Spring 2017

Crossing the bridge: A descriptive pilot study of sensory tricks and related variables to musician's dystonia onset

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Crossing the Bridge: A Descriptive Pilot Study of Sensory Tricks and Related Variables to Musician's Dystonia Onset

An Honors College Project Presented to

the Faculty of the Undergraduate

College of Health Sciences

James Madison University

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May 2017

Accepted by the faculty of the Department of Health Sciences, James Madison University, in partial fulfillment of the requirements for the Honors College.

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PUBLIC PRESENTATION

This work is accepted for presentation, in part or in full, at JMU Honors Symposium on April 21, 2017.

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Dedication

This Thesis is dedicated to all instrumentalists experiencing the physical and emotional difficulties of musician's focal dystonia. It is my ardent hope that one day you will not always have to suffer for your art.

"If I only had no fingers, and could play with my heart to others!"

-- pianist Robert Schumann after dystonia onset

Acknowledgements

Without God and the loving inspiration of my family who have given me reason to persevere, this thesis could not have been completed. To my advisor and mentor Dr. Katherine Ott-Walter, the guidance and time you have shared with me throughout the duration of this project have been invaluable. Thank you for your support, both mentally and academically, and for imparting in me the knowledge that true growth and accomplishment occur when we can learn to adjust to difficulties which arise and still manage to reach our goals (even if the process/end results are not entirely what we expected). To my mentor and co-advisor, Dr. Derek Strong, you made a dynamic impact in inspiring me to undertake this project, and I thank you for fostering in me an intense fascination for research which has changed the way I view the world. Your continued support, teaching, and guidance have been inestimable, and my time spent learning from you will always be one of my most cherished memories as a JMU student. Thank you for your investment in me. Gratitude should also be expressed to my committee members: Dr. Collazo-Vargas for intensely inspiring me to love research through expression of her own passions and for instilling in me the confidence to begin down that path; Dr. Hynd who taught me the immeasurable lesson that research is not about knowing the answers, but rather the humble pursuit of continued knowledge; Dr. Koslow who exposed me to the exciting world of effort force and torque; and, Dr. Kurtz for her insight and recommendations regarding the psychological measures addressed within this study.

Further gratitude is owed to my mentors/friends, physical therapists Dr. Adler and Kristen Wright, who successfully enabled my complete return to violin playing after my own experiences with musician's focal dystonia. You gave me back my life and influenced my desire to embark on this study. Centennial Scholars Director, Mrs. Strawbridge, you have similarly shaped my way of thinking in inspiring me to persevere beyond struggle to accomplish what I never thought possible. Thank you for the irreplaceable opportunities you have given me. To my dear friends, Jen Lapierre, David O'Rawe, and Max Yamane, who unknowingly motivated me through a time I did not think I could continue, I will always be grateful. Lastly, I would like to recognize the memory of violin instructor Thomas Lindsay who helped me develop my musical voice following dystonia, but passed away during the completion of this project.

Abstract

Silencing music across the globe, musician's dystonia, a neurological condition with an unknown etiological basis, has played an integral role in terminating professional musician's careers. While limited research has been conducted into internal/external factors which may potentially influence musician's focal dystonia onset, this pilot study sought to identify specific instrumentalists' behaviors and traits which may exhibit a potential relationship with disease onset and, consequently, the ability to utilize sensory tricks. This specifically included examination of practice approach, auditory/kinesthetic feedback, years played, personality, and approach to practice among the musicians being studied. To assess these characteristics within the dystonic musician population and to determine how this data related to healthy/undiagnosed music students of James Madison University (JMU), a survey instrument created based upon application of the Social Cognitive Theory was distributed. Resulting data analysis indicated fatigue based practice techniques were commonly used among both dystonic musicians and symptomatic JMU students and that maladaptive auditory/kinesthetic feedback mechanisms were positively correlated with negative symptoms. Findings further helped identify which sensory tricks were most commonly employed by dystonic musicians, exposing that instrumental genre may be influential in determining which types are typically chosen to ameliorate negative symptoms. In addition, results which revealed that half of JMU's music student population currently exhibit dystonic symptoms and unknowingly use sensory tricks generates implications for future research in regards to what preventative changes could be implemented within the educational program. Therefore, the objective of this thesis was to gain not only a comprehensive understanding of potential factors related to musician's dystonia, but to both expand on previous literature and potentially impact future health outcomes of musicians.

Chapter I

Introduction

Purpose and Significance

The exact derivation of musician's focal dystonia remains largely undetermined, yet current scientific research is not without a plethora of hypothetical theories regarding factors which may play an associated role in manifesting disease onset (Altenmuller & Jabusch, 2009). Characterized by spasmodic and paralytic symptoms localized to body areas which perform musical movement, the disorder is primarily classified as a neurological condition due to somatosensory dysfunction noted on functional MRI (fMRI) (Haslinger, Altenmuller, Castrop, Zimmer, & Dresel, 2010). This classification appears to be further justified by documented cases of the usage of sensory "tricks," the employment of sensory/tactile stimuli to temporarily alleviate negative neurological symptoms among dystonic musicians (Loyola, Camargos, Maia, & Cardoso, 2012).

Though this phenomenon (which may include supporting the affected arm, refingering music, holding a pencil with the affected fingers while playing, etc.) is prevalent throughout previous research findings on musician's dystonia, a significant deficit of knowledge still exists regarding the exact nature of sensory tricks being employed by musicians (Conti, Pullman, & Frucht, 2008). This lack of information is further intensified by unknown correlations with other variables including age, underlying psychological traits, and repertoire impact on auditory/kinesthetic feedback. Therefore, the intention of this research study was to both identify existing sensory tricks being utilized across the affected population and examine how the dystonic symptoms they were intended to help ameliorate were impacted by personality traits, age, and auditory/kinesthetic feedback abilities.

This study further aimed to determine whether sensory tricks would/would not be useful by all dystonic musicians of a particular instrumental genre and whether potential correlative factors may impact their effectiveness. Research into this aspect sought to address the idea present within past literature concerning generalized non-musician's dystonia which upholds the idea that the effectiveness of specific sensory tricks is specific to the affected individual and not effective if shared with other dystonic patients (Ramos, Karp, & Hallet, 2014). Thus, the present study also sought to determine whether sensory trick usage was similar between musicians of comparable instrumental genres due to the specificity of musically related movement types. Examining a proposed hypothetical linkage between sensory tricks and correlative variables was directed towards establishing, according to the instrument played, a foundational understanding necessary to conduct a future experimental analysis to determine the degree of predictability of the phenomenon in effectively reducing brain mechanisms which perpetuate dystonic movements. This specifically included a focus on reducing cortical area increased facilitation to inhibition ratios. To address this, research questions and objectives, constructed through application of Albert Bandura's Social Cognitive Theory, were created in order to increase understanding of musician's behaviors which impact dystonia onset and sensory trick usage.

Research questions of the study were:

RQ1: Are musicians diagnosed with dystonia more likely to use sensory tricks?

RQ2: Are musicians diagnosed with dystonia more likely to be right or left handed?

RQ3: Do undiagnosed JMU music students experience negative symptoms similar to musicians diagnosed with dystonia?

RQ4: Do undiagnosed, symptomatic JMU music students use sensory tricks to manage negative symptoms?

RQ5: Is there a correlation between level of experience and dystonia diagnosis?

RQ6: Is there a correlation between years played and dystonia diagnosis?

RQ7: Is there a correlation between age and dystonia diagnosis?

RQ8: What is the relationship between instrument genre and sensory tricks in musicians diagnosed with dystonia?

RQ9: What auditory/kinesthetic traits are commonly exhibited in musicians with dystonia?

RQ10: Is there a difference in personality scoring between dystonic and non-dystonic musicians?

RQ11: Is there a difference in self-esteem levels between dystonic musicians and non-dystonic musicians?

RQ12: Is there a difference in stress level between dystonic and non-dystonic musicians?

RQ13: What auditory/kinesthetic traits are most commonly exhibited in symptomatic JMU music students?

RQ14: Is there a difference in self-esteem levels exhibited between symptomatic JMU music students and asymptomatic JMU music students?

Objectives of the study were to:

1. Identify sensory tricks being utilized across dystonic musicians of varying instrumental genres.
    a. Determine whether type of sensory trick usage is similar between instrumental genres.
2. Determine how the dystonic symptoms sensory tricks were intended to help ameliorate were impacted by personality traits, age, and auditory/kinesthetic feedback abilities.
3. Examine whether potential trends in characteristics of practice approach (as related to repertoire level), auditory/kinesthetic feedback, years played, and personality type present in dystonic musicians are also present within the healthy JMU music student population.
    a. Determine if there are JMU students already exhibiting potential symptoms.
    b. Determine whether healthy JMU students are utilizing sensory tricks and whether these could potentially be adapted as a preventative measure to help guard against disease onset.

Foundational Theoretical Model:

Signifying a growing need for research into the underlying physical and mental influences affecting fluid practicing mechanisms, musician's dystonia is steadily becoming synonymous with the termination of performance careers. Though many theories may be utilized to address this issue, the social cognitive theory, distinctly characterized by its intense focus on human potential, provided a singular method for understanding, addressing, and implementing strategies for behavior change (Bandura, 1986). Thus, this model was adapted to fulfilling the objectives outlined within this study with the purpose of identifying potential musician's behaviors which impact dystonia onset and sensory trick usage.

Postulating that behavior is a result of interactions between personal factors, behavior, and environmental influences, Albert Bandura from Stanford University originally proposed the social cognitive theory in his 1986 book entitled, Social Foundations of Thought and Action (Bandura, 1986). This model, adapted from the social learning theory and written in association with Richard Walters from the University of Waterloo, focuses on how individuals learn to respond, whether maladaptively or effectively, to their environment (Sharma & Romas, 2012). It is this aspect which makes it applicable to performance preparation. By emphasizing how individuals learn vicariously (learning from observing others), through external pressures, and self-exploration, this model was able to be adjusted to expose how musicians adapt behavioral practicing techniques specific to such learning patterns (Bandura, 1986).

Providing a foundational structure which encompasses variations within individual capabilities, the social cognitive theory serves to address a plethora of ways knowledge, learning, and skills are obtained, adapted, and maintained (Bandura, 1986). This includes a concentrated focus on self-reflection, self-regulation, forethought, vicarious learning, and symbolizing

capabilities. From this underlying emphasis that individuals exist as independent moral agents who are capable of shaping and controlling their own lives, Bandura created several constructs with the purpose of enhancing and implementing health educational and promotional programs to influence behavior change (Bandura, 1986). This includes knowledge, outcome expectations, outcome expectancies, situational perception, environment, self-efficacy, self-efficacy in overcoming impediments, goal setting/self-control, and emotional coping constructs (Bandura, 1986). However, for the purposes of this project, this research study addressed five of the social cognitive theory's nine constructs, situational perception, emotional coping, outcome expectations, outcome expectancies, and self-efficacy, as a means to improve understanding of influences which help shape the mental and physical execution of music practice and performance. In addition, three more constructs, performance learning approach, performance well-being, and compensatory adaptation, created by the researcher for the purpose of improving applicability to the action of music performance, were implemented to researching each objective.

Each model construct was applied with respect to reciprocal determinism, focusing primarily on how behavioral, environmental, and personal factors interact to influence musicians to engage in behaviors which may increase the risk for dystonia onset (Bandura, 1986). Furthermore, all constructs were used to provide the basis for understanding the intertwining relationship of thought and behavior underlying all variables being studied. Thus, the variables of auditory/kinesthetic feedback, personality, age and years played, repertoire level, sensory tricks, and approach to practice were analyzed as presented in the summary of objectives.

Conceptual definitions and application of social cognitive theory constructs:

1. **Situational Perception:** The way an individual interprets and perceives their environment and its corresponding influences.
    - *Operational definition:* This construct was referenced within the survey to help quantify musician's beliefs concerning their current situation (accomplishments, success, etc.) in relation to their aspirations concerning where they would like to be. This was addressed by observing individual responses to survey questions regarding their interactions with and perceptions concerning their social surroundings, including their views toward their present state in life and the imminent future. Specific research questions being addressed included:
        - Does the musician feel in control of the situation in which they live?
        - Does the musician feel they have accomplished all there is to do in life?
2. **Emotional coping:** The ability of an individual to capably handle emotional stressors without physiological or psychological harm.
    - *Operational definition:* This construct was used to measure musician's psychological and physical capabilities of managing their emotions. This was assessed through survey questions regarding how musicians handle stressful performance related challenges (learning a new piece, playing a concert, etc.). Example research questions being addressed included:
        - If the musician, has a concert coming up in 1 week, how would they best approach practicing a musical passage that is giving them difficulty?
        - During periods of high stress, does the musician notice that specific sensory tricks work more or less?

- Does the musician feel capable of being successful?

3. **Outcome expectations:** Positive or negative expectations regarding outcomes/results.
   - *Operational definition:* This construct was used as a means to determine whether musicians typically have a positive or negative outlook regarding the outcomes of practice and, ultimately, a performance. Research questions which were addressed included:
     - Does the musician feel they perform the way they deserve based on the amount of effort and time they practice?
     - To what degree, does the musician feel "in control" of their future performance and optimistic that it will be successful?
4. **Outcome expectancies:** Degree of worth an individual assigns an outcome.
   - *Operational definition*: This construct was addressed by assessing how individuals responded when being given survey questions which ask about their personal self-worth related to instrumental and non-instrumental abilities. Sample research questions outlining these issues included:
     - If the musician performs at a lesser level than desired, do they feel less worthy as an individual?
     - Does the musician express that they feel a sense of purpose in life?
     - Does the musician enjoy planning and preparing for the future?
5. **Self-efficacy:** The extent to which an individual has confidence that they possess the capability to successfully perform a behavior.
   - *Operational definition:* This construct was examined in regards to how individuals responded to questions concerning their beliefs in their capability to achieve a desired

musical outcome. Research questions to ascertain confidence and self-esteem level in performance approach included:

- Does the musician express feeling confident in managing daily responsibilities?
- Do responsibilities (practice and otherwise) often prove overwhelming?
- How confident does the musician feel that they are able to do work as well as other musicians?

Conceptual definitions and application of created constructs:

6. **Performance Learning Approach:** The method in which a musician studies and practices rhythm, musicality, musical organization, and technique.
   - *Operational definition:* This construct was addressed by assessing how individuals approached learning a new piece such as concentration on speed, repetition, or on visualization with breaks. Example research questions which were used to meet this requirement included:
     - If the musician has a concert occurring in 1 week, how would they undertake learning a new piece?
     - How many hours does the individual spend practicing/performing in a week?
7. **Performance Wellbeing:** A state or condition in which an individual is healthy overall (physically, cognitively, etc.).
   - *Operational definition:* This construct was addressed by observing how musicians responded to survey questions which may indicate that the individual had perceived negative symptoms when performing their instrument. Research questions to help ascertain negative symptoms included:

- Do you exhibit negative symptoms while playing?
- During what technique does the individual mostly exhibit negative symptoms?
- Is there a correlation between specific tempi and negative symptoms?
- Does pitch appear to be related to negative symptoms?

