

HEARING TEST IN SIMULATION

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The importance of having at one's disposal tests of malingering which are ever more perfect has been, for social, military and economic reasons, steadily increasing these last few years, step by step with the extraordinary increase of cases of simulation. The purpose of this work is to sum up the situation as it appears to-day and refer briefly on the various tests at one's disposal. Regrettably, the report will be short because of the limited space allowed.

The malingerer can attempt to feign partial or total deafness, monaurally or binaurally. Faced with these types of malingering, the audiologist can carry out the following tests:

A) ABSOLUTE OBJECTIVE AUDIOMETRIC TESTS

These methods, suitable for monaural or binaural malingering, ascertain the efficiency of a part of the ear of the subject without any voluntary or involuntary participation by the subject under test.

They are essentially based on the establishment of the function of the mechanical parts of the middle ear by means of special electronic devices (capacitive probe of v. Békésy (1)).

It is obvious that the value of these tests is circumstantial, not being by themselves definite means of detecting a simulation: they can only indicate whether or not the middle ear is damaged. This can, anyway, be of great value to the audiologist's final judgment, particularly when the frequency characteristics of the ossicular chain and ear drum mechanical unit traced with this method should show to be roughly similar in shape to the audiometric absolute threshold curve of the subject.

B) MEDIATE OBJECTIVE AUDIOMETRIC TESTS

These tests, suitable for monaural and binaural malingering, ignore the verbal response on the subject's part but are based on automatic uncontrollable reactions (neurovegetative or muscular) elicited from the subject through the perception of the signal by the supposedly deaf ear. Among these are to be remembered the psycho-galvanic test (2), the psycho-voltaic test (3), the sphygmomanometric test (4) and the EEG test, and the tests based on the observation of the cochlear reflexes. To these are also to be added the tests based on the detection of muscular contraction of the tensor tympani through the measurement of the middle ear impedance (5).

The related mediate objective audiometric tests can be taken as effective malingering tests through which it is not only possible to reveal the existence

of a simulation, but also, at least in the more successful cases, to determine roughly the actual hearing threshold of the subject, ignoring his will to simulate.

C) SUBJECTIVE RESPONSE AUDIOMETRIC TESTS

a) **Monaural tests**

In these tests, suitable for monaural or binaural malingering, the subject is expected to respond discriminately to tests, in which different techniques are employed to deceive him or to prevent him from assuming an elevated threshold and maintaining it during the test itself. The simplest and probably the most successful is the „repeated threshold test“, merely based on the repeating of the threshold audiogram after a lapse of time. It is unlikely that an individual will remember and feign the same audiometric pattern of hearing loss at different frequencies and at several sances. The drawback of this method of detecting malingering is, however, the fact that sometimes feigned hearing losses can at times be repeated successfully again and again.

Another test which can be positive is CARHART'S, based on the comparison between pure tone air and speech threshold levels. The relation between these two levels is, in normal or hard of hearing individuals, fairly constant, and any deviation is a sure sign of attempted simulation.

DOERFLER-STEWART's test (6) cannot be forgotten. This consists of a method exploiting speech threshold examination with masking noise added to the speech. This noise hardly affects the speech threshold in normal or truly deaf subjects. The malingerer, on the other hand, will use the noise to assume and maintain deliberately an elevated hearing threshold. Varying the masking level disturbs the subject into using the noise as a reference, causing unjustified shifts to the speech threshold level.

b) **Binaural tests**

These tests, suitable only for monaural malingering, can be subdivided into three main groups:

- i) Contralateral masking tests,
- ii) Auditory localization and binaural loudness balance tests,
- iii) Binaural summation or central fusion tests.

i) **Contralateral masking tests**

These are founded on the principle that if one ear is not as deaf as the individual claims, a masking tone which is fed to it will create an interference on the opposite ear. The best known method is STENGER's (7), most effective though limited exclusively to monaural malingering cases. This test consists in leading the same tone to both ears. When the ears are in truth normal, if the tone on the „deaf“ ear is louder than that on the „good“ ear, the tone will be heard exclusively by the ear where it is louder. No sound will be perceived by the individual on the „good“ ear, masked by the louder sound on the opposite side. The sound will, on the other hand, be perceived on the „good“ ear if the „deaf“ ear is actually impaired and cannot, as a result, hear the masking tone.

