

Parents and health workers must work as a team to identify hearing loss as early as possible.

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ANDREW SMITH



Testing small children's hearing with little or no equipment



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Hearing loss should be identified as early in life as possible. In developing countries, the interval between the onset of hearing loss and its identification is still unacceptably long in most cases. There is a lack of trained personnel and testing equipment to facilitate early detection of hearing impairment in children, both in the community as well as in rural health centres. In addition, although parents are often the first to suspect their child's hearing impairment, most of them consider it a low priority and are also at a loss as to where and how to obtain a consultation. As a result, many children with impaired hearing are not diagnosed early enough.

Role of primary health workers in suspecting hearing loss

Trained primary health workers can have a frontline role in suspecting and detecting hearing loss. There is a growing scarcity of nurses and health professionals and, in some areas, primary health workers are the only health professionals whom people have access to. Simple screening methods

exist to detect hearing loss in children of various age groups, which can be performed by health workers in the community when a child is suspected of having a hearing impairment or belongs to a 'high risk' group. As the validity of these tests depends mainly on the skill of the health worker in correctly performing the test and interpreting the child's response, primary health workers will need sufficient training and experience. Children who fail the initial screening should then be sent for further hearing evaluation to an audiologist.

Primary health workers can help communities to understand common ear diseases and hearing loss and can advise them on the signs to look for and when to seek help. Parents, caregivers and health workers must work as a team within the community to detect the signs and signals of hearing impairment, so that affected children can receive timely support and intervention.

Primary health workers can also play a vital role in encouraging people to contribute to the prevention of ear and hearing problems, since fifty per cent of the causes of ear disease and hearing loss could be avoided through measures in the community and at the basic level of health care.

“Trained primary health workers can have a frontline role in suspecting hearing loss”

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About this issue

Early identification of hearing loss in children leads to improved development, communication, educational achievements and employment prospects. It has lifelong benefits even when the hearing-impaired child does not have access to the full range of follow-up services that may be available in high-income countries.

The previous issue of *Community Ear and Hearing Health* detailed the many advantages of newborn hearing screening. However, if systematic hearing screening has not yet been implemented in your country and you have no specialised equipment at your disposal, something can still be done at primary level to suspect hearing loss in young children. The present issue describes simple tests and checks that can be performed by primary level health workers after a short training period. These have been ordered according to the approximate age at which they can be performed (see also Table below).



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Children of all ages can benefit from the detection of hearing loss. MADAGASCAR

These tests require no equipment, but please note they need to be performed in a **quiet** room by a person able to hear the sounds used at all testing levels. Attention should also be paid not to give any other sensory cues to the child being tested, such as visual or olfactory cues.

TABLE 1 SIMPLE WAYS TO CHECK A CHILD'S HEARING

| What primary health workers can do | From what age? | Where in this issue? |
|---|----------------------------|----------------------|
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| Ask parents questions about potential causes of hearing loss | From birth | Pages 3–4 |
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How newborn and infant carers can enable early detection of hearing loss

From birth



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Comprehensive universal newborn screening programmes are often not affordable or accessible in many low- and middle-income countries (LMIC). However, history taking and examination carried out by newborn and infant carers can still enable the early detection and/or suspicion of hearing loss in a sizeable number of cases and can play a crucial role in public health programmes for ear and hearing care in LMIC. This article focuses on those two aspects of the identification of hearing loss.

History taking

History taking requires time in the best of circumstances. In average maternities or neonatal units in LMIC, human resources are already stretched and time is primarily invested in health conditions responsible for a high mortality and morbidity. We should therefore be realistic when designing hearing screening programmes, in order to obtain efficient results without overloading available resources or placing extraordinary pressure and expectations on existing professional capabilities.

Here are suggestions as to what health workers can do to collect information specific to hearing without taking too much time:

A quick assessment: 'high risk' indicators

The Joint Committee on Infant Hearing produced in 2000 a 'High Risk Registry'¹ listing specific indicators often associated with hearing loss in newborn, toddlers and older children (see Box).

Questions should be asked to determine whether any of the indicators listed relate to the child, e.g. 'Did the child have bacterial meningitis at birth?'

What to do: If the baby or child has at least one of the indicators on the list, there is good reason to have his/her hearing tested or even monitored over a period of time.

Although these indicators are the most appropriate, they do not enable us to suspect all cases of hearing loss. Therefore, if health workers have time, they could also ask the extra questions below.

Infant health clinics are an opportunity to detect hearing loss.