8. **Compensatory Adaptation:** Methods used by musicians to stop or mitigate negative physical symptoms while playing. For the purposes of this study, this included an examination of sensory tricks, a physical act or position used to temporarily relieve negative dystonic symptoms.
   - Operational definition: This construct was examined by assessing whether musicians who were experiencing negative symptoms were able to physically compensate to alleviate symptoms. Example research questions which addressed this issue included:
     - Is there anything the musician can do to alleviate negative symptoms (changing fingering, changing positioning of instrument, wearing a band, touching chin, etc.)?
     - Does effectiveness of sensory tricks change during periods of high stress?

Limitations

Limitations within this study included non-respondents (not all individuals who received the survey link completed it) and the inability to control for possible medical conditions which may have perpetuated similar symptoms to dystonia, but were unrelated. Having a small amount of time to perform data collection may also have decreased accessibility to a more stratified population of musicians who, due to practice commitments, may not have had appropriate access to an online survey. In addition, cohort effect may have impacted results as musicians through JMU may have been exposed to differing environmental stressors and life experiences than

musicians recruited through Facebook. Musicians' subjective perceptions of technique level is an example of this. While one musician may consider themselves technically advanced, another musician with the same technical ability may believe they are only intermediate. Additionally, without physician verification of dystonia diagnoses, there was no clear means to determine whether individuals were self-diagnosed or received the diagnosis from a medical professional. However, these weaknesses may be corrected in future research by allotting more time for data collection, requesting participants undergo a physician evaluation before survey testing, and having respondents' musical levels be evaluated by an established music professional within a university.

Chapter II

Literature Review

Dystonia:

Dystonia, historically derived from the Greek meaning "altered muscle tone," is a chronic neurological condition characterized by sustained, involuntary muscle contractions, perpetuating irregular postures, mild to severe pain, possible paralysis, and patterned, repetitive movements (Moberg-Wolff, 2014). Though it has been shown that dystonia may affect several muscle groups simultaneously, the most common form, focal dystonia, is concentrated to one area. Its classification is based upon both clinical features (onset age, etiology, symptoms, and anatomic location) and causation factors (heredity, environmental features, etc.) (Moberg-Wolff, 2014). Focal dystonia is most commonly developed in adulthood (after age 20), though it may also be developed during infancy, childhood, or adolescence (Jinnah, 2010). It is most prevalent in regions of the upper face (blepharospasm), jaw and mouth (oromandibular dystonia), larynx, limbs (including hands and feet), and neck (cervical dystonia). Focal dystonias affecting the cervical region and limbs are commonly task specific, denoting that they are associated with participation in specific repetitive activities (Jinnah, 2010).

Musician's Dystonia:

Musician's dystonia is a subset of focal dystonia which affects approximately 1-2% of professional musicians and relates solely to the task of performing an instrument (Ellenberger, 2013). This task, which is highly complex and unique, requires the brain to sort and integrate intricate signals from both motor and sensory pathways in an effort to produce the desired motor movement. However, for a reason yet to be determined, dystonia distorts these pathways, forcing the sensory ("afferent") signals going to the central nervous system (CNS) and the motor

("efferent") signals travelling from the CNS to overlap. Thus, resulting messages which designate flexion, extension, or relaxation become distorted, resulting in the inability of the basal ganglia to generate a controlled motor response. Repetitive firing of neurons through constant use would further allow distorted pathways to become recognized or "riveted" in the brain, allowing for sustained spasmodic symptoms and possible paralysis (Ellenberger, 2013). However, to truly isolate the involved brain mechanisms, more information is needed regarding correlative factors potentially involved in disease onset which would include examining existing similarities and variations within both healthy and dystonic musicians (Altenmuller & Jabusch, 2009). For the purposes of this study, this examination included research into sensory tricks and possible correlating variables associated with disease onset such as sensorimotor dysfunction, auditory-kinesthetic feedback mechanisms, personality, age and years spent playing an instrument, and repertoire level.

Sensorimotor Dysfunction:

Practicing music has been found to positively increase brain plasticity by actively engaging the motor, visual, and auditory areas of the brain simultaneously (Ellenberger, 2013). Yet, intense practice of repetitive movements has been observed, in select individuals, to harmfully overexert/overuse areas of the cerebral cortex. Intense cortical pathway activation is, under normal conditions, considered beneficial to cognitive health since an increase in brain plasticity is positively correlated with an increase in the development of axons, dendrites, and enhanced neural activity. However, in select individuals, excessive stimulation by neural transmissions is believed to cause receptive fields of motor and sensory pathways in the frontal and parietal lobes of the brain to overlap, perpetuating somatosensory impairment in the development and expansion of networks for specific movements (Ellenberger, 2013). A study by

Konczak and Abbruzzese confirmed that enlargement, lack of clear definition, and overlap of receptive fields in the somatosensory and motor cortices are contributing factors which lead to faulty involuntary motor output (Konczak & Abbruzzese, 2015). This phenomenon enhances the ability of one network to overflow and invade another, triggering unwanted movements. For this reason, researchers have asserted that, though uncontrolled motor execution (muscle inhibition and contraction) is a major characteristic of the disorder, it cannot be viewed as a true motor disorder for its foundational basis results from distortions within the sensorimotor loop (Konczak & Abbruzzese, 2015).

Auditory-Kinesthetic:

Research has yet to determine whether over-practicing difficult, fast coordinated passages is a predisposing factor for distortion of somatosensory organization or whether difficult repertoire simply enhances awareness of the motor pathway distortions (Chang & Frucht, 2013). In an experimental study by Chang and Frucht, healthy pianists were asked to play a modified keyboard which produced delayed sounds in relation to key strike. Findings indicated that the sound delay produced consequential interferences with auditory feedback and motor programs as observed through altered performance of basic scale playing (Chang & Frucht, 2013). If researchers were able to conclude that a similar phenomenon such as increased/decreased hypersensitivity and reaction times are occurring in dystonic musicians, as hypothesized, this factor may be beneficial in understanding how auditory influences may impact sensory changes already present in dystonic individuals (Altenmuller, Finger, & Boller, 2015). Therefore, the proposed study sought to examine dystonia symptom onset in response to auditory stimuli (pitch, tone, etc.), a potential sensory trick, in relation to the piece they are playing. This feature was examined to aid researchers in differentiating whether the symptoms truly corresponded to

specific musical techniques or whether other factors such as increased speed or changes in dynamics were simply making them more obvious.

Personality:

An established connection has been found to exist between psychological traits and musician's dystonia (Jabusch, Muller, & Altenmuller, 2004). Yet, to date, no studies address personality, as a subset of psychological traits, specifically. In addressing the aspect that psychological factors may contribute to musician's dystonia, researchers have questioned whether anxiety and perfectionist tendencies are present before onset of dystonia or whether they are psychoreactive symptoms resulting from development of the disorder. In analyzing samples of 20 dystonic musicians and 20 non-dystonic musicians suffering with chronic pain by means of the Freiburg Personality Inventory in addition to the Questionnaire for Competence and Control Orientations, researchers were able to conclude that both had increased rates of anxiety. Considering documentation exposes that exaggerated sensory input often precedes chronic pain syndromes and that somatosensory dysfunction (affecting similar brain regions) has been observed in both conditions, researchers assert that this may indicate that underlying psychological factors attributed to enhanced anxiety may already be present before dystonia onset (Jabusch, Muller, & Altenmuller, 2004). However, though this aspect seems promising in helping determine a pathophysiological basis between anxiety and musician's dystonia, they state that, until more studies are done to help determine further correlations and relationships between the disorder and psychological traits, "it remains speculative" (Jabusch, Muller, & Altenmuller, 2004). Thus, the proposed study collected data on personality and musician's dystonia while testing the hypothesis that personality type may be correlated with the effectiveness of sensory tricks.

Age & Years played:

Both age and years spent practicing an instrument have been thought to play a role in the onset of musician's dystonia as indicated by studies which show that alterations within the somatosensory and motor brain regions exist between musicians who begin playing prior and post 7 years of age (Altenmuller, 2003). However, no documentation was found regarding whether sensory tricks are more effective in one age group over the other. In subjecting musicians to an fMRI, it was found that those who practiced an instrument before 7 years of age possessed a larger anterior midsagittal corpus callosum than control subjects who began playing later. It was also found that male musicians possessed a larger cerebellum than non-musicians. Researchers claim this increase in size is due to increased nerve fiber growth resulting from increased interactional demands between the right and left hemispheres. Conversely, instrumentalists beginning after 7 years of age did not present with the same enlargement of anatomical brain structures, but, instead, showed signs of increased adaptation and modification of existing neuronal pathways to adjust for learning of a new skill. Both instrumentalists beginning before and after age 7, were found to possess enlarged cortical representations of fingers and limbs associated with playing the instrument. This is an aspect which makes somatosensory dysfunction, with distorted overlap of neuronal pathways, an increased risk for both subsets of musicians. These changes were found to be more prevalent in musicians who began playing after age 7, suggesting they may be at increased risk for acquiring the disease (Altenmuller, 2003). For this study, survey questions regarding age and effectiveness of sensory tricks were included to help determine whether a possible correlation could exist. The goal of this aspect was to help researchers ascertain whether neuronal changes associated with normal aging may play a role in disease onset and influence effectiveness of sensory tricks.

Auditory-Kinesthetic Feedback/Repertoire Level**:**

Certain techniques have been proven to raise awareness of dystonic responses (Kompoliti & Verhagen, 2010); however, research into the effectiveness of tricks when compensating for specific repertoire demands (technique, pitch level, syncopation passages, etc.) has been lacking. As expressed by Kompoliti and Verhagen, musical demands which require sustained staccatos (series of short, articulated notes) and legatos (held note/notes, played smoothly) appear to be particularly affected by dystonic symptoms in string players while varying pitch ranges have been found to trigger differing effects in brass instrumentalist types (lip pulling and tremors are apparent in high-register brass instruments and lip lock is more common among low-register brass instruments). Though this suggests that certain techniques may raise awareness of dystonic responses, more studies need to be conducted regarding specific technical demands and pitch levels being practiced at dystonia onset and their impact on the effectiveness of sensory tricks (Kompoliti & Verhagen, 2010). Therefore, this study aimed to isolate problematic areas associated with specific musical techniques while examining effectiveness of specific tricks such as variations in practice approach (speed, ergonomics, etc.).

Sensory Tricks:

Limited documentation exists regarding whether sensory tricks, methods used to ameliorate negative physical symptoms, may be effective if used across musicians of a similar instrumental genre and whether external factors may impact their efficacy (Loyola, Camargos, Maia, & Cardoso, 2012). Considering most instrumentalists experience similar generalized patterns of dystonia based on instrument type (most keyboard and plucked string instrumentalists are afflicted by dystonia in their right hands and bowed string players are afflicted in their left), having a knowledge of exact variations of sensory tricks in musicians, may aid in formulating

future treatment strategies specific to the instrumental genre (Loyola, Camargos, Maia, & Cardoso, 2012). Such understanding may not only be beneficial in establishing rehabilitative musical learning for dystonic musicians, but in creating prevention musical learning techniques for upcoming students. According to research conducted by Conti and colleagues most musician's sensory tricks appear to be found by personal experimentation and are adaptations to a particular piece of music (a tabla player supporting his affected arm with his unaffected leg, a guitarist refingering music to ease use of a finger, a clarinetist holding a modified pencil in between fingers while playing, etc.) (Conti, Pullman, & Frucht, 2008). Thus, research into what types of sensory tricks are being utilized among varying musicians would be useful in determining whether specific tricks associated with a particular instrument would/would not be beneficial if used by all musicians of the same instrumental genre (Ramos, Karp, & Hallet, 2014).

Approach to Practice:

Most experimental methods in studies of musician's dystonia have a musician play a piece repetitively and monitor effects, but few have taken into account how different musicians may naturally vary their approaches to practice (speed, tension/force, taking breaks, etc.) (Pujol et al., 2000). Therefore, this study was conducted from the basis that certain approaches can elicit dystonic symptoms, but, on the other hand, modifying the approach can serve as a type of "trick" to attenuate or prevent symptoms. Complexity and overpracticed repetition of fine motor skills triggers dystonic symptoms, not the activity of holding or playing the instrument. This has been attributed to the fact that repetition perpetuates cortical activation areas to become "enlarged when a sequence has been overlearned," influencing negative overlap of afferent (sensory) and efferent (motor) pathways (Pujol et al., 2000).

Newly developed research exposes that dystonic symptoms may actually be reversed through adaptation of practice methods (Sakai, 2006). A study by Naotaka Sakai on 20 professional pianists with focal hand dystonia indicated positive changes from utilizing slow-down exercise therapy. Subjects were asked to practice dystonic affected techniques at slowed rates (defined as a speed at which symptoms were not apparent) for 30 minutes a day for two weeks, and, unless symptoms reappeared, speeds were increased in 2 week increments. Results indicated a significant improvement to normal levels in 12 affected musicians and mild improvement in 8, providing supportive evidence that dystonic symptoms are not irreversible, but that slowed motor learning of demanding techniques may correctively reduce distorted overlap of neuronal pathways (Sakai, 2006). In the survey created for this study, participants were asked about their approach to practice before dystonia and what changes they have made in their approach onset. Then, resulting data was analyzed to determine whether practice modifications which have worked for one particular instrumentalist are generalizable and work for others with similar symptoms.

Review of Methods

Survey Method

Formulated using the social cognitive theory as a foundational framework, a survey was created and distributed (utilizing Facebook and e-mail) to select populations of musicians with dystonia and music students from James Madison University (JMU). The rationale of choosing this method as a means for data collection was due to instantaneous and improved accessibility to a population considered representative of dystonic musicians and the JMU music department. As documented by the *Handbook of Practical Program Evaluation*, surveys are essential in that they allow researchers to take advantage of today's increased rates of internet usage. Not only

are surveys able to be easily distributed by various media forms, enhancing access to the target research population, but they can be created and administered in graphically attractive formats which increases public attention and desire to engage (Wholey, Hatry, & Newcomer, 2010). Thus, by ensuring increased access to the population of focus, this approach will help improve validity of our results while working within the confines of JMU's available resources.