Since the masking effect reveals itself only when the masking tone level begins to overtake the actual threshold level, Stenger's test allows the real threshold level to be ascertained, within reasonable limits. The use of speech instead of pure tones represents an extremely good, though lesser known version of Stenger's test.

A variation of this test has been described by AZZI (8), consisting of the employment of modulated or pulsing in place of continuous tones. The rhythmically interrupted tones (2 pulses per second) prevent the subject from perceiving the increasing steps of amplitude of the tone on the good ear during the assessment of threshold.

ii) **Auditory localization and binaural loudness balance tests**

It is well known that the localization of a sound source in space rests on the unconscious evaluation of some parameters of the sound when it is received by both ears. In order to localize sound correctly, hearing must be perfect on both sides, alternatively the ears must both be evenly impaired. In cases where one ear is deaf than the other, a sound originating from a source equidistant from both ears will seem to be coming from a source nearer to the healthier ear. The malingerer very rarely is aware of this simple physiological phenomenon and we can, as a result, carry out some very simple tests. The easiest, but the least reliable, is that described by AZZI (8) whereby the subject is expected to localize a source of sound, with his eyes shut, whilst this is being moved about. The shifts are numerous and in quick succession; the sound is discontinuous and it is turned on when the source has been placed in a different position. An erroneous and inconstant response to this test shows evident signs of simulation.

FOURNIER's Binaural Loudness Balance Test (9) is much more exact. This consists of a very simple and effective procedure, very similar to Stenger's test. It has the great advantage that it permits the examiner to establish the real threshold level for each frequency on the alleged deaf ear.

A very recent additional test of this type is proposed by ROESER (10). This would appear to be the most precise of this type of tests even though the equipment required is not the most economical. If the cost of the apparatus could be reduced, this test could become one of the most popular means of detecting unilateral malingerer.

The method followed requires a tape recorder with double track and two play-back heads, each leading sound to one ear. One of these is movable whilst the other remains in a fixed position. In normal conditions, when the two play-back heads remain in the position in which they found themselves at the moment of recording, the signal will be reproduced simultaneously by the two heads. If, on the other hand, the head is moved away from the other when playing back, the signals will not be simultaneous, the one reproduced by the mobile head being picked up with a little delay. This delay will produce a sensation of lateralization of sound in the subject resulting from the well known influence of the time of arrival on the judgement of lateralization and localization. If the apparatus is manouvered in such a way that the signal reaches the ear suspect of simulation first, the individual will think that the sound is perceived only on that ear and declares not to hear anything,

whilst on the contrary the delayed tone is also present on the opposite ear.
It is our belief that the success of this test is due not only to the phenomenon of sound localization, but also to the so-called „precedence effect” described by Rosenzweig.

iii) **Binaural summation tests**

Among these, the best known and undoubtedly the most elegant is CALEARO's (11). It is based on the ascertainment of the intelligibility difference of

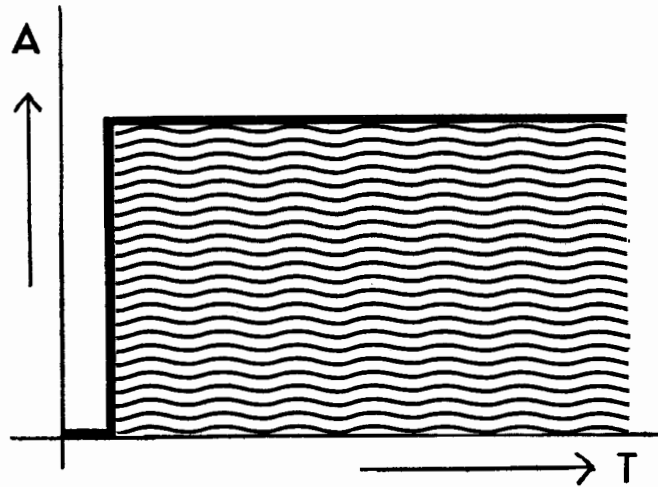


Fig. 1 - Stimulus in the allegedly good ear. A = amplitude of sound. T = time.

