional technology that an FM offers (Madell, 2012).

As infants become toddlers, it may be suggested that the distance between their ear and the mouth of their caregiver begins to increase which may compromise audibility. However, this can happen in reality from birth as the caregiver moves away from an infant. As a child develops and spends more time at a distance from their care giver, they are often not attending directly to the language model. In this scenario, it becomes appropriate to consider the use of FM (Gabbard, 2004). Families need to understand the negative effects of distance and noise on learning language and auditory brain development (Cole and Flexer, 2015).

Gabbard (2004) suggests that not only distance becomes a consideration for FM but also the degree of HL, the amount of background noise in the child's environment, the child's ability to tolerate the HAs, and the willingness and ability of a caregiver to manage the technology. Whenever FM is introduced, training and support are integral components to success (Gabbard, 2004).

It is important that amplified speech from an RM/FM transmitter has the same high quality as that from a HA/CI microphone in order to see the emergence of auditory skills and the development of spoken language (Gabbard, 2004).

2.5.2. Conclusions of the literature review

The aim of this literature review was to determine the underlying concepts of this study and to explore the attitudes of professionals on the fitting of RM/FM with very young children in non-academic settings.

The review of the existing literature has reinforced the need for more exploration into the early use of RM/FM technology particularly in non educational settings. There is evidence to demonstrate the acoustic challenges for infants with HL and evidence of the benefit of RM/FM has to be considered further.

Chapter 3 Methodology

3.1. Introduction

The primary purpose of this study was to explore the views of professionals on the fitting of RM/FM systems to pre-school children. The methodology can be described as mixed (Cresswell, 2003), including both a quantitative and qualitative approach. Although quantitative methods provide insight they cannot provide an in-depth analysis of the views of professionals. It is qualitative enquiry that enables themes and trends to be identified (Smith, 2003). The methodology regarding study ethics, recruitment, participants and overall procedure will be discussed in this section.

3.2. Research

The methodology employed to capture the views of professionals is both quantitative and qualitative. The gathered data must be relevant and provide insights that are valuable for both theory and practice (Smeyers, 2008). In this study, participants were required to respond to a series of pre-defined questions in the form of a questionnaire.

Thomas (2013) suggests that to have several viewpoints on a question is better than one. As there were several factors influencing the questions posed in this research, this approach was crucial to obtaining conclusions and identifying trends.

The Hawthorne effect (McCambridge et al, 2014) concerns research participation, the awareness of being studied, and resulting possible impact on behaviour. The original studies that gave rise to the Hawthorne effect were undertaken at Western Electric telephone manufacturing factory at Hawthorne, near Chicago, between 1924 and 1933. It was found that when workers were supervised intensively the result gave an increase in productivity. In 1953 the word was used in relation to methodology and has been a subject of debate ever since. Indeed if there is a Hawthorne effect, a study could be biased, with profound implications for research.

In this study there could be possible limitations due to the potential of the Hawthorne effect (Cohen et al, 2011). Participants may modify their responses as a means to an end, maybe hoping that availability of RM/FM would be widened. This is something extremely difficult to quantify if a considered difference might occur because of an external factor. These may be, budget constraints, locality, professional status, age of participants, length of service, up-to-date knowledge and appreciation of amplification. Research shows that the Hawthorne effect can increase in face-to-face interviews with the presence of a researcher a contributory factor. However, the use of a voluntary questionnaire should reduce the effect.

Cresswell (2003) describes how, in more recent years research has evolved to include both quantitative and qualitative strategies with the analysis of both forms of data within a single study. The concept of mixing different methods probably originated in 1959, when Campbell and Fiske used multiple methods to study validity of psychological traits (Cresswell, 2003). This mixed method design helps to capture the best of both quantitative and qualitative approaches. The researcher can generalise the findings to a population and develop a detailed view of the meaning of a concept for individuals. Indeed, it is considered that all methods have limitations, therefore, biases inherent in any single method could neutralise or cancel the biases of other methods.

The research approach employed in this study can be summarised as mainly qualitative in nature with an element of quantitative research that should be regarded as no less important. This study does not therefore, fit into a typical paradigm but rather adopts aspects of both positivism and interpretivism (Thomas, 2013). Smeyers (2008) states that, both a qualitative and quantitative approach is required, when studying educational matters. However, Smeyers (2008) raises the concern that this approach may lead to contradiction if there is an attempt to strip words out of a context to try and say something in particular. For this reason the questionnaire used in this study, distributed by TEF, has questions which fall into one field of study – professional attitudes on amplification for pre-school children.

3.3. Ethics

Cohen et al (2011) describe the questionnaire as being an intrusion into the life of a respondent. This could be simply the time needed to complete it, a perceived level of threat or potential sensitivity of the questions. Moreover, if a questionnaire is distributed electronically, the decision to be involved remains in the control of the participant. In returning the questionnaire a participant assumes consent and this is the case in this study. Confidentiality was assured at the time of distribution by TEF and participants had the ability to add as much personal data as they wished.

The data was anonymised at source by TEF prior to being given to the researcher and stored in accordance with data protection procedures. Data will be kept for the duration of 5 years, in a secure location. The ethics approval document can be viewed in Appendix A.

3.4. Participants

The questionnaire was distributed to hearing professionals across the UK. The BAA, BSA, TEF and other relevant email lists were used to distribute the questionnaire electronically (Mulla, 2012). 177 professionals completed the questionnaire; the spread of professional bodies can be seen in Table 3.1. The geographic locations are shown in Figure 3-1. TEF made the decision to exclude all non-UK responses.

Table 3.1: Profession of participants

PROFESSION	NUMBER
Teacher of the Deaf (TOD)	68
Speech and Language Therapist (SALT)	9
Educational Audiologist (EA)	31
Paediatric Audiologist (PA)	56
Other	13
Total	**177**

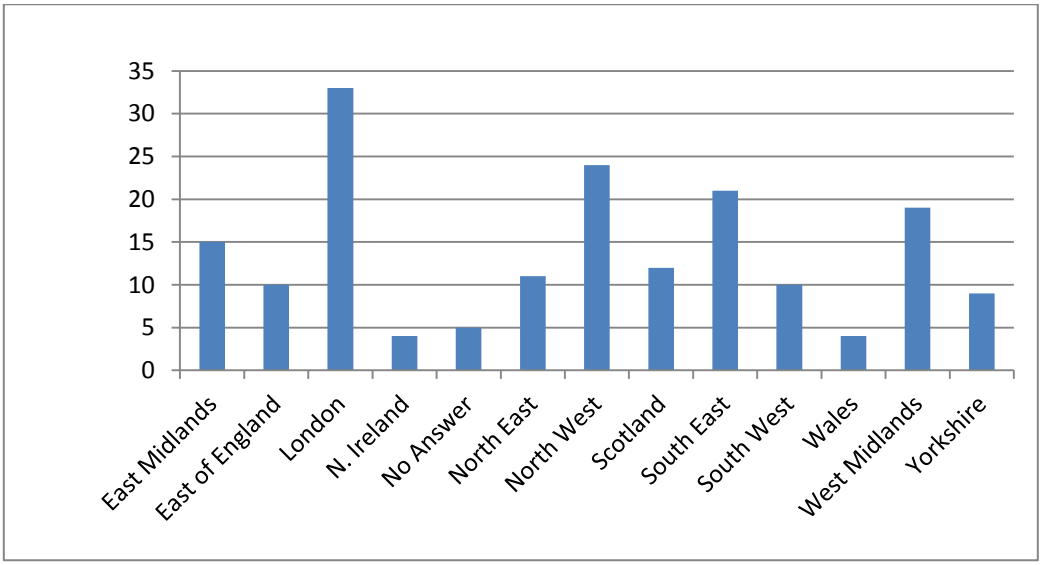

Figure 3-1: Location of participants.

3.5. Data Collection

3.5.1. Questionnaires

Designing a questionnaire requires discipline in the selection and formulation of questions as well as the distribution and return (Bell, 2014). Researchers are dependent upon the willingness and availability of respondents (Bell, 2014). Issues should be explored in multiple questions with the analysis in mind. Questions must not be leading, threatening and avoid negatives and double negatives. Beginning with simple factual questions, moving to more sensitive questions is considered to be productive.

Cohen (2011) describes the planning of a questionnaire as an eight stage process:

- Deciding the objectives for the research.
- Decide the population and sample.
- Itemise the topics.
- Decide the kinds of measures or responses needed.
- Write the questionnaire items.

- Check that each research question has been covered.
- Pilot the questionnaire and refine.
- Administer the questionnaire.

The questionnaire (see Appendix B), designed and distributed by TEF, contains questions seeking factual information as well as those exploring personal opinion. The aim was to be able to draw conclusions about the perceptions and understanding of professionals rather than to try and make a general claim (Smith, 2003).

Closed questions, termed dichotomous, provide clear answers, are quick to respond to and allow the generation of frequencies amenable to statistical analysis (Cohen, 2011).

Open-ended responses allow a participant to explain and qualify. They are appropriate when the possible answer is unknown or exploratory (Cohen, 2011). However, this may lead to citing irrelevant or redundant data and risk of refusal to complete, thus making the analysis of data more complex. The researcher is in danger of violating one principle of word based data, when trying to adopt principles of numerical data.

Open-ended questions are considered appropriate for small-scale research when they follow a closed question. Questions were devised to determine existence of policies and then quantify the number of FM/RM fitted. This was divided into two areas; those aged 3 years and below and those 4 years and above. Furthermore, questions were posed in two categories: HA wearers and CI wearers.

3.5.2. Qualitative Analysis

Flick (2008) describes qualitative research as that relating to an abstract idea involving quality and this provides an insight showing trends or changes overtime.

In the qualitative analysis, the researcher aims to identify the main themes through the open-ended responses to each question.

The qualitative approach allows initial themes to be listed and connections sought (Smith, 2003). The next stage, Smith (2003) describes as a more analytical and theoretical ordering, as the researcher makes sense of the connections between the emerging subthemes. Some themes begin to cluster together and main themes begin to emerge. Here, a researcher is drawing on their own ability to interpret and some themes may be dropped as the analysis continues.

Bell and Waters (2014) describe the qualitative method of enquiry as a desire to understand individuals' perceptions of the world and question the validity of a scientific approach when dealing with human beings. In light of the quantitative data, the qualitative part of this study will identify the themes for each question and be compared with the quantitative data. The aim of this qualitative form of research is to identify what is meaningful, based upon what emerges from the questionnaire (Smith, 2003). As the purpose of this study was to explore professional attitudes, a qualitative approach is well suited as the aim of qualitative research is to understand experiences.

Qualitative analysis can be seen as organising, accounting for and explaining the data (Cohen et al, 2011). It relies on interpretation and there are often multiple interpretations that can be made of qualitative data. Here, the researcher will set out to describe, generate themes and raise issues.

