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CRITICAL EVALUATION OF METHODS OF TESTING AND MEASUREMENT OF NONORGANIC HEARING IMPAIRMENT

Report of Working Group 36

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Preface

The report is intended as a review of test procedures rather than a procedure manual. Before applying tests specifically designed for detection of nonorganic hearing loss, appropriate instruction manuals should be consulted.

The report was prepared on the basis of and, hopefully, without changing the substance of individual contributions by the members of the Working Group. The editor contributed only a small share. He does not consider himself an expert on nonorganic hearing loss.

Jozef J. Zwislocki
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September 5, 1963

CRITICAL EVALUATION OF METHODS OF TESTING AND MEASUREMENT OF NONORGANIC HEARING IMPAIRMENT

Summary

Nonorganic hearing impairments include all of the classes of abnormal auditory function for which no plausible anatomical or physiological basis can be found or inferred. The basis for such impairments is presumably in the more complex activities of the central nervous system, which are better understood in psychological terms such as lack of cooperation, neurotic behavior, or deliberate deceit. A nonorganic impairment is usually presumed to have existed when auditory performance improves significantly on a subsequent test without any known change in the auditory system. The improvement must, however, be greater than the range of variation to be expected for the particular test. Nonorganic hearing impairment often appears as an "overlay" combined with a definite organic hearing loss.

Lack of cooperation or deceit is difficult to prove and is seldom fully established except by frank confession. Anxiety and inner tensions may cause changes in hearing without conscious intent on the part of the subject. Such behavior may appear quite irrational to a casual observer. There may be various degrees of conscious motivation.

Tests for nonorganic hearing impairment are of two general sorts: indicator tests and proof tests. Only a few tests can measure nonorganic hearing impairment even approximately, and then only under favorable circumstances. The quantitative tests and the most reliable of the proof tests require rather elaborate equipment, and some are quite time-consuming. Proof tests should not be administered as routine but only when indicator tests are positive or strong motivating factors are obvious.

Some of the best tests are limited to the detection of monaural nonorganic impairments. Some other tests lose effectiveness when the subject has learned their principles. In many cases a clever, practiced malingerer can still "beat the game." With almost all tests a "positive" result proves that some nonorganic impairment is present, but often the degree of nonorganic overlay cannot be estimated accurately. A "negative" result is rarely a true negative but only an inconclusive result.

Routine audiometry can and should include a few simple indicator tests such as consistency of thresholds on repeated trials or agreement of the speech reception threshold with the prediction from the pure tone audiogram. The well-equipped specialist or the diagnostic center should be able to administer not only one but several of the more specific or more elaborate tests.

The most effective detector of nonorganic hearing impairment is an alert and intelligent examiner. The basis of nearly all of the indicator tests is an inconsistency of some sort.

Among the classical qualitative tests for monaural malingering the <u>Stenger</u> and <u>Swinging Voice</u> are almost infallible if properly applied with sufficiently accurate

test instruments. For binaural nonorganic impairment, particularly malingering, the most satisfactory is the Doerfler-Stewart Test; the Lombard Test is also useful.

Among the more elaborate modern tests few have been fully developed and evaluated. Electrodermal audiometry with pure tones may, when positive, give a fairly good quantitative measure. Electroencephalographic audiometry is difficult and requires considerable experience but may sometimes give positive quantitative results. Delayed speech feedback may be good for qualitative proof of hearing, but it does not provide a quantitative measure. Audiometry under hypnosis or narcosis should be further studied.

Frank malingering is easy to understand and to anticipate when a motive of gain is strong and obvious; quick and imaginative improvisation by an alert examiner may be as effective in detecting it as the more elaborate tests. Such malingering occurs most often in military situations, in industry, and where accident claims are involved.

The prevalence of semiconscious or unconscious deceit, or lack of cooperation that is related to anxiety or neurotic behavior, is difficult to estimate. With proper attention to the possibility of such impairments of hearing, more of it will probably be recognized. A proper understanding of this type of impairment requires some experience in psychiatry or clinical psychology.

REPORT

Prevalence of Nonorganic Hearing Loss

Nonorganic hearing loss has been identified in military as well as in civilian populations, in adults as well as in children. A number of studies have indicated that its prevalence varies from one segment of the population to another, and also among samples of the same population. While actual differences among similar population samples appear possible, it is likely that differences in criteria applied to nonorganic hearing loss as well as methodological differences are important factors.

The largest number of studies of nonorganic hearing loss were performed during the second World War on military populations. They revealed that the condition occurred in 8 per cent to 20 per cent of the populations tested at military aural rehabilitation centers of that time. A more recent study of audiologically inconsistent patients at Walter Reed Army Hospital in Washington, D. C. indicated that 30 per cent of candidates for aural rehabilitation had hearing losses with nonorganic components. In addition to the prevalence figures, two consistent findings have emerged: (1) nonorganic hearing loss is frequently causally unrelated to stresses of combat; (2) when nonorganic components are present, they are usually superimposed upon hearing loss of organic origin.

