A Special Type of Hearing Aid

Science content

Working of the human ear, defects of hearing, (analogue and digital signals).

Science curriculum links
AT12 IT including microelectronics
AT14 Sound and music

Syllabus links

- GCSE Science, Biology, Physics

Cross-curricular themes

- Health Education

Lesson time
1½ hours

Links with other SATIS materials
407 Noise
903 What are the Sounds of Music?

NERIS
Search on
DEAFNESS
and UPPER SECONDARY

SUMMARY

The unit invites students to explore some of the problems associated with deafness and describes the functioning of the ear and a cochlear implant.

STUDENT ACTIVITIES

- ☐ Activity A: students simulate deafness and ask each other for objects.
- ☐ The story of Alison: reading material about deafness and the functioning of both the ear and a cochlear implant with associated questions Q1 to Q8.
- ☐ Activity B: short role-plays.
- ☐ Activity C: information and questions for discussion or writing on deafness induced by loud noise.

AIMS

- ☐ To complement work on the ear and hearing
- ☐ To illustrate an application of electronics in medicine
- ☐ To develop awareness of the problems associated with deafness
- ☐ To provide opportunities for role-play and discussion

USING AND ADAPTING THE UNIT

- ☐ This unit links with work on the ear.
- ☐ The unit may be adapted for a range of abilities by selecting appropriate activities. Teachers may wish to omit page 5 with younger or less able students.

First published 1991

Teaching notes

In January 1990, the National Health Service was given £3 million for a hearing implant programme to help the deaf. There are an estimated 5000 people in the UK who would benefit.

Multi-channel implants using several electrodes are available in Australia and the US where 5000 people have had the operation.

Alison Heath, who has campaigned for the availability of cochlear implants says, 'Currently implants are available to adults who have some memory of hearing. It would be wrong to raise any hopes of implants helping children at present. The operation would have to be performed very early in life – at the age of three – if they are to benefit from it and acquire language and speech more normally.'

'People who become deaf suffer tremendously as they adjust to the loss of many things they took for granted. The born deaf child has other problems and parents are traumatically affected as the full implications of the handicap become apparent. Deafness in a child is an enormous educational handicap and the acquisition of language is slow and difficult. Many people born profoundly deaf never acquire a good command of English and need to use a sign language to communicate effectively.'

Answers to questions

Q1 *OUTER EAR*
EAR DRUM
EAR BONES
COCHLEA
AUDITORY NERVE
BRAIN

Q2 *Hearing aids amplify the sound and help where there are conduction losses in the middle ear. Alison had inner ear deafness – no signal from the cochlea. No amount of amplification would help.*

Q3 *MICROPHONE*
PROCESSOR
TRANSMITTER
RECEIVER
ELECTRODE

Q4 *So that the wearer may disconnect the microphone/processor box.*

Q5 *Personal answers – no doubt dealing with the emotional stresses of a total change of life style.*

Q6 *Use telephone message system such as BT Telecom Gold with a personal computer and modem, teletext for subtitled TV programmes, etc.*

Q7 *The brain would not have learned how to interpret the signal.*

Q8 *Graph A – digital, graph B – analogue.*

Activity B

This activity need not take long especially if students work in groups of four or five and a strict time limit is put on each scene – say, four minutes. Preparation could be a form period or homework activity.

Suggestions for organising mini role-plays are given in UPDATE 91.

Some scenarios are

- Danger – on the roads
- Missing out – conversation, watching TV, listening to music
- Job – being interviewed, answering the telephone.

Activity C

C1 Especially f, j, p, t.

C2 Damage to hearing depends both on the intensity of sound and on the length of time during which a person is exposed to high levels. Personal stereos put all their sound energy directly into the ear and so the intensity (energy / m^2) is high. They tend to be used for long periods of time and hence the risk is increased.

C3 People who listen to personal stereos, loud pop music, workers in certain industries where there are high levels of sound (e.g. using a pneumatic drill, bottling plants, metal stamping, or where the acoustics of the building lead to high levels etc.) Workers are advised to wear ear protectors and have a limited period of exposure.

Acknowledgements

The activities were developed by Sylvia Camberlain.

