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Young deaf children with hearing aids or cochlear implants: early assessment package for monitoring progress

Thomas P. Nikolopoulos*, Sue M. Archbold, Susan Gregory

Nottingham Pediatric Cochlear Implant Programme, 113 The Ropewalk, Nottingham NG1 6HA, UK

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Summary

Background: Very few assessment measures exist for evaluating progress in young deaf children with hearing aids and cochlear implants.
Objective: To introduce and describe an early assessment package that covers auditory perception, communication/language development, and speech production in very young deaf children.
Main outcome measures: Seven of the assessment measures (Listening Progress Profile, Categories of Auditory Performance, Tait Video Analysis, Stories—Narratives Assessment Procedure, Profile of Actual Linguistic Skills, Speech Intelligibility Rating, and the Profile of Actual Speech Skills) have been specifically developed at the Nottingham Cochlear Implant Programme, and a further one (Meaningful Auditory Integration Scale) was modified for use within the package. Moreover, two commercially available tests (Pragmatics Profile of Everyday Communication Skills and Preschool Language Scale) are included to complete the package.
Methods: The present paper describes each measure, how to use it, and its time frame. In addition, two case studies demonstrate the usefulness of the package as a whole.
Results and conclusions: The Nottingham Early Assessment Package (NEAP) offers a framework with which to assess in young deaf children the use of audition and language and communication in real-life situations. Being simple, reliable, and time effective can be used in everyday clinical practice. NEAP is innovative in design and offers a structured approach to monitor very young deaf children, both in short and long term. In addition, it allows the identification of additional problems and areas of difficulty as well as specific abilities and skills. This enables the clinician to determine appropriate intervention strategies.

* Corresponding author. Present address: 116 George Papandreou Street, Nea Philadelphia, Athens 143-42, Greece. Tel.: +30 210 25 13 312; fax: +30 210 69 94 904.
E-mail address: Thomas.Nikolopoulos@Nottingham.ac.uk (T.P. Nikolopoulos).

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1. Introduction

The advent of pediatric cochlear implantation necessitated the development of assessment measures appropriate for very young deaf children to inform the decision making process, to monitor device functioning, the appropriateness of support and help identify the presence of any additional learning difficulties. The Nottingham Early Assessment Package (NEAP) is a collection of measures which have been chosen to meet this need. Having been initially developed for use within an implant programme, the package focuses on the use of audition in the development of communication and spoken language skills. However, it is an important feature of the package that the development of audition is not viewed in isolation, but in its role in the development of communication and language by the child.

The package is particularly useful in providing a structured way of looking at development at the pre-lexical and early word stage, before the period when most standardized tests of linguistic skills can be used. NEAP offers a range of assessments providing a profile of the child at a stage when most tests are limited in their application or require more formal assessment procedures. Some of the assessments included in NEAP can be used regardless of mode or language, and focus on communication itself. The development of the package took place within a multi-disciplinary context and it reflects this philosophy in working with young children.

2. The package

The measures developed by Nottingham Pediatric Cochlear Implant Programme over the years for assessing young deaf children both before and after cochlear implantation, now form the Nottingham Early Assessment Package. NEAP can be used from the first months of life, providing useful markers in that early period, guiding decision making about appropriate intervention and providing a tool for continuing assessment and monitoring. The package uses video analyses, observational profiles, interviews, and questionnaires. Some of the measures can be used from early infancy right through to adulthood, providing continuity and the basis for