Data on the prevalence of nonorganic hearing loss in civilian populations are scant. A survey of 30 audiology centers made in 1951 revealed that 53 per cent of these centers had seen few or no civilian adults with nonorganic hearing loss. An additional 37 per cent estimated the prevalence of such loss at less than 5 per cent, and only 10 per cent of the centers reported a prevalence of 5 per cent or more. With respect to children, approximately 74 per cent of the surveyed centers reported the prevalence of nonorganic hearing loss as negligible, 21 per cent estimated it at less than 5 per cent, and only 7 per cent reported figures in excess of 5 per cent. The incidence of nonorganic hearing loss among children has been confirmed in recent publications, but no estimates of its prevalence were made.

The Veterans Administration routinely contends with the problem of nonorganic hearing loss in providing rehabilitation services and in processing claims for compensation. The condition is estimated to be present in 15 per cent to 20 per cent of the veteran population. This estimate is conservative in that individuals who subsequently modified their responses to agree with the organic hearing loss were not included.

Recent study of a group of veterans referred to a large VA audiological contract clinic indicated that 22 per cent had nonorganic components in their hearing loss.

Because of the motive of gain, nonorganic hearing loss may be expected to constitute a problem in the area of industrial claims for compensation. The pertinent literature is not revealing on the subject of prevalence, but unpublished estimates indicate a range from 25 per cent to 40 per cent. In a great majority of cases, the condition is superimposed on organic hearing loss. A questionnaire sent to the directors of Workman's Compensation Boards in the United States, Puerto Rico, and Canada yielded the following information concerning the prevalence and the recognition of nonorganic hearing loss as a compensable disability.

<u>Prevalence</u>

Frequent	1 state
Occasional	5 states
Seldom	21 states
Never	4 states
No experience	7 states

<u>Recognition</u>

Recognized	9 states
Questionable	2 states
Not recognized	22 states
No experience or opinion	7 states

Note: Michigan - nonorganic hearing loss is compensable if related to employment and causes wage loss

Louisiana - court decides on compensation for nonorganic hearing loss

New Jersey - nonorganic hearing loss is recognized as a neuropsychiatric hearing loss and is a compensable disability

It can be expected that baseline audiograms obtained in an increasing number of industrial hearing conservation programs will tend to discourage outright malingering and conscious aggravation.

More accurate estimates of the prevalence of nonorganic hearing loss will become possible when uniform criteria are adopted for its diagnosis, when more clinicians are alerted to the likelihood of its presence, and when routine detection methods are established. The prevalence will be influenced by the availability of baseline audiograms, the refinement of methods of quantification, and their competent application.

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Detection of Nonorganic Hearing Loss

A skillful examiner can often detect a nonorganic hearing impairment during the taking of history and physical examination. Further evidence may be gained from routine audiometric tests with pure tones and speech. If nonorganic impairment is suspected, a variety of specialized tests may be administered.

The determination of the amount of nonorganic hearing loss is difficult and estimates having reasonable accuracy can be made only under favorable conditions. Few quantitative tests are available.

It is rarely possible to distinguish between subconscious, psychogenic hearing loss and outright malingering. Positive proof of voluntary simulation can be obtained only by inducing the tested person into a frank admission of deceit. Several of the specialized tests may be helpful in encouraging admission of malingering.

Because of the difficulty in discriminating between psychogenic hearing loss and malingering, the following classification and evaluation of tests refer to nonorganic hearing loss without regard to its origin. Tests that appear particularly useful for detecting outright malingering are pointed out.

It should be emphasized that none of the available tests is capable of demonstrating absence of nonorganic involvement. They are conclusive only when their outcome is positive.

Classification and evaluation

Procedures for the detection of nonorganic hearing loss may be divided into three broad categories: informal observation, indicator tests, and proof tests. The first two categories overlap with routine auditory examination; the third category aims specifically at the nonorganic hearing loss.

Informal observation

An alert examiner can usually detect the nonorganic origin of hearing loss by noting obvious discrepancies between auditory behavior and test performance. He should observe the patient carefully during the interview and when taking the case history. The attitude of the patient toward his hearing loss can be revealing. The person with a severe organic hearing loss is usually demonstrably worried about it, the person with a nonorganic hearing loss often seems quite unconcerned. Establishment of a suitable motivation is also important. Few, if any, individuals malinger without a motive. Frequently, when the motive is removed, the nonorganic component of hearing loss disappears.

