National Sensory Impairment Partnership

BRIEFING NOTE

Date: March 2017

THE USE OF THE LANGUAGE ENVIRONMENT ANALYSIS (LENA) TOOL

Introduction

Permanent hearing loss can have long-term implications for speech, language and communication, as well as social interaction, educational attainment, employment opportunities and quality of life (Davis, Bamford, Wilson et al., 1997). Early diagnosis and intervention are widely recommended to reduce the risk of speech, language and communication difficulties and to maximise spoken language potential (Davis *et al*. 1997, Pimperton & Kennedy 2012).

The introduction of the universal Newborn Hearing Screening programme has made early diagnosis of hearing loss routine for children born deaf and most babies are diagnosed and aided within a few weeks of life (NHS Newborn Hearing Screening Programme, 2016). Despite this important early advantage, children with hearing loss often continue to have difficulty developing spoken language and their educational attainment remains below that of their hearing peers (NDCS 2016).

Spoken language outcomes are significantly affected by factors such as maternal level of education, socio-economic status and degree of hearing loss (Moeller et al, 2007, Kirkham et al, 2009). Clearly, these are beyond the influence of support services such as Speech and Language Therapists (SLTs) and Teachers of the Deaf (ToDs). However, several other important factors in the child's listening and language environment are widely held to be beneficial, including:

- *Achieving adequate audibility*
  Factors such as noisy listening environments and inconsistent use of hearing technology affect audibility (the child's hearing for speech); in turn, this impacts on exposure to language (Van Dam, Ambrose and Moeller, 2012).
- *Quantity of language*
  spoken to the child: The amount of language spoken by parents to their hearing children from birth to three years has been shown to partially predict their IQ, language abilities and academic achievement ages 9 and 10 years (Hart and Risley, 1995).
- *Active parent-child interaction*:
  The importance of parent-child communication for language development is well-documented. For many children with hearing loss, limited responsiveness or linguistic ability can create conversational breakdown, which reduces both adult-child interaction and the quantity of linguistic input (Van Dam *et al*. 2012).
- *Intervention and support to facilitate language development*
  Parents are typically the biggest influence in their baby's life and current clinical guidelines recommend working through parents as the most appropriate approach with young deaf children (Muse, Harrison, Yoshinaga-Itano *et al.* 2013, Royal College of Speech and Language Therapists 2009). Recent research has shown that in general, parent-implemented interventions (where strategies are implemented by the parents rather than a professional) had a significantly positive effect on language outcomes when compared to a control group and less significantly when compared to therapist-led interventions (Roberts & Kaiser, 2011).

Consequently, training and support for parents to improve their child's listening and language environment form the basis of many early communication interventions (Zaidman-Zait & Young 2008). Whilst *understanding* what makes a good language and listening environment is important, *making changes* to this environment in everyday life is a challenge both for parents who have busy lives, and professionals who may only get to see the child for short periods of time.

LENA: The Language Environment Analysis system

The Language Environment Analysis (LENA) system is a recent technological innovation, which was developed in response to the work of Hart & Risley (1995). LENA is unique in that it captures the natural language and listening environment of a child across a whole day. LENA provides a simple way to demonstrate to parents the important factors of the listening and language environment and to use this as a basis for intervention and change.

The child wears a tee-shirt specially designed to hold a small device, the digital language processor (DLP). The DLP records all the speech and environmental sounds which occur around the child during their normal daily activities from when they wake up in the morning until they go to bed at night. The recording is uploaded to the LENA software which uses advanced speech recognition technology to analyse the audio file and provide the results in an accessible visual format, which can then be shared with parents as a basis for learning and supporting change.

