Robert M. Dawley
Purdue University
West Lafayette, Indiana

Medical Research in Music: Foundation for a Theory of Music Instruction

Introduction

The purpose of this study was to ascertain the significant findings of medical science concerning musical learning and physiology, the rationale being that this research could form the basis for a theory of music instruction. The procedure consisted of a content analysis of the international medical literature for the years 1971-1983 by means of a computer based information search of MEDLINE (MEDLARS ONLINE), using various combinations of relevant descriptors. Reliability checks were made by reviewing Index Medicus and inspecting research journals from the medical literature.

Seven hundred sixty-three studies grouped into seven broad areas of research activity pertaining to music were identified:

	number of studies	%
(1) Physiology of instrumental musicians	104	14%
(2) Physiology of vocalists	23	3%
(3) Psychoacoustics of music	181	24%
(4) Music therapy	119	15%
(5) Music history	90	12%
(6) Physicians' musical lives	22	3%
(7) Miscellaneous	224	29%

Physiology of Instrumental Musicians

In a recent medical study, Harman (1982) attacked the music education profession on two grounds: (1) music educators are ignorant of physiology and teach harmful techniques, postures, and synergies which actually cause medical problems; and (2) the music education research literature is a wasteland devoid of empirical or case studies and merely consists of a tradition of biased opinions of music teachers handed down from generation to generation. Numerous things are wrong with these conclusions. Harman incorrectly assumes there is a direct cause and effect relationship between teaching procedures and disease, when the medical studies she cites do not indicate this relationship. In fact, she fails to mention any medical research on malocclusion, an area which is weighted in favor of music teaching procedures. Also, she cites no research studies from music education research journals. Although her indictment is too strong, nevertheless, it shows the confusion which results when medical researchers treat music *in vacuo*, without careful interdisciplinary consultation and collaboration. It also shows the necessity of music educators being cognizant of medical research in music so that teaching practice checks medical theory, and the importance of collaborating in research studies so that medical theory can check music teaching practice.

Medical research on the physiology of instrumental musicians consists of 104 studies (14 percent) for the period reviewed and can be grouped into studies which are biochemical or physiopathological. For example, Pearson and Simpson (1979) examined the effect of oxprenolol on stage fright in 24 healthy career string players aged 18-47 from the London colleges and academies of

music. Using a conventional two-way crossover double-blind design, this study indicated that, when solo recitalists were premedicated with oxprenolol, they had lower pulse rates and blood pressures, felt calmer before performing, and were more pleased with their performances than when they had the placebo treatment. Assessment by two independent adjudicators elicited a significant improvement in performance concerning left-hand and right-hand technique, intonation, and tremor when recitalists were premedicated with oxprenolol. Memory showed no significant difference. Liden and Gottfries (1974) conducted a similar study concerning alleviating anxiety while playing in a symphony orchestra. These studies strengthen the case for using beta-adrenoreceptor-blocking drugs in normal individuals subject to acute emotional stress.

Such studies are of importance to music educators: (1) music performance teachers need to know of therapies to alleviate stage fright; and (2) exemplary studies, such as Pearson and Simpson, can serve as models for research in music. At the Eighth International Seminar on Research in Music Education, Christoff (1981) eloquently described the need for well designed and statistically accurate music studies which are reported in enough detail so as to be replicated by other researchers at other locations, precisely what the medical research model supplies.

Research in the physiopathology of music falls into these areas: (1) malocclusion and oral-intraoral pressure problems; (2) respiratory stress; (3) cardiac irregularities; (4) dermatitis; (5) nerve compression syndromes; and (6) muscular-joint cramps and paresis.

Studies dealing with tooth movement are of particular interest to the wind performance teacher. Herman (1981) conducted a 2-year longitudinal investigation at five New York City junior high schools on ninety-one 11- to 13-year-old

children starting wind instruments to determine what tooth movement resulted from playing certain winds. Thirty-six noninstrumentalists served as controls. Significant results were obtained:

1. Cup-shaped mouthpieces (trumpet and horn):
   a. reduce overjet
   b. decrease overbite in a 2-year period
2. Single-reed mouthpieces (clarinet and saxophone):
   a. increase overjet
   b. increase overbite
3. Double-reed mouthpieces (oboe and bassoon):
   a. reduce overjet
   b. increase overbite
4. Mouthpieces with small openings (flute and piccolo):
   a. reduce overjet
   b. increase overbite

Herman concluded that the playing of a wind instrument can serve as an adjunct to the dentist or orthodontist in trying to accomplish certain tooth movements and these specialists can now suggest more than one wind instrument to help with most changes in overjet or overbite.