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INDICATORS ASSOCIATED WITH A HIGH RISK OF HEARING LOSS*

- Any family history of hereditary permanent childhood hearing loss
- Infant infections contracted during pregnancy (e.g. rubella, syphilis, cytomegalovirus, herpes and toxoplasmosis)
- Head and/or facial deformities seen at birth
- Birth weight less than 1,500 grams
- Bacterial meningitis
- Extreme jaundice (hyperbilirubinemia) at birth, where exchange transfusion would have been indicated (whether performed or not)
- Head fracture or trauma with loss of consciousness
- Recurrent ear infections
- Parental or caregiver concern about the infant or child's hearing
- Speech delayed compared to children of the same age group

*Adapted from the Joint Committee on Infant Hearing's list of high risk indicators¹

Extra questions

1 Questions about specific causes

Very often, parents and relatives will not identify conditions leading to hearing impairment as the possible cause for their child's hearing loss, until directly enquired about them. The following questions can identify potential causes of hearing loss:

- Any birth trauma? Especially if affecting the neck and/or head during delivery process.
- Was the child premature? (Pay special attention if the baby was born before seven full months of pregnancy.)
- Was there hypoxia (low oxygen) at birth? Ask if resuscitation and/or oxygen were necessary.
- Has the child had meningitis, malaria, congenital cytomegalovirus or other infections such as mumps, toxoplasmosis and measles?
- Has the child been given an ototoxic treatment? Many drugs can damage the hearing, such as some antibiotics (gentamicin), cytotoxics (anti-cancer drugs) or anti-tuberculosis drugs (streptomycin). However, in life-threatening conditions, such as foetal suffering due to meconium aspiration, hearing loss may be a lesser consideration.
- Was the child deficient in iodine? Iodine deficiency is endemic in certain regions.
- Has the child been exposed to excessive noise, either social or environmental? Some clinical incubators generate enough noise to induce hearing loss in the babies using them.
- Was the mother using drugs or consuming excessive amounts of alcohol during pregnancy? Specify the type and amount of drug or alcohol used and the duration of the addiction.

Continues overleaf ➤

- Is there a previous history of impacted wax or foreign bodies in the ear canals?
- Has the child had an ear discharge?

What to do: If one of the above causes apply, consider that there is a suspicion of hearing loss until proven otherwise. If in doubt, ask a more senior colleague or refer the infant to the appropriate centre for diagnosis.

2 Questions about specific hearing and speech milestones

Ask parents about the simple development milestones suggested by the World Health Organization:

- Newborn: the infant startles to a loud sound
- Age 0–3 months: the infant is soothed by a moderately loud voice or music
- Age 3–4 months: the infant turns towards the source of a sound
- Age 6–8 months:
 - the infant turns and locates the source of a quiet sound
 - the infant makes his/her first babbling sounds, e.g. 'Dada'
- Age 12 months:
 - the child's babbling increases and his/her first word is heard
 - the child understands one or two simple instructions e.g. 'clap hands'
- Age 18 months: the child says at least six words
- Age 2 years: the child joins words together in twos
- Age 3 years: the child's speech is mainly clear.

What to do: If the above milestones are not met at the appropriate age, consider this a suspicion of hearing loss.

Physical examination

General examination

Some general health conditions and certain diseases which may seem unrelated to the ear and hearing could be the cause of a hearing loss that has not been noticed yet.

- What is your general impression of the patient's condition? Sometimes your first impression may remind you of a similar diagnosis you have experienced in the past.
- Does the child look healthy? Keep in mind the systemic conditions already mentioned under history taking which may affect the child's healthy appearance (meningitis, malaria, cytomegalovirus, mumps, toxoplasmosis, measles, rubella...).
- Is the child growing well? Lack of growth may indicate a possible developmental delay due to ill health (previous or current).
- Check the weight curve of under-fives when available: this is an objective indicator of the health development history in the first years of life.
- Does the child appear to have good hygiene? This will give you an indication of the attention paid by his/her family to general and health care and of other possible risks factors.
- Does the child present generalised glands or sores? These indicate underlying health conditions.
- Is the patient breathing through the nose or through an open mouth? The latter indicates the

possibility of enlarged adenoids/tonsils, which will increase the risk of middle ear diseases, like otitis media with effusion, acute otitis media, etc.

- Does the child make a harsh vibrating sound when breathing (stridor)? This indicates a serious airway obstruction due to infection/inflammation or to congenital malformation. It needs to be treated as an emergency. Once the main problem has been resolved, middle ear conditions should also be investigated.
- Are the child's speech and communication normal? Subtle difficulties with speech and communication may indicate an underlying hearing loss.

Examination of the pinna

- Is the pinna normal? Look for congenital malformations of the pinna and check that the ear canals are both open and of normal and equal size.
- Check for signs of infection, abnormal shape, tumours (growths), fistulas (holes) and scars (from accidents or from surgery). Also look for pus, blood, serous or mucoid secretions, and anything that looks abnormal or out of the ordinary.
- Do not forget to check behind the ear and under the ear lobe, especially for tumours, fistulas and scars.

Examination of the nose, throat and neck

The signs and symptoms listed below may indicate the existence of an obstructive, inflammatory or infectious condition of the upper airways. These may directly involve the middle ear through the Eustachian tube, or may indirectly impair the ventilation of the middle ear cavity, leading to otitis media with effusion, acute otitis media or chronic otitis media. They may affect both the ear and the hearing.

- Is the nose blocked or is the child breathing normally through the nose?
- Is there a nasal discharge?
- Look into the mouth. Are there infections/sores of the tongue and mucosa?
- How are the gums?
- Are the tonsils enlarged, inflamed?
- What is the condition of the teeth?
- Are there adenoids?
- Palpate the areas of the neck: retromandibular, submandibular, submental, pre-jugular and posterior. Are there enlarged glands? (**Note:** multiple enlarged glands, especially submental, are suspicious of HIV).

