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## The Additional Demands on the Musical Theatre Performer and Potential Links to Increased Laryngeal Tension: A Rapid Review

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**Abstract** The Musical Theatre genre places a myriad of demands upon the performer. The complex nature of the artform results in additional physiological and psychological demands not found in other areas of the performing arts. There is a need to identify existing literature exploring these demands and the link to potential causes of laryngeal tension in musical theatre singers to both potentially mitigate vocal issues developing and support initial diagnosis and treatment for musical theatre performers diagnosed with muscle tension dysphonia (MTD). This study aimed to identify and discuss existing literature documenting the current demands placed upon the musical theatre performer and the potential links to laryngeal tension of each. Evolving vocal demands, the demands of score and rehearsal, combined choreography and singing, the logistics of performing, and stress and anxiety are examined. The review concludes that each demand has the capacity to increase laryngeal tension, leading to the hypothesis that a combination of demands may compound the potential for detrimental tension further.

**Keywords** Musical Theatre, vocal, demand, load, anxiety, tension, instrument.

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## 1. Introduction

Musical theatre is a rapidly changing art form, continuously including and reflecting a wide range of musical genres and styles (Benson, 2018; Cox, 2020; Hoch, 2018; Kayes, 2015; Melton, 2007). There is a lack of research specifically analysing the multitude of demands that make up the role of musical theatre performer and their potential impact on vocal function, despite recent studies attempting to measure vocal load in an effort to create a desired baseline for performers in rehearsal, training and performance in order to mitigate the development of vocal disorders (Zuim, Stewart and Titze, 2023).

Additional demands placed upon musical theatre performers include but are not limited to; varied and ever-evolving vocal demands, combining choreography and singing, integrating instrument use, role of the swing, logistical considerations, performance anxiety, financial anxiety and associated stress. Little research has attempted to critically assess the possible increase in laryngeal tension related to the particular demands of performing in musical theatre, either combined or in isolation. Were individualised, evidence-based studies available to provide a clearer picture of the potential impacts, this may inform preventative behaviour across the industry, influence design of rehabilitative treatment of voice disorders and empower the musical theatre performer with regards to voice care in a holistic sense. The additional demands that the musical theatre genre places on its performers have not been extensively studied in terms of their effects on vocal function and health, particularly laryngeal tension levels. Against this background, a rapid evidence review was proposed. The aim of the review was to explore the potential link between the extra demands of musical theatre performance and increased laryngeal tension in musical theatre singers. This report presents a rapid evidence review of key articles, with discussion supported by a broad range of sources to map out the nature and scope of the field. Drawing on a range of voice-focused bibliographic databases and singing-specific literature, the evidence included has been screened for relevance and quality.

### 1.1 Eligibility Criteria

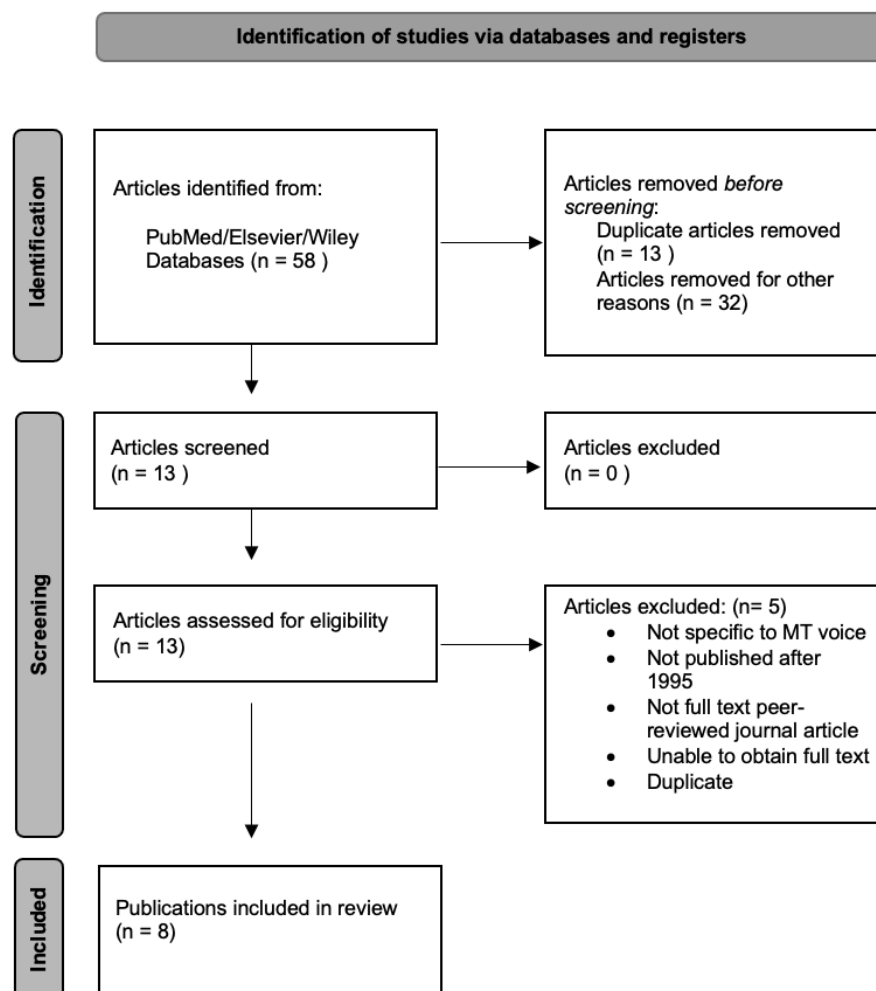
Included articles are those that discuss the demands of musical theatre performing. Due to the nature of the musical theatre genre, international publications are included. Only articles published from January 1995 to March 2024 were gathered in an attempt to maintain relevance to more recent trends within musical theatre.

### 1.2 Search Strategy

An electronic search was undertaken in January 2024. Articles archived in PubMed, Wiley Library and Elsevier were reviewed. The following keywords were used for the search: Musical Theatre, Musical Theater, vocal demands, performer, voice, vocal load, swing, Broadway, performance, anxiety, tension, instrument, playing. Secondary searches to include other associated papers via reference chaining, hand searches of hard copy pedagogical and grey literature were also carried out by the researcher.

### 1.3 Study Selection

A total of 58 results were obtained and screened. A total of 8 key articles were included in this study (Figure 1). Articles were included within the following criteria: Published between January 1995 and March 2024 inclusive, Peer-reviewed, linked directly to the musical theatre genre or the acting voice, full text available, and translated to English where required. Articles were excluded for the following reasons: Not directly relating to the musical theatre industry, no full text available, publishing date before 1995.