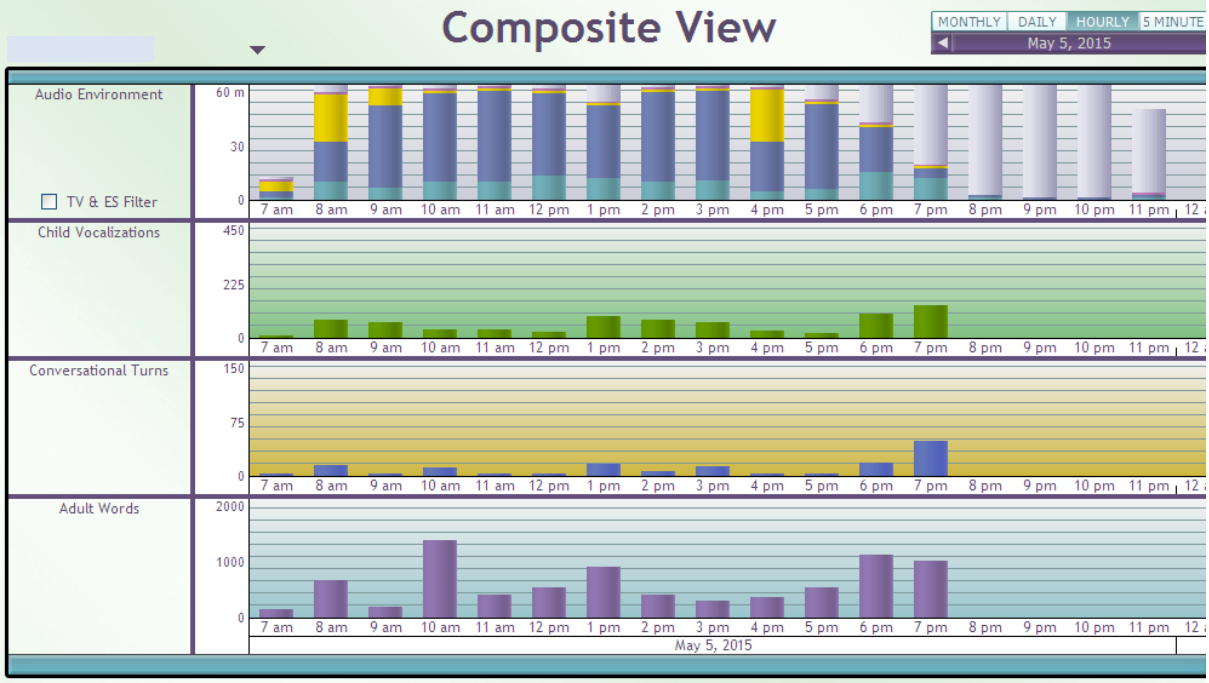
LENA Digital Language Processor

The primary LENA measures reflect the important factors in a child's listening and language environment:

- Audibility: LENA captures the daily *audio environment* of the child in terms of meaningful speech, silence and background noise.
- Quantity of input: *adult word count* counts the number of adult words spoken that are audible to the child.
- Active parent-child interaction: *conversational turns* demonstrates the number of spoken alternations between adult and child.
- Intervention: Clinicians use this information to support parents/carers make changes to facilitate their child's communication development.

Additionally, LENA captures the number of *child vocalisations,* including words and "protophones" or pre-speech sounds.

The core reports show both the language and listening environment of the recording day. Each of these reports can be explored individually. Below is an example of the way the information is displayed for families.



Example of a LENA report (Composite view)

Each bar represents an hour of the day. For the *audio (or listening) environment*, the light blue sections represent the proportion of that hour in which there was *meaningful* speech, that is "live", close and clear vocalisations; dark blue represents *distant* or overlapping speech. Yellow is *TV and electronic sounds.* Pink is *noise* (for example, toys rattling) and grey is *silence*.

This example also illustrates the quantity of *child vocalisations, conversational turns and adult words* for each hour of this day, representing not only the *amount of talking* but also the *interactions* between adult and child.

Professionals share these visual reports with parents and work together to identify how to modify the child's listening and language environment. Subsequent recordings demonstrate the changes made by the parent and the child's developing communication.

