HEARING MUSIC

Noise and the classical musician

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Abstract

***Objectives*—To test the hypothesis that noise exposure may cause hearing loss in classical musicians.**

***Design*—Comparison of hearing levels between two risk groups identified during the study by measuring sound levels.**

***Setting*—Symphony orchestra and occupational health department in the west Midlands.**

***Main outcome measures*—Hearing level as measured by clinical pure tone audiometry.**

***Results*—Trumpet and piccolo players received a noise dose of 160% and 124%, respectively, over mean levels during part of the study. Comparison of the hearing levels of 18 woodwind and brass musicians with 18 string musicians matched for age and sex did not show a significant difference in hearing, the mean difference in the hearing levels at the high (2, 4, and 8 KHz) audiometric frequencies being 1·02 dB (95% confidence interval −2·39 to 4·43).**

***Conclusions*—This study showed that there is a potential for occupational hearing loss in classical orchestral musicians.**

Danger—musicians at work (illustration Elisabeth Smith)

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Introduction

The association between exposure to noise and occupational hearing loss has been recognised for well over a century, but only recently leisure noise, and particularly music, has attracted attention as a possible cause of deafness. The law in Britain requires that specific steps be taken to safeguard workers' health,[1] including their hearing.[2] Classical musicians may not be a group in which occupational hearing loss would be suspected, but a recent review emphasised that high sound levels may be found within symphony orchestras.[3] This suggests that noise exposure should be assessed. Studies of noise induced hearing loss in musicians have been descriptive and have not estimated the importance of the hearing losses found.[4] We measured the sound levels in a symphony orchestra, identifying those musicians at risk of noise exposure, and compared their hearing with an internal "low risk" group.

Method

Sound levels were measured during five rehearsals and two concert performances by the City of Birmingham Symphony Orchestra. Three concurrent measurement strategies were used. The general level of exposure to be expected in the body of the orchestra the musicians at risk of hearing loss. Finally, the personal exposure of selected "high risk" musicians was measured with Brüel and Kjær type 4428 and was measured by placing a Brüel and Kjær type 1613 sound level meter in a central position on the stage. The sound levels produced by the various sections were measured to identify high exposure areas and thus Dupont MK-1 personal dosimeters. The dosimeters were calibrated with a Brüel and Kjær standard tone source before each measurement session.

We measured equivalent continuous sound level (L_{eq}dB(A)), which is an average of the fluctuating sound levels over a period of time, the maximum or peak level attained, and the noise dose. The noise dose is an occupational exposure standard which limits exposure to 90 dB for eight hours a day and defines the maximum permissible (or 100% of) daily noise dose. This is not completely protective; this exposure will result in a hearing loss of 26 dB or more at age 65 in 15% of a working population so exposed.[5]

Musicians attended a hospital audiometry clinic for hearing assessment. An audiometric questionnaire was completed and the ears were examined before audiometric testing. Pure tone audiometry was performed with a Grason Stadtler GSI 16 audiometer and the audiometric technique recommended by the British Society of Audiology.

Results

The results of the general sound surveys are shown in tables I and II for rehearsal and performance. The Noise at Work Regulations 1989[2] require an assessment of exposure to be made if an employee is likely to have a daily personal noise exposure in excess of 85 dB. As half of the rehearsal measurements were above this level, noise levels were measured for two full days. The results show that exposure during the Varese-Messiaen

TABLE I—*Sound levels during rehearsal*

Composer, work	Sound level (dB)		Duration (minutes)
	Equivalent continuous	Peak	
Goldschmidt, Ciacona Sinfonica	89·7	106	103
Haydn, Symphony No 7	83·3	106	36
Mozart, Piano Concerto in E♭	81·6	108	36
Ravel, Mother Goose Suite	85.5	95	27
Ravel, La Valse	87·0	112	29
Ravel, Piano Concerto for Left Hand	83·0	108	24
Ravel, Piano Concerto in G Major	77·0	108	42
Schnittke, Symphony No 4	86·9	109	60
Shostakovich, Symphony No 1	88·8	110	47
Turnage, Night Dances	84·6	105	25

TABLE II—*Sound levels during rehearsal and performance*

	Equivalent continuous sound level (dB)	Duration (minutes)
Messiaen, Turangalila Symphony; Varese, Deserts		
Rehearsal	87·4	120
Performance	90·9	107
Total	87	227
% Of daily permissible dose	65	
Mahler, Ninth Symphony		
Rehearsal	87·3	72
Performance	89·8	64
Total	88·6	136
% Of daily permissible dose	21	

performance exceeded the 90 dB occupational exposure limit, but exposure for an eight hour period produced only 65% of a daily dose, suggesting that there is a margin of safety.