Indicator tests

Several tests in this category belong to routine audiometric examination, i.e., determination of hearing loss for pure tones and speech (Speech Reception Threshold). Examples are listed in Table 1. They rely on the consistency of the listener's responses to test signals. The inexperienced listener with nonorganic hearing loss has difficulty in duplicating his responses on repeated trials, particularly when speech is the test signal. If on repeated trials hearing loss varies by more than 10 decibels (dB), nonorganic hearing loss should be suspected. The chief limitation of this method is that the expert malingerer can duplicate his responses by noting a loudness level well above his threshold and waiting until this level is reached before responding.

Instead of comparing results of repeated trials, the Speech Reception Threshold (SRT) can be compared to the average hearing loss at 500, 1000, and 2000 cycles per second (cps). In organic hearing loss, both agree to within a few decibels. If the difference exceeds 10 dB, nonorganic hearing loss should be suspected. Under these conditions the measured hearing loss for pure tones is usually higher than for speech, since control of responses by judging loudness is more difficult for speech than for pure tones.

In general, the indicator tests rely on the listeners' conscious decisions with respect to the audibility of test stimuli presented in quiet, i.e., without any interfering sound. Responses involving conscious decisions are known to depend highly on the motivation of the listener. For instance, if the listener's job depends on acute hearing, he will tend to make some responses in the absence of any stimulus. If, on the contrary, he receives compensation for hearing loss, he may tend to respond only when the presence of the stimulus becomes very obvious. It is assumed that individuals with normal hearing or with organic hearing loss are highly motivated to respond to test signals. On this basis intra-test variabilities and inter-test relationships are established. Significant deviations from the expected results indicate a nonorganic impairment. While it is inconceivable that any one individual could master the stimulus-response relationships to a point of being able to conceal the nonorganic origin of his hearing loss if given a sufficiently extensive battery of uncomplicated psychophysical tests, no one test of this category can be considered sufficiently conclusive for a definitive diagnosis.

Proof tests

Proof tests are specifically oriented toward detecting nonorganic hearing loss although some of them may also be used for other purposes. They are usually more complex and more time-consuming than the indicator tests. They should not be administered unless informal observation or at least one of the indicator tests, or both, have led to a suspicion of nonorganic hearing loss.

The proof tests can be divided into five subcategories, depending on the basic method involved.

Stimulus interference. It is possible to include in the first category all tests that rely on patients' voluntary responses, but where the test stimulus is presented together with an interfering stimulus. The basic principle involved is the observation that one sound cannot appreciably interfere with the audibility of another sound unless it itself is audible. When the interfering sound becomes effective before it reaches the previously indicated threshold of audibility, it suggests that the threshold has been elevated by nonorganic hearing loss.

When a test of this kind is so designed that the test sound is completely masked out before the interfering sound reaches the threshold indicated by the patient, the test results may provide convincing evidence of nonorganic loss. This is so because the listener loses all information necessary to make decisions correlated with changes in the test sound. The Stenger Test fulfills these requirements. It is based on the principle that a relatively loud sound in one ear makes an identical but fainter sound inaudible in the other ear. The Stenger Test can produce a quantitative estimate of the nonorganic component of hearing loss. It is probably the most foolproof test against malingering requiring only a two-channel pure-tone or speech audiometer. Unfortunately, its usefulness is limited to strongly asymmetrical hearing losses.

Another test that is based on stimulus interference, although of quite a different nature, is the Swinging Voice Test. In this test, a story is delivered to the listener through earphones in such a way that parts of it reach both earphones; other parts are channelled alternately to each earphone separately. The listener is requested to repeat the story, and his answer depends on whether he heard the story through both or through only one earphone. Like the Stenger, the usefulness of the Swinging Voice Test is limited to asymmetrical hearing losses. Otherwise, it is highly efficient and requires only a two-channel speech audiometer with an appropriate switch.

When the interfering sound does not make the test stimulus completely inaudible but only changes some of its characteristics, a sophisticated listener may obtain sufficient information to conceal the nonorganic origin of his hearing loss. Nevertheless, where such a situation exists, experience with the Doerfler-Stewart Test, has shown that the concealment is extremely difficult. In this test, a saw-tooth noise is made to interfere with speech reception. The signal-to-noise ratio at which speech reception is affected by noise has been determined for listeners with normal hearing and for those with organic hearing loss. Test results that deviate appreciably from the established norms strongly indicate nonorganic hearing loss.

The great advantage of the Doerfler-Stewart Test is that it applies to binaural hearing losses. It requires only a small modification of standard speech audiometers and is not difficult to perform. When skillfully administered, it can be of help in uncovering malingering, and it can produce a quantitative estimate of the nonorganic component.