Findings suggest that using LENA has the potential to change both the parent's linguistic behaviour and the child's listening and language environment (Suskind et al 2013). It also has potential as a useful research tool.

LENA is already used with children with hearing loss in the USA, whereas in the UK there is little awareness of this technology. However, recent research suggests that using LENA with families of young children with hearing loss in the UK is both acceptable and useful (Allen et al, 2016). Parents reported that they found LENA easy to use, they were comfortable to use it and found the feedback sessions and reports useful. Sharing LENA reports encouraged active parent involvement. However, parents still appreciated and required support to help interpret the reports and facilitate goal-setting.

Current use of LENA in the UK

As described above, LENA use in the UK is limited despite its more widespread use in countries such as the USA. This is likely to be largely because of the regulatory, technological and financial limitations on professional practice working within statutory services, such as the National Health Service. Introducing new technology, such as LENA, requires evidence from a UK context. Allen *et al.* (2016) considered the acceptability of LENA to UK families of young deaf children, which included addressing the ethical issue of recording a family. Of ten participating families, only one found the LENA recording to be unacceptable. Understanding of LENA and consent from both parents/carers is important. Additionally, trust in the professional who is managing the recording, reassurance about what will happen to the recording and that it can be deleted if the family chooses to do so, are all important pre-requisites.

Examples in the literature illustrate clinical use of LENA in other countries, for example Aragon and Yoshinaga-Itano (2012), Charron, Fitzpatrick, McSweeney *et al.* (2016), Sacks, Shay, Repplinger et al. (2014), Suskind, Leffel, Hernandez et al. (2013) and others.[1]

Examples of LENA use in the UK

Clinical use: The London Borough of Newham

The Newham Sensory Service has included the LENA system as part of their child assessment kit since 2014. To date, 27 full-day initial recordings have been undertaken from hearing-impaired pre-school children in both their nursery and home settings. LENA has also been used with a blind teenager at secondary school.

Following a recording day, each LENA report is provided and discussed with the parents. Advice is given regarding adaptations in the home setting to improve their child's language development.

If possible, a repeat recording is made after three months or twelve months to review the progress. Newham Sensory Service will review the majority of the repeat recordings next year (2017).

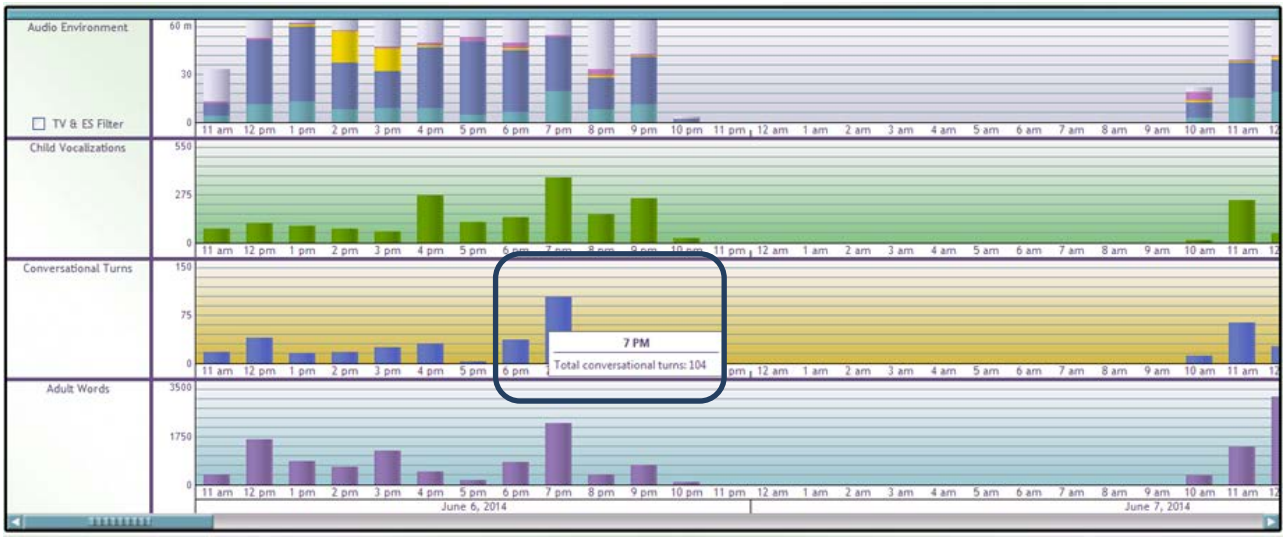
Case Studies:

These case studies demonstrate examples of LENA use from the London Borough of Newham.

Case Study 1:
'PI' a 4 year old girl with bilateral cochlear implants and severe language delay.

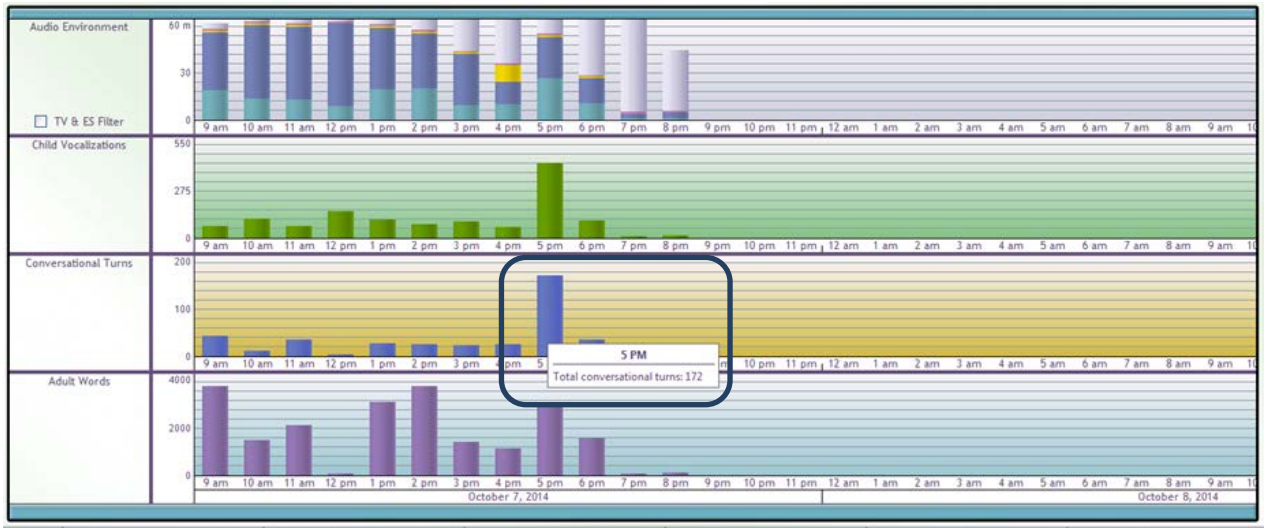
The report below shows the analysis of the initial recording from a single day in June 2014. The conversational turn taking in row three shows 104 conversational instances of turn taking between the adult(s) and the child around 7pm. The data results were explained to the parents.

[1] See The LENA Foundation website at http://www.lenafoundation.org



Recording from June 2014

The second report (below) is a repeat recording from a single day in October 2014. Conversational turn taking has dramatically increased from 104 to 172 turns. 'PI' no longer needs additional support.