**Figure 1. Study Selection Process (Adapted from PRISMA SC-R).**

#### 1.4 Data Collection and Synthesis

The following information was extracted and tabulated: title, author(s), year published, country, type of research, and primary musical theatre demands discussed (Table 1). Key studies were analysed thematically via deductive categorisation of additional demand. Four main themes were identified to be discussed: the evolution of vocal demands, the demands of score and rehearsal, combining singing and choreography, and the logistics of performing. A separate examination of the theme of stress and anxiety was undertaken based on prevalence within the key literature. Findings from the key studies were then amalgamated with supporting sources in a final overview of the physiological and psychological demands and considerations judged to be specific to the musical theatre performer, alongside their links to laryngeal tension.

#### 2. Results

In this rapid review of the literature, the additional demands on the Musical Theatre performer and potential links to increased laryngeal tension are discussed. A summary of the included key article characteristics and key findings are presented in Table 1.

**Table 1: Publications included in rapid review.**

<b>Title</b>	<b>Author/s</b>	<b>Year Published</b>	<b>Country</b>	<b>Type of Research</b>	<b>Musical Theatre Demands included</b>
Music theater voice: Production, physiology and pedagogy.	Bourne, T., Garnier, M., & Kenny, D. T.	2011	USA	Mixed Methods	Vocal Range Vocal Demand
Act, Sing, Speak: Voice in the World of Theatre	P. Wilson	2013	Australia	Qualitative	Part time jobs Pyrotechnics Make up allergies Heavy costuming and headpieces Vocal loading over loud music Dehydrating theatre conditions
An evaluation of the breathing strategies and maximum phonation time in musical theatre performers during controlled tasks	Sliden, T, Beck, S & MacDonald, I.	2017	London	Mixed methods	Singing while dancing
Deciphering Vocal demands for today's Broadway leading ladies	Freeman, W, Green, K & Sargent, P	2015	USA	Mixed methods	Vocal and range demands
Perspective on the impact on vocal function of heavy vocal load among working professional musical theatre performers	Phylant et al.	2012	Australia	Qualitative	Vocal loading and impact on voice function
Music Performance Anxiety in Musical Theatre Performers: A Pilot Study	James, A and Shipley, M	2022	UK	Mixed methods	Anxiety in MT performers and those currently unemployed
Physiological Characteristics of Musical Theatre Performers and the Effect on Cardiorespiratory Demand Whilst Singing and Dancing.	Stephens, N., & Wyon, M.	2020	UK	Qualitative	Combined Singing and Dancing Respiration
Vocal demands of musical Theatre Rehearsals: A Dosimetry Study	Zuim, A., Stewart, C., Titze, I.	2023	USA	Quantitative	Vocal load of specific MT show and role requirements

### 3. Discussion

Few performing employment contexts demand the combination of skills required of the musical theatre performer (Wilson, 2013). The traditionally termed triple threat of acting, singing and dancing has been intensified by the integration of musical instrument playing within the 'Actor-Muso' show type, increased vocal requirements, the demands of the swing, inconsistent vocal loading, psychological and emotional stressors, including performance anxiety and financial anxiety, creating an employment context with the potential to intensify the risk of vocal health disorders due to increased laryngeal tension caused by a myriad of potential stressors.

#### 3.1 Evolution of Musical theatre

Inspired by the European form of comic musical theatre called operetta, developed around 1850 by Herve, and expanded by Offenbach and Strauss II, Gilbert & Sullivan designed their comic operas to attract family audiences. Combined with improved street lighting and transportation options, these popular shows brought a theatre building boom to London's West End in the late Victorian and Edwardian periods (McWilliam, 2020). Edwardian musical comedy dominated the stage by the late 1800's, followed by the light comic repertoire of Ivor Novello and Noel Coward in the early 1900's.

In recent years, the musical has evolved from classic book format to concept and genre-specific shows and the regular production of a varied range; including 'jukebox' musicals which use existing pop or contemporary songs, revivals of the classics, musical adaptations of films, regional writing and long-running shows. As public taste undergoes fundamental change, the genre of musical theatre responds in kind (Kenrick, 2024). Musical theatre composers continue to draw from many different influences and styles which include, although not limited to; Opera, Operetta, Art Song, Jazz Standards, Pop/Rock (usually reflecting the time period in which the musical was composed unless it is a biographical or period piece), Folk, Country, Bluegrass, R&B, Motown, Rap, Gospel, Latin and Disco.

Furthermore, there are an increasing number of crossover opportunities for vocal performers from different genres. As contemporary commercial music (CCM) artists may be featured in shows such as *Chicago* (Kander & Ebb, 1975), *Ghost* (Reubin & Stewart, 2011), *Jesus Christ Superstar* (Lloyd Webber, 1970) which have reduced range or pop-specific vocal approaches, musical theatre performers must master a range of styles in order to compete for the roles available.

### 3.2 Evolving Vocal Demands

Callaghan and Wilson (2002) describe singing as *"a form of sport, within which neuromuscular training is essential"* (p.112) and indeed, the complex processes involved in singing include neurological, physiological, respiratory and psychological activity. As the genre of musical theatre evolves through, and is inspired by, mainstream musical trends, both past and present, the variety of musical and vocal styles contained within the genre continues to evolve, resulting in the assertion by LoVetri et al. (2014, p.65). that *"everybody needs to sing everything"*

With regards to the creative and physiological aspects of singing, the ever-expanding range of musical and vocal aesthetics within the musical theatre genre have not led to an increase in vocal specialism, but rather to the expectation that the individual musical theatre performer should master a broad range of singing and musical styles (Bourne et al., 2011; Cox, 2020; Flynn, 2022). From pop/rock belt to relaxed folk styles, the multitude of different musical theatre composition styles and genres require that same multiplicity of different vocal approaches. Contemporary research into the physiological, anatomical and acoustic properties of the voice has allowed a greater understanding with regards to the difference in activity between vocal registers and qualities (Echternach et al., 2014; Flynn et al., 2018; Kayes, 2015, 2019; McGlashan et al., 2017). These insights can ensure both singing teachers and performers are equipped with more evidence-based resources than ever before, allowing the exploration and skill acquisition required to master a greater number of vocal styles. Johnson et al. (2019) assert that it is now the norm in musical theatre to have multiple voices, however this does not negate the fact that due to the variety of style demands, greater pressure is placed on the singer to master the sustainable production of each vocal quality, ensuring high levels of vocal flexibility and agility between the many approaches.

When examining audition requirements for female musical theatre performers on Broadway, Freeman et al. (2015) found that 84% of the musical theatre productions required belting and over half of the belted notes were spent on E5. Whereas previously within the musical theatre canon, notes within the range of C5 and above were traditionally sung in M2/Head voice, figure 2 illustrates the many shows now requiring that these be performed in a belt set up (Freeman et al., 2015).