Auditory motor control. In tests of this subcategory, the listener makes motor responses that are influenced by or are dependent on the auditory feedback. Speaking or reading out loud are typical examples. If the individual can actually hear the sound he produces, and uses auditory clues, his performance can be altered by interference with the auditory feedback. Conversely, a change in performance due to interference with the feedback indicates that the individual can hear the sound. The Lombard Test and the Delayed Feedback Test are typical examples.

In the Lombard Test the tested person is given a text to read out loud. An interfering noise is produced by means of earphones or a loudspeaker, and its intensity is gradually increased. When the noise becomes sufficiently strong to interfere with speech perception, the reader tends to raise his voice. The Lombard Test can be administered monaurally or binaurally and requires only a noise source. Its major shortcoming is a strong susceptibility to learning certain cues, allowing the patient to set a voice level sufficiently invariant so that repetition decreases its efficiency.

The Delayed Feedback Test, known also as Delayed Playback or Delayed Side Tone Test, is based on a time delay between the patient's speech output and his auditory feedback. When the delayed input is sufficiently strong and is audible to the listener, his speech tends to become loud and distorted. The test has shown considerable promise and is difficult to outmaneuver when done properly. However, it requires special equipment, and there are some individuals on whom the delayed feedback has little effect. In cases of moderate organic loss with nonorganic overlay, the test is of limited value because it requires excessively high signal levels.

Reflex responses. In tests of this category, the function of the auditory system is inferred from reflex responses, like eyeblink or change of skin resistance. Since the listener is not asked to make conscious decisions, the psychological factors responsible for nonorganic hearing loss are presumably eliminated, and the reflex threshold may be taken as an indication of normal hearing or organic hearing loss. It should be kept in mind, however, that a reflex response to a sound stimulus can only be taken as evidence that the peripheral end organ and associated neural structures of the brain stem are functioning. It does not necessarily indicate that the sounds that elicit reflex response are also consciously perceived. Reflex responses to sound stimuli have to be conditioned, for instance by a mild electric shock, and several difficulties arise from the conditioning procedure. It is not always possible to elicit the desired reflex even when the stimulus is known to be above the threshold of audibility. A response that is established for strong stimuli may vanish at lower sound intensity levels that are still above the threshold. During prolonged testing, habituation may abolish the reflex but not necessarily if a periodic reinforcement is used rather than a regular schedule. In addition, the use of aversive conditioning stimuli, especially of electric shock, has certain negative psychological effects.

The most widely used test of this category is based on reflexive changes of skin resistance. It is known under the names: Electrodermal Response (EDR), or Psychogalvanic Skin Response (PGSR). The conditioned reflex to tone bursts is elicited by pairing the tones with electric shocks. When the test administrator is experienced and skillful, conditioned responses can usually be maintained during fairly long test sessions. The temporal pattern of resistance changes is plotted by means of a graphic level recorder. Because of spontaneous skin responses, and because the reflex is not always elicited by the same sound signal on repeated presentations, evaluation of the recordings is sometimes difficult. The test requires special equipment and skilled personnel. Under favorable conditions, it can produce quantitative data and help effectively in detecting nonorganic hearing loss.

The Eyeblink Reflex has not been used routinely because it disappears at near threshold stimulus intensities and is subject to fast habituation.

Electroencephalography. Tests of this category rely on changes in the Electroencephalogram (EEG) that may be produced by sound stimuli. The technique is severely limited by the requirement of elaborate equipment and by the fact that with current methods of recording no specific change in the wave form of the EEG is seen to follow a sound signal. Noticeable changes occur in whatever wave form is present at the time of auditory stimulation, but they decrease rapidly as the signal approaches threshold intensity as determined by ordinary audiometer tests, and disappear before the threshold is reached. There is some evidence that low level outputs from the cortex can be detected by computers which average EEG responses evoked by sound stimuli. Further experiments must be done before the procedure can be used in clinical tests. In any event, the broad use of the technique is limited by the relatively high cost of the necessary computer equipment.

Narcosis and hypnosis. The use of narcosis or hypnosis in examining patients with suspected nonorganic hearing loss is successful only in the hands of an experienced psychiatrist, and, even then, to a limited degree. These methods are best employed on individuals who have suffered from shock that resulted in a sudden hearing loss. They serve little or no purpose after the hearing loss has lasted for several years. In general, narcosis and hypnosis do not yield as valid or as precise information as do audiological techniques, but this technique has not been systematically investigated.

Summary

Although a large number of tests for nonorganic hearing loss are available, no test is foolproof. Quantification of nonorganic hearing loss and differentiation between voluntary malingering and subconscious psychogenic, auditory disorders appear particularly difficult. In each case of suspected nonorganic hearing loss, several methods must be used to substantiate the diagnosis. It is recommended that, after informal examination, one or several indicator tests and at least one proof test be administered.