Examination of past literature provides evidence that surveys have proven reliable in not only assessing prevalence of other types of dystonia, but in categorizing these types according to either age of onset, gender, or country of origin (Jankovic, Tsui, & Bergeron, 2007). However, though such studies confirm that this method of data collection is extremely conducive in reaching the wide distribution of the dystonic population (Jankovic, Tsui, & Bergeron, 2007), they yielded no examples to demonstrate that this method had been used to analyze differences occurring within musicians with dystonia and healthy musicians. Therefore, since surveys have been shown to be advantageous in reaching the dystonic population, we will utilize this method to assess potentially related variables (personality, auditory/kinesthetic feedback, practice approach, repertoire level, and age) to musician's sensory trick usage. We will then categorize each variation according to instrument type, location, effectiveness, comparing it to resulting survey data from healthy musicians to determine whether potential variations or trends are correlated to dystonia and not other factors.

Data regarding personality type was assessed, via inclusion of the Ten Item Personality Test (Gosling, Rentfrow, & Swann, 2003), and coping by means of the Ryff scale of Psychological Well-being (Ryff, 1989) and Rosenberg Self-Esteem scales (Rosenberg, 1989). Adapted by Gosling from the Big 5 Personality Test, the Ten Item Personality Test is a validated measure which enables researchers to gather information regarding a participant's personality

traits of extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience (Gosling, Rentfrow, & Swann, 2003). Knowledge of which traits are distinctive of respondents allows for needed insight into how musicians characteristically respond to sociocultural influences both internally and externally (Gosling, Rentfrow, & Swann, 2003). Further aiding in analyzing psychological state, inclusion of the Ryff scale of Psychological Well-being provided a means to assess stress coping abilities and the overall ability to manage life (Ryff, 1989). Self-esteem and self-efficacy levels, were measured utilizing the Rosenberg Self-Esteem Scale, a uni-dimensional scale which quantifies self-worth on a global level (Rosenberg, 1989). All measures, including those modified to determine approach to practice and association with music, were used to examine both positive and negative perceptions of self and applied to understanding how musician's coping mechanisms interplay with their physical well-being. Thus, this study, in addressing the interplaying roles of behavior, environment, and personal factors, not only expands on previous literature, but potentially impacts health outcomes of musicians by helping provide a broader focus on the overall performer.

Chapter III

Methodology

Participants:

For the purposes of this cross-sectional study, participants were recruited via convenience sampling from both the closed group Facebook page, "Musicians with focal Dystonia" and the JMU music program. The target population consisted of both healthy and dystonic musicians of at least 18 years of age. This included a populace of professional, semi-professional, and non-professional musicians ranging in different playing experiences and practice approaches.

Recruitment

Participants with musician's dystonia were recruited based on past/current membership with either the Musician's Dystonia Foundation (MDRF) or the Musician's with Focal Dystonia Facebook community. Participants were required to identify as having received a medical diagnosis of musician's dystonia, were made aware that any participation in the study was voluntary, and were notified that all results would remain anonymous. Volunteers were directed to a link where they completed an online Qualtrics® survey either through the closed group Facebook page, "Musicians with Focal Dystonia," or the JMU research Facebook page, pre-approved by the JMU Honors College (https://www.facebook.com/honorstudentresearch/). Following the initial posting on 9/19, periodic reminders were posted on Facebook twice a week for three weeks on the dates of 9/23, 9/26, 10/1, 10/10, 10/22, respectively.

For comparison, the researcher selected a population of musicians without a dystonia diagnosis was selected from the JMU Music Program to assess correlative factors between

the two groups. JMU music students and faculty, recruited through email on 9/26, were sent a direct link to the Qualtrics® survey study which contained the IRB approved email cover letter. A reminder email was then sent to the JMU music program one week following the initial communication on 10/3. A flyer, pre-approved by the IRB and JMU music faculty, was also distributed throughout the JMU music building to encourage participation. All participants were made aware that participation was voluntary and all results would remain anonymous.

Data Collection:

Procedures Overview

To collect data regarding potential relationships between the effectiveness of sensory tricks and auditory/kinesthetic feedback, personality, age, years played, repertoire level, and approach to practice, a survey was constructed using the online platform Qualtrics®, an online survey platform. Following approval by JMU's Institutional Review Board (No.17-0103), an anonymous link to the survey was distributed via email to the JMU music program and through Facebook postings to members of the "Musicians with focal dystonia" closed group. All prospective participants, with respect to personal autonomy and human rights, were given written notification that their responses would remain anonymous and that they could stop the survey at any time in the event of a negative response. No compensation or deception was utilized to influence involvement; however, to encourage participation, individuals were given the option to enter their email addresses as part of an optional drawing for a $50.00 Visa gift card. Those that chose to participate, were directed to a separate page through Qualtrics which collected their email addresses unattached to their responses. Following the drawing, which was conducted after closing the survey on 10/22,

the chosen participant was notified through e-mail to pick up the gift card or request that it be mailed to them. No penalties were incurred by those who opted out of participating.

Instrument

The survey instrument consisted of 47 questions regarding demographic background, health, well-being, and practice habits (see appendix A). All questions regarding self-esteem, stress level, and personality were adapted from existing validated measures while select questions were constructed to increase relatability to music performance. Personality type was assessed via the brief, validated Ten Item Personality Test, a 10-item scale based on the Big Five Personality Questionnaire, which classifies individuals according to the five domains of personality: extraversion, openness to experience, conscientiousness, agreeableness, and neuroticism (Gosling, Rentfrow, & Swann, 2003). Resulting data was then quantified in conjunction with modified validated measures such as the Ryff Scale of Psychological Well-being and Perceived Stress scales to assess the psychological state and coping mechanisms of each participant (Ryff, 1989; Cohen, Kamarck, & Mermelstein 1983). However, as no validated measures had been published to assess sensory trick usage amongst musicians with dystonia or the general dystonic population, questions specific to music performance mechanisms were created by the researcher following an extensive literature review. All such questions were pre-approved for validity by JMU faculty. Survey sections only applicable to dystonic musicians utilized skip logic so as to omit non-applicable sections for those not experiencing the specific variable being studied (sensory tricks, etc.).

Question distribution

Eleven demographic and background questions (questions 1-11) allowed for musicians to be catalogued based on age, music education level, symptoms, side of symptom occurrence, music status (professional, college music student, etc.), instrument played, years played, hours spent practicing, and handedness (right vs. left). This section further included questions regarding whether the individual had/had not received a dystonia diagnosis. If a diagnosis was present, the researcher assessed whether the musician experienced any recovery of negative physical symptoms. Further questions aimed to measure both the social cognitive theory constructs and constructs created by the researcher for the purposes of addressing music practice mechanisms specifically. This included 10 questions on personality (questions 38-47) and 26 questions based on constructs. All construct questions, in assessing sensory trick usage, personality, auditory/kinesthetic feedback, and approach to practice both behaviorally and psychologically, evaluated the underlying role of thought and behavior on practicing mechanisms. Construct question distribution throughout the survey is described in detail below:

Self-Efficacy and Emotional Coping

The construct of Self-Efficacy addressed three questions (Stress level section: questions 2, 3, and 6) adapted from the Ryff Psychological Well-Being scale (Ryff, 1989) and nine questions (Self-Esteem section: questions 1-9) modified from the Rosenberg Self-esteem Scale (Rosenberg, 1989). Both the Ryff (1989) scale, measurinng coping ability, and the Rosenberg (1989) scale, quantifying self-value, are validated measures deemed reliable in assessing personal self-worth and psychological well-being. Furthermore, both the Ryff (1989) and Rosenberg (1989) scales were used to measure emotional coping to evaluate how musicians managed stressful performance challenges and controlled their emotions psychologically and

physically. All eight questions from the Ryff (1989) scale (Stress level section: questions 1-8) and one question from the Rosenberg (1989) scale (Self-esteem section: question 7) addressed this topic.

Outcome Expectations, Outcome Expectancies, and Situational Perception

Outcome Expectations were assessed through two question adapted from the Ryff (1989) scale (Stress level section: questions 4 and 8) and one from the Rosenberg (1989) scale (Self-esteem section: question 9). One question from the Ryff scale (1989) (Stress level section: question 5) and one question from the Rosenberg scale (1989) (Self-esteem section: question 8) measured outcome expectancies. These questions aimed to test expectations regarding performance outcomes, outcome expectations, and the degree of worth that the musician assigns, outcome expectancies, to instrumental and non-instrumental abilities. In order to assess the musicians' psychological reactions, the related construct of situational perception, was addressed by inclusion of the Ryff scale (1989) (Stress level section: questions 1, 4, and 7).

Performance learning approach, Performance Well-Being, and Compensatory Adaptation

Questions 11, 12, and 13 assessed the approach to performance construct, focusing on how musicians approach learning a new piece. These questions assessed what aspect of learning (repetition, visualization, speed, etc.) musicians typically prioritized when under pressure. Further focusing on performance ability, questions 7-9 and 14-16 addressed the performance well-being construct, evaluating whether musicians experienced negative symptoms when playing and whether specific techniques, tempos, pitch appeared to exacerbate them. If musicians indicated on the survey experiencing negative or dystonic symptoms, they were directed to questions 17-20 which addressed the construct of compensatory adaptation. These

questions assessed whether musicians were/were not able to mitigate symptoms by aid of sensory tricks.

All survey questions were formulated with the purpose of addressing the hypothetical connection between musician's dystonia and sensory tricks with variables of personality, practice approach, auditory/kinesthetic feedback, age, years played, and repertoire level. Thus, the following research questions, adapted from both the social cognitive theory and performance constructs created by the researcher, provided the necessary framework to construct the survey.

Social Cognitive Theory Research Questions

- **Situational Perception**
    - Does the musician feel in control of the situation in which they live?
    - Does the musician feel they have accomplished all there is to do in life?
- **Emotional coping**
    - If the musician has a concert coming up in 1 week, how would they best approach practicing a musical passage that is giving them difficulty?
    - During periods of high stress, does the musician notice that specific sensory tricks work more or less?
    - Does the musician feel capable of being successful?
- **Outcome expectations**
    - Does the musician feel they perform the way they deserve based on the amount of effort and time they practice?
    - To what degree, does the musician feel "in control" of their future performance and optimistic that it will be successful?

- **Outcome expectancies**
    - If the musician performs at a lesser level than desired, do they feel less worthy as an individual?
    - Does the musician express that they feel a sense of purpose in life?
    - Does the musician enjoy planning and preparing for the future?
- **Self-efficacy**
    - Does the musician express feeling confident in managing daily responsibilities?
    - Do responsibilities (practice and otherwise) often prove overwhelming?
    - How confident does the musician feel that they are able to do work as well as other musicians?

<u>Created construct research questions</u>

- **Performance Learning Approach**
    - If the musician has a concert occurring in 1 week, how would they learn a new piece?
    - How many hours does the individual spend practicing/performing in a week?
- **Performance Wellbeing**
    - Does the individual exhibit negative symptoms while playing?
    - During what technique does the individual mostly exhibit negative symptoms?
    - Is there a correlation between specific temps and negative symptoms?
    - Does pitch appear to be related to negative symptoms?

- **Compensatory Adaptation**
    - Is there anything the musician can do to alleviate negative symptoms (changing fingering, changing positioning of instrument, wearing a band, touching chin, etc.)?
    - Does effectiveness of sensory tricks change during periods of high stress?

Final Data Analysis:

Data were analyzed with the Statistical Package for the Social Sciences (SPSS 23). The researcher performed descriptive statistics, frequencies, and crosstabs to determine whether the effectiveness of sensory tricks among individuals with dystonia were associated with auditory/kinesthetic feedback related to repertoire level, personality, age, years played, and approach to practice. In order to determine if there was a significant difference between the independent variable, dystonia diagnoses, and the dependent variables, alterations in sensory tricks, age, personality, and auditory kinesthetic feedback resulting from repertoire exposure, the researcher conducted t-tests. Correlations between the factors, including personality and sensory trick type and instrument type verses sensory trick type, were assessed to ascertain whether certain sensory tricks were more predominately used/effective and how this related to the dependent variables and possible mechanisms of action. Frequencies were also found for demographic information, including age, years/level played, and hours practiced using the formula, Relative frequency = frequency /number of observations.

For the purposes of this study, ordinal (questions 21-37), scale (questions 1,3, and 11), and nominal (questions 2, 5-10, and 12-20) data were collected. All scale and nominal data were examined using descriptive analysis while ordinal data, collected from questions organized according to a Likert scale format, were analyzed utilizing a t-test and frequency/contingency

table. All included Likert scales, specifically the modified Rosenberg and Ryff scales, collected scores ranging from 1-5 with 1 being “strongly agree” and 5 being “strongly disagree,” allowing for uniformity in result calculation (all low scores indicated a positive response and all high scores indicated a negative response). No recoding of Rosenberg and Ryff scale variables was necessary to ensure compatibility of scoring through SPSS as this process was already completed during survey construction. All consequential data from all scales was organized into tables upon analysis completion.

Chapter IV

Results

Demographics

Of, approximately, 900 individuals to whom the survey was distributed on the "Musicians with Focal Dystonia" Facebook page and the James Madison University Campus, 76 participants completed it. This sample consisted of 33 individuals *with* and 43 *without* a dystonia diagnosis. JMU students, playing on a semi-professional level, represented 72.1% of those without a dystonia diagnosis while 2.8% identified as having experienced a recovery from the condition. Conversely, the majority of participants reporting a dystonia diagnosis represented mostly professional musicians (51.5% of these subjects consisted of orchestral, chamber, wedding, or band musicians and 15.2% represented professional soloists), playing above the college music major level. An increase in dystonia diagnoses was also noted with advanced playing levels (a 9.1% increase in dystonia diagnoses was noted between beginner to intermediate levels, a 15.1% increase was observed between intermediate and semi-professional levels, and a 42.5% increase was evident between semi-professional and advanced levels). As no significant difference was observed in handedness between both dystonic and non-dystonic respondents (87.9% dystonic musicians and 90.7% non-dystonic musicians selected right handedness), whether the instrumentalist played right or left handed did not appear to be a related variable (Table 1).

Table 1. Distribution of Sample

	With Dystonia		Without Dystonia	
Variables	Frequency(f)	% Frequency	Frequency (f)	% Frequency
Age				
18-24	0	0%	37	86%
25-34	8	24.2%	2	4.7%
35-54	16	48.5%	2	4.7%
55-64+	9	27.3%	2	4.7%
Years Played				
1-6	0	0%	3	7%
7-10	0	0%	17	39.5%
10-20	12	36.4%	20	46.5%
30+	21	63.6%	3	7%
Level Played				
Beginner	0	0%	2	4.7%
Intermediate	3	9.1%	2	4.7%
College Level	8	24.2%	37	86%
Advanced	22	66.7%	2	4.7%
Hours Practiced				
0-2	3	9.1%	2	4.7%
2-4	5	15.2%	6	14%
4-6	11	33.3%	8	18.6%
6+	14	42.4%	27	62.8%

Objective 1: Identify sensory tricks being used across dystonic musicians of varying instrumental genres and determine whether type of sensory trick usage is similar between instrumental genres.