A number of congenital syndromes affect hearing. Sometimes we may suspect that a person has a congenital syndrome, but we do not recognise it. Identifying syndromes is not easy because they may affect several organs and systems. Final diagnosis should be done by a multidisciplinary team. If you suspect a syndrome, refer the patient.

If there is a suspicion of hearing loss

If there is any abnormality or suspicion of hearing loss, ask for a second opinion from a more experienced colleague. If there is nobody else who can examine the child, then refer him/her to a centre where a final diagnosis can be made.

¹ Joint Committee on Infant Hearing. Pediatrics Oct 2000; 106(4): 798-817.

“Newborn and infant carers can facilitate the early detection of hearing loss in a sizeable number of cases”



Examining the external ear. MADAGASCAR

Informal assessment of behaviour as an indicator of hearing difficulties

From
6
months



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We know that good hearing is important for even very young children to learn language and social skills. Early identification of a child's hearing difficulties leads to early management of his/her hearing loss. This will result in more successful communication at home, at school, and eventually at work.

While there exist advanced behavioural hearing assessments that are objective and require specialised training, this article describes simple and informal observations of a child's behaviour that can be used to assess his/her ability to hear. These can be made at home, in health centres or immunisation clinics, by parents, caregivers, community workers, primary health workers and teachers. Age plays a part in a child's behaviour in listening situations, therefore optimal ages are suggested for each informal test.

In the course of the observations described below, if there is an indication that the infant or child may have any amount of hearing loss, it is important to refer the child to a specialised clinic for further testing.

Similarly, if the child has at least one of the 'high risk' indicators for hearing impairment (see page 3 of this issue), there is good reason to have his/her hearing tested or monitored over a period of time.

Important note: Since a child's attention can vary, it is wise to observe them while in a quiet room and to test again to check the child's responses are consistent (if the responses differ, you can test once more).

12 months of age and older: two quick observations

The following simple observations can take place in just a few minutes and can be made by a parent, caregiver or health worker.

Whispered voice test

This requires the child to be capable of speaking and understanding language.

Stand or sit at arm's length behind the child and, out of view:

- Say the child's name.
- Softly whisper questions that the child would be motivated to respond to (e.g. 'Shall we go to the market?'). Adapt your question to the child's age.
- Alternatively, stand or sit in the same position and ask the child to listen closely and to repeat the few letters or numbers that are being said behind them (e.g. 'A24', or 'J6K').

In both cases, if the child is unaware of anyone speaking or unable to provide the correct response, this would indicate that the child is having difficulty hearing. Further testing should be recommended.

Finger rub test

The parent or health worker stands directly behind the child and rubs a piece of paper between thumb and forefinger within about 2 inches (5 cm) of each ear (and out of view, making sure not to accidentally touch the child's hair), first softly then vigorously. Each ear can be tested separately.

If the child's behaviour does not change nor indicate he/she heard the noise, this means that further testing is required.

Six months to 36 months of age: listening activities

The instructions and listening activities below have been adapted and simplified from Karen Anderson's *Early Listening Function*.¹

The infant or toddler should be awake and alert, but calm, and seated or reclined in a quiet room.

You need two persons for this test (referred to as 'observers'), in addition to the person holding the child. The testers can be relatives of the child or health/community workers. One observer stands behind and performs the listening activities listed below. The other observer stands in front of the child to observe his/her reactions.

The observer standing at the front notes whether the child responds to any of the listening activities, e.g. whether the child:

- startles
- mimics the sound
- turns his/her head in the direction of the sound
- becomes quieter or more active when the sound is heard
- cries.

The second observer performs the listening activities listed below at three distances, beginning with the furthest away:

- 10 feet (3 m)
- 5 feet (1.5 m)
- 6 inches (15.4 cm)

A questionnaire can help collect information on listening difficulties.

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ROSARIO R. RICALDE

Continues overleaf ➤

TABLE 1 LISTENING ACTIVITIES TO ASSESS HEARING DIFFICULTIES*

| | Activities |
|---------------|---|
| Soft sounds | 1 Observer saying 'sh, sh' quietly |
| | 2 Hands together, palms rubbing together briskly |
| | 3 Observer saying 'buh buh buh' quietly |
| Normal sounds | 4 Observer singing a familiar song |
| | 5 Clapping index and middle finger in the palm of the other hand |
| | 6 Observer saying 'ship ship ship' in a normal voice |
| Loud sounds | 7 Observer saying 'shoo-buh, shoo-buh' in a loud voice (as if addressing someone on the other side of the room) |
| | 8 Knocking loudly with knuckles on a flat wood surface, e.g. the top of a stool |
| | 9 Hitting a frying pan or a metal pot with a metal cooking utensil, e.g. spoon (do not do this at 6 inches away if the child responds to any other distances) |

*Adapted from Anderson (2002)¹

The tester should start at the furthest distance, first performing the loud sounds, then the normal sounds, then the soft sounds. He/she should then move on to the middle distance, and then to the near distance, performing all levels of sounds at each distance.

However, if the infant responds to all soft, normal and loud sounds at the furthest distance, there is no need to proceed with the middle or near distances. Infants and children with normal hearing will be able to hear all of the sounds at all of the distances.