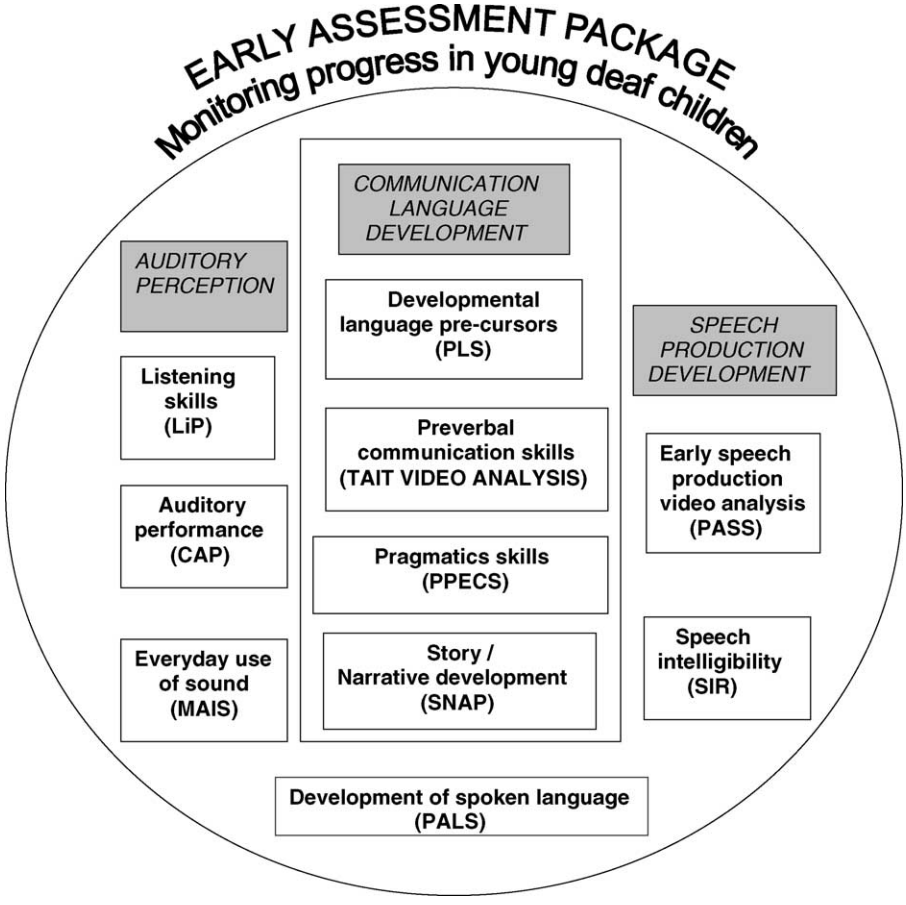

Fig. 1 The measures used in the Nottingham Early Assessment Package (NEAP).

long-term comparisons in the various areas of development.

NEAP covers the following areas:

- communication and language development;
- auditory perception; and
- speech production.

Fig. 1 illustrates the measures used in these areas of focus. Fig. 2 demonstrates the use of the measures over time, and the time-scales for which they are applicable, showing the range of each. Seven of the assessments have been specifically developed at the Nottingham programme, and a further scale (MAIS) was modified for use within the package. Two commercially available tests are included to complete the package.

The present paper describes each measure and concludes with two case studies, which demonstrate the usefulness of the package as a whole.

3. The measures

3.1. Communication and language development

Fundamental to any early assessment of young children is a consideration of communication and language development. The measures used in this area have been chosen to cover the range of areas of early communication skills, from the preverbal stage through to the development of spoken language. They are:

- Tait Video Analysis: preverbal communication skills;
- Preschool Profile of Early Communication Skills (PPECS): pragmatic skills;
- Story/Narrative Assessment Procedure (SNAP Dragons): story/narrative development;
- Profile of Actual Linguistic Skills (PALS): development of spoken language; and
- Preschool Language Scale (PLS): developmental language pre-cursors.

3.1.1. Tait Video Analysis (TVA): developed by Margaret Tait (Nottingham Pediatric Cochlear Implant Programme)

Tait Video Analysis assesses, in a video sample, deaf children's preverbal communication skills: responses in an interaction with a known adult, eye contact, turn-taking, vocal initiative, gestural initiative, and auditory awareness.

TVA is very useful in the early stages of assessing communication skills is a sensitive measure which can monitor changes over short time frames, months rather than years. It measures the developments

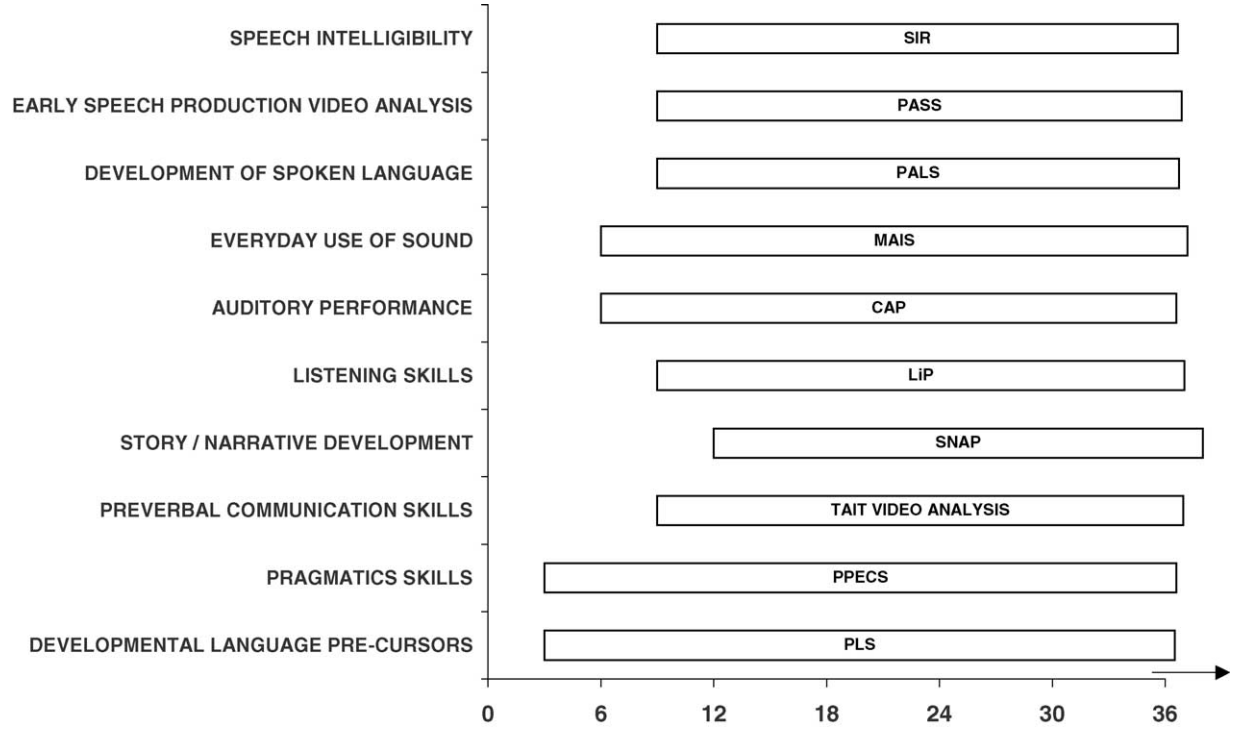

Fig. 2 Nottingham Early Assessment Package (NEAP) time frame in children's life (months) for the use of the assessment measures.

which take place before understanding of spoken language is evident and certainly before the emergence of speech.