The importance of the music teacher, student-patient, and physician working together has been underscored by Herman (1974) and by Rieder (1976). Herman referred to possible deleterious effects from playing the violin or viola for long periods of time without rest and his studies suggest that some subjects may have cross-bite malocclusion, some premature degenerative temporomandibular joint pain, and/or the habit of jaw clenching as a result of holding the instrument under the chin. Rieder reported a similar case in which a 20-year-old violinist also suffered from chronic headaches as a result of habitual clenching of the jaw muscles and recommended routine occlusal and temporomandibular joint examinations.

A number of studies measure the oral and intra-oral pressures which occur while playing wind instruments. For example, Dibbell, Ewanowski, and Carter (1979) studied velopharyngeal stress incompetence which occurs when the soft palate collapses under the stress of air pressure thus causing air to leak and the wind player to abort performing.

Closely related to oral-intraoral pressure are studies dealing with respiratory stress and cardiac irregularities. Wind players sometimes experience dizziness and blackouts after performing extended passages in the high range. Davis (1975) found that this is due to respiratory stress. Medical researchers have not established a cause and effect relationship between playing wind instruments and cardiac irregularities; however, they have studied the occurrence of such abnormalities in wind players while performing. Nizet, Borgia, and Horvath (1975) found premature ventricular contractions and a high incidence of wandering pacemaker activity in hornists. Tucker, Faulkner, and Horvath (1971) studied the lung function in brass players and found tachycardia, arrhythmias, and arterial blood pressure changes. They recommended medical diagnosis of circulatory stress by means of electrocardiograms taken while brass players are performing long musical passages.

Medical research has been devoted to a number of diseases and conditions in the area of dermatitis. Violinists and violists often experience fiddler's neck which is a rash and chafing of the skin caused by rubbing the neck on the chinrest. Peachey and Matthews (1978) and Stern (1979) have researched this condition. Similar problems have been recently reported as case histories in the correspondence section of the British Medical Journal: flautist's chin (Dahl, 1978); (Gardner, 1978); clarinetist's chelitis (Hindson, 1978); guitar nipple (Curtis, 1974); and cello scrotum (Murphy, 1974). These studies are good sources for prevention and

treatment and underscore the importance of using correctly student-proportioned instruments, effective pedagogy, and caution against over-exertion in practicing.

Various nerve compression syndromes also have been newly reported: viol paraesthesia (Schwartz and Hodson, 1980); occupational palsy (Mladinich and Dewitt, 1974); and flautist's neuropathy (Cynamon, 1981). These studies emphasize the value of research reporting case studies.

Muscular-joint cramps and paresis are closely related to nerve compression syndromes and researchers sometimes are uncertain concerning the specific cause of a condition. For example, Bird and Wright (1981) reported a case study of a classical guitarist who had been incorrectly diagnosed as suffering from tendonitis, when the condition was actually due to traumatic synovitis, a joint disease. Cynamon (1981) reported incidences of tendonitis and lower back pain in musicians. Brattberg and Fagius (1978) related a case study of a guitarist's cramp. The older medical literature, as reported by Singer (1932), is filled with case histories of cramps among violinists, pianists, organists, cellists, harpists, flautists, clarinetists, trumpeters, and drummers. These conditions are so common that most instrumental music teachers have encountered them; thus enlightened medical opinion is most appropriate for developing effective pedagogic strategies and thereby preventing any possible physical damage from incorrectly applied techniques.

Physiology of Vocalists

In the area of physiology of vocalists, twenty-three studies (3 percent) were found for the years 1971-83. These mainly discuss various voice

medical examination procedures (Gross, 1981); and/or describe adverse effects of tonsillectomy on singers (Flach, Heidelbach, and Schwickardi, 1980). The study by Sataloff (1981), however, is particularly important for singers since specific guidelines are presented concerning caring for the singing voice: avoid singing in noisy, dry, dusty, and smoky places; avoid smoking and cheerleading. Treatments for reflux laryngitis, anxiety, muscle spasm, voice abuse, vocal nodules, and infectious laryngitis in the professional singer are detailed.