Interpreting this test

- 1 If the infant responds to all soft, normal and loud sounds at the furthest distance, the child is assumed to have normal hearing.
- 2 If the infant or child responds to at least two out of three of the **soft** sounds at the far distance and to all levels of sound at near and middle distances,

¹ K Anderson (2002). Early Listening Function (ELF). <http://home.earthlink.net/~karenlanderson/ELF.html>

² K Anderson & J Smaldino (2000). Children's Home Inventory of Listening Difficulties (CHILD). <http://home.earthlink.net/~karenlanderson/child.html>

then no further testing is required. This test should be considered as passed.

- 3 If the child only responds to one or none of the soft sounds at the far distance, and all sounds at the near and middle distances, further testing is required.
- 4 If the child does not respond to one or more of the sounds listed at near or middle distances, refer the child for further testing.

Note: if the infant is under 6 months of age

Many babies younger than six months of age with normal hearing may not respond to soft sounds but will startle to loud sounds.

3–12 years of age: questionnaire on listening difficulties

A parent or caregiver can be asked to fill in a questionnaire about the child's listening difficulties, which requires them to recall the child's behaviour in various listening situations.

The questions in Table 2 have been adapted, abbreviated and simplified from Anderson & Smaldino's *Children's Home Inventory of Listening Difficulties*.²

If the answer is 'No' to two or more of these questions, then the child should be referred for further testing.

Other ways of using this questionnaire:

- Each situation can be tried at home by the parent as a listening activity, with a view to filling in the questionnaire.
- When the child is old enough, he/she can also be asked to evaluate his/her own listening difficulties. For this, you will have to modify the questions slightly. For example, question 3 would become: 'When you are in your room playing quietly and your mother or father walks into the room to tell you something, how difficult is it for you to hear and understand what was said if your mother or father does not get your attention before talking to you?'

TABLE 2 QUESTIONS ON LISTENING DIFFICULTIES**

| DOES THE CHILD USUALLY REACT WHEN: | YES or generally yes | NO or generally no |
|---|----------------------|--------------------|
| 1 While in a quiet place, you sit next to the child and talk in a normal voice (without the child seeing your face) about something in front of you, using familiar words | | |
| 2 The family is gathered together sitting in a circle. While sitting across from the child, you ask some questions about a family topic or event | | |
| 3 The child is in a room playing quietly. You walk into the room and tell or ask the child something (without calling the child or getting his/her attention first) | | |
| 4 The child is playing indoors with another child, and the other child asks him/her to do something | | |
| 5 You call the child's name from another room when he/she is not able to see you | | |
| 6 When it is time for your child to get up, you use your voice to wake him/her <i>without</i> touching or shaking him/her | | |
| 7 While in a large room with the child, you speak to him/her from across the room | | |
| 8 You are travelling in a vehicle with your child in the seat behind you, and you say something or ask a question without turning round | | |
| TOTAL | | |

**Adapted from Anderson & Smaldino (2000)²

The distraction test for checking hearing in a low-resource setting



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Rationale

The distraction test is a hearing test that relies on infants' normal turning response to the source of a sound. During the test, the infant sits on the parent's lap whilst their attention is controlled by a tester in front of them. Sounds are presented behind the infant on each side and the tester evaluates the infant's response.

The test can be used as a screening test by specially trained primary health care workers. Any infant who fails the test needs further testing by an audiology team. If the hearing loss is confirmed, appropriate communication choices (e.g. signing, speech) will need to be made according to local resources and parental choice.

Age range

- The distraction test is best carried out on infants around the developmental age of 7 to 8 months if they can sit without support and turn their head from side to side. It can also be attempted on babies who have reached this stage from the age of 6 months.
- The test can be used up to the age of about 18 months, but it becomes progressively more unreliable with age: the infant learns to inhibit turning in response to sound and becomes more interested in the play in front or becomes uninterested in the situation and makes random turns which can easily be misinterpreted as responses to sound.

Test requirements

A suitable room

- The room should be quiet. The level of background noise should be consistently low during the test (less than 35 dBA). You should not be able to hear any activity from outside the room (e.g. traffic or

voices) or internal sounds (e.g. water flowing in pipes). The test should be paused if there is any temporary noise, but this should not happen often (e.g. there should be no frequent traffic or footsteps). If rain hits the roof or windows, it may be necessary to postpone the test.

- The light in the room may be natural (window) and/or electric, but you need to check that the assistant (see Figure 1) does not cast shadows when standing in the test position behind the infant.
- Similarly, there should be no reflective surfaces in front of or to the side of the infant (including the surface of the table), which might reflect the assistant's body or stimulus. This will cue the infant and cause a false turn.
- There should be no pictures or objects which are attractive to infants and might cause them to look at them during the test.
- The room should contain an adult-size upright chair for the parent/carer and, if available, a low table for play activity.
- The room should be big enough to accommodate the infant, their parent(s) and two testers, in addition to the furniture listed above.

Toys

You will need toys that do not make a lot of noise (e.g. no rattles). Building blocks and items that spin or roll on the table are often good toys to use.

Two testers

You will need two testers with good hearing and able to produce the 'ss' sound:

- The 'distractor' faces the child and is in charge of the test. They are the person who controls the infant's attention.
- The 'assistant' stands behind the parent/carer and makes the test sounds (see Figure 1).

