The origin of the tuning fork

R C Bickerton FRCS **G S Barr** FRCS *North Staffordshire Royal Infirmary, Stoke-on-Trent*

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John Shore and his pitch fork

The invention of the tuning fork is credited to James II's trumpeter and lutenist, John Shore in 1711[1]. He was famous at the time for his playing, and Handel – who was then court composer – wrote many of the more florid trumpet parts for him. Unfortunately, at one of these concerts he split his lip and was 'ever after unable to perform'[2]. Shore, being a man and musician of many parts, turned his attention to the lute and it was for this instrument that he devised his tuning fork[3]. Apparently he was a humorous character and at the start of any performance would commence by saying, 'I never go anywhere without my pitch fork', before beginning the then novel practice of using it to tune his instrument.

John Shore gave Handel one of his forks, which is still in existence today[4]. It gives the pitch C at 512 vibrations per second, equivalent to A at 422.5 Hz. The existence of this tuning fork allows musicologists to place the exact pitch at which Handel, Mozart, Beethoven and their contemporaries intended their works to be heard.

During the 19th century the standard pitch rose by at least a semi-tone, from A at 422.5 to 452 Hz, a standard known as the Philharmonic Pitch. By the end of the last century an official European Standard was set by the French government at 435, known as the International Pitch in France and the New Philharmonic Pitch in this country[5].

Interestingly, the instruments of English military bands remained at the old Philharmonic Pitch, and it was only through the strenuous efforts of a Colonel Somerville that in 1929 the British Army finally accepted the International Standard, so allowing French and British bands to play together[6]. Colonel Somerville must have died a happy man, with the sound of massed bands ringing in his ears.

The tuning forks in clinical use today are based on the so-called 'philosophical' or 'scientific' pitch stated in terms of C at 512, which accords with Handel's A at the original figure of 422.5 Hz.

Handel's tuning fork and the Foundling Hospital

Handel gave a tuning fork to the Foundling Hospital in 1751[5], but its exact whereabouts were not stated. The hospital was the first establishment intended specifically for children in Britain. It was founded by a retired sea captain, Thomas Coram, in 1742 after he had been frequently shocked by the sight of so many abandoned children dying in the streets of London[7]. Boys were kept in the west wing and girls in the east, only meeting once a year on Christmas Day; segregation continued after death, with two mortuaries – one for each sex. However, news about the existence of the hospital spread throughout the country and children appeared in droves.

Initially entry was on a 'first come, first served' basis, but this caused street disturbances when disappointed mothers were asked to take their children elsewhere. The governors decided to introduce a balloting scheme. Each mother drew a coloured ball from a leather bag: white signalled admission, black meant that mother and child were asked to leave, and a red ball entitled a child to be put on a waiting list in case one of the 'white' children was suffering from an infectious disease. An admission system that might just appeal to some unit administrators today.

Thomas Coram raised funds by encouraging many well known artists to become patrons. They included Hogarth, Reynolds and Gainsborough, and their close association exhibiting their pictures in the hospital encouraged them to found the Royal Academy in Piccadilly. Dickens visited the hospital and Handel raised £7000 by giving performances of the *Messiah*. It was after one of these that he gave his tuning fork to the hospital.

The hospital was situated just to the north of Great Ormond Street but was completely demolished in 1926. Only the entrance arcades remain, the site now being used as a children's playground. Many of the possessions were moved to 40 Brunswick Square. When we called to enquire about the existence of Handel's tuning fork, the initial response was, 'we do have a few of his things'. These included original manuscripts, a harpsichord and his tuning fork (Figure 1).

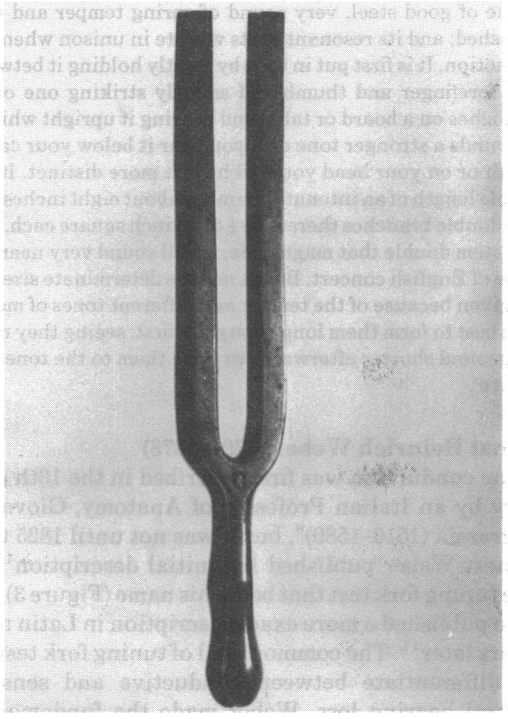

Figure 1. Handel's tuning fork. (Photographed with the kind permission of the Directors of the Thomas Coram Trust)