The classification of tests is summarized in Table 1 and their evaluation in Table 2. A more detailed description of the most widely used tests is given in this section.

Table 1

Classification of Tests for Nonorganic Hearing Loss

Informal examination	Indicator tests	Proof tests				
		Stimulus interference	Auditory motor control	Reflex responses	Electroencephalogram	Narcosis and hypnosis
History	Repeated PT	Doerfler-Stewart	Lombard	EDR	Changes in EEG	Narcosis
Interview	Repeated SRT	Stenger (monaural)	Delayed feedback	Eyeblink	Cortical responses with averaging computer	Hypnosis
General behavioral observation	Consistency between PT and SRT	Swinging Voice (monaural)				

PT - Pure tone hearing loss
SRT - Speech reception threshold
EDR - Electrodermal response
EEG - Electroencephalogram

Table 2

Evaluation of Tests for Nonorganic Hearing Loss

Test	Equipment	Kind of results	Evaluation	Rating
History, interview, general behavioral observation	No equipment (intelligent and experienced examiner)	Qualitative	Experienced observer can make good estimate of auditory efficiency	Good to excellent
Repeated P T	Pure tone audiometer	Qualitative	Response inconsistency is usually an indication of nonorganic hearing loss	Good
Repeated SRT	Speech audiometer	Qualitative	Same as for PT	Good
Consistency between PT and SRT	Pure tone and speech audiometers	Qualitative	Discrepancy between average PT at 500, 1000, and 2000 cps and SRT indicates nonorganic hearing loss	Good
Doerfler-Stewart	Two-channel speech audiometer with masking noise	Qualitative Quantitative	Doerfler-Stewart should be routine in all cases where personal gain is motivation	Excellent
Stenger	Two-channel pure tone audiometer	Qualitative Quantitative	When properly done, impossible to beat in unilateral cases	Excellent
Swinging Voice	Two-channel speech audiometer	Qualitative	Good for unilateral cases	Fair
Lombard	Controlled noise	Qualitative	Severely limited by learning	Fair
Delayed feedback	Tape recorder with delayed playback head	Qualitative	Positive results strongly indicative, more research needed	Good
EDR	EDR audiometer compliment	Qualitative Quantitative	Difficult to interpret, useful effect on repeat PT	Good
Eyeblink	Phonograph pickup and oscilloscope or high speed recorder	Qualitative	Special equipment; not reliable near threshold	Fair
EEG	EEG equipment	Qualitative	Interpretation of results difficult; complex equipment necessary	Fair

Routine test procedures for nonorganic hearing loss

This section refers to proof tests for nonorganic hearing loss. It includes short descriptions of specific procedures, the required equipment, and references where more detailed information can be found. The tests that are described follow the order of Tables 1 and 2.

Doerfler-Stewart Test

The test is based on noise interference with speech reception. The signal-to-noise ratio at which speech reception is affected by noise has been determined for listeners with normal hearing and organic hearing loss. Test results that deviate appreciably from the established norms usually indicate nonorganic hearing loss. Additional information may be obtained from measurement of noise threshold as compared to SRT in quiet and in noise.

In the Doerfler-Stewart Test the assumption is made that the listener with non-organic hearing loss gauges his responses according to perceived loudness. In routine pure tone and speech audiometry, he makes loudness judgments in absence of noise. When a masking noise is introduced loudness perception is altered.

Equipment. Two-channel speech audiometer with masking noise (preferably saw-tooth). Speech and noise intensity must have separate, calibrated controls.

Procedure. Both speech and noise are delivered binaurally. In the first step, the noise is turned off and the SRT determined in the usual manner by means of live voice and spondee lists. In the second step, the speech level is set at 5 dB above the measured SRT, and, while the spondees are presented at regular intervals, the masking noise is introduced. At first, the noise intensity is set at its normal threshold level; then it is gradually increased until the listener stops repeating correctly the test words. The resulting noise level is recorded and the difference between this level and the speech level is compared to data obtained on listeners with normal hearing and organic hearing loss. In case of serious discrepancy, the examiner should assume the presence of nonorganic hearing loss.

In addition to the primary test, valuable information can be extracted from measurement of the threshold for the noise and from a repeated measurement of the SRT in quiet. For this purpose, the relationship between the noise threshold and the SRT has been determined for normal hearing and organic hearing loss. The repeated SRT may differ from the first when nonorganic hearing loss is present.

Skillful manipulation of the speech and voice levels may lead to a response more consistent with the actual organic hearing loss.

A more detailed description of the Doerfler-Stewart Test can be found in Newby (1958).