Sensory Trick Usage: Dystonic musicians

Sensory tricks most often employed by dystonic instrumentalists were changes in positioning of the hand/instrument (30.3% of cases), fingering (21.2% of cases), device usage (12.1% of cases), touch/sensory stimulation (12.1% of cases), or other methods not defined within a category (30.3% of cases). Advantageous sensory tricks undefined within the available categories included keyboard instrumentalists reporting usage of the Taubman technique (a retraining method used to increase motor control), splints, and a split keyboard (40%); brass instrumentalists reporting usage of a stop mute, wearing a bell, altering their embouchure, or slurring chromatic passages (28.6%); woodwind instrumentalists undergoing brain retraining, taking adrenaline supplements, altering their embouchure, and breathing exercises (44.4%); and string instrumentalists reporting usage of relaxation techniques (50% upper orchestral string; 10% non-orchestral string, and 100% of lower string instrumentalists). Nevertheless, 18.2% of respondents indicated no advantageous effects from the usage of sensory tricks (Figure 1).

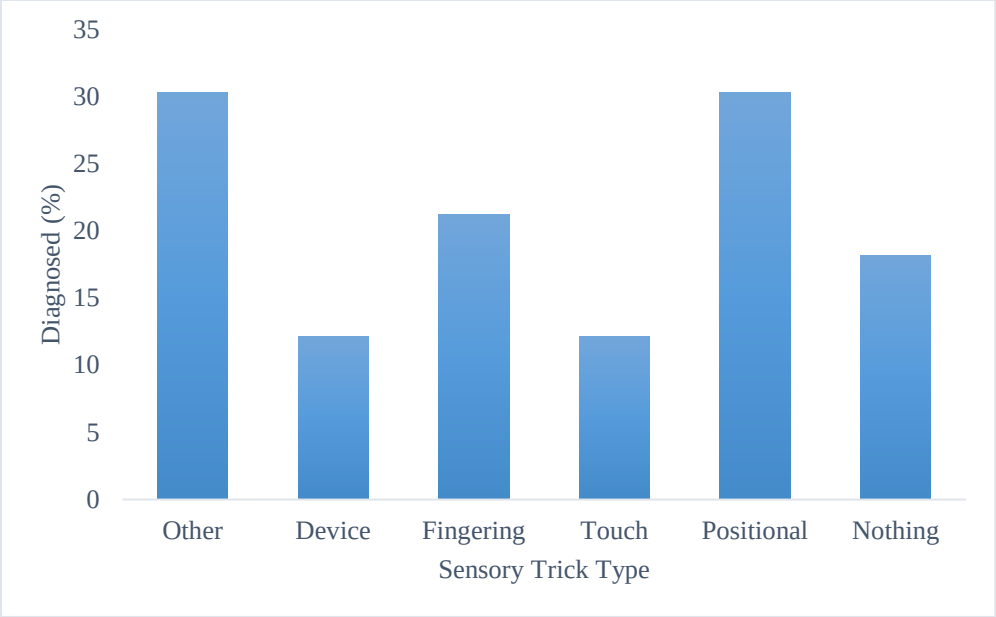

Figure 1. Distribution of sensory tricks used by musicians with dystonia.

Instrumentalists experiencing positive outcomes from sensory trick usage included 23.3% of keyboard performers followed by non-orchestral string (23.3%), woodwind (16.3%), brass (11.6%), percussion (11.6%), upper orchestral string (4.7%), and lower orchestral string (2.3%) instrumentalists. In assessing which sensory tricks were commonly utilized among the varying instrumental genres, no instrumental classification groups reported being able to utilize each sensory trick listed. Specifically, of the instrumentalists who played only keyboard instruments while finding sensory tricks effective indicated that they were not able to utilize any of the commonly defined sensory tricks of altering position, fingers, device usage, tactile stimuli, but rather relied 100% on utilizing other undefined sensory trick methods such as the Taubman techniques and split keyboard. However, keyboard instrumentalists playing other instruments including lower strings, clarinet/bass clarinet, saxophone, trombone, tambourine/triangle, vocalists (alto, tenor, bass), guitar, and banjo, were found to alleviate negative symptoms by altering position in 21.4% of cases, fingering in 21.4% of cases, device usage in 21.4% of cases, touch in 7.1% of cases, and other methods

(Taubman, splint, breathing exercises, and a split keyboard) in 28.6% of cases. Likewise, musicians playing only non-orchestral string instruments indicated positive effects from changing fingering in 42.9% of cases, position in 28.6% of cases, touch/sensory stimuli in 14.3% of cases, and device usage in 14.3% of cases. Non-orchestral string instrumentalists who were also vocalists in the alto/tenor range or played non-orchestral strings in combination with other instrument types, including clarinet/bass clarinet, saxophone, piano, tambourine/triangle, or other instruments not listed reported good results from the usage of fingering changes in 35.3% of cases, positional changes in 23.5% of cases, device usage in 17.6% of cases, tactile changes in 11.8% of cases, and splint and breathing exercises in 11.8% of cases.

Woodwind and brass instrumentalists reported sensory tricks were effective in helping alleviate negative symptoms, both genres were found to use dissimilar sensory trick methods overall. Woodwind instrumentalists playing only woodwind instruments reported positive changes in negative symptoms from alterations in fingering in 25% of cases, position in 25% of cases, and other methods, including brain retraining and adrenaline supplements, in 50% of cases. Yet, woodwind instrumentalists playing additional instruments such as horn, trombone, piano, tambourine, or guitar, or vocalists (tenor range), were found to use an increased amount of sensory tricks, reporting positive effects from changing fingering in 22.2% of cases, position in 22.2% of cases, using a device in 11.1% of cases, and other methods such as breathing exercises, changes in embouchure, apathy, adrenaline supplements, and brain retraining in 44.4% of cases. Unlike woodwind musicians who indicated that fingering was helpful in eliminating symptoms, brass musicians playing only brass instruments reported a greater usage of positional changes (50% of cases), tactile

stimuli (25% of cases), and other methods including playing stop-muted with bell on leg, altering focus to the mouthpiece, collapsing embouchure, playing in pedal register slurred chromatics, using TMJ and facial muscle stretches, and breathing exercises. Brass musicians playing additional instruments (clarinet, saxophone, and piano), indicated a preference for changing position (33.3% of cases), tactile stimuli (16.7%), and device usage (16.7%) in addition to the same changes in embouchure as previously listed. Conversely, upper string instrumentalists playing only the violin or viola reported primarily using tactile stimuli (50% of cases) and relaxation techniques (50% of cases) while musicians who played only lower string instruments reported not using any sensory tricks. In addition, musicians playing both lower strings with an additional instrument, such as the piano, were found to only utilize changes in positioning (100% of cases) (Figures 2 and 3).

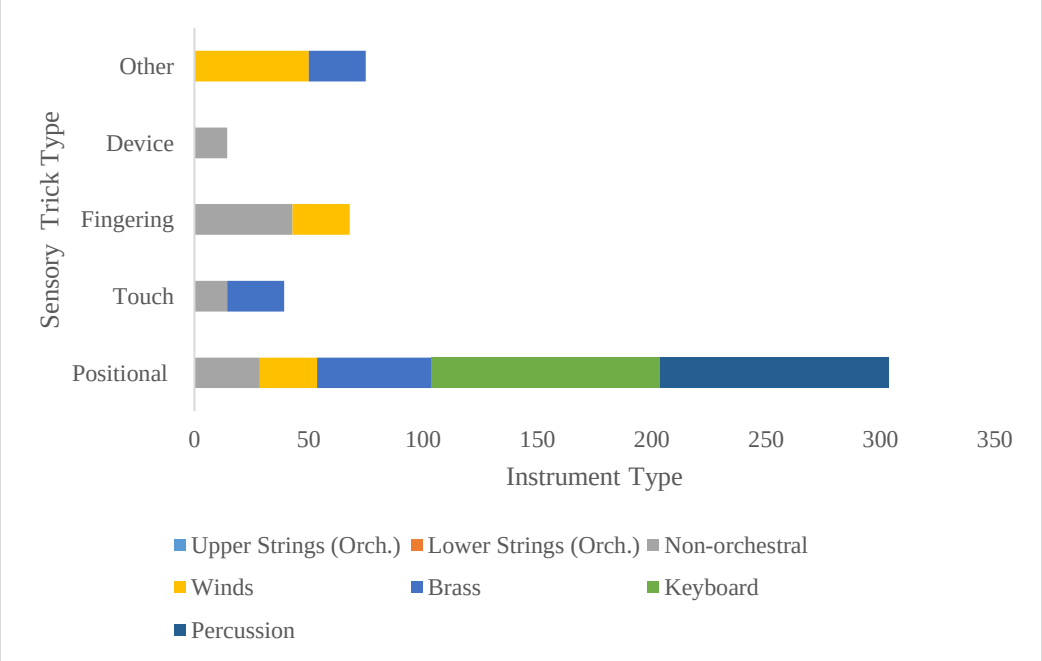

Figure 2. Sensory trick distribution across genres if only one instrument is played.

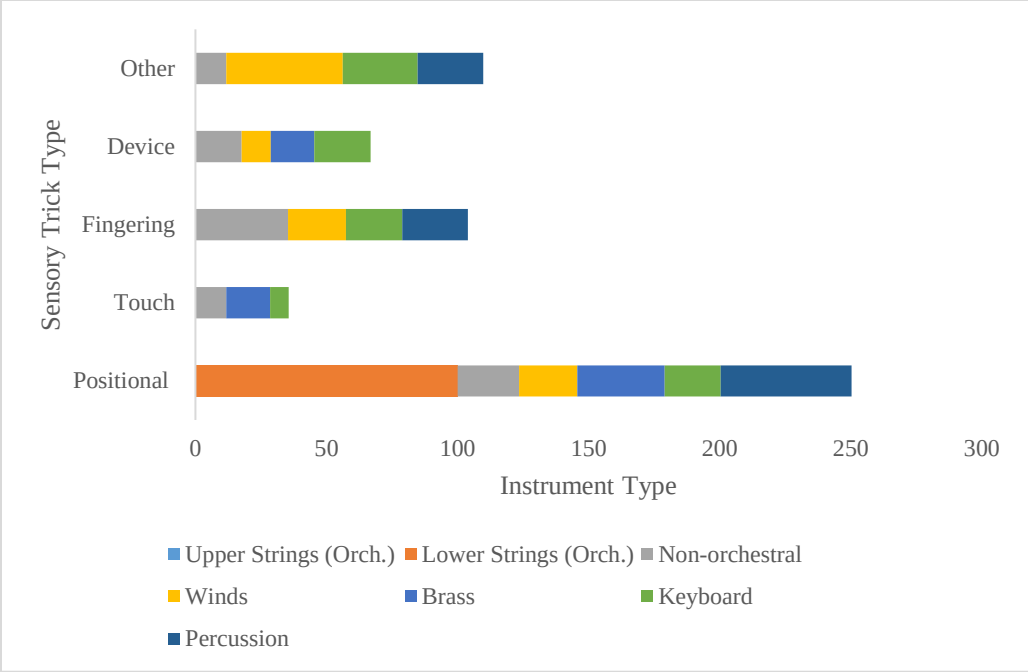

Figure 3. Sensory trick distribution across instrumental genre if multiple instruments are played.

Lastly, instrumentalists playing only percussion instruments were found to use positional changes while percussionists who were also vocalists (tenor range) or played other types of instruments (including the clarinet/bass clarinet, saxophone, piano, or guitar), indicated being able to successfully utilize additional sensory tricks. This included changes in fingering (25% of cases), positional changes (50% of cases), and breathing exercises (25% of cases). Overall, within dystonic musicians, sensory trick usage affecting the wrist, hands, or fingers was found to be the most prominent. Among upper string instrumentalists, sensory tricks using the arm (13% of cases), wrist (13% of cases), or fingers (13% of cases) were the most common while sensory tricks created using the foot (33% of cases), shoulder blade (33% of cases), or shoulder (33% of cases) were the most commonly used by lower string musicians. Differing from woodwinds which commonly used sensory tricks involving the hands (19% of cases), fingers (19% of cases), and head (14% of cases), brass musicians were more inclined

to use sensory tricks involving their mouth (20%), chin (13% of cases), hand (13% of cases), or neck (13% of cases). All other instrumental types, keyboard, percussion, and non-orchestral strings reported predominantly using their hands, fingers, and wrists. Keyboard instrumentalists were mostly found to initiate sensory tricks with their hands (24% of cases), their fingers (19% of cases), and wrist/arms (14% of cases). Similarly, percussionists were found to use their hands in 33% of cases, fingers in 17% of cases, and wrist/arm/neck in 17% of cases while non-orchestral strings were discovered to use their hands in 29% of cases and fingers/wrist in 18% of cases. Yet, despite sensory tricks having advantageous effects in 75.8% cases of dystonia, 24.2% of individuals indicated that sensory tricks were not effective in helping eliminate negative symptoms.

Sensory Trick Usage

Of musicians reporting a dystonia diagnosis, 72.3% of respondents indicated that sensory tricks were effective. Percussion, upper string, and lower string instrumentalists reported advantageous usage of sensory tricks as represented by 100% reporting positive effects. Successively, 83.3% of keyboard, 71.4% of brass, 70% of woodwind, 66.7% non-orchestral string, 66.7% vocalist, and 50% of all instrumentalists not included in a specified instrumental genre reported sensory tricks as beneficial. Both keyboard (41.6% of cases) and non-orchestral string instrumentalists (41.6% cases) were among the most common groups to report using sensory tricks. In addition, 29.1% of woodwind, 20.8%% of percussion and brass, 8.3% of upper string and vocalists, and 4.2% of lower string instrumentalists reported sensory trick usage in addition to 4.1% of instrumentalists not identifying with the specified instrumental categories listed (Figure 4).