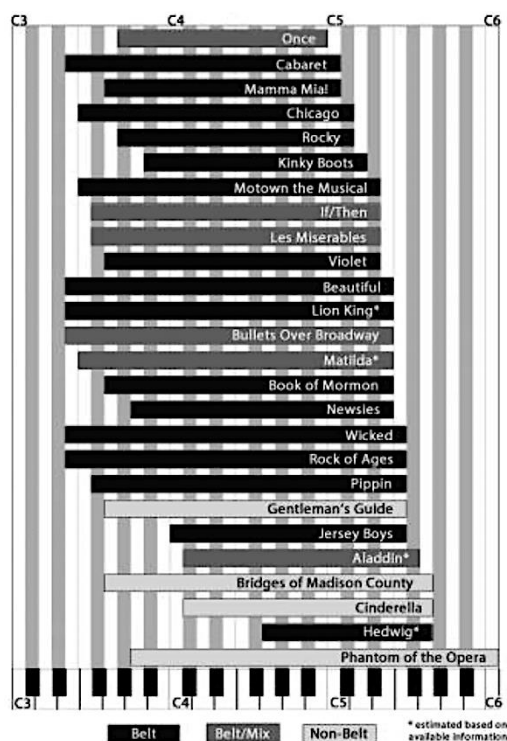


Figure 2 – Vocal ranges for Broadway leading female roles as of 2014 (Freeman et al., 2015).

### Link between evolving vocal demands and increased laryngeal tension

Sustained heavy vocal loading, such as those found in the Belt demands of many musical theatre shows, increases the potential for vocal fatigue leading to or as a result of compensatory tension. The requirement to sing higher in the upper range in a belt set up which in previous years have been performed in a lighter vocal set up (Freeman et al., 2015) may also cause tension for those whose natural vocal tendency is lighter in that range. As musical theatre writing often reflects the trends of contemporary music, there are additional challenges associated with integrating mainstream CCM styles and vocal choices which may not allow the supported, stamina-reliant vocalisation found in more traditional musical theatre voice qualities.

### 3.3 The Demands of Score and Rehearsal: Vocal Loading and Vocal Dose

The vocal requirements of a musical theatre rehearsal demand unpredictable amounts of singing and speaking. As regular voice use continues during rehearsals, singers' additional vocal demands include conversation, an aspect which is often overlooked. Beyond the rehearsal additional commitments such as interviews, media work and socialising may increase demand without clear acknowledgement. Many contemporary musical scores require heavy mix and belting strategies that may overload the vocal instrument (Freeman et al., 2015). This is due to the concentration of mechanical stress confined to the middle third of the vocal folds, which can lead to tissue reactions and phono trauma. As the rehearsal process often involves multiple repetitions of specific sections of the score, this focused production and repetition of a limited frequency range can overburden the vocal mechanism of soloists and ensemble cast members, and potentially lead to vocal trauma (Zuim et al., 2023). In recent research this concept has been referred to as vocal loading (Phyland et al., 2013).

In an attempt to define the concept of vocal loading, Hunter et al. (2019) examined the current use of the term within the literature, finding it described as perception or phonatory effort, which is described as heavy, moderate or light. Solomon (2008) described vocal load as phonating at higher-than-normal frequency and intensity, with Titze et al. (2007) describing it as the accumulated voicing within a set duration. Vocal loading capacity is defined by Echternach et al. (2014) as the amount of load that a voice user can handle before experiencing negative vocal impact. Both the Vocal Loading Test (Richter et al. 2016) and the Vocal Loading Index (Svec et al. 2003) are used to quantify vocal load through perceptual questionnaire and survey. Hunter et al. (2019) proposed a new definition of 'Vocal demand' and 'vocal demand response' (2019) to clarify the areas between vocal load, vocal loading, vocal effort and vocal fatigue,



however this review will use the term vocal loading as proposed by Solomon (2008), with the additional consideration of Titze et al's definition of accumulated voicing within a set timeframe (2007). This definition is applicable to the musical theatre performer and allows for specific discussion. The exposure of vocal fold tissue to vibration is referred to as the vocal dose. Previous research has identified changes in the vocal folds and voice production over time, as well as the prevalence of voice disorders in vocalists as a result of the contact stress brought on by each collision of the membranous portion of the vocal folds, the impact of repeated stress on vocal tissue due to intraglottal pressure, and fatigue brought on by repeated vibration (Assad et al., 2017). A baseline of vocal dosing which can be assessed as safe for singers has yet to be established (Zuim, Stewart & Titze, 2023). The vocal dose is impacted by many elements, such as duration of vocalisation, sound pressure level, range of frequency used, and styles of singing required by the score. Louder and fuller phonation results in 'larger distance doses, representing the cumulative load placed on vibrating tissue' (Zuim, Stewart & Titze, 2023).

The measurement of vocal fold exposure to vibration is measured through a vocal dosimeter (Assad et al., 2017), which is attached to an accelerometer to the sternal notch and measures the vocal load without recording background noise or the content of the vocal sound produced. Zuim et al (2023) found in a recent study of vocal demands in the rehearsal period for the musical 'Nine' (Yeston, 1982) that due to the vocal demands of a specific musical score, particular aspects of a singer's vocal dose usually increased during rehearsals. This was thought to be in response to the focus on specific types of vocal quality and desired vocal sound, especially when the range in which most of the notes fall within the musical focuses on a belting or high-intensity vocal quality area.

The variability and unpredictability of the vocal demands for individual performers through the rehearsal process were highlighted. The study also noted that even if the pace of the rehearsal was not deemed too great, the specific demands of the score alone may prove to be much larger than the vocal dose reported through the rehearsal. Zuim et al (2023) concluded that further studies are needed to establish the overall dose of each musical theatre role to serve as considerations for vocal pacing and voice care during rehearsal and performance.

#### **Link between vocal dose and increased laryngeal tension**

This concentrated production and repetition of a small frequency range can tax the vocal mechanism of soloists and ensemble cast members and lead to vocal trauma (Roll, 2016; dos Santos et al. 2019). Previous investigators have identified changes in the vocal folds and voice production across time (Jiang, Lin & Hanson, 2000) and the prevalence of voice disorders in singers (Pestana, Vaz-Freitas & Manso, 2017) due to the contact stress that results from each collision of the membranous portion of the vocal folds (Mehta et al, 2021) the intraglottal pressure and impact of repetitive stress on vocal tissue (Chan & Titze, 2006), and the resulting fatigue from repetitive vibration (Svec et al. 2003; Palaparthi et al, 2019). If the vocal dose of each role and the potential impact was made apparent, musical theatre singers may be better equipped to manage their voices during rehearsals and performances using appropriate strategies. Directors, teachers and performers would also be equipped to develop strategies to establish and maintain the vocal stamina required throughout rehearsals and 8 performances per week.