Psychoacoustics of Music and Music Therapy

Recent medical studies in the psychoacoustics of music deal with musical perception and music aptitude and are the medical studies that seem familiar to music education researchers. Many treat musical listening and the psychological effects of rock music. Overall, the literature consists of 181 (24 percent) studies which are audiological, clinical, psychoanalytic, psychophysical, neuropsychological, neurosurgical, and neuropathological. Most of these are interactive studies, thus there is a great deal of overlapping between subject matter and specialities, such as music therapy, i.e., 119 studies (15 percent). For example, Lowenstein (1982) found music listening to be an effective therapy in treating extreme shyness in maladjusted children. Heyde and von Langsdorff (1983) concluded that art and music therapy coupled with psychotherapy that included relaxation exercises and group talks were effective therapies in the rehabilitation of cancer patients. The therapeutic use of music in neurology has been detailed by Morley (1981), in psychiatry by Nielzen (1982), in internal medicine by Huppmann (1977) and

Lasky (1982), in the operating room by MacClelland (1979), and in dentistry by Skjerve (1981) and Corah (1981).

Audiological and psychoacoustical studies still tend to deal with isolated pitches (Turner, Burns, and Nelson, 1983), and two-tone complexes (Houtsma, 1979), totally removed from a real musical setting of melody or harmony; thus it is difficult to generalize concerning the external validity of such research for a theory of music instruction. Some studies, however, attempt to use musical settings. For example, Kalmus and Fry (1980) studied dysmelodia (tune deafness) using a distorted tunes test of British melodies and concluded that some deep structure of tonality, comparable to Chomsky's deep language structure, must be operating since Asians who have not been previously exposed to such melodies found the test very difficult compared with Britishers.

Fifty-three (7 percent) of the clinical studies deal with the psychophysical effects of rock music, particularly harmful decibel levels, (e.g., Nakamura, 1977; Bohne, 1976). For music educators, these studies offer significant findings regarding music listening and aid in defining the aesthetics of music versus noise in music listening, thus establishing parameters for musical taste.

Neuropsychological research in music consists mainly of 72 studies (9 percent) in cerebral dominance based upon three viewpoints: (1) right hemisphere mediation of music (McDonough, 1973); (2) left hemisphere mediation of music (Spreen, 1973); (3) bilateral mediation (Gates and Bradshaw, 1977). In reviewing the early clinical literature, Gates and Bradshaw found evidence for left hemisphere control: in the sequencing of manual activity (Lomas and Kimura, 1975); motor control (Sussman, MacNeilage, and Lumbley, 1974); and in the properties of speech important for musical abilities, i.e., temporal order, duration, simultaneity, and rhythm (Krashen, 1973). They con-

cluded that the assumption of right hemisphere dominance of musical ability is over-simplified: "One hemisphere should not be regarded as 'dominant' for music, but rather each interacts with the other, operating according to its own specialization." Recent medical studies still seem divided and the scientific results appear to be inconclusive, needing further case histories and replication, and depend upon the specificity and difficulty of the musical task studied, as well as the neuropsychological measurement used. For example, Musiek, Pinheiro, and Wilson (1980) studied auditory perception in three "split brain" patients and found that for a correct verbal report of an auditory pattern, interhemispheric transfer of acoustic information is required, while "humming" the pattern does not. McFarland and Fortin (1982) in a case study of an accomplished organist suffering from amusia (organic brain disease which impairs musical capacity) found evidence of right hemispheric dominance for musical execution, relatively independent of musical knowledge and training. On the other hand, Tasaki (1982) studied nineteen college music majors and found that different degrees of musical training affect the perception of melodic stimuli. In the early stages of musical training, melodies are perceived as a whole and are processed in the right hemisphere, but musically expert individuals (trained musicians) perceive melodies by breaking down tonal sequences by processing them in the left hemisphere. Tasaki suggests that musical training brings about this shift of hemispheric lateralization in melodic perception. In an earlier study, Brust (1980) had warned that this view was an over-simplification and Morais (1981) stated that the dichotic listening test (such as used by Tasaki) cannot predict cerebral dominance in normal subjects. The inconsistencies in empirical method and data and speculative nature of research in cerebral dominance require one to take care in

using such research results in developing a theory of music instruction. However, the important points are that medical researchers place value on music and find it fascinating enough to warrant expenditures of time, personnel, and money; thus music educators should be more directly involved in joint studies with medical researchers.