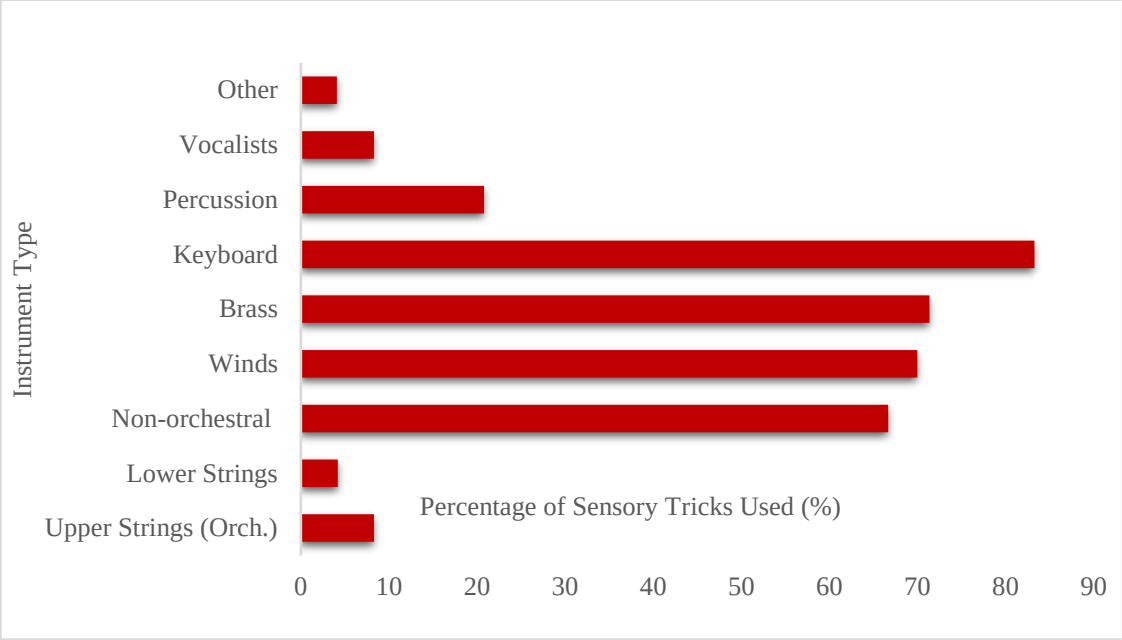

Figure 4. Distribution of Sensory Trick Usage across Instrumental Genre.

Objective 2. Determine how dystonic symptoms were impacted by personality traits, practice approach, and auditory/kinesthetic feedback abilities.

Practice Approach: Dystonic Musicians

Respondents reporting a dystonia diagnosis comprised 45.5% non-orchestral string instrumentalists followed by 36.4% keyboard, 30.3% woodwind, 21.2% brass, 15.2% percussion, 9.1% vocalists, 6.1% upper string, 6.1% unclassified, and 3% of lower string instrumentalists (Table 2). Of these instrumentalists, fatigue based practice mechanisms were largely selected as the preferred method of approaching learning a new piece during performance preparation. This was confirmed by 66.7% of respondents indicating that they used increased effort force than was necessary to adequately perform. In addition, 63.6% of respondents indicated that, when faced with an upcoming performance, they would be more apt to utilize repetition (39.4%) and demanding technical exercises (24.2%) as their primary

approach to practice verses less fatiguing methods which included visualization (9.1%) or taking sporadic breaks (27.3%) as a means of physical and mental rest/recovery. Further exemplifying a preference for fatigue based practice methods, a high volume of individuals, 39.4%, indicated that they favored learning technically demanding "show" pieces through a focused concentration on speed before technique (15.2% of cases) or by aggressively repeating passages without breaks (24.2% of cases). Yet, 60.1% indicated that they would be more apt to practice these types of pieces slowly, one measure at a time, with frequent breaks (Figure 5).

Table 2. Distribution of musicians with Dystonia.

Characteristics	**n**	**%**
Instrument		
Upper Strings	2	6.1
Lower Strings	1	3
Non-orchestral Strings	15	45.5
Woodwind	10	30.3
Brass	7	21.2
Keyboard	12	36.4
Percussion	5	15.2
Vocalist	3	9.1
Unclassified	2	6.1

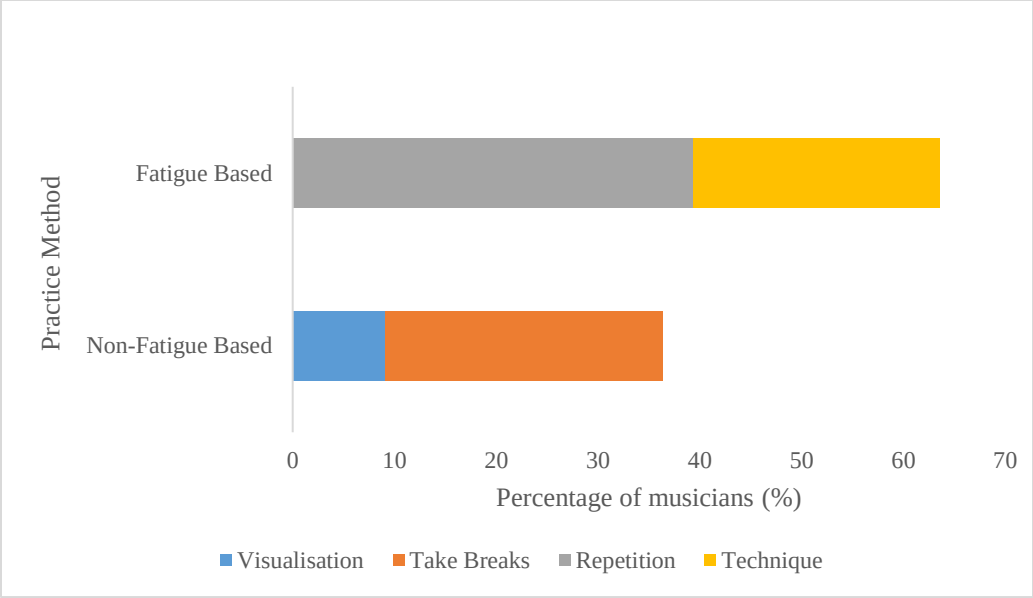

Figure 5. Practice approach among musicians with dystonia.

Personality

In analyzing the modified Ryff Stress scale via the Statistical Package for Social Sciences (SPSS 23), no significant difference was noted when conducting an independent sample t-test between stress levels of musicians *with* (M = 18.03, SD = 6.04) and *without* (M = 18.23, SD = 5.43) a dystonia diagnosis. Exceeding the standard significance value of 0.05, this difference was not significant at $t(74) = -0.153$, $p = 0.879$. Likewise, there was no significant difference in stress scores, $t(29) = -0.317$, $p = 0.753$, between JMU students reporting negative symptoms (M = 17.38, SD = 5.30) verses those who did not (M = 18.00, SD = 5.67). Thus, as stress level did not appear to be a related variable to dystonic symptoms, it did not appear to impact sensory trick usage or type.

Analysis of the Rosenberg Self-esteem scale, exposed that, on average, there was not a significant difference in scores for musicians *with* (M = 22.39, SD = 4.2) and *without* (M = 21.28, SD = 6.3) a dystonia diagnosis; $t(74) = 0.880$, $p = 0.382$. Similarly, no significant

differences in self-esteem were noted in JMU students *with* (M = 20.81, SD = 6.27) and w*ithout* (M = 21.67, SD = 7.05) negative symptoms; t(29) = -0.357, p = 0.724. Additional t-tests conducted on results of the Big 10 TIPI personality test yielded no significant differences in personality, $t(74) = 0.391$, p = 0.697, between dystonic (M = 34.82, SD = 4.86) and non-dystonic (M = 34.37, SD = 4.98) musicians. Conversely, a significant difference, $t(29) = -2.876$, p = 0.007, was found in personality scores when comparing JMU students *with* (M = 32.94, SD = 5.01) symptoms to those *without* (M = 37.40, SD = 3.42) (Tables 3 and 6). However, as the sample size was small, each individual trait could not be tallied to determine which specific personality characteristics varied.

Auditory/Kinesthetic Feedback Related to Repertoire and Technique Level

Among dystonic musicians, staccato (18.8%) and legato (12.1%), techniques associated with advanced levels of musical training, were found to produce pain for instrumentalists, whereas spiccato did not appear to be associated with negative symptoms. Speeds or "tempos" at which intense muscular and mental control are required to maintain rhythmic and tonal accuracy were also found to be correlated with increased negative symptoms. Translated to mean "very, very fast," Prestissimo was the tempo most closely associated, at 30.3%, with dystonic-like symptoms while Andante or "walking speed" was linked to a small increase, 9.1%, in faulty playing ability. Similarly, these respondents indicated that octaves above middle C were minutely connected to this phenomenon. Pitches above middle C were documented as affecting 15.2% of individuals while tones below this set point were recorded to bring awareness to negative symptoms by 9.1%. Yet, despite these percentages, 66.7% of students asserted that tempo and 75.8% that pitch had no bearing on lessening or worsening negative physical symptoms (Table 4). Furthermore, all dystonic instrumentalists reporting

negative symptoms were found to practice over 4 hours daily (33.3% specified they play longer than 4 hours and 42.4% over 6+hours).

Table 3. T-test data for musicians with and without dystonia.

Characteristics	t	df	p-value
Stress	-0.153	74	0.879
Self-Esteem	0.880	74	0.382
Personality	0.391	74	0.697

*denotes a significant difference at the 0.05 level

Table 4. Technique, tempo, and pitch associated with musician's dystonia symptoms.

Characteristics	n	%
Technique		
All technique	16	69.7
Staccato	6	18.1
Legato	2	12.1
Spiccato	1	3
Tempo		
Prestissimo	10	30.3
Andante	3	9.1
Grave	0	0
Does not matter	22	66.7
Pitch		
Above	5	15.2
Lower	3	9.1
Does not matter	25	75.8

Objective 3. Examine whether potential trends in characteristics of auditory/kinesthetic feedback, age, years played, repertoire level, and approach to practice present in dystonic musicians are also present within the healthy JMU music student population.

-Determine if there are JMU students already exhibiting potential symptoms.

-Determine whether healthy JMU students are utilizing sensory tricks and whether these could potentially be adapted as a preventative measure to help guard against disease onset.

JMU Music Students

Though not having received a diagnosis of dystonia, 51.6% of JMU music students reported experiencing dystonic-like symptoms. The most prevalent negative symptom, undesired curling, clenching, bending, or sticking of fingers, was found to occur in 41.9% of students, followed by muscle contractions (occurring in 32.3%), loss of coordination/control (occurring in 32.3%), gradual loss of being able to play a passage (occurring in 25.8%), involuntary/abnormal movements (occurring in 19.4%), and tremors (occurring in 9.7%) (Table 5). These symptoms were largely reported to occur bilaterally in 62.5% of students during instrumental playing though 31.3% indicated that the right side was more problematic than the left (only 6.2% of individuals indicated the left side was problematic during playing).

Of JMU students experiencing dystonic-like symptoms, percussionists were found to represent the largest percentage, 40.7%, of students affected. Succeeding this amount, 18.6% of keyboard, 18.6% of wind, 8.5% of vocalist, 6.8% orchestral string, and 5.1% of brass instrumentalists indicating that they also experienced negative symptoms. Student cellists, as part of the lower orchestral string classification group, and non-orchestral string (classical

guitar, rock guitar, banjo, etc.) instrumentalists indicated that they did not experience negative symptoms (Figure 6).

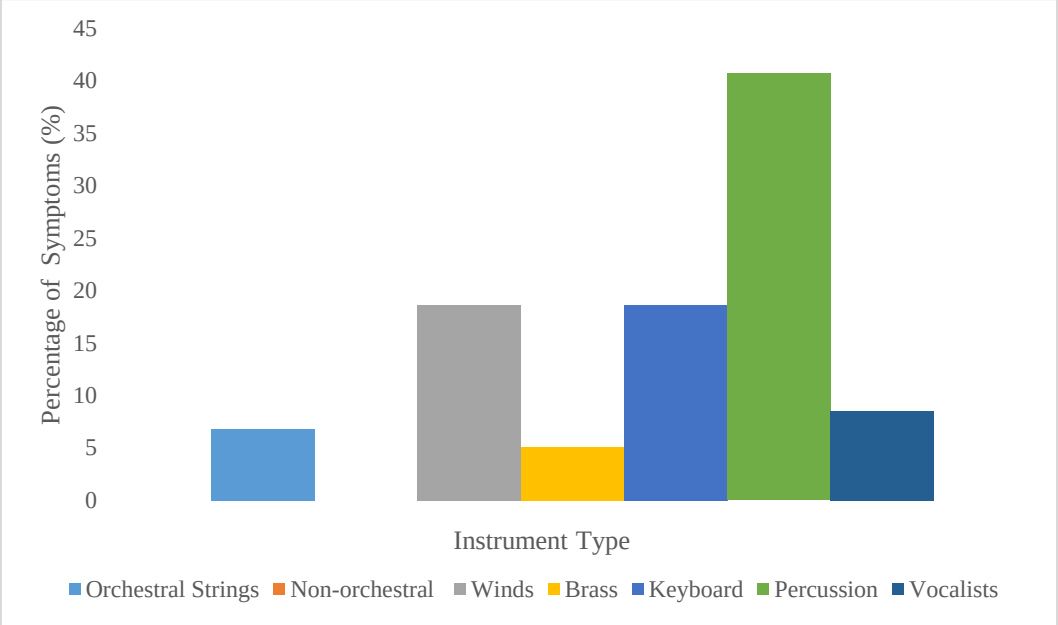

Figure 6. Dystonic symptoms among JMU students based on instrumental genre.

Table 5. Distribution of dystonia symptoms among JMU students.

Characteristics	**n**	**%**
Symptoms		
Gradual loss of ability	8	25.8
Involuntary/abnormal movements	6	19.4
Muscle contractions	10	32.3
Loss of control//coordination	10	32.3
Undesired curling, clenching, bending, or sticking	13	41.9
Tremor	3	9.7

Practice Approach

Of the students reporting negative physical symptoms, 62.6% indicated a preference for fatigue based practicing mechanisms when faced with stressful performance demands of having to practice a new piece for an upcoming concert performance. This included 56.3% of individuals indicating that they would use repetition as a means of achieving positive performance results and 6.3% of individuals reporting that they would utilize technical exercises as the primary means of preparation. Only 6.2% of individuals suggested that they would counter such performance demands with healthy, non-fatiguing visualization techniques and 31.3% reported they would use breaks for physical recuperation. This reported preference for fatiguing based practicing techniques is further represented by 43.8% of respondents exposing a focus on working aggressively with repetition and no breaks in addition to a 6.3% indication of emphasis on speed before technique (Figure 7). 68.8% of respondents also reported that they perceived themselves as using more effort force than required when playing. Yet, the remaining 50% of respondents indicated that they would be more apt to use the healthy practice method of concentrating slowly on one measure at a time with frequent rest periods while 31% reported that they believed they used a healthy degree of force.

