POSTURE DURING PIANO PERFORMANCE: VARIABILITY AND POSTURAL CHANGES FOLLOWING TRAINING IN THE ALEXANDER TECHNIQUE

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Table of Contents

Preface

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Abstract

Musicians can develop and suffer from playing-related musculoskeletal disorders (PRMDs) with pianists being a group of instrumentalists that experience a higher occurrence of PRMDs in comparison with other musicians. One cause of PRMDs is posture. The Alexander Technique (AT) is a popular somatic method among musicians that purports to alter its students' postural and movement behaviour. Such changes may be beneficial in improving music performance. However, there is a lack of quantitative research to offer support for the effectiveness of the AT in altering posture in musicians, especially in pianists. To address this issue, four studies were conducted. The first study addressed the AT alone to determine what postural changes could be expected following lessons in the AT. Findings of this study showed that changes include a larger craniovertebral angle, head tilt, and head-neck-trunk angle as well as smaller trunk, thoracic, and thoracolumbar angles. The second study addressed variability in individual pianists' postures and its implications for intervention studies. The results of this study demonstrated that within-person variability is present in posture between performances but does not vary widely enough to exhibit inconsistent posture across measurements. The third study examined the effects of 10 AT lessons on pianists' postures. Findings showed that, in comparison with their pre-lesson measurements, pianists demonstrate a postural pattern of larger craniovertebral and head-neck-trunk angles as well as smaller trunk, thoracic, and thoracolumbar angles in both the post-test and follow-up tests. The fourth study explored the relationship between pianists' perceptions of their posture and their application of the AT with quantitatively measured changes in their posture. The results of this study showed that participant perception and reported application of the AT does not necessarily always reflect the postural changes that have occurred.

Keywords: posture, pianists, Alexander Technique, spinal angles, variability, intraindividual variability, perception

List of Tables

Chapter 6

List of Appendix Tables

Appendix F

List of Figures

Chapter 3

Chapter 5

Chapter 1: Introduction

Introduction

Musicians are at risk of developing medical problems related to playing an instrument, known as playing-related musculoskeletal disorders (PRMDs) (Bejjani et al., 1996; Blackie et al., 1999; Blanco-Piñeiro et al., 2015; Bragge et al., 2006a; Bragge et al., 2006b; Edling & Fjellman-Wiklund, 2009; Fry, 1986; Kaufman-Cohen & Ratzon, 2011; Zaza et al., 1998; Zaza & Farewell, 1997). PRMDs are "painful and disabling conditions" (Zaza et al., 1998, p. 2013) that interfere with an instrumentalist's ability to play his instrument. Symptoms include pain, numbness, tingling, weakness, and loss of function (Allsop & Ackland, 2010; Furuya et al., 2006; Zaza et al., 1998; Zaza & Farewell, 1997). Examples of such disorders are tendinitis, carpal tunnel syndrome, thoracic outlet syndrome, and focal dystonia (Allsop & Ackland, 2010; Blackie et al., 1999; Bruno et al., 2008; Furuya et al., 2006; Rogers, 1999; Zaza, 1998; Zaza et al., 1998). One possible cause of PRMDs is posture, or the position of the body during activity (Allsop & Ackland, 2010; Blackie et al., 1999; Blanco-Piñeiro et al., 2015; Medoff, 1999; Rogers, 1999; Roset-Llobet et al., 2000; Shamoto, 2013; Shields & Dockrell, 2000; Yoshimura et al., 2006; Zaza et al., 1998). Pianists in particular are among instrumentalists that experience a higher incidence of PRMDs in comparison with other musicians (Blackie et al., 1999; Bragge et al., 2006a; Manchester, 2014; Shields & Dockrell, 2000). Posture may be an issue with pianists because instead of focusing on the body as a whole entity, they focus on specific parts of the upper extremity such as the arm, wrist, or hand (Barlow, 1948; Ben-Or, 1978; Kaplan, 1994; Jones, 1949). However, the way in which pianists position themselves at the piano affects the movements of the upper extremities, so it is necessary to be aware of posture and to evaluate whether or not such tendencies are conducive to playing (Ben-Or, 1978; Kaplan, 1994; Kleinman & Buckoke, 2013; Macdonald, 2015; Mark, 2003; Santiago, 2004). The Alexander Technique (AT) may be able to address this issue.

The AT is a popular somatic method among musicians as it is thought to be able to improve music performance and provide a way with which to cope with performance-related issues. The AT can alter the postural and movement behaviour of its students (Cacciatore, Gurfinkel, Horak, & Day, 2011; Macdonald, 2015), which is of importance to musicians. Its aim is to teach its students to become aware of posture and movement patterns that can interfere with the working of the body in everyday living. The AT is regarded not as a treatment for any particular problem, but as a method by which students learn how to recognize typical posture and movement patterns and to change them if they are not beneficial. Lessons are often given on a one-to-one basis. Teachers provide gentle, physical manipulation to give students a sensory experience with which to guide them toward a new way of moving. This hands-on work is also accompanied by verbal directions so that they become associated with the sensations given by the teacher (Barlow, 1990; Maisel, 1990). The Technique is built upon several principles: primary control, inhibition, direction, habit, and faulty sensory awareness. *Primary control* is defined as a relationship between the head, neck, and trunk (Alexander, 1946; Conable & Conable, 1995) and is essential in determining the quality of movement, or how well the body functions (Jain et al., 2004). By altering the primary control, one can alter the quality of resulting movements and posture during a task. *Inhibition* emphasizes the importance of stopping and thinking before acting. It is defined as “refusing to do anything immediately in response” to a stimulus (Alexander, 2001, p. 40). *Direction* is the set of instructions to help re-organize the body in preparation for movement or rest. *Habit* is one’s typical response to a stimulus (Jones, 1997). *Faulty sensory awareness* is the idea that one’s perception of oneself may not be accurate. All these work together to provide the student of the AT with information about their use and provides them with a way to change their use.

In AT terminology, *use* is “posture as it changes over time” (Jones, 1997, p. 212). While proponents of the AT would argue that this is a limited view of the Technique, for the purpose of this dissertation, only this definition of use will be utilized. People can demonstrate good use or misuse during rest and activity. *Good use* is adaptive postural behaviour that is suitable for the task (Batson, 2008) while *misuse* is the opposite and involves a distortion of the body (Barlow, 2005). This dissertation will address changes in head-neck-trunk posture as observed in the sagittal plane following lessons in the AT.

Chapter 2: Literature Review

Literature Review

The Alexander Technique (AT) has been researched in many fields due to its capability of being applied in many different circumstances. According to one study (Eldred et al., 2015), people begin lessons in the AT for various reasons. The purpose of their research was to describe teachers of the AT and the people who took lessons. A cross-sectional survey was sent out to three AT teachers' professional associations in the UK asking teachers about their background, teaching practice, and the people who took their lessons. A total of 534 teachers of the AT responded to the questionnaire. Findings of this study revealed that 74% of teachers were female and the majority of all teachers were self-employed. Many teachers taught out of their own premises or in a rented room, teaching both private one-on-one lessons and group lessons. People who took AT lessons were largely female and paid for lessons privately. Sixty-two percent began lessons in the AT to cope with musculoskeletal disorders including posture, back issues, neck pain, and shoulder pain. Some began lessons for the sake of general well-being and for releasing excessive tension. Others took lessons in the AT to help with voice-related, music-related, and sport-related issues, and others sought the AT for psychological and neurological help. What is of relevance to this dissertation are the reasons why people pursued the Technique. People seem to think that the Technique can help them manage pain and improve performance, but is there evidence for this?

Woodman and Moore (2012) conducted a systematic review to examine available studies concerning the effects of the AT on medical and health-related conditions. Their findings revealed strong evidence for the effectiveness of the AT in managing back pain and moderate evidence for the management of disability in people with Parkinson's. However, there is little evidence concerning the effectiveness of the AT in improving balance, posture, and respiratory function. Further research is warranted in these areas to provide an evidence base for the effectiveness of the AT.

This literature review, while not an exhaustive review of all research conducted on the Technique, will summarise the available research concerning areas in which the AT is commonly researched including the effects of the AT on pain, posture and movement, Parkinson's disease, balance in older adults, and other health and wellness issues. The review will also discuss studies that have specifically examined participants' experiences with the AT. The review will then summarise available research concerning the AT and musicians, followed by those concerning the AT and pianists.

Alexander Technique and Pain

Several studies have been conducted concerning the impact the AT can have on neck pain. In MacPherson and colleagues' (2015) study, the effectiveness of the AT or acupuncture in comparison to usual care on chronic neck pain was examined. A total of 517 participants with chronic neck pain were involved in the study. All were randomly assigned to either the AT group, the acupuncture group, or the usual care group. The AT group received 20 private (i.e., one-on-one), 30-minute lessons for a total of 600 minutes of intervention while the acupuncture group received 12 acupuncture sessions for a total of 600 minutes of treatment. All interventions were completed within 5 months. The Northwick Park Questionnaire was administered prior to the beginning of the interventions as well as at 3, 6, and 12 months. Participants also rated their pain intensity on a scale of 0 to 8 through text messages sent every second week for the first 6 months followed by once a month until the twelfth month. In addition, participants rated their self-efficacy (i.e., "the extent of the participants' confidence in their ability to reduce their pain using methods other than medication" (Wenham et al., 2018)) using the Chronic Pain Self-Efficacy Scale. Results revealed that both AT lessons and acupuncture sessions helped reduce neck pain and increased self-efficacy in comparison with usual care.

To follow up on MacPherson and colleagues' (2015) study and to gain greater insight into how the AT and acupuncture had an effect on participants, a qualitative study was conducted by Wenham and colleagues (2018). The purpose of this study was to investigate participants' experience with their respective interventions as detailed in the previous paragraph. In-depth interviews were conducted twice after the intervention had concluded with 10 participants from the AT group and 10 participants from the acupuncture group at the first interview and eight participants from the AT group and 10 from the acupuncture group at the second interview. The first interview was conducted at the end of the intervention while the second interview was conducted 6 months after the end of the intervention to examine the long-term effects of both the AT and acupuncture. Results of this study showed that participants in both groups felt that their respective interventions had a positive impact on self-care (i.e., participants' ability to care for themselves) and self-efficacy.

Woodman and colleagues (2018) also offered further insight into MacPherson and colleagues' (2015) study and explored the change in self-efficacy and self-care in those who participated in AT lessons and compared it to those who received usual care. Data about pain and self-efficacy were obtained through the Northwick Park Questionnaire as well as the Chronic Pain Self-Efficacy Scale. The Perceived Stress Scale was also administered to determine how participants felt about different aspects of their lives. These were completed at baseline, after the end of the intervention period, as well as 6 months after the end of the intervention. Findings of this study demonstrated that participants in the AT group reported greater improvements in comparison with the usual care group in most self-efficacy and self-care measures. The authors concluded that the AT could have long-term impacts on neck pain management because the AT appears to be able to foster self-efficacy and self-care.

Lauche and colleagues (2016) investigated the efficacy of the AT on pain and quality of life in people with chronic neck pain. A total of 72 participants with chronic neck pain were randomly assigned to the AT group, a local heat application treatment group, or guided imagery group, but only 64 participants completed the study. All interventions involved 45-minute sessions, once a week for 5 weeks. Neck pain intensity, measured on a 100-mm visual analogue scale, was measured daily to calculate a weekly average across the 5 weeks of intervention. Pain during neck motion was also measured using a 100-mm visual analogue scale. Neck-related disability was measured using the Neck Disability Index and quality of life was assessed with the Short-Form 36 Health Survey Questionnaire. Following the interventions, participants were asked to rate how much they felt they had benefitted from their sessions on a 100-mm visual analogue scale. Results of this study showed no difference in pain intensity between the AT group and the local heat group but demonstrated a significant difference between the AT group and the guided imagery group. No significant differences were found between groups for neck disability and pain during motion, but findings showed that the AT treatment was more favourable for improving quality of life than both local heat application and guided imagery.

The purpose of Becker and colleagues' (2018) study was to determine if AT classes were a feasible option for people with neck pain and to examine the effects of the AT on self-efficacy, neck muscle activity, and posture. Ten participants with neck pain completed two baseline measurements before receiving ten group classes in the AT. Each class was one hour in length and classes were held over a period of 5 weeks. Following the intervention period, participants completed a post-test as well as a follow-up test 5 weeks after the end of lessons to determine if benefits gained from lessons were retained. At each measurement session, participants completed the Northwick Park Questionnaire and the Pain Self-Efficacy Questionnaire. Electromyography was used to measure neck flexor activity and fatigue during a cranio-cervical flexion test. Postural alignment was assessed by placing reflective markers on the tragus, C7, and the manubrium. Photographs were taken while participants played a video game. The results showed no significant differences between baseline measurements. Following the intervention, post-test findings demonstrated significantly reduced neck pain, less fatigue, and slightly more upright postural alignment. Follow-up results demonstrated a retention of these changes. The authors concluded that group AT classes was a feasible approach to reducing neck pain as it can reduce excessive muscular tension in the neck.

In another study conducted by Becker and colleagues (2021), a comparison was made between the AT and targeted exercise for reducing neck pain and for reducing superficial neck flexor activity. A total of 16 participants with neck pain were assigned to either the AT group or the exercise group. Each group received 10 lessons in their respective interventions. All participants completed a baseline measurement, a post-test, and a follow-up test 6 weeks after the post-test. At each measurement session, participants completed the Northwick Park Questionnaire and Pain Self-Efficacy Questionnaire. At the follow-up, participants were given an additional survey concerning their experience with their intervention and how it impacted their life. In addition to these self-report measures, electromyography was used to measure sternocleidomastoid activity during a cranio-cervical flexion test. The following postural angles were also measured while participants played a video game: head-torso angle, as defined by the tragus, C7, and manubrium; neck angle, as defined by the tragus, C7, and horizonal plane; and head angle, as defined by the orbit, tragus, and horizonal plane. Photographs of these angles were taken during the video game task. The results of this study showed that both groups demonstrated a decrease in neck pain following their respective interventions. However, only the AT group showed a decrease in sternocleidomastoid activity. For measures of posture, head-torso angle was smaller at the follow-up for both groups. Neck angle in the AT group was larger at the follow-up in comparison with the baseline measurement. Head angle was larger at the follow-up in comparison with the baseline for both groups. The authors concluded that both AT and exercise were effective in reducing neck pain.

In addition to neck pain, studies have been conducted concerning the effects of the AT on back pain. In Cacciatore and colleagues' (2005) case study, the authors reported on the effects of AT lessons on a person with low back pain. The single participant received 20 AT lessons over the course of 6 months. Each lesson lasted approximately 45 minutes. Outcome measures included postural coordination, measured by examining the participant's response to surface translations on a force platform, one-legged balance, and lateral curvature in the trunk; and pain, measured using a visual analogue scale. Four baseline measurements were taken prior to the beginning of the intervention, each one a month apart. Measurements were also taken following the end of lessons for a total of three post-intervention measurements, each one a month apart. The findings of this study showed that prior to lessons in the AT, the participant demonstrated asymmetric postural responses to surface translations. The participant also exhibited lateral spine curvature in the lumbar spine. Following lessons in the AT, the participant demonstrated less asymmetrical responses to surface translations as well as improved balance during one-legged balance tests. Lateral spine curvature decreased, and the participant reported feeling less low back pain.

Little and colleagues (2008) examined the effects of the AT, massage therapy, exercise, and normal care on chronic back pain. A total of 579 participants were randomly assigned to a normal care group, massage therapy group, six private AT lessons, or 24 private AT lessons. Half of the participants in each group were also assigned exercise prescription. Outcome measures included disability, measured using the Roland Morris Disability Questionnaire; number of days in pain; quality of life, measured using the Short-Form 36 Survey; pain and disability measured using scales designed by Von Korff and colleagues (1992) and Deyo and colleagues (1997). The researchers also designed questions for participants to answer using 7-point scales concerning their back health. The results of this study showed that at 3 months, all interventions had affected change in disability as measured by the Roland Morris scale and number of days in pain. At 1 year, the AT was more effective than it was at 3 months at decreasing disability and days in pain. The effect of six lessons was also maintained at 1 year. In addition to having an influence on the Roland Morris Disability score and days in pain, 24 lessons in the AT had an effect on other outcomes as well. Six lessons in the AT had similar, but smaller changes. The combined effect of exercise and 24 AT lessons was similar to what 24 AT lessons achieved on its own. Exercise combined with six AT lessons achieved results that were almost as good as 24 AT lessons alone. The authors concluded that lessons in the AT could have long-term benefits for people with chronic back pain.

As a part of Little and colleagues' (2008) study, Yardley and colleagues (2010) conducted additional research that described participants' expectations and experiences of the AT and exercise prescription. A total of 183 people were assigned to the AT group and 176 people were assigned to exercise prescription. A questionnaire asking participants about their attitudes toward their intervention was given prior to the beginning of the intervention period and again at the 3-month follow-up. In addition, semi-structured interviews were conducted with 30 people at baseline and with 15 people at the 3-month follow-up. Findings showed that both groups initially had positive attitudes toward their respective interventions, but only those who received lessons in the AT became more positive at the follow-up. Those who had participated in AT lessons felt that they had learned how to better manage back pain and felt that the Technique could be applied in everyday situations. The authors concluded that the AT was effective in managing back pain and that the acceptability of the AT was superior to exercise prescription due to the social support received from AT teachers as well as the applicability of the Technique to everyday life.

Beattie and colleagues (2010) performed a study that described professionals' perspectives of the impact of the interventions given to people with chronic back pain in Little and colleagues' (2008) study. In-depth interviews were conducted with 20 professionals including general practitioners, nurses, AT teachers, and massage therapists. The results of this study showed that general practitioners felt there was a need for scientific evidence to assess the effectiveness of these interventions as the lack of evidence "led to uncertainty and scepticism about the value of these interventions for chronic back pain" (p. 121). Nurses, AT teachers, and massage therapists felt that patient reports were a form of evidence and could help in determining the effectiveness of the interventions. They also felt that quantitative research was limited in its ability to assess the benefits that these interventions could bring to people with chronic back pain. However, both general practitioners and nurses felt that exercise combined with lessons in the AT were more effective than massage in reducing back pain.

Another study (Little et al., 2014) examined the effects of the AT and physiotherapy exercises on back pain. A total of 83 participants with recurrent back pain were randomly assigned to one of four groups: normal care (control group), physiotherapy exercise classes, AT lessons, or AT lessons in addition to exercise classes. Participants in the AT groups received ten 30–40-minute private lessons. Participants in the exercise classes received 1-hour classes for 12 weeks. The main outcomes were those measured by the Roland Morris Disability Questionnaire. Other outcomes included number of days in pain, pain and disability scale as outline by Von Korff and colleagues (1992), and overall improvement in back health. In addition, muscle tone and activity were measured using a trunk rotation device and electromyography respectively. Questionnaires were answered and measurements were made at baseline, 3 months, and 6 months. Results showed that while most outcomes did not reach statistical significance, there were clinically important findings. Participants in all intervention groups showed some improvement, although participants who received both AT lessons and exercise classes demonstrated clearer improvements. The researchers also correlated participants' Roland Morris Disability score with their muscle tone and activity and found that both interventions were able to affect change in muscle activity which may have accounted for the improved scores seen in the questionnaire. The authors concluded that both interventions, especially if combined, could have benefits for people with back pain.

In McClean and colleagues' (2015) paper, the impact of the AT on back pain was investigated. Forty-three participants were involved in the study, all of whom received six weekly private AT lessons. All participants completed three questionnaires (Brief Pain Inventory, Measure Your Medical Outcome Profile, and Client Service Resource Inventory). These questionnaires were completed at baseline, at the end of AT lessons, and 3 months after the baseline measurement. Interviews were conducted with 27 of these participants. Findings revealed that those who took AT lessons felt that there were improvements in their health, including pain reduction and pain management. The authors concluded that the AT appeared to be a viable method for pain management and could improve self-efficacy, but participants had to be motivated enough in order for those changes to occur.

Hafezi and colleagues' (2022) study examined the effects of the AT on pain intensity in people with chronic low back pain. Eighty participants with back pain were randomly assigned to the control group or the AT group. A visual analogue scale of pain was used to assess participants' pain intensity before, immediately after, and 1 month after the intervention. Results revealed that in comparison with the control group, the AT group demonstrated a statistically significant decrease in pain, both immediately after the intervention and at the follow-up 1 month later. The authors concluded that the AT is an effective method in reducing pain intensity.

A study by Little and colleagues (2022) developed, implemented, and looked at the effects of an AT course that included both private and group lessons. Participants included 39 people with chronic low back pain and 32 AT teachers. Participants with low back pain were given a 10-lesson AT course consisting of six group lessons and four private lessons. Semi-structured interviews were conducted with both AT teachers and those who took AT lessons to explore participant perceptions. The Roland Morris Disability Questionnaire was also used to measure disability because of back pain at baseline and at 3 months. Results of this study showed that most participants enjoyed group lessons although some preferred only private lessons. AT teachers also expressed some concern over group lessons, but most felt they were an acceptable means of teaching students. At 3 months, most participants demonstrated a decrease in their Roland Morris Disability score, indicating an improvement in back pain management.

In summary, the AT can improve neck pain, although acupuncture and exercise appeared to be able to achieve similar results. The AT can also reduce muscular tension in the neck which can potentially lead to reductions in neck pain. The AT alone as well as AT combined with exercise can also improve back pain with long-lasting results and appears to be more effective than massage in doing so. The AT can also improve self-care and self-efficacy in those with neck pain and back pain, although acupuncture was shown to be capable of improving these two factors as well.

Alexander Technique and Posture and Movement

The AT has also been shown to alter posture and movement patterns. The purpose of one study (Cacciatore, Gurfinkel, Horak, & Day, 2011) was to characterise postural coordination in AT practitioners during a sit-to-stand task. Fifteen certified AT teachers participated as well as 14 healthy age-, height-, and weight-matched adults that served as the control group. Participants were asked to stand from a chair “as smoothly as possible without using momentum” (p. 497). Markers were placed along the spine as well as near the eye and on the ear to collect data from which to calculate spinal angles. Weight shift during the task was measured using a force plate underneath participants’ feet. Outcome measures included movement phases, weight shift, and spinal angles. Results revealed that AT teachers spent a significantly longer amount of time transferring weight onto the feet prior to standing up in comparison with the controls and showed a more gradual and continuous transfer of weight onto the feet in AT teachers than the control group. The control group appeared to apply force suddenly through their feet, indicating a heavier reliance on momentum to stand up in comparison with the AT group. AT teachers also demonstrated less spinal movement than the control group during sit-to-stand. The authors concluded that AT practitioners exhibit a different pattern of movement coordination than healthy adults.

In a follow-up study, Cacciatore and colleagues (2014) examined the possibility that healthy adults untrained in the AT have difficulty rising smoothly from a chair in comparison with AT-trained adults. This study was conducted to exclude the possibility that differences found in the previous study were due to unclear directions and self-selected standing speed. A total of 20 participants were involved in this study. Ten of these participants were AT teachers and the other 10 were healthy untrained adults. Participants were asked to sit on a stool fitted with a force plate with their feet on the floor, each foot resting on a force plate. They were asked to complete the sit-to-stand task at four different speeds: 1 second, 2 seconds, 4 seconds, and 8 seconds. Variables measured included weight shift, centre of mass velocity, and bipedal balance. Findings from this study showed that all participants were able to stand at the instructed speeds. However, there were differences in results between the AT teachers and healthy adults. AT teachers demonstrated a smoother weight shift than the untrained adults and relied less on centre of mass momentum to stand up, resulting in more stable balance. This was apparent in the conditions requiring slower rise times. These findings led the authors to conclude that "[poor] postural regulation has the capacity to affect movement profoundly" (p. 727).

In another study conducted by Cacciatore and colleagues (2011), differences in postural tone between AT teachers and healthy untrained adults were examined. Additionally, a 10-week AT training program was given to people with low back pain to determine if the AT could alter postural tone in this population. Fourteen certified teachers of the AT formed the AT group, 15 healthy adults formed the control group, and eight participants with low back pain formed the back pain group. Only the back pain group received training in the AT. During test sessions, participants were asked to stand on a rotating platform while trunk, hip, and neck torque were measured. Only trunk and hip torque were measured in the back pain group. Results revealed that AT teachers demonstrated less axial stiffness in comparison with the control group. Low back pain participants exhibited a decrease in both trunk and hip stiffness following lessons in the AT.

Ketcham and colleagues (2017) examined the effects of the AT on postural control in older adults. They measured the centre of mass velocities of six certified AT teachers as well as healthy age-matched adults. In addition, the centre of mass velocities were also measured in five younger adults. All participants completed a set of four tasks: standing with eyes open on a stable surface, standing with eyes closed on a stable surface, standing with eyes open on an unstable surface, and standing with eyes closed on an unstable surface. Results revealed that the AT group exhibited slower postural sway than the healthy age-matched adults when standing with eyes closed on both stable and unstable surfaces. Additionally, postural sway was similar across all tasks between AT teachers and younger adults. The authors concluded that the AT could lessen the effects of aging on postural control.

Reddy and colleagues' (2011) study evaluated the efficacy of the AT in altering posture and surgical ergonomics. A total of seven participants who were completing surgical training at the local university and hospital were given two group AT lessons and six private AT lessons. Participants were also required to practice a specific AT exercise 15- to 20-minutes a day and were assigned readings to complete on the weekends. Prior to the intervention period, participants completed basic postural coordination and laparoscopic skill assessments. Participants also completed self-reports concerning their own posture. Following the intervention period, the same assessments were completed again. Results demonstrated improved coordination and ergonomics. In their self-assessments, participants felt their posture had improved following AT lessons.

Kutschke's (2010) thesis examined the effects of the AT on neck and shoulder biomechanics and posture. A total of 20 healthy participants were divided into experimental and control groups. Those in the experimental group received 20 AT lessons over the course of 8 weeks. Both experimental and control groups were measured before and after the AT intervention. EMG measured muscular activity of the cervical erector spinae, upper trapezius, infraspinatus, and serratus anterior. Reflective markers were placed on various parts of the head, spine, sternum, upper extremities, and hips to assess postural alignment. Range of motion data were also collected using a work simulator. Measurements were taken during static sitting and during a computer typing task. Findings of this study revealed a decrease in upper thoracic kyphosis in the AT group as well as increased shoulder range of motion. Kutschke reasoned that since posture is a risk factor for musculoskeletal disorders, the AT may be able to serve as a rehabilitative and preventative measure for neck and shoulder conditions as the AT appears to be able to alter posture.

Another area in which the AT appears to have an effect is gait. O'Neill and colleagues (2015) studied the effect of the "temporospatial characteristics and [centre of mass] displacement of gait during over-ground walking in older adults" (p. 475). Six certified AT teachers and 7 age-matched controls participated in this study. Variables measured in this study included stride width, stride length, velocity, percentage of gait cycle spent in single and double limb support, centre of pressure displacement, and centre of mass displacement (p. 475). These were measured using a walkway embedded with pressure sensors. Results showed that AT teachers demonstrated less centre of mass displacement during faster walking speeds than the control group. The AT group also exhibited smaller stride width and less variability during the gait cycle in comparison with the control group. The authors concluded that these changes are the result of AT training. These differences may also point to better balance in those with AT training which has implications for fall reductions in older adults.

Hamel and colleagues (2016) investigated the effects of AT training on gait kinematics. Six AT teachers participated along with 7 age-matched controls. Participants were asked to walk in a specified area while motion capture recorded head, trunk, hip, knee, and ankle kinematics. Results showed that, in comparison with the control group, during the stance phase of gait, the AT group demonstrated larger range of motion in the ankle and larger plantar flexion while simultaneously demonstrating smaller range of motion in the trunk and head. During the swing phase of gait, the AT group exhibited larger hip and knee flexion as well as larger dorsiflexion than the control group. The authors concluded that older AT teachers walk with different gait kinematics than age-matched adults and that AT teachers' gait more closely resembled those of younger adults. The findings of this study point to benefits that AT training can bring to its students.

In summary, practitioners of the AT exhibit different posture and movement patterns than untrained adults. The studies reviewed in this section also suggest that the AT may be able to alter posture.

Alexander Technique and Parkinson's Disease

Several studies have been conducted concerning the effects of the AT on people with Parkinson's disease. Stallibrass (1997) examined the effects of the AT in the management of disability and depression in people with Parkinson's. A total of seven people with Parkinson's participated in this study. All received a median of 12 AT lessons. The following questionnaires were given to participants prior to and following the intervention: the Activities in Daily Living Scale, in which participants rated how easily it was for them to perform daily activities; the Body Concept Scale, in which participants rated their attitudes toward their bodies; the Functional Disability Scale, in which participants rated how much Parkinson's had affected their engagement and performance in social activities; and the Beck Depression Inventory, in which participants rated how they felt. Results showed that participants were significantly less depressed following lessons in the AT and demonstrated improvements in managing associated disabilities. However, Stallibrass stated that due to a lack of control group and a small sample size, it was not possible to fully attribute the positive findings to the AT.

Stallibrass and Chalmers (2002) conducted a randomised controlled trial to determine if the AT, along with normal care, would benefit people with Parkinson's. A total of 93 people with Parkinson's participated in this study. All were randomly assigned to one of three groups: AT group, massage therapy group, and control group. The AT group received 24 lessons in the AT while the massage therapy group received 24 sessions of massage. Prior to the intervention period, a pre-test was conducted. Each participant was given the Self-Assessment Parkinson's Disease Disability Scale, the Beck Depression Inventory, and an Attitudes to Self Scale. The same tests were administered following the intervention period to all participants and again at a follow-up test 6 months later. Results showed that in comparison with the control group, the AT group demonstrated improvements in disability at the post-test. These results were maintained at the 6-month follow-up. The AT group was also less depressed following lessons in the AT and at 6 months had improved on the Attitudes to Self Scale. In comparison with the massage therapy group, both the AT and massage groups demonstrated similar improvements in depression at post-test and follow-up. On the Attitudes to Self Scale, however, massage showed no difference between pre-test and post-test, and demonstrated a worsening at the follow-up test. The authors concluded that the AT could provide lasting benefits for people with Parkinson's.

To assess the retention of skills learned from the AT, Stallibrass and colleagues (2005) administered questionnaires to 28 people with Parkinson's disease 6 months after they had participated in AT lessons. Their findings showed that 27 out of 28 participants continued to apply the AT in their daily lives, specifically during walking, sitting, and standing. Some also applied the AT while lying down and others also mentioned applying the AT in non-physical situations. The authors concluded that participants had retained what they had learned from the AT although to different degrees. They also stated that questionnaire responses demonstrated a wide range of application.

Cohen and colleagues (2015) investigated whether instructions based on AT principles would alter posture in people with Parkinson's. A total of 20 participants with Parkinson's applied two different sets of instructions. One set of instruction, termed "Lighten Up," was based on principles of the AT to "[reduce] excessive muscular activity" (p. 879) while the other set, termed "Pull Up," was "based on the idea of increasing effortful trunk stabilization" (p. 879). Another set of instructions, termed "Relax," was used as a control condition. Outcome measures included postural tone (or trunk stiffness), measured using a rotating platform; postural sway, measured using an inertial sensor; postural alignment, assessed by measuring the horizontal and vertical distances between markers placed in front of the ear and on the acromion process; and centre of pressure during step initiation, measured using force plates. Findings revealed that both the "Lighten Up" and "Pull Up" instructions led to more upright postural alignment in relation to the control condition. However, only the "Lighten Up" instructions reduced trunk stiffness, postural sway, and smoother centre of pressure trajectory. The authors concluded that the AT may be an appropriate method for improving balance and mobility in people with Parkinson's.

In Gross and colleagues' (2019) study, the researchers examined the ability of group AT lessons to improve posture and mobility in people with Parkinson's disease. Twenty-five people with Parkinson's disease participated in this study. Fifteen were allocated to the AT group while 10 were allocated to the control group. Outcome measures included balance as measured by the Brief BESTest, mobility as measured by a 7-point Physical Performance Test, and posture, specifically the neck angle. Findings revealed improvements in balance, mobility, and posture in the AT group in comparison with the control group, leading the authors to conclude that the AT is a viable method to improve motor performance and posture in people with Parkinson's.

In a follow-up study, Gross and colleagues (2020) examined the retention of benefits gained by people with Parkinson's after having taken AT lessons. Of the 25 participants in the previous study (Gross et al., 2019), 18 of those participants returned for a follow-up test session held 3 to 6 months following the intervention. Thirteen of those participants were a part of the AT group and five were a part of the control group. Outcome measures again included balance, mobility, and posture. Results showed that the AT group demonstrated an improvement in posture in comparison with their pre-AT lesson results while the control group showed no improvements. Balance in the AT group also showed no decline at the follow-up.