Music History

The ninety research studies in music history (12 percent) consist of personality profiles and medical histories of both renowned and unknown composers. The researchers Schubert, Wagner, and Schubert (1977) examined the families of 80 classical music composers and found that renowned composers were predominantly firstborn children, or indeed the only child in their family. Cytowic (1976) reported on a retrospective case history of Maurice Ravel who at age 58 was stricken with aphasia making him incapable of expressing his musical ideas through either composing or performing. Hemispheric lateralization for verbal (linguistic) and musical thinking is offered as an explanation.

Analysis of the medical literature (1971-83) elicited the following number of studies on renowned composers:

Beethoven	11	Gesualdo	1
Multiple general biographies	4	Handel	1
Chopin	4	Haydn	1
Paganini	4	Janacek	1
Mozart	3	Machaut	1
Schumann	3	Mahler	1
Berlioz	2	Ravel	1
Borodin	1	Szymanowski	1
Gershwin	1	Wagner	1

Renowned folk and jazz composers seemed to be noticeably absent from the medical literature, and appear to be a significant area for future research.

Physicians' Musical Lives

Twenty-two medical research studies (3 percent) dealt with physicians' musical lives. For example, Shampo (1975) analyzed the life of the physician-composer, Alexander Borodin. P'asztor (1982) in a lecture on the personality of neurosurgeons concluded: "Appreciation of literature, art, and music, and interest in other sciences than our professional knowledge, enrich the personality." These studies are evidence of the high value placed upon music by the medical profession.

Miscellaneous

The 224 studies (29 percent) in the miscellaneous category include philosophical, psychological, and sociological research articles dealing with a wide variety of topics: content analysis of song lyrics (Rocchietta, 1982); creativity training (Khatena, 1972); music composition (Bradshaw, 1981); ethnomusicology and sociology of music (Buhrmann, 1981); pedagogy of teaching music reading (Flynn, 1982); aesthetics and music appreciation (Cantor, 1973); musical taste (Colter, 1971); and various replications of studies having a socio-musico-medico orientation. Since music education researchers appear to be most active and familiar with medical research in this area, as well as in the area of psychoacoustics, a detailed description will not be presented here.

Conclusions

The inclusion of music research studies in the international medical research literature points up a number of important considerations for music educators. The value of music and a musical education is enormous, more so than many music educators realize, and it is particularly significant when notable medical authorities proclaim their high regard for the art of music. Medical opinions are highly prized by society and can be used as ammunition for public support of music education and the musical arts. On the other hand, negative medical opinions on music are symptomatic of researchers operating *in vacuo* without being aware of the real problems of music practitioners. Many of these problems appear not to be neat, discrete ones with simple solutions; rather they are complex and require interdisciplinary research to arrive at reasoned solutions. To help facilitate communication between the medical and music education professions it is necessary that music educators also become familiar with medical research in music. Courses in research in music need to include reviews of this important literature, for medical studies can serve as exemplary scientific research models and as scholarly theoretical treatises. Journals like the *New England Journal of Medicine* and the *British Medical Journal* regularly include a section for continuing correspondence between medical researchers and practitioners concerning case histories and medical research findings. This dialogue and the emphasis on case studies would be of enormous assistance to problem solution, research dissemination, and professional communication in our music education research journals. It is also interesting to note that medical indices selectively include studies

relating to medicine from psychology and sociology, thus further helping information retrieval and research dissemination. Music research which is published in music education research journals is not included in Index Medicus, even though many of the studies have as much and even more medical basis than studies published in sociology journals. Indexing music education research journal articles in medical indexes would enhance the status of the music education profession as well as encourage interdisciplinary research. It is also recommended that more music researchers publish their studies in the medical literature.

References

Bird, H.; Wright, V. Traumatic synovitis in a classical guitarist: a study of joint laxity. Annals of Rheumatic Diseases, 1981, 40, 161-3.

Bohne, B. Irreversible inner ear damage from rock music. Transactions; American Academy of Ophthalmology and Otolaryngology, 1976, 82, 50-9.

Borgia, J.; Horvath, S.; Dunn, F.; Von Phul, P.; Nizet, P. Some physiological observations on french horn musicians. Journal of Occupational Medicine, 1975, 17, 696-701.

Bradshaw, S. Music Composition. A psychological view. Bulletin of the Meninger Clinic, 1981, 45, 62-4.