### **3.4 Combining Singing and Choreography**

The combined skill of singing and dancing is one of the fundamental aspects of musical theatre performance (Sliiden, Beck and MacDonald, 2017). Gates et al. (2013) highlight the potential impact of movement on the musical theatre voice, raising the possibility that in some performers the demands of movement may contribute to the development of MTD due to increased respiratory demand.

#### **3.4.1 Breathing for singing**

Controlled breathing is necessary for singing, with an emphasis on low, controlled airflow through partially adducted vocal folds during expiration. Breath control is introduced early in singing pedagogy as constant fluctuations in pressure are required in response to the musical demands. Depending on the prosody of the piece, frequent, varied changes to air volume, flow and rate are required. In a study comparing particle emissions in both spoken and sung voice use, Alsved, et al (2020) found singing to require sustained voicing, a greater range of frequencies, increased sound pressure, an increase in articulated consonants, and higher peak airflows than the spoken voice. As these combined aspects contribute to increased exhaled emissions, the findings that the professional singer produced more than double the level of particle emissions (1480) compared to loud talking (570). These results are supported by Barbosa and Madureira (2020), who found notable differences in their study concerning professional singers, including longer breath cycle duration and increased volume of inhalation in song when compared to speech.



Control of rib cage movements is considered to be of great relevance in singing technique. Studies by [Binazzi et al. \(2006\)](#) and [Thorpe et al. \(2001\)](#) found that breathing when singing resembles breathing at rest more than breathing during athletic activity, with less differentiation between rib cage and abdominal wall excursion, with the rib cage and abdominal muscles jointly activated so that the respiratory system acts as a single compartment. Neither study considered the integration of aerobic activity with phonation. [Thomasson and Sundberg \(1999\)](#) and [Watson, Willams and James \(2012\)](#) found that within singing (opera) there are many individual variations in muscle recruitment patterns from the rib cage, abdominal wall, and accessory respiratory muscles, suggesting that professional opera singing does not require strictly uniform breathing strategies. This variety of approach may be useful when seeking to develop the optimum approach to breath control during dance.

### 3.4.2 Breathing for dancing

Open airways and a glottis with the vocal folds abducted, a regular breathing rate and tidal volumes (the volume of air that enters or exits the lungs with each respiratory cycle), are all necessary for spontaneous breathing during cardiovascular work, including dance. The ability to regulate airflow is essential when singing or playing wind instruments, particularly when trying to play extended, continuous phrases. When singing and dancing at the same time, this skill becomes more difficult to perform ([Sliiden, Beck & Macdonald, 2017](#)).

### 3.4.3 Integration of Singing and Choreography

While discussing body movement in performers, [Gates et al. \(2013\)](#) highlight that some performers may run out of breath during choreographed movement due to the difficulties in maintaining volume when running out of breath and may have to induce muscular tension in the larynx to maintain enough subglottic pressure while singing. Over time such vocal tension can become habitual and problematic. Furthermore, the impact of dance on cardiorespiratory demands within a musical theatre performance, explored by [Stephens and Wyon \(2020\)](#) found that although musical theatre performers have a greater maximal aerobic capacity than dancers from other genres, the singing component reduces breathing frequency. Consequently, this may have a negative effect on the physiological recovery from the dance sections and increase lactate levels, leading to suppressed cardiac output ([Stephens and Wyon, 2020](#)). Musical theatre dancers may need to either compromise the singing component to improve breathing frequency or decrease the intensity of the dance sequences to ensure singing is not affected by the breathing frequency required by the movement demands.

### 3.4.4 Maximum Phonation Time

In a 2016 study, [Sliiden, Beck and Macdonald](#) found that maximum phonation time (MPT) has been demonstrated to correlate with a number of different voice disorders and is a useful tool for monitoring the effectiveness of voice therapy, surgery, or other forms of treatment. While respiratory muscle dysfunction is not unheard of, singers are more likely to experience imbalances in their musculature, or even hyperfunction, which can result in irregularities at vocal fold level including inadequate approximation. Reduced breath efficiency and increased airflow may result from this ([Sliiden, Beck and MacDonald, 2017](#)). In a 1988 study, [Schmidt, Klingholtz, and Martin](#) found the MPT to be higher in classically trained female singers than in non-trained women. In order to measure respiratory or sound control the MPT test measures an individual's ability to sustain a sung tone, after filling their lungs to maximum capacity ([Maslan, 2011](#)). The decline in MPT was an increase in sound pressure of 3 seconds per 10dB observed in the results. In their mixed-method study conducted in 2016, [Sliiden, Beck and MacDonald](#) discovered a 65.2% decrease in MPT between singing while dancing (7.1 seconds) and singing at rest (20.4 seconds). The study also revealed that participants were in agreement that dancing had the greatest potential to negatively affect singing phraseology and prosody because dancing rapidly reduced the control of the breathing apparatus. The ability to even support and sustain notes was found to be the group's largest challenge when singing while dancing. By opening night, only 45% of the participants thought they could fully execute the combined singing and dancing. [Sliiden, Beck and MacDonald \(2017\)](#) concluded that in order to better prepare performers who must sing while dancing, as well as those who instruct aerobic circuit training classes, more research is needed.

### **Link between simultaneously singing and dancing and increased laryngeal tension**

While discussing body movement in performers, [Gates et al. \(2013\)](#) highlight that some performers may run out of breath during choreographed movement due to the difficulties in maintaining volume and may have to induce muscular tension in the larynx to maintain enough subglottic pressure while singing. Over time such vocal tension can become habitual and problematic. [Gates et al. \(2013\)](#) highlight the potential impact of movement on the MT voice, raising the possibility that in some performers the demands of movement may contribute directly to the development of MTD.