3.5.3. Quantitative Analysis

Bell and Waters (2014) describe quantitative research as collecting facts and studying the relationship between them. This type of enquiry relies on numerical data and questions that are structured and pre-determined. As a result this method of enquiry, as stated by Bell and Waters (2014), has structured and predetermined research questions.

The initial questionnaires were analysed and the data presented in statistical and tabular format. The findings from the research were compared to findings from the background reading and conclusions were drawn.

3.6. Data analysis

3.6.1. Results

In this study the researcher looked at the quantitative data initially by looking at spread of professional roles. This was followed by investigating the responses for the closed element of each question where a yes or no response was required (Appendix B). The data is presented in tables and pie charts.

The analysis of the data is both quantitative and qualitative. The in-depth analysis of the quantitative data explores the descriptive statistics overall. Qualitative enquiry is carried out to explore in depth analysis of the open-ended responses.

All participants' questionnaires were inputted into Microsoft Excel 2013. Formulas and formatting within Microsoft Excel 2013 were used to analyse the quantitative data. Initially, work sheets were created for each specific question and data collated under columns with a broad heading. Data that was relevant to more than one column was copied into both. As this continued a number of sub-themes emerged and over time some were not relevant and collapsed.

The researcher carried out a thematic content analysis for the open-ended responses given to questions 6-8 (see Appendix B). This was where the participants were asked personal opinions. Codes were generated and as expected during any qualitative analysis, some were collapsed into others as it became apparent they were capturing the same overall theme.

Whilst part of qualitative analysis, there must be an acknowledgement and recognition of how the knowledge and experiences of a researcher may influence the research in itself. As a TOD the researcher has an interest in establishing early

amplification as well as embracing the appreciation of the wider amplification options available and also a theoretical understanding of the signal processing limitations of HA/CI technology alone. Furthermore, the data from professionals provided an opportunity to understand what role, if any, the use of an RM/FM system had in the amplification packages of pre-school children.

The results aim to identify factors for consideration and barriers to implementation of RM/FM across the UK. Quantitative research looks for the distribution of variables (Smeyers, 2008) producing explanations either in terms of an argument or logical structure. The responses to the closed questions will help to identify trends in views of a particular body of professionals. Smith (2003) describes Interpretive Phenomenological Analysis as the desire to explore how participants make sense of their personal and social world. This type of research does not have a strive to test a predetermined hypothesis but moreover to explore in detail an area of concern. This study is looking at personal perceptions and not objective statements.

It is hoped that this research plays a part in contributing to the task of improving our practical knowledge and on-going work with pre-school children. It is also noted that the research can be vulnerable as it is dependent upon the researcher's subjectivity (Smith, 2003).

Based on these arguments, this study analysed the qualitative findings using deductive methods. The findings from each respondent and questionnaire theme were analysed according to the literature review topics discussed. Where different respondents had something to say about a particular issue, these were taken into consideration in the analysis of findings.

Chapter 4 Results

4.1. Introduction

Professional opinion provides insight into the perceived benefits and challenges of using RM/FM technology with pre-school children. Opinions were divided and detail differed in consistency.

4.2. Policy for the use of FM at home

4.2.1. Children aged 3 years and below

Of the 177 responses, 47 acknowledged the existence of a policy of which 46 were able to explain its rationale. Of these, 4 had a policy not to fit, 3, all PAs, stated that FM was activated on HAs with fitting FM the responsibility of education. 100 stated no policy existed and 30 submitted no answer. However, of these 100, 42 were PAs and 8 SALT's who either referred to education as being the major provider or felt unable to comment. A number of common themes were identified (Table 4.1).

Table 4.1: Criteria for policy on FM provision for children aged 3 years and below

Thread of reason	**responses**
To meet NDCS Quality Standards	14
Once amplification is fully established	6
Parental request for FM	8
Children can reliably report if it is working	5
A pre-school placement with poor acoustic conditions	6
Total responses to themes	39

36% identified the NDCS Quality Standards as the driving force of their policy and 21% were fitting at parental request. Of those stating the child needed to be able to reliably report, 4 were Cochlear Implant Centres (CIC's) and another referred to CI children as not fitted until a stable map was established.

4.2.2. Children aged 4 years and above

79 reported that a policy existed, 82 that no policy existed and 16 did not submit an answer. 35 of the 82 responses stating no policy existed were PAs and 8 SALT's, who cited education as the main provider.

The data was analysed under two categories, those from health and those from education (Figure 4-1 and Figure 4-2), more than twice the number of those from education than health were aware of the existence of a policy.

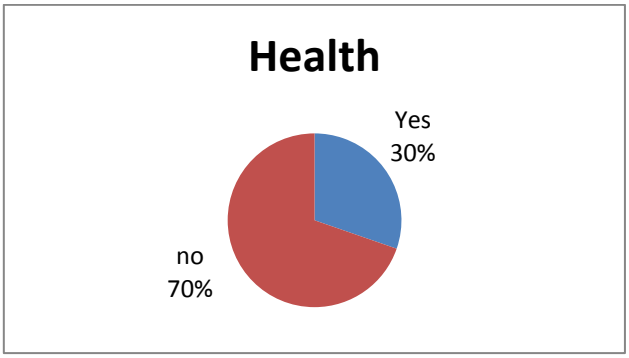

Figure 4-1: Shows the number of participants with a health background that have a policy in place for the fitting of FM to children aged 4 years and above for home/personal use.

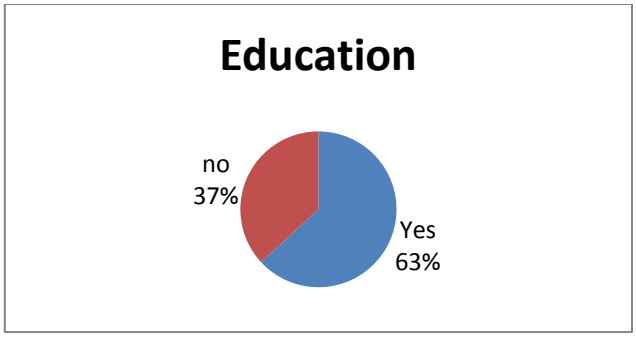

Figure 4-2: Shows the number of participants with an education background that have a policy in place for the fitting of FM to children aged 4 years and above for home/personal use.

4 out of the 5 CICs acknowledged a policy. 72 participants (Ps) outlined the criteria; 10 having a policy not to fit and 3 PAs stated the feature was activated in clinic. The analysis of the remaining data can be broken down into themes (Table 4.2).

Table 4.2: Criteria for policy on FM provision for children aged 4 and above for home/personal (out of school) use

Thread of reason	**responses**
To meet NDCS Quality Standards	23
Once amplification is fully established	13
Parental Request for FM	12
Children can reliably report if it is working	10
Degree of HL	1
Responses	59

The most common theme, almost 40%, was to meet NDCS Quality Standards. Parental request was acknowledged in 20% of the cases.

4.3. Children aged 3 years and below with HAs

4.3.1. Quantitative Analysis

Figure 4-3 shows those who reported that HA children in their area, aged 3 years and below, were fitted with FM.

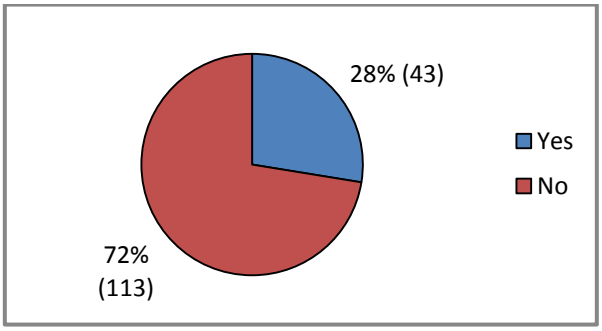

Figure 4-3: Shows the number of areas where FM is fitted to children aged 3 years and under who are HA wearers

Some participants quoted the number of children fitted with FM. This ranged between 6% and 25% of their total caseload. In one instance, it was reported to be as high as 45%, a figure reported by the Elizabeth Foundation, acknowledging children were fitted by their local service.

Some quoted a quantity but with the absence of the total on caseload, this could not be equated to a percentage. For these, the number fell between one and five. Additionally, one child was fitted as part of CI assessment and another following a diagnosis of ANSD but these were isolated instances so no conclusions could be drawn.

Over 75% of those involved felt FM was something that should be available for this age group (Figure 4-4).

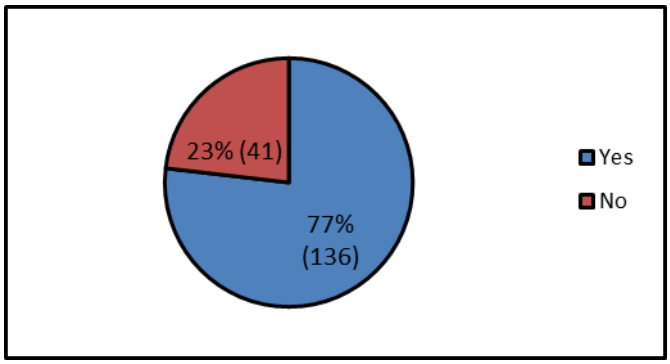

Figure 4-4: Professional opinion – should HA wearers under 3 years of age have access to FM

The data was divided into two categories according to the response given above (Figure 4-4). Of the 136 positive responses, 130 provided a comment, some referred to a number of themes and this is reflected in the data analysis. Responses were thematically analysed and three main themes identified:

- Carer perspective
- Child development
- Technological practicalities

The key main theme identified by 60% of participants was the technological practicalities. Additionally 56% discussed the overall advantage for the development of the child and 19% were of the opinion that FM should be considered from the point of view of the carer.

4.3.2. Qualitative Analysis

In analysing the main themes a number of subthemes emerged. Although, initially there is a quantitative element involved in the analysis, it is then further expanded in a qualitative manner gaining a more meaningful insight.

4.3.2.1. Carer Perspective

Even though a significant number of professionals were in favour of fitting FM, analysis suggests that the decision to do so, remains in the hands of the professionals involved (Table 4.3).

Table 4.3: Professional opinions of those in favour of fitting RM/FM to children aged 3 years and below with HA from a carer perspective

Sub theme	Number of times	Percentage of responses
It is parental choice	7	5.4%
Carer competency to use	13	10%
Safety	5	3.8%

Although parental feedback seems to be positive, on only 7 occasions (5.4%) was there reference to parental choice.

P131, an EA and Manager of HI team, wrote "Have had very good feedback from parents who use FM at home. Reported significant benefit in specific situations. e.g. in the car, pushchair, safety out and about, reassurance if child is in another room/out of HA range, ..."

P126, a PA, wrote "If there is a delay between chronological age and speech development, or parents want to arrange FM provision, it should be part of the parents' choice."