In summary, studies have shown that the AT can improve depression in people with Parkinson's disease. The AT can also improve balance, mobility, and posture in this population.

Alexander Technique and Balance in Older Adults

Another area in which the AT has often been researched is balance in older adults. Dennis' (1999) study examined if the AT was able to affect balance as measured by functional reach (i.e., "the maximal distance one can reach forward beyond arm's length while maintaining a fixed base of support in the standing position" (p. M8)). Eighteen women who were older than 65 years of age were divided into three groups: a pilot study group, an experimental group, and a control group. Both the pilot and experimental groups received eight 1-hour lessons in the AT. All groups completed a pre-test and post-test following the intervention period. The experimental group also returned for a follow-up test. All participants completed functional reach tests to assess balance. The pilot and experimental groups completed a questionnaire following the end of AT lessons to rate "their perceived improvement in…balance…leg strength…posture…overall ease of movement…general body awareness…self-confidence in movement…enjoyment of classes, and…extent of learning in classes" (p. M9). Results showed that participants in both pilot and experimental groups demonstrated improvements in functional reach performance, indicating improved balance following AT lessons. Questionnaire responses indicated that participants felt improvements had been made in balance, leg strength, posture, ease of movement, body awareness, and self-confidence. Most participants also enjoyed classes, and all felt they learned something from the AT.

The purpose of Batson and Barker's (2008) study was to investigate the feasibility of group AT lessons for improving balance in older adults. A total of 19 people with a mean age of 79 years and with a fall history participated. At the pre-test, participants completed the Timed

"Up and Go" test and the Fullerton Advanced Balance Scale, both of which were used to assess balance. Participants also submitted self-reports using the Modified Fall Efficacy Scale to assess balance confidence. All participants received 10 group AT lessons over the course of two weeks from certified AT teachers. Within a day of completing the intervention, all participants completed the post-test. Findings revealed improved balance in participants following AT lessons, although there was no significant difference in balance confidence.

Gleeson and colleagues (2015) examined the effect of AT lessons on balance and mobility in older adults with visual impairments. A total of 120 participants who were 50+ years old with visual impairments were randomly assigned to experimental or control groups. The experimental group received usual care and weekly AT lessons for 12 weeks while the control group received only usual care. Prior to the intervention period, all participants completed the Short Physical Performance Battery to assess balance. This series of timed tests included sit-to-stand, walking, and standing balance tests. Participants also completed the Short Falls Efficacy Scale to gather data about participants' concerns about falling. Postural sway and number of falls were also recorded. Participants completed the same tests at a post-test immediately following the intervention period and at a follow-up 12 months after the start of the study. Results showed that the AT group demonstrated reduced postural sway and improvements in the walking category in the Short Physical Performance Battery, indicating an improvement in balance. Additionally, participants in the AT group exhibited fewer falls and improved mobility following lessons in the AT.

The effect of the AT on psychological and physical benefits for care partners was examined in Cohen and colleagues' (2018) study. Fifteen women over the age of 60 participated in this study. Prior to the intervention, the following variables were measured: posture, balance, caring burden, and self-efficacy. The intervention consisted of weekly 90-minute group AT lessons held over a course of 10 weeks. Participants completed a post-test and two follow-up tests at 3 months and 6 months after the end of AT lessons. The same variables were measured at these tests and participant perception of the AT was also collected following the intervention. Findings of this study revealed improvements in balance as well as slightly more upright posture. Although statistically non-significant, perceived care burden was reduced while self-efficacy increased. Participants reported enjoying the classes and felt that they learned self-care strategies. The authors concluded that group AT classes are a feasible option for improving balance.

In a previous study by Cohen and colleagues (2015), specific postural instructions were given to people with Parkinson's disease to evaluate changes in posture. In this study, Cohen and colleagues (2020) examined the effect of the same instructions in healthy older adults to determine if instructions based on principles of the AT could alter balance in this population. Nineteen participants over the age of 60 were asked to stand with their eyes open on a foam surface as well as to raise a foot for 3 seconds. They were to repeat these tasks in three different conditions: while performing "Light" instructions, which were based on principles of reducing "excessive muscle activation while maintaining spinal length and sense of connection throughout the body" (p. 2); while performing "Effortful" instructions, which were based on "prevalent public conceptions of 'good posture' as something requiring effort" (p. 2); and while performing "Relax" instructions, which was "based on the widespread idea that maintaining upright posture is inherently fatiguing" (p. 5). Outcome measures included postural sway, kinematics, and muscle activity. Results demonstrated that "Effortful" instructions induced increased postural sway in the standing task. During the foot lifting task, "Light" instructions elicited longer "foot-in-air duration" (p. 1) and less postural sway. The "Relax" instructions led to a more forward head position relative to the neck while the "Effortful" instructions led to increased torso muscle activity in the foot lifting task. The authors concluded that changing the way one thinks about posture through methods like the AT may improve balance.

The aim of Glover and colleagues' (2018) research was to explore changes that occurred following group AT classes and the acceptability of those classes for older adults who had a fear of falling. Twelve participants that were 65+ years old received 12 group AT lessons. Before receiving the intervention, all participants completed a baseline measurement which assessed fear of falling, as measured by using the Falls Efficacy Scale; depression, as measured by the Short-Form Geriatric Depression Scale; health status, as measured by the 12-item Short Form Health Survey; and balance, as measured by the Short-Form Berg Balance Scale. Immediately following the intervention and one month after the intervention, participants completed a post-test and a follow-up test which consisted of the same measurements. In addition to these quantitative tests, seven participants took part in a focus group after the end of lessons to talk about perceived changes following the intervention and their experience with the AT. Findings revealed inconclusive results concerning fear of falling, depression, health status, and balance. However, the focus group results yielded some insights into the effect participants felt the AT had on them. Participants found the AT an enjoyable experience and felt that they could apply what they learned to everyday situations. Participants also felt that there were physical improvements, such as ease of movement when walking, sitting, or lying down.

Tunnicliffe's (2021) dissertation examined the effect of the AT on balance and movement in people who were 60 years old and over. A total of 29 adults participated in this study and all received eight lessons in the AT. Prior to the intervention, all participants completed two baseline measurements. At each measurement, they completed the Short Falls Efficacy Scale, in which participants rated themselves on how concerned they were about falling during certain tasks, and the Balance Confidence Assessment, in which participants were rated on how well they completed tasks. The same measurements were taken immediately after the AT intervention as well as four weeks after AT lessons had ended. Focus groups and individual interviews were also held to explore participants' perceptions on how the AT affected them. Results from quantitative assessments revealed an increase in balance confidence, but no improvement in fear of falling. Qualitative results showed that participants were able to engage in more activities in their daily lives following lessons, which the author ascribed to increased balance confidence.

In summary, the AT can improve balance and balance confidence in older adults. The AT can also improve ease of movement in this population. Participants in these studies found lessons enjoyable and felt they learned self-care strategies and could apply what they learned to everyday situations.

Alexander Technique and Other Health and Wellness Issues

Besides research in pain, posture, Parkinson's, and balance, research has also been conducted in other areas. In Austin and Ausubel's (1992) study, the effect of the AT on respiratory function was investigated. Twenty participants were evenly divided into an experimental group and a control group. The control group matched the experimental group in demographics such as age, gender, height, and weight. Prior to the intervention period, all participants completed spirometric tests to assess breathing. The experimental group then received 20 AT lessons, following which the same spirometric tests were conducted again. Results revealed significant increases in breathing measures in the experimental group, but no significant changes in the control group. The authors concluded that because the AT may alter muscular activity in the torso, this may in turn affect breathing and enhance respiratory function.

Preece and colleagues (2016) conducted a study to examine the effectiveness of the AT in managing knee osteoarthritis. A total of 41 participants were involved in the study. Twenty-one participants had knee pain and received 20 lessons in the AT. The other 20 were age-matched, healthy adults serving as a control group. Prior to the intervention, participants with knee pain completed a pre-test in which they rated their knee pain, stiffness, and function. In addition to this self-report, participants' knee muscular activity was measured using electromyography and pain processing was observed using electroencephalography during a walking task. The control group also had their muscular activity measured. Following the AT lessons, participants with knee pain returned to complete a post-test and a follow-up at 15 months consisting of the same tests. Results showed that pain was reduced immediately following lessons and was maintained at the follow-up, although no changes in brain activity were found. Muscular activity also demonstrated similarities with the healthy control group.

Gleeson and colleagues (2017) conducted a randomised controlled trial to examine the effect of the AT on well-being in people with visual impairments. A total of 120 people between the ages of 50 and 90 with visual impairments participated in this study. Participants were randomly allocated to the AT group or the control group. The AT group received 12 AT lessons and usual care over the course of 12 weeks while the control group received only usual care. Prior to the beginning of the intervention period, several measurement tests were administered to all participants to establish a baseline: the Perceived Visual Ability Scale, the Keele Assessment of Participation, the emotional section of the Impact of Vision Impairment Profile, the Positive and Negative Affect Scale, and the Geriatric Depression Scale. The same tests were given to participants immediately following the intervention at 3 months and again at 12 months, one year after the beginning of the study. Results revealed that there were no statistically significant differences between baseline, 3 months, and 12 months although participants in the AT group showed a trend towards less emotional distress due to visual impairment.

In Armitage's (2009) dissertation, the psychological impact of the AT on its students was examined. Semi-structured interviews were conducted with ten participants who had studied the Technique prior to the beginning of Armitage's study. Questions asked during the interview were designed to help participants speak on why they sought the AT, their experience with the Technique, and how the AT had affected their lives. Results showed that participants cited "pain reduction, improving singing performance, improving posture, reducing stress and tension, and personal growth" (p. 61) as reasons for seeking out the AT. Participants also felt that the AT had influenced psychological changes in themselves including "increased self-awareness, calm, confidence, balance, presence, and ability to detach from problems" (p. 55).

Kinsey and colleagues (2021) conducted a systematic review to examine the effect of the AT on psychological and non-physical outcomes. They found that the AT was able to improve general well-being and increase confidence in those who participated in AT lessons. They concluded that the AT was able to bring about positive changes because it appeared that the AT could improve physical well-being which led to psychological well-being and that the mind-body integration taught in the AT was able to help people apply its principles in non-physical circumstances.

In summary, the AT may be able to affect respiration and improve knee pain. The AT may also be able to bring about positive psychological improvements in general and improve emotional distress in people with visual impairments.

Participant Experiences with the Alexander Technique

A number of the studies discussed previously asked participants about their experience with the AT. In the following studies, participant experience was the focus of each research paper. In Krim's (1993) thesis, five athletes who had taken lessons in the AT prior to the study were interviewed to gain insight into their experience with the AT. Findings revealed that all athletes had a positive experience with the Technique as they felt that the AT provided them with "increased kinesthetic awareness, greater ease of movement, reduced stress, and more of a sense of being present, in the moment" (p. 160).

In Gibbs and Young's (2008) paper, the purpose was to determine if the AT would provide useful and practical applications to sonographers. AT training sessions were held for postgraduate ultrasound students with questionnaires given to participants at the end to gather their perspectives of the training session. Twelve participants completed the questionnaire and results showed that there was no negative feedback concerning the session. In addition, participants felt that the session was relevant to ultrasound practice and felt that they would be able to apply what they had learned to real-life situations.

Gibbs and Young (2011) conducted another study to determine if a workshop concerning how to reduce and prevent work-related musculoskeletal disorders could help sonography students develop approaches to prevent such issues from arising in the future. A total of 96 postgraduate sonography students participated in this study. A workshop was held to introduce sonographers to “a variety of techniques to help overcome the stress and damage of the body caused by repetitive movements” (p. 224). Techniques included ergonomics advice from a physiotherapist, lessons with AT teachers, and a talk from a Health and Safety representative. At the end of the workshop, evaluation forms were given to the participants to ascertain if they found the workshop useful. In addition to these forms, to determine the long-term benefits of these workshops, 23 phone interviews were conducted 6 weeks after the end of the workshop and 10 phone interviews were held 12 weeks after the end of the workshop. For the purposes of this dissertation, only feedback about the AT sessions will be reviewed. Results showed that almost all participants found the AT relevant to them as sonographers. Participants found that the AT brought increased awareness concerning their body positions while working and felt that they could apply what they learned to the workplace. Follow-up interviews at 6 weeks revealed that most participants experienced a decrease in work-related musculoskeletal symptoms although many found it difficult to constantly apply what they had learned while working. Follow-up interviews at 12 weeks showed that participants felt they would benefit from reinforcement of what they had learned at the workshop.

In summary, participants who receive lessons in the AT have a positive experience and feel that the Technique is able to improve movements, provide strategies to decrease musculoskeletal symptoms in the workplace, and provide approaches for experiencing less stress.

Alexander Technique and Musicians

As mentioned earlier in this dissertation, the AT is a popular somatic method among musicians for its perceived benefits. This section of the literature review will summarise available research concerning how the AT has been shown to affect musicians and their performance.

General Effects of the Alexander Technique on Musicians

In Lloyd’s (1987) thesis, the effect of the AT on singers was examined. Case studies were conducted with six singers. Each received 30 lessons in the AT. Before and after the intervention period, all participants were measured for their height, weight, chest girth, waist, and girth of ribs. All participants kept a diary of their experience with the AT. General observations concerning how the AT impacted each singer were also made. Results showed that some physical measures (i.e., height, weight, etc.) had changed and that tone and breathing had improved for some of the participants.

Bosch and Hinch (1999) conducted two case studies to examine the application of the AT to flute teaching and the effects it had on students. Two flute students participated in this study. One participant reported deteriorating tone, fatigue, low back pain, and found practising difficult. Problems observed by one of the authors included poor alignment of the body, neck tension, and diminishing breath capacity. Following lessons, the student exhibited better sound, changes in walking and sitting, and reported no back pain. In the second student, the participant reported feeling fatigued. Problems observed by one of the authors included poor alignment of the body as well as poor alignment in relation to the flute, tension in the embouchure, and a breathy tone. Following lessons in the AT, the student exhibited better sound, improved posture, and appeared to be less tense physically and psychologically.

The purpose of Kwon's (2012) dissertation was to provide insight into the benefits of applying the AT to cello performance through case studies. The author designed lesson plans for three cellists based on the principles of the AT and Body Mapping. All participants received five concurrent lessons. All participants demonstrated improvements in problem areas after the five lessons. In the first participant's case, the author described improvements in finger agility, better tone quality, and better tuning. The author also noted "greater poise and effortlessness" (p. 64) in this participant following lessons. In the second participant's case, the author described better consistency in the bow's position, more graceful bow arm movements, better tone quality, and overall "more efficient and comfortable" (p. 64) playing. In the third participant's case, there was a development of more fluid movement in the bow arm and less tension in his hands. Tone quality was also observed to have improved. The participant himself reported less discomfort in his shoulder following lessons.

Kvammen's (2013) thesis explored musicians' experiences with the AT. Interviews with six professional musicians were held including one horn player, one trumpet player, one cellist, one double bassist, one violinist, and one oboist. The interviews revealed that all participants felt that the AT had affected change in their professional careers. Prior to beginning their study of the AT, some participants reported experiencing pain, play-related injuries, stress, and discomfort while playing. Two participants sought the AT as a preventative measure to prevent problems from occurring farther along in their careers. Participants described performance-related improvements following lessons in the AT including “an increased sense of freedom while playing, and…[playing] with greater ease” (p. 55). Musical improvements included “a more stable sound, increased energy…more overtones, richer timbre, increased rhythmical precision and less effort” (p. 56). Participants also found that the AT provided them with a means with which to manage performance anxiety and also increased their level of awareness and attention while playing in ensembles.

In summary, the AT may be able to help musicians manage performance anxiety as well as improve sound quality and movements while playing. Specifically, the AT may be able to improve tone and breathing in singers, sound and posture in flautists, and tone and movements in cellists.

Alexander Technique and Anxiety

Valentine and colleagues (1995) conducted a study to determine the effects of the AT on music performance in high stress and low stress situations. A total of 25 music performance students participated. The musicians included six singers, five violinists, two cellists, three pianists, two organists, three flautists, one oboist, two clarinettists, and one trombonist. Four of these musicians left the study, so results were based on 21 participants. Participants were randomly assigned to a control group or to an experimental group which received 15 lessons in the AT. Two measurements were taken prior to the intervention period and two measurements were taken after. Prior to the intervention, all participants were measured during an audition and in their performance class. Following the intervention, all participants were measured during their final recital and in their performance class. In-class measurements were deemed low stress situations while the audition and final recitals were considered high stress situations. In each of these test sessions, the following outcomes were measured: height; peak expiratory flow; heart rate; mood, as measured by the Nowlis Mood Adjective Checklist; and anxiety, as measured by the Music Performance Anxiety Self-Statement. Performances were video recorded and rated by two AT teachers for misuse, and by two music faculty members for music performance. Evaluators were blind to participants’ conditions as they watched the videos. Results of this study showed that heart rate variance increased more in the control group from audition to recital in comparison with the experimental group. Concerning misuse, the AT teachers did not agree in their ratings. One thought that misuse was greater in low stress situations while the other thought that misuse was greater in high stress situations. However, comments made by both teachers indicated that four participants in the experimental group improved while none in the control group showed improvement. Concerning musical performance, musical quality and technical quality improved in the experimental group but worsened in the control group. Mood was shown to have improved, and anxiety was shown to have decreased from pre-intervention to post-intervention in low stress situations in the experimental group. The authors concluded that while 15 lessons could affect change in low stress situations, it was not enough to affect change in high stress situations.

Lorenz’s (2002) thesis also examined the effect of the AT on anxiety during music performance in the choral classroom. Twenty-two high school students participated in this study and were divided into either a control group or an experimental group. The experimental group received exercises based on the AT over the course of 13 weeks. Pre-test and post-test measurements were taken prior to two performances. One performance occurred before the intervention began while the other took place after the intervention had ended. At both performances, all participants completed a questionnaire, comprise of rating scales, concerning their experience with performance anxiety. Participants were also provided with a checklist of symptoms related to anxiety and were asked to indicate which symptoms they experienced. There was also space for participants to list any other symptoms that were not in the checklist. Only participants in the experimental group completed a questionnaire about how they felt the AT had impacted performance anxiety before their post-test performance. Lorenz stated that the findings were inconclusive due to a lack of statistically significant results, although participants appeared to demonstrate a trend towards feeling that the AT had a positive impact on posture, relaxation, breath control, and vocal technique.

In summary, the AT may be able to affect performance anxiety, particularly in low stress situations.

Alexander Technique and Respiration

In Dennis’ (1987) dissertation, the effect of the AT on respiration in various instrumentalists was researched. A total of 13 wind instrumentalists, including three flautists, three oboists, three clarinettists, one bassoonist, one horn player, one trumpet player, and one trombonist, were randomly assigned to either a control group or an experimental group which received 20 AT lessons. Variables related to respiratory function were measured using spirometry and static mouth pressures. Music performances were also recorded both before and after the intervention period. Recordings were assessed by six experts who evaluated posture and movement, breath control, and overall performance. The experts consisted of two professional wind instrumentalists, two AT teachers, and two movement analysts. Results revealed no significant differences between groups, although subjective statements imply positive outcomes associated with taking AT lessons.

Holm's (1997) dissertation examined how the AT could affect breathing in flautists. A survey was sent to 100 flute professors across the United States. Thirty-four of those surveys were returned. Results showed that 71% of respondents were familiar with the AT, having had some experience with it. Of those that were familiar with the Technique, 75% stated that they used principles of the AT to try to improve breathing in their students, although many were not familiar enough to apply principles very well. However, most of the respondents to the survey felt that the AT could be useful in improving breathing in flautists.

In summary, the AT may be able to affect respiration, although these improvements were only reported through qualitative methods.

Alexander Technique and Muscular Activity

In Englehart's (1989) dissertation, the effect of the AT on neck muscle activity in singers was studied. Twenty-three participants were assigned to either an AT group, a Body Awareness group which received Jacobson's Progressive Relaxation therapy, or a control group which received "standard vocal exercises" (p. 81). All groups received 10 days of group training over the course of two weeks. Prior to the intervention period, all participants completed a pre-test. Audio recordings were taken for the purpose of evaluating tone quality and surface electromyography was taken to measure neck muscle activity of the right sternocleidomastoid, the left sternohyoid muscle, and the right upper trapezius. Only four participants from each group underwent electromyography testing due to time and equipment restrictions. The same process was repeated for the post-test. Assessments of tone quality were made by a voice and music education teacher, a choral director, and a vocal performer. Findings revealed that there were no significant differences in tone quality between groups although there were significant differences between groups for changes in neck muscle activity. The AT group in particular were able to alter upper trapezius muscle activity more than participants in the other groups.

In Wolf and colleagues' (2017) study, the effects of a 10-week AT intervention on violinists' and violists' muscle activation, movement kinematics, and musical performance were investigated. Seven collegiate violinists and violists participated. Four were allocated to the experimental group which received weekly 1-hour group AT lessons. Three were allocated to the control group which received no lessons. A single pre-test and post-test were completed by both groups and consisted of electromyography to measure muscle activation and motion capture to record movement kinematics. Video recordings were also made so that a violin and viola performance expert could evaluate muscular tension, movement patterns, and sound quality using 4-point Likert scales. The AT group also kept a journal of their AT progress. Descriptive analyses of electromyographic results showed no trends in muscle activation as the result of AT training. Descriptive analyses of movement kinematics revealed more flexibility in head movements and a reduction in flexibility in the shoulder. Expert evaluation revealed that there were both "positive and negative [changes] in participants' patterns from pre- to post-test" (p. 83). Participant records of their experience with the AT showed that violinists and violists developed a better awareness of muscular tension especially in the head and neck. However, the researchers did not find a strong relationship between increased awareness and improved performance quality. The authors concluded that 10 weeks of AT training, while capable of introducing a new way of thought, may not have been sufficient for the participants to integrate the AT into their playing.

In summary, the AT can affect muscular activity in singers, although results for violinists and violists remain inconclusive.

Alexander Technique and Pain and Posture

Mozeiko's (2011) dissertation studied the effects of the AT on violinists' and violists' pain, skill function, awareness, and well-being and also described the experiences of those who took AT lessons. A total of 51 violinists and violists participated in this study and were randomly assigned to a control group or an experimental group. The experimental group received 20 AT lessons which occurred twice a week over a 10-week period. Questionnaires were administered before and after the intervention period to all participants. Questionnaires asked participants to rate their pain, skill function, awareness, and well-being. In addition, the participants in the experimental group were observed while they attended their lessons. Semi-structured interviews were also held with six participants from the experimental group to discuss their experience with the AT. Findings of this study showed significant differences between the experimental and control groups, especially in pain reduction – the AT group demonstrated a greater reduction in pain than the control group. In the AT group alone, awareness and skill function were significantly different between pre-test and post-test. Interviews revealed that most participants felt that there was a decrease in pain and an improvement in skill function, awareness, and well-being.

The purpose of Davies' (2020b) study was to examine the effects of the AT on playing-related pain and its associated risk factors in musicians as well as its impact on musical performance. Twenty-three music performance students participated in this study. Instrumentalists included three violinists, three violists, four cellists, two flautists, two clarinettists, eight pianists, and one conducting student. All participants completed questionnaires before and after an AT program which consisted of one AT class per week for one semester. The pre-program questionnaire included questions on "frequency, severity and impact of current and past pain and other musculoskeletal symptoms (such as numbness, tingling, tightness, weakness) specially related to playing instruments" (p. 3). In the post-program questionnaire, participants were asked to rate the benefits of the AT concerning health and performance outcomes. Participants were also directly asked about how they felt the AT affected their playing-related pain. Results of this study showed that all participants rated the AT as beneficial for reducing playing-related pain, improving posture, releasing excessive muscular tension as well as for improving instrumental technique and performance. Participants also reported reductions in stress levels and performance anxiety following lessons in the AT.

In a follow-up to her previous study, Davies (2020a) conducted a more in-depth study to determine music students' perceptions as well as their teachers' perceptions of their playing following lessons in the AT. A total of 12 music students from the previous study and eight teachers participated in this study. The music students included two violinists, two violists, three cellists, two clarinettists, and five pianists. All music students filmed video recordings of themselves playing before and after the AT program. Both students and teachers watched the videos and were asked to rate the amount of change they saw for each of the outcome measures. Outcome measures included "posture, excess muscle tension, and instrumental technique" (p. 197). Tone quality was also assessed. Findings demonstrated that students and teachers felt that posture had improved, excessive muscular tension had decreased, and movement quality had improved. Participants also felt that instrumental technique and tone quality had improved.

In summary, the AT may be able to improve pain, posture, and movement quality.

Alexander Technique and Pianists

Many of the abovementioned studies included a variety of instruments or focused on string and wind instrumentalists, with very few including pianists in their research. There are, however, a few studies that have examined the effects of the AT on pianists alone.

Armstrong's (1975) dissertation examined how lessons in the AT affected nervousness during piano performance. Eight college pianists participated in the study and were divided into experimental and control groups with four participants in each group. All pianists were video recorded while playing a musical excerpt for a small audience. A questionnaire was given to the pianists following their performance asking whether they considered nervousness to be a problem during performances, if they had methods of coping with nervousness during performances, and whether they were nervous while playing that day. Participants were also provided with a checklist to indicate which parts of their bodies experienced muscular tension. Following the initial performance, participants in the experimental group received four to six private lessons in the AT over the course of six weeks. Each lesson was approximately 30 to 45 minutes in length. All participants returned for the final video recording session in which the pianists again performed in front of a small audience. The control group was given a questionnaire similar to the first one that was administered to them following their first performance. The experimental group was given a questionnaire that asked if they felt the AT had an impact on decreasing nervousness during performances. The results of this study showed that pianists who had participated in AT lessons felt less nervous during their second performance and that they believed the Technique helped them to cope with nervousness. Based on visual observation, Armstrong reported that those who had taken lessons appeared to be "less [stiff]" (p. 45) in their upper extremities and neck during their final performance.

Kaplan's (1994) dissertation was comprised of six case studies that explored the experiences of pianists who had taken lessons in the AT. Intensive interviews were conducted with each of the six participants. Each participant was interviewed at least twice with each interview lasting approximately 1.5 to 2 hours. Results of this study showed that pianists initially sought the AT because they experienced pain or discomfort while playing. They found that the AT was "a long, ongoing process" (p. 137) without a clearly "defined time line for achieving results" (p. 145). Participants also stated that they had good relationships with their teachers and found that AT teachers were different from piano teachers in that the expectations and attitudes from each were different. Concerning applying the Technique to piano playing, participants stated that prior to learning the AT, they had not realised that playing the piano involved the whole body. They also stated that playing the piano is a complex activity which made it difficult to focus on applying the AT all the time. Participants found that overall, the AT improved their self-image and confidence as well as increased their awareness about the relationship between their bodies and the piano. In addition, they felt that the AT provided a way with which they could release tension.

In Santiago's (2004) dissertation, the effect of the AT on improving piano performance in young pianists was explored. Twenty students between the ages of 10 and 14 were randomly assigned to a control or experimental group. The control group received 8 weeks of sessions in mythology while the experimental group received 8 weeks of 15- to 20-minute lessons in the AT. Before the intervention period began, students' teachers completed observation forms comprising of rating scales to evaluate students' body and hand postures at the piano, perceived levels of muscular tension, and musical quality of the performance. These forms were completed once a week for four weeks. At the fourth week, students were video recorded while playing two pieces. At the post-test, students performed the same pieces again while being video recorded. Recordings were assessed by piano teachers (both those who taught the students in the study and those that did not), three doctors, and four AT teachers. Evaluators participated in group discussions to talk about the video recordings they viewed. Results of this study showed that the AT appeared to have a great influence on posture and tension. In addition, tone quality appeared to improve. However, improvements were also found in the control group, so the author stated that it was not possible to attribute these changes to the AT alone.

Wong's (2015) thesis examined the effects of a single somatic workshop on the body usage and musical quality of pianists. Ten pianists participated in this study and were allocated to three different groups: an AT group, a Body Mapping group, and a Feldenkrais group. There were three pianists in the AT group, four in the Body Mapping group, and three in the Feldenkrais group. Each participant performed a variety of playing tasks in the pre-test including scales and two pieces selected by the author. Following the pre-test, each participant was given a 50-minute lesson with a certified AT teacher, Body Mapping teacher, or Feldenkrais practitioner and then completed a post-test that followed the same procedure as the pre-test. Video and audio recordings were made of both the pre-test and post-test. The video recordings were sent to two

AT teachers, one Body Mapping teacher, and one Feldenkrais practitioner to assess body usage. Evaluations were conducted using rating scales asking about participants' usage of the head and neck, torso, upper and lower extremities, and general body usage. Video recordings were also sent to one AT teacher, two Body Mapping teachers, two Feldenkrais practitioners, and two Euthonie teachers for the purpose of asking certified somatic teachers to identify the post-intervention performance from the pre-intervention performance. Audio recordings were sent to four piano teachers to assess musical quality. Evaluations were again conducted using rating scales asking about participants' tone, rhythm, expressivity, and the ease with which playing tasks were performed. Audio recordings were also sent to eight piano teachers and piano pedagogy students with the purpose of identifying the post-intervention performance from the pre-intervention performance. Results of this study showed that there were statistically significant differences in usage of the head and neck as well as evenness of sound following a somatic workshop. No other statistically significant results were found, although patterns in the data indicated perceivable differences in body usage and musical quality in other areas. Findings also suggested that it was more difficult to identify post-intervention recordings based on musical quality than body usage.

The purpose of Loo and colleagues' (2015) research was to determine the effectiveness of the AT in reducing muscular tension in piano playing. A total of 15 undergraduate piano major students participated in this study. The same questionnaire was administered before and after the AT intervention and asked participants to rate the amount of tension they experienced in their upper and lower extremities as well as torsos while playing. Participants received 14 weeks of group AT training between pre-test and post-test. Each training session was 3 hours in length and conducted once a week by a certified AT teacher. Results showed that there was a significant decrease in tension following lessons based on participants' ratings of their perceived levels of tension.

Brandes and colleagues (2020) examined how the AT can be applied by a piano teacher in the context of teaching a lesson. This case study was conducted by video recording six piano lessons with a seven-year-old student who played at the skill level of Royal Conservatory of Music's Level 2. Her piano teacher had already included some AT concepts into their previous lessons, so the student had a little experience of incorporating ideas based on the AT into her playing. The videos were then watched by a panel of four people consisting of the authors of the paper and an external reviewer who was not a part of the study design process. One of the authors was the piano teacher who taught the student. She had experience taking lessons in the AT but was not a certified teacher of the Technique. Another author was an Alexander teacher, and one other was both an Alexander and piano teacher. The external panel member was a piano teacher. Each individual watched, coded, and commented on what they observed in the videos. It was found that the piano teacher, although not a teacher of the AT, used her understanding of the AT to teach the student. She would observe the student's *use* of her body during piano playing and make suggestions on how to change the exhibited behaviour. For example, the teacher observed that the student "shortened her back, correspondingly tightened her arms and hands, and leaned her torso to play each chord" (p. 25). To address this issue, the teacher utilised AT concepts that brought the student's attention to the connection between *use* and how it affects the function of the upper extremities. The student was eventually able to identify the issues for herself and put in her own words what she needed to do to change the way she played. The external piano teacher observed that there were improvements in the way the student played over the course of the six lessons. The Alexander teacher noted that the student played with "more ease" (p. 28) as she progressed through the lessons, although the student was clearly still in a state of transition in which the "tightening" mentioned beforehand was still occurring, but she was able to change her behaviour quickly when attention was brought to the issue. It was observed that the piano teacher incorporated more AT terminology into her teaching as the lessons continued. The authors concluded that it is possible to integrate AT into piano lessons by using it as a tool to observe and assess students as they play. However, the piano teacher who wishes to use AT in her lessons must have had experience with the Technique in order for Alexander concepts to be used during lessons.

In summary, the AT may be able to help pianists lessen performance anxiety, reduce tension, improve posture, and increase awareness about the relationship between the body and the piano.