Stenger Test

The Stenger Test utilizes the observation that a strong sound in one ear prevents hearing of a weak sound in the opposite ear, provided both sounds are practically identical with respect to frequency spectrum. The test can be performed with pure tones, noise or speech, as long as the same signal is delivered to both ears. It is also of paramount importance that the signal be turned on and off simultaneously and with the same rise and decay time in both ears. Any abrupt changes in the weak stimulus alone may be detected by the listener despite the presence of a strong stimulus in the opposite ear. This applies to attenuation changes by means of a step attenuator.

The efficiency of the test may be impeded by extreme interaural diplacusis, although there are no clinical records to this effect.

The usefulness of the Stenger Test is limited to unilateral nonorganic hearing loss.

Equipment. Two-channel pure-tone or speech audiometer with binaural on-off switch. Theoretically, two single channel audiometers or one single channel audiometer and one auxiliary oscillator can be used. This solution is impractical, however, since it is extremely difficult to match the test signals.

Procedure. A binaural headset is secured over the ears of the listener, each phone being connected to a separate channel with a calibrated attenuator. The listener is instructed to raise his right hand when he hears the test signal in the right ear, the left hand when the signal appears in the left ear. In a preliminary step, the hearing loss of each ear is determined, beginning with 1000 cps if pure tones are used. Next, the intensity level in the better ear is set at 5 dB above the measured threshold. The listener should respond to each stimulus presentation at this level. If the response is erratic, the intensity level should be increased by an additional 5 dB. Once a 100 per cent response in the better ear is achieved, the examiner makes sure that the test signal is turned off in both ears and sets the signal in the worse ear at an intensity level 10 dB higher than in the opposite ear. Then, the stimulus is turned on simultaneously in both earphones. If the organic hearing loss is approximately the same in both ears, the listener will not be aware of the signal in the allegedly better ear and, in general, will not respond. Consequently, lack of response indicates nonorganic hearing loss.

A response to the test signal in the allegedly better ear indicates that the stronger signal remained inaudible. Under such conditions, the intensity of the stronger signal is further increased by 10 dB, and the test repeated. This procedure is continued until the listener ceases responding to the stimulus in the better ear. If this does not happen until the initially measured threshold of the poorer ear is reached, there is no evidence of nonorganic hearing loss. Otherwise, it can be assumed that the organic hearing loss is in the vicinity of the intensity level at which the listener stopped responding to the signal in the better ear.

When the intensity difference between the two earphones exceeds 50 dB, the stronger stimulus may be heard in the opposite ear. This does not invalidate the test, since the listener will continue indicating the presence of stimulus in the better ear.

The Stenger Test has been described in a number of articles and textbooks, and various modifications have been suggested. The most conveniently accessible reference is probably Newby (1958).

Swinging Voice Test

In the Swinging Voice Test, a story is delivered to the listener through earphones in such a way that parts of the story are channelled to the allegedly better ear, other parts to both ears, and the remainder to the allegedly poorer ear. The part of the story delivered to the better ear and to both ears constitutes a distinct story in itself. The listener is requested to repeat the story he heard, and from his answer it is possible to determine whether he heard the story in both ears or in only one.

The usefulness of the test is limited to asymmetrical hearing losses.

Equipment. A two-channel speech audiometer with a switch that makes it possible to select either channel, or to connect both channels together.

Procedure. A binaural headset is secured in place and the SRT of each ear determined. Subsequently, the speech intensity is set at a level that is above the SRT of the better ear and below the SRT of the poorer ear. A story especially prepared for the test is delivered so that a predetermined part of it reaches only the better ear, another part both ears, and the remainder the poorer ear. The listener is instructed to remember the story he hears and to repeat it at the end of the test. If he is able to repeat the entire story, nonorganic hearing loss must be assumed.

The story cannot be presented at a level higher than 40 dB above the threshold of the better ear; otherwise, cross-hearing may invalidate the test. This puts a limit on the interaural difference in hearing loss that can be explored.

The following is an example of a test story.

UF Story No. 2

Good	Both	Poor
(1) A bootblack		(2) a tailor
	(3) and two cab-drivers won	
		(4) 400 and
	(5) 75 dollars	
(6) shooting dice		(7) in the alley .
	(8) They	
(9) went on a spree	(10) and spent	(11) 33 dollars of
(12) it on		(13) wine
	(14) women	
(15) and song.	(16) Before they got	
(17) started they		(18) met three bums to whom they

Continued: UF Story No. 2

Good	Both	Poor
	(19) lost every cent	
(20) in a game of		(21) draw
	(22) poker.	
(23) Moral - it never	(24) pays to gamble	(25) especially with bums.

A somewhat different procedure, called "Shifting-Voice Test," is described in Johnson, Work, & McCoy (1956).