Preverbal development is measured in four areas: turn-taking, initiative, eye contact and auditory awareness. *Turn-taking* can be either 'vocal', with or without the addition of sign/gesture, or 'gestural' without vocalization. *Initiative*, which can also be vocal or gestural, is judged to be shown if a child's turn contains elements that cannot be predicted from the adult's preceding turn. *Eye contact* notes when the child looks at the adult and when the child looks elsewhere. *Auditory awareness* of the adult's voice is considered to be shown if the child 'replies' when they have not been looking at the adult for the adult's last few words. Such a reply might be an attempted repetition of a recognized word, or just a vocalization. This is termed a *non-looking vocal turn* [1].

TVA has been shown to be repeatable and been found to predict to a significant extent the later development of speech perception in children with cochlear implants [1—3]. Thus, in this difficult area of preverbal assessment, it is a proven tool.

3.1.2. The Pragmatics Profile of Everyday Communication Skills: preschool version: developed by Hazel Dewart and Susie Summers (NFER—NELSON Publishing Co. Ltd., Widsor Be, UK, 1995)

The Pragmatics Profile of Everyday Communication Skills (PPECS preschool version) is an informal interview carried out to explore a child's communication in everyday interactions at home or at school. The information is obtained indirectly through interview. The person responding is encouraged to describe *in his or her own words* the way the child typically behaves and this description is recorded on the PPECS interview schedule. The child's current communication strategies are recorded under four main headings:

A. Development of Communicative Functions: the way the child comes to express a range of intentions, such as requesting, greeting and giving information.
B. Response to Communication: the way the child reacts to and understands communication from other people.
C. Interaction and Conversation: how the child participates in social interactions involving initiation, turn-taking and repair strategies when communication breaks down.
D. Contextual Variation: how the use of pragmatics is affected by variations in context, such as time and place and the people involved.

3.1.3. Stories/Narratives Assessment Procedure (SNAP Dragons): developed by Helen Starczweski and Hazel Lloyd (Nottingham Pediatric Cochlear Implant Programme)

Stories/Narratives Assessment Procedure (SNAP Dragons) is a child centered assessment which has been specifically developed for deaf children in order to monitor their narrative abilities. Using picture-based stories, written and illustrated specifically for preschool deaf children, children are asked to retell a story using their preferred communication mode and language and this is video-recorded.

SNAP Dragons consists of a set of 14 picture-based stories, written and illustrated specifically for preschool deaf children. The books feature a family of dragons involved in every day events throughout the year which are familiar and appealing to this age group. The narrative analysis of the video is carried out in two stages: (a) story grammar analysis; (b) narrative stage (Table 1).

Story grammar analysis looks at the structure of information in the child's story. It is particularly concerned with the identification of setting information, initiating events, actions of the characters, consequences and any internal responses of the characters in the story. Each utterance of the child's story is coded on the transcription. Analysis then goes on to determine whether a complete episode is present. This is a story unit or episode represented by the presence of an initiating event, action and consequence [4,5]. The developmental sequence is described elsewhere [6—8].

An inter-rater reliability study has been carried out on the SNAP rating with excellent results. The SNAP rating is easily undertaken and shows high inter-observer reliability. Moreover, the progress of young implanted children in the narrative skills using SNAP as the assessment method has been demonstrated and a shift towards more speech orientated communication modes following cochlear implantation has been found [8].

3.1.4. Profile of Actual Linguistic Skills (PALS): developed by Dee Dyar (Nottingham Pediatric Cochlear Implant Programme)

The Profile of Actual Linguistic Skills is a criterion-referenced procedure that assesses a deaf child's ability to use oral language, effectively, in every day linguistic and learning environments. The PALS profile looks at the child's rate of progress at five interrelated linguistic levels: social and pragmatic skills, receptive skills, expressive skills, voice skills, and speech skills.

PALS has been found to be a sensitive means of 'profiling' changes in the spontaneous communication/linguistic skills of profoundly deaf children who

Table 1 Narrative stages (''SNAP Dragons rating'')

Narrative stage	Story grammar	Narrative behavior
1	Pre-analysis	Child is not ready to respond to the task
2	Pre-analysis	Child is happy to look at the book while the adult tells the story, but is not ready to retell the story
3	Child labels or comments on pictures	Child needs prompting/scaffolding to retell the story (>3 prompts)
4	One or two story categories used. Not a complete episode	Some prompting needed (<3)
5	One complete episode	Spontaneous retelling. No prompting needed. Can include a ''verbatim'' stage
6	One episode complete and second nearly complete (2/3 categories)	Verbatim stage may persist
7	Two complete episodes	Confident story telling
8	Greater than two episodes. Internal responses used increasingly to show reasoning of characters	Confident and creative story telling

are functioning at the pre-lexical stage of language acquisition.