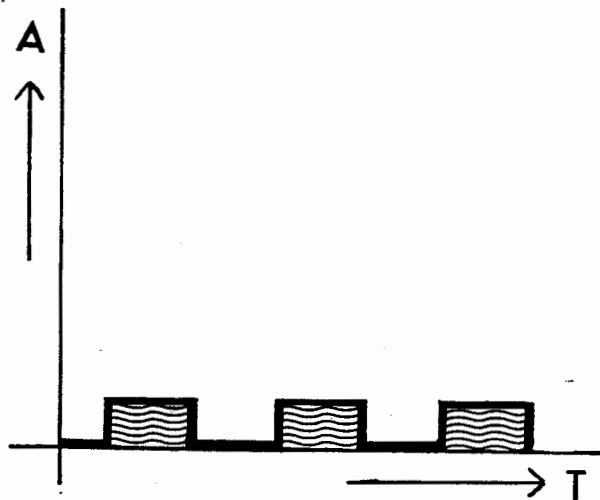


Fig. 2 - Stimulus in the purportedly deaf ear. A = Amplitude of sound. T = time.

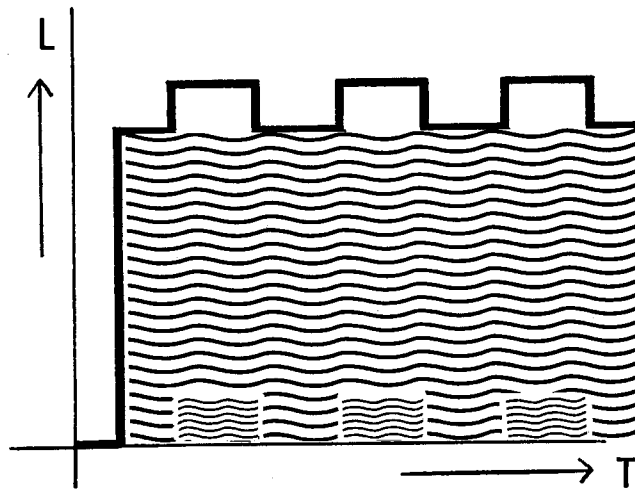


Fig. 3 - Sensation resulting from the central fusion of stimuli reaching both ears separately. The loudness L of the ultimate pattern of perception is equal to the sum of the amplitude of the two stimuli.

a verbal message periodically switched from one ear to the other, or periodically switched from one ear to the other, or periodically interrupted in one ear. If one ear is really deaf, and thus the fraction of the message fed to it is not received, the subject will only perceive the portion fed to the healthy ear. This will in practice result in an interrupted message being heard. The message will be unintelligible until the rate of switching will not reach a frequency of 8-9 per second. If, on the other hand, the message is understood when the switching rate is still limited to 2-3 per second, the subject is most likely malingering, since it is obvious that the alleged deaf ear must have perceived that portion of the message which was fed to it: this would allow a central synthesis of the two fractions into a complete verbal pattern.

Some tests based on binaural summation and probably also based on the so called „funneling effect” described by v. Békésy, have been elaborated by AZZI (12). The first of these, named „apparent modulation test” for short, is carried out as follows: a continuous sound is fed to the healthy ear at a level of 60 db beyond the threshold. A sound of equal frequency but interrupted twice each second is fed to the purportealy deaf ear starting from zero level. By gradually increasing the amplitude of the interrupted tone until the threshold of the suspected ear is reached, the individual will not perceive this sound with this ear, since the 60 db on the healthy ear are enough to mask the interrupted sound until this does not rise above the threshold by 15-20 db or more. By reason of a summation effect, the interrupted sound on the supposedly deaf ear adds itself to the continuous sound on the opposite ear, which will be heard as a pattern of amplitude modulated sound.

The subject is warned prior to the test that only the good ear will be examined and asked to report when the sound appears to be modulated. The individual who hears subjectively only the signal fed to the healthy ear thinks that the test only concerns that ear, and responds truthfully in all cases. Obviously, if the other ear is genuinely deaf the interrupted sound is not perceived and the apparent modulation effect will not be shown. The test, which for unknown reasons is only positive in the range of 200-800 cps, is extremely thorough: the apparent modulation takes place clearly when the interrupted sound is fed with merely 5 db beyond the real threshold on the suspected ear. This allows the examiner to ascertain the real threshold level with high reliability.

