Cortical Evoked Response Audiometry

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Standard audiometry requires the patient to co-operate and to respond to an auditory stimulus. Thus reliance is placed on the patient's own judgment. There are a few clinical situations where the patient's co-operation cannot be gained or his judgment relied upon. Thus methods of audiometric testing have been derived which rely on observer judgment only. One of these objective methods of audiometry which is being investigated is Evoked Cortical Response Audiometry.

This method is based on observing changes in the averaged electroencephalograph activity (E.E.G.) in response to a sound stimulus. Small disc electrodes are used to record cortical potential differences between the vertex and the mastoid process. Recordings are taken during a succession of short tone bursts and averaged by a computer. The final result is displayed on an oscilloscope screen, and recorded.

Computer averaging is required because the voltages produced in response to a tone burst are frequently not great enough to be seen among the other E.E.G. activity. When the successive E.E.G. recordings are averaged, the small time-locked potentials produced by the tone become larger while the background E.E.G. activity becomes smaller.

This is illustrated in Figures 1 and 2. Figure 1 shows the voltage recorded following the presentation of a single tone and there is no response time-locked to the acoustic stimulus. On the other hand when the E.E.G. activity is averaged following the presentation of a number of stimulus presentations (Fig. 2), an auditory evoked response develops. It should also be noted that the evoked response only occurs at the onset or offset of the tone and there is no response to a steady tone.

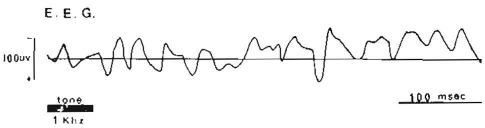

FIGURE 1

An EEG tracing of 500 m secs. in duration following the presentation of a 50 m sec. tone of 1000 Hz at 60 db.

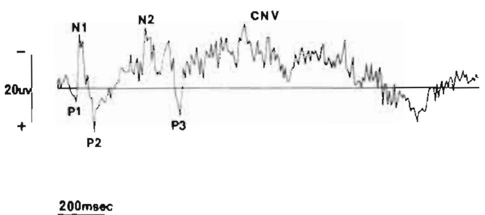

FIGURE 2

A typical evoked cortical response to sound. An average of 60 successive EEG tracings following the presentation of a 50 m sec. tone of 1000 Hz at 60 db.

An evoked response may have P_1, N_1, P_2, N_2 and P_3 waves. P_1 is the first positive wave, it occurs at 40-60 m sec. following the onset of the tone. It is a small sharp wave which is not always present. N_1 is the first negative wave, it occurs between 80-120 m sec., is a large well-defined wave and in an adult, along with the P_2 wave it forms the most prominent part of the response. P_2 occurs at 150-200 m sec. N_2 occurs at 200-300 m sec., it is usually lower and longer than N_1. P_3 occurs at 300-400 m sec. after the onset of the tone. (Beagley, 1970.)

An evoked response audiogram is performed by progressively decreasing the intensity of the tone. As the intensity decreases the size of the response becomes smaller, while the latency of the waves becomes longer. Finally a point is reached when the response cannot be detected from the background activity. The intensity of a tone which just gives a detectable evoked response is said to be the threshold for that tone.

In adults the threshold for a tone when performed by an evoked response audiogram is usually within 10 db of the subjective threshold levels for that tone (Beagley, 1972). As it is fairly reliable if passive co-operation is gained, it can be used on people with non-organic hearing losses (McCandless, 1968), or those who are confused or lack comprehension.

Most hope for the future of evoked response audiometry is held in the testing of young children. Using this method most children have thresholds which are about 20 db above their subjective levels. In infants this level increases to 40 db (Beagley, 1972).

There are a number of factors which make the testing of children difficult. There are frequently errors in observer judgment. It requires experience in performing and reading evoked responses in children. This is because the response is more variable in both size and latency than in adults. The early well-defined components (N_1, P_2) are frequently small, while the more diffuse late waves (N_2, P_3) are the major components of the response (Beagley, 1970). It was also found that as the intensities were decreased the pattern of the response changed due to the fact that the latencies became longer (Pugh, 1964) and this added to the difficulty of observer judgment, especially close to threshold.

Passive co-operation was not easily gained in children. Muscular movements, crying or even sitting tensely in the chair produced background potential activity which was difficult if not impossible to average out. This problem can be overcome in several ways. The surroundings of the sound-attenuated room can be made congenial by using toys and having pictures on the walls, an understanding assistant should accompany the child into the room, the sight of electronic equipment should be avoided as much as possible and the computer can be programmed to reject E.E.G. tracings which contain excessive muscular activity. This was not completely satisfactory, however, as continual movement of the child will produce continual rejection, thus adding more time to an already lengthy procedure.

In many children co-operation cannot be gained at all. This occurred particularly in those children most in need of the test, e.g. the mentally retarded, the hyperactive or the psychologically disturbed. Evoked response audiometry can still be done in these children by sedating them prior to testing. During sleep the evoked response, even though the size and latencies change still gives a fairly reliable threshold of hearing. The drugs found to be of most value are oral or intramuscular phenergan or largactil (Beagley, 1972). General anaesthetics or barbiturates on the other hand are unsatisfactory as they grossly suppress the cortical response. More work is required before the effects of sedation on the evoked response audiogram are fully assessed.

It would be unwise to consider that evoked response audiometry has all the answers in the audiological assessment of children as there are still many problems to overcome. It would appear, however, to be of great value and with further research could become the method of choice in the very young.

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