The developmental framework approach of PALS makes it an appropriate pre-cursor to norm-referenced language performance measures. It can provide global data on the linguistic status of children and identifying ''gaps'' enables the user to plan immediate communication priorities and goals for the deaf child.

The PALS profile is usually completed by a speech and language therapist. After preliminary training, it can be used by other experienced professionals.

The outcomes obtained on the five inter-related levels of the PALS individual profile can be collated further to provide *an overall classification* of the child's *current linguistic effectiveness* in a spoken language at a specified assessment interval: (1) preverbal; (2) transitional; or (3) functional language (Table 2) [9].

3.1.5. Preschool Language Scale: 3 (UK): developed by I.L. Zimmerman, V.G. Steiner and R.E. Pond, UK, adaptation by J. Boucher and V. Lewis (Psychological Corporation Limited, London, 1997)

The Preschool Language Scale (PLS3) measures the pre-cursors to language as well as a broad range of early language skills; early interaction and early vocal development. It can be used to test children aged from 3 months to 6 years 11 months or for older children functioning developmentally within this age range. This scale has been included to enable us to evaluate the deaf child's relative ability in receptive and expressive language when compared to a hearing peer (UK and US norms are available). It looks at receptive language pre-cursors, for example, a child's shared attention abilities, and also at expressive language pre-cursors, for example, social communication and vocal development.

This commercially available test can be used by speech and language therapists, educational psychologists, specialist teachers and other professionals who may work with communication impaired children in the preschool years, and has a comprehensive manual.

3.2. Auditory perception

The relationship between degree of deafness and auditory perception is not a simple one and the ability to use hearing aids or cochlear implants effectively will vary considerably. In order to complement the formal audiological measures taken within the clinic, indicators of the functional use of audition in everyday life are necessary. The three measures of auditory perception are:

- Listening Progress Profile (LIP): measuring early listening skills.
- Categories of Auditory Performance (CAP): measuring auditory performance in everyday life.
- Meaningful Auditory Integration Scale (MAIS): measuring everyday use of sound and hearing aid or implant.

3.2.1. Listening Progress Profile (LIP) developed by Sue Archbold (Nottingham Paediatric Cochlear Implant Programme)

The Listening Progress Profile measures the developing listening skills in young deaf children, in everyday situations. Specific activities are used to enable completion of the profile, in observation and

Table 2 PALS: outcome categories preverbal, transitional and functional language

Preverbal	Transitional	Functional language
The deaf child is functioning at the 'pre-lexical' stage of oral language acquisition	Recognisable words and simple formulaic expressions are *reported* by the deaf child's parents/carers/ support professionals. Some single words or phrase patterns may be *elicited* on a minimum of two occasions in an assessment context	The deaf child demonstrates the ability to use language(s) spontaneously and in a systematic way. A knowledge of meaning and the rules of the ambient spoken language is apparent

play, rather than by testing. It covers a range of abilities from first response to environmental sounds and first response to voice, through to discrimination of environmental sounds and discrimination of voice, to identification of the child's own name [10—12].

A prospective and longitudinal study found that all the children studied following implantation could be assessed by LIP; no child scored 0 as early as 3 months post-operatively. The study included children implanted under the age of two. LIP has also been useful in highlighting those children who may have a potential device problem [10,11].

The inter-observer reliability on LIP as a measure of auditory perception has been formally validated and has shown high levels of agreement between different observers [13].

3.2.2. Categories of Auditory Performance (CAP): developed by Sue Archbold (Nottingham Pediatric Cochlear Implant Programme)

The Categories of Auditory Performance is a global outcome measure of the developing auditory skills in deaf children, designed to give a readily accessible measure for non-specialists. It is carried out by observation, using standard criteria, and assesses the functioning of the child in everyday situations at home and at school covering a range of abilities from awareness of environmental sounds to discrimination of speech sounds and from understanding common phrases and conversation without lip-reading to telephone use with a known speaker. Table 3 shows the categories. CAP is useful in all the stages of assessing hearing skills, whether use of hearing aids or cochlear implants. When used following implantation it shows changes over the short and long term [11,14—18].

CAP is simple, easily undertaken, and easily understood by professionals, parents and ordinary people who have no experience in tests or other assessment methods for deaf children.

The inter-observer reliability of CAP has been formally validated and has shown high levels of agreement between different observers [19].

3.2.3. Meaningful Auditory Integration Scale: developed by Amy McConkey-Robbins, modified with permission by Nottingham Pediatric Cochlear Implant Programme

The Meaningful Auditory Integration Scale was developed to evaluate the meaningful use of sound in everyday situations by profoundly deaf children [20]. Nottingham Pediatric Cochlear Implant Programme has extended it to include the opinion of their teachers as well as parent. Ten questions are given ranging from the child's initial adaptation to using the hearing aid or cochlear implant, through response to name, to sounds in the environment through to more sophisticated levels of hearing such as identifying speakers and the ability to identify emotions from vocal tone.

In the early days after the fitting of hearing aids or cochlear implants, the MAIS may provide early evidence of the use of the system, when other signs are few. Parents and carers can be encouraged to consider the ways in which their child is using the hearing system in everyday life, and to be observant of changing behaviors. Its use may alert carers and professionals to early signs of the child not adapting to the use of the system; for example, where the child is not happy wearing the device, or not aware where there are any problems with its functioning. Similarly, its use over the long term may highlight a child who may be becoming an intermittent user.