Research Problem

Many of the studies summarised in this literature review show a positive effect of the AT on those who take their lessons. Benefits include improvement in pain (Becker et al., 2018; Becker et al., 2021; Hafezi et al., 2022; Little et al., 2008; Little et al., 2014; Little et al., 2022; MacPherson et al., 2015; McClean et al., 2015; Yardley et al., 2010), increased self-efficacy in people with pain (MacPherson et al., 2015; McClean et al., 2015; Wenham et al., 2018; Woodman et al., 2018), and improved quality of life in people with pain (Lauche et al., 2016). Research has also shown than the AT can affect postural coordination (Cacciatore, Gurfinkel, Horak, & Day, 2011; Cacciatore et al., 2014), postural tone (Cacciatore, Gurfinkel, Horak, Cordo, & Ames, 2011), postural control (Ketcham et al., 2017), and postural alignment (Becker et al., 2018; Becker et al., 2021; Cacciatore et al., 2005; Cohen et al., 2015; Gross et al., 2019; Gross et al., 2020; Kutschke, 2010). There have also been reports of people feeling their posture had improved following exposure to the AT (Reddy et al., 2011). Research has also been conducted about the effects that the AT can have on gait (Hamel et al., 2016; O'Neill et al., 2015). The AT has been shown to have beneficial effects for those with Parkinson's disease (Cohen et al., 2015; Gross et al., 2019; Gross et al., 2020; Stallibrass, 1997; Stallibrass & Chalmers, 2002; Stallibrass et al., 2005) and improve balance in older adults (Batson & Barker, 2008; Cohen et al., 2018; Cohen et al., 2020; Dennis, 1999; Gleeson et al., 2015; Glover et al., 2018; Tunnicliffe, 2021). Research has also been conducted concerning the effects the AT can have on respiration (Austin & Ausubel, 1992), knee osteoarthritis (Preece et al., 2016), well-being in people with visual impairments (Gleeson et al., 2017), and the psychological effect of the AT (Armitage, 2009; Kinsey et al., 2021). There is also research that documents participants' experiences with the AT (Gibbs & Young, 2008; Gibbs & Young, 2011; Krim, 1993). In addition to these studies, the effects of the AT on music performance have been examined. Reported effects include improvements in posture (Bosch & Hinch, 1999; Davies, 2020a; Davies, 2020b), pain (Davies, 2020b; Mozeiko, 2011), muscular activity (Englehart, 1989; Wolf et al., 2017), respiration (Dennis, 1987; Holm, 1997), anxiety (Lorenz, 2022; Valentine et al., 1995), and tone (Bosch & Hinch, 1999; Davies, 2020a; Kvammen, 2013; Kwon, 2012; Lloyd, 1987).

There are commonalities across these research that are of relevance for this dissertation. Namely, the frequent use of self-report measures to determine the effectiveness of the AT on various measures and posture as an expected change following lessons in the AT. Self-reports were obtained through interviews and focus groups (Armitage, 2009; Beattie et al., 2010; Gibbs & Young, 2011; Glover et al., 2018; Kaplan, 1994; Krim, 1993; Mozeiko, 2011; Tunnicliffe, 2021; Wenham et al., 2018; Yardley et al., 2010), questionnaires with open-ended questions (Armstrong, 1975; Gibbs & Young, 2008; Gibbs & Young, 2011; Holm, 1997; Stallibrass et al., 2005), and rating scales or yes/no surveys (Armstrong, 1975; Becker et al., 2018; Becker et al., 2021; Davies, 2020a; Davies, 2020b; Dennis, 1999; Gibbs & Young, 2008; Gibbs & Young, 2011; Gleeson et al., 2017; Glover et al., 2018; Hafezi et al., 2022; Lauche et al., 2016; Little et al., 2008; Little et al., 2014; Little et al., 2022; Loo et al., 2015; Lorenz, 2002; MacPherson et al., 2015; McClean et al., 2015; Mozeiko, 2011; Preece et al., 2016; Stallibrass, 1997; Stallibrass & Chalmers, 2002; Tunnicliffe, 2021; Woodman et al., 2018; Yardley et al., 2010). While some studies employed quantitative means of collecting data other than rating scales, such as through electromyography or motion capture (Becker et al., 2018; Becker et al., 2021; Cacciatore et al., 2005; Cacciatore et al., 2014; Cacciatore, Gurfinkel, Horak, Cordo, & Ames, 2011; Cacciatore, Gurfinkel, Horak, & Day, 2011; Cohen et al., 2015; Cohen et al., 2020; Dennis, 1987; Dennis, 1999; Englehart, 1989; Gleeson et al., 2015; Gross et al., 2019; Hamel et al., 2016; Ketcham et al., 2017; Kutschke, 2010; Little et al., 2014; Preece et al., 2016; Wolf et al., 2017), there is an overall lack of objective and quantitative measurements, especially when assessing the effectiveness of the AT in musicians, giving rise to the concern that there is a lack of evidence-based research to support the claims made in these self-evaluations (Beattie et al., 2010; Klein et al., 2014).

In a number of these studies, it appears that changes in posture are expected following lessons in the AT (Becker et al., 2018; Becker et al., 2021; Bosch & Hinch, 1999; Cacciatore et al., 2005; Cacciatore, Gurfinkel, Horak, & Day, 2011; Cacciatore, Gurfinkel, Horak, Cordo, & Ames, 2011; Cacciatore et al., 2014; Cohen et al., 2015; Davies, 2020a; Davies, 2020b; Gross et al., 2019; Gross et al., 2020; Ketcham et al., 2017; Kutschke, 2010; Reddy et al., 2011; Santiago, 2004) although few studies have dedicated the bulk of their research to examining this topic. Posture, particularly postural alignment, is mostly a secondary outcome measure rather than a primary one despite being a reason why people decide to learn the AT. Posture in the studies reviewed was assessed through photographs (Becker et al., 2018; Becker et al., 2021; Gross et al., 2020), observation (Davies, 2020a; Santiago, 2004), and self-reports (Davies, 2020b; Reddy et al., 2011), although occasionally the methods by which posture was measured was not always specified (Cohen et al., 2015; Gross et al., 2019). There is a lack of direct measurements although in Cacciatore and colleagues' (2005) study, the researchers employed the use of motion capture cameras to collect data about the participant's posture during tasks which may provide more accurate insights into postural alignment.

There is also a lack of research concerning pianists in particular. Several studies concerning the AT and musicians tend to research a variety of musicians rather than focus on a specific instrument (Davies, 2020a; Davies, 2020b; Dennis, 1987; Kvammen, 2013; Valentine et al., 1995). While this may provide researchers with the possibility of generalising their results to a larger musical population, it ignores the reality that each musical instrument comes with its own constraints – not all instruments are played in the same way. Standardising the type of instrumentalist studied in a single research project would better ensure that changes seen between measurements are not due to the different instruments played. The studies about the effects of the AT on pianists contribute to our understanding of how the AT can have an impact on piano performance. However, half of these studies are subjective in nature with participants providing their own assessment of how they feel after having received lessons in the AT (Armstrong, 1975; Kaplan, 1994; Loo et al., 2015). Other studies relied on external evaluators (Brandes et al., 2020; Santiago, 2004; Wong, 2015) which provided more objective viewpoints, but were still lacking direct measurements of effects.

To establish whether postural changes truly occur following study of the Technique, it is necessary that quantitative measurements of posture be taken. To date, posture in pianists has not yet been evaluated with direct measurements following AT lessons.

Research Questions

The main purpose of this dissertation was to better understand pianists' postures during performance and the effects of the Alexander Technique on posture through quantitative and objective measurements. To address this issue, four research studies were conducted to answer the following questions:

1. Are there quantifiable differences that can be objectively measured in postural angles and pressure distribution between good use and misuse as defined by the Alexander Technique?
2. Do individual pianists demonstrate consistent postural angles within a task across multiple measurements?
3.
    a. Are there quantifiable differences in postural angles within individuals following 10 lessons in the Alexander Technique?
    b. Are changes persistent after a 4-week cessation of Alexander Technique lessons?

4.

a. How do pianists perceive their posture and describe their application of the Alexander Technique following lessons?

b. Is there a relationship between pianists' perceptions and changes in their spinal posture?

Research Studies

Study 1: The Influence of the Alexander Technique on Spinal Angles and Seated Pressure Distribution

According to the AT, the body can exhibit *good use*, which is adaptive postural behaviour (Batson, 2008), or *misuse*, which involve postural distortions (Barlow, 2005). However, the available literature is vague about what physically constitutes good use and misuse and has yet to provide a description of the manifestation of these concepts. Additionally, before an intervention can take place for the purposes of potentially altering posture, it is first necessary to establish how posture might change in view of the AT. It is assumed that participants of these intervention studies will start from a place of misuse and progress to good use following lessons, but what are the anticipated changes? Is there a specific pattern of change from pre-Alexander to post-Alexander lessons or a specific posture to be exhibited? To explore this issue, 10 certified AT teachers and teachers-in-training (i.e., trainees) were asked to demonstrate good use and misuse to examine the physical differences between the two. Variables for this study were chosen based on the AT principle of primary control. The Alexander literature states that the *primary control* is the relationship between the head, neck, and trunk (Alexander, 1946; Conable & Conable, 1995) which can manifest itself through the alignment of the axial skeleton and weight distribution (Conable & Conable, 1995; Mark, 2003). Postural angles along the spine and pressure distribution on the sitting surface were measured in both conditions using data collected from a motion capture system and a pressure mat. The results of this study demonstrate the postural differences between good use and misuse and provide guidelines concerning expected postural changes following AT lessons.

Study 2: Postural Variability in Piano Performance

To date, no previous study has taken multiple measurements for pianists to examine postural variability between repeated performances. Therefore, the purpose of this study was to determine if there is a significant amount of variability in individual pianists' postures between performances. In this study, 15 pianists completed three measurements. Each participant completed their first measurement followed by a second measurement one hour after their first session. Participants returned one week later to complete the third measurement. At each session, participants performed a series of tasks in a randomised order including quiet sitting, raising the hands on and off the keyboard, playing a scale, sight reading, and playing an excerpt from a pre-determined piece. Postural angles were calculated from data collected using motion capture. The results of this study showed whether there was a considerable amount of postural variability between repeated performances. This is important, especially for intervention studies, because it is necessary to establish pianists' typical playing postures to ensure that post-intervention changes can be attributed to the intervention rather than variability between performances.

Study 3: The Effect of the Alexander Technique on Pianists' Postures during Performance

While posture is often cited as an aspect of music performance that improves following AT lessons, no previous study has objectively and quantitatively examined what postural differences exist before and after this intervention. The purpose of this third study was to determine if there is a difference in spinal posture after the completion of 10 AT lessons. Following the completion of their initial measurements (i.e., baseline measurements), as outlined in Study 2, pianists received 10 lessons in the AT with a certified AT teacher. Each participant was assigned to a teacher who would teach them for the duration of the study. Lessons were given over the space of two weeks at the advice of the director of the local AT school as it was thought that 10 lessons spaced closely together would be more intensive and effective in yielding results. Pianists returned for a post-test within a week of completing their final AT lesson and completed a follow-up test session one month after lessons had concluded. The tasks and postural variables were same as those performed in the baseline measurements. The results of Study 1, involving the AT teachers and trainees, had revealed a specific pattern of postural change between misuse and good use, and as it was assumed that the pianists would move from misuse to good use, this trend was searched for in this study. The results revealed whether there are measurable changes in posture following lessons in the AT and determined if pianists' postures had changed in the expected manner. The results also revealed whether any postural changes seen in the post-test persisted at the follow-up.

Study 4: The Relationship Between Pianists' Perceptions and Spinal Postures Following Alexander Technique Lessons

Many studies concerning the AT and musicians have relied on the perceptions of people who have experienced the Technique with many participants reporting a positive impact of the AT on their performance. What has not yet been explored is the relationship between qualitative reports and quantitative measurements. What do pianists have to say about their posture following lessons in the AT and how did they apply the Technique while playing? How do their perceptions relate to their postural measurements? In this study, the same pianists who participated in the previous two studies (Studies 2 and 3) completed questionnaires following lessons in the AT. At their post-test, pianists were asked to rate themselves on whether they felt they played with good posture following AT lessons. At the post-test and the follow-up, they were asked to rate themselves on how often they attempted to apply principles of the Technique while playing and, in a short open-ended question, to elaborate on how they applied the Technique. Analyses were done to determine if there was a relationship between pianists' perceptions and their postural change.

Chapter 3: The Influence of the Alexander Technique on Spinal Angles and Seated Pressure Distribution

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Abstract

The Alexander Technique (AT) is a method that teaches its students how to change their postural behaviour. The purpose of this paper was to determine if it is possible to differentiate postural behaviour that exhibits principles of the AT from behaviour that does not, based on objective measurements. The participant group consisted of 10 teachers and trainees of the AT. Each individual was requested to perform a series of tasks in two conditions: demonstrating the teachings of the AT and demonstrating a lack of those teachings. The tasks were performed while sitting in front of a digital piano to simulate piano playing-related tasks. All tasks and conditions were randomised. Data were collected using a VICON motion capture system which was used to calculate the following postural angles during tasks: craniovertebral angle, head tilt, head-neck-trunk angle, trunk angle, thoracic angle, thoracolumbar angle, and lumbar angle. Participants sat on a pressure mat to collect data, allowing the assessment of the symmetry of pressure distribution, or dispersion index, across the sitting surface during tasks. These variables were chosen based on discussions with teachers of the Alexander Technique as well as literature written about the AT. The results demonstrate that it is possible to distinguish postural behaviour that exhibits teachings of the AT from behaviour that does not. The findings show that postures demonstrating teachings in keeping with the AT cannot be characterised by any one specific angle. Additionally, there are no discernible patterns in dispersion index when comparing postural behaviour that exhibits principles of the Technique to behaviour that does not. Postural behaviour in keeping with teachings of the AT can be characterised by a larger craniovertebral angle, head tilt, and head-neck-trunk angle as well as smaller trunk, thoracic, and thoracolumbar angles in comparison with behaviour that does not employ the principles of the AT. In addition, to distinguish between postures that demonstrate teachings of the Technique and those that do not, results must be interpreted in relation to a second set of data (i.e., a comparison of two conditions). In conclusion, this study provides a method for future researchers to determine if changes following AT lessons show a trend toward exhibiting postural behaviour that reflects the application of the Alexander Technique.

Keywords: Alexander Technique, postural behaviour, spinal angles, dispersion index

The Influence of the Alexander Technique on Spinal Angles and Seated Pressure Distribution

The Alexander Technique (AT) is a method for altering postural behaviour (Cacciatore, Gurfinkel, Horak, Cordo, & Ames, 2011; Macdonald, 2015). Proponents of the AT would argue that this is a narrow view of the Technique as the method involves aspects that are both physical (i.e., that which relates to the movement and posture of the body) and psychological (i.e., that which relates to the thought processes of mind) (Macdonald, 2015). Through gentle physical manipulation and a set of verbal directions, students of the Technique are taught "to associate a new sequence of thought with a new manner of using the body," (Barlow, 1990, p. 195) thereby bringing about changes in postural behaviour. The word *use* has a particular meaning in the AT. In view of the scope of this paper, the term refers to changes in posture over time and the manner in which the body is utilised to accomplish tasks (Barlow, 1990; Jones, 1997). *Good use* is an Alexander expression that describes adaptive postural behaviour that is well-suited to the task (Batson, 2008). *Misuse* involves "distortions of the muscular and bony framework" (Barlow, 2005b, p. 46). The terms good use and misuse, when employed in this paper, refer to whether postural behaviour is in keeping with the teachings of the AT.

To date, little research has been conducted to characterise good use, but inferences can be drawn from studies that have compared the postural behaviour of Alexander teachers to healthy adults. One study (Cacciatore, Gurfinkel, Horak, Cordo, & Ames, 2011) examined the differences in postural tone between teachers of the AT and healthy adults. "Postural tone" was defined as the "tonic activation of skeletal muscles" used to "maintain the relative positions of body segments and to prevent the body from collapsing against gravity" (p. 75). The healthy adults acted as a control group with which the Alexander teachers were compared. Participants stood on a rotating platform while the "reaction force to torsional rotation of the body axis" was measured (p. 77). It was found that the Alexander teachers had less axial stiffness than the control group, indicating that postural tone could be altered through extended training and practice. In another study (Cacciatore, Gurfinkel, Horak, & Day, 2011), weight shift and axial behaviour were investigated in the context of a sit-to-stand task. "Smoothness of weight transfer" and spinal angles were measured while participants completed the task (p. 497). Alexander teachers and healthy adults started by sitting on a chair and then were asked to stand up "as smoothly as possible" (p. 497). The results showed that Alexander teachers were capable of consistently and gradually increasing the amount of force applied through their feet over the course of the task while the healthy adults demonstrated a sudden increase in force just before they left contact with the seat. Alexander teachers also generally displayed less change in spinal angles during the task than the healthy control group. The researchers concluded that the Alexander teachers were able to employ a different pattern of weight shift and spinal coordination during sit-to-stand than normal healthy adults. To ensure that the results of the study were not a consequence of a misinterpretation of the instructions on the part of the participants and to exclude the possibility that the outcomes were due to completing the task at a self-selected speed, another study was conducted (Cacciatore, Mian, Peters, and Day, 2014) where more specific instructions were given to the participants. Alexander teachers and healthy adults were asked to rise from a chair in the span of one, two, four, and eight seconds at a constant speed. They were also asked to place their feet in three different positions for each speed. Weight shift, centre of mass (COM) velocity, and bipedal balance were measured during each trial. Results indicated that weight shift was more gradual for the Alexander teachers in comparison with the healthy adults, who tended to demonstrate a sudden increase in force output just before lifting off the seat (i.e., seat-off). Healthy adults also demonstrated an increase in COM velocity just before seat-off for each time condition. For the four- and eight-second trials, Alexander teachers were able to maintain a constant COM velocity throughout the task. Concerning bipedal balance, Alexander teachers were not as affected by foot placement in comparison to the healthy controls. Overall, the results seemed to indicate that Alexander teachers had less difficulty standing up “smoothly” in comparison to healthy adults, possibly due to differences in postural tone. A separate study (Ketcham et al., 2017) examined the difference in postural control between Alexander teachers, healthy older adults, and healthy younger adults by comparing COM velocity between the three groups. The mean age of the Alexander teachers was 65.8 years old and the mean age of the older adults was 66.6 years old. The younger adults had a mean age of 28.2 years. Each participant was asked to complete a balance task on a firm surface and an unstable surface in two conditions: eyes open and eyes closed. Alexander teachers displayed slower sway velocities than the older adults in the tasks requiring participants to keep their eyes closed. Sway velocities were similar between the Alexander teachers and the young adults in all tasks and conditions. The researchers concluded that the AT may have an impact on postural control.

From these studies, it is possible to infer that the application of the principles of the AT may manifest itself in different postural behaviour when compared to the behaviour exhibited by healthy adults. It is interesting to note that most of the variables examined in these studies relate to the axial structure of the body. The Technique emphasizes the importance of the “positional and tensional” relationship between the head, neck, and trunk (Cacciatore, Gurfinkel, Horak, & Day, 2011, p. 496). This is one of the main principles of the AT known as primary control which can physically manifest itself through the alignment of the axial skeleton and weight distribution. Assuming the skeletal structure is well-aligned (e.g., as when posture is examined with a plumb line), weight will be evenly distributed through points of contact with the seat or floor (Conable & Conable, 1995; Mark, 2003). The primary control affects the usage of the body, so it may be beneficial to study variables related to this Alexander principle to examine both good use of the body as well as misuse with an assessment of spinal angles and pressure distribution.

The abovementioned studies have provided valuable insight into the AT, especially concerning differences in postural behaviour between Alexander teachers and healthy adults, but there are areas that have yet to be researched. The studies were conducted with participants in a standing position or rising from a chair, but there is a lack of research concerning the Technique in the context of sitting and the performance of tasks while sitting. Also, in the Alexander literature, misuse is often mentioned, but no studies have been conducted to determine whether good use is measurably different from misuse and how the two differ. The purpose of this paper is to address these issues and examine good use and misuse during the performance of tasks while sitting through the study of postural angles and pressure distribution in teachers and teacher trainees of the AT. Specifically, the tasks will mimic those executed during piano performance as the AT is a popular method among musicians and is thought to be able to improve musical performance (Barlow, 2005a; Valentine, 1991; Valentine, 2004; Woodman & Moore, 2011). The research question is as follows: are there quantifiable differences that can be objectively measured in postural angles and pressure distribution between good use and misuse?

Method

Participants

A total of 10 teacher trainees and certified teachers of the Alexander Technique participated in this study.[1] All were partnered with the Ottawa School of the Alexander Technique. To become a teacher of the AT, a trainee must complete 1,600 hours of training or three years of full-time study. Of the 10 participants, three were trainees (2 females, 1 male) with a mean age of 50.67 ± 17.56. The trainees had between 1.75 and 3 years of training. Seven of the participants were certified teachers of AT (5 females, 2 males) with a mean age of 59 ± 9.06. Teachers were certified by the Canadian Society of Teachers of the Alexander Technique or the Society of Teachers of the Alexander Technique and had between 1 and 29 years of teaching experience.

Tasks

All tasks were performed while sitting in front of a digital piano to simulate piano playing-related tasks.[2] Participants were to complete the following during the test session: sit for 30 seconds (quiet sitting task), raise their hands from their laps onto the keyboard and return them again to their laps (raising hands task), move their hands from the extreme left end of the keyboard to the extreme right end and back again (lateral motion task), and read an excerpt from a Shakespearean play for 30 seconds (reading task). For the lateral motion task, participants were also requested to pause with their hands on the keyboard at the extreme left, middle, and extreme right of the keyboard. Cards were placed on the keyboard to indicate the place at which they were to pause each time they passed by. However, as the participants were not pianists, we could not control how they placed their hands on the keyboard, whether they would be placing their hands in a position that was conducive to piano playing. The excerpt for the reading task was placed on the music stand attached to the keyboard and participants were asked not to touch or move the pages closer. This was to mimic music reading, but as the participants were non-musicians, music reading was replaced with text reading. They were to complete each task once in two conditions–once while demonstrating good use and once while demonstrating misuse. Tasks and task conditions were randomized for each participant.

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[1] See Appendix A for consent form and participant demographic and background questionnaire.
[2] See Appendix B for protocol guide.

Procedure

Before the test session began, reflective markers were placed on the participants. A headband with a total of four markers was placed on the head. Two markers on the front indicated the glabella and two markers at the back indicated the external occipital protuberance. Individual markers were placed on the following anatomical locations: tragus of the right ear; the spinous processes of C7, T5, T10, and L3; sacrum; left and right greater trochanters of the femur; and left and right forearms, placed approximately 7 to 10 centimetres above the wrist joint when the forearms were pronated. Position data of each reflective marker was collected using a 7-camera VICON Nexus motion capture system (Oxford Metrics) and recorded at 100Hz. Participants were asked to sit centred on a pressure mat with an array of 24 evenly spaced sensors (S4 Sensors). Pressure data was collected at a sample rate of 10Hz. The mat was attached to the height-adjustable bench and participants were permitted to adjust the height of the bench as well as its distance from the keyboard (Yamaha Digital Piano P-255) prior to beginning the test session. This was to prevent potentially biasing participants' postures by imposing a specific seat height and distance from the keyboard. The participants then proceeded to complete the series of tasks. Video recordings were taken of the test sessions to corroborate the timing of the tasks recorded by the motion capture system and the pressure mat.

Data Collection

The markers were used to calculate the following postural angles. All angles were viewed from the right side and measured in the sagittal plane.

- Craniovertebral angle, defined as the angle formed by connecting the tragus and C7, relative to the horizontal
- Head tilt, defined as the angle formed by connecting the glabella and external occipital protuberance, relative to the horizontal
- Head-neck-trunk angle, defined as the angle formed by connecting the tragus, C7, and the greater trochanter
- Trunk angle, defined as the angle formed by connecting C7, T10, and the greater trochanter
- Thoracic angle, defined as the angle formed by connecting C7, T5, and T10
- Thoracolumbar angle, defined as the angle formed by connecting T5, T10, and L3
- Lumbar angle, defined as the angle formed by connecting T10, L3, and the sacrum

For the thoracic, thoracolumbar, and lumbar angles, negative numbers indicated lordosis and positive numbers indicated kyphosis.

Pressure data were used to calculate the dispersion index. Dispersion index is defined as the percentage of pressure applied by one contact area (i.e., area under the left or right ischial tuberosity) relative to the pressure applied by the whole contact area (Maurer & Sprigle, 2004; Reenalda et al., 2009). All variables were chosen based on discussions with teachers of the AT as well as literature written about the Technique.

Data Analysis

Marker data were exported into MATLAB (MathWorks, R2017b) to calculate the postural angles. Pressure data were also exported into MATLAB where the sensors were split into two halves: left and right side. The amount of pressure applied to each side was converted into a percentage to provide the dispersion index. For the sitting and reading tasks, 10 seconds of data were taken from each condition. Data were not taken from the very beginning of the task to prevent any bias that may arise from taking measurements while participants were potentially still adjusting their bodies to demonstrate the application of Alexander principles or the lack thereof. For the raising hands task, data were taken from the point when participants began to lift their hands from their laps onto the keyboard to the moment their hands returned to their lap. The position of the hands was determined by observing the forearm markers. When the markers began to move upwards, it indicated that the participant was moving their hands up from their laps. Once the markers stopped moving and remained in place, it indicated that the hands were on the keyboard. When the markers moved downwards and stopped, it indicated that the hands had returned to their lap. For the task in which the hands were moved from one end of the keyboard to the other, data were taken from the point when participants placed their hands on the left side of the keyboard to when they returned to the left side again at the end of the task. Again, the position of the hands was determined by observing the forearm markers. Prior to analysis, to represent deviation from a centred seating position, 50% was subtracted from the dispersion index and the absolute value was used in the analysis. This provided a way to determine if pressure was unevenly distributed on the bench.

For each task, the mean angle across time points (hundredths of a second) was first obtained. Within-participant comparisons were then conducted to compare good use to misuse conditions using Wilcoxon signed rank tests in SPSS. Because this study is the first of its kind and thus exploratory, no adjustments were made to prevent missing any potentially worthwhile results. Outliers (i.e., any value with a *z*-score greater than 1.96 or less than -1.96) were Winsorized prior to data analysis. Occasionally, there were insufficient data to calculate some angles or dispersion index for a few participants due to missing data points. In such cases, the data for those values were imputed using expectation maximization in SPSS. A value of $p \leq .05$ was considered a statistically significant difference. Graphs were made to determine if there were any consistent trends between the angles and dispersion indices demonstrated in good use and in misuse.

Results

Postural Angles

Table 1 shows the results of the analysis for postural angles during the task of quiet sitting. The trunk, thoracic, and thoracolumbar angles showed statistically significant differences between good use and misuse with large effect sizes. For the task of raising the hands on and off the keyboard, the craniovertebral, trunk, thoracic, and thoracolumbar angles showed statistically significant differences between good use and misuse with large effect sizes (see Table 2). The craniovertebral angle, head tilt, head-neck-trunk, trunk, thoracic, and thoracolumbar angles showed statistically significant differences between good use and misuse with large effect sizes in the lateral motion task (see Table 3). In the reading task, the craniovertebral angle, head tilt, head-neck-trunk, trunk, thoracic, and thoracolumbar angles also showed statistically significant differences between good use and misuse with mostly large effect sizes (see Table 4).

Table 1

Postural Angles in Good Use and Misuse during Quiet Sitting

Angle	Good use	Misuse	*z*	*p*	*r*
	Median (°)	Median (°)			
Craniovertebral angle	49.21	46.51	1.68	0.093	0.38
Head tilt	16.36	14.11	0.36	0.721	0.08
Head-neck-trunk angle	147.15	141.03	1.78	0.074	0.40
Trunk angle	226.04	240.88	2.5	0.013	0.56
Thoracic angle	19.46	27.05	2.8	0.005	0.63
Thoracolumbar angle	-3.09	8.32	2.7	0.007	0.60
Lumbar angle	-0.34	-0.97	0.97	0.333	0.22

Table 2

Postural Angles in Good Use and Misuse during Raising Hands

Angle	Good use	Misuse	*z*	*p*	*r*
	Median (°)	Median (°)			
Craniovertebral angle	45.10	40.22	2.4	0.017	0.54
Head tilt	10.82	5.05	1.48	0.139	0.33
Head-neck-trunk angle	143.82	137.12	1.89	0.059	0.42
Trunk angle	226.33	232.37	2.8	0.005	0.63
Thoracic angle	19.91	25.52	2.29	0.022	0.51
Thoracolumbar angle	-6.89	-2.98	2.5	0.013	0.56
Lumbar angle	-1.49	-3.07	1.17	0.241	0.26

Table 3

Postural Angles in Good Use and Misuse during Lateral Motion

Angle	Good use	Misuse	*z*	*p*	*r*
	Median (°)	Median (°)			
Craniovertebral angle	46.92	38.40	2.8	0.005	0.63
Head tilt	8.83	4.35	2.5	0.013	0.56
Head-neck-trunk angle	141.71	131.36	2.5	0.013	0.56
Trunk angle	225.45	239.84	2.7	0.007	0.60
Thoracic angle	19.82	22.85	2.7	0.007	0.60
Thoracolumbar angle	-4.19	2.32	2.5	0.013	0.56
Lumbar angle	-1.56	-1.54	0.56	0.575	0.13

Table 4

Postural Angles in Good Use and Misuse during Reading

Angle	Good use	Misuse	*z*	*p*	*r*
	Median (°)	Median (°)			
Craniovertebral angle	41.52	24.15	2.70	0.007	0.60
Head tilt	8.69	3.04	2.09	0.037	0.47
Head-neck-trunk angle	138.68	109.64	2.70	0.007	0.60
Trunk angle	225.59	238.26	2.70	0.007	0.60
Thoracic angle	22.30	27.69	2.40	0.017	0.54
Thoracolumbar angle	-7.98	5.65	2.60	0.009	0.58
Lumbar angle	-1.47	-1.51	0.05	0.959	0.01

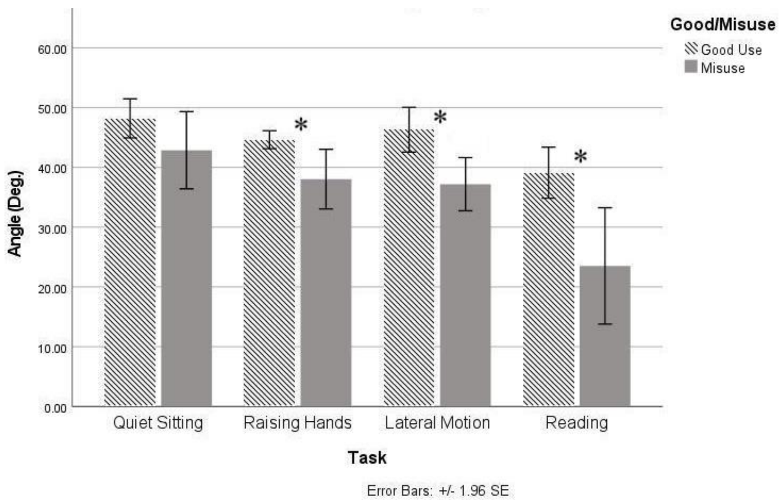
Based on the findings of these analyses, the angles that showed significant differences across most tasks were the craniovertebral, trunk, thoracic, and thoracolumbar angles. A particular trend was also found in which certain angles were always larger or smaller in the good use condition in comparison with the misuse condition (see Figure 1). According to the graphs, the craniovertebral angle, head tilt, and head-neck-trunk angle were consistently larger during good use in comparison with misuse. The trunk, thoracic, and thoracolumbar angles were constantly smaller in good use in comparison with misuse. The lumbar angle did not show any discernible trends. In addition, the range of angles displayed demonstrated a pattern. With the exception of the thoracolumbar and lumbar angles, all angles in all tasks exhibited a smaller range of angles in good use than in misuse.

Individuals were not compared with each other on any characteristic (e.g., teacher vs. trainee) due to the small sample size, but the range of angles demonstrated by each participant was examined descriptively. Results showed that participants displayed varying ranges of angles in both conditions, indicating that there is no one specific range of angles for good use or misuse.

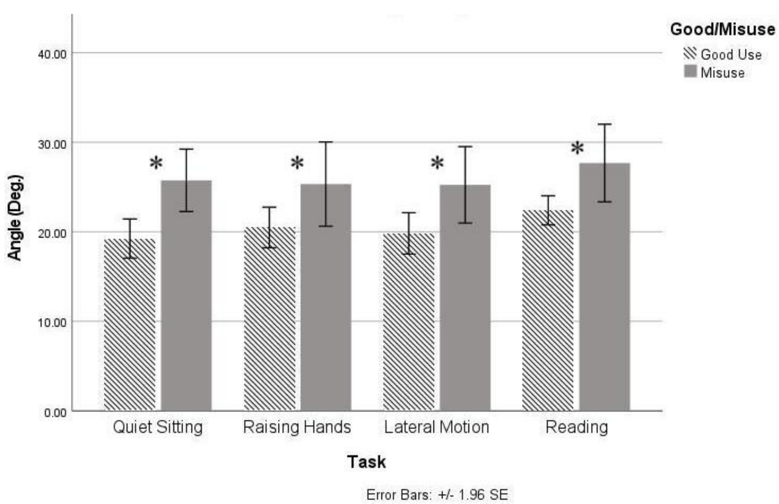
Figure 1

Examples of Consistent Trends in Postural Angles Across Tasks

A



B



Note. Panel A: Mean craniovertebral angle during good use and misuse. Panel B: Mean thoracic angle during good use and misuse.

