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## **Infantile deafness and audiometric techniques of deafness diagnosis**

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The diagnosis of infant deafness is very crucial. It must be carried by specialized doctors and technicians. If you want to make a good diagnosis, you have to use both subjective and objective audiometry test. Children, especially when very young, are not able to cooperate in the performance of the tests; therefore it's essential to check the results with subjective and objective audiometry and, eventually, to repeat the same tests later.

### **Infant Audiometry**

subjective technique

Looking for auditory threshold level in children with age between 3 month and 3 year is very difficult, because it's not possible to obtain voluntary responses, due to their young age. To overcome this difficulty, some tests are performed, based on unconditional reactions to sounds or reactions obtained after a specific conditioning.

It's very important that the environment, where you do the audiometric tests, is particularly comfortable, without the hospital settings eg. white clothes because it's always scares children.

The atmosphere must be relaxed and in the room you need toys and nice pictures so that the audiometric test is experienced as a game. Before doing the test, the child must not undergo any medical examination, so that the avoid the fearing, as you need a lot of cooperation to do the test. As the method is very delicate, the technician has to be very patient and sensible to catch every minimum reaction of the child to the sonorous stimulation, and he must to be able to adapt the test to the general maturation level of the child. He has also to consider that children have an auditory maturation, that means they have better results in tests as they grow up.

Before choosing the method to be used it's important to talk to the parents and observe the child's behaviour.

According to the response to sonorous stimulation, it's possible to distinguish:

- audiometry based on spontaneous reactions - called behavioural audiometry; used from the first day of the child's life to 12 months
- audiometry based on unconditioned orientation reflex - used between 6 and 12 month
- audiometry based on conditioned orientation reflex - used between 1 and 3 years (suzuky's theatre - play)
- audiometry with toys - play audiometry; for children between 3 and 5 years (conditioned instrumental reflexes)
- tonal audiometry without conditioning - for children between 4 and 5 years. This is the usual audiometry: the stimulus is the pure tone. This test is based on subjective responses given by the child who lifts up his hand. With kids of this age, you can do the test with earphones, so you can evaluate the function of both ears separately, by air and bone conduction.

Please consider that the age limits are given only as an indication: the technician can choose one of the different kind of audiometry tests, not only based on the chronological age, but also on the mental age of the child.

Audiometry based on spontaneous behavioural reactions (0 – 12 months)

During the first week of life it's possible to study the reactions provoked by the presentation of a sound with suitable intensity, that causes changes in the baby's behaviour. For this test, we use acoustic stimuli coming from instruments calibrated in intensity and frequency (white noise, narrow band noise, sound from musical instruments or sonorous toys).

The most common reactions are the following:

- auropalpebra reflex (eyeblink)
- startle reflex (a small jump of the infant's body)
- wrinkling of the forehead
- awakening/crying
- stop/increase of the sucking
- changes in breathing rhythm

Audiometry based on unconditioned orientation reflex (6 – 12 months)

At the age of 6-9 month, the child nervous maturation allows to obtain clear responses to the orientation reflex at sound. The orientation to sound matures at about 6 months of age. It's a very clear and manifest response: for this reason it also used during the diagnosis.

The instruments of the AMBO test, that it used for this examination, is shown in fig.1-2. The choice of these instruments is based on the following parameters:

- the reaction power - that is the ability of the sound to excite the child's emotional sphere
- the frequency spectrum - the signal should be able to cover selectively and totally the word frequency range with different intensity level
- the produced intensity - based on distance and strength with which you use the instrument. The data reported in the table, represent the average value of the intensity at a regular distance from the patient's ear
- the ease of use - to allow a quick and practical use

INSTRUMENTAL ANALYSIS				without haid		with haid	
Instrument	KHz	dB	distance	response		response	
				orient	others	orient	others
Little bell	1-4	45-50	20-30cm	.....	.....	.....	.....
Rub paper	1-4	60-65	"	.....	.....	.....	.....
Chick	2-3	65	"	.....	.....	.....	.....
Cow	0.7-1.5	65	"	.....	.....	.....	.....
Clown	0.5-4.5	75	"	.....	.....	.....	.....
Triangle	1.5-2.5	80	50cm	.....	.....	.....	.....
Castanet	2.4	80	30cm	.....	.....	.....	.....
Jingle bell	4	80	30cm	.....	.....	.....	.....
Small-hammer	3.2	90	50cm	.....	.....	.....	.....
Grater	0.7-4	90	50cm	.....	.....	.....	.....
Bird	2.5	100	30cm	.....	.....	.....	.....
Bell	1.1	100-105	50cm	.....	.....	.....	.....
Cow-bell	0.7	100-105	50cm	.....	.....	.....	.....
drum	0.5	100-105	80cm	.....	.....	.....	.....
vocal test	voice	50	100cm	.....	.....	.....	.....
	voice	50-70	100cm	.....	.....	.....	.....
	voice	>70	100cm	.....	.....	.....	.....