Lombard Test

Speech production is controlled to a large extent by the auditory feedback. For this reason, speakers tend to raise their voices in a noisy environment. The phenomenon is utilized in the Lombard Test where the tested individual is required to read aloud in presence of noise background. When the noise intensity is increased above that of speech and the individual can hear it, his voice tends to become louder. In the presence of a substantial organic hearing loss, the noise has no effect on speech production since the auditory control is eliminated altogether.

The Lombard Test can be performed binaurally or monaurally. However, the equipment needed for monaural examination is more involved than for binaural examination, and there are more effective tests. Consequently, the Lombard is recommended only as a binaural test.

Equipment. Although the Lombard Test has been performed in the past with a variety of noise generators, an electronic source of white noise or saw-tooth noise is usually employed. The noise should be delivered through a binaural headset, with its intensity controlled by means of a calibrated attenuator.

Procedure. The tested individual is given a simple text and is instructed to read aloud until he is told to stop. A binaural headset is secured in place and the individual is allowed to read a few sentences without noise interference while the examiner notes the loudness of his voice. Next, the noise is turned on and its intensity gradually increased. If at some intensity the individual begins raising his voice, that intensity is maintained for a while, and then, abruptly turned off. The reaction to a sudden removal of the interfering stimulus usually observed as an abrupt reduction in the loudness of the reader's speech may constitute an added evidence of nonorganic hearing loss. In general, such a loss has to be assumed if the individual raises his voice at a noise level that is below the previously measured threshold.

It should be emphasized that some individuals do not raise their voices in presence of very loud noises. Such voice control can be learned, so that the Lombard Test may lose its effectiveness when repeated.

Additional information can be found in Newby (1958).

Delayed Feedback Test

The Delayed Feedback Test is based on distortion of auditory speech control. The individual's voice is recorded on magnetic tape which passes over an auxiliary reproducing head. The recorded speech is picked up, amplified, and delivered to the speaker's ears with a delay. A delay of 0.18 to 0.2 sec has been found to be the most effective. When the delayed speech reaches the intensity level of voice transmitted directly from the mouth to the ear, and is audible to the talker, various parameters of speech may change. Most talkers tend to speak slower and louder, and the articulation may become clearly distorted. Clinical experience shows that such effects occur when the delayed speech is 20 to 30 dB above the SRT of the better ear. When the tested individual reacts to the delayed feedback at a lower level, nonorganic hearing loss should be suspected.

The test may be administered monaurally or binaurally. In monaural testing, the opposite ear must be masked by white or saw-tooth noise.

It should be noted that not all individuals react to the delayed feedback, so that a negative result does not necessarily indicate absence of nonorganic hearing loss.

Equipment. A good tape recorder with an auxiliary pickup head providing the necessary speech delay. A binaural headset that can be used binaurally or monaurally. In monaural tests, the second earphone should be connected to a noise source with a calibrated intensity control.

Procedure. The tested individual is given an easy text and is instructed to read it aloud until told to stop. The earphones are secured in place and, at first, the delayed feedback is turned off. After a few sentences, the delayed feedback is turned on and its intensity gradually increased until the reader's articulation voice level or speech rate shows signs of distortion. If this happens at an intensity lower than 20-30 dB above his SRT nonorganic hearing loss should be assumed.

The distorted speech may be preserved on tape as evidence of nonorganic hearing loss.

Additional information on the Delayed Feedback Test can be found in Lee (1950); Black (1951); and Gibbons & Winchester (1957). A summary of delayed auditory feedback research is found in Yates (1963).

Electrodermal Response (EDR)
(Psychogalvanic Skin Response, PGSR)

The test is based on the detection of changes in the electric skin resistance associated with emotional responses to a variety of stimuli, for instance electric shock. By means of conditioning, it is possible to evoke skin responses to tone bursts. Usually, a series of tone bursts is presented above the admitted threshold level, and each tone burst is followed by a weak to moderate electric shock to the wrist of one hand. After a few shocks the skin response can be elicited by the tone bursts alone. By manipulating the tone intensity it is then possible to find the threshold of audibility as indicated by the presence of skin response.

Since no conscious decisions on the part of the tested individual are involved in the test, the hearing loss indicated by electrodermal responses is considered to be organic in nature.

In order to measure the skin resistance, a pair of electrodes is attached to one hand and connected to a low voltage source. The electric current flowing in the circuit depends on skin resistance, so that resistance fluctuations produce current changes. These are recorded by means of a graphic-level recorder. Since the skin resistance is subject to spontaneous fluctuations and not every audible stimulus elicits a response, the interpretation of the recordings is not always easy, and it requires an experienced examiner.

Another limitation of the test is that not all individuals can be conditioned to respond to sound stimuli.

Equipment. A pure tone audiometer with EDR accessory equipment. Such equipment is commercially available.

