

Performance efficiency evaluation on professional artists of Baroque Repertoire through simultaneous monitoring of vocal doses and breathing pattern

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Introduction

The voice production involves the synergic cooperation of the respiratory and the vocal systems. Among voice professionals, singers need to focus on efficient phonation strategies to optimize voice production in their artistic exhibitions [1]. A wearable tool providing quantitative evaluation of breathing pattern and voice production would be very helpful, as current quantitative assessment approaches are based only on the analysis of vocal parameters and do not consider the efficiency of respiratory muscles in producing the sounds. The aim of this study is to develop a wearable device for the simultaneous measurement of vocal doses and breathing pattern in order to evaluate the interaction between the respiratory and vocal systems in singing voice production.

Methods

The device included an electronic circuit integrating a skin accelerometer for measuring vocal parameters together with an abdominal (AB) and rib cage (RC) respiratory inductive plethysmography belts for monitoring breathing without interfering with singing (Figure 1).

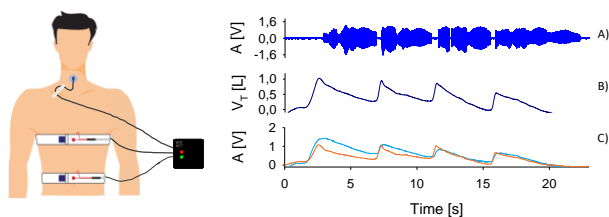


Figure 1: wearable device (left panel) and a representative tracing showing the amplitude of skin acceleration (A), total respiratory volume (B) and its subdivision in RC and AB components (C).

Nineteen professional singers of Baroque repertoire were enrolled in the study together with 18 control (not trained to sing) subjects. All participants were studied during the execution of a series of vocal tasks and of the Italian air “Caro Mio Ben” [2]. The computation of vocal doses [3] and the characterization of the expiratory phase (as in Figure 2.A) were used to evaluate the performance of both groups. The study was approved by the Ethical Review Board of the Politecnico di Milano.

Results

Compared to controls, in singers the RC provided a lower contribution to the overall volume displaced at every phase of the expiration (Figure 2.B).

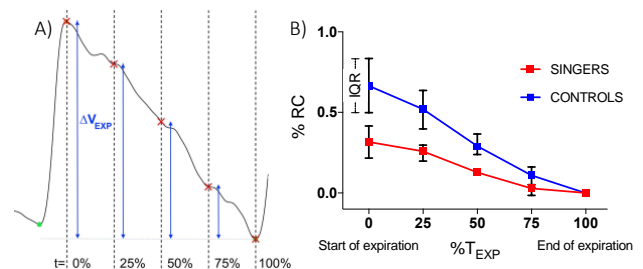


Figure 2: Reduction of the total respiratory volume with time during a singing phrase (A) and percentage of RC contribution to total volume averaged in singers and controls (B).

The RC contribution for exhaling the first 25% of the expiration is compared with Distance Dose (D_D) and the Energy Dissipation Dose (D_E) showing that the effective amount and quality of voice produced is higher in the group of singers (Figure 3).

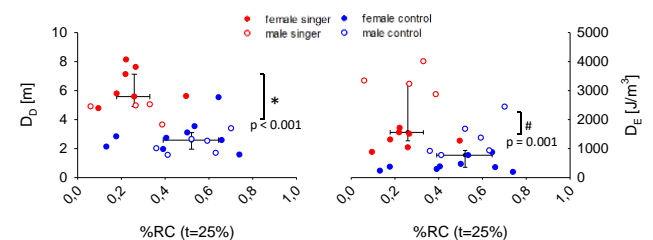


Figure 3: Comparison between vocal doses (D_D and D_E) and RC contribution at 25% of expiration in singers and control subjects (p-value of t-test * or Mann-Whitney Rank Sum Test #).

Discussion

Our data suggest that artists reduce the use of the RC in favor of abdominal compartment which, being more compliant, provides airflow with lower effort. The region of the graphs in Figure 3, where most of the singers' data points are positioned, may identify an optimal breathing/singing strategy. This approach may support future research for developing a better understanding of the synergistic interactions between the respiratory and vocal systems, as well as for providing a useful training tool for evaluating the efficiency of the performances.

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References

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