*$p \leq .05$.

Dispersion Index

There were no significant differences in the dispersion index in any of the tasks. Table 5 displays the results for the analysis of dispersion index. According to the graphs, there were no noticeable trends in pressure distribution between good use and misuse when comparing across tasks (see Figure 2).

Table 5

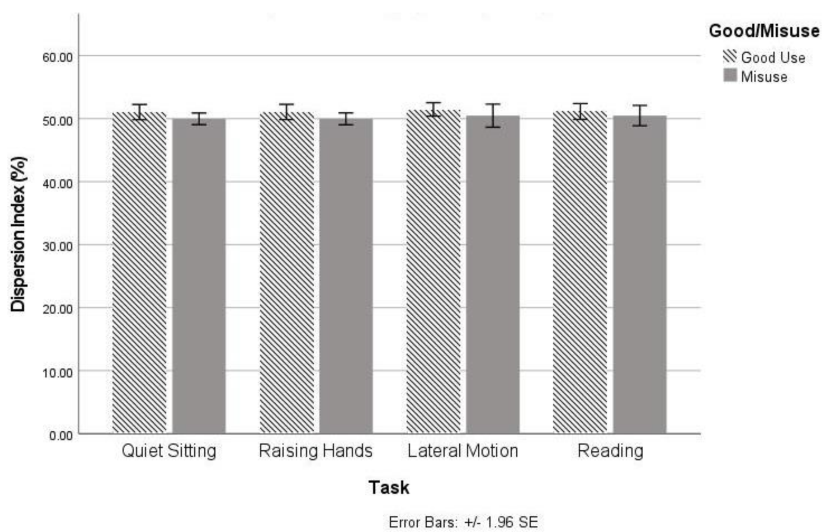
Dispersion Index as Absolute Deviation from Centre

Task	Good use	Misuse	*z*	*p*	*r*
	Median Absolute Deviation from Centre (%)	Median Absolute Deviation from Centre (%)			
Quiet sitting	1.35%	1.21%	0.87	0.386	0.28
Raising hands	1.45%	1.19%	0.76	0.445	0.24
Lateral motion	1.84%	0.96%	0.26	0.799	0.08
Reading	1.28%	2.00%	0.46	0.646	0.15

Note. Results presented in this table were taken from the right side.

Figure 2

Trends in Dispersion Index for the Right Side



Discussion

Postural Angles

According to the Alexander Technique literature, good use is different from misuse and the two conditions should present differently from each other. To date, there has been little empirical evidence to support this claim. The findings of this study indicate that there are observable differences in postural angles between when principles of the Technique are applied and when they are not. In addition, all angles, with the exception of the lumbar angle, show a certain trend in which values are either larger in good use when compared with misuse or smaller. Based on this pattern, it is possible to differentiate an angle measured while demonstrating the application of principles of the Technique from an angle measured when teachings are not applied for an individual. It is important to note that a set of data should not be interpreted in isolation. Results must be interpreted in relation to a second set of data to distinguish the good use condition from the misuse condition (i.e., there must be a comparison between the good use and misuse data to differentiate between the two conditions).

The trends exhibited by the postural angles may be interpreted from the perspective of the AT. One of the main principles of the Technique, primary control, states that good use will be exhibited if there is a certain relation between the head, neck, and trunk (Alexander, 1946). This relation is exhibited in a pattern known as “forward and up” (Alexander, 1985, p. 30). Forward and up “is a tiny extension of the head and spinal column” (Macdonald, 2015, p. 43). Based on the findings of this study, forward and up presents with a larger craniovertebral angle in conjunction with smaller trunk, thoracic, and thoracolumbar angles, resulting in an overall pattern of spinal extension. This contrasts with misuse. Misuse can present itself in many ways, including what is known as a pattern of “downward pull” (Conable & Conable, 1995, p. 2). This pattern is exhibited when the head is pulled towards the back while the neck juts forward (Barlow, 1990). The results of this study show that misuse is accompanied by a smaller craniovertebral angle and larger trunk, thoracic, and thoracolumbar angles. This presents an overall kyphotic curve of the spine, or flexion of the spine. However, it must be noted that according to the Alexander literature as well as teachers of the Technique, misuse is an “umbrella term for which no simple definition can be given” (Barlow, 2005b, p. 46). While the results of this study show that, in general, participants tended to demonstrate spinal flexion in misuse, there are a multitude of ways in which spinal posture can be manifested that is not in keeping with the teachings of the AT.

The results of this study show that in general, a larger craniovertebral angle, head tilt, and head-neck-trunk angle along with smaller trunk, thoracic, and thoracolumbar angles are displayed during good use in comparison with misuse, regardless of the task. Taken together, it is possible to see an overall pattern of extension in the spine during good use when compared with misuse, therefore demonstrating the relation between the head, neck, and back as defined by the AT.

In Cacciatore, Gurfinkel, Horak, and Day's (2011) study, the researchers found that the group of Alexander teachers demonstrated less change in spinal angles during tasks in comparison with the healthy adult control group. In this present study, the findings show that the range of angles is smaller in good use than in misuse, reflecting that there are fewer changes in postural angles in good use conditions. Perhaps the control group in the aforementioned study were exhibiting signs of misuse since they displayed more changes in angles during the task in comparison with the Alexander teachers. It is possible to surmise that those without training in the AT are apt to demonstrate misuse than good use, especially in comparison to those with training.

Dispersion Index

According to the literature (Conable & Conable, 1995; Mark, 2003), weight should be evenly distributed through the points of contact with the seat in good use, but the results of this study did not show any indication that the pressure applied to the seat approached a distribution of 50% of pressure on the left side and 50% on the right side any more in good use than in misuse. The findings show no discernible trend in dispersion index. In future research, other measures of pressure distribution (e.g., centre of pressure) could be examined to determine if there is indeed a difference in pressure between good use and misuse. Previous studies (Cacciatore, Gurfinkel, Horak, & Day, 2011; Cacciatore et al., 2014) have compared weight shift between healthy adults and Alexander teachers during sit-to-stand. The same comparison could be conducted while performing sitting tasks to provide a more accurate representation of how weight is distributed and whether there are particular patterns of weight shift during different sitting tasks.

Guidelines for Assessing Good Use

Based on the results of this study, a guideline for assessing good use in future research and practice can be established. The angles that show the clearest differences between good use and misuse are the craniovertebral, trunk, thoracic, and thoracolumbar angles. The craniovertebral angle should be larger following the AT intervention while the trunk, thoracic, and thoracolumbar angles should be smaller to correspond with the teachings of the AT. Because these angles show the most obvious differences, they should be included in future studies. Those studies are not limited to examining the differences between good use and misuse in AT practitioners but could be extended to studies that wish to determine if a change has occurred following an intervention in the AT. Measurement of the head tilt, head-neck-trunk, and lumbar angles should not be dismissed too quickly. The angles that show the most noticeable differences in this study may apply to Alexander teachers and trainees, but other populations may show changes in other areas as well. If there are differences, the pattern that should be seen following an intervention are a larger head tilt as well as a larger head-neck-trunk angle in keeping with Alexander teachings. It is not known what trend the lumbar angle will exhibit, if any, following lessons in the AT. In future research, it is possible to determine if a change has occurred by observing whether participants are showing the expected trend for each postural angle.

Conclusion

Students and teachers of the Technique often state that they feel a difference in their bodies after having taken lessons, but there has been little quantitative data to support this claim. This study demonstrates that good use is measurably different from misuse. That is, there is a difference in postural behaviour when applying principles of the Alexander Technique. The terminology used in the AT is vague, which is appropriate for the learning and applying of the method as it allows the student of the AT to focus on the whole self. The goal is not to perceive the body as separate parts, but as a whole functioning organism. However, vague terminology makes scientific study difficult as it is unclear what to observe should the Technique be researched from a quantitative perspective. The guidelines provided in this study give clearer suggestions of what can be measured. However, there are some limitations to this study. Participants were measured on a single occasion and future research would benefit from having participants perform the tasks several times and over the course of a few days to establish a more reliable measure of a person’s average baseline as well as to provide information about variability over time. Nevertheless, this study has shown that it is possible to distinguish between postural behaviour consistent with the idea of good use as described by the AT and misuse, not just in one situation, but across various tasks. Guidelines have been provided to differentiate spinal angles exhibiting principles of the AT from angles that do not and can be used to determine if changes have occurred following an AT intervention, providing a basis from which future research can proceed.

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Chapter 4: Postural Variability in Piano Performance

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Abstract

Variability is inevitable in human movement and posture, including piano performance, although little research has been conducted in this area. The purpose of this study was to determine if, when comparing individuals to themselves, pianists demonstrate consistent postural angles within a task across multiple measurements and to ascertain if, between various tasks, there are discernible task-related postural patterns. Fifteen pianists participated in this study. Each pianist returned for a total of three measurement sessions. The tasks they were required to perform at each session were quiet sitting, raising their hands on and off the keyboard, playing an ascending and descending scale, sight reading, and playing a piece in three expressive conditions (i.e., deadpan, projected, exaggerated). The following postural angles were calculated based on motion capture data collected during the performance of these tasks: craniovertebral angle, head tilt, head-neck-trunk angle, trunk angle, thoracic angle, thoracolumbar angle, and lumbar angle. The within-person variability ratio across the three measurements was calculated for each angle and across all tasks. Task-related patterns in angles were examined by comparing the same postural angle across different tasks. Results showed that there is a considerable amount of within-person variability, but not enough to be inconsistent over time. Task-related patterns indicate that reading a musical score or playing at the extreme ends of the keyboard tend to involve leaning closer to the instrument. Implications for future studies, intervention studies in particular, include taking more than a single baseline measurement to provide a more accurate picture of an individual pianist's typical posture.

Keywords: posture, postural variability, intraindividual variability, piano performance, multiple measurements, baseline measurements

Postural Variability in Piano Performance

It is generally accepted that there are multiple degrees of freedom involved in human movement which result in a multitude of ways that a task can be completed (Bernstein, 1967; Rosenbaum, 2010). Even after much training and practice, skilled individuals demonstrate changes while performing repeated tasks and cannot replicate them identically (Bartlett et al., 2007; Dhawale et al., 2017; Preatoni et al., 2013). This is known as *motor variability* which is when multiple repetitions of the same task result in varying patterns of kinetics, kinematics, muscle activation, and spatiotemporal measures (Chau et al., 2005; Latash et al., 2002). Variability is not necessarily a negative aspect of performance. Rosenblatt and colleagues (2014) differentiated between two types of variability, good variability and bad variability. *Good variability* does not affect the resulting performance while *bad variability* can affect the outcome (e.g., resulting in a fall in an older adult). For the purposes of this paper, variability will simply refer to changes in an outcome measure. Variability is not limited to movement alone. It also includes variation in posture (Srinivasan & Mathiassen, 2012). Variation is inevitable due to the numerous combinations of joint movements and muscle activities available to complete a task as well as the constraints that influence the resulting performance (Furuya & Altenmüller, 2013; Lipke-Perry et al., 2019). Types of constraints include individual (e.g., height, weight, motivation), environmental (e.g., temperature, lighting, sociocultural norms), and task constraints (e.g., goals of the task, equipment used) (Haibach et al., 2011; Newell, 1986). When researching variability, there are two variables that relate to task performance: execution and result variables. Joint angles are considered an execution variable while distance travelled is an example of a result variable (Müller & Sternad, 2009). It should be noted that variability seen in a result variable does not necessarily reflect differences in execution variables (Preatoni et al., 2013). For example, in music the same piece can be played with the same fingering, but the musical effect can be different.

Many studies that research variability examine athletics or daily human movement. Little research has been conducted with musicians, in particular pianists, although the field of music lends itself well to the study of variability. Timing is often the topic that is examined when researching piano performance and variability. Van Vugt, Jabusch, and Altenmüller (2012) examined how motor sequencing impacts the timing patterns of scale playing at the piano. Findings revealed that there were variations in timing throughout scale playing. In another study

(Demos et al., 2016), the researchers began with the assumption that there would be variability between repeated performances by the same pianist. The results showed that the performer tended to vary the tempo at phrase boundaries by slowing down. Variability in timing relative to task constraints were examined in Lipke-Perry and colleagues' (2019) study. Seven pianists played scales on three different pianos to determine if the equipment (i.e., piano) influenced timing consistency. The findings showed that similar patterns in timing were demonstrated across keyboards. However, when examining the repeated performance of scales, irrespective of the instrument, consistent deviations in timing were observed. Tominaga and colleagues (2016) began their research with the assumption that variation exists across performances. Their purpose was to identify possible causes of rhythmic and loudness inconsistencies in expert pianists from a kinematic perspective. The results showed that joint angle and angular velocity were related to variability in rhythm and loudness.

These studies have offered insight into repeated piano performances, but with a focus on result variables. Studying result variables increases our understanding concerning different performance outcomes, but they do not address variability within the performers themselves. It is important to examine execution variables as it is the action of the performer that produces the resulting performance. Because variability in result variables is not necessarily an indicator of variability in execution variables (Preatoni et al., 2013), it is necessary to make a separate study of the kinetics and kinematics of an individual during performance. Piano performance is area that requires a substantial amount of coordination from the individual (Furuta & Altenmüller, 2013). In studies that do examine the kinematics of pianists, but not necessarily variability, there is a focus on the upper extremities (Degrave et al., 2020; Furuya et al., 2011; Furuya et al., 2012; Minetti et al., 2007). Little attention is given to the posture of the performer, specifically spinal posture. Studies have shown that posture can affect movement in the upper limbs which is of importance to piano playing. Forward head posture and the degree of thoracic kyphosis can affect shoulder range of movement (Lewis et al., 2005) while an upright sitting posture, in comparison with an individual's natural sitting and slouched posture, can increase the distance between the acromion and the humerus, increasing the subacromial space. A decrease in this space can lead to pain in the shoulder joint and rotator cuff disorders (Kalra et al., 2010). It is worthwhile, then, to examine posture during piano performance tasks.

It is also interesting to examine whether the task influences spinal posture. Different tasks involve different task constraints, and it is important to determine if postural behaviour changes in various circumstances. This is applicable to future studies, including intervention studies. These types of studies involve a pre-intervention test, an intervention, and a post-intervention test. To determine if the intervention had an effect on the variables measured, it must be established prior to the intervention what influence the task may have on the behaviour of the participant. It is important to take into consideration the task and its influence on the outcome before drawing conclusions about the effect of the intervention on changes in the variables measured.

Most of the studies mentioned in this paper begin with the assumption that there will be variability between performances. If this is the case, what does it mean for intervention studies? If there are variations between performances, is a single measurement prior to an intervention sufficient to establish a baseline or a pianist's typical playing posture? If only one baseline measurement is taken and assuming there is variability between performances, can any changes that appear in post-tests be attributed to the intervention itself or to variability? In light of these questions, the purpose of this study was twofold:

1. To determine if individual pianists demonstrate consistent postural angles within a task across multiple measurements.
2. To determine if, when comparing various tasks, there are discernible postural patterns associated with specific tasks.

Method

Participants

Ethical approval was given by the Research Ethics Board of the University of Ottawa prior to the commencement of this study.[3] Fifteen pianists participated in this study. All participants had to meet at least one of the following requirements: completed Level 9 training in keeping with the standards of the Royal Conservatory of Music or its equivalent, or studied piano as their major instrument in university at the time of data collection, or studied piano as their major instrument in university prior to data collection. While those in the latter category were no longer active students, all still maintained some level of piano playing at the time of the study.

[3] See Appendix C for consent form and participant demographic and background questionnaire.

These requirements ensured that all pianists were able to play at an advanced level. There were 12 females and three males with a mean age of 35.33 ± 18.16 years.

Procedure

Prior to the beginning of the test session, reflective markers were placed on the tragus of the right ear; the spinous processes of C7, T5, T10, and L3; the sacrum; and the left and right greater trochanters of the femur. A headband was also placed on participants' heads with two markers at the front to indicate the glabella and two markers at the back indicating the external occipital protuberance. In addition, markers were placed on the posterior side of participants' left and right forearms (i.e., palm facing down) approximately 7 to 10 centimetres above wrist joint. Pianists sat on a height-adjustable bench in front of a digital piano (Yamaha Digital Piano P-255) and were permitted to change the height of the seat as well as the distance from the keyboard. This was done to reduce potential bias in the data from forcing a particular sitting arrangement. A 7-camera VICON Nexus motion capture system (Oxford Metrics) was used to record the position data of each reflective marker at 100Hz while the participants performed tasks. Video recordings were taken in the case that anomalies appeared in the data that required explanation. Participants performed a series of tasks during each test session. Tasks and task conditions (if applicable) were randomised for each participant and for each session. The first measurement, which will be referred to as "Measurement 1", was performed, following which a one-hour break was given to the participant. The markers were left on the participant during this time to minimize measurement errors. After the hour, the participant returned and performed the series of tasks again in a different order ("Measurement 2"). A week after the second measurement, the participant returned and performed the series of tasks again ("Measurement 3"). The spacing of the test sessions was to determine if participants exhibited similar postures over time.

Tasks

Pianists were to complete the following tasks: quiet sitting, raising both hands simultaneously from their laps onto the keyboard and back down to their laps ("raising hands task"), playing a bi-manual C-major scale in sixteenth notes at a tempo of 104bpm, sight reading, and playing mm. 1-12 of *Sonatina in C Major, op. 36, no. 3, First Movement* by Muzio Clementi.[4] Pianists received the score for the playing task at least a month in advance of their

[4] See Appendix D for protocol guide.

first test session and were informed of the exact excerpt they were to play. This excerpt was chosen because it required minimal lateral motion. Because the scale would allow for a study of posture during lateral motion, the piece was chosen to allow for a study of posture from a more central position relative to the keyboard. Participants were unaware that their postural behaviour was being measured during the quiet sitting task to prevent any alteration of posture from the knowledge that they were being assessed. The researcher stood in front of the participants as they sat in front of the keyboard and reviewed the protocol for the test session to ensure that participants would face the same direction for each trial while the measurements were being taken. For the raising hands task, pianists were asked to leave their hands on the keyboard until further instructions were given to lower their hands. This was to provide a clear indication to distinguish between when the hands were being raised onto the keyboard and when they were being lowered. For the scale, participants were requested to play an ascending and descending C-major scale from the lowest C on the keyboard to the highest C. This was to explore the pianist's full range of lateral motion. The participants were also asked to pause at the top of the scale as well as when they reached the bottom of the scale. This was to provide a clear marker for the researcher to distinguish between the ascending and descending portions of the scale. The tempo of the scale was selected in keeping with the Royal Conservatory of Music's Level 9 requirements. For the sight reading task, pianists played an excerpt from a piece of music they had never seen before. Confirmation that participants had never seen the piece prior to the test session were given following the playing of the excerpt. All participants played the same excerpt for the sight reading task with a new selection from a different piece given at each measurement session. Pianists were asked to play the excerpt (mm. 1-12) from the *Sonatina* a total of three times, each time in a different expressive condition: deadpan, projected, and exaggerated musical expression (Davidson, 1993). In the deadpan condition, participants were to play with as little expressive features as possible (e.g., no variation in dynamics or tempo). In the projected condition, pianists played as they normally would as for a peer, a teacher, or in a performance. In the exaggerated condition, pianists were to exaggerate all expressive features (e.g., tempo, dynamics). The various conditions were employed to determine that any changes seen in spinal angles were not the result of pianists' musical interpretation of the piece (Thompson & Luck, 2011). The score was placed on a fixed stand that was attached to the keyboard.

Data Collection

The following postural angles were calculated from the measurements taken from the right side of participants in the sagittal plane:

- Craniovertebral angle: formed by connecting the tragus and C7, relative to the horizontal
- Head tilt: formed by connecting the glabella and external occipital protuberance, relative to the horizontal
- Head-neck-trunk angle: formed connecting the tragus, C7, and the greater trochanter of the right femur
- Trunk angle: formed by connecting C7, T10, and the greater trochanter of the right femur
- Thoracic angle: formed by connecting C7, T5, and T10
- Thoracolumbar angle: formed by connecting T5, T10, and L3
- Lumbar angle: formed by connecting T10, L3, and the sacrum

Negative angles for the thoracic, thoracolumbar, and lumbar angles indicated lordosis while positive angles indicated kyphosis.

Data Analysis

Data were exported into MATLAB (MathWorks, R2017b) to calculate the angles. For the quiet sitting task, 10 seconds of data were taken from the middle to the end of the task, to assess pianists' typical spinal postures. This was done so that it was possible to examine participants' posture after they had time to adjust to sitting on the bench. Exceptions were made if there were missing data points in the stated time frame. For the raising hands task, data were taken from the point when the forearm markers began to rise from participants' laps to the point where they settled back onto the participants' laps. Data for the scale were taken from when the participant began playing the scale, as indicated by the forearm markers moving to the right of the keyboard, to the end of the scale when the forearm markers rested on the left side of the keyboard. For the sight reading and playing tasks, data were taken for the entire duration of the excerpt from when the pianist placed their hands on the keyboard to when they began to lower their hands back onto their laps, as indicated by the forearm markers.

Postural Variability Between Measurements

For this study, variability in posture rather than variability in movement was examined. Intraindividual variability, or variation within an individual, was the type of variability measured in this study. There are two kinds of intraindividual variability: variation in a person within a session, known as *dispersion,* and variation in a person from session to session, known as *inconsistency* (Costa et al., 2019; Hultsch & MacDonald, 2004). Inconsistency is the type of intraindividual variability that was examined in this study.

The tasks involved in this study did not require significant movement of the head, neck, and back. It was assumed that the posture of the head, neck, and back would be relatively stable throughout the course of each task. This allowed an average of each angle related to the head, neck, and back to be taken for each task to provide a representation of a pianist’s general posture during the performance of a specific task. While the tasks required pianists to move their arms and hands, the movements themselves were not the focus – attention was given to the posture exhibited by the pianist. It was also assumed that although the posture of the torso would be relatively stable, it would not be completely static. The standard deviations of each angle related to the head, neck, and back could represent postural sway, indicate participants moving closer to the music stand to read the score, or indicate participants reaching for keys that were further away. If participants demonstrated large fluctuations in torso movements, the mean and standard deviation calculations did not distinguish these from postural sway or movements related to participants interacting with the keyboard.

To examine whether individual pianists demonstrate consistent postural angles within a task across multiple measurements, the method described by Salthouse (2007) was used to determine whether participants varied substantially from one measurement to another. In this method, the ratio of the mean within-person standard deviation across the three measurements to the standard deviation of the between-person means across the three measurements was obtained. The ratio is therefore a direct comparison of the within-participant variability to the between-person variability. Stated more simply, the ratio compares the typical amount of change that a single person undergoes from one time point to another with the amount of change observed from one person to another. This ratio is compared against a value of 1 (Fagot & Mella, 2015), with the latter representing the situation where individuals differ as much within themselves over time as they do from each other. This will be referred to as the within-person variability ratio.

The process to calculate the within-person variability ratio is as follows. The mean for each individual's set of angles was calculated across time points (hundredths of a second). Outliers (i.e., any value with a *z*-score greater than 1.96 or less than -1.96) were identified and Winsorized and expectation maximization was used to impute any missing data points.

For each individual participant, seven postural angles were measured for each task in each of the three measurement sessions.

For each measured angle, the mean was calculated to represent the average position of a person's posture throughout each task.

To determine how much individual participants varied between sessions, the standard deviation across all three sessions for each angle was calculated. This standard deviation represented how much each participant varied in posture across all three sessions. The average of all participants' standard deviations was then calculated to provide the *mean within-person standard deviation*.

The mean angle of each participant for each task was calculated across all three sessions. This mean represented the average position of a person's posture throughout all three sessions for each task. The standard deviation of all participants' mean angles was then calculated to provide the standard deviation across all participants, or the *standard deviation of the between-person means*.

The *mean within-person standard deviation* was then divided by the *standard deviation of the between-person means* to obtain the *within-person variability ratio* (Salthouse, 2007). This ratio compared the amount of change within a person to the amount of change between people. Recall that the standard deviation does not allow for differentiation between systematic movements and unsystematic variations in posture.

Tasked-Related Postural Patterns

To examine if there were task-related postural patterns, repeated-measures ANOVAs were run to determine if there were significant differences between tasks for each postural angle. As sphericity was violated ($p > .05$) for all analyses, a Huynh-Feldt correction was applied. Pairwise comparisons were conducted with Holm-Bonferroni corrections to determine which tasks, if any, were significantly different for each angle.

Results

Postural Angles Within Tasks

Overall, when comparing angles and tasks across measurements, the within-person variability ratio was .46 (see the median of medians in the bottom right corner of Table 1). This means that individuals' postural angles changed about half as much over time as postural angles changed across participants. In other words, within-person variability is about half as much as between-person variability. This is a substantial amount of within-person variability (Salthouse, 2007), though it is far enough below a value of 1 to indicate that people show fair consistency over time (Fagot & Mella, 2015). The differences from angle to angle are informative: people demonstrated relative consistency over time and tasks in their craniovertebral angle and their thoracic angle (with median ratios of .37 and .34, respectively), while they showed relative variability over time and tasks in their trunk angle (with a median ratio of .60). The within-person variability ratios were remarkably consistent across repeated performances of the tasks, though people were a little more consistent over time when playing a scale and when engaged in exaggerated playing (median ratios of .38 and .39, respectively) and a little less consistent over time when engaged in deadpan playing (median ratio of .53).

Table 1

Within-Person Variability Ratios

Task	CVA	HT	HNT	Tr	Th	TL	Lu	Median
Quiet sitting	0.35	1.04	0.39	0.72	0.34	0.92	0.47	0.47
Raising hands	0.34	0.53	0.41	0.53	0.33	0.59	0.49	0.49
Scale	0.37	0.40	0.42	0.53	0.29	0.38	0.33	0.38
Sight reading	0.44	0.45	0.41	0.60	0.34	0.60	0.49	0.45
Playing (deadpan)	0.41	0.54	0.43	0.56	0.37	0.53	0.53	0.53
Playing (projected)	0.40	0.46	0.48	0.60	0.39	0.46	0.48	0.46
Playing (exaggerated)	0.32	0.39	0.34	0.70	0.32	0.52	0.52	0.39
Median	0.37	0.46	0.41	0.60	0.34	0.53	0.49	0.46

Note. CVA: craniovertebral angle. HT: head tilt. HNT: head-neck-trunk angle. Tr: trunk angle. Th: thoracic angle. TL: thoracolumbar angle. Lu: lumbar angle. The ratios in this table are computed by taking the mean of the within-person standard deviations (across the three time points) and dividing it by the standard deviation of the between-person means (across the three time points).

Task-Related Postural Patterns

Comparisons of postural angles across tasks are presented in Table 2. Results showed that for each angle, significant differences were found across all tasks with moderate to large effect sizes, indicating that participants' postures varied widely between tasks.

Pairwise comparisons showed that the craniovertebral angle was significantly larger in the quiet sitting and raising hands tasks in comparison with the playing task in all conditions (i.e., deadpan, projected, and exaggerated) as well as the scale and sight reading tasks. The craniovertebral angle was also significantly larger in the deadpan playing task in comparison with the projected playing, exaggerated playing, scale playing, and sight reading tasks. In addition, the craniovertebral angle was significantly larger in the projected and exaggerated playing tasks in comparison with the sight reading task.

For head tilt, significantly larger angles were displayed in the quiet sitting task in comparison with all other tasks. Head tilt was also larger in the raising hands and deadpan playing tasks in comparison with the projected playing, exaggerated playing, scale playing, and sight reading tasks. Both projected and exaggerated playing tasks exhibited significantly larger head tilt angles in comparison with the scale and sight reading tasks.

Concerning the head-neck-trunk angle, significantly larger angles were demonstrated in the quiet sitting and raising hands tasks in comparison with all other tasks. Again, a significantly larger angle was displayed in the deadpan playing task in comparison with the projected playing, exaggerated playing, scale, and sight reading tasks. The head-neck-trunk angle was also significantly larger in the projected playing and exaggerated playing tasks in comparison with the sight reading task.

The trunk angle was significantly larger in the sight reading task in comparison with the exaggerated playing, projected playing, deadpan playing, quiet sitting, and raising hands tasks. The exaggerated playing task demonstrated a significantly larger trunk angle than the deadpan playing, quiet sitting, and raising hands tasks. The trunk angle was also significantly larger in the projected playing task in comparison with the quiet sitting and raising hands tasks. The angles demonstrated in the scale and deadpan playing tasks were significantly larger than the one exhibited in the raising hands task.

For the thoracic angle, significantly larger angles were found in the sight reading task in comparison with the playing task in all conditions (i.e., deadpan, projected, exaggerated) and with the quiet sitting and raising hands tasks. The thoracic angles demonstrated in the scale playing tasks was significantly larger than the ones shown in the quiet sitting and raising hands tasks. Thoracic angles demonstrated in the projected playing and exaggerated playing tasks were significantly larger than the one exhibited in the raising hands task.

Results for the thoracolumbar angle demonstrated significantly larger angles in the scale task in comparison with the projected playing, deadpan playing, quiet sitting, and raising hands tasks. The thoracolumbar angle displayed in the sight reading task was also significantly larger than in the deadpan playing, quiet sitting, and raising hands tasks. The thoracolumbar angle exhibited in the projected playing and exaggerated playing tasks were significantly larger than those in the quiet sitting and raising hands tasks.

Concerning the lumbar angle, the angle displayed in the scale playing task was significantly larger in comparison with those shown in the quiet sitting and raising hands tasks as well as all conditions of the playing task.

Table 2

Comparison of Postural Angles Across Tasks

Angle	Task							F	p	η_p^2
	Quiet Sitting	Raising Hands	Scale	Sight Reading	Playing (Deadpan)	Playing (Projected)	Playing (Exaggerated)			
CVA	51.36° [a]	48.64° [a]	35.54° [c, d]	31.07° [d]	43.49° [b]	38.28° [c]	37.89° [c]	42.59	<.001	0.75
	(5.63°)	(7.47°)	(8.24°)	(9.11°)	(7.63°)	(7.59°)	(9.04°)			
HT	23.60° [a]	11.53° [b]	-4.04° [d]	-5.36° [d]	5.33° [b]	3.21° [c]	1.98° [c]	49.03	<.001	0.78
	(4.83°)	(8.59°)	(8.90°)	(8.94°)	(8.69°)	(8.30°)	(8.85°)			
HNT	148.65° [a]	147.77° [a]	127.31° [c, d]	121.78° [d]	139.45° [b]	132.13° [c]	131.30° [c]	40.89	<.001	0.75
	(7.67°)	(8.75°)	(12.37°)	(14.10°)	(11.12°)	(11.13°)	(13.20°)			
Tr	228.56° [d, e]	227.95° [e]	232.89° [a, b, c, d]	236.48° [a]	230.93° [c, d]	232.35° [b, c]	232.79° [b]	14.32	<.001	0.51
	(5.31°)	(6.69°)	(6.32°)	(6.11°)	(5.81°)	(5.77°)	(5.92°)			
Th	22.96° [c, d]	22.90° [d]	25.75° [a, b]	26.26° [a]	24.16° [b, c, d]	24.63° [b, c]	24.64° [b, c]	11.49	<.001	0.45
	(4.98°)	(5.04°)	(3.85°)	(5.47°)	(5.38°)	(5.10°)	(5.36°)			
TL	-0.15° [d, e]	-1.30° [e]	7.33° [a]	6.11° [a, b]	2.19° [c, d]	3.97° [b, c]	4.32° [a, b, c]	17.14	<.001	0.55
	(5.28°)	(6.81°)	(8.03°)	(7.31°)	(7.11°)	(8.03°)	(7.39°)			
Lu	-7.24° [b]	-8.66° [b]	-4.81° [a]	-6.01° [a, b]	-7.99° [b]	-6.48° [b]	-6.65° [b]	10.68	<.001	0.43
	(4.88°)	(4.80°)	(5.23°)	(5.32°)	(4.60°)	(5.00°)	(4.75°)			

Note. CVA: craniovertebral angle. HT: head tilt. HNT: head-neck-trunk angle. Tr: trunk angle. Th: thoracic angle. TL: thoracolumbar angle. Lu: lumbar angle. Cell entries are means across all three measurements along with the standard deviation of these means in parentheses. Means with differing superscripts differed significantly in pairwise comparisons following a Holm-Bonferroni post-hoc correction. Holm-Bonferroni corrections are for all 21 pairwise comparisons between tasks for a given angle.