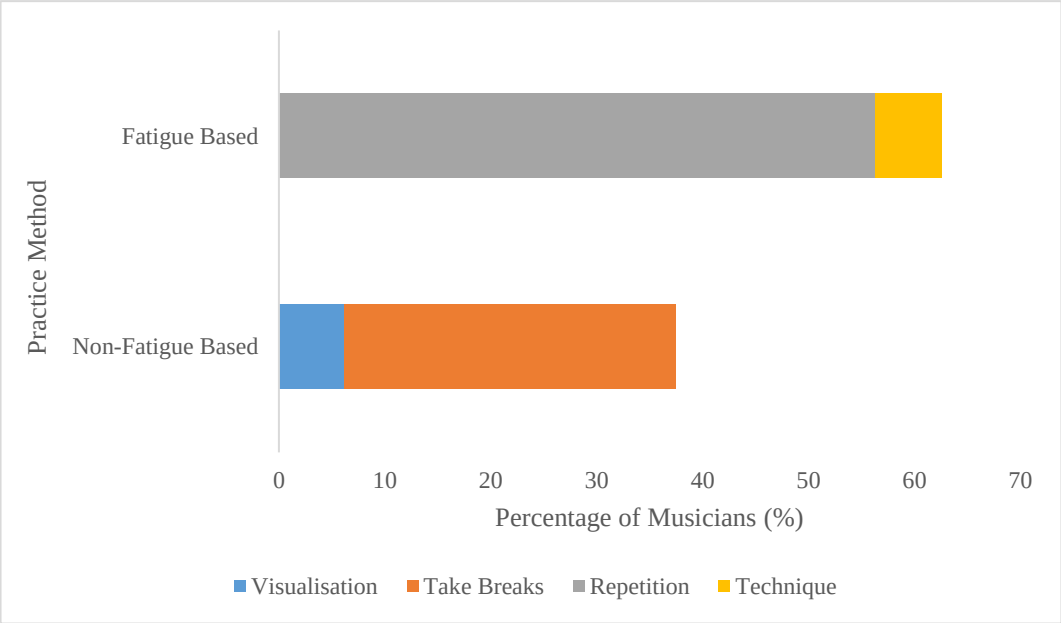

Figure 7. Practice approach among symptomatic JMU music students.

Personality

With the accepted significance level of 0.05, analysis of the modified Ryff Stress scale ($p = 0.753$) and Rosenberg Self-Esteem ($p=0.724$) scale exposed that there were no significant differences in stress or self-esteem levels between JMU students reporting negative symptoms verses those who were asymptomatic. However, analysis of the Big 10 TIPI did render a significant p-value of 0.007. Yet, as the sample size was small, each individual trait could not be tallied to determine which specific personality characteristics varied (Table 6).

Table 6. T-test data for JMU music students with and without symptoms.

Characteristics	t	df	p-value
Stress	-0.317	29	0.753
Self-Esteem	-0.357	29	0.724
Personality	-2.876	29	0.007*

*denotes a significant difference at the 0.05 level

Auditory/Kinesthetic Feedback, Repertoire Level, and Technique

68.8% of JMU students indicated that their negative physical symptoms occurred regardless of technique type (staccato, legato, etc.), while 31.2% suggested that technique does impact their playing symptoms. Techniques of staccato, legato, and spiccato were found to produce pain for students at the percentages of 18.8%, 6.3%, and 6.3% respectively, and tempos requiring intense musical control were also found to be correlated with increased negative symptoms. In addition, prestissimo was found to be associated, at 56.3%, with dystonic-like symptoms while Grave and Andante were linked to a small increase, 12.5%, in maladaptive playing ability. Additionally, respondents indicated that octaves above middle C were most closely associated with producing negative symptoms. Pitches above middle C were documented as affecting 37.5% of individuals while tones below this set point were recorded to bring awareness to negative symptoms by 12.5%. Nevertheless, 37.5% of students asserted that tempo and 50% that pitch did not alter negative physical symptoms (Table 7). In conducting further analysis to determine differences in sensory trick effectiveness across instruments of differing pitches, violins were assessed verses basses, piccolos verses contrabassoons, and trumpets verses tubas. Results yielded, regardless of variation in pitch, an equal distribution between the instruments. Nevertheless, all students

reporting negative symptoms indicated that they practiced over 4 hours daily (25% specified they play longer than 4 hours and 75% over 6+hours).

Table 7. Technique, tempo, and pitch associated with dystonic symptoms among JMU students.

Characteristics	n	%
Technique		
All technique	11	68.8
Staccato	3	18.8
Legato	1	6.3
Spiccato	1	6.3
Tempo		
Prestissimo	9	56.3
Andante	2	12.5
Grave	2	12.5
Does not matter	6	37.5
Pitch		
Above	6	37.5
Lower	2	12.5
Does not matter	8	50

Sensory Trick Usage

In assessing whether JMU music students experiencing negative dystonic symptoms could utilize sensory tricks as a means of relief, it was discovered that the majority were able to successfully ameliorate their symptoms with the same methods typically associated with

dystonia diagnoses. This included students reporting cessation of symptoms by aid of altering the position of the instrument/hand in 37% of cases, using sensory stimulation (touching the affected body part, etc.) in 22.2% of cases, utilizing stretching/resting in ,% of cases, changing fingering in 14.8% of cases, and using a device in 3.7% of cases. Despite the majority indicating positive results from the usage of sensory tricks, 3.7% indicated an inability to use such techniques (Figure 8).

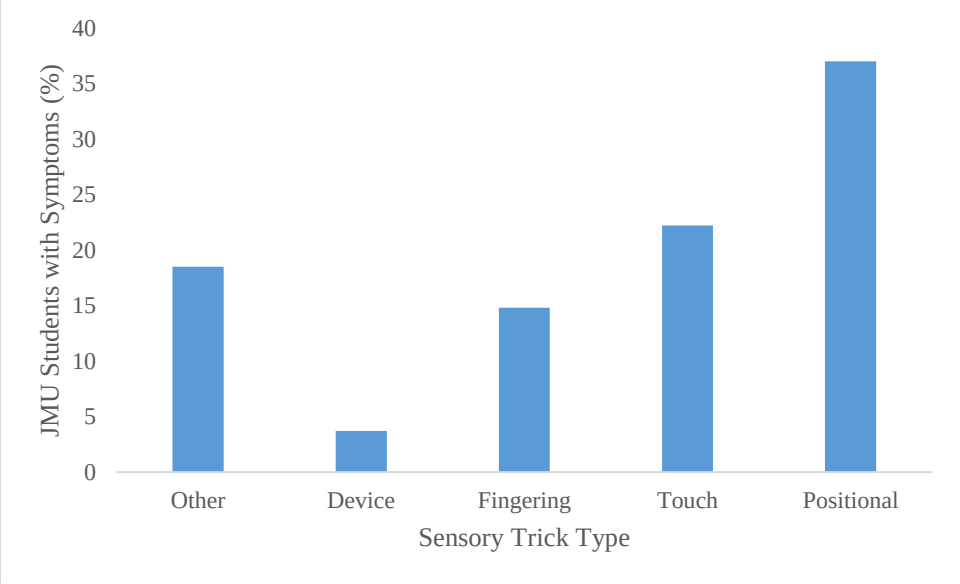

Figure 8. Distribution of sensory tricks among JMU students with symptoms.

Among JMU students reporting negative symptoms, sensory tricks were found to be most commonly used by percussion instrumentalists (25.4%) followed by keyboard (23.7%) and woodwind instrumentalists (23.7%). 20.7% of vocalists, 13.8% of brass, 3.4% of upper string, 3.4% of unclassified, and 1.7% of lower string instrumentalists also reported positive results from sensory trick usage. In analyzing which sensory tricks were commonly utilized among the varying instrumental genres, it was found that individuals who played only upper string instruments generally employed changes in fingering (50% of cases) and positioning (50% of cases) whereas instrumentalists who played upper strings in association with other

instrument types, specifically piano, vocal (alto range), and oboe/English horn, also employed stretching techniques (33% of cases). Conversely, lower string instrumentalists were found to not use sensory tricks unless noted as playing another instrument, specifically piano. This included changing fingering (33% of cases), tactile stimuli (33% of cases), and positional changes (33% of cases). Percussionists, similarly, were found to only utilize sensory tricks of positional changes (38% of cases), tactile stimuli (25% of cases), device usage (13%), fingering changes (13%), and resting (13% of cases) if associated with another instrument such as piano, clarinet/bass clarinet, singing (Alto range), or bassoon/contrabassoon (Figures 9 and 10).

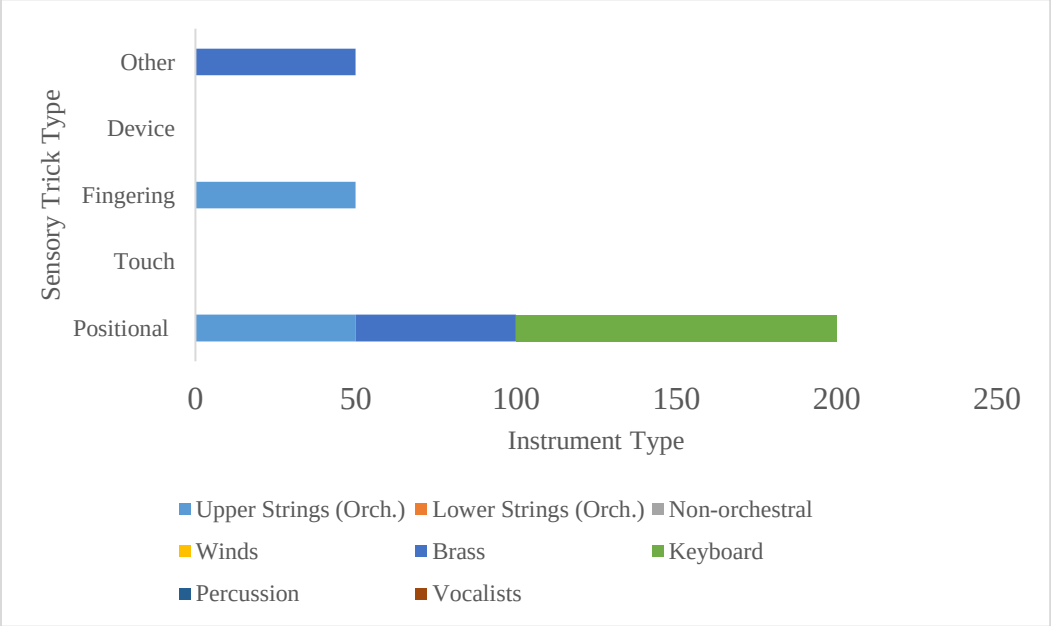

Figure 9. Sensory trick distribution across genres if only one instrument is played.

Musicians playing only keyboard instruments were found to use only positional changes whereas those who played additional instruments reported the ability to use additional sensory tricks of positional changes (33% of cases), tactile stimuli (28% of cases), resting/stretching (22% of cases), and changing fingering (17% of cases). Vocalists,

discovered to only use sensory tricks if also an instrumentalist, were found to primarily use positional changes (40% of cases), tactile stimuli (30% of cases), changing fingering (10% of cases), device usage (10% of cases), and stretching (10% of cases). This was noted among vocalists who indicated that they also played the violin, piano, flute/piccolo, oboe/English horn, clarinet/bass clarinet, trumpet, piano, or marimba or were able to sing dual ranges (e.g. mezzo soprano, alto, or tenor range). Similarly, woodwind instrumentalists were found to not use sensory tricks unless also playing another instrument, specifically violin, flute/piccolo, oboe/English horn, clarinet/bass clarinet, bassoon/contrabassoon, saxophones, piano, organ, unclassified, or vocalists (mezzosoprano or alto). Of this subgroup, musicians indicated positional changes were helpful in 27% of cases in addition to tactile stimuli (27% of cases), changing fingering (18% of cases), stretching (18% of cases), and device usage (9% of cases). Unlike woodwind musicians, brass instrumentalists only playing brass instruments indicated that they were able to utilize stretching (50%) or positional changes (50%) in order to help alleviate symptoms. However, if playing another instrument such as the piano or if a vocalist (tenor range), they reported being able to use tactile stimuli (25% of cases) (Figures 9 and 10).

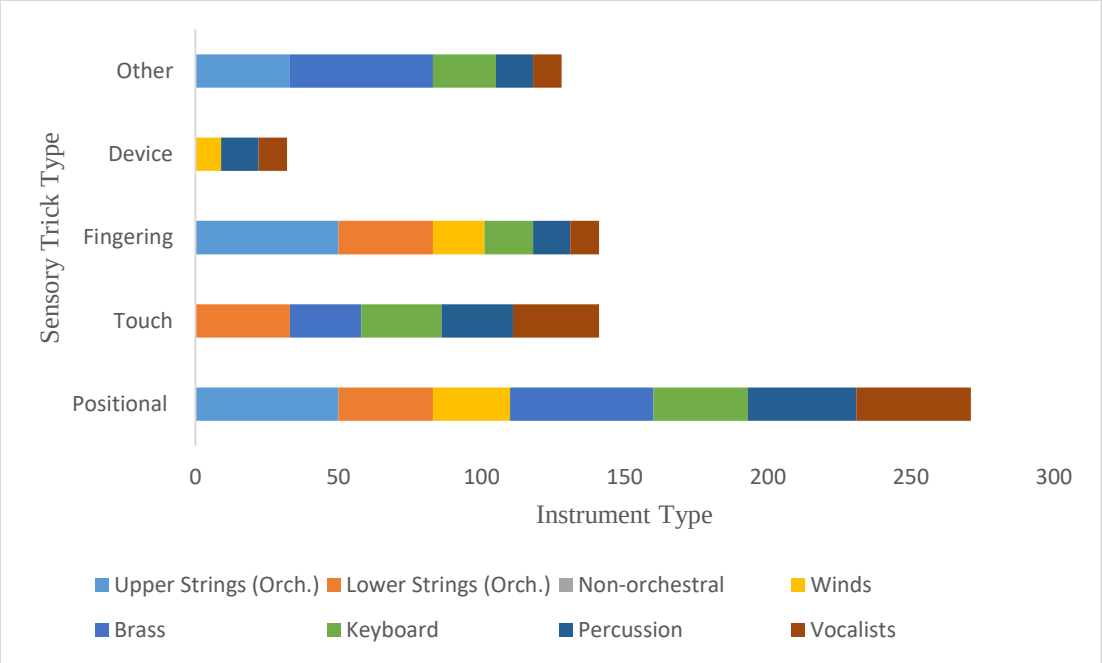

Figure 10. Sensory trick distribution across genres if multiple instruments are played.

Chapter V

Discussion

The purpose of this study was to identify sensory tricks being utilized by musicians of varying instrumental genres and evaluate a potential association with personality, practice approach, auditory/kinesthetic feedback, age, years played, and approach to practice. This information was then used to assess whether similarities exist between dystonic musicians and the JMU music student population. As previous studies expose a deficit of knowledge regarding dystonia manifestation and the associated usage of sensory tricks (Konczak & Abbruzzes, 2015), this research was essential in gaining an improved understanding of the disease. Utilizing Bandura's Social Cognitive Theory to assess behavioral, environmental, and personal factors impacting musicians, this study provided a foundational knowledge of extrinsic and intrinsic variables potentially correlated to dystonic symptoms and the effectiveness of sensory tricks. Developing an awareness of how these variables, specifically personality, age, practice approach, and auditory/kinesthetic feedback abilities, relate to dystonia and sensory trick usage, could help with constructing and instituting preventative injury measures within music education. Thus, constructs of the Social Cognitive Theoretical Model, including situational perception, emotional coping, outcome expectations, outcome expectancies, and self-efficacy, in addition to the created constructs of performance learning approach, performance wellbeing, and compensatory adaptation, were applied in creating the survey instrument for this study. Each construct was then applied to the objectives of this study.

