

POLITECNICO DI TORINO
FIRST SCHOOL OF ARCHITECTURE
Master of Science in Architecture Construction City
Honors theses

Influence of acoustics on vocal performance of lyric singers

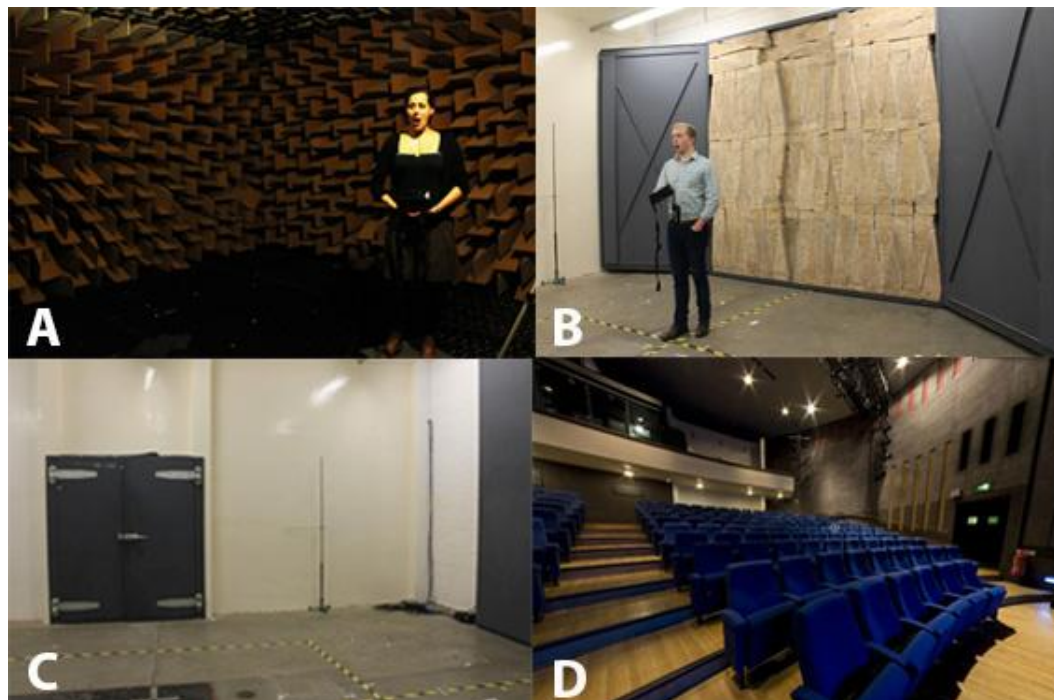
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Voice use play a significant role in the causation of many common voice disorders caused by chronic and recurrent conditions, which result from an incorrect use of the voice or from poor acoustic conditions in the environments where the voice is used. Scientific data in literature show that the singers of classical lyric orchestras are exposed to high risk of damage to the vocal apparatus due to the intense effort they have to face during the artistic performances. New protectionist laws impose to evaluate all different risk factors in the workplaces. All categories of workers are included and, among them, workers employed in recreational activities and shows should be considered.

The object of this dissertation is an investigation in singers' vocal parameters in order to understand how they change under different acoustical conditions. At the beginning the acoustics of 5 different spaces was analyzed: the Sir Jack Lyons Theatre and a rehearsal room, both located at the Royal Academy of Music in London, and the anechoic, semi-reverberant and reverberation chamber located at the LSBU (London South Bank University).



A anechoic chamber, B semi-reverberant chamber, C reverberant chamber, D theatre

After the room's acoustics study, four singers volunteer (3 females and 1 male) were monitored in those different spaces and they were asked to execute some vocal exercises such as scales or arpeggios for 3 minutes.

To take these measurements two battery powered devices were used (Kaypentax APM and Voice-Care Politecnico of Turin prototype) and during the test an accelerometer was attached on their throat using a medical secure silicone adhesive.