Discussion

Many studies have examined variability by focusing on the outcome of the performance (e.g., loudness, tempo changes). Those that have studied pianists' kinematics and kinetics often focused on the upper extremities, but this present study focused on posture which can affect the upper extremities (Kalra et al., 2010; Lewis et al., 2005). Variability within a task was examined by determining if similar postural angles were demonstrated across multiple measurements. The findings show that in general, there is a considerable amount of within-person variability, but not so much as to be too inconsistent over time. When comparing within individuals, pianists' postural angles may change half as much as when comparing with other pianists. The craniovertebral and thoracic angles exhibit the least amount of variability across multiple measurements and across tasks while the trunk angle demonstrated the most amount of variability. These variabilities in postural angles may also imply some variabilities in the motion of the hands, arms, and shoulders due to the influence of spinal posture on the movement of the upper extremities, but further investigations are needed to explore this phenomenon.

The results of this study also revealed task-related postural patterns. The craniovertebral angle, head tilt, and head-neck-trunk angle appeared to be larger in tasks that required less movement (i.e., quiet sitting, raising hands, and deadpan playing tasks) while the trunk, thoracic, and thoracolumbar angles were generally larger in the sight reading task in comparison with other tasks. These results may indicate that tasks requiring less movement may allow pianists to sit in a more upright position. The angles demonstrated in the scale playing task were also significantly different in comparison with the quiet sitting and raising hands tasks, indicating that pianists may lean closer to the keyboard to reach keys at the extreme ends of the keyboard. In addition, the smaller craniovertebral angle, head tilt, and head-neck-trunk angle along with simultaneously larger trunk, thoracic, and thoracolumbar angles demonstrated during the sight reading task may infer that pianists need to lean closer to the keyboard in comparison with other tasks. While both the playing and sight reading tasks required pianists to read a score, the overall shape of pianists' spines appeared to be more kyphosed with increased forward head posture in the sight reading task than in the playing task which may indicate that pianists lean in closer to read an unfamiliar score than when reading a score with which they are familiar. The craniovertebral angle, head tilt, head-neck-trunk angle, trunk angle, and thoracic angle displayed in all conditions of the playing task indicated a more upright posture in comparison with those demonstrated in the sight reading tasks.

A limitation of this study was its small sample size. However, based on the variety of tasks that were examined individually in this study and their results, it can still be seen that although individual pianists display some postural variability, there is a level of consistency displayed in their postures between measurements.

The results of this study have implications for future studies, in particular intervention studies. While it may be possible to take a single baseline measurement prior to beginning an intervention, it may not be the best practice. Spinal posture, although demonstrating some consistency, still demonstrates variability across time. It may be better practice to take the average of several baseline measurements to present a more comprehensive picture of the pianist’s typical postural behaviour. Additionally, it may be beneficial to examine posture in a variety of tasks to ensure that the findings of future studies are not a result of the task’s influence.

Conclusion

Pianists exhibit variability in postural angles between multiple measurements within a task. This raises the issue of whether the postural angles seen on one day are representative of pianists’ postural behaviours every day in the context of that task. In an intervention study, changes attributed to the method that are being researched would be less reliable as it would be uncertain whether those differences were due to variability or to the method itself. This study took a total of three measurements which was sufficient to demonstrate variability, but at the same time establish individual pianists’ average playing postures. Because of the relatively consistent posture demonstrated across measurements within individuals despite the variability shown, it is possible to take an average of the angles demonstrated at each measurement to represent a pianist’s typical posture. Another finding of this study shows that the task influences the posture of the pianist. The benefit of examining a variety of tasks is the possibility of studying pianists’ postures in different contexts. Taken together, this is a more comprehensive representation of a pianist’s typical playing posture and can be used as a baseline in future intervention studies.

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Chapter 5: The Effect of the Alexander Technique on Pianists' Postures During Performance

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Abstract

The Alexander Technique (AT) is a somatic method often employed by musicians, including pianists, which teaches its students to become consciously aware of their own postural behaviour while carrying out various tasks, to evaluate whether it is beneficial for completing them, and to change the behaviour if necessary. Little research has been conducted as to whether and, if so, how the AT affects the posture of pianists while they are playing the piano, and quantitative measurements of their postural angles have not yet been taken. The purpose of this study was to determine the potential effects of an intervention consisting of 10 AT lessons on pianists' postural angles while playing and to find out if the effects persisted four weeks later. The following postural angles were measured before and after the intervention: craniovertebral angle, head tilt, head-neck-trunk angle, trunk angle, thoracic angle, thoracolumbar angle, and lumbar angle. There were significant effects ($p \leq .05$) of the intervention such that, as predicted, craniovertebral and head-neck-trunk angles were found to have increased, and trunk, thoracic, and thoracolumbar angles were found to have decreased both immediately post-intervention and four weeks later. The AT appears to be a viable method of altering postural behaviour while playing the piano, as seen in an overall pattern of spinal extension.

Keywords: posture, spinal posture, postural angles, pianists, Alexander Technique

The Effect of the Alexander Technique on Pianists' Postures During Performance

The Alexander Technique (AT) is a somatic method that is sought after by musicians as it is thought to enhance performance by "improving ease and freedom of movement, balance, support, flexibility, and coordination" (Conable & Conable, 1995, p. 1). This is achieved by teaching students of the AT to recognize and alter counterproductive postural behaviour (Cacciatore et al., 2011; Cacciatore et al., 2020; Macdonald, 2015). The postures and movements of musicians can affect the sounds they make (Klein et al., 2014; Shoebridge et al., 2017). The AT can help change their usual postures which in turn could improve their music making. In AT terminology, *use* is the word to describe changes in posture over time throughout tasks, albeit in a very narrow sense (Barlow, 1990; Jones, 1997). Behaviour that "[distorts]…the muscular and bony framework" (Barlow, 2005, p. 46) is termed *misuse* while behaviour that involves "a coordinated and balanced distribution of muscle tension throughout the body" is termed *good use* (Valentine, 2004, p. 179). In order to change the use of the body, students are taught a set of verbal directions that bring their awareness to the amount of tension in their body. This sequence of instructions also helps them to return to a balanced muscular state (Barlow, 1990). In conjunction with these directions, the Alexander teacher provides the physical sensation accompanying this sequence through touch.

Although learning the AT may improve musical performance, the Technique itself does not work directly on music-making skills. Instead, its focus is to teach students AT principles and how to apply those principles practically to daily living. These principles relate to the axial structure of the body and provide verbal directions on how to prepare the body for movement. One of the core principles of the AT is the *primary control*. This is defined as a relationship between the head, neck, and trunk (Alexander, 1946; Conable & Conable, 1995) and is essential in determining the quality of movement, or how well the body functions (Jain et al., 2004). Pianists in particular focus a great deal on their upper extremities. However, from an AT perspective, the movement of these parts are a by-product of the behaviour of the head, neck, and trunk (Bosanquet, 1987). According to Brandes and colleagues (2020), "it is not well understood [by piano teachers] that a collapsed spine may cause shoulder tension and thereby poor coordination in the hands and arms" (p. 17). Attention should primarily be given to learning the Technique before applying it to piano performance.

To date, little research has been conducted on the AT and pianists specifically concerning changes in posture. Some studies (e.g., Armstrong, 1975) have looked at the effects of the AT on anxiety while providing only a cursory glance at posture. Kaplan (1994) conducted an exploratory study of six pianists' experiences of the AT. She conducted two to three in-depth interviews with each participant, each one lasting approximately one and half to two hours. After identifying "major themes and patterns" (p. 32), the findings of the study demonstrated that pianists initially sought lessons in the Technique because they experienced pain, discomfort, or excessive muscular tension while playing. Pianists also stated that the Technique "[allowed] for continuous improvement and change" (p. 178) in their posture through the application of AT principles and was a helpful tool in identifying and changing habits in various activities, as well as in releasing excessive muscular tension.

Santiago (2004) examined the extent to which the AT helped young piano students improve performance, specifically in relation to musical quality (e.g., tone) and posture. Twenty students between the ages of 10 and 14 participated and were randomly assigned to the control or experimental group. The experimental group received eight weeks of 15- to 20-minute lessons in the AT while the control group attended sessions about mythology. Video recordings taken after the intervention period were assessed by the piano teachers who taught the students in the study, piano teachers who did not teach the students, three doctors, and four AT teachers. The results of these evaluations revealed that the AT appeared to be able to influence posture and tension although the tone quality of both groups had improved post-intervention.

Loo et al. (2015) investigated the effects of the AT on muscular tension in 15 undergraduate piano performance students, all of whom reported feeling excessive muscular tension prior to the beginning of the study. Participants used a 5-point Likert-type scale to rate the amount of tension they experienced in their "fingers, hands, arms, wrists, shoulders, back, legs, and neck" (p. 2414) before and after receiving 14 weekly group lessons in the AT, each session lasting for three hours. During each session, participants received one-to-one instruction for ten minutes while the others observed. Post-intervention, participants demonstrated a statistically significant reduction in muscular tension, suggesting that the AT has the potential to help relieve excessive tension in pianists.

Brandes and colleagues (2020) examined how the AT can be applied by a piano teacher in the context of teaching a lesson. This case study was conducted by video-recording six piano lessons with a seven-year-old student who played at the skill level of Royal Conservatory of Music Level 2. Four piano teachers and AT teachers watched, coded, and commented on what they observed in the videos. The authors concluded that it is possible to integrate AT into piano lessons by using it as a tool to observe and assess students as they play. However, the piano teacher who wishes to use the AT in their lessons must have had experience with the Technique in order for Alexander concepts to be used during lessons.

Most research to date on the AT and pianists has mentioned posture in brief and has not quantified differences before and after lessons in the AT using quasi-experimental or experimental means. Rather, studies have utilized self-report rating scales (Loo et al., 2015) and qualitative methods (Brandes et al., 2020; Kaplan, 1994; Santiago, 2004). Muscular tension is a common theme in the papers reviewed, although in most cases it is not the main focus. However, from the perspective of the AT, tension is an outcome resulting from the use of the body, and use is affected by the primary control. This can be measured to a certain degree by examining spinal angles to determine the shape of the spine in various tasks. Very little research has been conducted concerning spinal angles while sitting or carrying out tasks while employing the AT. However, Cacciatore and colleagues (2005) conducted a detailed case study in which they followed a 49-year-old woman with low back pain through her experience with the AT. Lateral curvature in her trunk at the level of L3 was one of the variables that was examined during a quiet standing task. Before she started taking AT lessons she had a more leftward curvature, but when they measured the curvature after the lessons had ended they found that it had shifted towards the right, indicating a more symmetrical lumbar spine. In a subsequent study Cacciatore and colleagues (2011) asked AT teachers and healthy adults who did not have training in the AT to carry out a sit-stand task (i.e., they were asked to stand from a sitting position) and examined the two groups' patterns of spinal coordination. There was less movement in the cervical, thoracic, and lumbar spine of the AT teachers than the non-AT participants throughout the task.

Wong and colleagues (2022a) conducted a study to determine which spinal angles were most likely to change and how they would change following AT lessons. Teachers and students training to be teachers of the AT performed a series of tasks twice, once while applying the principles of the AT and once while not applying them. The results suggested that the craniovertebral angle, head tilt, and head-neck-trunk angle could be expected to increase after a period of studying the AT while trunk, thoracic, and thoracolumbar angles could be expected to decrease, both sets of changes representing spinal extension. This study showed that it is possible to find out if the AT can be used to alter postural behaviour by measuring changes in spinal angles, as such changes represent changes in posture. In general, most research on the AT and pianists is anecdotal. Little quantitative research has been reported, and objective measurements of change are lacking, as are studies of its lasting effects. Klein and colleagues (2014) have argued that research on the effects of the AT on musicians should be better designed. The purpose of the present study was therefore twofold, to determine 1) the potential effects of an intervention consisting of 10 AT lessons, such that there would be quantifiable changes, post-intervention, on pianists' postural angles while playing, and 2) if these effects persisted four weeks later.

Method

Participants

A total of 15 pianists (12 females, 3 males) with a mean age of 35.33 ± 18.16 years volunteered to take part in the study. To ensure that they were all capable of playing at approximately the same skill level, participants were required to be playing at Level 9 or higher as determined by the Royal Conservatory of Music, studying piano as their major instrument at a university, or had studied piano as their major instrument at a university. None had previously taken more than two one-to-one (private) AT lessons. All participants gave their informed consent.

Procedure

Before taking part in the first of three baseline measurement sessions and the intervention itself, participants completed a questionnaire gathering demographic information (i.e., age, gender), playing history (i.e., number of years playing piano, highest level of playing achieved, post-secondary education, number of hours of practice per day, number of days of practice per week), and any previous experience they may have had with the AT or any other somatic method (e.g., Feldenkrais Method, Body Mapping).[5] They were instructed not to begin any new activity (e.g., yoga) other than the AT for the duration of the intervention and not to continue AT lessons between the fourth measurement session, which took place within a week of the participant's last AT lesson, and the fifth measurement session, which took place four weeks later.

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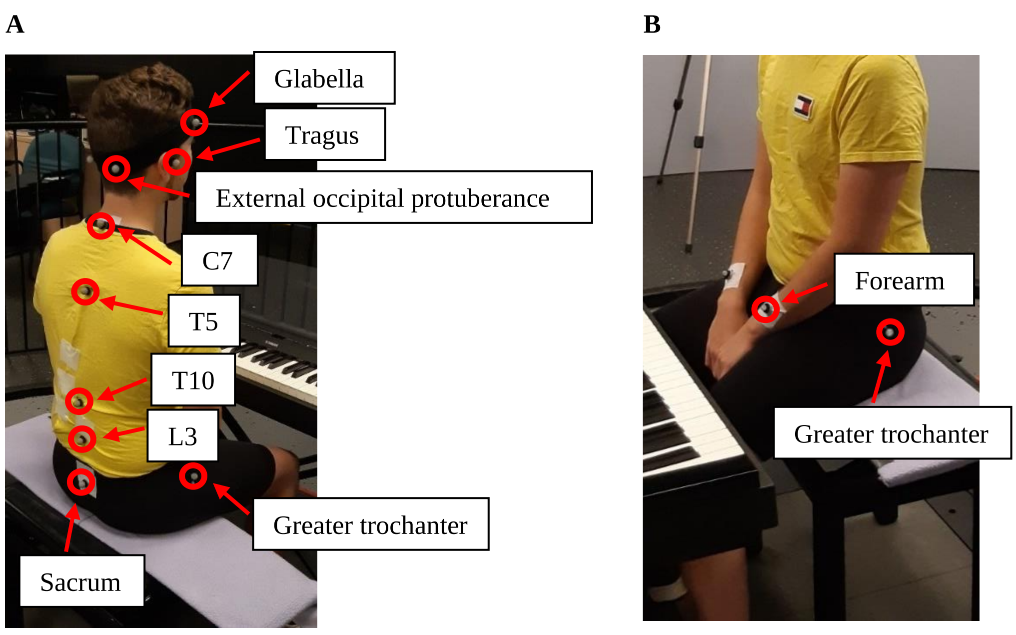
[5] See Appendix C for consent form and participant demographic and background questionnaire.

In the first measurement session, reflective markers were placed on the following anatomical locations (see Fig. 1): the tragus of the right ear, the spinous processes of C7, T5, T10, and L3, the sacrum, the left and right greater trochanters of the femur, and the posterior side of participants' left and right forearms (i.e., palm facing down) approximately 7 to 10 centimetres above the wrist joint. A headband with four reflective markers was placed on their heads. Two markers at the front indicated the glabella and two markers at the back indicated the external occipital protuberance. After the markers had been attached, participants sat in front of a digital piano (Yamaha Digital Piano P-255) on a height-adjustable bench. They were permitted to change the height of the bench as well as the distance from the keyboard. Then they performed five tasks, described below, in a randomized order. The position data of each reflective marker was recorded using a 7-camera VICON Nexus motion capture system (Oxford Metrics) at 100Hz. Video recordings were also taken in case of anomalies in the data that needed to be explained. The same procedure was followed in the second baseline measurement session an hour later and the third session one week after the second session.

Figure 1

Marker Placement



Note. Panel A: Marker placement on head, spinous processes, and trochanter. Panel B: Marker placement on forearms and trochanter.

After the baseline measurements had been taken, all participants received 10 private AT lessons in a two-week period from eight teachers certified by the Canadian Society of Teachers of the Alexander Technique or the Society of Teachers of the Alexander Technique. Each participant was assigned to one teacher who taught them for the duration of the intervention, the number of lessons and their spacing having been discussed with and recommended by the director of the local school of AT. The post-intervention and 4-week follow-up measurement sessions followed the same procedure used in the baseline measurement sessions.

Data Collection

Pianists completed a series of five tasks during each of the test sessions.[6] Participants' typical sitting postures were measured in the quiet-sitting task, whereby participants sat facing the keyboard while the researcher stood in front of them reviewing the protocol for the session. Participants were not told that measurements were being taken to reduce the possibility that they might consciously or unconsciously alter their posture. Ten seconds of data taken from the middle to the end of the task were analysed.

In the raising hands task, participants lifted both hands simultaneously from their laps onto the keyboard in front of them where they were asked to leave their hands until told to return them to their laps. The data analysed were taken from the point when the forearm markers began to rise from participants' laps to when they had been returned.

In the scale-playing task, participants played an ascending and descending C-major scale with both hands in sixteenth notes at a tempo of 104bpm.They started from the lowest C on the keyboard and played to the highest C, pausing with their hands on the keyboard until told to play the descending portion of the scale. Again, they left their hands on the keyboard until asked to remove their hands. The data analysed were taken from the beginning of the task (i.e., when the forearm markers began to move toward the right side of the keyboard) to the end (i.e., when the hands rested on the left side of the keyboard).

In the sight-reading task, participants played an excerpt from a musical score they had never seen before. All participants played the same excerpt, but different excerpts were used in each session.

In the playing task, participants played the first 12 measures of the first movement of Muzio Clementi's *Sonatina in C Major, op. 36, no. 3.* They had received the musical score

[6] See Appendix D for protocol guide.

before taking part in the first baseline measurement session so that they could familiarize themselves with it. To ensure that any changes in spinal angles were not the result of playing with musical expression (Thompson & Luck, 2011), participants were asked in each session to play the excerpt three times in three expressive conditions: deadpan, projected, and with exaggerated musical expression. In the deadpan condition, participants were to play with little to no variation in expressive features (e.g., tempo, dynamics). In the projected condition, they were to play as they usually would for a colleague, a teacher, or in a performance. In the exaggerated condition, they were to exaggerate all expressive features. The data analysed in both sight reading and playing tasks were taken for the duration of the entire excerpt from the moment the pianists placed their hands onto the keyboard to the point where they began to move their hands back onto their laps, as indicated by the forearm markers.

The following angles were calculated using the position data recorded by the motion capture cameras. Measurements were taken from the right side of the body in the sagittal plane:

- Craniovertebral angle: formed by connecting the tragus and C7, relative to the horizontal
- Head tilt: formed by connecting the glabella and external occipital protuberance, relative to the horizontal
- Head-neck-trunk angle: formed connecting the tragus, C7, and the greater trochanter of the right femur
- Trunk angle: formed by connecting C7, T10, and the greater trochanter of the right femur
- Thoracic angle: formed by connecting C7, T5, and T10
- Thoracolumbar angle: formed by connecting T5, T10, and L3
- Lumbar angle: formed by connecting T10, L3, and the sacrum

Kyphosis in the thoracic, thoracolumbar, and lumbar areas were indicated by positive angles while lordosis was indicated by negative angles.

Data Analysis

Data were exported into MATLAB (MathWorks, R2017b) to calculate postural angles. The mean of each participant’s angles in each measurement session was calculated across time points in hundredths of a second. Values with a *z*-score greater than 1.96 or less than -1.96 were considered outliers and Winsorized. Expectation maximization was used to impute missing data points. As Wong and colleagues (2022b) had shown that it is possible to obtain an overview of a participant's typical posture from the mean of multiple measurements, the angles were averaged across the three baseline sessions to provide a single pre-intervention score. Repeated-measures ANOVAs were conducted using SPSS to compare the pre-intervention, post-intervention, and follow-up measurements. Because this is the first study to explore pianists' postures following AT lessons from a quantitative perspective, no corrections were made to prevent missing any potentially important results. A Huynh-Feldt correction was applied if sphericity was violated and a value of $p \leq .05$ was considered statistically significant. The repeated-measures ANOVAs indicated whether there was any change across the three time points and did not specify exactly where the changes took place. Thus, following the repeated-measures ANOVAs that were statistically significant, to determine which pairs of the time points were significantly different, comparisons of estimated marginal means were conducted; because there were multiple pairwise comparisons being conducted, the alpha levels were adjusted using Holm-Bonferroni corrections for three analyses. In the three pairwise comparisons, the smallest *p*-value was considered significant if below .0167, the middle *p*-value was considered significant if below .0250, and the largest *p*-value was considered significant if below .0500. Graphs were created to illustrate any trends between the pre-intervention, post-intervention, and follow-up angles. Multiple linear regression determined if age, number of years playing piano, highest pianistic level achieved, number of hours practiced per day, and number of days practiced per week had an influence on the post-test results found in the repeated-measures ANOVAs.

Results

The statistical results for comparisons within the quiet sitting task are presented in Table 1. Significant differences were found in the craniovertebral, head-neck-trunk, trunk, and thoracic angles with small to moderate effect sizes. Pairwise comparisons demonstrated that the craniovertebral angle was significantly larger in the post-test in comparison with the baseline while there was no difference between the post-test and the follow-up. There was also no significant difference between the baseline and the follow-up. For the head-neck-trunk angle, there was no significant difference between the post-test and the follow-up, but both were significantly larger than the baseline. Pairwise comparisons for the trunk angle revealed that the means from each measurement were not significantly different from each other. Pairwise comparisons for the thoracic angle showed that while the baseline and follow-up were not significantly different from each other, the post-test was significantly smaller than both the baseline and the follow-up.

Table 1

Postural Angles Between Baseline Measurements, Post-Test, and Follow-Up during Quiet Sitting

Angle	Baseline		Post-Test		Follow-Up		$F(2, 13)$	p	η_p^2
	M (°)	*SD (°)*	*M (°)*	*SD (°)*	*M (°)*	*SD (°)*			
Craniovertebral angle	51.36 [b]	5.63	53.06 [a]	5.64	52.54 [a, b]	4.23	3.70	0.038	0.21
Head tilt	23.60	4.83	21.56	6.77	23.15	6.50	1.21	0.314	0.08
Head-neck-trunk angle	148.65 [b]	7.67	151.53 [a]	6.92	151.67 [a]	5.40	8.03	0.002	0.36
Trunk angle	228.56 [a]	5.31	224.20 [a]	7.79	227.87 [a]	5.46	3.92	0.032	0.22
Thoracic angle *	22.96 [a]	4.98	20.53 [b]	5.84	21.65 [a]	5.77	6.20	0.013	0.31
Thoracolumbar angle *	-0.15	5.28	-2.44	7.19	-0.38	5.66	1.73	0.203	0.11
Lumbar angle	-7.24	4.88	-9.50	5.58	-7.87	4.99	2.10	0.142	0.13

Note. Means with differing superscripts were significantly different ($p \leq .05$) following a Holm-Bonferroni correction which assumed three different analyses. Means with the same superscript were not significantly different following a Holm-Bonferroni correction.

* Uses Huynh-Feldt correction

Table 2 shows the results for comparisons within the raising hands task. Significant differences were found for the head-neck-trunk, trunk, and thoracic angles with small effect sizes. However, pairwise comparisons for these angles showed there were no significant differences between the baseline, post-test, and follow-up.

Table 2

Postural Angles Between Baseline Measurements, Post-Test, and Follow-Up during Raising Hands

Angle	Baseline		Post-Test		Follow-Up		$F(2, 13)$	p	η_p^2
	M (°)	*SD* (°)	*M* (°)	*SD* (°)	*M* (°)	*SD* (°)			
Craniovertebral angle	48.64	7.47	50.45	6.36	49.62	7.28	1.14	0.334	0.08
Head tilt	11.53	8.59	11.16	8.00	9.94	11.09	0.30	0.740	0.02
Head-neck-trunk angle	147.77 [a]	8.75	151.02 [a]	6.48	151.03 [a]	8.36	3.44	0.046	0.20
Trunk angle	227.95 [a]	6.69	222.73 [a]	7.76	225.60 [a]	4.17	4.42	0.022	0.24
Thoracic angle	22.90 [a]	5.04	21.08 [a]	5.55	21.68 [a]	5.96	3.54	0.043	0.20
Thoracolumbar angle *	-1.30	6.81	-3.14	6.57	-2.53	4.46	0.97	0.376	0.06
Lumbar angle	-8.66	4.80	-11.11	6.18	-9.44	5.15	2.17	0.133	0.13

Note. Means with differing superscripts were significantly different ($p \leq .05$) following a Holm-Bonferroni correction which assumed three different analyses. Means with the same superscript were not significantly different following a Holm-Bonferroni correction.

* Uses Huynh-Feldt correction

The results for the scale task showed significant differences for all angles with the exception of the head tilt (Table 3). The craniovertebral angle demonstrated a large effect size while the head-neck-trunk, trunk, thoracic, and thoracolumbar angles showed moderate effect sizes. The lumbar angle had a small effect size. Pairwise comparisons for the craniovertebral and head-neck-trunk angles showed that were no significant differences between the post-test and follow-up, but both were significantly larger than the baseline measurement. Pairwise comparisons for the trunk, thoracic, thoracolumbar, and lumbar angles demonstrated that again, there were no significant differences between the post-test and follow-up, but both were significantly smaller than the baseline.

Table 3

Postural Angles Between Baseline Measurements, Post-Test, and Follow-Up during Scale Playing

Angle	Baseline		Post-Test		Follow-Up		$F(2, 13)$	p	η_p^2
	M (°)	*SD (°)*	*M (°)*	*SD (°)*	*M (°)*	*SD (°)*			
Craniovertebral angle	35.54 [b]	8.24	39.85 [a]	7.55	40.55 [a]	7.50	18.08	0.000	0.56
Head tilt	-4.04	8.90	-5.68	9.86	-3.92	9.28	0.71	0.501	0.05
Head-neck-trunk angle	127.31 [b]	12.37	132.62 [a]	10.79	133.37 [a]	10.02	8.05	0.002	0.37
Trunk angle	232.89 [a]	6.32	227.6 [b]	6.05	229.64 [b]	5.22	8.82	0.001	0.39
Thoracic angle	25.75 [a]	3.85	23.57 [b]	4.30	23.72 [b]	4.36	10.18	0.000	0.42
Thoracolumbar angle	7.33 [a]	8.03	2.22 [b]	6.64	3.85 [b]	6.82	12.09	0.000	0.46
Lumbar angle	-4.81 [a]	5.23	-7.79 [b]	5.29	-7.46 [b]	4.18	5.53	0.009	0.28

Note. Means with differing superscripts were significantly different ($p \leq .05$) following a Holm-Bonferroni correction which assumed three different analyses. Means with the same superscript were not significantly different following a Holm-Bonferroni correction.

All angles except for the thoracic angle showed significant differences across the three measurements for the sight reading task (Table 4). All significant differences were accompanied by moderate effect sizes except for head tilt which demonstrated a small effect size. Pairwise comparisons for the craniovertebral angle revealed that the follow-up was significantly larger than the post-test and the baseline while the post-test was also significantly larger than the baseline measurement. Pairwise comparisons for the head tilt showed that the baseline was significantly smaller than the follow-up, but there were no significant differences between the baseline and post-test or post-test and follow-up. Concerning the head-neck-trunk angle, results of the pairwise comparisons showed that the post-test and follow-up were significantly larger than the baseline measurement. There was no significant difference between the post-test and the follow-up. For the trunk, thoracolumbar, and lumbar angles, the baseline was significantly larger than both the post-test and follow-up measurements, but there were no significant differences between the post-test and the follow-up.

Table 4

Postural Angles Between Baseline Measurements, Post-Test, and Follow-Up during Sight Reading

Angle	Baseline		Post-Test		Follow-Up		$F(2, 13)$	p	η_p^2
	M (°)	*SD (°)*	*M (°)*	*SD (°)*	*M (°)*	*SD (°)*			
Craniovertebral angle	31.07 [c]	9.11	33.80 [b]	9.30	37.30 [a]	8.55	13.97	0.000	0.50
Head tilt	-5.36 [b]	8.94	-2.87 [a, b]	10.40	-0.90 [a]	9.13	5.51	0.010	0.28
Head-neck-trunk angle	121.78 [b]	14.10	127.84 [a]	13.83	130.34 [a]	11.97	11.88	0.000	0.46
Trunk angle *	236.48 [a]	6.11	227.91 [b]	9.58	229.58 [b]	3.78	9.69	0.002	0.41
Thoracic angle	26.26	5.47	25.26	5.28	25.29	5.69	1.28	0.292	0.08
Thoracolumbar angle	6.11 [a]	7.31	0.73 [b]	8.26	0.84 [b]	5.10	6.60	0.004	0.32
Lumbar angle	-6.01 [a]	5.32	-10.86 [b]	7.25	-9.26 [b]	5.47	6.83	0.004	0.33

Note. Means with differing superscripts were significantly different ($p \leq .05$) following a Holm-Bonferroni correction which assumed three different analyses. Means with the same superscript were not significantly different following a Holm-Bonferroni correction.

* Uses Huynh-Feldt correction

The results for the playing (deadpan) task are presented in Table 5. Significant differences were found for the craniovertebral, head-neck-trunk, trunk, thoracolumbar, and lumbar angles with effect sizes ranging from small to large. Pairwise comparisons for the craniovertebral and head-neck-trunk angles revealed that the follow-up was significantly larger than the post-test and the baseline while the post-test was significantly larger than the baseline. Comparisons for the trunk angle showed that the baseline was significantly larger than both the post-test and the follow-up, but there were no significant differences between the post-test and the follow-up. Pairwise comparisons for the thoracolumbar and lumbar angles showed no significant differences between any of the measurements.

Table 5

Postural Angles Between Baseline Measurements, Post-Test, and Follow-Up during Playing (Deadpan)

Angle	Baseline		Post-Test		Follow-Up		$F(2, 13)$	p	η_p^2
	M (°)	*SD (°)*	*M (°)*	*SD (°)*	*M (°)*	*SD (°)*			
Craniovertebral angle	43.49 [c]	7.63	45.92 [b]	6.53	47.11 [a]	7.09	11.83	0.000	0.46
Head tilt	5.33	8.69	4.48	6.15	6.30	7.79	0.84	0.444	0.06
Head-neck-trunk angle *	139.45 [c]	11.12	144.93 [b]	9.32	146.74 [a]	8.11	17.76	0.000	0.56
Trunk angle	230.93 [a]	5.81	224.39 [b]	8.52	227.34 [b]	4.51	8.11	0.002	0.37
Thoracic angle	24.16	5.38	22.94	4.55	23.18	5.14	1.94	0.163	0.12
Thoracolumbar angle	2.19 [a]	7.11	-1.62 [a]	7.02	-0.69 [a]	5.10	3.48	0.045	0.20
Lumbar angle	-7.99 [a]	4.60	-11.19 [a]	6.42	-10.28 [a]	5.59	3.35	0.050	0.19

Note. Means with differing superscripts were significantly different ($p \leq .05$) following a Holm-Bonferroni correction which assumed three different analyses. Means with the same superscript were not significantly different following a Holm-Bonferroni correction.

* Uses Huynh-Feldt correction

Results for the playing (projected) task are given in Table 6. Significant differences were found for the craniovertebral, head-neck-trunk, trunk, thoracolumbar, and lumbar angles with moderate to large effect sizes. Pairwise comparisons showed that for the craniovertebral and head-neck-trunk angles, both the post-test and follow-up were significantly larger than the baseline. There were no significant differences between the post-test and the follow-up. Results for the trunk, thoracolumbar, and lumbar angles showed that the baseline was significantly larger than the post-test as well as the follow-up, but there were no differences between the post-test and the follow-up.

Table 6

Postural Angles Between Baseline Measurements, Post-Test, and Follow-Up during Playing (Projected)

Angle	Baseline		Post-Test		Follow-Up		$F(2, 13)$	p	η_p^2
	M (°)	*SD (°)*	*M (°)*	*SD (°)*	*M (°)*	*SD (°)*			
Craniovertebral angle	38.28 [b]	7.59	42.92 [a]	7.70	43.93 [a]	8.45	15.35	0.000	0.52
Head tilt	3.21	8.30	3.16	7.01	4.52	6.97	0.53	0.592	0.04
Head-neck-trunk angle	132.13 [b]	11.13	140.18 [a]	11.16	141.98 [a]	11.08	19.77	0.000	0.59
Trunk angle	232.35 [a]	5.77	226.08 [b]	6.96	227.28 [b]	4.91	8.98	0.001	0.39
Thoracic angle	24.63	5.10	23.33	4.73	23.73	5.40	2.10	0.141	0.13
Thoracolumbar angle	3.97 [a]	8.03	-0.77 [b]	7.25	-0.89 [b]	5.34	7.28	0.003	0.34
Lumbar angle	-6.48 [a]	5.00	-11.11 [b]	6.48	-10.28 [b]	5.21	7.83	0.002	0.36

Note. Means with differing superscripts were significantly different ($p \leq .05$) following a Holm-Bonferroni correction which assumed three different analyses. Means with the same superscript were not significantly different following a Holm-Bonferroni correction.