Procedure. The function of electrodes is described in general terms to the individual to be tested so as to decrease somewhat his apprehension. He is instructed that occasionally he will feel a mild electric shock. The stimulating and the recording electrodes are secured in place and the earphones are placed over the individual's ears. Tone stimuli are presented above the previously measured threshold of audibility and followed by electric shocks. Subsequently, the electric shocks are eliminated and, if the individual responds to tone stimuli, the intensity is lowered until the response ceases. The conditioning and testing procedures must be repeated several times before the threshold for the electrodermal response can be established. If the resulting hearing loss is less than previously measured by means of conscious voluntary responses, nonorganic hearing loss can be assumed.

Many variants of the conditioning and testing procedure have been described. Directions are usually supplied by equipment manufacturers. Additional recommended reference: Goldstein, Ludwig, & Naunton, (1954).

Psychiatric diagnosis of nonorganic hearing loss

General considerations

The diagnostic entities dealt with by psychiatry differ in nature from those of many other medical specialties. They are broad and comparatively crude. They have a high degree of overlap and a low degree of specificity.

The conversion process, that is, the expression of psychological conflict through somatic symptoms, appears in a wide number of such psychiatric categories. The three most frequent groups are:

1. Delinquent states, showing pronounced antisocial trends.

2. States of classical neurotic conflict called hysteria.

3. More serious personality disorders, psychoses, or major mental derangements.

There is no black and white distinction between conscious feigning, i.e., malingering, and hysterical symptom formation based on unconscious conflict. The two fall along a continuum. Conscious malingering may rarely be present in a comparatively pure form; it is almost always imbedded in a chronic personality inadequacy which grossly impairs the subject's useful functioning.

Thus, psychiatry cannot yield unequivocal diagnostic compartmentalization of the sort provided by audiologic examination. It can, and should, provide an evaluation of the individual patient. This should assess systematically not only the severity of the symptom picture, and the incapacity resulting from it, but also the predisposing and precipitating factors.

Requirements for adequate psychiatric evaluation

Psychiatric experience. Obviously, a psychiatrist making such a complex evaluation must be able to go behind the masquerade of health which may be presented by an individual whose tensions are funneled, for whatever reason, into a single symptom such as hearing loss. He must establish as meaningful a relationship as possible to the patient, must be able to elicit spontaneous communications and understand them as they emerge. The psychiatrist must also be acquainted with the special problems of hearing loss, must be alert to discrepancies in the history and inconsistent reactions to avowed hearing deficit, and must be sensitive to the special aspects of acoustic function which may throw light on why this particular area has become vulnerable.

Auxiliary information. At times the psychiatrist should have access to auxiliary information of two main sorts. One is an outside social history, whether from family or from the work environment of the subject. This may provide important information which, again, might be obscured by the special circumstances of the presenting illness. A second source is psychologic testing. There are no specific, nonauditory psychologic tests, either for patients with hearing loss, or for the detection of "malingering" as against "hysteria." The Minnesota Multiphasic Personality Inventory is one of the simplest to administer, and produces a quantitative result. However, there is a question in the minds of many experienced clinical psychologists as to whether it yields correspondingly valuable information. Most psychologists advocate—as parallel to the psychiatric examination—a broad evaluation of the personality, using a battery of tests and relying upon clinical assessment of their results.

When data are obtained from auxiliary sources by different observers, ideally each examiner should make an initial independent judgment about the patient, but final assessment may most profitably be on a consensus basis.

Special techniques. Two special measures, hypnosis and interviewing with the aid of a sedative drug, such as amytal, may be of great help in particular cases when used by a therapist familiar with them and confident in their application. Probably, he has to transmit this confidence to the patient. There is evidence that both techniques depend to a great extent on the willingness of the subject to entrust himself to the intense emotional experience surrounding them. In the rare cases of "pure" malingering, such willingness may be negligible, and hence, these tools limited in their effectiveness. These techniques in the hands of persons not trained in their use may be dangerous. They may create profound suspicion and hostility, aggravate existing neurotic conflicts, and provoke major psychotic manifestations.

Gains from psychiatric evaluation

Psychiatric assessment of the various trends in the personality, particularly delinquent tendencies, neurotic conflict, and major mental derangement, as well as estimates of their duration, will be essential to proper management of the case with functional symptoms. It is obviously extremely important to know whether one deals with an anti-social individual exaggerating a mild impairment, or with a profoundly disturbed, hopelessly psychotic patient. Finally, psychiatric assessment may point the way to treatment.

Military experience has shown increasingly that the sooner psychiatric disorders are treated, the greater the chance of restoring functional capacity to a patient for the future, and of salvaging the milder cases for some sort of effective duty.

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