Another test suggested by Azzi consists of feeding a continuous tone of 60 db to the healthy ear whilst the other (suspected) ear receives a tone of the same frequency but frequency modulated. The rate of modulation is 2 cycles per second and the depth of modulation 50 %. Because of summation effect, the continuous sound appears to be frequency modulated. This effect does not take place if the suspect ear is really deaf. The same procedure is followed as in the case of the previously described test.

D) TESTS INVOLVING DISTURBANCES OF AUDIO-PHONATORY REFLEX

These tests are based on the fact that ear monitors speech. Any upset in this control will affect speech more or less seriously. On these tests, during the monitoring of speech the ear function is artificially disturbed thus causing an alteration in the speech pattern. This happens only when the ear perceives the disturbance. If the ear is really deaf as it claims to be, speech will remain unaffected since the interference cannot be heard.

Under this heading, the best known test is LOMBARD's (13), in which the disturbance to the ear interferes with the loudness control of speech.

The introduction of a time delay in the speech feed-back loop with apt electronic devices produces a more complex interference in phonation. The test, based on a phenomenon observed by LEE (14), has been developed by AZZI (15) for application in detecting simulation of deafness or psychogenic deafness.

It must be mentioned that these tests find little or no use in cases of monaural simulation, whilst they do not permit to reveal the real threshold level except very approximately. These tests on the other hand are ideal in establishing beyond any doubt and often dramatically, as in the delayed speech test, the actual extent of malingerling.

For clarity's sake, a summary table follows, where the main features of each test are shown.

Type of test	Principle of test	Indications		Equipment required	Advantages	Disadvantages	Possibility of asserting the effective threshold
		mon. bal.	bin. bal.				
Psychogalvanic	recording of electrodermal potential	X	X	special	highly reliable (only in positive cases)	results not always reliable	yes
Capacitive probe test (v. Békésy)	recording of the frequency characteristics of the ear drum	X	X	special	absolute reliability (true objective test)	the frequency characteristics are related only to the mechanical devices of the middle ear. No inference on the function of the inner ear	no
Middle ear impedance measurement (Metz)	variation of the middle ear impedance due to the tensor tympani contraction	X	X	special	highly reliable (true objective test)		no
Cochlear reflexes	eliciting of palpebral or pupillary reflex	X	X	simple audiometer	simplicity	very poor reliability	no
Repeated threshold	repeating of threshold tests	X	X	simple audiometer	simplicity	uncertainty of the results	yes
Doerfler-Stewart	speech threshold test with or without background noise	X	X	simple audiometer	simplicity	uncertainty of the results	no
Stenger	masking of the opposite ear by a sound heard with alleged deaf ear	X		simple audiometer	extreme reliability		yes with high degree of accuracy

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Stenger with interrupted or warbled tone (Azzi)	same as Stenger	X		simple audiometer with tone interrupter or warbler	more evident results than usual Stenger		yes with high degree of accuracy
Localization of scattered sound sources	localization as a binaural hearing function	X		simple audiometer	simplicity	poor reliability	no
Binaural loudness balance (Fournier)	modified Stenger	X		simple audiometer	high reliability		yes with high degree of accuracy
Localization with delayed signals (Roeser)	localization as a time arrival function	X		special	high reliability		no
Alternate switching of signals in both ears (Calearo)	binaural integration and synthesis	X		special but not expensive	high reliability		no
Apparent modulation (Azzi)	binaural summation or „funneling“	X		special	high reliability		yes with high degree of accuracy
Lombard	disturbance of the auditive speech feedback loop	X	X	simple audiometer	fair reliability		no
Delayed speech feedback (Azzi)	Lee effect with delayed speech feedback		X	special	fair reliability		no

TESTS D'AUDITION DANS LA SIMULATION

Sous l'angle strictement technique, les tests de simulation peuvent se classer comme suit:

1) TESTS D'AUDIOMETRIE OBJECTIVE ABSOLUE

Ces tests établissent l'activité fonctionnelle d'une partie de l'oreille du sujet, sans exiger de ce dernier aucune participation, volontaire ou involontaire, à l'épreuve en cours. Ils sont effectués sur l'oreille moyenne, et l'activité des dispositifs mécaniques de cette partie de l'appareil auditif est contrôlée à l'aide de systèmes électroniques (sonde capacitive de V. Békésy).

