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Searching For the Truth About Hearing

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Abstract

The search for the truth about hearing is an attempt to describe the facts about hearing, in accordance with the existing reality, regardless of previous depictions. Objective reality cannot be changed by the person describing it. Such a view was already presented by the great philosophers of antiquity – regarding ancient philosophy. This problem was already known and described: Plato (424-347 BC) claimed: "Someone tells the truth when and only when they say something that is and as it is. To speak as it is not is false." Aristotle (384-322 BC) drew attention to the importance of separating faith from knowledge. Faith does not require proof, it is unconditional, it does not require verification.

Keywords: Traveling wave theory; Middle ear amplification; Eardrum and the stapes plate; Sound wave pressure

Introduction

The search for the truth about hearing is an attempt to describe the facts about hearing, in accordance with the existing reality, regardless of previous depictions. Objective reality cannot be changed by the person describing it. Such a view was already presented by the great philosophers of antiquity – regarding ancient philosophy. This problem was already known and described: Plato (424-347 BC) claimed: "Someone tells the truth when and only when they say something that is and as it is. To speak as it is not is false." Aristotle (384-322 BC) drew attention to the importance of separating faith from knowledge. Faith does not require proof, it is unconditional, it does not require verification. Knowledge is changeable, requires evidence; counter-evidence, verification, and comparison are possible. Knowledge is not synonymous with truth. The truth is more important than knowledge on a given topic. Belief in knowledge at a given time can be an obstacle to learning the truth to which this knowledge relates. Science is about seeking the truth about what is and how it is, and rejecting falsehood when one says it is but it is not. These principles have not changed for 26 centuries, they are universal.

The Truth About Hearing

With regard to the issue of hearing, it is necessary to consider what is faith, what is knowledge, what is true and what is false. Leaving aside the belief itself (which mainly applies to people with no knowledge of hearing), there remains the analysis of what constitutes knowledge consistent with the truth. What is not true is false. Having searched for the truth about hearing for 30 years, I can say with full responsibility that the current, accepted knowledge about hearing is not true in some respects. The difference between the truth about hearing and accepted knowledge is significant. Knowledge about hearing, according to Bekesy's traveling wave theory, is based on assumptions from the turn of the 19th and 20th centuries [1]. It contains erroneous theses, has dubious calculations, and erroneous descriptions, which makes this knowledge partly inconsistent with the truth, i.e. it also contains falsehood. As a typical example of erroneous description and calculations, we can cite the knowledge presented by Bekesy and contained in a 2005 textbook on Audiology: Middle ear amplification - 3 mechanisms: Lever mechanism – 1.3-fold amplification. Amplification with the difference in the surface of the eardrum and the stapes plate – 17-fold

amplification. Conical shape of the eardrum – 2-fold amplification. In total, the amplification in the middle ear is 1.3 x 17 x 2 = 44-fold [2]. This is an increase in the sound wave pressure on the stapes plate by 44 times, or 33 dB, compared to the wave pressure exerted on the eardrum. According to the textbook theory propagated by Bekesy, an input sound wave with, for example, 90 dB and an amplitude of 500 nm increases 44-fold? Is this true? Or is it false? Another example is straightening a spiral cochlea into a straight tube to simplify calculations. In addition, Bekesy changed the anatomy of the inner ear. He eliminated Reissner's membrane and connected the atrial canal to the cochlear canal so that the sound wave could travel on both sides of the basilar membrane, creating a traveling wave on the basilar membrane. Changing the anatomy, changing the physiology of the inner ear, affects the calculations. Using a very simple method, Bekesy calculated the natural vibrations of the basilar membrane for a thin, dissected plate of the basilar membrane, which is not an independent entity. It vibrates together with the organ of Corti and the cochlear fluids. He assumed incorrect dimensions of the basilar membrane for the calculations. A basilar membrane measuring 0.1 mm wide cannot separate the cochlear canal from the tympanic canal, with 4.3 mm in diameter [3]. There are many examples of fallacies in Bekesy's traveling wave theory. There is no discussion about the currently accepted knowledge, no analysis of what is true and what is false? This knowledge is still propagated at the university level, reproduced in textbooks, and this is the knowledge received by otolaryngologists during their specialization training. The most important proof of the truth of the traveling wave theory is the belief in the perfection of Bekesy's theory, supported by the Nobel Prize in 1961. The Nobel Committee ruled that this theory explained all hearing-related problems. This theory did not and still does not properly explain many of the problems of our hearing.