Procedure

1 Introducing the test to the parents

It is important that the parents understand that this is a hearing test for infants which aims to ensure that they can hear a specific range of quiet sounds. Infants need this ability in order to develop clear speech and an understanding of speech. It is not sufficient for a child to appear to respond to sounds in everyday life, therefore all infants should have a hearing test.

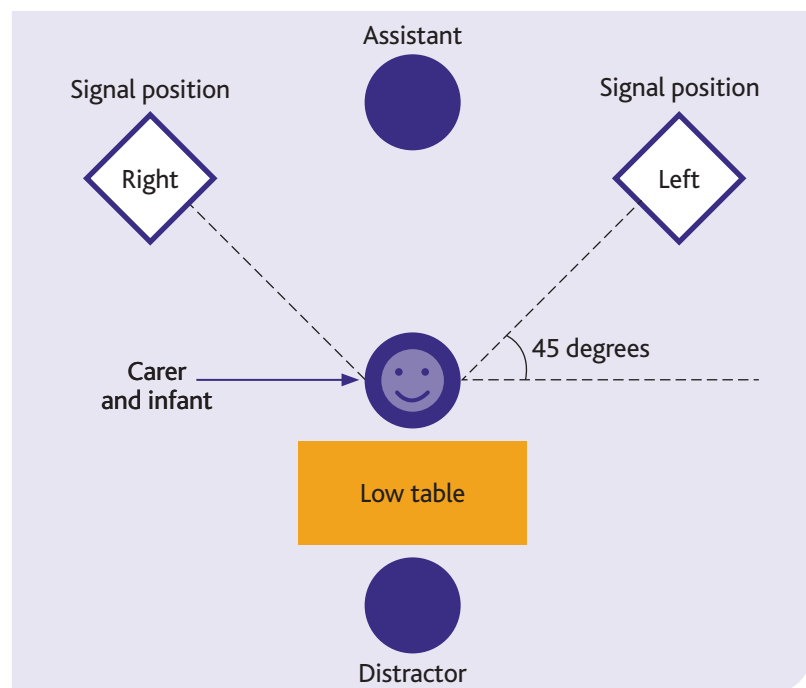
You should then explain that sounds will be presented behind the infant whilst they sit on their parent's lap, to see if they turn. The parent should take care not to give any cues to their child.

2 Checking the child can turn

You should examine the infant to see if they can physically make a head turn sufficient to show a

Continues overleaf >

FIGURE 1 POSITIONING DURING A DISTRACTION TEST



ISMAEL BYARUHANGA



Distraction test: child turning to a voiced signal on the left.
 DEMOCRATIC REPUBLIC OF CONGO

response and if they can be visually distracted. Usually, this can be observed while the test is being explained to the parent, but with some infants it will be necessary for preliminary tests to be carried out, e.g. testing the infant's ability to visually follow a moving object in a 180-degree arc from side to side.

If the infant does not have this ability then you should see them about a month later and observe them again to check whether they are ready for the test. Some infants may need to be referred for testing by an audiologist if they are not making sufficient development for the test.

3 Positioning (Figure 1)

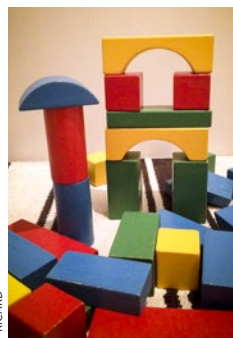
The infant sits halfway along the parent's lap supported at the waist, facing the distractor. The distractor kneels or sits facing the infant. The assistant stands behind the parent at about one meter from the child's ear and moves as little as possible in order to avoid giving any visual or auditory cues to the test stimulus.

4 Engaging and releasing the child's attention

The distractor performs a play activity to hold the infant's attention. They reduce this play activity before the assistant introduces the stimulus, in order to slightly release the infant's attention. This phasing out of the play activity is an important aspect of the test. The infant's attention will not be oriented towards the sound if they are too engrossed in the activity in front of them.

The assistant and stimulus should be ready and waiting for the time at which the distractor phases out the play activity, rather than moving when this moment occurs. The distractor controls the timing of the test, but the assistant's role in responding to these timing cues is crucial to the success of the test.

To engage the infant's attention forward, the distractor uses a simple play activity, such as spinning a toy. This distracting activity can be modified to suit the infant's abilities: for example, if the infant is over 12 months, the distractor can gradually build a tower with toy bricks and leave it in sight, to try to prevent false turns occurring. Visually impaired children can be distracted using tactile (stroking) stimuli.



Choose toys that do not make a lot of noise, such as building blocks

Alternatively, the room lights can be dimmed and a light source, such as a penlight torch, can be used to control the infant's attention.

To phase out the play activity, the distractor commonly covers the toy being used, while continuing to move his/her fingers or the toy in a minimal movement as the assistant presents the sound behind the child. Pauses in distracting should not be so long that they allow the infant's gaze to wander. The distractor should also take care not to distract in a manner which is so interesting that the infant does not turn even though they have heard the sound.

5 Combining test stimuli and no-sound trials

The distraction test is a mixture of specific auditory stimuli and of no-sound trials performed periodically to ensure that the infant's turning response is true.