10% referred to the competency of the parents to manage the equipment effectively.

P61, an EA, wrote "Where families/carers are confident about managing the system."

P167, a TOD, wrote "If there is appropriate support and motivation from parents, the ability for a small child to hear their carers voice more clearly should support language development."

4.3.2.2. Child Development

As previously discussed, fitting FM to pre-school children enhances their development. A number of themes were identified in this area (Table 4.4).

Table 4.4: Sub themes of the professional opinions of those in favour of fitting RM/FM to children aged 3 years and below with HA from a child development perspective

Sub theme	Number of times	Percentage of responses
Environment/Situations where FM it would be of benefit (situation specific)	28	21.5%
To improve listening skills	14	10.8%
To promote communication	6	4.6%
To promote language development	25	19.2%
Access to language at all times	7	5.4%
Additional disability	2	1.5%
Only if the child can report	2	1.5%
Child characteristics	12	9.2%

The promotion of language development and situations where FM would be of benefit were most common. Some were of the opinion that technology (HA and FM) should come as a whole package, with guidance from professionals.

> *P17, a PA, wrote "I feel strongly that all children who receive HAs should be offered FM as part of the package from first fitting if appropriate. Evidence and experience suggests that babies and children can benefit greatly from the improved SNR at this crucial time in their speech and language development. Issues such as interference need to be carefully addressed and monitored with this group but this is not a reason to withhold technology. I am not sure that there is any evidence that children who have used FM from an*

early age are any less able to localise than other children with hearing loss."

The improvement of communication, language development and continual access to language were positive outcomes of FM.

P159, a TOD wrote, "It encourages access to sound at a distance, better general awareness for safety and language development."

4.3.2.3. Technological Practicalities

Unsurprisingly, the vast number of professionals appreciated the technological practicalities provided. Distance from the speaker, background noise and poor acoustics in rooms contribute to a poor SNR, resulting in a compromised auditory signal. As seen in Table 4.5 30.8% of professionals favoured the improvement in SNR.

Table 4.5: Professional opinion of those in favour of fitting RM/FM to children aged 3 years and below with HA from a technological practicality

Sub theme	Number of times	Percentage of responses
Provided regular evaluation is required	8	6.2%
Provided the child is a good HA user	9	6.9%
To overcome HA limitations	2	1.5%
Used to it before starting school	2	1.5%
Improved SNR	40	30.8%
Overcome the problem of distance	24	18.5%
Professional experience	7	5.4%
Cost	2	1.5%

P43, a team leader, wrote "As soon as children are mobile they have the potential to benefit from an improved SNR."

P13, a TOD wrote "I think they could be useful for children in the home, for children to get access to speech against a home environment which may have a lot of background noise."

P109, a PA wrote, "Focus and attention are very important when learning to listen. Providing times with excellent SNR can only help children who are learning the rules of conversational turn taking, and accessing language."

A small percentage of participants, all with an education background, although were in favour of the fitting of FM, acknowledged that cost inhibited this.

P166, a TOD, wrote: "... Cost is becoming more of an issue with services."

P111, a TOD wrote: "...Funding for such provision is not currently available in our LEA…"

Professional experience was referred to in a minority of cases and others were willing to accept the advantages but did not have the resources to implement.

4.3.2.4. Barriers to FM use

41 participants stated FM should not be fitted to this age group, of which 34 provided a comment. Analysis of the themes can be seen in Table 4.6. Some referred to more than one theme and this is reflected in the data analysis. Additionally, 6 reported that their view was due to lack of funding.

P77, a TOD wrote, "Impossible to answer in context of extreme budget constraints. Pre-school is not a statutory requirement. Who would fund this?"

Table 4.6: Professional opinion of those not in favour of the fitting of RM/FM to children aged 3 years and below with HAs.

Main theme	**Number of times**	**Percentage of responses**
The child not able to report	6	21.4%
Localisation/directionality	7	25%
Distance perception	7	25%
Situational Use	2	7.1%
Irrelevant speech	6	21.4%
Lip reading skills	1	3.6%
Understanding of who is speaking	1	3.6%
Unsafe	3	10.7%
Managing the technology	2	7.1%

The main reasons were inability to localise a sound source, ascertain directionality, distance perception and a child to report functionality of equipment.

P138, a TOD, wrote, "As yet I have not heard convincing arguments and would worry about being able to judge how far away sound/speech is, directionality, and of course the fact that only one person is wearing it at a time...

P5, a TOD, wrote, "Not unless the child is able to say whether equipment is working, or if there is an unusual noise - my worry is that if equipment is not working optimally, the quality of sound being received could be compromised."

3 participants were concerned about safety and providing a false sense of security.

> *P27, a TOD, wrote "This is usually due to parental pressure and when they want to do things such as call their child when they run ahead or are in their bedroom etc. I feel that it gives a false sense of security and is not safe. Behaviour management strategies would be better used than an FM. Deaf children need to learn (as hearing children) that the further away from a source of sound you go the quieter it becomes. They also need to have close contact to their parents for good bonding as well as for lip reading and other clues used in communication...An FM is considered a "plaster" but hearing children developing language, often with glue ear, also need good listening conditions"*

> *P152, a PA, wrote "small children should spend much of their time in direct contact with their parents either sitting on the parent/carers lap or in close quarters face to face. Would this be discouraged by use of FM system in the home? Parents would be freer to move around, but might this give them a false sense of security?"*

2 participants were concerned about managing the technology, overburdening parents and made references to the danger of providing a technical solution.

> *P45, a TOD, wrote: "FM systems help overcome the problems associated with noise, reverberation and distance ... In the home it is more important for parents to create a quiet environment and get close to communicate and interact with their child. This is the most important for early communication and FM systems do not help with this. There is a danger of providing technical solutions for every problem when the best answer is more practical."*

P97, a TOD, wrote "In most cases it's enough for parents to take on board accepting their child is deaf, using HAs or CIs consistently, and supporting language development. Another factor is that our service is currently stretched to its absolute limit; each child is given a limited number of allocated TOD time hours each term. Teachers are not permitted to exceed these hours, and allocating, monitoring and maintaining a radio aid eats into the time allowance significantly. There is also an issue with funding ...this does not really come on board until the children are school aged. In an ideal world a radio aid might be desirable, but this is not realistic ..."

4.4. Children aged 3 years and below with CIs

4.4.1. Quantitative Analysis

The responses for children with a CI were weighted differently and can be seen in Figure 4-5.

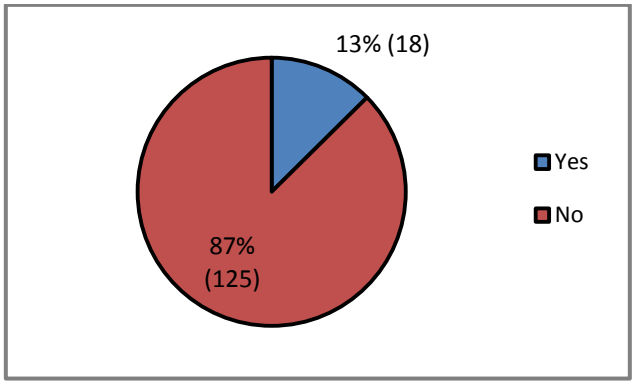

Figure 4-5: The number of participants stating FM is fitted to children aged 3 years and under with CIs

3 of the 18 positive responses reported 13%, 17% and 50% of those on caseload were fitted with FM. Additionally, 1 participant said this would only happen in exceptional circumstances, 1 cited parental insistence and 2 referred to the reluctance of the local CI team.

62% of professionals considered FM as something that should be available for this age group (Figure 4-6). When comparing this to the number actually fitted with FM (13%) there is remarkable difference (62%).

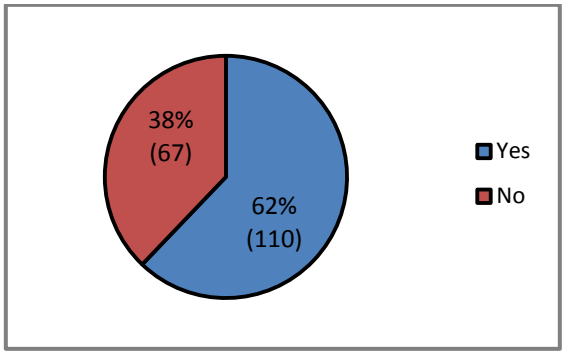

Figure 4-6: Professional opinion regarding whether CI children aged 3 years and below should have access to FM systems

The data was clustered into two categories. Firstly, for the participants that answered positively that FM should be an option for CI users. There were 110 positive responses with 96 providing a comment. Some included a number of themes and therefore are included in more than one category. Responses from the questionnaires were thematically analysed and three main themes identified:

- Carer perspective
- Child development
- Technological practicalities

The key main theme was the technological practicalities of fitting FM cited by 66.7% of participants, the same key theme identified for HA wearers. Additionally, 50.1% discussed the overall advantage for child development. The carer perspective plays less of a role than for HA wearers, with just 9.4% of professionals willing to consider FM.

4.4.2. Qualitative Analysis

In analysing the main themes a number of subthemes emerged. The quantitative analysis involved was expanded in a qualitative manner to gain a more meaningful insight. Although in reality few children with CI have access to FM, professional opinion was more supportive.

> *P1, an EA, wrote: "every child with a HL should be entitled to the provision of assistive listening equipment if the parents wish to use it."*

4.4.2.1. Carer Perspective

Table 4.7: Professional opinion of those in favour of fitting RM/FM to children aged 3 years and below with CI from a carer perspective

Sub theme	Number of times	Percentage of responses
Parental choice	4	4.2%
Carer competency to use	8	8.3%

Unsurprisingly, there were few participants that referred to parental choice. However, for some it remained a joint discussion and decision making process between professionals and parents.

> *P170, an EA, wrote: "Given the often difficult listening conditions that all children face, I feel it is reasonable to consider this option. This would be discussed with the TOD/parents/CIC before any decision is made."*

4.4.2.2. Child Development

Table 4.8: Professional opinion of those in favour of fitting RM/FM to children aged 3 years and below with CI from a child development perspective

Sub theme	Number of times	Percentage of responses
Environment/Situations where FM it would be of benefit (situation specific)	29	30.2%
To improve listening skills	10	10.4%
To promote communication	8	8.3%
To promote language development	18	18.8%
Access to language at all times	8	8.3%
Additional disability	2	2.1%
Only if the child can report	10	10.4%
Child characteristics	6	6.3%

Over 30% felt that FM would be beneficial from a child development perspective.

