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Noise exposure and attitudes to hearing protection in orchestral brass musicians

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Among professional orchestral musicians, brass players are exposed to the highest continuous levels of sound in the workplace. Although much of their working life is spent in private practice, little is known about sound level exposure during this activity or the hearing health and hearing conservation practices of this group in particular, making exposure estimation and development of appropriate hearing conservation approaches very difficult. The current study aimed to assess practice room exposure levels, self-reported hearing health, and hearing conservation practices of this group. Ten professional musicians practicing comparable musical material were assessed for sound exposure and questionnaires were distributed to brass players of eight professional orchestras. Findings indicated brass instrumentalists are likely to exceed acknowledged "safe" sound exposure limits in under an hour of private practice and that, of brass players surveyed (N=65), 50% of those under the age of 50 self-report a hearing loss of some kind while 95% reported the use of hearing protection while playing to be difficult or impossible. Improvements to personal protective devices together with enhanced education for musicians and their teachers, managers, and audiologists is essential to further safeguard the hearing of those in the field and those training to enter it.

Keywords: orchestras; hearing; noise; exposure; musicians

Orchestral brass players (players of the trombone, tuba, trumpet, and French horn) are exposed to the highest continuous levels of sound in the orchestral workplace and, as such, are at risk of permanent damage to their hearing (Schmidt *et al.* 2011). This risk is likely to be significantly greater once exposure in individual practice rooms (where these musicians hone their craft) has been taken into account. There are a range of administrative and engineered

mechanisms for reducing sound exposure to these musicians; however, even with the most rigorous strategies in place there is inevitably a need for the use of devices such as earplugs (O'Brien *et al.* 2012).

There are no data available on practice room sound exposure for these musicians and existing reports indicate rates of earplug usage generally to be poor, with a range of reasons for non-compliance, including earplugs interfering with these musicians' abilities to perform, rehearse, or practice in a productive and musically useful way (Laitinen and Poulsen 2008, Zander *et al.* 2008).

This study aimed to assess the noise exposure of professional brass players during private practice and determine approaches and attitudes to hearing conservation to help develop solutions to this on-going problem.

METHOD

Participants

A questionnaire was distributed to brass musicians in eight professional orchestras across Australia. Additionally, ten full-time tenured brass players from a professional orchestra volunteered to participate in the practice room noise exposure trial component of this study.

Materials

Musicians were assessed in a room (54 m^3) built and acoustically treated for individual instrumental practice (see Figure 1). Three Type I Sound Level Meters were used, calibrated prior to and at the conclusion of each measurement using a matching calibrator. Participants also completed a short questionnaire on practice habits.

The broader questionnaire collected data on playing history, perceived hearing health, perceived risk of noise-induced hearing loss (NIHL), ease of use of earplugs, motivation and history of earplug use, type of earplugs used, and difficulties experienced while wearing earplugs.

Procedure

To determine exposure, sound levels were recorded simultaneously within 5-10 cm of each ear and 1.5 m in front of the musician. The assessment consisted of three main elements: a warm up, where participants played A=440Hz (or its nearest comfortable octave equivalent) for 10-15 seconds at various dynamic levels (soft, moderately loud, loud, and very loud) with a short break after each note; five minutes of technical work (scales, arpeggios,

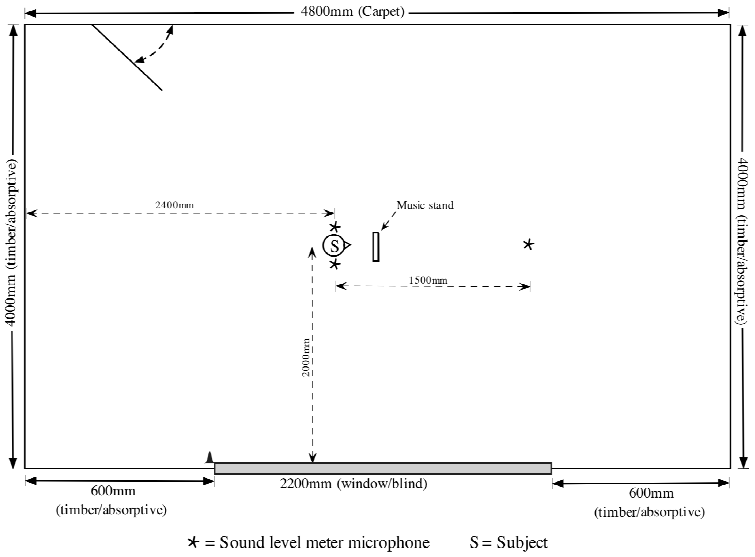


Figure 1. Testing room layout.

etc.) of own choice; and fifteen minutes practice of their instrument's first-chair part for *Don Quixote* (Richard Strauss). Results were analyzed using software associated with the sound level meters, at which point the overall exposure for each assessment was assessed as well as the various elements of each assessment. Within the results, dBA L_{eq} refers to the equivalent steady state sound level required to replicate the expended energy of the actual (fluctuating) exposure as measured. Analysis of the broader questionnaire data was undertaken using *Stata* and *SAS* statistical software.

RESULTS

Practice room exposure data

The most exposed individual musician (trumpeter) was exposed to 98.6 dBA L_{eq} (left ear) over the duration of the assessment (equivalent to 94% of the allowable daily noise dose or 286% if exposed to this level for one hour). Inter-aural differences were highest for the horn and tuba players and levels in front of the musicians (dBA L_{eq} Ctr) were consistently lower than at either ear (see Table 1).