This unit is based on an article, *Electrode helps deaf mum to hear*, by Bob Perrin in the *Bucks Free Press* on 26 May 1989.

Figures 1 and 4 are reproduced by permission of the Bucks Free Press Group.

Figure 3 is based on an illustration supplied by the RNID.

A Special Type of Hearing Aid

Total silence

Sit still for a moment and listen. Try to imagine total silence. Think how you would cope if you were deaf.

Nearly one person in five has some loss of hearing. About one in twenty is deaf, that is two and a half million people in Britain. Some people are born deaf while others may lose their hearing through accident or disease.

This unit is about a type of deafness of the inner ear and the functioning of a cochlear implant. The activities for groups of students include:
- a lip-reading activity
- a short role-play, simulating some problems encountered by deaf people
- discussion
- questions based on information in the text.

Activity A

- ☐ Provide yourselves with a collection of at least 20 objects (or the cards provided with this unit). There can be duplicates.
- ☐ Work in a group of 4 or 5. Do this activity in total silence.
- ☐ One person should start by mouthing the name of one object. The person who recognizes it may remove the object.
- ☐ That person mouthes the name of another object.
- ☐ See who collects the biggest pile.

The story of Alison Heath

What is life like for someone who cannot hear the door bell, traffic, music and voices?

Alison Heath was eight years-old when she fell ill with meningitis. Her illness left her unable to hear with her right ear. Two years later she lost the hearing in the left ear too.

At the age of ten, Alison's world became totally silent. She was classed as profoundly deaf. Alison had to go to a school for deaf children. Her whole life was transformed.

Although she learned to lip-read, being deaf brought problems that it is hard for people with hearing to imagine.

'It isn't bad lip-reading one-to-one, but it's not very good when you're in a group. When you're totally deaf, you're not sure who, if anyone, is talking.'

But in spite of deafness, she grew up to lead a 'normal' life. She went to university and studied modern history. She married and had children. When they grew up she took a job in London.

Figure 1 Mrs Heath with the sound processor that sends signals to the electrode in her inner ear

How does a deaf mother cope with children? 'When they were very young', she recalls, 'I kept them in the room with me, wherever I was in the house. At night, of course, my husband had to get up when they cried, because I couldn't hear. When they got older, they'd run off to other parts of the house, if they fell over and hurt themselves, I wouldn't know anything about it till they came to me, tugged my skirt, demanding comfort.'

Activity B

Work in groups.

Make up and act a scene in which a deaf person is:

- in more danger than a hearing person,
- 'missing out' on an enjoyable activity,
- applying for a job.

How does the ear work?

The ear consists of the outer ear, the middle ear and the inner ear. The **outer ear** merely collects sound waves and funnels them along the ear canal. This is where the sound waves hit a piece of skin called the **eardrum** and make it vibrate. The **middle ear** contains a lever system of three little bones, called the hammer, anvil and stirrup. They are connected together in a way that amplifies the signal to the **inner ear**. The **cochlea** of the inner ear is shaped like a snail shell and is filled with a watery fluid.

When sound makes the eardrum vibrate, the vibrations pass through the three little bones across the air-filled middle ear.