## **3.5 The Logistics of Performing**

### **3.5.1 Stage Effects**

Stage effects that impact the performance environment are commonly encountered by vocalists in MT. The ability to prevent or minimise negative effects on the voice depends on an understanding of the special effects, the chemicals used to create them and their possible impacts on voice quality ([Rossol, 2021](#)). A short medical study of 25 pit orchestra musicians at *Beauty and the Beast* on Broadway, was undertaken by Dr Jacqueline M. Moline ([Moline & Golden, 2000](#)). Medical tests clearly showed signs of ill health each pit musician. Dr Moline stated that “The conditions for the musicians in the music pit at *Beauty and the Beast* are unhealthy. A large percentage of the musicians are suffering from symptoms related to the irritative effects of the work environment. Several musicians now require medical care and medication to treat their symptoms which have developed or worsened since taking part in this production.” The data from the *Beauty and the Beast* study may not be generalisable to other Broadway shows, due to the use of pyrotechnic effects that created an additional type of smoke alongside the fog and haze used. A 2003 report to SHAPE (Safety and Health in Arts, Production, and Entertainment) by the University of British Columbia School of Occupational and Environmental Hygiene which studies the effects of theatrical fog on 100 stage workers found that overall, the health study results suggested that exposure to theatrical smokes and fogs causes non-specific respiratory irritation and increases the risk for chronic airflow obstruction among theatrical industry employees. The study also reported a “measurable drop in lung function (over the testing period of about 4 hours on average) was more often seen when mineral oil fog was used.” There remains a lack of contemporary research on this aspect of musical theatre performance. On the recommendation of Dr Moline, clear guidelines have been put in place by the actor’s union Equity regarding the duration and proximity of haze and fog within the theatrical setting. Yet, the evaluation of the health effects of theatrical smoke, haze and pyrotechnics was last updated in 2000 by Moline et al., leaving room for more current research. The dry and dusty air during rehearsals and performances is another common complaint from performers. The findings of Richter et al. (2000) supported the complaints of performers as they consistently discovered that the heat and dryness in theatres lacking compensatory humidification were generally too high for healthy voice performance. The performer may be expected to use extreme vocal ranges, such as screaming, crying, or sobbing within this potentially irritant environment ([Wilson, 2013](#)).

### **Link between stage effects and increased laryngeal tension**

The performance of singers, actors, and musicians can be adversely affected by a decrease in pulmonary function and it is unknown whether this change in lung capacity occurring repeatedly could develop into a chronic condition ([Rossol, 2021](#)). In a link to restricted breath use identified previously in this review, a lack of breath capacity may encourage tension in the larynx, as the performer recruits muscle to maintain subglottic pressure while singing. This tension, combined with the potential irritant impact of haze, fog, dust, and dry conditions may lead to coughing and additional habitual tension in the larynx.

### **3.5.2 Costuming**

[Wilson \(2013\)](#) states that some bulky or heavy costuming in the more fanciful areas of theatre, opera, and music theatre have become a source of income for local physiotherapists. A lack of research into the impact of additional weight, the need to balance and compensate for uneven weight distribution and the potential for neck strain while wearing heavy headpieces, masks or bulky costuming makes this aspect difficult to examine. Shoe design for women in musical theatre is typically based on the style period or stylistic decisions made by the director. Differing heel heights might be required to change the appearance of a character on stage. Additionally, the production may employ the use of a raked stage, which may affect the posture of the performer in a similar way to wearing high heels. The requirement to wear heels within a production may directly impact phonation. Data from a [2018 study by Rollings](#)

into the impact of heel wearing on head position, long-term average spectra, and perceptions of singers, found that for the majority of participants, heel height encouraged a significant lowering of head position, and notable changes in vocal timbre and resonance. An investigation into optimum singing posture by Luck and Toiviainen (2007) found that *"a lowered head position could produce spectral irregularity and an elevated head position could increase perceived loudness in singers"*. Although a lowered head position may produce a useful vocal timbre within a genre requiring lowered laryngeal position and lengthened vocal tract, this position may not be effective when producing the MT belt sound, which typically needs the first formant frequency to be raised and a slightly higher laryngeal position (Echternach et al., 2014; Sundberg, Thalen & Popeil, 2012). With regards to the impact on respiration, a historical study by Mathews and Wooten (1963) observed participants used significantly more oxygen while moving in high-heeled shoes compared with non-heeled shoes. These findings were later supported by Lee et al. (2001) who found an increase in the height of the mean centre of gravity and subsequently increased activity in the erector spinae muscle group when wearing high heels. As erector spinae muscles contribute to postural stability and flexibility, the impact on tension within the accessory muscles of respiration may prove detrimental to phonation.

### **Link between costuming and increased laryngeal tension**

It may be hypothesised that the impact of additional extrinsic neck tension may lead to maladaptation of the laryngeal mechanism resulting in MTD as a by-product of compensatory postural alignment strategies. Additionally, the impact of carrying additional weight while dancing may lead to compromised breath control, overheating, dehydration and the associated increased muscle use, irritation at vocal fold level, and increased cardiac function. All of which may increase stress on the body, leading to a rise in maladaptive approaches throughout the system.

### **3.5.3 Raked Stage**

In a 1998 survey which remains the only one compiled to date, Neurologist Randolph Evans found raked stages, inclined platforms at various angles, to be a risk factor on Broadway and in the West End. He argued that raked stages cause the performer to *"put your weight back, making you reset the centre of your balance[...]. It's like standing on a ski slope or an inclined highway. It's not your natural position"* (Evans, Evens & Carajal, 1998, p585). Several studies by Cielo, et al (2014), Gilman and Johns (2017), Grini, Ouaknine and Gionvanni (1998) and Lagier et al (2010), had reported that sub-optimal posture or tension produced compensation in muscles at both respiratory and phonatory levels. This was described as a result of an increase in muscle activity and tension which negatively affected inspiratory volume by placing the respiratory muscles in a shortened position, alongside head and neck level muscle tension at laryngeal muscles, which had the potential to translate to dysphonia.

### **Link between raked stage and increased laryngeal tension**

Although Evans, Evans and Carajal's 1998 survey targeted the collection of data regarding bodily injuries, findings suggest that the impact on posture may have an associated impact on voice production due to the compensatory muscle use in the larynx, upper back, and neck while performing on an incline, resulting in increased tension or maladaptation of laryngeal muscle use. A study into muscle activity and aerodynamic changes in voice within different body postures by Castillo-Allendes et al. (2022) hypothesised in their limited study that if allowed the appropriate amount of time to practice on the incline or unstable surface, singer may be able to adapt to the impact.