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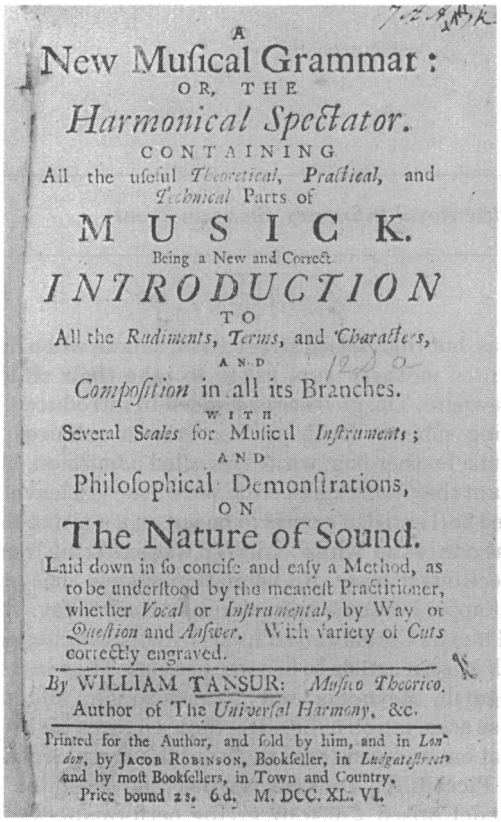

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Figure 2. An early description of the tuning fork appeared in this book by William Tans'ur in 1746. (Reproduced with kind permission of the British Library, British Museum, London WC1)

A New Musical Grammar, 1746

The first description we could find of the tuning fork was in a book by William Tans'ur[8] published 35 years after its invention (Figure 2). It was named an intonator or retonator and described as:

'An elastic sounding instrument of one tone, of late invention and used to set other instruments to concert pitch. It is made of good steel, very sound of spring temper and well polished; and its resonant parts vibrate in unison when put in motion. It is first put in tone by lightly holding it between the forefinger and thumb and smartly striking one of its branches on a board or table and bearing it upright while it resounds a stronger tone or if you hear it below your ear or tooth or on your head you will hear it more distinct. If the whole length of an intonator be made about eight inches and the double branches thereof be $\frac{1}{8}$ of an inch square each, and the stem double that magnitude, it will sound very near the tone of English concert. But as no true determinate size can be given because of the temper and different tones of metal, it is best to form them long enough at first, seeing they must be ground shorter afterwards to raise them to the tone you desire'.

Ernst Heinrich Weber (1795–1878)

Bone conduction was first described in the 16th century by an Italian Professor of Anatomy, Giovanni Ingrassia (1510–1580)[9], but it was not until 1825 that Ernest Weber published his initial description[10] of the tuning fork test that bears his name (Figure 3). He also published a more exact description in Latin nine years later[11]. The common goal of tuning fork tests is to differentiate between conductive and sensorineural hearing loss. Weber made the fundamental observation that, in some cases of deafness, when the tuning fork was placed anywhere on the midline of the skull it was heard in the worse hearing ear – as would be the case in a patient with a conductive hearing loss.

Figure 3. Ernst Heinrich Weber (1795–1878)

Weber was a Professor of Anatomy and Physiology at Leipzig University, and in collaboration with his brother also described the action of the vagus on the heart. He was never interested in the practice of medicine, but he believed his physiological experiments with the tuning fork would one day be used for the diagnosis of ear disease[12]. In fact it took a decade for his idea to be taken up by clinicians. It was the French army doctor Jean Pierre Bonnafont (1805–1885), who also popularized the myringotomy, who introduced Weber's experiment as a diagnostic test[13].

Heinrich Adolf Rinne (1819–1868)

It would be difficult to think of a more German-sounding name than Heinrich or Adolf, yet generations of doctors and medical students have pronounced Rinne's surname as if there was an acute accent above the 'e'. Rinne [rin'neh] *was* German, not French (Figure 4). Why has this self-perpetuating error come about? The reason is probably a typesetting error in a 19th century otology textbook, follow-

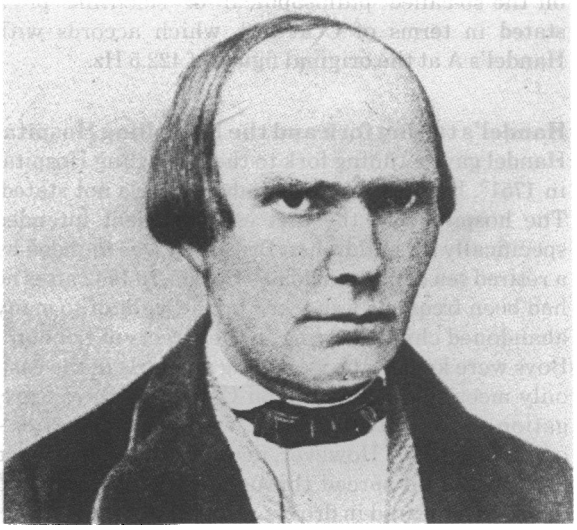

Figure 4. Heinrich Adolf Rinne (1819–1868)

