An Evaluation of the Breathing Strategies and Maximum Phonation Time in Musical Theater Performers During Controlled Performance Tasks

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Summary: Objectives. Breathing strategies for athletic dancing are quite different from those needed for legato singing. This study considers the respiration data recorded by a telemetric heart rate monitor, mask, and gas analyzer collected from 20 musical theater professionals performing set tasks.

Methods. Scores were taken of maximum phonation time (MPT), relative oxygen uptake, and heart rate immediately after three tasks: (1) singing only, (2) dancing only, and (3) singing while dancing. Scores were also collected of the ability to sustain unbroken notes immediately before performing and then immediately after each of the above tasks (1), (2), and (3). Vital capacity scores were recorded at the beginning and at the end of the testing schedule. A questionnaire took demographic information and asked questions regarding performer perception, training, and experience. Most were aware of breathing inconsistencies and adjustments related to changes of task and/or direction.

Results. (Means) Tidal volume was constant for (1) singing and (2) dancing; MPT reduced by 65.2% for singing while dancing; and minute volumes reduced by 16% but relative oxygen uptake (mL/kg/min) remained unchanged, despite increased heart rates, and when singing while dancing compared with dancing only. The mean MPT dropped from 20.4 seconds to 7.1 seconds (change of 65.2%) between the at rest and postsinging while dancing scores.

Conclusion. The likelihood of developing vocal dysfunction (overtime) and the risk of compromising performance aesthetic lead the researchers to the conclusion that further study is required in this area.

Key Words: musical theater performers–respiration–maximum phonation time–relative oxygen uptake–heart rate.

BACKGROUND

The physical act of breathing forms a vital part of various tasks, such as respiration and phonation; changes in intra-abdominal and thoracic pressure, combined with peri-abdominal and thoracic muscle activities, also affect fluid dynamics, postural support, movement, efficacy of the kinetic chain, and so on with prioritization of effort changing, depending on the activity being undertaken.

During physical exercise, such as dancing, bodily process normally focuses on increasing gas exchange to a level high enough to meet the demands of the increased muscle work. Particularly taxed are the respiratory muscles simultaneously contributing to postural support and movements of the body. In contrast to this, singing demands that the control of the airflow takes priority. If the singing is relatively static, postural support worries cause less concern to the performer as the need for rapid gas exchange for larger postural movements is less of an issue.

From personal experience and from discussions (informal research) over the years, combining both singing and dancing, at the athletic end of the performance spectrum, is often fraught with difficulty. Indeed this research has made it even more difficult to imagine how these two tasks can successfully be combined seven (or more) days per week without such physiological adaptations as to warrant concern for both the musical aesthetic and the performer's well-being. Yet this combined skill is one of the basic tenants of musical theater.

Being relatively unique as a study, the aim was to design tasks that would imitate a performance scenario as closely as possible. The hope was to take into consideration not only freedom of movement and ease of voicing but also to somehow recreate the heightened sense of excitement (arousal/anxiety) performers experience prior and during performance.

Reliable data on respiratory function, laryngeal function, degrees of movement, acoustic measures, and heart rate (HR), as well as creating (or finding) settings that would not undermine the performers' psychology, were collected and these were discussed as part of the preparation process. Realizing the specific research question, setting the hypotheses, and deciding on the equipment and the most authentic experimental arena were debated in the few months, preparing the research proposal with experts from different performance and performing arts medicine backgrounds.

Various types of instrumentation were considered (Appendix S1) before deciding on the use of a portable gas analyzer that fitted snuggly on the performer like a waistcoat, a simple recording device to monitor what was sung, a stopwatch, and decibelometer to record and guide the participants' voicing. This allowed us to collect a broad spectrum of respiratory and acoustic data.

Questionnaire

A questionnaire collected the base demographic data and provided some information on training, experience, and perceived difficulties and expectations regarding the participants' abilities and concerns (Appendix S1).

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Breathing during exercise and breathing during singing

The main difference in the pedagogy between the use of breath in singing and its use in dancing begins early on in the teaching environment. Because the prosody of the art itself requires the fuel for voicing to adapt to the fluctuations within the music, early on it becomes part of the artistic kitbag. In dancing, fitness, suppleness, strength, balance, and proprioception are the initial focus. Breath and body awareness are certainly a part of the learning-to-dance-well process, but it is not difficult to argue that the control of breathing in singing is more crucial, particularly in the early days.