> *P92, a PA, wrote: "Will facilitate better communication in places ... - all places where meaningful communication takes places where currently some children will be missing out"*

> *P42, a PA, wrote: "Yes I feel that they should because it allows them better access to speech in noisy environments. This will help them in their speech development and possibly other areas of development too. It could play a big role in speech development as the first 5 years are key to speech development, this can be enhanced by ... increasing the SNR..."*

To promote language development was key in almost a fifth of responses.

> *P41, a PA, wrote "Yes, CI children must be fitted with FM as they have lot more catch up to do in the early ages."*

> *P52, a TOD, wrote "Children are developing language at this important stage of development and an FM system gives them better opportunities to access language without added background noise."*

There were also a number of participants who, although were in favour of FM, felt it should only be fitted when the child was able to report.

> *P15, a TOD, wrote: "The difference here is that the implanted child does need to be able to report problems with the system as it's not possible to listen to it through the implant as it is with the HA. I would expect the child to be at least one year post implantation and able to make simple statements about its functioning, e.g. too loud, quiet, broken."*

> *P85, an EA, wrote: "Yes - but only if the child has the language ability to report if there is a 'fault' with the FM system. As CIC's are now implanting at around 1 year of age I would hope that this is an increasing possibility."*

4.4.2.3. Technological Practicalities

Table 4.9: Professional opinion of those in favour of fitting RM/FM to children aged 3 years and below with CI from a technological practicality perspective

Sub theme	Number of times	Percentage of responses
Regular evaluation is required	10	10.4%
Provided the child is a good CI user	11	11.4%
Safety	2	2.1%
Improved SNR	22	22.9%
Overcome the problem of distance	4	4.2%
Cost makes it impossible	2	2.1%

> *P52, a TOD, wrote "As long as there are guidelines and standards in place to guide the fitting, management and training of the FM."*

The improvement in SNR was the most significant factor and was referred to by 7 PAs (health background) and only 3 TOD's (education background).

> *P31, a PA, wrote "Provides better SNR and will help children with speech and language, provide consistent exposure and thus development..."*

4.4.3. Barriers to FM use

67 participants were of the opinion that FM should not be fitted to this age group and 47 provided a comment. Some referred to more than one theme and this is reflected in the data analysis. The main themes identified were:

- Detrimental to the child
- Child competency

The perceived competency of the child was a significant barrier, cited by 83% of participants. A further 27.7% felt it could be detrimental to the child. Additionally 1 stated it should not be fitted unless the child was in an environment where listening was compromised and 5 said it should not be fitted due to funding issues.

4.4.3.1. Detrimental to the Child

Almost one third of participants were concerned that the fitting of FM would be detrimental to a CI user. This was investigated further and a number of subthemes emerged as seen in Table 4.10.

Table 4.10: Professional opinion of those not in favour of the fitting of RM/FM to children aged 3 years and below with CI from a detrimental to the child perspective

Sub theme	Number of times	Percentage of responses
Localisation/directionality is compromised	6	12.8%
Distance perception is impossible	3	6.4%
Unable to source the person speaking	2	4.3%
Unsafe	1	2.1%
Over Reliance on Technology	1	2.1%
Unable to check	4	8.5%

Some participants felt the ability to localise sound and detect directionality would be compromised.

> *P6, an EA, wrote: "…Feel unsure whether such young children would benefit from FM. Need to … learn to locate sound and that sound is quieter, the further a speaker is away…"*

P176, an EA, wrote: "…a child needs to learn directional sound, without FM. Too much use of FM can inhibit this. Also, it has to be used selectively, and not all time, so child does not get parent talking to everyone else all the time. Only when specifically addressing child. Useful in certain circumstances when out and about, ... but still needs to be used with care. One to one individual speech at this age, far more important."

4 participants voiced concerns regarding the checking of FM with a CI.

P43, a team leader, wrote: "It is not possible to test a system through an implant and therefore you cannot check the integrity of the system nor can the child report that it's working correctly"

P130, a TOD, wrote: "Because one cannot listen to the whole FM/CI system one has to be much more careful about issuing an FM .... The child would need to be extremely reliable at letting adults know if there were any distortions in their listening experience and it is unlikely they would have the language to express those problems at such a young age."

P157, a TOD from a CIC, wrote: "No, not normally. The signal from CI systems cannot be checked other than by the user. You need to be a competent user, both in language and in the social use of language to give robust feedback, and in our experience this can be a challenge, even for older children. FM systems attached to CI can be subject to chronic, persistent but intermittent degradation of signal, and we would hate our children not to have the very best input at all times."

4.4.3.2. Child Competency

The competency of the child was referred to on a number of occasions. Further analysis resulted in a number of subthemes emerging as seen in Table 4.11.

Table 4.11: Professional opinions of those not in favour of the fitting of RM/FM to children aged 3 years and below with CI from a child competency perspective

Sub theme	Number of times	Percentage of responses
The child not able to report	27	57.4%
Not necessary for those 3 and below	9	19.1%
CI Centre raise concerns	3	6.4%

In 48% of responses the main reason identified was the perception that a child would be unable to report if the FM was working correctly or not and the quality of the sound. A further 10 participants responded yes, as long as the child could report on the signal. Therefore 23.3% of the total participants felt that a child with a CI should not be fitted with FM if they were unable to reliably report on sound quality and functionality.

> *P92, a TOD, wrote 'No NEVER. CI processors work by transmitting sounds by FM radio waves across to the internal implant. If a radio aid is also introduced, the two FM frequencies can interfere with each other, and produce a much poorer quality of sound for the recipient. It is ESSENTIAL that the child has language to report on sound quality when an FM is used in conjunction with an implant processor. No child under the age of three has this maturity.'*

4.5. Children aged 4 and above

4.5.1. Quantitative Analysis

When analysing the data for children aged 4 years and above it included children with either HAs or CIs. Figure 4-7 shows the number of participants that say children aged 4 years and over are fitted with FM.

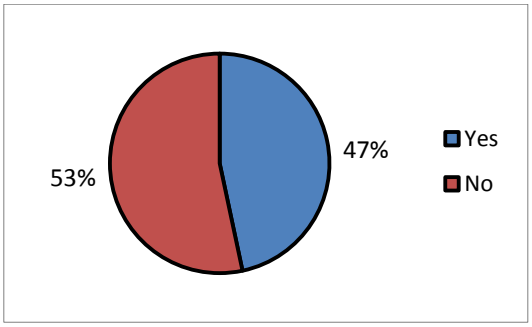

Figure 4-7: The number of areas where FM is fitted to children aged 4 years and over for personal/out of school use

Of those involved, few were able to attach a numerical value to the number on caseload having access to FM. Some participants provided a single figure between 1 and 20. Another said 30 children had been fitted, funded from 'Aiming higher for Disabled Children' but, as this is was no longer available it would not continue in the future.

For those who expressed the quantity as a percentage, it ranged between 1% and 10%. There were however two exceptions, a TOD who said 25% and an EA who reported 35%.

4.5.2. Qualitative Analysis

Professional opinion (Figure 4-8) shows that an over whelming majority think that FM should be fitted routinely.

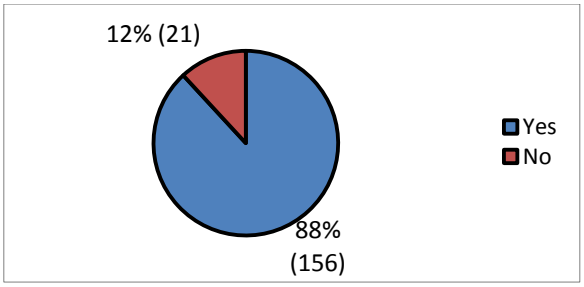

Figure 4-8: Professional opinion on the fitting of RM/FM to children aged 4 years and over for personal/out of school use

> P63, an EA, wrote *"Listening in the home environment is as important as listening in the school environment."*

141 of the 156 professionals that answered yes provided a comment. When analysing this data a number of themes emerged (Table 4.12) and some comments are reflected in a number of themes.

Table 4.12: Professional opinion of those in favour of fitting RM/FM to children aged 4 years and above for personal use

Main Theme	**Number of times**	**Percentage of responses**
It is our provisional statement	1	0.7%
It is parental choice	13	9.2%
To improve SNR	39	27.7%
If parents can be responsible	18	12.8%
To aid language development	12	8.5%
To ensure continuous access to language	27	19.1%
If training is put in place	5	3.5%
To avoid isolation	2	1.4%
For external clubs	36	25.5%
For external devices	15	10.6%

The primary reason was to improve SNR for almost 30% of participants. 9.2% were of the opinion that FM should be fitted at parental request, which is a significant increase on the 4.9% of professionals who would fit FM to a child under 3 years of age.

> *P9, a PA, wrote "While school maybe the main situation where FM is needed to combat poor SNR there will always be outside of school situations where one would be of great benefit..."*

In almost 26% of cases professionals felt that FM would benefit a child if they attended an outside club.

> *P7, an EA, wrote "Yes, if the child and parents want to use FM e.g. at after school activities like Cubs, Brownies"*

A significant number referred to the need to have continuous access to language.

> *P46, a TOD, wrote "Learning does not stop when children leave the school premises...a radio aid is used to communicate with hearing impaired pupils in the same way that hearing siblings are able to join in all conversations."*

21 professionals were not supportive of the fitting of FM and 17 of these provided a comment. The analysis of the data can be seen in Table 4.13.

Table 4.13: Professional opinion of those not in favour of fitting RM/FM to children aged 4 years and above for personal use

Main Theme	Number of times	Percentage of responses
Children need to listen in the real world	2	11.8%
Parents can't cope with FM	1	5.9%
Children need to access to sound not FM signal	3	17.6%
Unable to provide support/training	4	23.5%
Unable to fit due to cost implications	3	17.6%
Unable to provide insurance/equipment loss	4	23.5%
Not necessary to use out of school	1	5.9%

Due to the lack of support and training available for parents, some professionals remain sceptical with respect to fitting FM. Budget restraints, worries with regard to insurance and loss seem to play a significant role. Additionally, there are professionals who feel that FM is unnecessary and a child needs access to a natural sound signal.

> *P165, Clinical Specialist with Cochlear, wrote "They need to listen using their two ears and in more natural surroundings rather than constantly attached to FM"*

> *P45, a TOD, wrote "mainly practical reasons the main benefit of FM is for educational settings. ... but the cost and problems of replacing lost or broken equipment ... has an impact on the education of the child as it cannot be replaced immediately and this is our primary responsibility. If you make the systems available to some children you have to make them available for all. Increasing Deaf awareness for clubs and out of school activities is possibly of greater benefit.*

4.6. Training needs

108 participants responded to this question. 3 delivered training as part of their role and 1 was currently in training as an EA. A further 13 acknowledged another person in post as a technician/EA and stated they therefore had no requirement for training. 1 wanted support to identify funding streams and 2 stated they had no current training needs. Additionally, 4 participants cited that as a CIC they had no involvement with the fitting of FM. Analysing the data revealed three main themes:

- Regular technology updates
- To increase experience with FM
- Understand more about functionality and checking of systems

Needs were fairly evenly spread with 25 participants wanting regular updates, 24 to increase knowledge and 18 to understand more about functionality and checking of equipment. Additionally 24 had the confidence to admit they had little experience and wanted to rectify this.