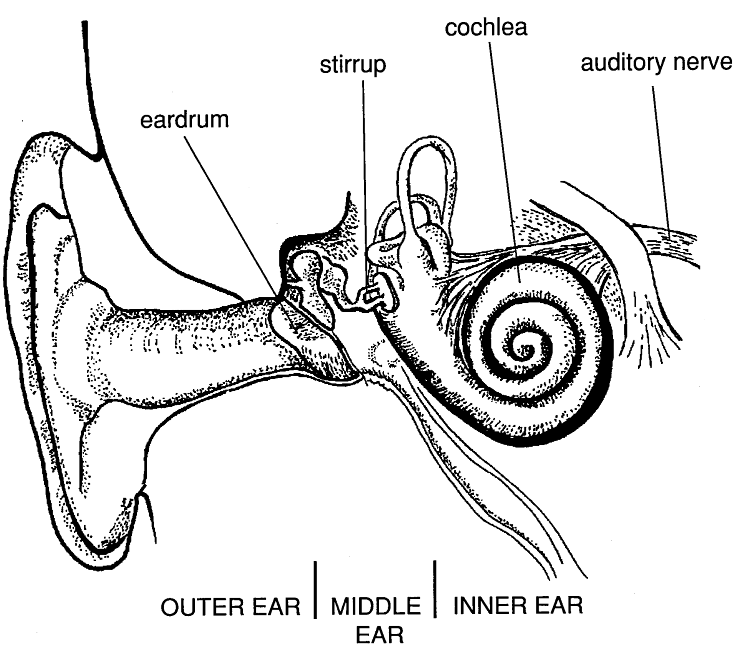


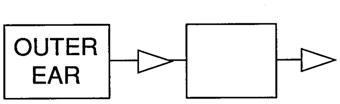
Figure 2 The main parts of the ear

The bone called the **stirrup** presses against the cochlea and pumps the fluid inside it to and fro across little hair-like nerve cells making the hairs move. The nerve cells turn these movements into **electrical signals** and pass them along the **auditory nerve** to the **brain**. The brain decodes the electrical signals and interprets them as sound.

Q1 *These are parts of the hearing system:*

AUDITORY NERVE
EAR BONES
BRAIN
COCHLEA
EAR DRUM
OUTER EAR

Link them together in a flow chart to show how a sound signal passes to the brain. The flow chart has been started for you.



Alison's operation

Deafness is usually due to damage to the middle or inner parts of the ear. Many people suffer from **conduction deafness**. They lose their sensitivity to sound. They can be helped by wearing a hearing aid which makes the sound louder. Hearing aids cannot help people with total **sensori-neural** deafness which is due to damage in the inner ear.

In Alison's case, vibrations from sounds were reaching as far as the inner ear and the auditory nerves to her brain had survived her illness. However, the hair cells in the cochlea were not sending any signals to the auditory nerve.

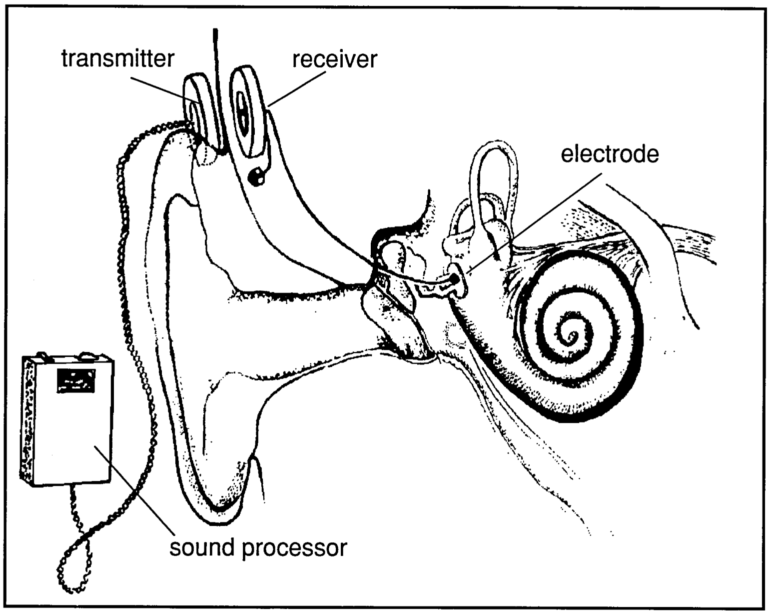


Figure 3 How the sound signal reaches the cochlear implant

In the mid-1980s Alison Heath was one of the first people to have her hearing partly restored by a new operation. Doctors put an electrode on the cochlea in her inner ear. It was to bypass the cochlea and send a tiny current along the auditory nerve to her brain. The electrode was connected to a receiver coil that doctors implanted just under the skin behind her ear.

How would this tiny current be produced? She wears around her neck a box the size of a personal stereo, containing a microphone, a processor and a battery. The microphone turns the sounds it picks up into an electrical signal. The signal is processed and passed to a transmitter worn behind the ear. It is picked up by the receiver coil under the skin. The signal passes then along a wire to the electrode on the cochlea.

Q2 Explain why Alison could not use an ordinary hearing aid, worn in the outer ear, for her kind of deafness.