Table 7 shows the results for the playing (exaggerated) task. Significant differences were found for the craniovertebral, head-neck-trunk, trunk, thoracolumbar, and lumbar angles with effect sizes ranging from small to large. Pairwise comparisons for the craniovertebral and head-neck-trunk angles showed that both the post-test and follow-up were significantly larger than the baseline. There were no significant differences between the post-test and the follow-up. For the trunk and thoracolumbar angles, pairwise comparisons revealed that the baseline was significantly larger than the post-test as well as the follow-up. There were no significant differences between the post-test and the follow-up. For the lumbar angle, pairwise comparisons showed that the follow-up was significantly smaller than the baseline measurement. However, there were no significant differences between the baseline and the post-test or the post-test and the follow-up.

Table 7

Postural Angles Between Baseline Measurements, Post-Test, and Follow-Up during Playing (Exaggerated)

Angle	Baseline		Post-Test		Follow-Up		$F(2, 13)$	p	η_p^2
	M (°)	*SD* (°)	*M* (°)	*SD* (°)	*M* (°)	*SD* (°)			
Craniovertebral angle *	37.89 [b]	9.04	44.42 [a]	7.21	44.44 [a]	6.93	16.43	0.000	0.54
Head tilt	1.98	8.85	3.93	8.25	4.72	5.75	1.73	0.195	0.11
Head-neck-trunk angle *	131.3 [b]	13.20	142.23 [a]	9.86	142.09 [a]	9.51	20.62	0.000	0.60
Trunk angle	232.79 [a]	5.92	226.00 [b]	7.75	227.62 [b]	4.20	12.12	0.000	0.46
Thoracic angle	24.64	5.36	23.09	4.89	23.91	4.98	2.49	0.101	0.15
Thoracolumbar angle	4.32 [a]	7.39	-0.76 [b]	7.38	-0.96 [b]	5.74	8.28	0.001	0.37
Lumbar angle	-6.65 [a]	4.75	-10.42 [a, b]	6.41	-10.10 [b]	5.05	4.93	0.015	0.26

Note. Means with differing superscripts were significantly different ($p \leq .05$) following a Holm-Bonferroni correction which assumed three different analyses. Means with the same superscript were not significantly different following a Holm-Bonferroni correction.

* Uses Huynh-Feldt correction

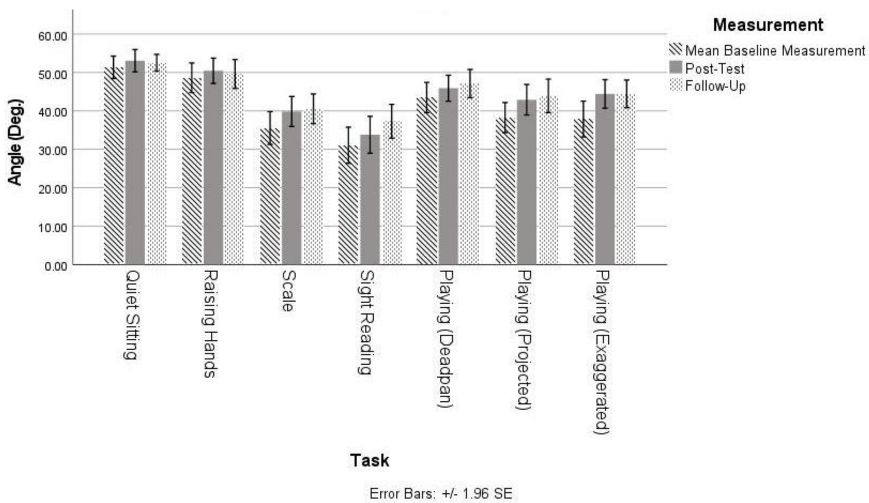
Trends in Postural Angles Between Measurements

Between the pre- and post-intervention measurements, larger craniovertebral and head-neck-trunk angles were seen in both the post-test and the follow-up in comparison with the baseline for all tasks. Smaller trunk, thoracic, thoracolumbar, and lumbar angles were demonstrated in the post-test and follow-up in comparison with the baseline for all tasks. According to the graphs (Figure 2), pianists appeared to exhibit similar postural angles during the follow-up in comparison to the post-test or demonstrated a slight reverting to the postural angles displayed prior to lessons in the Alexander Technique (e.g., if the angle was larger prior to the intervention, the follow-up angle was larger in comparison with the post-test, but not quite as big as the baseline).

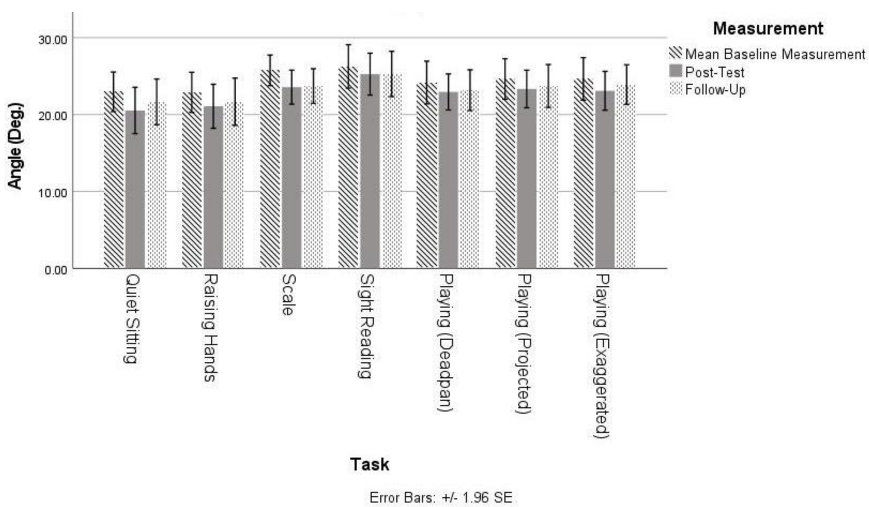
Figure 2

Examples of Trends in Postural Angles Between Measurements

A



B



Note. Panel A: Mean craniovertebral angle across baseline, post-test, and follow-up. Panel B: Mean thoracic angle across baseline, post-test, and follow-up.

Effect of Demographics on Post-Intervention Findings

Results showed that there were no statistically significant effects of age, number of years playing piano, highest pianistic level achieved, number of hours practiced per day, and number of days practiced per week on post-intervention postural angles. Exceptions to this are presented in Table 8. Only results that demonstrated significant changes in angles between baseline and post-test measurements, as discussed earlier in this paper, are listed in the table. As the level of pianistic achievement increased, the craniovertebral angle decreased by 1.50° and head-neck-trunk angle decreased by 2.31°. Both show small effect sizes.

Table 8

Significant Results of Demographics on Post-Intervention Postural Angles

Task and Angle	*B*	*t*	*p*	Part
Scale				
Highest pianistic level achieved: craniovertebral angle	-1.50	-2.96	0.012	-0.25
Highest pianistic level achieved: head-neck-trunk angle	-2.31	-2.27	0.042	-0.25

Note. B is the unstandardized beta coefficient. "Part" column provides semi-partial correlation.

Discussion

This study showed that there were measurable differences in postural angles following 10 lessons in the Alexander Technique. The angles that presented changes in most tasks and conditions are the craniovertebral, head-neck-trunk, and trunk angles. Interestingly, these angles reflect the principle of primary control in the Alexander Technique where there is a focus on the relationship between the head, neck, and trunk. These angles provide a general overview of the shape of the head and torso during tasks, and the changes seen in these variables indicate a pattern of spinal extension, which could reflect the Alexander idea of “lengthening” the spine. In comparison with the post-intervention measurements, pianists appear to be more kyphosed in the baseline measurements but display a pattern of extension from pre-intervention to post-intervention. The findings of this study concur with the results of self-reports found in Davies’ (2020a, 2020b) studies. Musicians, including pianists, and their teachers felt that the AT was beneficial for altering their playing posture. Participants felt that posture was “more easy and upright” (Davies, 2020a, p. 8). The findings of this present study offer some explanation as to why musicians may feel this change. However, only pianists participated in this study and further research is needed to confirm if this pattern of spinal extension is present in other musicians following lessons in the AT.

Findings in an earlier study (Wong et al., 2022a) provided expected changes in postural angles following lessons in the AT. These were a larger craniovertebral angle, head tilt, and head-neck-trunk angle as well as smaller trunk, thoracic, and thoracolumbar angles. With the exception of head tilt, this trend was seen in the post-intervention measurements of this present study in which all angles changed according to the predicted pattern. This indicates that pianists were integrating the AT into their playing. Becker and colleagues' (2021) study revealed that following AT lessons, the neck angle, equivalent to the craniovertebral angle in this present study, was larger following an AT intervention. This finding agrees with the results of the present study in which the craniovertebral angle was found to be larger following lessons in the AT.

For the angles that exhibited statistically significant changes, there were often differences between the baseline and post-test or the baseline and follow-up, but there were much fewer differences between the post-test and the follow-up, indicating that the AT had an effect on those postural angles not just immediately after lessons, but also after lessons had ended for a month. This could indicate that with continued practice, there may be some lasting effects on postural angles even in the absence of lessons which makes the AT a viable method of changing posture during piano performance. In addition, analyses showed that in general, demographics such as age, number of years playing the piano, highest pianistic level achieved, number of hours practiced per day, and number of days practiced per week had no impact on whether significant changes in postural angles were found following lessons in the AT. In the two cases where there was both a significant change between the baseline and post-test as well as a significant effect of demographics on changes in angle, the task was scale playing and the factor influencing the change was an increase in pianistic playing level. These appear to lead to smaller craniovertebral and head-neck-trunk angles, which seem to indicate that higher level pianists tend to exhibit a more kyphotic posture during scale playing than those who do not play at the same level. However, the impact on the decrease in angle was small. In general, postural angles appeared to be unaffected by demographics, making them appropriate variables for future research. It also shows that the AT is not influenced by age or piano playing experience and is effective in changing spinal posture.

Study Limitations

There were a few limitations to this study, one of which was a small sample size. Additionally, because participants for this study were volunteers, expectation bias may have been introduced into the results as those who volunteered may have had an interest in the AT and may have expected a change in their posture following lessons. Data collection for this study was also conducted over a short period of time. A follow-up after a year may provide a better idea of the long-term impact the AT has on posture.

Conclusion

The Alexander Technique can alter postural angles following 10 lessons. There is an overall pattern of spinal extension in comparison with pre-intervention measurements and a predicted pattern of change in keeping with a previous study (Wong et al., 2022a) was observed. The craniovertebral angle, head tilt, and head-neck-trunk angle increased following AT lessons while the trunk, thoracic, and thoracolumbar angles decreased. While the sample size of this study was small, significant changes ($p \leq .05$) were still found between the baseline and the post-intervention sessions. This indicates a noticeable difference between pre- and post-tests, supporting the claims of the AT. Namely, that the AT can alter postural behaviour. No previous research yet has calculated the difference in pianists' postures before and after participating in at least 10 lessons. This study has quantifiably measured how large the differences in posture were after AT lessons and has shown that there are indeed changes in postural angles. This study can be used as a basis for future quantitative research concerning the effects the AT can have on posture. It has shown that certain postural variables can be measured to see clear changes before and after lessons in the AT. The pattern of postural change can be used as guidelines for future studies to aid in assessing whether observed postural differences following AT lessons are changing in accordance with the principles of the AT. Future studies should research the long-term effects of extended practice of the Technique to determine how long the postural effects will last.

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Chapter 6: The Relationship Between Pianists' Perceptions and Spinal Postures Following Alexander Technique Lessons

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Abstract

Research concerning musicians and the Alexander Technique (AT) has examined different aspects of music performance such as anxiety, tension, breathing, and posture. Studies have collected both qualitative and quantitative data about musicians' perceptions and experiences with the Technique and have also collected data through direct measurements (e.g., measurements that quantify a musician's kinetics and kinematics). However, studies have not yet examined the relationship between participants' perceptions of the effect of the AT and direct measures following lessons in the AT. This study explored the relationship between pianists' perceptions of their posture as well as their application of the Technique following lessons in the AT and measurements taken of their spinal posture. Fifteen pianists completed questionnaires concerning how they perceived their posture and how they applied principles of the AT while playing. These responses were then compared with the postural data of the same pianists collected during a previous study to determine if there were commonalities between pianists' perceptions and their postural changes. Results showed a wide range of responses concerning how pianists applied the Technique while playing. Findings also showed that there was not always a clear relationship between participants' perceptions and their postural data. For example, some pianists felt they played with good posture and were applying principles of the Technique, but their postural changes did not reflect this. Meanwhile, other participants demonstrated the very opposite, showing clear postural changes without feeling as if they played with good posture. In conclusion, pianists' perceptions do not always agree with direct measures of posture.

Keywords: perception, posture, pianists, Alexander Technique

The Relationship Between Pianists' Perceptions and Spinal Postures Following Alexander Technique Lessons

The Alexander Technique (AT) is a somatic method by which its students are taught to alter the way they move to enhance day-to-day activities, including playing a musical instrument (Conable & Conable, 1995; Klein et al., 2014). Several key principles are taught to students to help them change their movement patterns through indirect means (i.e., without actively trying to change movement or posture). These principles are the primary control, inhibition, direction, habit, and faulty sensory awareness. Students' understandings on how to alter their body usage are based on these ideas, so these principles will be briefly defined from the perspective of the AT. *Primary control* is a "dynamic relationship" between the head, neck, and back which "facilitates movement throughout the body" (Jones, 1997, p. 200). *Inhibition* is "refusing to do anything immediately in response" to a stimulus (Alexander, 2001, p. 40). This allows students to stop and think before moving to change their typical movement or posture patterns. *Direction* is "the process of sending motor commands to influence…muscular activity" (Cacciatore et al., 2005, p. 567). Examples of directions are, "Allow the neck to be free," "allow the head to go forward and up," and "allow the back to lengthen and widen." *Habit* is one's typical response to a given stimulus (Jones, 1997) and *faulty sensory awareness* is "the unreliability of…the kinaesthesia upon which people base the control and direction of their bodily activities" (Barlow, 2005, p. 81). This means that what one perceives about one's body, including its movement and position, may not necessarily be true. Lessons in the AT are conducted by a certified teacher. Students learn the principles of the Technique through both verbal instruction and hands-on guidance (Barlow, 1990). The hands-on guidance consists of the teacher physically manipulating the student, so he/she receives "sensory experiences" associated with the directions being learned (Maisel, 1990).

There are often benefits associated with learning the AT for musicians. Such benefits include developing ease of movement while playing, developing an awareness of excessive tension, improved coordination, reduced discomfort, and improved posture (Ben-Or, 1987; Conable & Conable, 1995; Kleinman & Buckoke, 2013; Rosenthal, 1989). Research conducted concerning the AT and musicians address these outcomes but are mostly either quantitative or qualitative in nature. The few mixed methods studies available (Davies, 2020a; Mozeiko, 2011; Santiago, 2004; Valentine et al., 1995), while providing important insights into how the AT influences music performance, do not explore the relationship between the different types of data collected. Self-reports are important in providing valuable information concerning how participants perceive themselves following lessons, but there is no research that compares participants' perceptions of change following lessons in the AT to objective and direct measurements of change. The purpose of this study was to describe what participants experienced after having had AT lessons (i.e., pianists' perceptions of their posture following lessons in the AT, how they thought they applied principles of the Technique while playing) and to determine if there is a relationship between pianists' perceptions and changes in their spinal posture as measured in a previous study.

Method

Study Design

A qualitative descriptive design was chosen for this study as it allows for the description of a phenomenon and the usage of a variety of data collection methods, including documentation (Sandelowski, 2000).

Participants

The responses of fifteen pianists (12 females, 3 males) between the ages of 18 and 71 who participated in a previous study (Wong et al., 2022a) were analysed in this study. All participants were required to be playing at Level 9 or higher, based on the standards of the Royal Conservatory of Music (RCM), or studying piano at a university level at the time of data collection, or had studied piano at a university level prior to data collection. All participants were still playing piano at the time of the study. In addition, participants must not have had more than two private (one-on-one) sessions in the AT to prevent biasing the data. Sources on the AT (Cacciatore et al., 2005; Gelb, 2004; Tarr, 2008) vary in the number of lessons to take to establish a basic understanding of the AT, but it is generally understood that two lessons are not sufficient for a student to understand and apply the AT.

Data Collection

At both the post-test and the follow-up after lessons in the AT had ended, participants were given a set of questionnaires to complete.[7] Questionnaires were loosely based on questions used in previous studies concerning the AT, studies concerning pianists' postures, and suggested

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[7] See Appendix E for post-intervention questionnaires.

questions from Alexander teachers (B. Caron, personal communication, March 9, 2018; Santiago, 2004; Shamoto, 2013). At the post-test, pianists were asked to rate themselves on whether they felt they had good posture following lessons in the AT (1 = no, 3 = somewhat, 5 = yes). At both the post-test and follow-up, participants were asked to rate themselves on how often they applied what they learned in the AT to their playing (1 = never, 10 = always). Participants were also asked to write about how they applied the AT to their playing. At the follow-up, pianists were not able to see their responses from the post-test.

Data Analysis

Participant Perception

Participant ratings were interpreted. For example, for participants who rated themselves a 4 out of 5 concerning what they thought about their own posture following AT lessons, it was interpreted to mean that they felt they had good posture after lessons, but not as confidently as those who had rated themselves a 5 out of 5. In the case of how often participants applied the AT while playing, pianists who rated themselves a 7 or an 8 out of 10 were considered to have applied the Technique often while playing.

Conventional content analysis (Erlingsson & Brysiewicz, 2017; Hsieh & Shannon, 2005) was conducted on participants' responses to open-ended questions (i.e., how participants applied the AT while playing) taken at both the post-test and follow-up. Participants' answers were divided into smaller pieces, known as *meaning units*. These were then condensed into even smaller pieces, or smaller meaning units. Each smaller meaning unit was then labeled by giving a short descriptor to summarise what was said, known as *coding*. Codes were then grouped into *categories* based on similarities between the codes. Constant reflection throughout the process evaluated whether the meaning units, codes, and categories adequately described what was written by the participants.

Participant Posture

Previous studies (Wong et al., 2022a; Wong et al., 2022b) found that there were measurable changes in spinal posture between pre-Alexander and post-Alexander lessons and that there were specific changes in postural angles between pre- and post-lesson measurements. Namely, the craniovertebral and head-neck-trunk angles would be larger and the trunk, thoracic, and thoracolumbar angles would be smaller following lessons. To compare participants' responses with changes in their spinal posture, collected from a previous study (Wong et al., 2022a), calculations were made to determine how closely participants followed the expected trend from pre-lesson to post-lesson measurements and if their follow-up measurements demonstrated a reversion in the direction of their pre-lesson measurements.

Trend Percentage. The trend percentage summarizes how closely a participant followed the expected postural trend following lessons in the AT by expressing the total number of times a participant exhibited the expected change for each postural angle as a percentage of total number of postural angle measurements. This was calculated for each participant's post-test and follow-up measurements, both in relation to pre-lesson measurements.

Reversion Percentage. The reversion percentage summarizes how many angles in the follow-up demonstrated a reversion, or a return, in the direction of pre-lesson measurements when comparing against the post-test angles by expressing the total number of follow-up angles that demonstrated a return in the direction of pre-test measurements as a percentage of total number of postural angle measurements. This was calculated for each participant's follow-up measurement.

Descriptive Report

A description of each participant's perception of their posture as well as their experience with the AT was written. The reports also describe the potential relationship between participants' perceptions and their postural data. For each participant, their demographics and playing history will be presented, followed by the results of their post-test (i.e., participants' perceptions of their posture following lessons, the frequency with which participants applied principles of the AT to piano playing, how participants applied principles of the Technique, results from their postural data, and commonalities between participants' experiences and the postural data). The results of their follow-up (i.e., the frequency with which participants applied principles of the AT to piano playing, how participants applied principles of the Technique, results from their postural data, how their post-test and follow-up results compare, and commonalities between participants' experiences and the postural data) will be presented following their post-test results. A table summarising these findings is also presented at the end of the Results section (see Table 1).

Results

Participant 1

Participant 1 was an 18-year-old female who had been playing piano for 13 years at the time of the study. The highest level of playing she achieved was RCM Level 10. She practiced an average of three hours per day and an average of five days a week. She was no longer studying music at the time of the study and had no prior experience with the Alexander Technique before this study began.

At the post-test, participants were asked to report on their experience with the AT. When asked to rate her posture following lessons in the AT, Participant 1 gave herself a 4 out of 5, indicating that she felt that she played with good posture. When asked to rate herself on the frequency with which she applied principles of the Technique to her playing during a typical practice session, Participant 1 gave herself a 6 out of 10, indicating that she would sometimes attempt to apply AT principles. Answering the open question concerning how she tried to apply the AT to her playing, Participant 1 wrote:

> I tried to pay more attention to sitting up and applying pressure through the length of the arm, rather than just the fingers or wrists. I tried not to slouch over or bend too much when reaching across the piano, and to keep my forearms generally level.

Postural angle data collected at the post-test showed that she demonstrated the expected change from pre-Alexander lessons to post-Alexander lessons with every angle in every task following the pattern of larger craniovertebral and head-neck-trunk angles as well as smaller trunk, thoracic, and thoracolumbar angles. Only the head-neck-trunk angle in one of the tasks did not follow the expected pattern of change from pre-test to post-test. When comparing the reported experience of Participant 1 to the postural data, some commonalities were found. Participant 1 felt she played with better posture, and that she focused on not slouching or bending as she played. Her postural data showed that she demonstrated an overall pattern of spinal extension, indicating that she was indeed slouching less in the post-test in comparison with her pre-intervention measurements.

At the follow-up, four weeks after her post-test and without any further instruction from an AT teacher, Participant 1 again reported on how often she applied principles of the AT to her playing and what she did to apply those principles. Concerning how often she applied principles, Participant 1 gave herself a score 6, showing that she continued to apply principles some of the time during her practice sessions. When asked how she applied the AT to her playing, she wrote:

> By generally being conscious of my body and spine position, leaning instead of scrunching when reaching high or low notes and exerting force through the arm instead of the wrist. I also try to be more aware of adjusting the seat before I sit, so I can play with better posture.

When comparing the postural data from the follow-up to the pre-test, Participant 1 continued to exhibit the expected postural trend for all angles in all tasks except for the craniovertebral angle in one of the tasks and the trunk angle in two of the tasks. When comparing the postural data from the follow-up to the post-test, Participant 1 sometimes demonstrated postural angles that were similar between the two measurement sessions. Other times, she appeared to demonstrate a reverting back to measurements like those seen in her pre-test, but not enough to be a full reversion. In general, there appeared to be similarities between the participant’s perception of herself concerning her posture and the postural data. She continued to demonstrate a pattern of spinal extension in comparison with her pre-test, indicating that she was not slouching as much in the follow-up, but when comparing the follow-up to the post-test, results showed that her overall spine shape was not as upright as that seen in her post-test. This could be that without lessons, there is a lack of constant reinforcement of Alexander principles, leading to a return of pre-intervention posture.

Overall, the thoughts of Participant 1 concerning her posture appear to agree with the postural data collected. A focus on not slouching while she practiced may relate to the spinal extension seen in her post-intervention posture.

Participant 2

Participant 2 was a 71-year-old female who had played piano for 60 years. She did not state which level of playing she achieved, but she studied music at a recognized postsecondary institution. At the time of the study, she was practicing an average of one and a half hours a day and an average of five days a week. She had no previous experience with the AT.

At the post-test, Participant 2 rated herself on how she perceived her posture following lessons in the AT. She gave herself a score of 3 out of 5, indicating that she felt she had somewhat good posture after lessons. Participant 2 also rated herself a 7 out of 10 for the frequency with which she tried to apply the AT during a typical practice session, indicating that she would often apply Alexander principles while playing. When asked how she applied these principles to her playing, she wrote, “I apply it most when playing scales and also when I'm playing something that uses the ends of the piano (a Brahms Rhapsody for example). I'm never quite sure whether the A.T. lessons have actually ‘taken.’” Postural data collected at the post-test showed that Participant 2 followed the expected trend between pre-test and post-test. The only exceptions were the trunk angle in one task and the thoracic angle in another. When comparing her thoughts to the postural data, a commonality was found. She stated that she tried to apply the Technique while playing scales and the postural data showed that there were consistently larger changes measured in the scale playing task in comparison with the other tasks, indicating that the conscious application of the AT while playing scales can affect a change in posture. While Participant 2 herself was not sure if the lessons had worked for her, her postural data showed that there was a change in her posture following lessons. This is a demonstration of the AT principle, faulty sensory awareness, in which the student had a false conception of her own body usage.

At the follow-up session, Participant 2 again rated herself on the frequency with which she tried to apply AT principles in the weeks between the post-test and follow-up. She gave herself a score of 6 out of 10, indicating that she sometimes applied AT concepts during piano playing. Concerning how she applied those principles while playing, she wrote:

> I find I think about it when playing scales, as these can go right to each end of the piano. Also, when playing big chords in the bass. But it's difficult to remember at other times when I'm concentrating on the tricky bits or reading.

Postural data taken at the follow-up showed that Participant 2 continued to exhibit the expected change between the pre-test and follow-up except for the head-neck-trunk angle in one task and the thoracolumbar angle in two tasks. When comparing the data between the post-test and the follow-up, there were some angles that showed a continued trend towards post-AT posture, but in general, there was some reversion to measurements closer to those seen in the pre-test, but not enough to be a complete reversion. Participant 2 stated that she tried to apply AT principles while playing scales, but the postural changes that were measured were not as distinct in the follow-up as they were in the post-test for this task. With regards to playing chords, the excerpt participants were asked to play had some chords, but Participant 2 did not show any changes that were markedly different in the playing task in comparison with the other tasks. Perhaps this was because most of the chord was played in the treble part of the piano instead of the bass, which was when she would try to apply concepts. As for having difficulty remembering to apply the Technique while reading, Participant 2 did not show any particular differences in posture in the playing or sight reading tasks.

In general, Participant 2 demonstrated the expected postural change from pre-Alexander lessons to post-Alexander lessons. It was apparent during the scale playing task in the post-test, which was an area in which she had focused on applying the AT. However, at the time of the follow-up, her posture had begun to change in the direction of her pre-test posture but had not completely reverted.

Participant 3

Participant 3 was a 43-year-old female who had been playing piano for 30 years at the time of the study. She studied piano at two post-secondary institutions and was practicing an average of one to two hours a day, five days a week. She had no previous experience with the AT.

At the post-test, Participant 3 rated herself on whether she felt she played with good posture after having had lessons in the AT. She gave herself a score of 2 out of 5, indicating that she did not feel as if she had good posture after lessons. When asked to rate herself on how often she applied principles of the Technique during a typical practice session, she rated herself a 2 out of 10, indicating that she almost never applied Alexander concepts to her playing. Nevertheless, she still wrote about her experience with AT lessons and how she tried to apply some principles when those occasions arose:

> I found myself unconsciously reverting back to old habits and routines more often than not. However, there were several times, particularly towards the end of the lessons that I found myself more consciously applying some of the instructions or practices. We spent quite a bit of time sitting and standing and I did definitely have more awareness of my

> neck, back and knees while doing so. I was also more acutely aware of where tension builds up while practicing (in my left forearm and right shoulder). At these points, again during the later days of the lessons, I would try to incorporate more of the techniques (ie. awareness of finger-tips to shoulder blades, armpits pointing in opposite directions) while continuing the practice session.

Postural data collected at the post-test showed that Participant 3 followed the expected trend between pre-Alexander and post-Alexander lessons with the exception of the craniovertebral angle in two tasks, the head-neck-trunk angle in two tasks, the thoracic angle in three tasks, and the thoracolumbar angle in one task. Despite her perception that she did not have good posture after lessons in the AT, the postural data showed that Participant 3 followed the expected change in spinal angles from pre-test to post-test. She did not adhere perfectly to the pattern in that not all angles in all tasks changed in the predicted way, but many of the angles did. While Participant 3 reported that she mostly did not apply principles of the Technique, her postural data still showed a change in the anticipated manner following lessons in the AT. Of note is her development of an awareness of her neck and back as well as an awareness of excessive tension in her body during Alexander lessons. The increase of awareness regarding one's own body is an important component of the AT and may account for the changes seen in her post-test postural data. In the case of Participant 3, personal perception was different from the actual change that took place, demonstrating that postural change may happen even if the pianist does not feel that it is.

At the follow-up, Participant 3 gave herself a score of 2 out of 10 concerning how often she attempted to apply Alexander concepts to her piano playing. This meant that she almost never applied principles of the AT to her playing, but, as she explained in her response below, she did attempt to apply the Technique in other aspects of her life:

> I've largely been away (3 weeks out of the last 4) - so have not been applying the technique while playing. I did however attempt to "free my neck" while driving long distances over the last few weeks and keep my knees parallel (vs. bow-legged) and spread weight evenly over my feet (vs. the outer edges) as are my tendencies.

Postural data from the follow-up session showed that between the pre-test and the follow-up, Participant 3 was still demonstrating the expected changes in posture. She continued to have an awareness of her usual posture and attempted to apply the AT to change those tendencies. However, she adhered less to the pattern of change from pre-Alexander to post-Alexander lessons in comparison with the post-test data. She demonstrated a reverting back to her posture the way it was before she had lessons in the AT, but it was not enough to be a full reversion.

Overall, Participant 3 demonstrated the expected change from pre-Alexander to post-Alexander lessons despite her reported lack of application of AT principles. She demonstrated that even if one does not have a positive personal perception of one's own posture, it does not necessarily equate to a lack of postural change when measured objectively. The results of Participant 3 showed that it is possible to demonstrate postural change right after lessons in the AT, possibly because up to that point, she had the guidance of a teacher, but if there is a lack of continued application of the principles after lessons have ended, there will be a rapid return to a pre-Alexander posture. Despite this, an awareness of one's own body may be a factor in influencing changes in posture.

Participant 4

Participant 4 was a 56-year-old female who had been playing piano for over 50 years. She studied piano at several post-secondary institutions and received her doctorate in Musical Arts. She was teaching at the time of the study, but not practicing. Participant 4 had no previous experience with the AT.

At the post-test, she was asked to rate herself on whether she felt she played with good posture after having had Alexander lessons. Participant 4 gave herself a score of 5 out of 5, indicating that she felt she had good posture following lessons. When asked to rate how often she applied principles of the Technique while playing, she gave herself a score of 10 out of 10, indicating that she always tried to apply the AT to her playing. Her comments about her experience with the AT said, “The most striking thing of Alexander Technique was that you play from the back-centred; playing from the shoulder back.” Postural data collected at the post-test showed that Participant 4 followed the expected trend from pre-Alexander to post-Alexander lessons. All angles in all tasks followed the expected pattern of change except for the craniovertebral angle in two tasks, the head-neck-trunk angle in two tasks, and the thoracic angle in one task. Participant 4 seemed to focus on her back which corresponded with the trunk, thoracic, and thoracolumbar angles in the postural measurements. These were the angles that changed most consistently between the pre-Alexander and post-Alexander lessons (i.e., these angles always changed in the expected manner between pre-test and post-test in all tasks, except for the thoracic angle in one task). It appears that, in the case of Participant 4, the area in which one focuses is the area in which one will most likely exhibit consistent change in a variety of playing tasks. She also felt that she played with good posture after having had lessons and her postural data supported her perception in that her spinal angles changed in the expected direction between pre-test and post-test.

Participant 4 was asked at the follow-up to rate herself on how often she tried to apply AT principles to her playing. She once again gave herself a score of 10 out of 10, indicating that she felt she always tried to apply Alexander concepts while playing. Concerning how she applied the Technique to her playing, she wrote, "More aware of my body movements especially core as I turn sideways or moving to right or left. More aware of how I sit and my placement of feet." Her postural data from the follow-up showed that between the pre-test and the follow-up, Participant 4 demonstrated the expected pattern of change in most angles except for the craniovertebral angle in one task, the head-neck-trunk in one task, the trunk angle in one task, and the thoracolumbar angle in four tasks. In her comments about her application of AT principles, Participant 4 stated that she had increased awareness of her body movements and how she sat at the piano. This is reflected in her follow-up posture in that she continued to demonstrate the expected change between pre-Alexander and post-Alexander lessons. Between the post-test and the follow-up, a few angles showed some continued development in the direction of post-lesson changes. However, there was in general a reversion in her posture in the direction of her pre-test measurements between the post-test and the follow-up. This may be because she was no longer taking lessons and was not having the principles reinforced by a teacher.