These problems require analysis and evaluation: True or false?

The traveling wave theory recognizes only that the signal reaches the receptor through wave resonance, the basilar membrane, cochlear fluid flows, and the tip-link mechanism. High frequencies are not transmitted through this mechanism, as evidenced by stapedotomy surgery [4]. Humans can hear high frequencies up to 20 kHz. Bekesy's theory does not take into account the inertia in the wave motion in the middle and inner ear, which affects the transmission of information to the receptor. The rocking movements of the stapes hinder the transmission of high frequencies. The 100% transmission of information, necessary for hearing, is impossible. The resonance of the longitudinal wave in the cochlear fluid with the transverse wave of the basilar membrane's natural vibrations does not transmit all information. The force vectors of these waves act in directions perpendicular to each other. There is no transmission of 100% information. If the energy of the forcing wave is less than the attenuation energy of the forced wave – there will be no resonance. Such a situation arises when listening to near-threshold tones, when the amplitude of the forcing wave is 0.01-0.05 nm. This signal reaches the receptor via a different path, via the sound wave traveling directly to the receptor [5,6]. Is it true that in bone conduction, the signal from the bone is transmitted to the cochlear fluids, creating a traveling wave, fluid displacement, and the tip link mechanism works? Why can't the wave energy have conducted by the bone act directly on the hearing receptor, through sound-sensitive molecules? Sound wave energy is a specific stimulus for the hearing organ. Hair cells have receptors sensitive to a given sound wave frequency. They are located along the basilar membrane. How is information encoded as it travels through the cochlear fluids and the traveling wave? How does a traveling wave arise in the case of blockage of the oval window, or both windows in the case of otosclerosis or other inner ear pathologies? How and where does the maximum deflection on the basilar membrane occur for a 100 Hz wave? When the wavelength in the fluid is 14.5 m? There is no analysis of the difference in the speed of the sound wave in the cochlear fluid (1450 m/s) and the traveling wave speed on the basilar membrane, which varies from 50 m/s at the base of the cochlea to 2.9 m/s near the cap according to Bekesy). As a result, the resonance of each wave frequency in the fluid with the basilar membrane frequencies occurs at a different location on the basilar membrane and at a different time. Transmission of such information to the cochlear fluids is impossible. What information does the brain receive? How does the compression of information caused by the difference in the speed of the wave in the fluid and the traveling wave, varying from 29-fold to 500-fold, affect the transmission of information from the traveling wave to the cochlear fluids? How is it read by the receptor? Is it possible to view the traveling wave on the basilar membrane through a hole in the cochlear wall? In which duct is the hole? What do we see? Nature has placed the organ of Corti, with its hair cells, on the basilar membrane. The basilar membrane, tightly connected to the organ of Corti, cannot vibrate independently and create waves solely on the basilar membrane. Together with the basilar membrane, the organ of Corti, the hair cells with their hairs, the reticular membrane, and the fluid of the cochlear duct vibrate. What fluid flows are generated by the greatest deflection on the basilar membrane — vibrating in conjunction with the organ of Corti, the receptor, and the fluids? Does the vibrating basilar membrane with the greatest deflection transmit information to the cochlear fluid rotating in line with the basilar membrane, which tilts the rotating hairs of the hair cells in line with the rotating basilar membrane? This mechanism is responsible for the