Q3 Here are the parts of a cochlear implant hearing system:

ELECTRODE,
MICROPHONE,
PROCESSOR,
RECEIVER,
TRANSMITTER.

Make another flow chart to show how the sound signal reaches the brain.

Q4 Suggest why the electrode is connected with the microphone via a transmitter and receiver.

Cochlear implants, as they are called, are successful for some people but others get less benefit. Would the artificial signal give her a sensation of hearing? After 30 years of silence, there was an anxious four week wait before 'switch on'.

'At first', she said, 'my noise tolerance was very low, I couldn't stand the sound of London traffic and would switch off when travelling in a car or on a train. I'll never forget the first time I met a police car on an emergency call!'

'It took me time to identify background noises. They didn't sound as I remembered them. Animal voices, the chinking of china and footsteps on the stairs were among the first sounds I learned to recognise. After a few weeks, I could recognise pitch changes when my husband played the piano.'

Q5 If you were to lose your hearing, what do you think you would find most distressing?

Q6 What aids could deaf people use to make life easier
(a) at home,
(b) at work,
(c) at leisure?

It has taken her five years to make full use of the cochlear implant. She can now recognise speech in a quiet room without lip-reading. Listening to the radio or talking on the telephone is impossible. Television still needs sub-titling.

Figure 4 Mrs Heath uses the computer that tunes her into the telephone service

More about cochlear implants

Cochlear implants cannot give normal hearing. Alison's implant used just one electrode on the outside of the cochlea. How it works for deaf people is not fully understood. Of course a lot depends on whether the nerve fibres in the auditory nerve (there are about 30 000) still work, but also on whether the brain can interpret the electrical impulses.

People who might benefit from a cochlear implant are those who have some memory of sound and hearing. That means they must be people who were born with hearing but became deaf after they had learned to talk. Without this memory they would be unlikely to make sense of the signals from the implant.

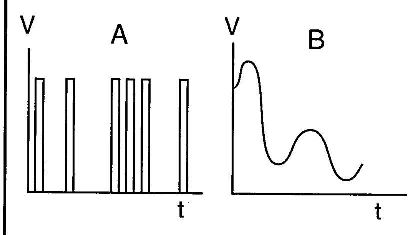
As the technology improves, it is hoped that some born deaf children will be able to have implants, learning through regular use of the implant to make sense of the sounds they hear.

The operation takes between two and four hours. It needs sound engineers to test the hearing threshold of each patient and electronic experts to program the system to the patients' individual needs. The greatest benefit is for patients to be able to hear their own voices so they can control how loudly they speak. After many years of deafness, patients forget how to do this and need intensive speech therapy.

There are more complex implants that enable patients to distinguish between high-pitched and low-pitched sounds. One Australian digital implant has 22 electrodes and some totally deaf people can even use the telephone with it. On the other hand, the Americans are getting similar results with a simple four electrode analogue implant. So the designers of the very complicated Australian implant have not solved the mystery.

Q7 People who are born deaf are unlikely to benefit from a cochlear implant. Explain why.

Q8 Which graph of voltage (V) against time (t) could be
(a) a digital signal,
(b) an analogue signal?



Activity C

For discussion or writing

Loud noise can damage tiny hair-like nerve cells in the cochlea. Deafness caused by loud noise often starts with a loss of hearing of high-pitched sounds. These sounds enable you to understand speech, especially conversations over the telephone.

C1 People who lose their hearing in this way cannot distinguish the sounds of consonants like 's', which have a lot of high pitch sounds in them.

Try out the *sounds* of the consonants in the alphabet. Which other letters would be difficult to hear?

C2 Personal stereos do not produce loud sounds, but can cause this sort of deafness. Explain how this might happen.

C3 Which groups of people might be in danger of damaging their hearing from loud sound? What could be done to prevent this happening?

SATIS No. 407 Noise*, describes examples of the deafening effects of loud noise.*

Answers to questions are in the *Teachers' Notes.*

elephant	brother
tennis ball	supermarket
apple tree	horse
banana	dog
washing machine	car

Buckingham Palace	**computer**
fish	**loaf of bread**
bicycle	**sister**
carpet	**telephone**
baby	**laboratory**