Table 3 Categories of Auditory Performance (CAP)

Category	Criteria
7	Use of telephone with known listener
6	Understanding of conversation without lip-reading
5	Understanding of common phrases without lip-reading
4	Discrimination of some speech sounds without lip-reading
3	Identification of environmental sounds
2	Response to speech sounds (e.g. "go")
1	Awareness of environmental sounds
0	No awareness of environmental sounds

3.3. Speech production

It is important to monitor the developing speech skills, from the early stages of vocalization in communication through to the emergence of spoken language. The two measures in this area cover speech production from the earliest vocalizations through to intelligible speech. They are:

- Profile of Actual Speech Skills (PASS): early speech production video analysis.
- Speech Intelligibility Rating (SIR): a profile of speech intelligibility.

3.3.1. Profile of Actual Speech Skills (PASS): developed by Dee Dyar (Nottingham Paediatric Cochlear Implant Programme)

The Profile of Actual Speech Skills is a systematic recorded sampling technique that enables a speech and language therapist to establish a developmentally and linguistically appropriate *baseline measure of speech production* in profoundly deaf children, and to transcribe and analyze any changes that occur at the speech production level. A key emphasis of the PASS is to describe the *actual* spontaneous speech patterns produced by deaf children at the pre-lexical stage of spoken language development.

The PASS summary of findings consist of three *quantitative level* outcomes and two *qualitative level* outcomes. The quantitative level outcomes include the change in quantity of overall tokens over time through the transition from silent articulation postures through non-speech through speech-like to speech. The qualitative level outcomes look at changes in the child's vowel and consonant repertoire.

PASS is a developmentally and linguistically appropriate technique for 'profiling' the spontaneous speech patterns of young profoundly deaf children. It can influence the choice of short term (re)habilitation goals for individual deaf children [21].

3.3.2. Speech Intelligibility Rating (SIR): developed by Dee Dyar (Nottingham Paediatric Cochlear Implant Programme)

Speech Intelligibility Rating measures speech intelligibility of deaf children who use hearing aids or cochlear implants. SIR is a five-point hierarchical scale (Table 4) describing various degrees of speech intelligibility from unintelligible speech through to speech that is intelligible to all listeners.

SIR measures progress in speech intelligibility from before the first words until connected speech is established over the long term. It is not intended to monitor small changes in intelligibility over a short time frame. SIR is a rating of a child's everyday spontaneous speech and has been found to be a practical clinical measure which can be readily applied to large groups of young deaf children over time irrespective of children's age and speech abilities [22], and has been shown to be reliable between observers [23]. There is no need for children to have language skills or to be able to produce a speech sample. Moreover, the overall pattern of development produced is easily understood by parents and non-professionals, fostering realistic expectations.

3.4. Case studies

The two case studies below of contrasting young deaf children implanted below the age of two, illustrate the use of the measures described above. These case studies demonstrate the use of these assessments to establish base-line measures before implantation, and to monitor progress over the following year, or longer if necessary.

3.4.1. Case study 1

The first (C) is an example of a child who has made good progress with her implant. She was born profoundly deaf and received a cochlear implant with full insertion of the electrode array at the age of 19 months. Her preimplant assessments took place over the preceding 3 months. The only reliable

Table 4 Speech Intelligibility Rating criteria

Connected speech is intelligible to all listeners. Child is understood easily in everyday contexts	Category 5
Connected speech is intelligible to a listener who has a little experience of a deaf person's speech	Category 4
Connected speech is intelligible to a listener who concentrates and lip-reads	Category 3
Connected speech is unintelligible. Intelligible speech is developing in single words when context and lip-reading cues are available	Category 2
Connected speech is unintelligible. Pre-recognisable words in spoken language, primary mode of communication may be manual	Category 1

response to sound observed before implantation was an elicited response to drum; no responses to environmental sounds or to the sound of voice were observed. She was therefore rated on the lowest category of the CAP ('no awareness of environmental sounds'), and scored only 5% on the LIP (elicited response to drum). She scored 0% on the MAIS, both parent and teacher versions, as she had no interest in her acoustic hearing aids, being unaware of sound through them.

Her preverbal communication skills were well established. Tait Video Analysis showed her to be taking all her conversational opportunities, but to be as likely to do so silently (53%) as vocally (47%). She had begun to show initiative, again both silently and vocally. No auditory response to the sound of the adult's voice was observed (NLVT 0%). On the PALS she was rated as 'preverbal'. Her SIR level was category 1 (pre-recognisable words) and her PASS rating showed 10% speech sounds, 26% speech-like sounds and 63% non-speech sounds.

By the 6-month interval C had made rapid progress in her listening skills. On the CAP she had gone up four levels (to 'discriminates some speech sounds without lip-reading') and on the LIP she scored 100%: for example, she was observed to be recognizing, and spontaneously repeating, all Ling's five sounds without lip-reading, and recognizing family names, again from the sound alone. She also scored 100% on the MAIS (parent and teacher versions), for example, knowing who had spoken to her by the sound of their voice, and recognizing the sound of a cross or excited voice from the vocal tone, without looking. PALS and SIR are not used at this interval, but PASS showed her to be using far more speech (58%) and speech-like (7%) than non-speech (25%) sounds. Tait Video Analysis showed her to be becoming predominantly vocal in her turn-taking (76% vocal compared with 12% gestural) and to be beginning to respond vocally to the sound of the adult's voice (NLVT 35%). Vocal initiative remained at a low level at this stage.