> *P80, a PA, wrote "I still feel under-trained with the latest FM technology. I would like to understand more about the technology and troubleshooting"*

Further analysis of the main themes can be seen in Table 4.14 where subthemes have emerged.

Table 4.14: Subthemes of identified training needs

Identified need	**Number of responses**
Regular technology update needed	24
Have nothing to do with FM but would like to	1
To share good practice	1
No experience at all with FM	23
To be able to check a FM system	2
To be able to balance with the test box	6
FM and a CI	7
Troubleshooting equipment	3

The primary need for training was for regular technology updates which professionals regard as advancing on a regular basis.

> *P35, a TOD, wrote "As technology is constantly being updated, professionals need ongoing training to ensure children are receiving the best service possible."*

A significant number stated they had nothing to do with FM but would like to. These were solely from PAs or SALT's and it is clear that FM is primarily the responsibility of education.

> *P41, a PA, wrote "mainly because I don't fit them. If I started to fit them, I would definitely need training as I don't know how to do it!"*

> *P93, an EA, wrote "Audiological services tend to lack knowledge or skills in assessing benefit and poor understanding of the technology and how to set it up for use."*

Some participants from education, referred to a training need for colleagues across services.

> *P95, an EA, wrote "More a need for centralised information on how many Services fit FM to early years children, in what situations and the rationale for doing this. It would be useful to know what guidance is provided to families/professionals across Services."*

Chapter 5 Discussion

This study was carried out to quantitatively and qualitatively explore the views of professionals on the use of RM/FM technology with pre-school children. The findings are discussed under four sections. The first section will focus on access to language and listening, the second, acoustic environments and the third, technology as a solution in the context of engagement, safety and the well being of the child. The final section will address barriers to the fitting of RM/FM. The chapter will conclude with a summary of the key points that will discuss strengths, implications for practice and future scope for research.

The UK based professionals who completed the questionnaire voiced concerns related to RM/FM use including; parents ability to cope with the extra technology, the potential for misuse or over using technology and the possibility of affecting localisation. Additionally, some professionals appreciated the role of RM/FM technology but funding of equipment was a significant barrier.

When acknowledging a policy for the fitting of RM/FM there was a noted difference between professionals from an education and those from a health background. Moreover, fitting appears to remain the primary responsibility of education. Additionally there were those who were of the opinion that RM/FM should be part of the total amplification package, the practicalities of this were governed by funding and time.

5.1. Access to Language and Listening

From a theoretical perspective, it is relatively easy to highlight and identify situations and environments that would benefit from the use of RM/FM. The importance of the listening experience was explored by Eimas et al, (1971) who found that infants as young as one month could discriminate speech sound contrasts. These early years are a crucial time in language development, an issue appreciated by those involved in this study. The number of words spoken to children in the first three years of life has a significant impact on language and

educational outcomes in later years; once again this was supported by the participants views documented. A study by Moeller et al, (1996) supports the positive outcomes of language development for pre-school children when using FM. More recently the qualitative findings of Mulla (2011), when researching parental attitudes to FM, support this theory with parents reporting positive outcomes. The findings of this study identify the positive attitudes of professionals to support early fitting of RM/FM, particularly for HA wearers. The reluctance around CI appears to stem largely from CIC's and the perceived practicalities of checking systems.

Professional opinion demonstrates a desire to provide all children with optimum acoustic conditions in order to optimise spoken language development, thus closing the language gap between hearing and hearing impaired peers and striving to achieve age appropriate language skills. Moeller (2000) found that early intervention at this critical time of language acquisition can result in similar language abilities as hearing peers.

Some professionals, who were concerned about exposure to irrelevant speech, questioned the value of continual access to spoken language. It is well documented that compared to their hearing peers, children with HL have reduced potential to overhear (Cole and Flexer, 2015). Incidental listening through overhearing refers to times when speech is not directly addressed to a listener (Cole and Flexer, 2015). This approach assumes overheard speech is of no value, whereas the findings by Moeller et al, (1996) and Mulla (2011) suggest this approach may need to be modified. Additionally, the findings of Akhtar et al, (2001) support the claim that young children are quite adept at overhearing and they can acquire vocabulary from non directed speech as young as 2 years 6 months. More recently, Floor and Akhtar (2006) found that children as young as 16 months were able to learn new words through overhearing. Mulla (2011) in his study, found that parents reported increased instances of overhearing taking place as a direct result of using FM with pre-school children. The findings from this

study suggest that some professionals did not value the incidental language that would be associated with RM/FM use. However, as previously stated there is research to support the claim that a considerable portion of early language acquisition is incidental (Cole and Flexer, 2015) and indeed can be so for children with HAs and CIs.

5.2. Distance, noise and reverberation

As stated previously, increased distance of the speaker, background noise and poor acoustics result in a poor SNR and as a less clear auditory signal. These factors pose a more significant barrier for children (Johnson, 2000) and for those with a HL an even greater disadvantage (Nittrouer et al, 2013, Crandell and Smaldino, 2000). Additionally, reverberation is a major factor in room acoustics and Crandell and Smaldino (2000) found that speech intelligibility was greatly reduced in the presence of reverberation.

Logically, it can be argued that once a child reaches the developmental phase of crawling, close microphone distance is potentially lost. In this study professionals acknowledged that the ideal distance from a speaker, for children with HA/CIs was between one and two metres, with an appreciation it may be less in noisy conditions (Madell, 1992). For families, routine activities can place the parent and child at distances in excess of two metres, resulting in a decrease of the speech signal as it reaches a HA/CI microphone. Similarly, the home environment commonly exposes children to widely varying acoustic conditions resulting from internal and external noise sources and poor room acoustics. Although a HA/CI may present an audible speech signal to a child, simply detecting the presence of speech is not always sufficient for understanding. Unsurprisingly, the vast majority of professionals valued the increased SNR achieved by the RM/FM device which supports the findings of Killion (1997), Johnson (2000), Nittrouer et al, (2013) and Norrix et al, (2015).

Speech perceived through the RM/FM and HA/CI will both be processed with higher level cortical activities involving phonetic, phonological, syntactic, semantic and pragmatic/contextual processing (Cole and Flexer, 2015). This highlights the important function the RM/FM signal can play in allowing a child to access speech at normal conversational levels and potentially allowing the microphone of a HA/CI to assist in locating a sound source. Although in theory as the RM/FM signal is wirelessly transmitted it is not possible to receive any directional cues. However, Mulla (2011) in his study found that children were able to accurately and instantly locate the FM user and in some instances there were reports that a child could actively monitor who was using it. As there are no directional cues a child must be making use of other cues and we cannot ignore the possibility of an improved ability for auditory location. Additionally, as HA/CI are set to FM+M both the HA/CI and the receiver are simultaneously receiving audio input and this will aid the ability to localise sound (Mulla, 2011).

As Gray et al, (2009) state, the brain is able to use the differences in SNR between the ears and identify what is not required. This occurs under conditions of spatial separation of signal and noise (Litovsky, 2006). Ching et al (2006) state that binaural squelch can provide a 1-2dB advantage in addition to binaural summation. However, as Ching (2005) suggests when a signal is presented binaurally, the ability to detect the signal improves when there is an IPD between the ears for either the signal or the noise. Therefore, when the signal is presented binaurally via an RM/FM system there is an improvement in speech discrimination.

5.3. Technology as a solution

One participant was of the opinion that there was a tendency to provide a technological solution rather than a more practical approach. This holds little weight as it can be argued that the fitting of HA/CIs is technology. It is well documented that early fitting and consistent use of amplification provides access to spoken language. Additionally, it was stated that behaviour management techniques would be more valuable than technology. However, behaviours often

stem from a lack of understanding and ability to express thoughts and feelings. If parental choice is to develop spoken communication then technology must be considered as an essential component.

5.3.1 Engagement with technology

5.3.1.1. Parents and carers

Professional concern regarding the ability of parents' to cope with the extra technology was also addressed by this research. There were concerns related to the child not having established consistent use of their primary mode of amplification which would directly impact the opportunities for the use of RM/FM technology. Mulla (2011) in his study found that although parents may have observed the benefits of FM in a room with poor acoustics, this was not clearly identified in their feedback as the real issue was the observable differences they noticed in their child. Mulla (2011) found that all those involved in his study appreciated the benefit the FM provided over HA use alone and for some it was the motivation to put HAs on.

Gabbard (2004) highlights the importance of parents buying into the technology. For parents to engage with the technology they need to believe the technology will help, therefore training and support are essential elements. Professional opinion highlighted the importance of training and support for parents but appreciated the vital role RM/FM could play in access to language. Although in principle this was considered optimal there was also an acknowledgement of the time this would take and the ability for professionals to provide in the current climate of reducing budgets and increasing caseloads.

Cole and Flexer (2012) highlight the importance for professionals to explain issues around the area of acoustics to parents. Families need to understand the negative effects of distance and noise on language learning and auditory brain development and make an informed choice for their child. However, professional opinion seems to suggest that parents are not always given the relevant information they need to

make this choice. However, it could be argued that professionals are driven by the constraints of budget and therefore see no value in providing this information if it cannot be funded.

5.3.1.2. Child reporting

A vast amount of professionals in this study felt that FM should not be fitted until a child could report. It could be argued that if this was a concern, why is there an emphasis on early amplification. Children as young as 4 weeks are fitted with HAs and many babies fitted with CIs around 12 months. If this argument carried any weight then amplification would not be fitted until a child could provide feedback. The advantage of SNR has already been stated, this is physics so why would reporting, which is not physics, become an important factor? In previous technology this would have been considered more cautiously due to the potential for interference when using FM. However, recent advanced technology uses 2.4GHz to broadcast the signal and as a result the potential for interference is no longer a viable issue.

5.3.2. Safety

Safety is paramount as part of the well being and quality of life for a child with HL. Some professionals felt that the use of RM/FM was positive in this area providing opportunities to overcome the problem of distance. On the other hand, there were those that felt this could result in a false sense of security and behaviour management strategies would be far better employed. It has been well documented that HA/CI microphones provide little benefit unless the user and primary talker are just a few feet apart and the notion of children with HL needing to learn that the further away you are from a sound source the quieter it becomes is arbitrary. Acoustic accessibility is crucial when relying on spoken language and there is well documented evidence to show the benefit of RM/FM technology.