These general results are, however, likely to underestimate the risk of hearing loss, as those playing or near to loud instruments are likely to be exposed to higher levels of noise. The personal exposure of selected musicians was therefore measured and compared with the general levels. Some typical results obtained during a section of a performance or rehearsal (table III) show that exposure is greater than expected for some sections of the orchestra. Sound levels near horns, trumpets, and bassoons sometimes exceeded 90 dB and these sections all exceeded the "general" sound levels by an average of at least 5 dB. It was expected that the violin and other string players would not be exposed to high levels, and this proved to be so. The results for percussion players may seem anomalous, but the spectrum of sound that they are exposed to is shifted towards low frequency, and therefore less damaging, sound. The converse is true with such high pitched instruments as the piccolo. In planning the full day assessments by personal dosimetry, priority was given to these high risk sections. Table IV gives the results.

During the survey period the trumpet and piccolo players were exposed to noise levels in excess of the occupational standards, with the horn player falling just short of excess exposure. The peak levels represent the greatest level of exposure during the day. Levels in excess of 110 dB may cause discomfort.

Sixty three musicians from a total of 89 (70%) attended for audiometry and examination. The response rate is low, and if a significant number of those not attending have a hearing loss then the risk of noise exposure may be seriously underestimated. The players attending were, however, said by the musicians as representative of the orchestra as a whole, so this effect may not be great.

With the findings of the sound survey the musicians could be divided into two risk groups, high risk being woodwind and brass, low risk being strings. Eighteen high risk musicians were matched for age (within two years) and sex with low risk musicians, and the means of the differences in hearing loss at the low (0·25, 1, and 2 KHz) and high (2, 4, and 8 KHz) audiometric frequencies were compared with a paired *t* test. No

ALAN WOODCBSO

The City of Birmingham Symphony Orchestra in rehearsal. Noise levels may occasionally exceed not only the discomfort threshold but the occupational exposure standard

TABLE III—*Sound levels in individual sections*

Instrument (work)	Equivalent continuous sound level (dB)		
	Section	General	Difference
Percussion (Schnittke, Fourth Symphony)	89·3	86·9	2·4
Horn (Mahler, Ninth Symphony)	96·0	89·8	6·2
Trumpet (Mahler, Ninth Symphony)	96·9	89·5	7·4
Bassoon (Ravel, La Valse)	97·0	87·0	10·0
Second violin (Turnage, Night Dances)	85·4	84·6	0·8

TABLE IV—*Noise doses*

Instrument (work)	Sound level (dB)		Duration (minutes)	% of dose
	Equivalent continuous	Peak		
Trumpet (Mahler, Ninth Symphony)	96	112	193	160
Piccolo (Messiaen, Turangalila; Turnage, Night Dances)	94.2	111·8	227	124
Horn (Mahler, Ninth Symphony)	93·6	N/A	193	92
Bassoon (Ravel, Mother Goose, La Valse, Piano Concerto for Left Hand)	95·4	113	80	58

significant difference was found at the high frequencies (mean difference=1·02 dB, t=0·6 (−2·39 to 4·43), p<0·25). At first there seemed to be a difference at the low frequencies (−1·93 dB, t=1·84 (−4·21 to −0·26), p<0·05), suggesting that hearing was better in the high risk group at these frequencies.

As there is limited evidence that noise causes a differential low frequency loss, a two sided test was thought to be more appropriate for the low frequencies; this gave a p value of greater than 0·05 but less than 0·1. The cause of this apparent low frequency loss is uncertain. It might have been a learning effect, the subjects improving their responses as the test proceeded to the higher frequencies, but a learning effect would be expected to show more in one ear than the other, depending on which is done first, and we found no evidence for this.

Discussion

The results of the sound level survey in this study confirm what was already known, that some musicians are exposed to levels of noise which occasionally exceed not only the discomfort threshold but the occupational exposure standard. The difficulty in estimating the risk of occupational hearing loss is that sound levels fluctuate and exposure to high levels is intermittent. Also, we have not so far been able to estimate total occupational exposures, as most professional musicians have other commitments such as teaching.

The issues raised in the provision of hearing protection to some extent mirror these difficulties in measurement. In industrial practice, the first step in noise control is to reduce emission at source, obviously not an option for a symphony orchestra. The next step is to provide hearing protection, but harmful levels of sound exposure may not occur often enough in an orchestra to warrant the provision of personal hearing protection such as foam inserts, and indeed this would not be acceptable to some musicians. Some form of sound insulation is undoubtedly necessary for the comfort of those exposed to high pitched instruments, and musicians have been known to improvise protection with cotton wool. Plexiglass baffles are available and may be placed in front of (for example) the trumpet,[6] providing protection without being intrusive to the performance for either musician or audience. Long term, the answer to excessive noise doses may lie in the programming of performances, ensuring that densely orchestrated and "loud" music is offset by a somewhat "softer" work.