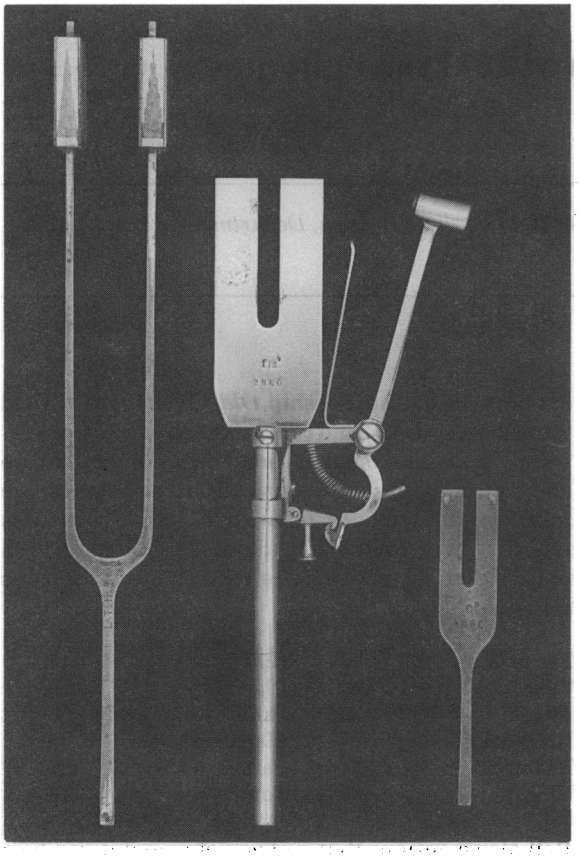

Figure 5. Tuning forks of the otologists Politzer, Bezold and Lucae. (Reproduced with kind permission of the Institute of Laryngology and Otology, London)

ing the misprinting of an accent for an apostrophe in the expression 'Rinne's Test' (*Bickerton and Milton's Biographical History of ENT*, The Vade-Mecum Press, in preparation). Successive reference books, including the American *Dorland's Medical Dictionary*[14], continued the error [rin'nez]. The English *History of Otolaryngology*[15] by Scott Stevenson, better known for counting the number of nameplates in Harley Street[16], got it right.

Rinne's tuning fork test compared bone conduction with air conduction on the same side. In 1885 he published a series of 22 different experiments[17]. The following is a translation of the first:

'An experiment which can be easily performed shows how much less the conduction by the skull bone is, than the normal conduction by air. I press a vibrating tuning fork against the upper incisors and keep it in this position until the sound, which was in the beginning very clear, becomes inaudible to me. Then I hold the tuning fork in front of the external ear and I again hear the sound with great intensity. Only after a considerable time does it disappear from there. In every person with healthy ears on whom I repeated this experiment the result was the same. If put at the lower jaw, the tuning fork can be heard a little bit longer. This is to be explained by the position of the joint in close vicinity to the ear.

This experiment may be used for diagnostic purposes in cases of deafness. If the result of this experiment performed on a deaf person is the same as on a normal one, then we are justified in concluding that the condition of the entire conduction apparatus is normal. Therefore, the auditory nerve must be the diseased part. If, however, the patient hears the sound transmitted by the bone as long or even longer than he hears it in the normal way, then we have to assume a disease of one of the parts of the conduction apparatus including the membrana of the fenestra ovalis.'

Adolf Rinne was an unusual character. He worked first as a general practitioner in Göttingen, later being employed in a lunatic asylum[18]. A list of some of his papers gives an insight into his unconventional scientific mind: 'On the organ of voice and formation of voice' in 1850; 'On the shape of the Firmament' in 1864; and 'Materialism and the ethical desire', published in 1868, before his death the same year of dysentery. In spite of his excellent description and advice on the clinical application of his tuning fork test, it took a quarter of a century before Friedrich Bezold and August Lucae popularized it in the 1880s.

The historical collection at the Institute of Laryngology and Otology has a number of early tuning forks belonging to well known otologists. The imposing example in the centre of Figure 5 belonged to Bezold and vibrates at 2860 vibrations a second. One could imagine that the pitch of the cry from catching a finger in the hammer would comfortably exceed this.

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(Accepted 26 March 1987. Correspondence to Mr R C Bickerton at the North Staffordshire Royal Infirmary, Stoke-on-Trent ST4 7LN)