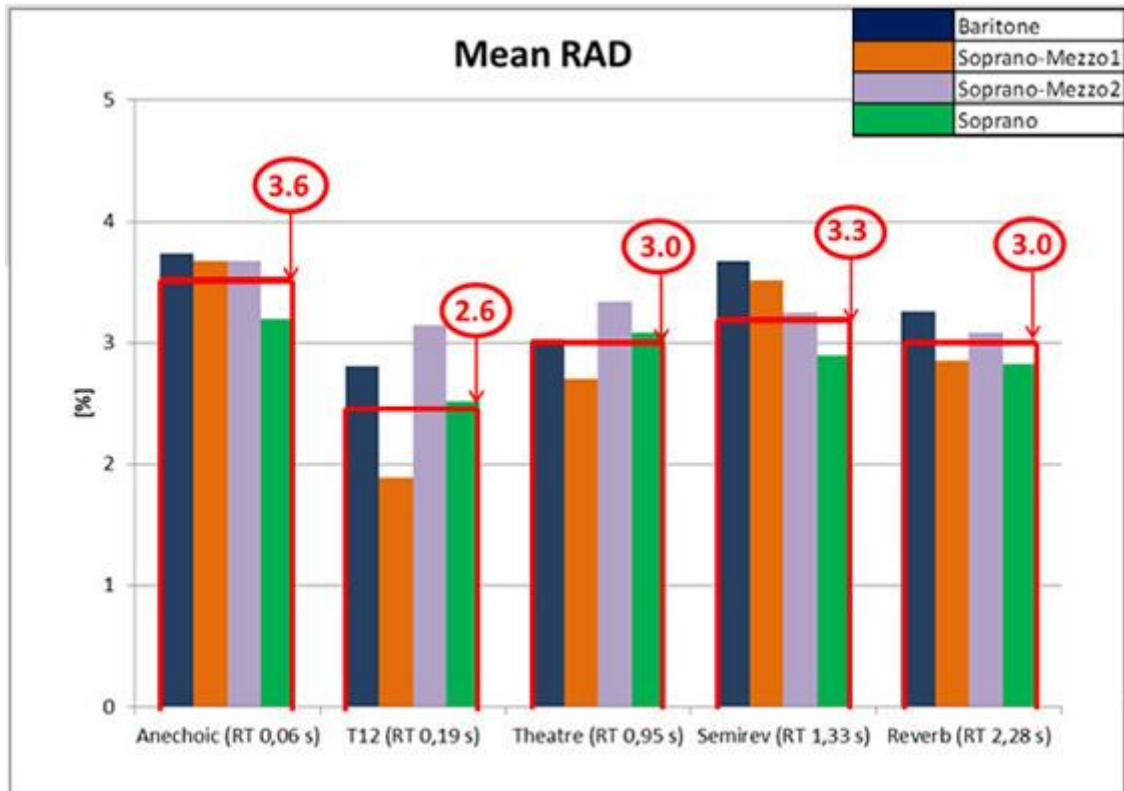


APM's accelerometer, unit front panel for plug all cables and singer during the calibration

For each singer in each space was selected a sequence of three arpeggios from the complete phonation time profile. Then, three masks with the exact frequencies they were supposed to sing were overlapped. From the difference between the sung notes and the reference notes, the average deviation for each arpeggio was calculated, and then the relative average deviation RAD [%].

During the test in the anechoic chamber they were asked to sing an opera aria too in order to record their voice to make auralizations with the software CATT. The auralization is typically the final stage in a predictive assessment and its aim is to demonstrate of a space's prospective performance to both experts and non-experts in acoustics. At the end of each test singers were asked to fill a short questionnaire about their personal perception singing in those different venues.

If we consider that singers adjust their voice basing on the reflections that come to their ear, the results show that they prefer spaces in which they can hear their voice and not a space with a very high sound dispersion, in fact the space in which the relative average deviation reach the highest value for all singers is the anechoic chamber, while for the other spaces the results couldn't be generalized because depending from the singer's training.



Mean Relative Average Deviation for each singers in all five spaces

But what would happen if people who are not concerned in architecture or acoustics listen to the same voice reproduced in those different spaces? In this research auralization for every space have been made. The soprano performance, previously recorded in the anechoic chamber, has been convolved in all five simulated spaces in order to made a test with the aim to evaluate the pleasantness of the singing voice in different spaces. The test has been submitted to professional architects, architecture students and people who are not concerned in architecture or acoustics. In contrast with the singers subjective perception, listeners don't need reflections which are considered as a "voice alteration", but they prefer the original clear and pure sound in the anechoic chamber.

This research and the methodology described could be a start point for future works about singers behavior and their vocal parameters analysis, with a significant number of monitored people it could be possible to come to general conclusions finding more common aspects.

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