Participant 4 demonstrated that her perception of her own posture was supported by the postural data taken at the post-test. She felt she had good posture and the result of the postural measurements showed that she was indeed demonstrating the expected trend between pre-Alexander and post-Alexander lessons. Her focus on her back as well as an increased awareness of her body movements while playing may have contributed towards the change seen in her spinal angles in both the post-test and follow-up. Despite a reversion in the direction of her pre-

Alexander posture at the follow-up, Participant 4 still showed the expected postural changes between pre-Alexander and post-Alexander lessons, although not to the same degree as that seen in the post-test.

Participant 5

Participant 5 was a 27-year-old male who had been playing piano for 17 years. He did not specify the highest level of piano playing he achieved, but he studied piano at a post-secondary institution. At the time of the study, he practiced an average of zero to one hour a day, one to two days a week. Prior to this study, he had one private 15-minute AT session and two sessions in the Feldenkrais Method.

At the post-test, Participant 5 gave himself a score of 3 out of 5 when asked if he felt he played with good posture after having had lessons in the AT. His self rating indicated that he felt he had somewhat good posture after lessons. When asked to rank how often he applied the AT to his piano playing, he gave himself a score of 6 out of 10, indicating that he sometimes tried to apply Alexander principles. Concerning his experience with how he applied the Technique, he wrote:

> I think about freeing my neck to allow my head to go forward and up. I am more conscious of my sit bones and how I shift my weight from side to side. I now try to have less sideways movement with my torso and be aware of the full length of my arms from the fingertips to the shoulder blades. I also try to think about not letting my throat (front part of my neck) go forward.

Postural data collected at the post-test showed that Participant 5 followed the expected pattern of change for every angle in every task from pre-test to post-test. Despite his perspective that he had somewhat good posture, his measurements show that his posture had certainly changed. Participant 5 thought a lot about his body and its movements. He mentioned several different parts of his body (i.e., neck, head, torso, sit bones, arms) indicating that he did not focus solely on a single part. The AT tries to teach its students to focus on the body as a whole rather than individual parts, and Participant 5 appeared to develop this whole-body awareness which may have led to a clear change in his posture.

At the follow-up, Participant 5 gave himself a score of 5 out of 10 concerning how often he tried to apply the Technique while playing. This indicated that he sometimes tried to apply principles of the AT during his practice sessions. Writing about how he applied the AT, he wrote:

> I tried to direct my head forward and up and to not let my throat come forward. I tried to feel the entire length of my arm back to the shoulder blades. When sitting I tried to not let my lower back collapse and have my hips a little bit further back. When shifting my body side to side, I also try to keep my opposing side hip from lifting off the bench (maintain its length).

Postural data collected at the follow-up showed that Participant 5 followed the expected pattern of change from pre-Alexander to post-Alexander lessons. All angles in all tasks demonstrated the trend with the exception of the thoracic angle in three tasks. Participant 5 again focused on his whole body and continued to have an awareness of his movements which, when comparing the follow-up to the pre-test, may have led to a continued demonstration of post-Alexander lesson posture. In his comments about his experience with the AT, Participant 5 mentioned his lower back, but not his upper back, which may account for why the exceptions concerning the postural trend were found in his thoracic spine. When comparing his post-test posture to the follow-up, it was found that some angles continued to follow the expected postural trend, but others demonstrated a reversal in the direction of the pre-test posture. In general, there was a reversion when comparing the post-test to the follow-up. While he continued to apply the Technique on his own, without a teacher to reinforce principles through touch, a return to pre-Alexander posture is possible.

In general, Participant 5 demonstrated that while he did not feel entirely confident about having good posture after lessons in addition to feeling as if he did not apply principles of the Technique all the time, it is still possible to exhibit a change in posture. Participant 5 mentioned at both his post-test and his follow-up that he thought about directing his head “forward and up,” a key component of the AT, which may be responsible for the changes seen in his posture. He showed that he had an awareness of his whole body, and even though his follow-up posture showed some return to his pre-test posture, the expected postural trend was still present when comparing his pre-test to his follow-up measurements. This may be because he continued to think about his body and its movements and continued to have a whole-body awareness.

Participant 6

Participant 6 was a 22-year-old female who had been playing piano for 8 years at the time of the study. She reached Level 9 of the RCM curriculum and studied piano at a post-secondary institution. She practiced an average of four hours a day, seven days a week. She had no previous experience with the AT but did have one introductory weekend workshop in Body Mapping as well as five sessions in the Feldenkrais Method.

At the post-test, Participant 6 was asked to rate herself on whether she felt she played with good posture after having had lessons in the AT. She gave herself a score of 3 out of 5, indicating that she felt she had somewhat good posture after lessons. Concerning how often she tried to apply principles of the Technique during practice sessions, she gave herself a score of 5 out of 10, indicating that she sometimes applied the AT while playing. When asked about how she applied the Technique to her playing, she wrote, "Thought of head/neck/back relationship to improve posture. Found more weight in my fingertips by making use of whole arm all the way up to the shoulder blade in the back. Avoided tensing my neck while playing big/accented chords." Postural data collected at the post-test showed that Participant 6 followed the expected postural trend from pre-Alexander to post-Alexander lessons for all angles in all tasks except for the thoracic angle in five tasks. When comparing the experience of Participant 6 to her postural data, some commonalities can be seen. Participant 6 stated that she thought of the head-neck-back relationship, a principle that is central to the AT, to "improve posture" and based on the postural measurements obtained from her post-test measurements, it was found that between her pre-test and post-test, she followed the expected pattern of change. When she rated herself on posture however, she felt that she had somewhat good posture after lessons while her postural data showed that all the postural angles measured except for one had changed in the anticipated way.

At the follow-up session, Participant 6 was again asked to rate herself on how often she applied principles of the Technique while she played. She gave herself a score of 3 out of 10, indicating that she rarely tried to incorporate concepts into her playing. Concerning how she applied the AT when she did try to integrate it into her playing, she wrote, "I thought about the alignment of my head and neck with my spine. I tried to incorporate my whole upper body into playing in the highest and lowest registries." Postural data collected at the follow-up showed that in comparison with the pre-test, Participant 6 demonstrated the expected change in posture. She again thought about the head-neck-back relationship, which may account for the changes seen between pre-test and follow-up despite her lack of application. When comparing the postural measurements taken at the post-test to those taken at the follow-up, it was found that some angles demonstrated continued change in the direction of pre-Alexander to post-Alexander lesson posture, while other angles showed a slight reversion in the direction of the pre-test measurements. However, calculations to determine how closely the participant adhered to the expected postural change showed no general difference between the post-test and the follow-up. That is, she scored 86% at both the post-test and the follow-up for how closely she followed the expected change from pre-Alexander to post-Alexander lessons. While the scores were the same, the exceptions at each measurement session were different. In the post-test, her exceptions to the pattern were all found in the thoracic angle. In the follow-up, her exceptions were found in the trunk angle in three tasks and the thoracic angle in two tasks. Based on this calculation, her posture at the follow-up is at the same level as at the post-test. When comparing the follow-up comments of Participant 6 to her postural data, although she felt she applied the Technique even less than at the time of the post-test, she still demonstrated changes in her posture in comparison with her pre-test. This may be because she continued to think about her head-neck-back relationship, a central element of the AT.

In general, Participant 6 demonstrated the expected trend from pre-Alexander to post-Alexander lessons in both the post-test and the follow-up. While she felt she did not apply principles of the AT very often, she did think about the head-neck-back relationship which may account for the changes seen in her posture following lessons in the AT.

Participant 7

Participant 7 was a 62-year-old female who had played piano for over 40 years. She completed Level 10 of the RCM curriculum and also studied piano at a post-secondary institution. Before the study, she was not practicing on a daily basis and had no previous experience with the AT.

At the post-test, Participant 7 was asked to rate herself on how she perceived her posture after having had lessons in the AT. She gave herself a score of 5 out of 5, indicating that she felt she had good posture after having Alexander lessons. When asked how often she tried to apply

Alexander principles to her playing, Participant 7 gave herself a score of 9 out of 10, indicating that she almost always tried to apply Alexander concepts. Concerning how she applied the Technique to her playing, she wrote:

> I keep my neck in the right position, do not lean forward my neck when playing. I rotated my body when playing the scale from lower to the higher, and keep my bottom stay on the chair. Expanding shoulder blade when playing chords.

Postural data collected at the post-test indicated that Participant 7 followed the expected postural trend between pre-test and post-test with exceptions for the craniovertebral angle in three tasks, the head-neck-trunk angle in five tasks, and the thoracolumbar angle in five tasks. A comparison of the participant's perception with the postural data show that although she felt she played with good posture following lessons, a few angles did not follow the expected pattern in several tasks. However, she mentioned the application of Alexander principles during scale playing specifically and for that task, the postural data showed that all angles followed the expected pre-lesson to post-lesson trend. Participant 7 also thought about her neck and its position while playing, specifically in not allowing the neck to jut forward while playing which can result in a forward head posture. One component of the AT is in thinking about allowing the head to go "forward and up," which will lessen forward head posture. Her craniovertebral angle, a commonly used measure to examine forward head posture, demonstrated the expected pre- to post-lesson pattern for several tasks, indicating that she was successful some of the time in decreasing how far forward she projected her neck.

At the follow-up session, Participant 7 again rated herself on how often she tried to apply Alexander principles to her playing. She gave herself a score of 7 out of 10, indicating that she often tried to apply concepts while playing. Concerning how she applied the Technique, she wrote, "While playing, turn your body to the direction instead of moving your body from side to side. Using shoulder to raise your arms to the keyboard instead of just arms rising. Sitting position to keep your lower back curved." Postural data indicated that she followed the expected trend from pre-Alexander lessons to post-Alexander lessons when comparing between the pre-test and the follow-up although there were some exceptions, particularly for the thoracolumbar angle in which none of the follow-up results demonstrated the expected pattern. Participant 7 again focused on applying the Technique when moving to extremes of the keyboard, reflected in her scale playing. Once again, all measured angles demonstrated the expected pattern of change in scale playing except for the thoracolumbar angle, possibly due to her awareness of her body while playing scales in particular. A possible reason for why her thoracolumbar angle did not demonstrate the expected change could be that she tried to "keep [her] lower back curved." In trying not to overextend her lower back, she may have overcompensated by flexing the thoracolumbar spine too much, leading to the results seen in the follow-up measurement. When comparing the post-test to the follow-up, a reversion in the direction of her pre-test measurements can be seen, although not enough to demonstrate a complete return.

Overall, the perception of Participant 7 did not always reflect the postural data taken at the post-test and follow-up. She felt that she had good posture after lessons, as reflected in how she rated herself, and she felt that she had often applied principles of the Technique, but she demonstrated a number of exceptions when comparing her postural results to the expected post-lesson trend. However, this may be because of overcompensation. In trying to change her posture directly, she may have overdone it, resulting in the postural data collected at the post-test and follow-up. In addition, her choice of words reflected an attempt to change her posture for herself, which is contradictory to what the AT teaches. The AT asks its students to become aware of undesirable posture and patterns in themselves and to stop doing them. It is then followed by saying Alexander directions to themselves to activate the hands-on experiences given to them by their teachers during lessons which leads to a change in posture and movement. Participant 7 appeared to actively try to change herself to achieve the posture she thought was required of her although, as the AT teaches, there is no fixed posture. It is possible, however, that her choice of words may have been how she construed the AT in her mind to help her remember the sensations she experienced while taking lessons with a teacher. Despite the number of exceptions and her involved efforts, Participant 7 still generally demonstrated the post-lesson trend.

Participant 8

Participant 8 was a 36-year-old female who had been playing piano for 29 years. She achieved her doctorate in musical studies at a post-secondary institution. At the time of the study, she practiced an average of two hours a day, five days a week. She previously had one group session in the AT and one or two workshop sessions in Body Mapping and the Feldenkrais Method.

At the post-test, Participant 8 rated herself on whether she felt she played with good posture after having had lessons in the AT. She gave herself a score of 4 out of 5, indicating that she felt she played with good posture following lessons. She also rated herself on how often she applied what she learned in the AT to her playing. She gave herself a score of 8 out of 10, indicating that she often tried to apply principles to her playing. Concerning how she applied the Technique, she wrote:

> The first instruction of the Alexander Technique is very useful for me. "Allow neck to be free" gives me freedom because I used to feel pain at neck of my body. During the Alexander Technique I could learn…how I manage my body weight. I could realise how my body posture changes. I think it is very important, because as a pianist, body is my instrument. So, these experiences gave me lots of changing. I will continue taking the Alexander lesson.

Postural data collected at the post-test indicated that Participant 8 followed the expected trend from pre-test to post-test. However, she exhibited several exceptions with each angle deviating from the pattern in at least one task. When comparing her experience with the AT to her post-test postural data, there are slight discrepancies in that she felt she had good posture after lessons and that she changed, but her exhibited postural pattern did not always follow the expected trend. While she focused on her neck, exceptions to the postural trend were found in the craniovertebral angle for a few tasks. However, she did appear to develop an awareness of her body, which is an important part of the AT. This may account for the changes seen in her post-test in comparison with her pre-test.

At the follow-up, Participant 8 again rated herself on how often she applied the Technique to her playing. She gave herself a score of 8 out of 10, indicating that she often tried to apply concepts while playing. Writing about her experience, she said:

> I am applying most of my practicing time. Especially when I was playing difficult passage, the Alexander Technique was very useful for me because I could manage my body and feeling. Also, I could feel energy of my body, and I could focus on my body posture. It was great experiences.

Postural data collected at the follow-up showed that Participant 8 followed the expected pattern of change from pre-test to follow-up for all angles in all tasks except for the trunk angle in four tasks and the thoracic angle in three tasks. When comparing the post-test to the follow-up, Participant 8 demonstrated a continued development in the direction of post-lesson postural change for some angles. Comparing the scores for how closely the participant followed the expected trend showed that she followed the pattern more closely in the follow-up than in the post-test. Participant 8 stated that she was applying the Technique most of the time while practicing and she continued to cultivate a whole-body awareness of herself. This may account for why she followed the expected pattern of change more closely in the follow-up than in the post-test.

In general, Participant 8 followed the expected postural change from pre-Alexander to post-Alexander lessons. While there were some discrepancies between her perception of her own posture and the postural data at the post-test, she exhibited a closer following of the expected pattern at the follow-up. She felt she applied the AT often, both leading up to the post-test and the follow-up. While this was not immediately apparent at the post-test, the postural data collected at her follow-up reflected that the continued application of principles can lead to continued postural change, even if those changes are not clearly noticeable directly following lessons.

Participant 9

Participant 9 was a 19-year-old female who had played piano for more than 10 years. She studied music at a post-secondary institution. At the time of the study, she was practicing an average of one to two hours a day, two to three days a week. She had no previous experience with the AT.

At the post-test, Participant 9 rated herself on how she perceived her posture after having had lessons in the AT. She gave herself a score of 4 out of 5, indicating she felt that she had good posture after lessons. She also rated herself on how often she tried to apply what she learned from the AT to her playing. She gave herself a score of 7 out of 10, indicating that she often tried to apply the Technique while playing. Concerning how she applied the AT, she wrote:

> I tried to imagine my body/arms not sinking in the piano but more like away from piano.

> I applied Alexander Technique mostly when I was practicing scales, and I focused on my body moving more like followed by my finger/arm motion. I was feeling my both feet rooted on the ground.

Postural data collected at the post-test showed that Participant 9 exhibited the expected changes from pre-test to post-test for all angles in all tasks with the exception of the thoracolumbar angle in three tasks. There are some commonalities between what Participant 9 perceived about herself and her postural results. She felt that she played with good posture after lessons, and she felt that she applied principles of the Technique often. Her postural data showed that she followed the expected postural trend from pre-Alexander to post-Alexander lessons, indicating that there was indeed a change after her experience with the AT. In addition to applying principles of the AT often, she also appeared to develop an awareness of her whole body and its movements in relation to the piano, which may account for why she followed the trend closely. She also stated that she mostly applied the Technique when practicing scales, but her results showed that her postural angles changed in more than just one task, again possibly due to the frequency of the application of the Technique as well as her developed body and movement awareness.

At the follow-up, Participant 9 was asked to rate herself on how often she applied the AT to her playing. She gave herself a score of 8 out of 10, indicating that she felt she applied the Technique often while playing. When asked to write about how she applied the AT to playing, she wrote:

> I tried to mostly think about relationship between me and the piano, me (my arm is pushed against the piano, and me and piano are sort of away from each other). Sometimes I felt really tired maintaining the posture and had to do a few scales in a short time. I still didn't know how to apply Alexander Technique with a pedal, but when I am not, I could relate it to practicing a bit more (sitting straight and my body and piano away from each other). It was hard to focus on the music especially when I sight read with Alexander Technique.

Postural data collected at the follow-up showed that Participant 9 followed the expected trend from pre-Alexander to post-Alexander lessons when comparing the pre-test to the follow-up.

Exceptions to this were found for the craniovertebral angle in one task, the head-neck-trunk angle in two tasks, and the thoracolumbar angle in one task. The comments of Participant 9 indicated that she continued to have an awareness of her body and its relation to the piano. While she found it difficult to focus on playing, especially while sight reading, her postural results showed that, compared to her pre-test measurements, her posture had changed, perhaps because of this continued body and movement awareness. Additionally, all angles followed the expected trend during the sight reading task, which shows a discrepancy between her perception of herself and her postural results. When comparing the post-test results to the follow-up, a return towards her pre-test posture was found, but it was not enough to be a complete reversion. In general, her posture continued to follow the expected post-lesson trend in the follow-up, but not as closely as she did in the post-test. This could be because she did not have a teacher to continue giving her the experiences associated with Alexander principles, but as she continued to think about how to apply the AT to her playing, she did not completely return to her pre-test posture.

Overall, Participant 9 followed the expected postural trend from pre-Alexander to post-Alexander lessons. Immediately after lessons, she felt as if she had good posture and the postural data showed that she had changed in the expected manner, showing some commonalities between her assessment of herself and her postural measurements. While she did not always feel confident that she was successfully applying principles to her playing, her postural results showed that her posture did change across all tasks. This may be because she developed a whole-body awareness, especially in relation to the piano, resulting in the postural changes that were found.

Participant 10

Participant 10 was a 21-year-old female who had been playing piano for 13 years. The highest level of playing she achieved was Level 9 with the RCM curriculum. She practiced an average of two hours a day, one to two days a week. She had no previous experience with the AT.

At the post-test, Participant 10 was asked to rate her posture and she gave herself a score of 4 out of 5, indicating that she felt she had good posture after lessons. Additionally, she was asked to rate herself on how often she applied what she learned from the AT to piano playing. She gave herself a score of 8 out of 10, indicating that she often applied principles of the Technique to her playing. Concerning how she applied the AT while playing, she wrote:

> I have to keep my feet on the ground to support myself and use the strength from my lower back and bring it to my shoulders, arms and hands while playing. My back and head have to be straight and neck and hands should be loose.

Postural data collected at the post-test showed that all angles in all tasks followed the expected trend for postural change between the pre-test and the post-test. Exceptions to this were found for the head-neck-trunk angle in one task and the thoracic angle in two tasks. There were some similarities between what Participant 10 perceived about herself and her postural measurements. She felt that she played with good posture after receiving lessons and her postural data showed that her measurements changed in the expected manner. She also felt she applied principles of the Technique often to her playing, which is reflected in how closely she followed the post-lesson trend. However, her choice of words (i.e., "have to") while reflecting on how she applied the Technique is interesting in that the AT does not force its students into positions. The AT provides directions which serve as instructions to the student concerning how to prepare the body for movement and how to use the body during movement. Directions do not provide a set posture to be achieved. The usage of words in the comments of Participant 10 may have been the way she interpreted the Technique to help her remember what to do, although actively trying to change one's posture is not encouraged in the AT.

At the follow-up, Participant 10 was asked to rate herself on how often she applied concepts of the Technique to her playing in the interim between the post-test and follow-up. She gave herself a score of 7 out of 10, indicating that she felt she applied them often. She was also asked to write about how she applied the AT to her playing. She wrote, "I planted my feet to the ground, straightened my back, and lifted my head." Postural data collected at the follow-up showed that, between the pre-test and the follow-up, Participant 10 exhibited the expected pattern. However, the postural results also showed that the expected trend was followed much less closely in the follow-up than in the post-test with several of the measured angles reverting in the direction of her pre-test posture. There are some discrepancies between the experience of Participant 10 and her postural data. She felt that she applied the Technique often to her playing, but her measurements did not reflect this application, especially considering the difference between how closely she followed the expected postural trend in the post-test versus the follow-up. Her comments written at the follow-up reflected an active involvement in trying to conform her body into a certain position which is contradictory to the teachings of the AT. This, combined with the lack of feedback from a teacher, may account for the rapid regression towards her pre-test posture.

In general, Participant 10 exhibited the expected change in postural angles from pre-Alexander to post-Alexander lessons. Her post-test perception of herself had more commonalities with her post-test postural data than her perception of herself at the follow-up. She demonstrated a reversion towards her pre-test posture at the follow-up, indicating that without the continued guidance of a teacher and without a proper understanding of how to apply the Technique, a return towards pre-Alexander posture can occur.

Participant 11

Participant 11 was a 28-year-old female who had been playing piano for 23 years. She studied piano at a post-secondary institution and obtained her master's degree and practiced an average of four hours a day, six to seven days a week. She had previous experience with the AT, having had three private lessons and two group lessons prior to the study. Her inclusion in the study stemmed from the reasoning that group lessons are not the same as private lessons and that three private lessons were still insufficient to establish a thorough understanding of the AT. She also participated in a study concerning Body Mapping for an unspecified length of time and had one session in the Feldenkrais Method.

At the post-test, Participant 11 was asked to rate herself concerning how she perceived her posture following lessons in the AT. She gave herself a score of 4 out of 5, indicating that she felt she played with good posture after having had lessons. She was also asked to rate herself on the frequency with which she applied principles of the Technique while playing. She gave herself a score of 8 out of 10, indicating that she applied concepts often. When asked to write about how she applied the AT to piano playing, she wrote, "Observing neck, back, head, arms and their relationship to one another. Readjusting when I noticed a tendency to fall back into an old habit." Postural data collected at the post-test showed that she followed the expected pattern of change from pre-test to post-test. Exceptions were found for the craniovertebral angle in two tasks, the trunk angle in one task, the thoracic angle in six tasks, and the thoracolumbar angle in three tasks. Participant 11 wrote that she observed the head-neck-back relationship, a central element of the AT. She also developed an awareness of her body and recognized when she "[fell] back into an old habit." While she appeared to develop her sense of awareness concerning her body, her posture may not have changed to the degree that she perceived. She felt that she played with good posture after lessons while her postural data showed that while she did exhibit the post-lesson trend, she also demonstrated several exceptions to the pattern.

At the follow-up, Participant 11 was again asked to rate herself on how often she applied the AT while playing. She gave herself a score of 7 out of 10, indicating that she felt she applied the Technique often. Concerning how she applied principles of the Technique, she wrote:

> Considering the length of the skeleton, not just of the spine, but also of the arms in both directions. Stopping to reconsider alignment and the skeleton's position. Stopping to remember the Alexander instructions: "Allow the neck to be free, to allow the head for a release forward and up..."

Postural data collected at the follow-up showed that, when compared with the pre-test, Participant 11 followed the expected trend from pre-Alexander to post-Alexander lessons, although she continued to exhibit several exceptions to the pattern. When comparing the post-test results to those of the follow-up, Participant 11 demonstrated a reverting in the direction of her pre-test measurements. She continued to think about her body, specifically about her skeletal structure, and she continued to say the Alexander directions to herself. While she did not have a teacher after the post-test, she continued to review and apply key principles of the AT on her own. This may account for why she showed a return, but not a complete reversion to her pre-test posture.

In general, Participant 11 demonstrated the expected post-lesson trend. However, her perception and her postural measurements did not always agree. Participant 11 thought that she changed more than her measurements showed in that she felt she played with good posture following lessons and she demonstrated an understanding of important Alexander principles, but her postural data showed that she followed the postural trend only some of the time.

Participant 12

Participant 12 was a 59-year-old female who had been playing piano for 40 years. The highest level of playing she achieved was Level 10 with the RCM curriculum. At the time of the first baseline measurement, she was practicing an average of 10 minutes a day due to an injury to her left arm. She practiced an average of five days a week. She had no previous experience with the AT but had 20 group sessions in the Feldenkrais Method.

At the post-test, Participant 12 was asked to rate her posture. She gave herself a score of 3 out of 5, but wrote, “better posture, not necessarily ‘good’,” indicating that she felt she had somewhat better posture following lessons in the AT. She was also asked to rate herself on how often she applied the Technique while playing and she gave herself a score of 7 out of 10, indicating that she often tried to apply what she learned. Concerning how she applied principles of the AT while playing, she wrote, “Keep my neck "free." Try to put/allow my head to be in a better place. Think of line directed through opposite hip when playing in "extreme" range of piano keyboard.” Postural data collected at the post-test showed that all angles in all tasks followed the expected pattern of change from pre-test to post-test except for the craniovertebral angle in one task and the head-neck-trunk angle in one task. There are some commonalities between the participant’s perception of herself and her postural data. She felt that she had better posture following lessons and her measurements showed that she followed the expected trend quite closely. She thought mostly about her head and neck and although her craniovertebral and head-neck-trunk angles, two angles which measure head and neck positions, did not always follow the expected trend, they exhibited the anticipated changes most of the time.

At the follow-up, Participant 12 was again asked to rate herself on how often she applied the Technique to her playing in the time between the post-test and follow-up. She gave herself a score of 5 out of 10, indicating that she sometimes applied principles of the AT. Concerning her experience with the Technique during the interim, she wrote:

> Initially (i.e., when sitting down at the piano) to get a more settled feeling before starting practice. When practicing difficult passages, AT seemed to lessen tension induced by technical difficulties/challenges. Breaks between practice "bits": "Breather" - AT seemed to help me breathe deeper and more fully.

Postural data collected at the follow-up showed that, in comparison with the pre-test, Participant 12 followed the expected change in posture for all angles in all tasks. In comparison with the post-test, several of the follow-up angles demonstrated a reversion in the direction of her pre-test posture, although the changes did not show a complete return to her pre-lesson measurements.

While Participant 12 stated that she applied principles of the Technique only some of the time, her comments showed that the effects of the AT were for her whole body and not a specific part. She felt a lessening in tension and found that the AT helped her to feel more "settled" before she began to practice. This effect of the AT on Participant 12 may have led to the measurements seen in the follow-up.

Overall, Participant 12 followed the expected postural trend from pre-Alexander to post-Alexander lessons. While she did not always seem confident about the AT's influence on her, she exhibited the anticipated changes in posture. She initially focused on her head and neck, but eventually found that the AT helped her to reduce tension which may have led to changes throughout her whole body.

Participant 13

Participant 13 was a 19-year-old female who had been playing piano for 11 years. She reached Level 9 with the RCM curriculum and was practicing an average of one hour a day, six days a week. She had no previous experience with the AT prior to this study.

At the post-test, Participant 13 was asked to rate herself on whether she felt she played with good posture following lessons in the AT. She gave herself a score of 3 out of 5, indicating she felt that she played with somewhat good posture after lessons. She was also asked to rate herself on how often she tried to apply principles of the Technique to her playing. She gave herself a score of 8 out of 10, indicating that she often tried to apply what she learned while playing. Concerning how she applied principles of the Technique, she wrote:

> The main issue I had was being able to make space in the shoulder blade and avoid using my pectoral muscles more than needed. I often had to stop playing to readjust the "spaced out" position as it always closed back up again once I started playing.

Postural data collected at the post-test showed that Participant 13 followed the expected pattern of change from pre-test to post-test, although she demonstrated at least one exception to the trend for all angles except for the thoracic angle, which followed the expected pattern in all tasks. She felt she applied the Technique often while playing but focused on specific parts of her body like her shoulder blades and pectoral muscles. Her focus on her upper torso rather than her whole body may be the reason why she exhibited multiple exceptions to the expected postural pattern.

This may also be why the thoracic angle was the only angle in which no exceptions to the trend were found. However, her perception regarding her own posture showed some similarity with the postural measurements collected at the post-test. Her response indicated that she did not feel very confident about playing with good posture, although she did not think her posture was bad. She felt she played with somewhat good posture while her postural data showed that she followed the expected trend only some of the time.

At the follow-up, Participant 13 was asked to rate how often she applied principles of the AT while playing. She gave herself a score of 7 out of 10, indicating that she often tried to apply the Technique. When asked to write about her experience applying principles of the AT, she wrote:

> Because the Alexander Technique is still fairly new to me, the easiest aspects for me to focus on were keeping my neck as relaxed and forward as possible throughout my playing. Additionally, because I have a habit of tensing my wrists, I tried letting go of my forearm muscles as much as possible and finding space in between all my hand and arm joints.

Postural data collected at the follow-up showed that, in comparison with the pre-test, she followed the expected postural pattern of change from pre-Alexander to post-Alexander lessons. Exceptions were found for the trunk angle in two tasks, the thoracic angle in two tasks, and the thoracolumbar angle in three tasks. At the time of the follow-up, her focus appeared to be on her neck and upper extremities, which may be why the exceptions were found in variables relating to her torso rather than in the craniovertebral and head-neck-trunk angles. This is in contrast with her post-test results in which she focused on her upper torso and showed exceptions in all but the thoracic spine. When comparing the postural data from the post-test to the follow-up, it was found that Participant 13 followed the expected pattern more closely at the follow-up. Her comments at the follow-up reflected a change in her thoughts towards more than just her upper torso. This may account for why, in comparison with the post-test, her follow-up results followed the expected trend much more closely. It is also possible that she simply needed more time to practice integrating principles of the Technique into her playing.

In general, Participant 13 followed the expected postural pattern from pre-Alexander to post-Alexander lessons. Her focus on various parts of her body seemed to determine where postural changes were found. She also seemed to demonstrate that time was needed in order for her to integrate the Technique into her playing, as seen by how closely she was able to follow the expected trend in the follow-up in comparison with results seen at her post-test.

Participant 14

Participant 14 was a 22-year-old male who had been playing piano for 16 years. He was studying for his master's degree in piano performance at the time of the study and practiced an average of four to six hours a day, seven days a week. He had no previous experience with the AT but had eight sessions in Body Mapping.

At the post-test, Participant 14 was asked to rate his perception of his own posture following lessons in the AT. He gave himself a score of 5 out of 5, indicating that he felt he played with good posture after having had lessons. He was also asked to rate himself on how often he applied principles of the Technique while playing and he gave himself a score of 9 out of 10, indicating that he almost always tried to apply concepts of the AT while playing. Concerning how he applied the AT, he wrote:

> I begin practice by doing 5-10 minutes of constructive rest. I often practice "Monkey" if my back feels achy or tense. I always sit while thinking of maintaining head and neck alignment. I frequently think of my sit-bones and my head leading my movements, especially when leaning to either side.

Postural data collected at the post-test showed that Participant 14 followed the expected change in posture from pre-test to post-test, with exceptions found for the craniovertebral angle in one task, the head-neck-trunk angle in one task, the trunk angle in all tasks, and the thoracolumbar angle in four tasks. While Participant 14 seemed to think he played with good posture after lessons and he felt he applied principles of the AT almost always, his postural measurements showed that while he followed the expected trend, he also demonstrated several exceptions. However, Participant 14 did demonstrate some knowledge about how to apply the AT during his practice sessions. He seemed to think of the relationship between his head and neck as well as his contact point with the seat while playing. He mentioned that he applied the Technique specifically while “leaning to either side [of the keyboard]”, and his postural measurements showed that he did not exhibit any exceptions to the postural trend during the scale playing task except for the trunk angle.

At the follow-up session, Participant 14 was again asked to rate himself on how often he applied principles of the AT while playing. He gave himself a score of 8 out of 10, indicating that he often applied concepts of the Technique while playing. When asked to write about how he applied the AT, he wrote, “Posture especially lower back when sitting, and how I use/hold my shoulders.” Postural data collected at the follow-up showed that, compared with his pre-test measurements, Participant 14 followed the expected change in pattern for all angles in all tasks except for the craniovertebral angle in one task, the head-neck-trunk angle in one task, the trunk angle in one task, and the thoracolumbar angle in one task. When comparing the post-test to the follow-up, it was found that Participant 14 followed the expected postural trend more closely in the follow-up than in the post-test. Concerning his application of the AT, Participant 14 continued to apply principles often and he focused on applying it to his posture, specifically to his lower back. This may account for why he followed the postural trend more closely in the follow-up than in the post-test. His continued application of the AT may have led to the continued changes in his posture.