At the 12-month interval the 100% ratings on the LIP and the MAIS were maintained, and she had moved up a further category on the CAP ('understands common phrases without lip-reading'). Tait analysis showed her to be taking 100% of her conversational turns vocally, with 68% of vocal initiative and 58% of non-looking vocal turns. By this stage the vocal turns were not simply vocalizations, but consisted mainly of phrases such as 'Where she gone?', 'There it is!', 'What is it?' and so on. On PALS she was rated as transitional, with some functional language features. On PASS she had 77% speech sound, 21% speech-like sounds and only 2% non-speech sounds. Finally, her SIR rating had improved to category 3: 'intelligible to familiar listeners who know the context'.

To summarize, C's ratings on all the assessments are at a high level by the 12-month interval. Two ratings (LIP and MAIS) have already reached the maximum level by the 6-month interval; in children of this age the majority would be expected to take 1 year to achieve these levels. Clearly, C has not only reached a high 12-month level, but her 6-month ratings show that the rate of progress has been rapid.

3.4.2. Case study 2

The case study of the second child, R, gives an example of monitoring a child who has made slow progress with her implant over the first 12 months. She became profoundly deaf following meningitis with resulting ossification of both cochleas. In addition, cerebral palsy was identified after meningitis. She received a cochlear implant at the age of 10 months, with partial insertion of the electrode array (6 electrodes). She had no response to sound before implantation and was therefore rated at the lowest level on the CAP ('no response to environmental sounds') and at 0% on the LIP. She was reluctant to wear acoustic hearing aids and did not respond to sound through them, so scored 0% on the MAIS also. Tait analysis showed that at this stage there was little real turn-taking. Her mother followed the normal procedure with young infants, i.e. waiting for any vocalization or body-movement from the child and then responding 'as if' R had communicated. It was estimated that communication from the child had taken place in 39% of the possible opportunities, evenly divided between vocal turn-taking (20%) and gestural (19%). No instances of initiative or auditory awareness were observed. She was rated as preverbal on the PALS and category 1 on SIR (pre-spoken language). PASS showed her to have 0% speech sounds, 0% speech-like sounds, 89% non-speech sounds and 3% other.

By the 6-month interval it was possible to observe some changes. R was at this stage responding to the sound of voice and turning if called, and could therefore be given the CAP rating of 'responds to speech sounds'. On the LIP she scored 36% as she was responding to musical instruments and (sometimes) to her own name. She scored 40% on the MAIS (both parent and teacher versions) as she clearly liked to wear the speech processor, responded to some environmental sounds, and sometimes alerted to the sound of her name. Tait analysis showed her turn-taking to have increased to 59% vocal plus 41% gestural, with some display of initiative (29% vocal), but with no vocal responses to the sound of the adult's voice when not looking (NLVT 0%). However,

by this stage R's vocalizations and gestures were becoming more clearly communicative, and there was less need for the adult to 'engineer' the turn-taking structure. Her PALS rating remained 'preverbal', but PASS showed her to be using sounds which were more speech-like in quality: 23% speech and 58% speech-like.

The 12-month assessment showed further improvement on all profiles. R had gone up one level on the CAP, to 'recognizes environmental sounds'. Her LIP score had increased to 52%, as her responses to musical instruments, to the sound of voice and to Ling's five sounds had become reliable. Her MAIS score had gone up to 83% (parent) and 68% (teacher), as she was by this stage showing clear indications that she liked the speech processor, for example, clapping her hands and getting excited when it was put on, and looking at the adult's face with a puzzled expression if the battery went flat. Tait analysis showed more positive and purposeful turn-taking with a definite vocal bias (75% vocal compared with 25% gestural). Her vocal initiative remained at a similar level to the 6-month interval, and she still displayed no vocal indications of auditory processing, preferring to maintain eye contact with the adult. PASS showed a continued improvement in her vocalizations, with 43% of her tokens now being classified as 'speech'.

3.4.3. Comment on case studies

The implant situation was different for these two children from the start, in ways that were like to affect progress. Child C was born profoundly deaf and received her implant at 19 months, when full insertion of the electrode array was achieved. Child R was born hearing, and became deaf due to meningitis, which also resulted in cerebral palsy. She received her implant at 10 months but only partial insertion of the implant was achieved. Significantly, she was younger at the time of the various assessments than child C.

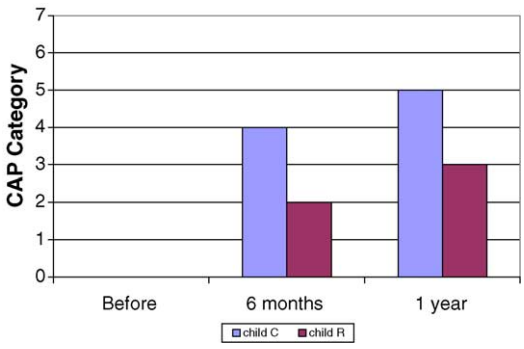

Fig. 3 Progress of children C and R using categories of auditory performance (CAP).