Brattberg, A.; Fagius, J. Guitarist's cramp -analogous to writer's cramp. Lakartidningen, 1978, 75, 4039-40.

Brust, J. Music and language: musical alexia and agraphia. Brain, 1980, 103, 367-92.

Buhrmann, M. et al. 1. The Xhosa healers of Southern Africa. 2. The songs sung in a healing ceremony. Journal of Analytical Psychology, 1981, 26, 297-312.

Cantor, J. et al. The effect of affective state and emotional arousal on music appreciation. Journal of General Psychology, 1973, 89, 97-108.

Christoff, D. For a renewal of scientific agreements for reliability and evaluation of experimental musical and psychological research. Bulletin of the Council for Research in Music Education, 1981, 66-67, 116-119.

Colter, V. et al. A nonverbal technique for studying music preference. Journal of Experimental Child Psychology, 1971, 11, 357-65.

Corah, N. et al. Relaxation and musical programming as a means of reducing psychological stress during dental procedures. Journal of the American Dental Association, 1981, 103, 232-4.

Curtis, P. Guitar nipple. British Medical Journal, 1974, 2, 226.

Cynamon, K. Flutist's neuropathy. New England Journal of Medicine, 1981, 305, 961.

Cytowic, R. Aphasia in Maurice Ravel. Bulletin of the Los Angeles Neurological Society, 1976, 41, 109-14.

Dahl, M. Flautist's chin: a companion to fiddler's neck. British Medical Journal, 1978, 2, 1023.

Davis, S. Stressed musicians. New England Journal Of Medicine, 1975, 292, 1197.

Dibbell, D.; Ewanowski, S.; Carter, W. Successful correction of velopharyngeal stress incompetence in musicians playing wind instruments. Plastic and Reconstructive Surgery, 1979, 64, 662-4.

Flach, M; Heidelbach, J.; Schwickardi, H. Adverse effects of tonsillectomy in singers. Folia Phoniatrica, 1980, 32, 342-6.

Flynn, P. et al. Photographic enlargement of printed music: technique, application, and implications. Gerontologist, 1982, 22, 540-3.

Gardner, L. Flautist's chin. British Medical Journal, 1978, 2, 1295.

Gates, A; Bradshaw, J. The role of cerebral hemispheres in music. Brain and Language, 1977, 4, 403-431.

Gross, M. The measuring of voice area, a method of examination for the otolaryngological practice. Larynøgologie, Rhinologie, Otologie, 1981, 60, 36-8.

Gualtieri, P. May Jonny or Janie play the clarinet? American Journal of Orthodontics, 1979, 76, 260-275.

Harman, S. Occupational diseases of instrumental musicians, literature review. Maryland State Medical Journal, 1982, 6, 39-41.

Herman, E. Dental considerations in the playing of musical instruments. Journal of the American Dental Association, 1974, 89, 611-619.

_____ Influence of musical instruments on tooth positions. American Journal of Orthodontics, 1981, 80, 145-55.

_____ Orthodontic aspects of musical instrument selection. American Journal of Orthodontics, 1974, 65, 519-530.

Heyde, W.; von Langsdorff, P. Rehabilitation of cancer patients including creative therapies. Rehabilitation, 1983, 22, 25-7.

Hindson, T. Clarinetist's chelitis. British Medical Journal, 1978, 2, 1295.

Houtsma, A. Musical pitch of two-tone complexes and predictions by modern pitch theories. Journal of the Acoustical Society of America, 1979, 66, 87-99.

Huppmann, G. et al. Possibilities of music therapy in internal medicine. Medizinische Klinik, 1977, 72, 2186-99.

Kalmus, H.; Fry, D. On tune deafness (dysmelodia): frequency, development, genetics and musical background. Annals of Human Genetics, 1980, 43, 369-82.

Khatena, J. Training music majors in college to think creatively with sounds and words. Psychological Reports, 1972, 30, 105-6.

Krashen, S. Mental abilities underlying linguistic and non-linguistic functions. Linguistics, 1973, 115, 39-55.

Lasky, I. Medicine and music. New York State Journal of Medicine, 1982, 82, 1862-4.

Liden, S.; and Gottfries, C. Beta-blocking agents in the treatment of catecholamine-induced symptoms in musicians. Lancet, 1974, 2, 529.