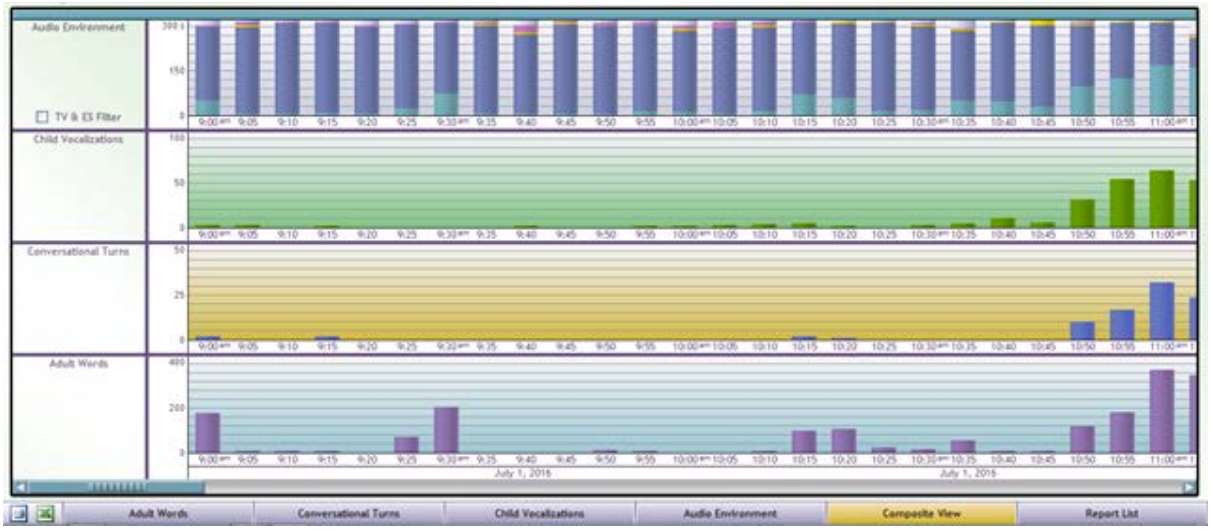


Repeat recording from October 2014

Case Study 2:
'BR' a 3 year old boy with bilateral hearing aids, but poor hearing aid use.

The Newham team wanted to get the parents on board about the benefit of wearing the hearing aids and their goal of better word development.

The report below is a section of the recording taken in July 2016. The conversational turn taking and child vocalisation were extremely low. The data results were explained to the parents.


Audio Environment
TV & ES Filter
Child Vocalizations
Conversational Turns
Adult Words
July 1, 2016
July 1, 2016
Adult Words
Conversational Turns
Child Vocalizations
Audio Environment
Composite View
Report List

The report from the repeat recording section from same time of day in December 2016 shows improved conversation turning taking and child vocalisation. In the top row, the yellow columns show TV activity and demonstrate clearly that conversational turning taking and vocalisation temporarily ceased during this time.