Fig.1 AMBO test report

The technicians, using this method, has to follow the instructions given for each instrument; It's important to note that instruments and sonorous toys physically similar to those we have selected, can have very different frequencies, so the test results might not be precise and correct.

### How to perform the test

The AMBO test usually has priority over other exams (eg. otoscopic examination), because it's carried out in a reassuring situation for that child, who doesn't see specific medical devices (for example white smock) and it's performed as a game.

There are factors which can affect the results of the test.

1. stage of approach – it's essential to have a quick careful observation of how the child relates with the environment, verbal communication etc.
2. production of the sound – the child can stay in mother's arm or sit on a little chair or on the floor. The audiologist stands in front of him, smiles to him, gives him a toy; in such a way that he can create a relationship that allows him to start the test. While the child is distracted (but not too much) by the toy, the technician, without being seen by the child produces the sound close to the child's ear. It should not be too close. If the child doesn't perceive the sound, you will not see any reaction. On the contrary, if the child hears, he will turn his head, towards the sound. The same stimulus will then be presented on the opposite side. It would be better if another technician sounds the sonorous toys, always out of the child's vision field. The sonorous stimuli have to be presented in right succession, so that each of them arrives by surprise. You have to go on with an increasing intensity and with a decreasing frequency, in fact if there is a neurological deficit it's more manifest in the high frequencies.
3. recording of the responses by the examiner, who will stay in front of the child.



Fig.2 AMBO instruments

It's important to remember that the behavioural test done with sonorous instruments has a real value only if related and compared with other diagnostic tests. The test is done in open field so the response will be for the one the better ear.

This test allows to plot on an audiogram the chart with a band concerning all the frequencies, and representing the child's threshold level estimated with the AMBO test.

### Audiometry based on conditioned orientation reflex

The device used to do the audiometry with conditioned orientation reflex is called Suzuki's and Ogiba's theatre. The name was given by the two researchers who invented it in 1959 (Fig. 3). The conditioning is created with a double stimulation; sound and light.



Fig.3 Suzuki's theatre

This method is based on giving a prize to the child turning towards the sound source. The "little theatre" consists of two pieces of furniture arranged at 45° degrees to each other. The sonorous stimulus is produced by two loudspeakers, one at the left and one at the right of the child on his mother knee. To begin you have to produce a low sound with high intensity, so you can be sure the child will hear it. This is followed immediately by a light coming from the same side. As the sound precedes the light, you can have in short time for a good conditioning. As soon as the child perceives the sound, he turns his eyes towards the side the sound before he can see his prize (the light). Obviously during the test it's important to alternate, in a non repetitive way, the side from which the sound is coming in order not to create a conditioning. By reducing the intensity you can determine a reliable auditory threshold.

#### Audiometry with toys (play audiometry) (3-5 years)

The method of play audiometry is based on sound conditioning. The child has to push a button as soon as he can hear a sound. This button activates a mechanical toy which is connected to the device for audiometry. The mechanism can be activated only when the child hears a sound. After some attempts, you can have a good conditioning. Everything is easier with the help of the toys. The sound is presented by loudspeakers in open field, but with fearless children, you can use the earphones. You can examine the threshold for both the ears separately. Nowadays this test we can be done by an automatic method that allows to collect data and then analysis the results.

The audiometric behavioural test not only presents an important technique for the diagnosis, but also a very good method to check the benefit of hearing aids during the time.

## Infant audiometry: objective techniques

### Auditory Evoked Responses (ERA)

This test allows us to evaluate the auditory threshold in patients who are not cooperative. It's a very good method in diagnosis of infant deafness . The nervous brain system has an electric activity that we can record by an instrument. We can evaluate a specific response, in this case a response given by a auditory stimulus.

It's possible to record the electrical activity with electrodes placed on the skin. The performance of this test is absolutely painless and with no risks to the patient. By using this technique we can record different kinds of evoked responses , namely

- electrical activity of the auditory nerve (E.C.G)
- electrical activity of the brainstem (ABR)
- electrical activity of cerebral cortex (SVR)

the commonly used test in audiologic field is the ABR, because it gives precise responses which are not influenced by external factors e g drugs, used as sedative don't cause altered responses.

### Otoacoustic emission (OAE)

The OAE are very low intensity sound given out by the cochlea, especially by the external cells. They can be produced spontaneously (SOAE) or due to a sonorous stimulus (TOAE) or distortion products (DPOAE). They are recorded by a small microphone inserted in the external auditory duct. The DPOAE is especially used during the diagnosis. The limit and characteristic of this procedure is that it is able to test only the acoustic periphery ear, especially the functioning of the internal ear.