2) TESTS D'AUDIOMETRIE OBJECTIVE INDIRECTE

Ces tests ne tiennent pas compte de la réponse verbale du sujet et se basent sur des réactions automatiques (neuro-végétatives ou musculaires) impossibles à dominer, déclenchées chez l'individu examiné par la perception du signal. On peut classer dans cette catégorie les tests basés sur des réactions psycho-galvaniques, pléthysmographiques et électro-encéphalographiques, ainsi que les tests basés sur l'étude des réflexes oculaires.

3) TESTS D'AUDIOMETRIE A REACTION SUBJECTIVE

Au cours de ces tests, le sujet est invité à donner une réponse discriminée en présence de systèmes d'essai ayant pour but de le tromper de différentes façons, ou bien de l'empêcher de réaliser la simulation de façon efficace.

Le plus simple de ces tests, c'est celui des seuils répétés.

Un autre test efficace, c'est celui de Carhart, basé sur l'évaluation de la divergence entre le seuil des tons purs et celui de la parole parlée. Celui de Doerfler-Stewart, basé sur le relevé de seuil de la parole en présence de bruit de masquage, s'avère moins probant.

A cette catégorie appartiennent en outre un grand nombre de tests bi-auriculaires, qui peuvent se subdiviser comme suit:

- a) tests basés sur le masquage du côté opposé.
Citons dans ce groupe le test classique de Stenger, dont l'efficacité peut être considérablement accrue si l'on emploie un ton modulé, ou mieux encore interrompu, à la place du ton continu.
- b) tests basés sur la localisation sonore et sur la balance des intensités.
Le simulateur ne connaît que rarement les simples lois physiologiques permettant, chez le sujet normal, l'expression d'un jugement directionnel. Il commet des fautes qui décèlent sa simulation au cours de l'épreuve.

Le plus efficace de ces tests, c'est celui de balance bi-auriculaire d'intensité proposé par Fournier. Une autre épreuve tout aussi efficace, proposée par Roeser, utilise un appareil spécial grâce auquel on parvient à envoyer à une oreille un signal retardé dans le temps par rapport à celui qui arrive à l'oreille opposée.

c) tests basés sur la sommation bi-auriculaire.

Le plus connu, et sans nul doute le plus efficace de ces tests, c'est celui de Calearo, qui se fonde sur l'évaluation de la différence d'intelligibilité d'un message verbal alternativement transmis à une oreille et à l'autre. L'épreuve en question n'exige qu'un dispositif peu coûteux, qu'on peut associer à tout audiomètre.

L'Auteur a élaboré de son côté un nouveau test, auquel il a donné le nom de „test de modulation apparente”. Il utilise un effet de sommation entre deux sons envoyés à l'oreille saine et, séparément, à l'oreille déclarée sourde. Le son envoyé du côté sain est d'une intensité considérable et ne permet pas à l'individu examiné d'avoir une perception subjective du son, beaucoup moins intense, envoyé à l'oreille déclarée sourde. Il se produit néanmoins une fusion entre les deux sons, que le sujet examiné perçoit additionnés et apparemment présents du seul côté sain. Si la sommation est perçue par l'individu (le son du côté sain semble modulé) cela prouve que l'oreille prétendue sourde ne l'est aucunement en réalité.

D) TESTS BASES SUR LE TROUBLE DU CONTROLE COCHLEO-PHONATOIRE

Ces épreuves se basent sur le fait que l'auto-contrôle de la phonation est intimement lié à l'efficacité de la fonction acoustique. Tout trouble de l'ouïe se répercute de façon plus ou moins grave sur la parole.

La plus classique des épreuves en question, c'est le test de Lombard, où le trouble provoqué dans l'audition compromet le contrôle de l'amplitude de l'émission verbale.

Le test de la voix retardée répond à un principe plus complexe: la voix de l'individu est ramenée à son oreille avec un certain retard, qui suffit à troubler considérablement la phonation si l'oreille est saine, et non sourde comme le prétend le sujet.

L'Auteur effectue une étude critique des différents tests, dont les caractéristiques sont ensuite récapitulées par un tableau synoptique conclusif.

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