### **3.5.4 Integrating Instrumental Performance**

In the only known study of its kind, Longo et al. (2020) believed that the postural changes involved in playing an instrument while singing may increase muscular resistance in the tracts of the phono-articulatory apparatus and lead to voice disorders. They undertook a study to track changes in vocal parameters in pianists and guitarists playing while they sang. Results showed that playing an instrument while singing led to an impairment of the singer's formant and a decrease in jitter, fundamental voice frequency, shimmer, soft phonation index and maximum phonation time; Shoulder and back position affected voice features, and playing the guitar decreased the amplitude of the singers formant and increased noise, causing a typical raucous rock voice. Professional music players frequently develop musculoskeletal disorders (Rotter et al., 2020). According to Zaza et al. (1998), the definition of playing-related musculoskeletal disorders (PRMDs) is *"pain, weakness, numbness, tingling, or other symptoms that interfere with their ability to play their instruments at the level they are accustomed to"*. These PRMDs are regarded as multifactorial health issues, with a number of risk factors including sudden increase in playing load, repetitive motions, posture, mental health conditions and number of hours played (Rousseau et al., 2021; Baadjou et al., 2016; Kok et al., 2016; Kenny and Ackermann, 2015). The practice of playing an instrument requires repetitive movements,

sometimes in an awkward posture (violin, trumpet, and accordion) which can result in significant musculoskeletal strain. Postural impairments, in particular are often regarded in the literature as one of the main injury risk factors among musicians (Blanco-Pineiro et al., 2017; Chan and Ackermann, 2014; Ranelli et al., 2011; Watson, 2009). Taking into account the variations between musical instruments, Ramella et al. (2014) demonstrated how playing an asymmetrical instrument, coupled with the influence of years of practice raises the possibility of assuming “non-optimal” posture. Additionally, studies have examined and contrasted standing and various sitting positions by examining factors such as the recruitment of abdominal muscles or spirometry parameters in woodwind players (Ackermann et al., 2014; Price et al., 2014). As researchers in the field of musical health have found that posture is a significant risk factor that should be considered when evaluating, treating and preventing PRMDs in musicians, various techniques have been used to assess and rate musician’s posture (Valenzuela-Gomez et al., 2020; Blanco-Pineiro et al., 2015; Chan et al., 2013). Chan et al., 2013 used photographs to describe changes in posture before and after an intervention, while Valenzuela-Gomez et al. (2020) used the Rapid Entire Body Assessment (REBA) to analyse posture. In 2015, Blanco-Pineiro et al. created the Postural Observation Instrument (POI) as a tool to systematically examine students’ posture in music classes. Due to a lack of specific studies into the potential impacts of combined instrumental playing with singing, it may be prudent to examine the physiological impacts of instrumental playing on the body, and how they may potentially impact voice use. A recent study by El-Demerdash et al. (2024) to examine voice and vocal tract changes in professional wind instrumentalists found dysphonia in almost a third of the participants screened, along with signs of arytenoid oedema, hyperadduction and phonatory waste.

#### **Link between instrumental playing and increased laryngeal tension**

Voice production has been observed to be influenced by variations in craniocervical posture (Scotto Di Carlo, 1998). Consequently, posture has been recognised as a significant aspect of voice quality, particularly from research on functional dysphonia and, more specifically since the classification of muscle tension dysphonia (Van Houtte, Van Lierde & Claeys, 2011). An ideal alignment of the body is said to be achieved by optimum posture which requires less energy from the neuromuscular system and does not put undue pressure on the different tissue (Dutton, 2008; Marques, Hallal & Gonclaves, 2010). Anywhere along the kinetic chain a change in one joint can have an impact. Gait, joint load, brain function, endurance, strength, balance, respiration, muscle coordination and phonation are among the areas where these alterations may show themselves (Dutton, 2008; Wilson Arboleda & Frederick, 2008).

#### **3.5.5 Irregular or late-night eating**

Musical theatre show performance times necessitate irregular and/or late-night eating schedules. Late-night or rapid eating may lead to gastroesophageal reflux disease, leading to increased acid around the hypopharynx and vocal folds. In contrast to an acute stress reaction, the two stress-related symptoms of heartburn and GERD may suggest prolonged exposure to stressors. Those who have experienced long-term stressors in their lives are more likely to report having GERD symptoms (Mizyed, Fass & Fass, 2009). Numerous mucosal alterations may result from acid in the larynx and pharynx (Khan et al., 2006) with laryngeal symptoms, including sore throat, persistent hoarseness, persistent coughing and clearing of the throat, and feeling of a lump or foreign body in the throat, caused by these lesions and mucosal alterations (Hamdan et al., 2001; Koufman, 1991). The findings of a research by Tokashiki et al. (2010) demonstrate that increased pressure or globus sensation in the upper oesophageal sphincter is a side-effect of gastroesophageal reflux.

#### **Link between irregular eating and increased laryngeal tension**

Laryngeal muscular tension and GERD were found to be strongly correlated ( $P < 0.001$ ) by Angsuwarangsee and Morrison (2002). Although muscle tension may be a secondary symptom of the disease, the results of this study may indicate that treating GERD or LPRD does not focus largely on treating this symptom. Reduction of stomach acid reflux on the upper respiratory tract may lead to a decrease in compensatory harmful functions in the larynx, including muscle tension. Muscle tension could persist even after treatment for GERD or LPRD if it is a secondary sign of stress. Stress can directly produce an increase in muscle tension, or it can occur indirectly as a result of mucous membrane stiffness brought on by inflammation of the mucous membranes caused by LPRD, or laryngitis. According to the findings of a study conducted in 1986 by Morrison et al, LPRD alone predisposes MTD. Additionally, Morrison et al (1986). noted that MTD typically occurs in individuals who use their voices a lot during stressful situations.

### 3.5.6 Stress and the role of the swing

At the time of this study, only grey literature was available regarding the role and demands of the musical theatre swing. A swing is so-called as they can move easily and quickly between two or more parts in the same show (Elster, 2023). Where the role of an understudy is to be able to fill in for a lead role, a swing may cover the parts usually played by an understudy, or additional roles within the ensemble. A super swing, or universal swing, is a performer who commutes around the country as required to perform in various productions of a widespread show. Eyer & Smith (2015) provide an in-depth examination of the pros and cons, using recollections from those who have worked extensively as swings, containing a common theme of stress, uncertainty and anxiety. Massazza et al. (2022) found a positive association between uncertainty and mental health problems, including anxiety, depression and stress.