Therefore, this piece of research focuses on the type of projected singing and athletic dancing associated with musical theater and extensive runs. Making comparisons between the breathing patterns required for singing and dancing separately and singing while dancing proved challenging as there is sparse research in this area.

Research on breathing when singing has tended to involve classically trained singers standing still, often focusing on subtle movements of muscle activity and/or changes to sound quality, whereas research examining breathing patterns in dancers tends to focus on the demanding cardiovascular aspects of the activity.

This sparse research on breathing in the field of musical theater (much, to this day, due to limitations of suitable testing methodology) required the researchers to draw heavily from sources such as sports exercises associated with running and cycling. Running, in particular, is similar to many dance movements.

During exercise, gas exchange, particularly the efficient elimination of the biproduct carbon dioxide, is crucial. Once athletic activity reaches a certain intensity, lactic acid enters the blood stream and needs to be broken down. To maintain a healthy blood pH, sodium bicarbonate buffers the increase of acid by breaking it down into water and carbon dioxide. It is essential that this carbon dioxide elimination process remains effective and consistent. Too high a level of pH will have a negative effect on a wide range of chemical processes in the body.

A healthy body adapts well to these increased demands, spontaneously increasing minute volume by increasing tidal volumes and/or respiratory rates (RR). Although there are many factors involved in regulating this automatic response, it can be overridden consciously when needed, such as in swimming under water or singing long phrases.

At rest, a highly coordinated diaphragm, abdominal, and intercostal muscle recruitment keeps the shape of the rib cage preferentially undistorted.[1] During exercise (dancing), the increase in minute volume comes predominately from increases in tidal volume (which can more than triple in some athletes). This increased volume is gained by recruiting peri-abdominal musculature to contract, pulling the ribs inferiorly and medially, which in turn increases the volume of expired breath utilizing expiratory reserve volume within the lungs. This action enables a greater diffusion rate as the distal part of the lungs allows for greater gas exchange. During times of high ventilation, increased RR is preferred.[1–3]

Rapid breathing and increased airflow during high intensity exercise are facilitated by an unconstricted airway, and this can be helped by keeping the breathing constant, or if necessary making only slow and gradual changes. Problems in this area can include exercise-induced asthma or bronchoconstriction, exercise-induced laryngeal obstruction, vocal cord dysfunction, paradoxical vocal fold motion, adduction or collapse of supraglottic structures, and inappropriate closure of the glottis.[4,5]

Differences between breathing during dancing (athletic movement/exercise) and breathing during singing (athletic voicing/musical theater singing)

The following comparative table (Table 1) bullet-points the main points of differences between the strategies employed for breathing during singing and those needed for dancing. These are the perceived norms taught in many institutions and are well recognized within the literature (Table 1). The point of labeling them clearly here next to each other is to highlight the differences likely to cause physiological and ergonomic challenges for the musical theater performer when attempting to sing while dancing.

It is not difficult to see the potential for respiratory difficulty when we examine this table. It is true that some items in table "a" could appear in table "b" and vice versa. But we do not need to concern ourselves with the vagaries of stylistics for the purposes of this study. In the more athletic arenas of dance and singing, having to sing while dancing will likely create something of a challenge.

Certainly when it comes to artistry (the non-subjective type such as sustaining long high pitches as required within the score, or performing a jete and singing an accented note, again as

TABLE 1.
A Comparative List of Patterns of Breathing for Singing and for Dancing

Breathing During Singing	Breathing During Dancing
1. Consciously controlled breathing	1. Spontaneous breathing
2. Varied minute volume	2. High minute volume
3. Controlled expiration	3. Free expiration
4. Lower air flow	4. Higher airflow
5. Airway—some impedance most of the time	5. Airway—low impedance most of the time
6. Adducted vocal folds most of the time	6. Abducted vocal fold most of the time
7. Valsalva maneuver discouraged	7. Valsalva—reasonably common
8. Breathing pattern regulated by musical structure	8. Breathing patterns regulated by respiratory need
9. Changes likely to depend on musical prosody	9. Slow progressive changes related to respiratory need

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