5.3.3. Well being

Diefendorf (in Katz et al, 2009) justifies the early identification of HL (prior to 6 months of age) as providing many advantages for a child. Part of this is the improvements in social and emotional development, which they found was significantly better compared to children with a later diagnosis. There has been very little research that has explored the quality of life benefits associated with the use of RM/FM technology. Moeller et al, (1996) did include qualitative data collection but the main focus of the study was centred on language specific outcomes rather than overall benefits.

More recently Mulla (2011) described the benefits of FM technology as not limited to communication and language but also to parents regularly reporting children's positive emotions. Mulla (2011) found that the use of FM technology was not just seen as a tool to benefit the child and to improve their well being, but many parents acknowledged it generated positive feelings in them also. In this study, professionals acknowledged how the use of RM/FM can result in an increased sense of social belonging allowing children greater "participation" in spoken language activities where previously there may have been risk of isolation.

5.4. Barriers to FM use

As with any technology, practical issues related to the device use and functions would be expected. Basic repairs and faults would arise with daily use in the same way as it does with HAs and CIs.

5.4.1. Challenges and faults

A small body of professionals were concerned about possible interference. Previous research in this area however was based on old technology and with the introduction of digital systems such as Roger, which works on 2.4GHz, interference has been significantly minimised.

This study shows greater concerns for CI users. Some were concerned with the checking of equipment and felt this could only be carried out by the user. However, listening devices are available for CIs and with appropriate training, a listening check can be administered. Additionally, as with all modes of amplification, carers and or professionals may notice changes in behaviour which may also indicate a device was not working optimally. TOD/EAs can monitor the microphone output and balance FM devices with test boxes. With the introduction of mini mics from Cochlear which streams speech directly to sound processors it suggests that thinking will need to move forward in this area as these become part of the initial fitting package.

Basic repairs and faults would arise with daily use in the same way as it does with HAs and CIs. Once again, with the right support and guidance this barrier could be overcome.

5.4.2. Cost

Cost was a serious concern expressed by a number of education professionals. Budget constraints and lack of funding streams result in difficulties proving RM/FM for schools. The notion of providing this equipment for the pre-school population, although positive, remains an issue. As a consequence, there were a number of responses, that although in essence stated they would not fit RM/FM this opinion was driven by funding rather than by the potential benefits.

5.5. Summary of key points

- Key strengths of the present research lies in the combination of the qualitative and quantitative approach to the subject. The qualitative data in this research offered an insight into the views, interpretation and perspectives of participants that could not be achieved through quantitative methods alone. This research has highlighted a number of implications for

practice and scope for future research in the area of RM/FM technology use with pre-school children.

- There are many auditory cues used to locate and discriminate a sound source. At the end of the day, these cues are not as accessible for individuals with HA/CIs. Evidence has shown that with the use of RM/FM technology children are provided with optimum opportunities to develop spoken language.
- Parents must be made aware of the difficulties faced by a child with a HL and how technology can be used effectively to overcome some of the problems that HA/CI wearers face.
- CICs are now in the process of providing mini mics and there is a need to consider the use of FM/RM technology as part of the assessment process.
- Generally, professionals appreciate there is a place for technology. However, as technology advances the need to keep abreast of this is paramount.
- From this evidence, a case could be devised to provide pre-school children with access to RM/FM technology to maximise their ability to hear and give them the best possible auditory access.

To conclude, research on the attitudes of professionals on the fitting of RM/FM technology to pre-school children is both timely and topical. The current research has contributed to the existing literature and research base and provides a basis for further research. It is anticipated that this work, together with future research, can lead to the provision of RM/FM technology to pre-school children with HL as a standard part of their early intervention and amplification package.

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Appendix A. Ethics Approval Document

UNIVERSITY OF HERTFORDSHIRE

FORM EC1: APPLICATION FOR ETHICAL APPROVAL OF A STUDY INVOLVING HUMAN PARTICIPANTS

(See Guidance Notes)

Relevant ECDA:	
Science and Technology	☐
stecda@herts.ac.uk	☐
	√

OFFICE USE ONLY
Protocol Number:

Office Use only	**Date Received by Clerk:**	
Expedited Review		
Approved by Reviewer 1 *(sign and date)*		Approved by Reviewer 2 *(sign and date)*
Further Action: *(tick appropriate box and provide details)*		
Request Further Information		Details:
Refer for Substantive Review		
Refer for Full review		
Reject		
Substantive Review		
Approved by Reviewer 1 *(sign and date)*		Approved by Reviewer 2 *(sign and date)*
Approved by Reviewer 3 *(sign and date)*		Approved by Reviewer 4 *(sign and date)*

Further Action: *(tick appropriate box and provide details)*		
Request Further Information		Details:
Refer for Full review		
Reject		
Full Review		
Request Further Information		Details:
Reject		

CONFIRMATION OF APPROVAL

[To be completed by the Chairman or Vice-Chairman of the relevant ECDA, or by the Chairman of the University Ethics Committee – (see GN 2.1.4)**]**

I confirm that this application has been approved by or on behalf of the committee named below.

Name/Sign……Date……..

Name of committee ……...

DECLARATIONS

1 DECLARATION BY APPLICANT (See GN 2.1.3)

1.1 I undertake, to the best of my ability, to abide by UPR RE01, 'Studies Involving the Use of Human Participants', in carrying out the study.

1.2 I undertake to explain the nature of the study and all possible risks to potential participants, to the extent required to comply with both the letter and the spirit of my replies to the foregoing questions (including information contained in Appendices 1 and 2).

1.3 Data relating to participants will be handled with great care. No data relating to named or identifiable participants will be passed on to others without the written consent of the participants concerned, unless they have already consented to such sharing of data when they agreed to take part in the study.

1.4 All participants will be informed **(a)** that they are not obliged to take part in the study, and **(b)** that they may withdraw at any time without disadvantage or having to give a reason.

(**NOTE**: Where the participant is a minor or is otherwise unable, for any reason, to give full consent on their own, references here to participants being given an explanation or information, or being asked to give their consent, are to be understood as referring to the person giving consent on their behalf. (See Q 19; also GN Pt. 3, and especially 3.6 and 3.7))

Dawn Bevington Date 12:09:15

2 **GROUP APPLICATION**

(If you are making this application on behalf of a group of students or staff, please complete this section as well)

I confirm that I have agreement of the other members of the group to sign this declaration on their behalf

Enter your name here …… Date ……

3 DECLARATION BY SUPERVISOR (see GN 2.1.3)

I confirm that the proposed study has been appropriately vetted within the School in respect of its aims and methods as a piece of research; that I have discussed this application for Ethics Committee approval with the applicant and approve its submission; that I accept responsibility for guiding the applicant so as to ensure compliance with the terms of the protocol and with any applicable ethical code(s); and that if there are conditions of the approval, they have been met.

Enter your name here: Dr. Imran Mulla ……...Date…26/09/2015…

PERMISSIONS

DECLARATION BY APPLICANT (please refer to Question 7 and GN 2.2.1)

All participants at the time of completing the survey gave consent for the data to be analysed. All data will be anonymised by the Ear Foundation before being shared for the analysis for this dissertation project.

Dawn Bevington. Date 12:09:15

Instructions for Applicants

Applicants are advised to read the Guidance Notes before completing this form. Use of this form is mandatory [see UPR RE01, SS 7.1 to 7.3].

Approval must be sought **and granted** before any investigation involving human participants begins [UPR RE01, S 4.4(iii)].

Abbreviations

GN=Guidance Notes

UPR=University Policies and Regulations

Q=Question

S=Section

SS=Sections

Pt =Part

PLEASE NOTE: Where alternative answers are offered, put a cross in the appropriate box.

For example: ☐ YES

Where a "write in" answer is requested, begin in the space provided below the question and continue as necessary**. All questions must be answered. Please answer in BLACK INK.**

1. THE STUDY

Q1. Please give the title (or provisional title) of the proposed study. (NB – you will be asked for further details later)

MSc Educational Studies (Educational Audiology)
Module: Research Methods and Dissertation – Mary Hare 7FHE1024-0905

2. THE APPLICANT

Q2. Please answer **either Q2.1 or Q2.2** by providing the information requested. **Q2.1** should be answered by individual applicants, both staff and students, who require protocol approval for work which they themselves intend to carry out. **Q2.2** should be answered by academic staff requiring approval for standard protocols governing classroom practical work (or equivalent work) to be carried out by a specified group of students. (See GN 2.2.2)

Q2.1. Name of applicant/(principal) investigator

Dawn Bevington

Student registration number (or staff number for staff application)

14018466

Email address

dawn_bevington@sky.com

(in the case of a group application, please list the names, registration numbers and email addresses of all members of the group, starting with the lead applicant)

Status:

(a)	undergraduate	☐
(b)	postgraduate (taught/research)	X
(c)	academic staff	☐
(d)	other - please give details here	☐

School/Department: Mary Hare (Partner organisation with School of Education)

If application is from member of staff or student NOT based at University of Hertfordshire, please give the name of the institution:

Mary Hare

Name of Programme (eg BSc (Hons) Computer Science)
MSc Educational Studies (Educational Audiology)

Module name and module code
Research Methods and Dissertation – Mary Hare 7FHE1024-0905

Name of supervisor
Dr Imran Mulla PhD, Dr Marina Rose PhD

Supervisor's contact details (email, extension number):
i.mulla@herts.ac.uk

Name of Module Leader if applicant is undertaking a taught programme/module:

Name of Programme Tutor:

Q2.2. Class Protocol Applications Only.
(do NOT use this section if you are a group of students undertaking a joint project, instead, complete Q2.1 and list the names of all students involved in the project, together with their student registration numbers. It is assumed that just one member of staff will be responsible for supervision.)

Name of applicant/(principal) investigator (member of staff)

School/Department

Programme of study or award (e.g. BSc/MA)

Module Title and Code

Year/group to be governed by the protocol

Number of students involved in study per academic year

Programme Tutor (if different from the applicant)

University of Hertfordshire E-mail address

Please note: Risk Assessment Form EC5 (or subject specific risk assessment) is mandatory for all Class Protocol Applications and must accompany this application.

3. DETAILS OF THE PROPOSED STUDY

Q3.1 Is it likely that your application will require approval by a National Research Ethics Service (NRES) ethics committee whereby completion of an IRAS form would be required? (See GN 2.2.3)

If you are unsure whether your application should be referred to a National Research Ethics Service (NRES) ethics committee, please use the NHS decision tool. The ECDA clerks have the details. Should you receive an indication that it is not necessary to submit your application to an NRES ethics committee, or if the application is being submitted to NRES by a collaborating institution, please continue to complete Form EC1.