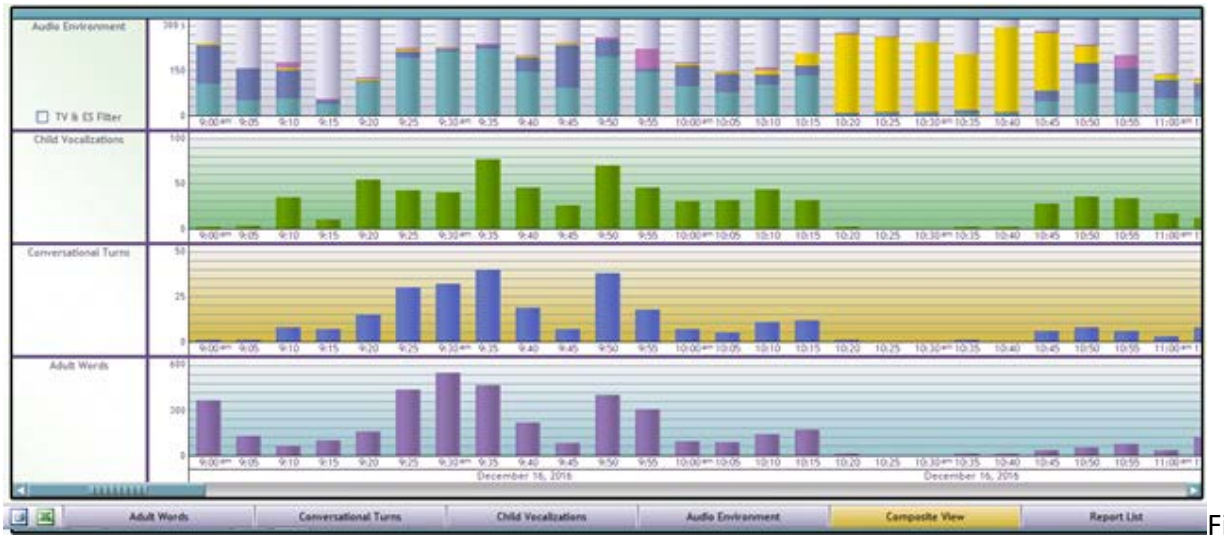


Figure 6

Learning from Newham

- *Time factors*
  Maintenance, delivery and collection, analysis of audio recording (if required) can be time consuming. An in-depth analysis of a full day's audio recording by the professional can take up to four hours.
- *Confidentiality and Trust*
  The trust of parents and teachers has to be gained. They should understand they are not being assessed. The confidential audio recordings and data needs to be secure. Any audio files that are no longer required need to be deleted immediately.
- *Cost*
  A dedicated, secure, high-specification computer is required for the analysis software. Information on pricing and software requirements is available from the LENA Research Foundation.[2] Pilot versions are available at a lower cost but with restrictions. The DLP recorders can be misplaced.

LENA use in UK research

As previously described, the acceptability of LENA has been explored (Allen *et al.* 2016). The findings of a follow-up pilot study investigating usefulness have yet to be published. However, this study used LENA in a way that closely replicates UK typical clinical practice, using LENA to carry out monthly recordings with a follow-up review session over a three month period.

Each family had three cycles of 'Record-Return-Review'. They were free to choose which day they recorded, the recording was returned, processed and a review session with the parents was carried out, generally within a week of the recording. The review took place in their home and this was when the reports or graphs were shared and discussed with the parents. The next cycle was always planned for the following month. Following the final cycle, parents were interviewed to explore their experience of using LENA over time and this interview data was analysed thematically.

[2] See: https://www.lena.org/

A recurrent and significant theme in the interview data was the value of 'seeing it black and white'. This seemed to be important for a variety of reasons, including:

- It helped parents to see things differently
- It enabled parents to take the lead
- It helped parents learn new skills
- It helped parents work with others

The NDCS commissioned another research study in 2016 exploring the use of FM/RM technology (such as radio aids) with pre-school deaf children. LENA has been used as one of the assessment tools. The purpose of LENA in this study is to compare samples of everyday situations, such as mealtimes, travelling in the car or outdoor play. Recordings have been made of a similar type of day one week apart, for example, a quiet Monday at home with a parent. For each recording, parents kept a detailed diary sheet of activities/times throughout the day. One recording was made on a day without using the FM system, but the FM system was used for the subsequent recording. A pilot study of this approach demonstrated noticeable differences between FM and no-FM situations/activities, such as increased child vocalisations, providing an objective measure of change.

Learning from research use

Findings suggest:

- UK families with a young deaf child find LENA acceptable and useful
- Using LENA effectively engages parents in creating appropriate everyday listening and language environments to maximise their child's potential for spoken language development
- Using LENA empowers parents in supporting their child's development and in their relationships with professionals
- LENA is a useful measure for demonstrating change and difference not only to families and professionals, but also in research activity

Considerations when implementing LENA

- Ethical issues: confidentiality, information governance, data protection, parental understanding of LENA and consent
- Cost of equipment
- Logistical management: to ensure the LENA is delivered, returned and the review session booked with appropriate timing
- Trust and confidence in the professional
- Training and resources to support professionals using LENA

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