Objective 1

Objective 1, built upon the compensatory adaptation construct, sought both to identify sensory tricks being used by dystonic musicians of varying instrumental genres and to determine

whether type of sensory trick usage would be similar between instrumental genres. Findings indicated that, overall, most dystonic instrumentalists used positional changes followed by fingering, device usage, touch/sensory stimulation, in addition to other methods not able to be defined within a known category (Figure 1). As 30.3% of respondents indicated using sensory tricks not previously documented in past studies (Loyola, Camargos, Maia, & Cardoso, 2012), this suggests that the current categories of sensory tricks which have been documented within past literature may be limited in that they are not able to encompass all sensory trick methods currently being used by musicians to alleviate symptoms. This includes usage of Taubman techniques, brain retraining, breathing exercises, splints, and instrumental adaptations (e.g. split keyboard, stop mute, and wearing a bell).

In determining whether type of sensory trick usage was similar in dystonic musicians across instrumental genres, findings indicated that most single instrument musicians utilizing fingering changes were primarily non-orchestral string or woodwind instrumentalists. In addition, it was found that positional changes were more prominent among non-orchestral strings, woodwind, brass, and percussion instrumentalists while device usage was found to more common amongst non-orchestral string instrumentalists and tactile stimuli was found to more common amongst non-orchestral strings, brass, and upper string instrumentalists (Figure 2). As woodwind and brass instruments are similar in regards to specificity of movement types, it was expected that the two instrumental groups would be more prone to select similar sensory tricks; however, this was only found to be the case with positional changes. An unexpected dissimilarity was also noted between these instrumental genres though this may largely be due to a low number of respondents for upper and lower orchestral strings. While all upper orchestral dystonic instrumentalists using sensory tricks indicated that they used tactile stimuli, lower orchestral

dystonic instrumentalists indicated that they either did not use or were not able to use sensory tricks. Requiring a different stance when playing than orchestral strings, non-orchestral strings were found to be associated with all sensory trick types except for tactile stimuli. This finding could suggest that more sensory trick types are being used because they are more effective for non-orchestral string instrumentalists compared to other musician types; yet, it may also indicate that a greater number of sensory tricks can be easily adapted to the physical postures associated with those instrumental types. However, as percussion instrumentalists, which are confined to highly specific, but less complex playing postures, indicate that they are only able to utilize positional changes, it is likely that the postural demands of holding the instrument are why some sensory trick types were selected more than others. This suggests that sensory trick type selected may be determined by the instrumental genre played, or more specifically the way/posture an instrument is held.

Considering that past literature indicates that woodwind and brass instrumentalists are more inclined to develop dystonia (Altenmuller, Baur, Hofmann, Lim, & Jabusch, 2012), expected results were that an increase of sensory trick usage would be found amongst these musician types as they more commonly reported negative symptoms. However, findings that keyboard and non-orchestral string instrumentalists were more apt to utilize sensory tricks than the woodwind/brass musician types suggest that dystonia diagnoses and the usage of sensory tricks are not correlated. This finding suggests that the presence of dystonia does not increase the likelihood of sensory trick effectiveness in ameliorating symptoms. In addition, it further suggests that postural differences associated with playing an instrument may be the greatest indicator in determining whether sensory tricks are more effective amongst some instrumental genres and not others.

Adding to findings from past literature which reveal a correlation between early age musical learning and a decreased risk for development of musician's dystonia (Altenmuller, 2003), results exposed that an increase in age was positively correlated with dystonic symptoms. As would be expected, a positive correlation was also noted between years played and negative symptoms. Frequencies of other demographic data did not yield similar results as shown by findings which suggest that the majority of both dystonic musicians and non-dystonic musicians selected right handedness. Thus, whether the instrumentalist played right or left handed did not appear to be a related variable to musician's dystonia onset or sensory trick usage.

Objective 2

Further SCT constructs of emotional coping, outcome expectations, outcome expectancies, and self-efficacy in addition to the created constructs of performance learning approach and performance well-being, were examined in meeting Objective 2. These were used to assess what characteristics of personality traits, practice approach, and auditory/kinesthetic feedback existed among the dystonic population. In first assessing the performance learning approach, performance wellbeing, and emotional coping constructs to assess how musicians approached learning various repertoire techniques, findings suggested that fatigue based practice mechanisms, including repetition, effort force, and demanding technical exercises, were preferred in comparison to less fatiguing methods. Dissimilarly, analysis of self-esteem and stress levels as applied from the emotional coping, outcome expectations, outcome expectancies, and self-efficacy constructs, yielded no significant differences between the dystonic and non-dystonic population (represented by p-values of 0.879 for stress level and 0.382 for the self-esteem scale). This finding suggests that perception of self and anxiety/tension differences were not directly associated with the onset of negative symptoms as expected. Assessment of overall

personality differences also yielded similar results (insignificant due to p-value 0.697); however, as the sample size for each individual trait of extraversion, openness, agreeableness, conscientiousness, and neuroticism was too small no judgment could be made concerning specific trait differences.

Examination of kinesthetic feedback traits related to repertoire level revealed that advanced techniques were not required to elicit dystonic symptoms as less than 20% of cases indicated that staccato, legato, or spiccato increased physical difficulty. Conversely, tempos were found to be positively correlated with dystonic symptoms, exposing an 21.2% increase in symptoms with an increase in speed from Andante to Prestissimo. Pitch was also found to increase negative symptoms overall, suggesting auditory feedback mechanisms may be related to maladaptive playing ability. However, as only a small increase in negative symptoms was detected between low to high tones, it would be advisable to conduct more tests with a larger sample size to determine the extent of pitch effects on dystonic symptoms. This finding may indicate that specific elements of sound and pitch quality may be contributing to negative symptoms, presenting implications for future research. This could potentially confirm a linkage between generalized dystonia which, as documented by past studies, suggests that individuals may experience increased symptoms when in the presence of environmental stressors such as construction noise. However, as music is entirely reliant upon the production of sound, this finding is significant in promoting future research into maladaptive auditory/kinesthetic feedback mechanisms which may result from select tone levels.

Analysis of outcome expectancies, outcome expectations, and self-efficacy constructs which measured the degree of control a musician feels in regards to both their life and performance ability further yielded results which differed from past studies (Altenmuller, 2005). As past

literature, has shown a strong connection between psychological traits and musician's dystonia (Troster, 2014), it was expected that those with dystonia would exhibit a higher stress level, lower self-esteem, while demonstrating personality tendencies associated with known anxiety and perfectionist behaviors. However, t-tests comparing dystonic and non-dystonic musician's traits in these areas yielded no significant differences between the two groups. Though psychological factors were not linked with dystonic musicians in this study, calculation of demographic frequencies did expose a positive correlation between both advanced age and years played and negative symptoms. Knowledge of this association may help explain why the disease is primarily noted among professional musicians who have devoted more time to playing at a heightened level. However, this does not explain whether the length of time spent practicing is the major contributor to disease onset or whether the disease is arising due to age associated changes.

Objective 3

Objective 3 was met by applying aspects of Bandura's social cognitive theory to examine emotional coping, outcome expectations/expectancies, self-efficacy, and the created constructs of performance learning approach and performance well-being. Descriptive analysis results exposed that similarities did exist between dystonic musicians and symptomatic JMU students in regards to both maladaptive practice techniques and negative symptoms. This finding suggests that learned practice behavior or environmental influences (continual stress of playing in rigid setting, etc.) may be associated with dystonic symptoms. Considering past studies identified most dystonic musicians as professional musicians (Altenmuller & Jabusch, 2009), university students, specifically JMU music students, were chosen to be the control group. Though a major difference did exist in age between the JMU students and dystonic musicians, these students

were selected as the control group as they would be representative of those closest in repertoire level while being healthy. However, results exposed that over half (51.6%) of the JMU music student population also reported negative symptoms characteristic of dystonia diagnoses.

In assessing whether JMU students reported negative symptoms based on application of the performance well-being and performance learning approach constructs, it was revealed that the students exhibited dystonic symptoms such as undesired curling, clenching, bending, or sticking of fingers, muscle contractions, coordination/control loss, gradual loss of being able to play a pass, involuntary/abnormal movements, and tremors (Table 5). These symptoms were found to be positively correlated with a perception of increased effort force (66.7% among dystonic musicians and 68.8% among JMU music students) when playing which was, sequentially, also found to be a characteristic noted within the dystonic population. This finding is significant as no studies have previously been conducted to detect whether a relationship exists between effort force and dystonic symptoms. As an excess of effort force would be fatiguing in performance, this presents implications for future research and could be influential in establishing precautional changes in music education.

Further suggesting a positive trend between dystonic symptoms and maladaptive practice techniques, findings indicated that fatigue based preparation methods of repetition and technical exercises were preferred by over half of dystonic musicians and symptomatic JMU music students. This corresponded with other results which showed a positive correlation between faster musical tempos requiring intense muscular control and negative symptoms among both dystonic and symptomatic JMU students. This finding may also help explain why, out of the fatiguing techniques of staccato, legato, and spiccato, both JMU students and dystonic musicians indicated that staccato, a technique which requires a combination of speed, tension, and effort

force, was slightly more problematic when compared to other technique types. These advanced repertoire techniques were further found to present a similar level of physical difficulty in both dystonic musicians (30.6%)and symptomatic JMU music students (31.2%). Such findings corroborate past research studies which suggest that specific techniques may play a role in perpetuating a dystonic response (Kompoliti & Verhagen, 2010).

As past literature suggests that sensory tricks may potentially have an auditory component, findings indicating that pitch was similarly a factor in dystonic symptoms was significant (Altenmuller, Finger, & Boller, 2015). Such tonal differences/pitch changes were found to affect both dystonic musicians (24.3%) and JMU music students (50%) with slightly more students indicating negative symptoms arising from pitches being played in octaves above middle C. As most JMU music students identified as being within the 18-24 age range which is generally associated with peek hearing levels, it was expected that they would experience elevated levels in negative symptoms compared to the exposure group if maladaptive auditory/kinesthetic feedback mechanisms were present. Thus, this finding alone may further implicate maladaptive auditory/kinesthetic feedback mechanisms in dystonia onset, suggesting further research needs to be conducted in this area. Just as acoustic screens have been implemented by orchestras to prevent hearing loss due to sound exposure, it is plausible that other protective measures could be implemented to guard against other potential auditory issues.

Emotional coping, outcome expectations/expectancies, and self-efficacy constructs utilized to assess whether stress, self-esteem, or personality differences could impact dystonia onset yielded mixed results. Though no significant differences were detected in stress or self-esteem levels between symptomatic and asymptomatic JMU students, ($p = 0.753$ and 0.724), there was a significant difference ($p = 0.007$), detected between personality type. However, as the sample

size was small no further tests could be conducted to break down variations within each trait without increasing risk for error. Thus, future tests could be conducted to determine whether select personality traits could increase the risk for dystonic symptoms in music students.

Application of the compensatory adaptation construct to Objective 3 to identify whether symptomatic JMU music students could utilize sensory tricks, exposed that only 3.7% indicated that sensory tricks were not effective. However, it should be noted that students reporting usage of sensory tricks did not necessarily understand that they were using them as a dystonic compensatory adaptation method, but were rather adopting these adjustment methods through experimentation to alleviate negative symptoms. This included, from highest to lowest, being able to alter position of instrument/hand, using tactile stimuli, stretching/resting, and device utilization (Figure 8). Sensory trick usage was most commonly found amongst instrumental genres in which a larger sample size was present, particularly percussion, keyboard, woodwind, vocalists, and brass; thus, more research should be conducted into all string instrumentalists to correct for the disparity in lack of responses.

Among musicians playing one instrument type, it was found that, on average 0.7 sensory tricks were used; however, among those playing multiple instruments an average of four sensory tricks were utilized. Percussionists, keyboardists, and vocalists on average were found to use the most sensory tricks, five, if playing multiple instruments, while woodwinds successively used four and brass, upper strings, and lower strings utilized three. This finding could further confirm that fatigue may play a role in manifesting dystonia onset; yet, it may also suggest that the more instruments a musician plays the more likely neurological symptoms which were present, but undetected will become evident through positional changes. Thus, future research is necessary to

determine the exact relationship between the usage of multiple instrument types and both dystonia.

Another similarity existing between symptomatic JMU students and dystonic musicians, was the selection of sensory tricks used. Both samples indicated that sensory tricks utilizing the wrist, hands, or fingers were the most preferred methods in ameliorating symptoms. Thus, more research into the types of specific tricks being used may help with implementing changes in music education methods (early fingering changes, having students wear a device when learning specific techniques, etc.). Conducting a follow-up study with a physician assessment could be important in establishing whether these methods could be useful for all symptomatic musicians of a specific instrumental genre and whether they could be adapted to music education as preventative measures to help prevent disease onset.

Limitations

Considering most dystonic participants identified as being 35 years of age or older while the comparative group, JMU students identified as being 18-24, age was found to be a confounding factor. This inability to control for age, however, could be easily accounted for in future study by refraining from using college musicians as the control group, but rather local orchestras which contain more variability in age and other factors. Changing the healthy sample population from college students to an external population would also be beneficial in establishing more helpful controls such as lifestyle factors, diet, health insurance, etc. Thus, including a more stratified population and taking extra precautions when controlling for extraneous variables may be beneficial for future study. Another limitation was that there was no true means to determine whether one sensory trick was more effective than another and, therefore, had to be assumed to be more advantageous than other sensory trick methods based on

increased usage. Recall bias, the inability of a respondent to accurately remember information, may have also impacted the results of the study.

Future Research

As this pilot study provides the foundational background information needed to conduct experimental research, implications for future study could include increasing statistical power by using a larger sample size of musicians across the various instrumental genres studied and eliminating potential confounding factors by controlling for age and performance level. Accuracy of results could further be enhanced by incorporating physician assessment of sensory trick usage by symptomatic musicians as a measure to ensure accurate documentation. This may aid in comparing whether the sensory tricks used would/would not be useful by all musicians of the same instrumental genre, helping researchers gain an improved understanding of the phenomenon as it relates to dystonia. Furthermore, as all research participants with a dystonia diagnosis or dystonic symptoms reported that they used more physical effort than necessary to play their instrument, future research could be conducted to establish the impact of effort force on dystonia onset and symptoms. This could include equipping the fingerboard of string instruments, piano keys, or brass/woodwind keys with force platform equipment to measure variations in effort force associated with specific musical techniques.