Presenting the stimulus and recording the response:

The assistant should present the stimuli in the following manner:

- One metre from the child's ear, to enable the sound to be at the ear at minimal levels of intensity (no greater than 35–40 dBA) i.e. just audible by normal hearing persons. This should be at an angle of 45 degrees on either side behind the infant (Figure 1) to avoid visual, auditory or olfactory cues being given by the assistant. The absence of these cues is paramount in ensuring the validity of the test.
- At the same vertical level as the infant's ear, as this makes it easier for the infant to localise the sound.
- For up to 5 seconds at the initial minimal intensity levels and then louder if the child does not respond.

If the distractor deems that the baby responds appropriately, the assistant 'rewards' the baby, e.g. by touching the baby, saying 'hello' or smiling at the baby. The assistant records the baby's response or lack of response to the minimal level of stimulus on the record sheet (see Figure 2 on page 9) while the distractor guides the infant's attention to the front.

No-sound trials (see page 9) should follow the same procedure.

Auditory stimuli:

The aim is to test the hearing of low and high frequencies on each side separately, because the baby needs to hear these frequencies independently at minimal levels to develop speech. Ideally, you should also test mid-frequencies, but this requires equipment such as a mid-frequency chime bar (e.g. 'G' at c1.6 kHz) or a frequency modulated warble tone generator at 1 kHz (see 'Extra equipment' at the end of this article).

If you have no equipment:

- **Low frequencies** can be tested using the human voice. The voiced sound with the purest low frequencies is the 'oo' sound, as in 'shoe'. You can vary the pitch and the rhythm when you make the sound 'oo, oo, oo' over a few seconds, to make it more interesting for the baby. Alternatively, you can also hum a tune. It usually takes persistent practice to ensure that a voiced low frequency sound is made very quietly.

- **High frequencies** can be tested with the unvoiced and rhythmical speech sound 'ss,ss,ss'. The 'ss' should be sibilant (that is, having a whistle-like character, as at the end of the word 'yes') and is best achieved with the tongue high in the palate. This sound is easier to produce if the lips adopt a smiling expression.

For voice and the sibilant 'ss', the assistant will lean to either side (thus moving as little as possible), rather than step to each side. When using sound generators, the assistant can simply use his/her outstretched arm to hold the source at one metre from the infant's ear.

The assistant usually decides which stimuli to use and the side of presentation. They should not alternate sides in a predictable manner, to avoid the baby guessing.

No-sound trials:

In a no-sound trial, all conditions of testing are met, with the assistant and stimulus in situ and the distractor phasing attention, but the assistant does not make any sound. These trials should help the distractor to decide if the infant is turning because they have genuinely heard the stimuli or is turning for some other reason. These trials should be performed periodically during the distraction test to ensure that the infant's responses are true.

Interpreting the child's turning action

It is the distractor's role to assess whether a turn was in response to the stimulus or for other reasons (such as visual cues or other auditory stimuli) or if it was a random check. The distractor should also assess whether or not the infant has correctly localised the sound source.

The distractor should observe the infant's face as this may give clues that they have heard the stimulus prior to localising it. The distractor may, for example, notice a look of recognition such as a widening of the child's eyes or a smile prior to turning. The distractor should take care not to maintain eye contact with the infant as this may fix their attention forward: it is better to concentrate the gaze a little below the eyes. Similarly, the distractor must be careful not to glance towards the stimulus and give cues of its presence and location. In some cases, where the infant is visually impaired, the test may be modified so that a repeatable response of reaching for the stimulus may be accepted.

The distractor tells the assistant whether a turn was a true response at the minimal level of intensity or not. The assistant then records this on the test sheet (see Figure 2).

If the infant displays random 'checking' behaviour, the first thing to do is to make sure that sensory cues have not been given inadvertently. Indeed, **deaf children are particularly prone to turning to check their environment** and are sensitive to inadvertent visual cues. If there are no sensory cues, then you may stop the infant's checking behaviour by using one of the following ploys:

- phasing the infant's attention without presenting a stimulus or giving a reward for turning until the checking ceases

FIGURE 2 DISTRACTION SCREENING TEST OF HEARING: RECORD SHEET

| | | |
|--|---|--|
| Name of infant: | | |
| Name of testers: | | |
| Stimulus at minimal levels of intensity | Right side ✗ : No response ✓ : Positive response | Left side ✗ : No response ✓ : Positive response |
| Low frequency voice | | |
| High frequency sibilant 's' | | |
| Have no-sound trials been carried out? <input type="checkbox"/> Yes <input type="checkbox"/> No | | |
| Result of screening test <input type="checkbox"/> Pass <input type="checkbox"/> Fail | | |

- keeping a toy in view to attract the infant's attention forward, i.e. providing more interesting distraction in front
- distractor and assistant changing places.

In order for the infant to pass the distraction test, they should turn to and localise correctly both low- and high-frequency stimuli at minimal levels on each side, for a minimum of two out of three trials (i.e. a total minimum of eight correct turns). If mid-frequencies are tested, then these too should produce correct turns at minimal levels in order for the infant to pass.