#### Link between stress and increased laryngeal tension

A number of studies have demonstrated a correlation between increased muscle tension and general anxiety or tension (Dahlstrom et al., 1985; Flor et al., 1991; Vanltallie, 2002). Unlike physical stress or exercise, emotional stress can continue even when there is no stressor present as it can maintain increased muscle tension (Lundberg, 2002). Hagg (1991) suggests that stress may maintain low-threshold motor unit activity. The continuous activation of the motor units may have physiological and motoric effects on the laryngeal structures. The main function of the larynx is to prevent foreign substances from entering the airway. From a neuromuscular standpoint, the larynx predates the neocortex's neuromuscular system for language and articulation, and its function in producing speech is incidental (Aronson, 1990). Primitive neural mechanisms take precedence over higher cortical functions in the brain when the stress reaction is triggered, leading to inadequate and imbalanced muscular behaviour during voice production. Stress and psychological variables are linked to muscle tension dysphonia or muscle tension in the larynx (Dietrich et al, 2006; Altman et al, 2005). Dietrich et al. (2005), propose that stress may increase laryngeal muscle tension in correlation with cardiovascular and emotional arousal, while Holmqvist et al. (2013), suggest the body's reaction to stress causes metabolic, immunological, neuroendocrine and autonomic changes in addition to changes in the psychoneuroimmunologic system, and vocal function may be impacted by both the primary and secondary effects of stress reaction. These views are supported by McEwen (2000), who describes the initial reactions to acute stress as defensive and intended to continue with increased activity. As a result of this reaction, the body becomes overstretched when the protective stress system is overworked, which increases susceptibility to disease (Toppinen-Tanner et al., 2005). The reciprocal relationship between the immune system and the central nervous system (Shanks et al., 1998) and as a result, the bloodstream is filled with cortisol during a stress response, which has the effect of boosting immunity, however if the stressor is not eliminated and the sympathetic nervous system (SNS) is activated for an extended length of time, cortisol has a detrimental effect on the immune system (Iverson, Iverson & Saper, 2000). Stress directly affects health and the ability to recover from illness (Cohen, 2005). It is therefore conceivable that long-term stress and fatigue that weakens the immune system may lengthen the course of a viral or LPRD-induced laryngitis.

### 3.6 Stress and Anxiety

#### 3.6.1 Performance Anxiety

According to Beilock et al. (2017), performance anxiety (PA) is "apprehension and fear related to completing a specific task or even engaging with a specific domain." Sweating, palpitations, lack of focus, and forgetfulness are just a few of the symptoms that performance anxiety can cause. Numerous factors have been linked to PA, including genetics, experiences, cognitions and environment (Kenny et al., 2014). A number of domains including singing, public speaking, sport, and music have been studied for performance anxiety (Niering et al., 2023). Musical theatre performers, however, have not been the subject of specific research. Most performers in musical theatre are required to be 'triple threats', meaning they must be able to sing, act and dance to a high standard. More recently, the introduction of the 'actor-muso' performance requires musical theatre performers to play instruments alongside the existing three disciplines. Higher levels of PA could result from performers having more of an obligation to live up to expectations in all three or four domains.

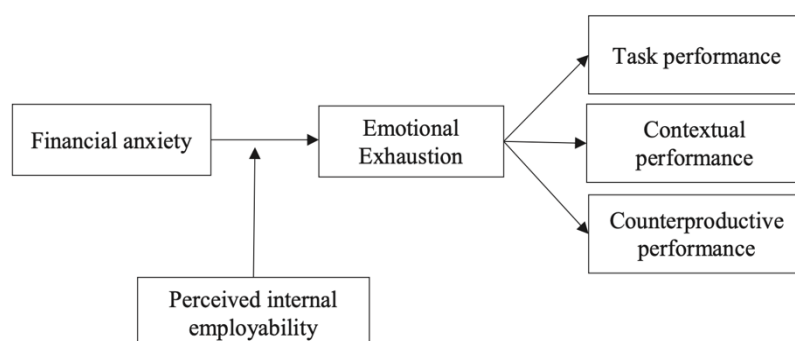
Although Kenny et al. (2014) define the cause of PA as "pressure placed on oneself, excessive arousal and inadequate preparation for the performance," it is accepted that musical theatre performances are subject to suitable rehearsal period and repetition of content. This suggests that musical theatre performers might have lower levels or instances of PA, however the multifaceted nature of musical theatre performance may make it difficult to feel adequately



competent in all aspects of the performance, which may expose MT performers to PA to the same extent as many other performers. In a recent study into music performance anxiety (MPA) in musical theatre performers by [James and Shipley \(2022\)](#), performance anxiety was shown to be a significant issue, which is in line with findings specific to musicians. The authors concluded that more research is required in order to suggest treatments designed specifically for MT performers. Some performers claim that the worst PA is not always the performance, but rather the audition process or what comes after the final show. Performers are evaluated during auditions with the possibility of employment at the conclusion of the process. This increases the pressure experienced. Comparably, as a run of a MT show is coming to an end, concern will increase with regards to subsequent employment, causing financial anxiety and the need to audition in tandem with final show performances. Naturally the two situations have the most profound effects on the performer's livelihood and, therefore in combination may cause additional anxiety.

### 3.6.2 Financial Anxiety

Sociologists studying the effects of low wages and uncertain income have documented the negative consequences of financial hardship. [Simmons and Swanberg's \(2009\)](#) study comparing the prevalence of depressive symptoms in workers with lower versus higher wages discovered that a higher percentage of lower wage workers reported having depressive symptoms. [Lund et al. \(2010\)](#) conducted a meta-analytic study and found a positive correlation between common mental health disorders like anxiety and depression, and perceived poverty. They also found that the lower the income level, the more common these disorders became. Research also indicates that having a particular objective financial situation has an impact on mental health ([Lund et al., 2010](#); [Simmons & Swanberg, 2009](#)) and may lead to negative outcomes. When compared to an objective financial state, financial anxiety is subjective and is defined as worrying or feeling anxious about personal financial status due to an assessment that present and future financial resources will not be sufficient to pay for the "basic necessities of life" ([Lim & Sng, 2006](#)). It is noteworthy to mention in this definition that financial anxiety, which is also called financial worry ([Meuris & Leana, 2018](#)), is an emotional evaluation of personal financial circumstances. It must be acknowledged that different individuals may have different interpretations and responses to the same objective situation. Some may experience anxiety from living within an uncertain or low-income setting, even though their personal finances may be sufficient to meet their needs in an objective sense. According to [Gasiorowska \(2014\)](#), financial anxiety is a more proximal determinant than objective financial condition because of its subjective nature, making it a better predictor of relevant outcomes. In their ground-breaking study, [Meuris and Leana \(2018\)](#) discovered that cognitive resources were depleted by financial worries to the point where people began to experience cognitive issues that interfered with their ability to perform tasks. [Jawahar, Mohammed and Schreurs \(2022\)](#) went on to research whether financial anxiety may contribute to emotional exhaustion due to the depletion of emotional resources in the same way. Support for a conditional indirect effect was found using data gathered in three waves from 434 respondents. In particular, perceived internal employability acted as a moderator of the indirect relationship between financial anxiety and performance through emotional exhaustion. If the level of perceived employability increased, anxiety decreased, along with symptoms of emotional exhaustion (Fig. 3).



**Figure 3. Research model visualising the indirect effect of financial anxiety on job performance via emotional exhaustion moderated by perceived internal employability ([Jawahar, Mohammed and Schreurs, 2022](#)).**

Although the majority of research is based within the business sector and not the performing arts, parallels can be drawn. Within the musical theatre profession, the continued lack of job security and pressure to compete for employment may lead directly to financial anxiety, which in turn may lead to cognitive issues and emotional exhaustion. These psychological and physiological impacts would be disastrous for the musical theatre performer and can be judged as a threat to livelihood.