Table 1. Exposure for whole assessment by instrument; projected percentage of allowable daily noise dose (where 85 dBA L_{eq} over 8 hours=100%, 3 dB exchange) and interaural difference (where bold type indicates right ear louder). Where n>1 mean arithmetic average of multiple assessments is given with range indicated.

	dBA L_{eq} (range)			*Projected dose after 1 hour (%)*	*dBA L_{eq} inter-aural difference*
Instrument (n)	*Left ear*	*Right ear*	*Ctr*		
Trombone (2)	96.1 (0.4)	95.7 (4.4)	94.0 (1.1)	161	0.4
Bass tromb (1)	95.8 (-)	96.1 (-)	93.8 (-)	161	**0.3**
Trumpet (3)	95.8 (4.4)	94.6 (4.8)	92.8 (6.0)	150	1.2
Horn (3)	92.2 (2.9)	95.2 (2.5)	90.0 (2.9)	131	**3.0**
Tuba (1)	94.7 (-)	92.2 (-)	87.8 (-)	117	2.5

Table 2. Exposure at fortissimo, Don Quixote, and technical work (dBA L_{eq}).

	dBA L_{eq} at ff (range)		*Don Quixote dBA L_{eq} (range)*		*Technical work dBA L_{eq} (range)*	
Instrument (n)	*Left ear*	*Right ear*	*Left ear*	*Right ear*	*Left ear*	*Right ear*
Trumpet (3)	102.3 (4.9)	100.8 (5.2)	96.5 (4.8)	95.3 (2.6)	95.2 (2.6)	94.3 (3.2)
Horn (3)	98.4 (4.4)	100.7 (2.1)	93.1 (2.0)	96.1 (2.6)	90.0 (5.2)	93.1 (3.2)
Trombone (2)	104.1 (5.1)	101.7 (4.8)	96.5 (1.8)	96.4 (5.4)	94.0 (2.7)	93.8 (0.7)
Bass tromb (1)	102.4 (-)	104.1 (-)	96.5 (-)	96.8 (-)	95.1 (-)	95.3 (-)
Tuba (1)	102.3 (-)	97.9 (-)	95.5 (-)	93.2 (-)	93.1 (-)	90.6 (-)

The individual with the highest exposure during the *fortissimo* section of the assessment alone (not including all other parts of the assessment) was a trombonist, registering 106.6 dBA L_{eq} in the left ear while playing at this dynamic. At this level the player would risk NIHL after around 3 minutes and fifteen seconds. Exposure during three sections of the assessment is detailed in Table 2. Practice sessions of 1.9 h per day, 5.8 days a week (mean average) were reported.

Questionnaire data

Of all respondents (N=65; 29 horns, 14 trumpeters, 17 trombonists, and 5 tubists; mean age approximately 41 y [24-61 y]; 78% male), 83% reported a risk of NIHL in the orchestra, while 32% reported risk of NIHL during private

practice. Fifty-one percent used earplugs at least some of the time and 6% used earplugs all the time or very frequently. Of earplug users, 70% used them in response to pain, while 67% did not use earplugs when they thought they were necessary. None reported earplug use during private practice and none reported use during performances. Ninety-five percent of respondents reported earplug use to be difficult or impossible, with no correlation between history of earplug use or of earplug type and ability with earplugs. Overall, the most commonly identified problems were: hearing other players while wearing earplugs (91%), being unable to hear themselves (75%), difficulties with balance (66%), and intonation problems (63%).

Of those ≤50 years of age (n=48), 50% reported hearing loss, with brass players significantly more likely to report a hearing loss than other instrumental sections (p=0.042). By instrument type, 62.5% of trumpets and 54% of horns ≤50 years reported a hearing loss.

DISCUSSION

Private practice is a major contributor brass players' daily sound exposure. The incidence of reported hearing loss among this group is high, and while most are aware of the risks they face in ensemble, fewer acknowledge the risks posed in private practice. Almost all experience difficulty using currently available personal protective devices.

Should orchestral rehearsal time (often 5 to 6 hours per day) be included, all brass players would be at high risk of NIHL in the course of their daily musical activities unless measures were taken to limit their exposure. The variability in exposure noted between players may be due to practice habits, technique, and position (principal or a section player). This is an indication that practice habits may be an effective tool to reduce daily sound exposure and this requires further investigation.

Age-related hearing loss typically takes effect around 50 years of age (Sataloff and Sataloff 2006). With 50% of those ≤50 years of age reporting a hearing loss it appears brass players are much more likely to consider themselves to have a hearing loss than the general population (Shield 2006). It is also evident from difficulties reported that current earplugs available (including the custom-moulded variety) are inadequate to ensure broad acceptance by this group of musicians. Problems with custom-molded plugs may include molds being too shallow and not adequately reducing occlusion (Chasin 2009) and results of this study indicate that over-attenuation is a significant problem. It is for these reasons that it is essential audiologists

ensure properly made, correctly fitting molds and consider prescribing lower levels of attenuation (9 or 10 dB instead of 15 dB) in order to increase usage.

This study took no audiological data, relying upon perceptions of hearing health only. Further study should further investigate this together with alternatives to currently available personal hearing protection (including recently released level-dependent earplugs) and methods to improve the dissemination of broader research findings.

It is essential that a viable solution be found that has minimal impact on the art these musicians create on a daily basis. Only when this has been achieved will we be able to ensure these musicians have long and fruitful careers free of significant hearing pathologies.

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