Additional equipment

If possible, some technical equipment can improve the quality of the test:

- **Sound level meter** (measuring down to 30 dBA): this is useful to check background noise levels and to train the testers to produce a low frequency with their voice and a sibilant 'ss' that is no louder than 35–40 dBA. This instrument is usually powered by 9V batteries.
- **G chime** (c1.6 kHz): this is useful for testing mid-frequency hearing.
- **Manchester High Frequency Rattle** (6–8 kHz): this can be used for testing high frequencies, which are most important for hearing speech clearly. This rattle is reliable and has been specially designed for testing hearing.
- **Frequency-modulated warble tone generator**: this allows testing to be done at specific frequencies, usually at 0.5 kHz, 1 kHz and 4 kHz. These instruments are usually powered by 9V or penlight batteries.

Further reading

T Sirimanna, B Olusanya. Early detection of hearing loss: an overview of methods and resources. *Community Ear and Hearing Health* (2014); 11 (15): 4–7.

Performance test of hearing in a low-resource setting

From
2½
years



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In the performance test, the child is conditioned to do something to indicate that they have heard a signal. Primary health care workers can use this test as a screening tool to determine whether a child needs to be tested by an audiology team.

Although the performance test can be also used as a diagnostic test for hearing loss, this is usually in the context of an audiology department and requires far more extensive training. In this article, we will solely focus on using the test as a screening tool at primary level.

Age range

This test can be carried out as soon as a child is able to wait before responding to a signal. This is usually possible by the age of 2½ years and a performance test should therefore be attempted when a child reaches this age. If the child's ability to wait has not yet been established by then, you can attempt a distraction test (see page 7), though it becomes increasingly difficult once children are over the age of one year.

Performance testing can be used up to the age when children can accept the wearing of headphones and be tested by pure tone audiometry, which is usually by the age of 4 years.

The test is valid for older children if a pure tone audiometer is not available.

Limitations

Performance testing does not test the ears separately, but will indicate the hearing level of both ears listening together. Sometimes, it is possible for the test to indicate a marked difference in hearing between the two ears (see below), but not the actual degree of difference.

Test requirements

1 A normal-hearing trained person to make the signals and interpret them

The signals used in the test are the word 'Go' (a low-frequency signal) and 'ss' (a high-frequency sound).

2 A play item for the child to use to indicate that the signal has been heard

If possible a toy requiring repetitive action should be used in the test. The action should be simple (e.g. it should not involve matching different shapes or colours), as this would distract the child's attention from listening to the sound signal.

Examples of suitable toys are rings of equal size to put on a stick or plain wooden cubes to drop into a box. However, objects such as smooth stones could be used to drop into a receptacle, e.g. a cooking pan. There should be several of these objects so that the child is not merely dropping the same stone or cube each time and is not at risk of becoming bored and uncooperative.

3 A quiet room

The room should be quiet throughout the test (background noise should not exceed 35 dBA).

4 Additional requirements

You will need a chair for the parent and, if available, a low chair on which the child can sit alongside or in front of the parent and a low table on which the toy can be rested.

If you do not have a small chair and a low table, the child can be sat on the parent's knee. The toy is then held by the parent.

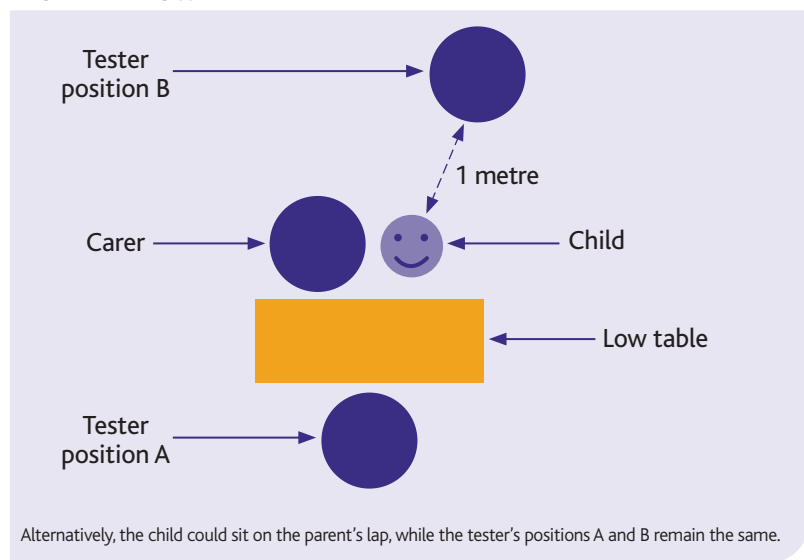
Conditioning the child for the test

Conditioning (or training) the child to carry out the test is done by giving visual clues (or tactile clues if the child is blind). This is in order to check that the child can wait for the sound signal and carry out the action required. It is **not** testing hearing at this stage. The signal 'Go' is used initially to condition the child.

If the child has good sight

- The tester kneels on the floor in front of the child if the child is sitting on a low chair (Figure 1) or sits on a chair if the child is sat on the parent's knee.
- The tester holds the toy, e.g. a wooden cube, close to his/her mouth to draw the child's attention to the visual (conditioning clue). The tester then says 'Go' in a normal voice and puts the cube in a box. This is repeated a few times, varying the interval between the signals, to avoid the child responding as a result of anticipating the signal.
- The child is then given the cube and encouraged to watch the tester's face. When the tester says 'Go', then the child should put the cube in the box.
- Most children will be eager to hold the cube but, if a child is reluctant, then the parent can be asked to hold their hand over the child's hand. The parent needs to be instructed to be careful not to help the child by moving the hand in response to 'Go', but to let the child make the move. After a few trials with the parent, the child will usually respond alone.