Lomas, J.; Kimura, D. Intrahemispheric interaction between speaking and sequential manual activity. Research Bulletin No. 314. London, Canada: University of Western Ontario, Department of Psychology.

Lowenstein, L. The treatment of extreme shyness in maladjusted children by implosive, counselling and conditioning approaches. Acta Psychiatrica Scandinavica, 1982, 66, 173-89.

MacClelland, D. Music in the operating room. AORN Journal, 1979, 29, 252-60.

McDonough, S. The psychology of musical processes as a function of the two cerebral hemispheres and handedness. Unpublished M.S. thesis, University of Edinburgh, 1973.

McFarland, H.; Fortin, D. Amusia due to right temporoparietal infarct. Archives of Neurology, 1982, 39, 725-7.

Mladinich, E.; Dewitt, J. A newly recognized occupational palsy. Journal of the American Medical Association, 1974, 228, 695.

Morais, J. The dichotic listening test in the determination of cerebral dominance in normal subjects. Acta Neurologica Belgica 1981, 81, 144-52.

Morley, J. Music and neurology. Clinical and Experimental Neurology, 1981, 17, 15-25.

Murphy, J. Cello scrotum. British Medical Journal, 1974, 2, 335.

Musiek, F.; Pinheiro, M.; Wilson, D. Auditory pattern perception in "split brain" patients. Archives of Otolaryngology, 1980, 106, 610-2.

Nakamura, K. et al. Noise-induced sudden deafness from discotheque sound. A case report. Nippon Jibiinkoka Gakkai Kaiho, 1977, 80, 729-31.

Nielzen, S. et al. The emotional experience of music by psychiatric patients compared with normal subjects. Acta Psychiatrica Scandinavica, 1982, 65, 450-60.

Nizet, P.; Borgia, J.; Horvath, S. Wandering atrial pacemaker (prevalence in french hornists). Journal of Electrocardiology, 1976, 9, 51-2.

P'asztor, E. European Association of Neurosurgical Societies. Third European Lecture. Naples, 23 April, 1982. Some aspects of personality of the neurosurgeon.

Peachey, R.; Matthews, C. Fiddler's neck. British Journal of Dermatology, 1978, 98, 669-74.

Rieder, C. Possible premature degenerative temporomandibular joint disease in violinists. Journal of Prosthetic Dentistry, 1976, 35, 662-4.

Rocchietta, S. Patients, physicians, pharmacists, hospitals and poisoning in popular songs from Lombardy and Piedmont. Minerva Medica, 1982, 73, 2686-7.

Sataloff, R. Professional singers: the science and art of clinical care. American Journal of Otolaryngology, 1981, 2, 251-66.

Schubert, D.; Wagner, M.; Schubert, H. Family constellation and creativity: firstborn predominance among classical music composers. Journal of Psychology, 1977, 95, 147-9.

Schwartz, E.; Hodson, A. A viol paraesthesia. Lancet, 1980, 2, 156.

Shampo, M. et al. Alexander Borodin. Journal of the American Medical Association, 1975, 234, 721.

Singer, K. Diseases of the Musical Profession: A Systematic Presentation of their Causes, Symptoms and Methods of Treatment. trans. by W. Lakond. N.Y.: Greenberg, 1932.

Skjerve, J. et al. The use of music to traquilize in the dental treatment of the mentally retarded. Norske Tannlaegeforenings Tidende, 1981, 91, 49-51.

Spreen, O. The contribution of Arnold Pick. In H. Goodglass and S. Blumstein, eds. Psycholinguistics and Aphasia. Baltimore: Johns Hopkins Press, 141-170.

Stern, J. The edema of fiddler's neck. Journal of the American Academy of Dermatology, 1979, 1, 538-40.

Sussman, H.; MacNeilage, P.; Lumbley, J. Sensorimotor dominance and the right-ear advantage in mandibular-auditory tracking. Journal of the Acoustical Society of America, 1974, 56, 214-216.

Tasaki, H. Perception of music stimuli by the dichotic listening test-studies on college students making a specialty of music. No To Shinkei. Brain and Nerve, 1982, 34, 1051-7.

Tucker, A.; Faulkner, M.; Horvath, S. Electrocardiography and lung function in brass instrument players. Archives of Environmental Health, 1971, 23, 327-34.

Turner, C.; Burns, E.; Nelson, D. Pure tone pitch perception and low-frequency hearing loss. Journal of the Acoustical Society of America, 1983, 73, 966-75.