Considering a positive correlation was noted between effort force and fatigue based practice mechanisms reported by symptomatic participants, an experimental musical analysis could also be included. This could entail a complex musical score being broken down and rewritten according to select practice methods, requiring participants to play each variation, and then comparing fatigue level after each practice session. Such research may help ascertain which practice methods are the most conducive for achieving/maintaining good performance health

while eliminating maladaptive practice techniques and obtaining musical improvement. Motion analyzer equipment could also be integrated into the study to help identify unwanted movements which may impede the performer's desired movement.

Appendix A
Survey Instrument

"Web"/ "Email" Cover Letter (used in anonymous research)

Identification of Investigators & Purpose of Study

You are being asked to participate in a research study conducted by (Jamie Agee) from James Madison University. The purpose of this study is to (examine practice approach, personality, auditory/kinesthetic feedback, age, sensory tricks, years played and repertoire level of both healthy and dystonic musicians and to determine if there is a correlation with increased health risks. These factors will be examined with respect of helping find potential therapeutic and preventative mechanisms for dissuading disease among musicians). This study will contribute to the researcher's completion of his/her (senior thesis as a part of the HTH 499B/499C requirement for the JMU honors program).

Research Procedures

This study consists of an online survey that will be administered to individual participants through the United States, using Qualtrics. Access will be given through a JMU Research Facebook Page approved by my advisor, Dr. Ott-Walter. JMU music students will also be emailed a survey link through their JMU email accounts. You will be asked to provide answers to a series of questions related to (your personal musical experiences and characteristics).

Time Required

Participation in this study will require 10 minutes of your time.

Risks

The investigator does not perceive more than minimal risks from your involvement in this study (that is, no risks beyond the risks associated with everyday life).

The investigator perceives the following are possible risks arising from your involvement with this study: Increased stress levels associated with thinking about possible negative health and technical issues while playing. To minimize risk, the participant will be made aware that they may stop at any time if experiencing any rare negative effects.

Benefits

Potential benefits from participation in this study include: Participants will become more knowledgeable in being able to identify factors which may predispose one for musician's dystonia. In addition, they may become more capable of identifying potential sensory tricks which may help serve as therapeutic or preventative mechanisms in dissuading dystonic onset and symptoms. This may provide future implications for future changes being implemented in educational music programs, particularly in regards to incorporating improved practicing methods geared toward prevention.

Confidentiality

The results of this research will be presented at (a poster symposium to HTH 499B/C students and Faculty and, prospectively, submitted to the JMU undergraduate research journal). While individual responses are anonymously obtained, recorded anonymously online through the

Qualtrics and kept in the strictest confidence, aggregate data will be presented representing averages or generalizations about the responses as a whole. No identifiable information will be collected from the participant and no identifiable responses will be presented in the final form of this study. All data will be stored in a secure location only accessible to the researcher. At the end of the study, all records will be destroyed. Final aggregate results will be made available to participants upon request.

Participation & Withdrawal

Your participation is entirely voluntary. You are free to choose not to participate. Should you choose to participate, you can withdraw at any time without consequences of any kind. However, once your responses have been submitted and anonymously recorded you will not be able to withdraw from the study.

Questions about the Study

If you have questions or concerns during the time of your participation in this study, or after its completion or you would like to receive a copy of the final aggregate results of this study, please contact:

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QUESTIONS ABOUT YOUR RIGHTS AS A RESEARCH SUBJECT

DR. DAVID COCKLEY

CHAIR, INSTITUTIONAL REVIEW BOARD

JAMES MADISON UNIVERSITY

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Giving of Consent

I have been given the opportunity to ask questions about this study. I have read this consent and I understand what is being requested of me as a participant in this study. I certify that I am at least 18 years of age. By clicking on the link below, and completing and submitting this anonymous survey, I am consenting to participate in this research.

____Jamie Agee_____ ___7/15/16_____

Name of Researcher: Jamie Agee

What is your age?

- ❍ 18-24 (1)
- ❍ 25-34 (2)
- ❍ 35-54 (3)
- ❍ 55-64+ (4)

What description best fits your musical status?

- ❍ Orchestral, Chamber, Wedding, or Band Musician (1)
- ❍ Professional Soloist (2)
- ❍ James Madison University music student (4)
- ❍ Music student attending any college/university OTHER than James Madison University (5)
- ❍ I just enjoy playing music for fun (6)

How many years have you played?

- ❍ 1-6 (1)
- ❍ 7-10 (2)
- ❍ 10-20 (3)
- ❍ 30+ (4)

How would you define your current level of playing?

- ❍ Beginner (1)
- ❍ Intermediate (2)
- ❍ College music major or semi-professional level (3)
- ❍ Advanced (4)

Are you right handed or left handed?

- ❍ Right (1)
- ❍ Left (2)

Have you been diagnosed with dystonia?

- ❍ Yes (1)
- ❍ No (3)

Answer If Have you been diagnosed with dystonia? No Is Selected

Have you ever experienced any of the below when playing your instrument? Please select ALL that apply.

- ❑ Gradual loss of being able to play a passage after practicing (1)
- ❑ Involuntary/abnormal movements when playing (2)
- ❑ Muscle contractions (3)
- ❑ Loss of control and coordination of fingers, hand, or other body part used to play your instrument (4)
- ❑ Undesired curling, clenching, bending, or sticking of fingers (5)
- ❑ tremor (6)
- ❑ I do NOT experience any negative issues when playing my instrument (7)

Answer If Have you been diagnosed with dystonia? Yes Is Selected

Have you recovered from dystonia?

- ❍ Yes (1)
- ❍ No (2)

Answer If Have you ever experienced any of the below answers when playing your instrument? Please select AL... I do NOT experience any negative issues when playing my instrument Is Not Selected

If you experience any negative symptoms when you play, please indicate which side they are on:

- ❍ Right (1)
- ❍ Left (2)

What instrument do you play? If you play more than one, please indicate all that apply:

- ❑ violin (1)
- ❑ viola (2)
- ❑ cello (3)
- ❑ bass (4)
- ❑ flute, piccolo (5)
- ❑ oboe, English horn (6)
- ❑ clarinet, bass clarinet (7)
- ❑ bassoon, contrabassoon (8)
- ❑ saxophones (9)
- ❑ trumpet (10)
- ❑ horn (French horn) (11)
- ❑ trombone (12)
- ❑ tuba (13)
- ❑ celesta (14)
- ❑ piano (15)
- ❑ harpischord (16)
- ❑ organ (17)
- ❑ synthesizer (18)
- ❑ harp (19)
- ❑ timpani (20)
- ❑ snare drum, bass drum (21)
- ❑ cymbals (22)
- ❑ tambourine, triangle (23)
- ❑ xylophone (24)
- ❑ Glockenspiel (25)
- ❑ Chimes (26)
- ❑ Marimba (27)
- ❑ Vibraphone (28)
- ❑ Soprano singer (29)
- ❑ Mezzo-soprano singer (30)
- ❑ Alto singer (31)
- ❑ Countertenor singer (32)
- ❑ Tenor singer (33)
- ❑ Baritone singer (34)
- ❑ Bass singer (35)

In a typical week how many hours do you spend practicing?

- ❍ 0-2 (1)
- ❍ 2-4 (2)
- ❍ 4-6 (3)
- ❍ 6+ (4)

You have a concert coming up in 1 week…how would you best approach practicing a musical passage that is giving you difficulty? (Please circle the response that is closest to what you normally do).

- ❍ Practice the difficult measure repetitively until stellar results are achieved (1)
- ❍ Visualize the difficult passage without touching the instrument (2)
- ❍ Practice finger exercises designed to help with the technique (scales, etudes, etc.) (3)
- ❍ Take a break and come back to it (4)

For this same concert (which is in 1 week), the audience has requested you play a show piece, but you have never played before! How would you best begin learning this piece to have it finished in time?

- ❍ Concentrate slowly on one measure at a time, taking frequent breaks in between (1)
- ❍ Work aggressively, frequently repeating measures, and taking few distracting breaks (2)
- ❍ Work on increasing speed before worrying about technique (3)

Answer If Have you ever experienced any of the below answers when playing your instrument? Please select AL... I do NOT experience any negative issues when playing my instrument Is Not Selected

During what technique do you "mostly" exhibit negative physical symptoms (uncontrolled movement, pain, etc.)?

- ❍ All, it does not matter what technique is being played (1)
- ❍ staccato (2)
- ❍ legato (3)
- ❍ spiccato (applies to string instruments) (4)

Answer If Have you ever experienced any of the below answers when playing your instrument? Please select AL... I do NOT experience any negative issues when playing my instrument Is Not Selected

During what tempos do you "mostly" exhibit negative symptoms?

- ❑ Prestissimo (very, very fast) (1)
- ❑ Andante (walking speed) (2)
- ❑ Grave (very slow) (3)
- ❑ I have symptoms no matter what the tempo (4)

Answer If Have you ever experienced any of the below answers when playing your instrument? Please select AL... I do NOT experience any negative issues when playing my instrument Is Not Selected

Are these passages typically in a high octave (above middle C) or lower (below middle C)?

- ❍ Above (1)
- ❍ Lower (2)
- ❍ the octave doesn't seem to matter (3)

Is there anything you can do to alleviate negative physical symptoms (pain, abnormal movements, clenching, etc.) when playing?

- ❑ changing fingering (1)
- ❑ changing position of instrument or hand (2)
- ❑ touching chin, hand, or other affected body part (3)
- ❑ wearing a band, bracelet, or other device on affected part (4)
- ❑ other (please specify in text box) (5) _____
- ❑ nothing helps (6)
- ❑ I never have negative symptoms (7)

Answer If Is there anything you can do to alleviate negative physical symptoms (pain, abnormal movements, clenching, etc.) when playing? nothing helps Is Not Selected And Have you ever experienced any of the below answers when playing your instrument? Please select ALL... I do NOT experience any negative issues when playing my instrument Is Not Selected

If you were able to answer the previous question, you are using what is known as a "sensory trick." What body regions are involved in initiating the sensory trick (or the method you are using to alleviate the negative symptoms)?

- ❑ head (1)
- ❑ neck (2)
- ❑ ear (3)
- ❑ chin (4)
- ❑ cheek (5)
- ❑ eye (6)
- ❑ mouth (7)
- ❑ nose (8)
- ❑ shoulder (9)
- ❑ abdomen (10)
- ❑ back/shoulder blade (11)
- ❑ arm (12)
- ❑ wrist (13)
- ❑ hand (14)
- ❑ fingers (15)
- ❑ knee (16)
- ❑ thigh (17)
- ❑ lower leg/ankle (18)
- ❑ knee (19)
- ❑ foot (20)

Answer If Is there anything you can do to alleviate negative physical symptoms (pain, abnormal movements, c... nothing helps Is Not Selected And Have you ever experienced any of the below when playing your instrument? Please select ALL that apply. I do NOT experience any negative issues when playing my instrument Is Not Selected

Please indicate the side involved in initiating this activity:

- ❑ Right (1)
- ❑ Left (2)
- ❑ Right with aid of device (3)
- ❑ Left with aid of device (4)
- ❑ device attached to music stand, instrument, or other object (5)
- ❑ if device is used, please indicate (6) _____

Answer If Is there anything you can do to alleviate negative physical symptoms (pain, abnormal movements, clenching, etc.) when playing? nothing helps Is Not Selected And Have you ever experienced any of the below answers when playing your instrument? Please select AL... I do NOT experience any negative issues when playing my instrument Is Not Selected

During periods of high stress and anxiety, do the activities such as changing fingering; changing position of instrument or hand; touching chin, hand, or other affected body part; wearing a band, bracelet, or other device on affected part help more or less?

- ❍ More (1)
- ❍ Less (2)

Stress Level:

1	2	3	4	5
Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree

In general, I feel I am in charge of the situation in which I live. (1)	❍	❍	❍	❍	❍
I am quite good at managing my responsibilities of my daily life. (2)	❍	❍	❍	❍	❍
I very rarely feel overwhelmed by my responsibilities. (3)	❍	❍	❍	❍	❍
I have a sense of direction and purpose in life. (4)	❍	❍	❍	❍	❍
I enjoy making plans for the future and working to make them a reality. (5)	❍	❍	❍	❍	❍
Some people wander aimlessly through life, but I am not one of them. (6)	❍	❍	❍	❍	❍
I never feel as if I've done all there is to do in life. (7)	❍	❍	❍	❍	❍
I always feel that I am in full control of my musical technique and that all my future performances will go well. (8)	❍	❍	❍	❍	❍

Self Esteem:

1	2	3	4	5
Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree

I feel that I am a person of worth, at least on an equal basis with others. (1)	❍	❍	❍	❍	❍
I feel that I have a number of good qualities. (2)	❍	❍	❍	❍	❍
I feel confident I am able to do musical work as well as most other people. (3)	❍	❍	❍	❍	❍
I take a positive attitude toward myself and never feel useless. (4)	❍	❍	❍	❍	❍
On the whole, I am satisfied with myself and my accomplishments. (5)	❍	❍	❍	❍	❍
I never feel that I could have more respect for myself. (6)	❍	❍	❍	❍	❍
No matter how hard I practice, I sometimes feel that I am not capable of being successful. (7)	❍	❍	❍	❍	❍
I feel that I am not worthy if I perform at a lesser level than I expected to. (8)	❍	❍	❍	❍	❍
I feel I perform the way I deserve based on the amount of effort and time I practice. (9)	❍	❍	❍	❍	❍

Personality:

1	2	3	4	5
Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree
Extraverted, enthusiastic (1)	❍	❍	❍	❍	❍
Critical, quarrelsome (2)	❍	❍	❍	❍	❍
Dependable, self-disciplined (3)	❍	❍	❍	❍	❍
Anxious, easily upset (4)	❍	❍	❍	❍	❍
Open to new experiences, complex (5)	❍	❍	❍	❍	❍
Reserved, quiet (6)	❍	❍	❍	❍	❍
Sympathetic, warm (7)	❍	❍	❍	❍	❍
Disorganized, careless (8)	❍	❍	❍	❍	❍
Calm, emotionally stable (9)	❍	❍	❍	❍	❍
Conventional, uncreative (10)	❍	❍	❍	❍	❍

Would you like to participate in the drawing for a $50 Visa gift card**?** If so, please select yes and you will be redirected to where you can provide your email address (your email will not be attached to your answers so everything you have shared will remain anonymous). If "no," you will be directed out of the survey. Thank you for your time!

- ❍ Yes, I want to participate in the drawing! (1)
- ❍ No (2)

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