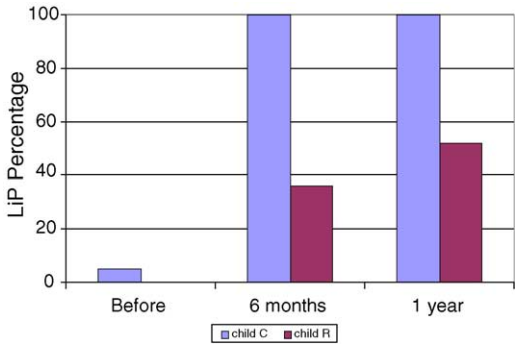

Fig. 4 Progress of children C and R using listening progress profile (LIP).

Figs. 3—5 compare the progress of the two children on the three measures of auditory perception used: CAP, LIP and MAIS, from before implantation until 6 and 12 months later. Both children make progress in this area, although there are clear differences. Before the implant, neither child shows evidence of significant auditory perception, although child C registers a score on the LIP, using what little residual hearing she has. After implant, the benefits of this residual hearing become clear, as by 6 months she has reached ceiling performance in both the MAIS and the LIP, and on the CAP, progresses from a score of 4 at 6 months to a score of 5 at 12 months. However, while child R shows steady improvement in all areas, it is at a much slower rate.

The TAIT Video Analysis of developing communication skills is shown for each child separately. Fig. 6 shows development for child C, and Fig. 7 for child R. Child C shows a decrease in gestural turns which start at 60% prior to implant, and decreased to zero by 12 months after implantation. However, vocal turns and non-looking vocal turns (NLVT) increase over the 12-month period. By contrast, although child R increases her vocal turns over the same period, she still uses gestural turns and has not developed non-looking vocal turns. The relationship

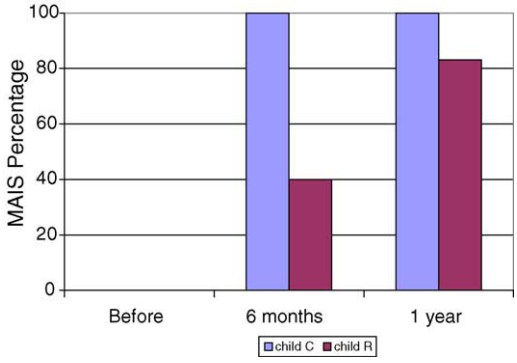

Fig. 5 Progress of children C and R using Meaningful Auditory Integration Scale (MAIS).

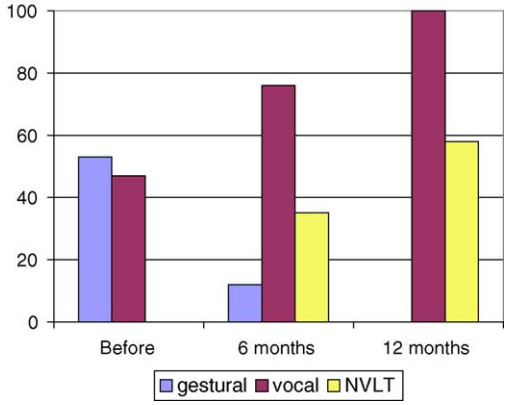

Fig. 6 Child's C progress using Tait Video Analysis.

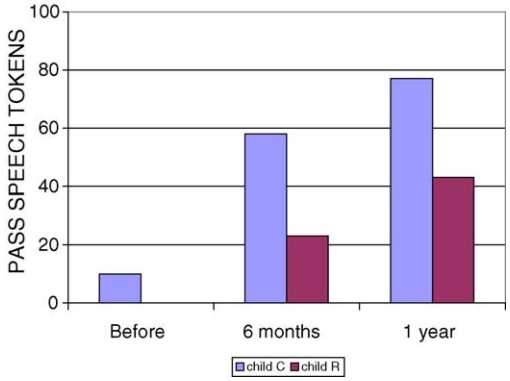

Fig. 8 Progress of children C and R using Profile of Actual Speech Skills (PASS).

between the various turn-taking responses is complex, but the analysis indicates that child C's developing communication skills are encouraging, while child R requires further careful monitoring.

Figs. 8 and 9 compare progress for both children using PASS and SIR, measures of speech production. SIR measures at 6 months are not available. Neither child has any intelligible speech before implant but child C shows progress over 12 months on both measures, and has some speech tokens before implant. One year after implant, she has progressed to SIR category 3, which means she has speech intelligible to an experienced listener. While child R is beginning to develop speech tokens over the first 12 months, she is not yet developing spoken language and therefore remains at category 1 of SIR. This is consistent with her results of assessments in the other two areas of communication and language development and of auditory perception.

Overall, child C is making good progress and we would expect this to continue, although of course monitoring will continue. Child R is making much slower progress than child C, and the assessments will need to be used for at least a further year to monitor the pattern of the development of her listening and speech and language skills. The assessments lead us to have confidence of device functioning, but the slow progress in some areas such as no vocal indication of auditory processing or use of auditory initiative indicate areas that need continuing monitoring. However, there are measurable changes, and it is particularly important in the case of slower progress to be able to document these early indications that the implant is providing access to sound.