As regards the methodology for analysing hearing

loss in this study, previous work has been descriptive in nature, presenting the numbers of cases of hearing loss, presumed to have been noise induced or comparing hearing levels with reference populations.[3 7-8] Both these descriptive methods have shortcomings: the former depends on the definition of noise induced hearing loss, and the latter depends on identifying a well matched reference population. Neither method of presentation is amenable to the necessary statistical testing. We believe that our method is suitable for estimating the risk of hearing loss in classical musicians as it does not depend on identifying cases but uses internal comparisons. Unfortunately, the numbers available limited the statistical power, but other orchestras might be recruited to an extended study. Our study shows that there is a potential for hearing damage in classical musicians and that some form of protection from excessive sound may occasionally be needed.

1 *Health and safety at work act 1974*. London: HMSO, 1974.
2 *Noise at work regulations 1989*. London: HMSO, 1989.
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Mozart's scatological disorder

Benjamin Simkin

The surprising scatology found in Mozart's letters has not yet been satisfactorily explained. When the first English edition of the Mozart letters was published in 1938 all of the previously suppressed, unexpurgated letters were made available. In her introduction Emily Anderson stated: "It was not only when writing to his 'Bäsle' (little cousin) that Mozart indulged in this particular kind of coarseness, but ... certainly his mother and very probably the whole family and indeed many of their Salzburg friends were given to these indelicate jests."[1] The possibility of Tourette's syndrome,[2] a syndrome of vocal and motor tics, was raised at the 1983 world congress of psychiatry in Vienna by Fog and Regeur, on the basis of Mozart's scatology and his portrayal in Peter Shaffer's stage play and motion picture, *Amadeus*. Peter Davies attributed Mozart's scatology to a hypomanic manifestation of his cyclothymic personality disorder.[3] Steptoe echoed Anderson and regarded the scatology as a coarse, immature characteristic which Mozart retained in his adult life.[4] With this background, this paper tabulates Mozart's scatology and suggests that its origin lay in Mozart's plausible affliction with Tourette's syndrome.

Incidence and characteristics of Mozart's scatology

The data on Mozart's scatology were obtained by a careful review of all of the published letters of Mozart and his family and are shown in the tables. Table I shows that scatology was present in 39 of the 371 letters written by Wolfgang Mozart, representing an incidence of 10·5%, whereas his father, mother, and sister contributed only one scatological letter each to the correspondence. This observation would seem to greatly diminish Anderson's argument that scatological writing was common to many Salzburgers, and in particular the whole Mozart family.[1]

Table II lists the scatological terms found in the 39 letters, and it is evident that they focus on the buttocks and defecation. If all letters referring to anal matters, including some without scatology, are added up, the total number of anal letters rises to 45, for an incidence of 12·1%. Some scatological words were repeated more than once in some letters: shit (29 mentions), arse (24), muck (17), fart (6), piddling or pissing (6), arse holes (3). This expression of offensive oaths or foul mouthing is termed coprolalia. These words are similar to those used by the series of patients in New York with Tourette's syndrome reported by Shapiro in 1978.[5]

Several of Wolfgang Mozart's letters were peculiar in their obvious word games and word scrambling, in the repetition of words just heard or written by someone else (echolalia), and in Mozart's repetitions of his own words (palilalia). There were a total of 23 such "bizarre" letters, for an incidence of 6·2%. This amalgam of coprolalia (scatology), echolalia, and palilalia suggested Tourette's syndrome as the common denominator, and was found in a total of 63 (17·0%) of Mozart's letters.

Table III shows an episodic clustering of Mozart's scatological and "bizarre" letters during his lifetime. There was a parallel incidence of scatology and other bizarre features in Mozart's letters. The first cluster occurred when he was 14, in 1770, the year of his triumphant first Italian tour, a tour of unremitting great excitement, great acclaim, and high honors—an emotional "high" for Mozart.

A second, more prolonged cluster of scatological and bizarre letters occurred in the five years between 1777 and 1781, an extremely unhappy and stressful period of Mozart's life, marked by the climax of his conflict with the Archbishop of Salzburg.

A small blip of scatological activity in 1783 coincided with the time of the birth of Mozart's first child, a son; the conflicting desires of his father and Jewish patron-landlord to be the child's namesake and godfather; and the unexpected death of the baby. Another small blip of scatological letters occurred in the spring of 1789,

TABLE I—*Distribution of scatological letters in the Mozart family's correspondence*

	No of letters	No (%) scatological
Wolfgang Amadeus Mozart	371	39 (10·5)
Maria Anna Mozart (mother)	40	1 (2·5)
Nannerl Mozart (sister)	15	1 (6·7)
Leopold Mozart (father)	319	1 (0·3)

TABLE II—*Features suggestive of Tourette's syndrome in Wolfgang Amadeus Mozart's letters. Figures are numbers (percentages)*

	No (%) of letters (n=371)
Features suggesting Tourette's syndrome	63 (17·0)
Buttocks and defecation	45 (12·1)
Scatology	39 (10·5)
Shit	21
Arse	19
Muck	7
Piddle or piss	6
Fart	4
Arse holes	3
Fondling and kissing, sexual fetish	4
Palilalia, echolalia, or word games	23 (6·2)

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