☐ YES ☒ NO

(If YES, please answer **3.2 and 3.3**)
(If NO, please continue on to **Q4**)

Q3.2 Please confirm whether your research involves any of the following:

Exposure to any ionising radiation	☐
NHS or Social Care patients	☐
NHS or Social Care staff* Note, it is not always necessary to refer studies involving this group of participants to the NRES for approval: students should consult their supervisor concerning use of NHS decision tool	☐
Clinical Trial of an Investigational Medical product	☐
Clinical Trial of a Medical Device	☐
Exposure to any ionising radiation	☐
Adults who lack the capacity to consent	☐
Human Tissue (see GN 2.2.3)	☐

Q3.3 If your study is considered to be a Clinical Trial of an Investigational Medical Products (CTIMP) or Clinical Trial of a Medical Device, please indicate if the study involves any of the following categories: (See GN 2.2.3)

Children under 5	☐
Pregnant women	☐

A trial taking place overseas ☐

A trial with more than 5,000 participants ☐

If you have answered 'Yes' to any of the above questions in (b), you will most probably require NRES ethics committee approval and a sponsor. You will need to apply for NRES ethics committee approval using an IRAS form. For University of Hertfordshire sponsorship, you will need to complete Form SP1, which is obtainable as well as further advice regarding IRAS from research-sponsorship@herts.ac.uk.

DO NOT complete this form any further but submit it to your relevant ECDA now. Please note, you will be issued with a UH Protocol Number but this will not be valid until you have sent your relevant ECDA a copy of your NRES ethics committee approval letter and copy of the synopsis of the study.

Q4. Please give a short synopsis of your proposed study; stating its aims and highlighting where these aims relate to the use of human participants. (See GN 2.2.4)
Please enter details here.

I am a qualified Teacher of the Deaf, undertaking a study with the aim of exploring the views and attitudes of professionals to the fitting of FM/RM assistive technology to pre-school children with existing hearing technologies (hearing aids, bone conduction aids and cochlear implants). I will carry out extensive analysis on data from up to 200 questionnaires sent and collected by the Ear Foundation. The information will be used to analyse existing professional attitudes and experiences of fitting assistive technologies. The data is held by the Ear Foundation which will be made anonymous and passed on to me.

Q5. Please give a brief explanation of the design of the study and the methods and procedures used, highlighting in particular where these involve the use of human participants. You should clearly state the nature of the involvement the human participants will have in your proposed study and the extent of their commitment. Thus you must complete and attach the Form EC6 (Participant Information Sheet) (see Appendix 2)**.** Be sure to provide sufficient detail for the Committee to be clear what is involved in the proposed study, particularly in relation to the human participants. (See GN 2.2.5)

The design of the study was a mixed methods survey including both quantitative questionnaire data and open ended qualitative data. In depth analysis of the quantitative data will explore the descriptive statistics overall and aim to statistically analyse any group differences if they exist. Qualitative enquiry will be carried out to explore in depth analysis of the open ended responses from professionals on their views of the use of assistive technologies with pre-school children.

Q6.1 Please give the starting date
As soon as possible after approval.

Q6.2 Please give the finishing date.
03/05/16

(For meaning of "starting date" and "finishing date", see GN 2.2.6)

Q7. Where will the study take place?

Please refer to the Guidance Notes (GN 2.2.1) which set out clearly what permissions are required; ensure that you complete the Permissions box near the front of this application form and indicate in Appendix 2 (last page of this application form) which permissions you are attaching to the application.

The study will take place in my own place of work.

Q8. It might be appropriate to conduct a risk assessment of the proposed location for your study (in respect of hazards/risks affecting both the participants and/or investigators) – this would be particularly relevant for off-campus locations but please consider potential hazards on-campus as well (Question 11 also refers). Please use Form EC5 which is an example of a risk assessment OR use a subject specific risk assessment form provided by your School or Supervisor (See GN 2.2.7 and Section 4 of the Guidance Notes).

If you do not consider it is necessary to make a risk assessment, please give your reasons:

As I will be analysing questionnaires already submitted I do not consider that a risk assessment would be necessary.

Q9.1 Will anyone other than yourself and the participants be present with you when conducting this study? (See GN 2.2.8)

☐ YES ☒ NO

If YES, please state the relationship between anyone else who is present other than the applicant and/or participants (e.g. health professional, parent/guardian of the participant)

Q9.2 Will the proposed study be conducted in private? If NOT, what steps will be taken to ensure confidentiality of the participants' information. (See GN 2.2.8)

Yes

4. HARMS, HAZARDS and RISKS

Q10. Will this study involve invasive procedures on the human participants? (See GN 2.2.9)

☐ Yes ☒ No

(If YES, please fill out **Appendix 1 – Increased Hazards and Risks.**
Once this is complete, move on to **Q15**)

(If NO, answer **Q11, Q12, Q13 and Q14**)

Q11, Q12, Q13 and Q14 - NON INVASIVE STUDIES ONLY

Note: You are advised to read GN 2.2.10, 2.2.11, 2.2.12 and 2.2.13 carefully before you answer the following questions.

Q11. Are there potential hazards to participant(s) and/or investigator(s) from the proposed study? (See 2.2.10)

☐ YES ☒ NO

If YES,

Indicate their nature here.

Indicate here what precautions will be taken to avoid or minimise any adverse effects.

Q12. Will or could the study cause discomfort or distress of a mental or emotional character to participants and/or investigator(s)? (See GN 2.2.11)

☐ YES ☒ NO

If YES,

Indicate its nature here.

Indicate here what precautions will be taken to avoid or minimise such adverse effects.

Q13. Will or could medical or other aftercare and/or support be needed by participants and/or investigator(s) as a result of the study? (See GN 2.2.12)

☐ YES ☒ NO

Q14 Please describe in appropriate detail what you would do should the adverse effects or events which you believe could arise from your study, and which you have mentioned in your replies to the previous questions, occur.
(See UPR RE01, S 2.3 (ii) and GN 2.2.13)

5. ABOUT YOUR PARTICIPANT

Q15. Please give a brief description of the kind of people you hope/intend to have as participants, for instance, a sample of the general population, University students, people affected by a particular medical condition, children within a given age group, employees of a particular firm, people who support a particular political party, and state whether there are any upper or lower age restrictions.

The participants are hearing professionals including teachers of the deaf, speech therapists and audiologists.

Q16. Please state here the maximum number of participants you hope will participate in your study.
Please indicate the maximum numbers of participants for ***each*** method of data collection.

There will be up to 200 questionnaire responses analysed from the data collected by the Ear Foundation.

Q17. By completing this form, you are indicating that you are reasonably sure that you will be successful in obtaining the number of participants which you hope/intend to recruit. Please outline here your recruitment (sampling) method and how you will advertise your study. (See GN 2.2.14)

Research data will be made available from the Ear Foundation, which has been approved by them.

6.CONFIDENTIALITY AND CONSENT

[For guidance on issues relating to consent, see GN 2.2.15 and Pt. 3.]

Q18. Is it intended to seek informed consent from the participants?

☐ YES ☒ NO

(See UPR RE01, S 2.3 and 2.4 and GN 3.1)

If YES, please attach a copy of the Consent Form to be used (See Form EC3 and EC4 for reference and GN 3.2), or describe here how consent is to be obtained and recorded. The information you give must be sufficient to enable the Committee to understand exactly what it is that prospective participants are being asked to agree to. If consent is implicit or to be provided by someone other than the participant (such as a parent or guardian), please provide details here.

If NO, please explain why it is considered unnecessary or impossible or otherwise inappropriate to seek informed consent.

The Ear Foundation has previously obtained consent from participants and as the data will be anonymised prior to being given to me, there is no way to gain individual consent.

Q19. If the participant is a minor (under 18 years of age), or is otherwise unable for any reason to give full consent on their own, state here whose consent will be obtained and how? (See especially GN 3.6 and 3.7)

Q20. Are personal data of any sort (such as name, age, gender, occupation, contact details or images) to be obtained from or in respect of any participant? (See GN 2.2.16) (You will be required to adhere to the arrangements declared in this application concerning confidentiality of data and its storage. The Participant Information Sheet (EC6 or equivalent) must explain the arrangements clearly.)

☒ YES ☐ NO

If YES,

Give details here of personal data to be gathered, and indicate how it will be stored.

Data will include occupation. All data will be anonymised to ensure subjects are not identifiable.

State here what steps will be taken to prevent or regulate access to personal data beyond the immediate investigative team, as indicated in the Participant Information Sheet?

All information about participants will be anonymised and confidentiality will be maintained at all times.

Indicate here what assurances will be given to participants about the security of, and access to, personal data, as indicated in the Participant Information Sheet.

The data will be anonymised at source and stored in accordance with data protection procedures. Data will be kept for a duration of 5 years, in a secure location. No personal identifiable data will be included.

State here, as far as you are able to do so, how long personal data collected during the study will be retained, and what arrangements have been made for its secure storage, as indicated in the Participant Information Sheet.

As above, no personal identifiable data will be collected. Any data collected will be kept for 5 years in a secure locked facility at work and on a password protected files on a personal computer.

Q21. Is it intended (or possible) that data might be used beyond the present study? (See GN 2.2.16)

[X] YES [ ] NO

If YES, please give here an indication of the kind of further use that is intended (or which may be possible).
The majority of the data used has been collected by the Ear Foundation and as such they may take a decision to use this in further study.

If NO, will the data be kept for a set period and then destroyed under secure conditions?

[ ] YES [ ] NO

If NO, please explain here why not.

Q22. If your study involves work with children and/or vulnerable adults you will require a satisfactory Disclosure and Barring Service (DBS) Disclosure. (See GN 2.2.17) Please indicate as appropriate:

(a) DBS Disclosure not required [X]

(b) DBS Disclosure required and obtained [ ]

A valid DBS certificate is essential as an entry requirement for the course and is kept on file at MARY HARE.

Please do not embed your DBS Disclosure within the (paper) application documentation. It is recognised that the DBS Disclosure is a confidential document: If a satisfactory DBS Disclosure is required, a copy of this must be forwarded to the ECDA Clerks for review by the Chairman of the relevant ECDA who will note this on a Register which will be kept in a secure place. (Note: only the relevant ECDA Clerk and Chairman will see this document.)

Declaration of Disclosure and Barring Service disclosure

Please state the date on which your most recent DBS Disclosure was obtained 23 JUNE 2015

I declare that I have received **NO** convictions, cautions, reprimands or final warnings or driving offences resulting in a criminal conviction and that I am not involved with ongoing police investigations since my most recent DBS screening.

I understand that ethics approval is given on the understanding that the three-year validity of my most recent DBS Disclosure will cover the period in which this study will be conducted and that, as a student, I will renew the declaration I make within the School in which I am registered on an annual basis.

I also understand that it is my responsibility to inform the ECDA as soon as a conviction or investigation arise during the period of the study to be conducted.

DAWN BEVINGTON Date 12:09:15

7. REWARDS

Q23.1 Are you receiving any financial or other reward connected with this study? (See UPR RE01, 2.3)

☐ YES ☒ NO

If YES, give details here.