transmission of information and for the gating of mechano-dependent potassium ion channels? The traveling wave on the basilar membrane is to encode not only amplitude and frequency, but also harmonic components, phase shifts, length of sound, and accent. This information is to be transmitted to the cochlear fluid and the tip link mechanism. This mechanism is supposed to transmit quantized energy, encoding the information contained in the sound wave [7]. The problem is compounded by the transmission of polytones and the music of great symphonic concerts, when at the same time we receive thousands of different pieces of information encoded in sound waves. How many maximum deflections can occur simultaneously on the basilar membrane? True or false? If the ion channels in the hair cell wall operate at a certain, limited, temporal rhythm, can they ensure the frequency of depolarization and cell contraction in an unlimited manner? Up to 200/s? (bat).

Measuring the frequency of OHC contractions with electric current is inappropriate. The ion channels of the cell wall that determine the frequency of depolarization and cell contractions are turned off. A signal introduced into the external auditory canal is measured as a receptor potential over a period of 1.5 ms. The signal's travel time through wave resonance, slow traveling wave, fluid flows, and the tip link mechanism is calculated and is approximately three times longer. This time depends on the path length and the procedures associated with energy conversions along the way. The decay of energy in a roundabout way should be taken into account – which has been confirmed by experimental studies. The amplitude decay of a 90 dB wave from the auditory canal to the oval window is 1000-fold. Energy decays a million-fold. Half of this path is the Bekesy path to the receptor, with a large decay in the amplitude and energy of the wave carrying auditory information [8]. It has not been explained how a traveling wave is formed for a threshold tone when the amplitude of the wave, after being reduced in the middle ear, is many times smaller than the diameter of the atoms that constitute the structure of the basilar membrane. In addition, vibrations in the fluid are attenuated. In the fluid of the spiral cochlea, there are three types of attenuation, as well as wave dispersion in the fluid. The energy of these waves, especially the high ones, reaches the receptor via a different route. There is a regulated amplification of quiet sounds intracellularly at the molecular level. The precise mechanism of quiet sound amplification, mechanically, through traction on the basilar membrane by contracting OHCs, has not been fully explained. Does every OHC contraction pull on the basilar membrane, regardless of the sound intensity? There is no mechanism for regulating the described procedure. Lack of clarity as to where the energy for high-frequency amplification comes from while accounting for inertia in the ear. Inertia in wave motion is directly proportional to the amplitude of the wave and to the mass of the vibrating element, and proportional to the square of the frequency. The vibrating mass in this case is the mass of the basilar membrane with the connective tissue on the lower surface of the basilar membrane, the mass of the organ of Corti, and the mass of the vibrating fluid together with the basilar membrane. For each amplitude of the wave, a different energy is required to cause vibrating mass constant vibration. On the other hand, increasing the frequency from 50 Hz to 5,000 Hz requires an increase in energy 10,000-fold. The electrochemical energy of the OHC cell membrane does not provide external energy. There is no such energy in OHC. Minor disturbances in the electrochemical potential of the excitable cell wall led to the death of this cell. There is no explanation as to what wave the contraction of OHC amplifies. During amplification – time-consuming, according to this theory – a completely alien wave is present on the basilar membrane, which may not require amplification. There are no calculations as to the energy required to pull on the basilar membrane at high frequencies? How are polytones amplified? Information about quiet sounds, amplified, delayed in time, is received separately by IHC? Is it together with the current wave on the basilar membrane? Are both waves transmitted to the brain together? There are many questions to which there is no clear answer. There are also proofs and answers, directly indicating what is true and what is false. There is no intermediate situation in nature, between truth and falsehood, just as there is no intermediate situation between one quantum of energy and another. Truth will prevail in the future regardless of the strength of resistance from certain elites interested in maintaining the status quo, with the acceptance of Bekesy's 100-year-old traveling wave theory. The reasoning behind this approach is difficult to understand. There is a view that a change of generation is needed to change the paradigm of hearing theory. confirms this hypothesis.

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