### 3.7 Exhaustion

According to Tache and Selye (1985), exhaustion is a sign of prolonged exposure to stressors. The body may experience changes to the cardiovascular system, and hormones, alongside neuroimmunologic changes. Stress on the body or mind lowers immunity and makes the body more vulnerable. According to McEwen (1998), the phrase “allostatic load” describes the long-term effects of the physiological changes brought on by the stress reaction, such as chronic over or under-activity of the neuronal, hormonal and/or immunologic stress arousal system. This could lead to recurrent episodes of acute stress, a delay in recovery, insufficient physiological stress responses, or an inability to adjust to a comparable stressor if it happens frequently. The physiological stress response may be triggered when someone is anxious or experiencing other comparable stressors. Previous research indicates that voice complaints were more common in people who described feeling tense or worn out. The development of negative voice symptoms may be related to stress-induced tiredness and the alterations it creates in the body.

### 3.8 Stress and the voice

The body’s two stress response systems are the hypothalamic-pituitary-adrenal axis (HPA) and the sympathetic nervous system (SNS). The SNS is triggered by a difficult circumstance that a person feels they can work hard to overcome (Kudielka, Hellhammer & Kirschbaum, 2007). The HPA axis is triggered when an individual experiences a stressor that they view as uncontrollable event that makes them feel helpless (Kudielka et al., 2007). This stressor also poses a threat to a goal they have committed to (Dickerson & Kemeny, 2004). When a stressor has a social-evaluative element (such as an audition) and the individual processing the stressor believes the stressor is uncontrollable, the HPA axis is most activated (Dickerson & Kemeny, 2004). Holmqvist et al. (2013) assert that vocalising when nervous and tense may result in higher cortisol levels because of increased HPA axis activation. This increase may result in negative changes in the voice. Indeed, self-reported voice complaints are more common in those whose cortisol levels were greater at any given time (Holmqvist et al., 2017). Furthermore, compared to before the stressor, those who have a significant rise in cortisol levels have a higher fundamental frequency (Pisanski, Nowak, & Sorokowski, 2016).

#### 3.8.1 Voice Disorders – stress factors

Psychosocial stress factors have been linked by researchers and clinicians to the development of functional voice abnormalities (Roy & Bless, 1998), although little consideration has been paid to the effects of the neuroendocrine and autonomic nervous systems. Dysphonia resulting from changes in the vocal fold tissue or brain innervation is referred to as a functional voice disorder (Roy, 2003). These alterations could be brought on by psychogenic causes or misuse of the laryngeal musculature, including hyper adductive or hypo adductive glottal shaping (Roy, 2003).

#### 3.8.2 Stressful life events and voice disorders

Compared to healthy controls, those with hyper functional voice disorders rated stressful events far higher. Remarkably, in contrast to the other groups, these participants did not report noticeably higher voice use. As these measurements do not account for how the stressful experience affected the individual, they should be evaluated cautiously (Cohen, Kamarck, Mermelstein, 1983). Participants in the Perceived Stress Questionnaire (Cohen et al., 1983) are asked to score the degree of stress that various life events have caused them during the past month. It provides an evaluation of stress that is more reflective of contemporary pressures than other scales. Dietrich et al. (2008) compared the norms of the Hospital Anxiety and Depression Scale (HADS) and the Perceived Stress Scale-10 (PSS-10) to patients with muscular tension dysphonia, benign vocal fold lesions, paradoxical vocal fold movement disorder, and glottal insufficiency. They discovered that in comparison to the norms of the corresponding measures, only 25% of patients with a range of voice abnormalities reported high stress (measured using the PSS-10), 36.9% reported high anxiety, and 31.2% reported a high depression score (evaluated using HADS). Compared to patients with vocal fold lesions, a greater proportion of patients with muscle tension dysphonia expressed stress and depression.



### 3.8.3 Anxiety and voice disorders

According to Brodnitz's (1962) theory, vocal difficulties can result in psychological issues, personality alterations, and emotional and personality disorders overall. It is difficult to determine whether anxiety disorders and voice problems originated independently of one another, or if the voice abnormalities and anxiety disorders co-occurred. Mirza et al. (2003) suggest that the link between anxiety disorders and vocal disorders is complex, supported by Nerriere et al's (2009) study using the Rand 36-item Short Form Health Survey which concluded that teachers without voice issues have lower levels of psychological distress than teachers with voice abnormalities.

### 3.8.4 Stress reactivity and impact on the voice

There appears to be a lack of evidence in the available literature regarding variations in the biological stress systems' underlying activity, which could account for some of the disparities between those who acquire a functional voice issue and others who do not. In particular there is a gap in the literature with regards to how variations in stress reactivity affects those with and without voice disorders. According to a number of studies, when a functional voice issue develops, it may be important to take into account variations in stress systems. Gassull et al. (2010) state that there appears to be a positive correlation between stress reactivity scoring nine or higher on the Voice handicap Index (VHI) and perception of voice issues. Salivary cortisol levels were observed to be higher in woman than men who reported voice complaints (Holmqvist et al., 2017). Extra laryngeal tension may result from "overactivity of autonomic and voluntary nerve systems in individuals who are overly excited and apprehensive" according to Morrison, Rammage & Nichol (1994) (p.644). Research by Holmqvist et al. (2013) and Morrison, et al. (1994) found that changes in voice quality that could result in the emergence of a functional voice disorder may be related to the actions of the sympathetic and parasympathetic nervous systems.

## 4. Conclusion

By collating and presenting information on the different demands within musical theatre performance, and subsequent potential impacts with regards to laryngeal tension and muscle tension dysphonia, this rapid review highlights the nature of a number of these demands and their capacity to increase laryngeal tension, leading to the hypothesis that a combination of demands may compound the potential for detrimental tension further. Awareness of additional stressors may impact treatment design of MTD in musical theatre singers as each physiological and psychological aspect has the potential to impact tension levels differently, depending on the reaction in the singer.

## 5. Recommendation for Research

It is hoped that further research into the specific physiological and psychological demands on the musical theatre performer may help to tailor diagnosis and treatment and subsequently allow voice care teams and performers to act to prevent additional tension where possible. Both qualitative and quantitative study of the perceived and actual impacts of individual and combined demands have on laryngeal tension levels would be valuable to ensure these factors are considered during therapeutic intervention for functional voice disorders. Findings of similar studies may help to provide further support for singing teachers and voice rehabilitation teams working to support rehabilitative progression with these specific musical theatre parameters.

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