Q23.2 Are participants going to receive any financial or other reward connected with the study? (Please note that the University does not allow participants to be given financial inducement (See UPR RE01, 2.3.))

☐ YES ☒ NO

If YES, give details here.

Q23.3 Will anybody else (including any other members of the investigative team) receive any financial or other reward connected with this study?

☐ YES ☒ NO

If YES, give details here.

8. OTHER RELEVANT MATTERS

Q24. Enter here anything else you want to say in support of your application, or which you believe may assist the Committee in reaching its decision.

APPENDIX 1 – INCREASED HAZARDS AND RISKS

This section is to be completed if your answer to Q10 affirms the **USE OF INVASIVE PROCEDURES** in your study.

Note: You are advised to read GN 2.2.10, 2.2.11, 2.2.12, 2.2.13 and 2.2.18 carefully before you answer the following questions.

QA1. Please give details of the procedures to be used (e.g. injection of a substance, insertion of a catheter, taking of a blood or saliva sample), and any harm, discomfort or distress that their use may cause to participants and/or investigator(s). (See GN 2.2.10)

Indicate here what precautions will be taken to avoid or minimise any adverse effects.

QA2. Will the study involve the administration of any substance(s)? (See GN 2.2.10)

☐ YES ☐ NO

If YES,

Give details here of the substance(s), the dose or amount to be given, likely effects (including duration) and any potential hazards to participant(s) and/or investigator(s).

Indicate here what precautions will be taken to avoid or minimise any adverse effects.

QA3. Are there any potential hazards to participant(s) and/or investigator(s) arising from the use of the proposed invasive procedures? (See GN 2.2.10)

☐ YES ☐ NO

If YES,

Indicate their nature here.

Indicate here what precautions will be taken to avoid or minimise any adverse effects.

QA4. Will or could the study cause discomfort or distress of a mental or emotional character to participants and/or investigator(s)? (See GN 2.2.11)

☐ YES ☐ NO

If YES,

Indicate its nature here

Indicate here what precautions will be taken to avoid or minimise such adverse effects.

QA5. Medical or other aftercare and/or support must be made available for participants and/or investigator(s) who require it where invasive procedures have been used in the study. Please detail what aftercare and/or support will be available and in what circumstances it is intended to be used. (See UPR RE01, S 2.3 (ii) and GN 2.2.12)

QA6.1 Please state here previous experience (and/or any relevant training) of the supervisor (or academic member of staff applying for a standard protocol) of investigations involving hazards, risks, discomfort or distress as specified. (See GN 2.2.13)

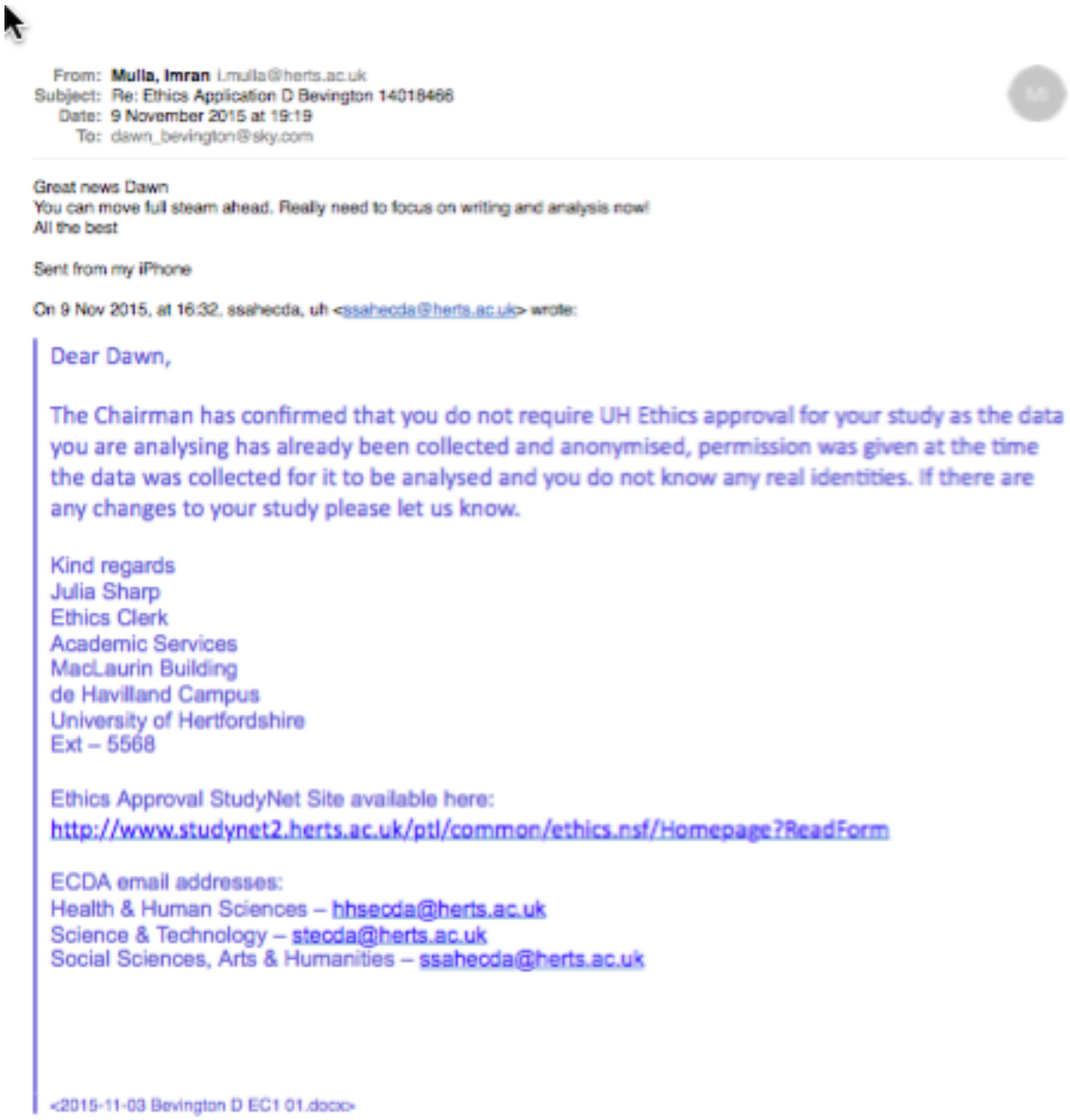
QA6.2 Please describe in appropriate detail what you would do should the adverse effects or events which you believe could arise from your study, and which you have mentioned in your replies to the previous questions, occur.

Please revert to Q15.

APPENDIX 2 – DOCUMENTS TO BE ATTACHED

Please indicate below which documents are attached to this application:

1	Permission to access groups of participants from student body	☐
2	Permission to use University premises beyond areas of Schools	☐
3	Permission from the off-campus location to be used to carry out this study	☐
4	Risk assessment(s) in respect of hazards/risks affecting both the participants and investigator(s) (Q8 and Q11)	☐
5	Copy of Consent Form (See Form EC3 and Form EC4) (Q18)	☐
6	Copy of Form EC6 (Participant Information Sheet) (Q5)	☐
7	Disclosure and Barring Service disclosure	☐
8	A copy of the proposed questionnaire and/or interview schedule (if appropriate for this study). For unstructured methods, please provide details of the subject areas that will be covered and any boundaries that have been agreed with your Supervisor.	☐
9	Any other relevant documents, such as a debrief, meeting report.	☐



From: **Mulla, Imran** i.mulla@herts.ac.uk
Subject: Re: Ethics Application D Bevington 14018466
Date: 9 November 2015 at 19:19
To: dawn_bevington@sky.com

Great news Dawn
You can move full steam ahead. Really need to focus on writing and analysis now!
All the best

Sent from my iPhone

On 9 Nov 2015, at 16:32, ssahecda, uh <ssahecda@herts.ac.uk> wrote:

> Dear Dawn,
>
> The Chairman has confirmed that you do not require UH Ethics approval for your study as the data you are analysing has already been collected and anonymised, permission was given at the time the data was collected for it to be analysed and you do not know any real identities. If there are any changes to your study please let us know.
>
> Kind regards
> Julia Sharp
> Ethics Clerk
> Academic Services
> MacLaurin Building
> de Havilland Campus
> University of Hertfordshire
> Ext – 5568
>
> Ethics Approval StudyNet Site available here:
> http://www.studynet2.herts.ac.uk/ptl/common/ethics.nsf/Homepage?ReadForm
>
> ECDA email addresses:
> Health & Human Sciences – hhsecda@herts.ac.uk
> Science & Technology – stecda@herts.ac.uk
> Social Sciences, Arts & Humanities – ssahecda@herts.ac.uk
>
> <2015-11-03 Bevington D EC1 01.docx>

Appendix B. Questionnaire

1. What is your professional role?

- ◯ Educational Audiologist
- ◯ Paediatric Audiologist
- ◯ Speech and Language Therapist
- ◯ Teacher of the Deaf
- ◯ Other (please specify)

2. Does your service have a policy on FM provision for:

	Yes	No
Children aged 3 years and below:	◯	◯
Children aged 4 years and above for home/personal (out of school) use:	◯	◯

If yes please list the main criteria for each:

3. Are hearing aided children aged 3 years and below under your service/caseload fitted with FM systems?

- ◯ Yes
- ◯ No

If yes please specify how many currently fitted with FM and the total number of hearing aided children aged 3 years and below under your service/caseload:

4. Are cochlear implanted children aged 3 years and below under your service/caseload fitted with FM systems?

◯ Yes ◯ No

If yes please specify how many currently fitted with FM and the total number of cochlear implanted children aged 3 years and below under your service/caseload:

5. Are children aged 4 years and above under your service/caseload provided with home/personal (out of school) use of FM systems?

◯ Yes ◯ No

If yes please specify how many currently provided this access and the total number of children aged 4 years and above under your service/caseload:

* 6. In your professional opinion should hearing aided children aged 3 years and below have access to FM systems?

◯ Yes ◯ No

Please give reasons for your opinion:

* 7. In your professional opinion should cochlear implanted children aged 3 years and below have access to FM systems?

Yes No

Please give reasons for your opinion:

* 8. In your professional opinion should children aged 4 years and above have home/personal access (out of school) to FM systems?

Yes No

Please give reasons for your opinion:

9. Do you have any training needs on FM fitting/provision?

Yes No

If yes, please list these below:

* 10. Personal details (these details will remain anonymous and will only be used for verification and to avoid duplication of data). Please include your email address if you are happy for The Ear Foundation to contact you about any follow up research.

Name:	
Service/organisation:	
Address 1:	
Address 2:	
City/Town:	
Post Code:	
Email Address:	
Phone Number:	