FIGURE 1 PERFORMANCE TEST ARRANGEMENT IN WHICH THE CHILD SITS ALONE AT A LOW TABLE



- Alternatively, the parent can 'play the game' themselves at first, by waiting and dropping the cube for a few trials in order to give the child confidence. The child is still encouraged to watch the tester's face.
- Once the child responds reliably alone, the screening test can start.

If the child is blind

If the child will allow the tester to hold their hand, then conditioning is performed by both tester and child carrying out the action together. If not, then the tester can kneel at the child's side and say 'Go' close to the ear, allowing breath on the outer ear to provide a tactile clue. Again, the parent can be used at first to give the child confidence: the parent responds to the sound, holding the child's hand, and at the same time the child is able to feel the tactile (breath) signal.

The screening test

Once the tester is satisfied that the child has been conditioned, the screening test can proceed. Moving from Position A (see Figure 1), the tester goes behind the child to about a metre away and slightly to the side, bending or kneeling so that the tester's mouth is at the level of the ear vertically (Position B). It is necessary to go behind the child as, when testing hearing, it is important to avoid the visual clues which may be given if staying in front and covering the mouth with a hand.

This performance test is a 'pass/fail' test and tests whether or not the child can hear the sound signal at very quiet sound levels (this is equivalent to 35–40 dBA, as measured on a sound level meter).

Using the sound 'Go'

Having made sure that the child is ready and waiting and looking forward, the tester says 'Go' softly. After the child has waited a few more seconds and responded, the tester repeats 'Go' for a second time.

Some testers will then go to the other side of the child and one metre behind as before and test with 'Go' twice again. The reason this is done is to check the original responses, but also to see if it indicates a difference between the two sides.

A 'pass' is given if the child responds correctly to 'Go' twice out of three trials at this very quiet sound level.

Using the sound 'ss'

The conditioning and screening test described for 'Go' is repeated with 'ss'. A 'pass' is two correct responses out of three trials, with the tester standing a metre away from the child.

If some equipment is available

If a handheld instrument which produces warble tones is available, then this can be used to supplement the 'Go' and 'ss' tests by checking the middle frequencies at 1 kHz. Alternatively, the warbler can be used for the whole test, using warble tones at 0.5, 1 and 4 kHz.

A child who can be tested easily using the performance test is ready for pure tone audiometry if an audiometer is available.



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Acting on test results

To pass the test, the child should respond correctly twice (out of three trials) to each sound ('Go' and 'ss') at minimal level.

To avoid referral for what might turn out to be a temporary condition (e.g. a cold), a child who has not passed the test can be re-tested after one month.

A child found to fail a second time should be referred to an ENT doctor or audiologist as soon as possible after the test, so that the hearing loss can be measured and the appropriate help given.

Performance test: child waiting for a sibilant 'ss' signal on the left.

DEMOCRATIC REPUBLIC OF CONGO

UNILATERAL HEARING LOSS

A child has unilateral hearing loss when one ear has normal hearing and there is a hearing loss in the other.

If the hearing loss is very slight, this would not be expected to cause the child much difficulty. If the hearing loss is moderate or more in degree, there is a significant difference between the two ears. This will cause problems for the child, such as:

- difficulty locating the source of a sound
- difficulty listening in an environment where there is a noise source on the side of the better ear, even though hearing may be good in quiet environments
- educational difficulties
- difficulty crossing roads safely.

A unilateral hearing loss may be suspected in the distraction test or performance screening test if the child:

- has difficulty locating the sound source during the distraction test
- shows normal results on one side only during the performance test.

The following behavioural test can be used as a further verification with infants and young children: make a loud noise (e.g. bang a drum) behind and on one side and see the child's reaction. If the child does not know which way to turn or turns to the wrong side, they may have unilateral hearing loss.

What can help children with unilateral hearing loss:

- making the teacher aware of the child's difficulty and sitting the child at the front of the class
- sitting the child with their good ear toward the speaker in social situations.

Suspecting hearing loss in early childhood

FROM BIRTH TO 3 MONTHS

- Recognise and quieten to a parent's voice?
- Startle to loud sounds?
- Gurgle and make soft sounds (cooing)?



BETWEEN 3 AND 6 MONTHS OF AGE

- Awaken to loud sounds or speech?
- Turn towards interesting sounds?
- Make a variety of sounds?

DOES YOUR BABY:

BETWEEN 6 AND 12 MONTHS OF AGE

- Understand his/her first words, such as: 'Stop it', 'Go', 'Come'?
- Respond to his/her name?
- Enjoy sounds from rattles and similar toys?
- Coo to music and imitate speech?

If the answer is 'No' to any of these questions, then your baby may have a hearing loss and should be seen by an ear doctor

An early diagnosis will help a child reach his/her potential

BETWEEN 12 AND 18 MONTHS OF AGE

- Use between one and six single words (e.g. 'milk' or 'more')?
- Understand one or two simple instructions, e.g. 'clap hands'?



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