4. Discussion

NEAP offers a framework with which to assess language and communication in real-life situations. It is innovative in design and offers a structured approach to the behavior of very young deaf children. Although designed for use within a cochlear implant programme, it can be used with a range of deaf children where information is required about their development in auditory development and speech production as well as aspects of communica-

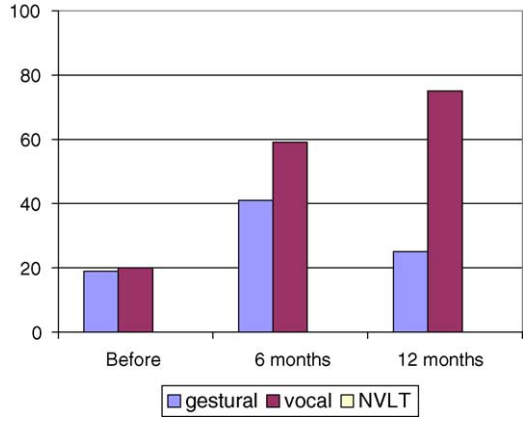

Fig. 7 Child's R progress using Tait Video Analysis.

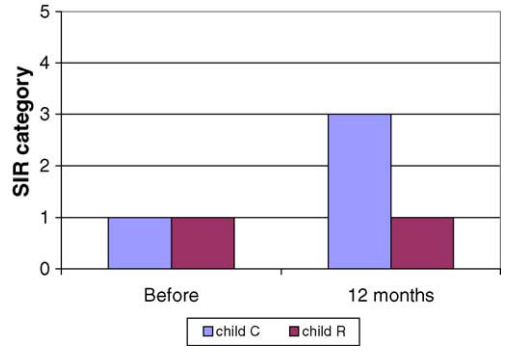

Fig. 9 Progress of children C and R using Speech Intelligibility Rating (SIR).

tion and language development. It also provides a means of monitoring development both in the short term, looking in detail at small changes in behavior; and in the long term, looking at significant changes over time, an essential requirement when considering young deaf children. The package is not time-consuming and can be incorporated into standard practice and procedures.

NEAP includes observational reports involving parents and other caregivers, with a focus on interaction. This means it does not depend only on elicited behaviors which can be unreliable with very young children. It is most suitable for deaf children from 12 months although there is some flexibility and many of the assessments can be used from 6 months or even earlier. Some assessments are designed to monitor progress in the short term (TVA, LIP, PASS) although the actual age span over which they are used would depend on the development of the child. Other assessments, such as CAP, SIR, and SNAP, are designed to look at changes over the long term.

Within the cochlear implant programme itself, NEAP can be used to assist in the assessment of candidates for cochlear implantation. It is particularly valuable with very young children and those who are audiologically borderline. Following implantation it is also essential to monitor progress in order to inform the tuning process. In young deaf infants it is very difficult to monitor the functioning of the device, and one of the uses of this package is that it can help to identify areas of difficulty to explore further.

The package is useful because it focuses on a child's strengths as well as weaknesses, providing a comprehensive assessment as a basis for management. In addition, in monitoring the child's development, it allows the identification of additional problems and areas of difficulty as well as specific abilities and skills. This enables the clinician to determine appropriate intervention strategies, and modify them according to the observed progress. It also provides indications of where other assessments may be necessary to explore areas of difficulty further. For example, a child may not be demonstrating good auditory skills, but communication skills not be developing as expected, warranting further investigation. In another child, auditory and communication development may be progressing well but no speech be emerging, again requiring further, more detailed, assessment.

Clear information about a young deaf child's progress is needed for a number of purposes. For example, parents of young deaf infants require information on which to base the decisions they make about the management of their child. The information obtained from the assessments included in NEAP provide clear, objective and accessible information on an individual child's development. As a more general resource, it provides both parents and professionals with information on large groups of children in terms of expected rate of progress as a basis for management decisions for an individual child. This information may also help highlight areas in which progress does not meet expectations and which may need further investigation. For local professionals working with deaf children it is very helpful to have means to measure change; one strength of NEAP is that many of its measures can be used in a variety of settings, at home in the nursery, or in school, where formal assessments are often not appropriate or are difficult to undertake. Moreover most of the measures are easily understood by non-professionals and can be translated into other languages making international comparisons possible. The data obtained from the package also contributes to the more general information required concerning the children's progress for audit and predictive purposes.

Although these measures are based on observation, rather than formal testing and clinic-based assessments, they have been demonstrated to have clinical application and to be robust. Reliability and validity for many of them are well established as described previously in this paper. Moreover, a number of the assessments have already been shown to have the ability to predict outcomes and work continues in this area.

NEAP has thus been shown to be innovative, time-effective, user friendly, informative, reliable and valid assessment for young deaf children with cochlear implants. Because its strengths lie in the assessing of development of spoken language and use of audition it is clearly significant for all young deaf children. However, it may need to be modified in some circumstances. In other contexts a more detailed look at language development would require the assessment of sign language skills and the use of gesture and vision in communication. A more comprehensive assessment would require assessment of cognitive development and consideration of symbolic and other play and social and emotional development. In future it may be possible to extend NEAP to cover these areas.

In this paper we demonstrated the use of NEAP with two significantly different young children and shown its sensitivity in monitoring changes in development. The use of a variety of assessments allows a more comprehensive view of the child and their strengths and weaknesses. Such profiles can alert us to any particular problems or areas requiring further investigation.

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