In general, Participant 14 followed the expected postural trend from pre-Alexander to post-Alexander lessons. While he initially felt that he played with good posture following AT lessons, he did not demonstrate the expected change in posture at the post-test as obviously as he did at the follow-up. However, his continued practice and application of the AT may have led to continued change in his posture.

Participant 15

Participant 15 was a 27-year-old male who had been playing piano for 13 years. He was studying for his master’s degree in piano performance at the time of the study. He practiced an average of six hours a day, seven days a week. He had some previous experience with the AT, having had six months of group sessions, which he stated were “really, really bad classes.”

At the post-test, Participant 15 was asked to rate his perception of his own posture. He gave himself a score of 5 out of 5, indicating that he felt he played with good posture following lessons in the AT. He was also asked to rate himself on how often he tried to apply principles of the Technique while playing and he gave himself a score of 7 out of 10, indicating that he often applied concepts of the AT. Concerning his experience with applying the Technique, he wrote, “Awareness of my posture. Relaxation and releasing the tension. Short breaks to rest and laying down. Releasing the tension on my neck.” Postural data at the post-test showed that Participant 15 followed the expected pattern of change from pre-test to post-test for all angles in all tasks except for the thoracic spine in all tasks. There are some commonalities between his perception of himself and his postural data. He felt that he played with good posture following lessons and he felt that the AT gave him an “awareness of [his] posture”, and his measurements showed that he mostly followed the expected trend, indicating a change in his posture. He also stated that the AT helped him to release tension throughout his body, particularly the tension in his neck. This may be reflected in that all angles measured pertaining to the neck (i.e., craniovertebral angle, head-neck-trunk angle) showed the expected post-lesson changes.

At the follow-up, Participant 15 was asked to rate himself on how often he applied what he learned from the AT while playing. He gave himself a score of 8 out of 10, indicating that he felt he often applied the Technique. Concerning how he applied the AT, he wrote:

> Every hour or when I feel that I need rest or I am tired I do at least 5 min of Alexander Technique. My piano technique isn't affected by it but I keep on mind Alexander Technique when I am sight-reading since it's when I get [stiff?] without awareness of my own body.

Postural data collected at the follow-up showed that, in comparison with his pre-test measurements, Participant 15 demonstrated the anticipated postural trend with exceptions found for the trunk angle in two tasks and for the thoracic angle in six tasks. Participant 15 continued to apply the AT on his own, especially when sight reading. His measurements from the sight reading task showed that all angles demonstrated the expected postural trend except for the thoracic angle. When comparing the post-test to the follow-up, a general pattern of regression was found except for the head-neck-trunk angle which continued to show changes in the direction of post-lesson changes for most of the tasks. The lack of a teacher to continue giving hands-on experiences of AT ideas during the interim between the post-test and follow-up may account for the regression. However, he did not return completely to his pre-test posture, indicating that with continued application of the AT, it is possible to still exhibit postural measurements that show the expected post-lesson trend.

Overall, Participant 15 demonstrated the expected pre-Alexander to post-Alexander lesson pattern of change. His perception of his posture showed some commonalities with the measurements taken at the post-test and follow-up. The lack of a teacher from post-test to follow-up may account for the difference in posture seen between the two measurements, but his continued application of the Technique may explain why he still exhibited the expected pre-lesson to post-lesson change, although to a lesser degree.

Table 1

Summary of Results

Participant	Participant Perception					Posture		
	Posture perception [a]	Frequency of application [b]		Appropriate language for AT		Trend percentage [c]		Reversion percentage
	Post-test	Post-test	Follow-up	Post-test	Follow-up	Post-test	Follow-up	Follow-up
1	4	6	6	Yes	Yes	97%	91%	74%
2	3	7	6	Yes	Yes	94%	91%	49%
3	2	2	2	Yes	Yes	77%	60%	69%
4	5	10	10	Yes	Yes	86%	80%	63%
5	3	6	5	Yes	Yes	100%	91%	49%
6	3	5	3	Yes	Yes	86%	86%	37%
7	5	9	7	No	No	63%	57%	51%
8	4	8	8	Yes	Yes	66%	80%	26%
9	4	7	8	Yes	Yes	91%	89%	57%
10	4	8	7	No	No	91%	60%	77%
11	4	8	7	Yes	Yes	66%	57%	60%
12	3	7	5	Yes	Yes	94%	100%	71%
13	3	8	7	Yes	Yes	54%	80%	26%
14	5	9	8	Yes	Yes	63%	89%	29%
15	5	7	8	Yes	Yes	80%	77%	63%

[a] 1 = no (confidently), 2 = no, 3 = somewhat, 4 = yes, 5 = yes (confidently)

[b] 1 = never, 2 = almost never, 3-4 = rarely, 5-6 sometimes, 7-8 = often, 9 = almost always, 10 = always

[c] 50-59% = not a close following, 60-69% = slightly close following, 70-79% = moderately close following, 80-89% = very close following, 90%-100% = extremely close following

Discussion

Participants' Perceptions

Of the fifteen participants, four of them confidently felt that they played with good posture following lessons. Five participants felt they played with good posture and five felt they played with somewhat good posture after lessons. Only one participant felt they did not play with good posture following AT lessons. Concerning how the Technique was applied, participants focused on a variety of aspects including different parts of their bodies, their head-neck-back relationship, alignment of parts of their bodies, how they sat at the piano, and their posture in general. The AT also brought increased awareness to participants about different parts of their bodies as well as awareness concerning posture in general, their skeletal structure, how they sat at the piano, movement while playing, tension, and weight shift. One participant also became aware of her body's relationship to the piano, and another developed an awareness for the need to adjust the seat before playing. Some participants found that they tended to revert to old habits. This is interesting because one of the main principles of the AT is inhibition: a "suspending [of] habitual responses to stimuli" (Jones, 1997, p. 211). To inhibit one's usual response, one must first recognize what their habit is. For participants who stated that they tended to return to old habits, they demonstrated a development of recognizing their typical response to a situation – in this case, playing the piano. Participants also wrote about using the Technique when playing at the extremes of the keyboard, playing scales, and when playing chords. Some referenced Alexander principles in their writings about how they applied the Technique while other participants found the AT difficult to apply while playing.

These perceptions and applications of the Technique agree with studies that have been conducted about the AT. Participants in Kim and Baek's (2014) study found that they gained a sense of body awareness. Participants in Reddy and colleagues' (2010, 2011) studies reported that they felt their posture improved after AT lessons while participants in Gibbs and Young's (2011) study found that the AT changed their body positions. For studies concerning musicians, Davies (2020a, 2020b) found that music students who took one semester of AT lessons felt that the Technique was beneficial for posture and for releasing tension. For studies concerning pianists, one of Kaplan's (1994) findings was that pianists who studied the Technique found that the AT brought increased awareness of the body and its part in playing the piano. Pianists who participated in Loo and colleagues' (2015) study reported feeling a decrease in muscular tension following lessons in the AT. The responses given in this present study show that, like Stallibrass and colleagues' (2004) findings, each participant applied what they had learned during lessons while demonstrating a wide range of applications.

Participants' Postural Trends

All participants followed the expected postural trend from pre-test to post-test, although not all of them followed the trend as closely as others. At the post-test, six participants followed the expected pattern extremely closely, three participants followed the pattern very closely, one participant followed it moderately closely, four participants followed it slightly closely, while one participant did not follow the trend closely. Many studies have shown that the AT can change posture (Cacciatore et al., 2005; Cacciatore, Gurfinkel, Horak, Cordo, & Ames, 2011; Cacciatore, Gurfinkel, Horak, & Day, 2011; Cohen et al., 2015; Gross et al., 2019; Santiago, 2004), but this present study detailed the expected change in spinal angles from pre-Alexander to post-Alexander lessons and determined how closely participants followed this expected pattern. This present study also found that ten of the fifteen participants followed the expected pattern of change less closely at the follow-up than at the post-test. One participant followed the trend the same amount but exhibited different exceptions when they did not follow the trend. Interestingly, four participants followed the expected pattern of change more closely at the follow-up in comparison with the post-test. Those who followed the trend less closely at the follow-up did not show a large change between the post-test and the follow-up (i.e., most of these participants showed a 2-9% drop in adherence to the expected postural trend), indicating that the AT was still effective in altering posture. All participants demonstrated some reversion in the direction of their pre-test posture when examining individual postural angles, but not to the same degree. Those that typically exhibited a smaller amount of reversion (i.e., Participants 8, 13, and 14) were also those that showed a closer following of the expected postural trend in the follow-up than in the post-test. The only exception to this observation was Participant 12 who demonstrated a reversion in several measured angles, but overall followed the trend more closely when comparing between pre-test and follow-up rather than between the post-test and follow-up. Despite demonstrating a return in the direction of their pre-test posture, all participants continued to demonstrate a following of the expected postural trend when comparing between pre-lesson and follow-up measurements.

Previous studies showed that the effects of taking AT lessons were retained up to a year following lessons, although not all these studies dealt with posture. Little and colleagues (2008) as well as MacPherson and colleagues (2015) found that the AT was still effective in managing neck and back pain a year following AT lessons. Stallibrass and colleagues (2005) found that six months after lessons in the AT had ended, participants with Parkinson's disease continued to apply the AT. These participants reported that the AT helped them in multiple aspects of their lives, such as sitting and walking. Participants also felt that the AT helped them to relax, improved posture, and reduced pain, indicating that they felt the Technique had lasting effects. Gross and colleagues' (2020) study revealed that between three to six months after lessons had ended, participants with Parkinson's continued to demonstrate improvement in head and neck posture in comparison with their pre-lesson measurements, leading the researchers to conclude that there are long-term benefits associated with learning the AT.

Relationship Between Participant Perception and Postural Trend

No previous studies have examined the relationship between pianists' perceptions of their postures and their measured posture following lessons in the AT. In this study, it was found that at the post-test, four of the fifteen participants felt very confident that they had good posture following lessons in the AT. However, this did not always mean they followed the expected postural trend very closely. Only two of these participants showed a very close following of the expected postural pattern while the other two followed only slightly closely. Of the five participants who felt they had good posture after lessons, although not to the same degree of confidence as the abovementioned participants, three of them demonstrated an extremely close following of the expected trend while the other two followed the pattern slightly closely. Of the five participants who felt that they had somewhat good posture following lessons, three of them followed the expected trend extremely closely, one of them followed the trend very closely, while the last one did not follow closely. The single participant who felt she did not have good posture following lessons demonstrated a moderately close following of the expected postural trend. These results show that being confident about having good posture does not necessarily equate to demonstrating the expected postural change following lessons in the AT.

The frequency of applying AT principles did not necessarily guarantee that participants would or would not follow the trend closely. At the post-test, one participant stated that she always applied principles of the Technique and she demonstrated a very close following of the expected postural trend. One participant felt she almost always applied the AT, and she followed the trend slightly closely. Eight participants reported often applying the Technique and they ranged from not following the trend closely to following the trend extremely closely. The three participants who stated that they sometimes applied the AT followed the trend either very closely or extremely closely. One participant felt she almost never applied principles of the Technique while playing and she demonstrated a moderately close following of the expected pattern. At the follow-up, one participant stated that she always applied the Technique, and she demonstrated a very close following of the expected trend. Eight participants felt they often applied the Technique and they ranged from not following the trend closely to following it very closely. Four participants felt they sometimes applied principles of the AT and these four followed the expected pattern extremely closely. One participant felt she rarely applied the Technique, and she followed the trend very closely. One participant reported almost never applying the AT and she demonstrated a slightly close following of the expected trend. It should be noted that participants did not always rate themselves the same way at the follow-up as they did in the post-test. Additionally, at both the post-test and follow-up, eight of the fifteen participants rated themselves as often applying principles of the Technique, so the wide range in how closely participants followed the trend could be attributed to the number of participants in this category.

All participants demonstrated a reversion in some postural angles between the post-test and follow-up. However, there appeared to be no relationship between how many of their angles reverted in the direction of their pre-test measurements and the frequency with which they felt they applied the Technique to their playing.

The AT places an emphasis on focusing on the whole body rather than specific parts, so it may be assumed that participants who focused on the whole body might follow the expected postural trend more closely than those who focused on a few specific parts. Nine participants appeared to demonstrate a whole-body awareness, mentioned many different parts of their bodies, the head-neck-back relationship, or posture in a general sense at the post-test based on their comments about how they applied the AT while playing. Of those nine participants, six of them followed the expected postural trend very closely or extremely closely. However, three participants who did not mention the above aspects also demonstrated a very close or extremely close following of the expected trend. At the follow-up, eight participants demonstrated a whole-body awareness, mentioned several parts of their bodies, the head-neck-back relationship, or posture in a general sense. Of these eight participants, six of them followed the expected postural trend very closely or extremely closely. However, four participants who did not write about the abovementioned aspects also demonstrated a very close or extremely close following of the expected post-lesson pattern. It appears that having a wider focus of the body may result in following the expected postural trend more closely than those do not. However, that is not always the case, so a general assumption cannot be made. There were participants who demonstrated a close following of the post-lesson pattern without mentioning or demonstrating a whole-body awareness, but it is possible that they thought about their whole bodies and did not write about it in their comments.

There were a couple of participants (i.e., Participants 7 and 10) who did not appear to understand the Technique very well based on their language usage in their written comments. Their choice of words (e.g., “keep my neck in the right position”, “keep lower back curved”, “have to keep my feet on the ground”, “back and head have to be straight”; “straightened my back”, “lifted my head”) indicated an active involvement in attempting to change their posture. This may have resulted in Participant 7 following the postural trend only slightly in the post-test and not following the trend closely at the follow-up. However, it was clear through her writings that she had continued to think about the Technique and how to apply it, within the scope of her understanding, between the post-test and follow-up so that while she followed the postural trend less closely at the follow-up than at the post-test, her overall change between the two test sessions was not very much. In the case of Participant 10, she initially followed the expected postural trend extremely closely. However, she dropped dramatically in how closely she followed the expected trend at the follow-up test. This may have been because, based on her writings, she may not have been thinking very deeply about how to apply the Technique during the interim between post-test and follow-up. However, it should be observed that despite their language usage, they were not the only ones who fell in the categories of “not closely following” or “slightly following” the expected postural trend. They seemed to have an understanding of the sensations given to them by their Alexander teacher and appeared to try to replicate them through active involvement rather than by issuing directions learned during their lessons.

No studies have examined if there is a relationship between self-reports and objectively measured posture for pianists who have taken lessons in the AT. Studies in other fields that have explored the relationship between self-assessment and objective measurements look at the agreement between questionnaires completed by participants (i.e., self-assessment) and observational and direct measurements. Observational measurements include video analysis and posture analysis programs while direct measurements involve measurement tools such as goniometers, accelerometers, and electromyography (Barriera-Viruet et al., 2006; Spielholz et al., 2001). Studies that examined agreement between self-assessments and observational and direct measurements all found that self-assessments were the least accurate method of evaluation, with low agreement between questionnaires and direct measurement methods (Barriera-Viruet et al., 2006; Spielholz et al., 2001; Zare et al., 2017). One study (Balogh et al., 2004) found that people with musculoskeletal issues rated physical activity and physical exertion as higher than what was measured through direct methods. From these studies, it can be seen that participant perception does not necessarily agree with objectively measured variables. This present study came to a similar conclusion and showed that participants' perceptions of their own postures as well as their perceived application of the AT did not always equate to following the expected postural trend closely.

Conclusion

To date, no previous study to our knowledge has compared the self-reported perceptions of pianists with objective measurements concerning their posture following lessons in the AT. This present study is the first that has shown that pianists' perceptions do not always agree with direct measurements of their posture. All participants demonstrated a change in posture from their pre-test measurements and most participants attempted to apply principles of the AT while playing, but the degree to which they followed the expected post-lesson trend varied. Some followed the predicted pre- to post-lesson pattern closely while others did not. Some felt that they played with good posture following lessons but did not demonstrate a very close following of the expected post-lesson trend while others who were not as confident about their posture exhibited a close following of the predicted pattern. Some participants felt they applied principles of the Technique often while their postural data did not show a close following of the expected trend while others who felt they applied principles only some of the time showed a close following of the pattern. Other cases revealed that some participants who felt they played with good posture or felt they applied principles of the Technique often showed a close following of the expected postural trend.

A limitation of this study was the broad wording of the open question issued to pianists. More detailed questioning may show more definite findings. For example, participants who demonstrated an awareness of their whole bodies or did not focus on a few, specific parts of their bodies tended to show a clear change in posture, following the expected pre-lesson to post-lesson trend very closely. However, there were also participants who did not mention whole-body awareness or a general focus on many parts of their bodies who also exhibited a very close following of the expected postural trend after lessons. Asking specific questions about the application of AT principles in future longitudinal studies may reveal more in-depth responses to how pianists apply the Technique while playing and if there is a relationship between whole-body awareness and changes in posture. Another limitation of this study was the number of lessons given to participants. While ten lessons may help pianists develop a basic understanding of the Technique, it is still too few to allow students to develop a deeper knowledge and application of the AT. The results found in this study provide a starting point for exploring the relationship between participants' perceptions and posture following lessons in the AT, but more lessons may give them a greater understanding of the Technique and help pianists to apply the Technique more confidently while playing. This may result in more definite relationships between pianists' perception of their posture, their application of the Technique, and their changes in posture.

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Chapter 7: Discussion

Discussion

The purpose of this dissertation was to examine pianists' postures during performance and to determine what effects the Alexander Technique (AT) had on posture during performance. To address this issue, four studies were conducted.

The first study investigated whether there are quantifiable differences between good use and misuse that could be objectively measured through postural angles and pressure distribution. The AT often refers to these two concepts but has not provided clear distinguishing features between the two conditions resulting in a lack of descriptions concerning their physical appearances. This study examined good use and misuse from a postural perspective by measuring spinal angles and pressure distribution to determine what distinctions exist between the two. The variables in this study were based on the AT principle of *primary control* which is described in AT literature as the relationship between the head, neck, and trunk (Alexander, 1946; Conable & Conable, 1995) and can affect the movements of the body (Jain et al., 2004) as well as how evenly weight is distributed through the points of contact with the seat or floor (Conable & Conable, 1995; Mark, 2003). The results of this study showed that while there was no specific range of postural angles that characterised good use, there was a clear difference when comparing between good use and misuse. It was found that good use is characterised by a larger craniovertebral angle, head tilt, and head-neck-trunk angle as well as smaller trunk, thoracic, and thoracolumbar angles in comparison with misuse. The results also showed that it is necessary for future studies to compare two data sets to each other as it is not possible to look at a single data set and determine if it exhibits good use or misuse. No differences in pressure distribution were found between good use and misuse. It is possible that dispersion index was not the most suitable variable with which to examine differences in pressure distribution. In future studies, perhaps measuring centre of pressure trajectory would provide greater insight into how good use and misuse affects pressure distribution. In addition to characterising differences between good use and misuse, this study was used to prepare for the third study in which the posture of pianists would be examined before and after lessons in the AT to determine if any perceivable changes had occurred. As such, the tasks for the AT participants were designed to be as similar as possible to what the pianists would perform so that changes seen in pianists could be compared to the results of the AT participants. Because the third study would be the first time posture in pianists was quantitatively examined following lessons in the AT, it was considered beneficial to standardise as much as possible to make the results of different studies comparable. The findings of the first study showed that there were distinguishable features in postural angles when comparing between misuse and good use. Because it was assumed that pianists would begin lessons from a state of misuse, given their lack of training in the AT at the beginning of the study, and progress toward good use, it was assumed that pianists would exhibit the expected pattern of change from pre-test to post-test.

Before the AT intervention could take place, it was necessary to first establish a postural baseline for each pianist. Most studies concerning the AT and musicians did not take more than one baseline measurement prior to the beginning of the intervention which creates some doubt about their results because it is possible that changes seen following the intervention could be due to motor variability rather than the intervention. The second study of this dissertation examined the issue of variability from a postural perspective to determine if individual pianists demonstrate consistent postural angles within a task across multiple measurements. The findings showed that while there is a considerable amount of within-person variability in posture between performances, it was not too inconsistent over time. Therefore, while it may be appropriate to take a single baseline measurement prior to an intervention, a more accurate description of a participant's pre-intervention posture may be formed by taking multiple baseline measurements and calculating the average of those measurements. The conclusion from this study is to take multiple baseline measurements to ensure post-intervention changes are not the result of motor variability. The findings of this study informed the data analysis decision made in the following study to take the average of postural angles exhibited by pianists across multiple measurements as their baseline rather than angles demonstrated in a single measurement session.

The third study addressed the issue of how the AT affects the posture of pianists following lessons by investigating whether there are quantifiable differences in postural angles within individuals following 10 lessons in the AT and if those changes are persistent after a 4-week cessation of lessons. To date, no previous study has explored pianists' postures from an objective and quantitative perspective despite posture being an expected change after having had experience with the AT. This study examined the changes in spinal angles following 10 AT lessons. As no discernible patterns in pressure distribution were found in the first study involving AT teachers and trainees, pressure distribution was not examined in this study. In addition to completing a post-test, participants also completed a follow-up test to evaluate the retention of changes that were found in the post-test. Results showed that the postural angles exhibited by pianists followed the expected trend, demonstrated in the first study by AT teachers and trainees, from pre-test to post-test as well as from pre-test to follow-up. This indicates that pianists had moved toward good use following lessons in the AT in the expected manner, manifested through changes in spinal angles. Namely, pianists displayed larger craniovertebral and head-neck-trunk angles and smaller trunk, thoracic, and thoracolumbar angles. Results for head tilt, however, were inconclusive as it did not demonstrate the expected pattern consistently from pre-test to post-test or from pre-test to follow-up. These findings may provide some insight into the AT principle of primary control. In general, posture appeared to be more upright following lessons in the AT, providing some evidence that the Technique can alter spinal posture. If altering the primary control can lead to changes in movements (Jain et al., 2004), it may be assumed that, given the change seen in spinal angles here, upper and lower extremity movements while playing the piano may also change following lessons in the AT which may lend support for the claim that the AT can improve movements in musicians (Conable & Conable, 1995). However, further studies outside the purview of this dissertation are necessary to determine whether such an assumption is true.

The fourth study explored the relationship between participants' perceptions of their posture, their experience with the AT, and their quantitatively measured posture. To date, no study has investigated this issue as these topics are normally kept separate and possible connections have not yet been revealed. In this qualitative descriptive study, individual participants' perceptions and experiences were compared with how closely they followed the expected postural trend as detailed in the third study of this dissertation. Head tilt was not included in this study because the results of the third study revealed it did not demonstrate the expected postural trend consistently from pre-test to post-test. The findings of the fourth study revealed that perception does not necessarily always reflect the postural changes that have occurred. A person who feels they play with good posture may not necessarily demonstrate a close following of the expected postural trend while someone who is less confident about their posture may demonstrate a closer following of the expected pattern of change. This is a clear demonstration of the AT principle of *faulty sensory awareness*, in which a student's perception of himself is not necessarily aligned with what he is physically exhibiting. Studies have shown that musicians who have experienced the AT felt that it had a positive impact on reducing tension (Kaplan, 1994; Loo et al., 2015; Wolf et al., 2017) and improving posture (Davies, 2020a; Davies, 2020b), but the findings of this study revealed that perception is not necessarily an accurate reflection of physical changes that have taken place. Statistical analyses were conducted to further explore the relationship between participants' perceptions and their posture, but these were not included in this paper. See Appendix F for the results of this analysis.

This dissertation has attempted to address the lack of research concerning the effects of the AT on posture. Posture is commonly considered an expected change following lessons in the AT, but few studies have examined this claim from a quantitative perspective. Most studies relied on self-reports and observation to draw the conclusion that the AT can alter posture. This dissertation examined posture by measuring spinal angles to provide quantitative evidence for the effects that the AT can have on posture. It may have been difficult for previous studies to investigate the effects of the AT on posture in the manner described in this dissertation because the terminology used in the AT can be considered vague. There is a lack of clear definitions about what constitutes certain concepts such as good use and misuse despite the usage of these terms during lessons and in the literature. The ideas are expressed in a way that make sense for the student of the AT but does not lend itself to scientific study. It was therefore necessary to first describe these concepts in a way that would allow for quantitative research to be conducted. This resulted in the characterisation of good use and misuse in the form of changes in postural angles relative to each other. These variables were based on the AT principle of primary control which resulted in measuring angles along the spine. This allowed for the translation of AT terminology into variables that would lend themselves to scientific study.

This dissertation also attempted to address the lack of research concerning musicians, specifically concerning pianists as there are few studies concerning this group of instrumentalists. The AT is thought to be beneficial for musicians in that it brings improvements to aspects of musical performance such as posture, movement, anxiety, and tone quality. However, many studies involving musicians are subjective, largely based on self-reports and observations without objective and quantitative measurements to support the perceived changes. The studies in this dissertation utilised quantitative methods to determine if there were changes in spinal angles to provide evidence that the AT can alter posture in pianists. Prior to investigating this issue, multiple baseline measurements were taken to establish each individual pianists' typical playing posture. While many studies involving musicians did not take more than one baseline measurement, multiple measurements were taken prior to the intervention in this dissertation to ensure that changes seen following lessons were not the result of variability between performances. Measurements taken after the intervention showed that the AT can indeed alter posture. Follow-up measurements demonstrated that the AT still had an effect on posture four weeks after the cessation of lessons, but the effects were not as clear as they were in the measurements taken immediately after lessons. That is, pianists demonstrated a closer following of the expected postural trend immediately after lessons had ended in comparison with four weeks after lessons had ended. Continuous lessons may be needed if the changes are to persist over a longer period of time. This dissertation, however, does provide quantitative evidence concerning how the AT can affect posture in pianists following AT lessons. In addition to providing quantitative measurements concerning the effects of the AT on posture, this dissertation also compared pianists' perceptions with their postural measurements. Because many studies have examined the effects of the AT from a subjective perspective, it was deemed worthwhile to compare subjective and objective measures to determine if there was a relationship between the two. Previous studies have found that participants feel as if the AT had improved their posture, but results of this dissertation have shown that while differences in posture exist following lessons in the AT, perception and posture do not always agree with each other. While participant perception is important in providing insight into how pianists feel following an intervention, it cannot be the deciding factor in claiming that a change has happened or that the change was as great as it was perceived by the participant. Future studies should take this into careful consideration when drawing conclusions from their research.

General limitations of this dissertation were the small sample size and the short intervention period. Future research should consider longitudinal studies to examine the long-term effects of the AT on posture.

In conclusion, this dissertation has provided evidence that the AT can alter posture. Clear differences were found between two key AT concepts, good use and misuse, and can be used as guidelines in future quantitative research concerning the effects of the AT on spinal posture, as shown in the study concerning pianists' postures before and after lessons. Variability in pianists' postures was also examined with implications for future intervention studies. It is recommended that multiple measurements be taken to establish more accurate descriptions of pianists' usual playing postures than a single baseline measurement. The intervention study provided quantitative evidence that showed that the AT can alter posture in pianists, even after 10 lessons. Lastly, pianists' perceptions of changes following AT lessons may not necessarily agree with their postural measurements. Future studies should be cautious in drawing conclusions that are based solely on self-reports and should verify those results through quantitative methods when appropriate.

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Appendices

Appendix A

Consent Form for Alexander Technique Teachers and Trainees

Title of the study: The effects of the Alexander Technique on the postural habits of pianists

Principal Investigator: Grace Wong
Department of Human Kinetics
University of Ottawa

Co-Researcher: Dr. Gilles Comeau
Department of Music
University of Ottawa

Invitation to participate: I am invited to participate in the abovementioned research study conducted by Grace Wong.

Purpose of the study: The objective of this study is to examine whether the perceived effectiveness of the Alexander Technique can be accounted for through the external observation of posture and movement at the piano.

Participation: I:

a. Am 18 years of age or older;
b. Am a teacher of the Alexander Technique or training to become a teacher of the Alexander Technique (i.e., trainee);
c. Am certified or will be certified by the Canadian Society of Teachers of The Alexander Technique (CANSTAT) or another recognized institution of the Alexander Technique (e.g., Alexander Technique International).

My participation will consist of demonstrating good and poor sitting postures on a seat as well as good and poor playing techniques. I am not required to know how to play the piano. I will instead mime playing the piano with good and poor postures. I demonstrate placing hands on the keyboard, mime playing a scale, read a paragraph placed in front of me while sitting, and demonstrate pressing the pedal. Markers will be placed on the following locations: external occipital protuberance; glabella; tragus of the right ear; spinous processes of C7, T5, T10, and L3; sacrum; posterior superior iliac spines; and greater trochanter of the right and left femurs. Video recordings will be taken throughout the testing session.

This session has been scheduled for (date) at a University of Ottawa laboratory and should last approximately one hour.

Risks: My participation in this study may result in my feeling slightly tired after the testing session due to miming playing. I have received assurance from the researcher that every effort will be made to minimize these risks (i.e. I may take a break if I need to).

Benefits: My participation in this study will benefit Alexander Technique teachers as well as the music community. For Alexander teachers, it will give our practice more credibility in the context of music performance. Musicians do seek out the Technique to improve their posture, and many report feeling better, but there is little scientific evidence to support this claim. There has been little quantitative research conducted concerning the observable effects of the Alexander Technique on postural aspects of piano playing. The focus of this study is to determine if there are quantitatively observable changes in piano performances after training in the Alexander Technique. Should this project demonstrate that there are positive results concerning postural aspects of performance, the music society would be provided with a quantifiably proven way to examine and improve on playing posture.

Confidentiality and anonymity: I have received assurance from the researcher that the information I will share will remain strictly confidential. I understand that the contents will be used only for the purposes of this study and that my confidentiality will be protected. Anonymity will be protected through alphanumerical identification. Any personal information collected (e.g., name, gender) will only be used in the context of this study and the consent form containing this information will be kept securely and removed from the laboratory at the end of testing sessions so that it will not be possible to link me to the data collected. Video data collected will only be associated with the alphanumerical identification assigned to my recordings and will be securely stored. Only selected people directly involved with the research project will have access to the data during this time. Any data collected for this project will be used for this project only.

Conservation of data: The data collected (personal information, consent form, answers to general questions, video and audio recordings) will be kept in a secure manner (kept under lock and key, password protected on laptop). All data will be kept for an indefinite length of time.

Compensation: I will not receive any form of compensation for participating in this study.

Voluntary participation: Participation in this study is strictly voluntary and I have the right to refuse to answer any questions during this session without fear of reprisal or ill treatment. I can choose to withdraw from the study at any time while the experimental session is being conducted. After the testing sessions, I will not be able to withdraw from the study since it will not be possible to identify the data associated with me. I do not have to provide any reason or justification to withdraw.

Acceptance: I, ____, agree to participate in the above research study conducted by Grace Wong of the School of Human Kinetics, Faculty of Health Sciences, University of Ottawa.

□ I agree to allow video recordings of my test sessions (i.e., recordings taken in the laboratory) to be shown in future presentations. I understand that the protection of my identity cannot be guaranteed should I agree to have my recordings shown (optional).

If I have any questions about the study, I may contact Grace Wong or Dr. Gilles Comeau.

If I have any questions regarding the ethical conduct of this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, Tabaret Hall, 550 Cumberland Street, Room 154, Ottawa, ON K1N 6N5
Tel.: (613) 562-5387
Email: ethics@uottawa.ca

There are two copies of the consent form, one of which is mine to keep.

Participant's signature: Date:

Researcher's signature: Date:

Demographic and Background Questionnaire for Alexander Technique Teachers and Trainees

First Name:	Last Name:
Gender:	Year of Birth:
Email (optional):	
Are you an Alexander Technique **teacher** or an Alexander Technique **trainee**?	
If you are a **teacher**, how many years have you been teaching? Which organization have you been certified by?	
If you are a **trainee**, how many years have you been training to become an Alexander Technique teacher?	

Appendix B

Protocol for Alexander Technique Teachers and Trainees

Preparation prior to test session

1. Calibrate motion capture system
2. Clear all previous test pressure mat data from SD card
3. Position keyboard and bench on platform (make sure music stand is attached to keyboard)
    a. Cover or mask any reflective surfaces on the keyboard
4. Cover piano bench with purple blanket
5. Position pressure mat on the bench and tape it to the bench
    a. Make sure middle of the mat and the middle of the bench are aligned
    b. Make sure there are no reflections
        i. Mask cameras if there are any reflections or cover the reflective parts
6. Position the two video cameras
    a. Mark position of the cameras on the floor with masking tape or painter's tape (left side and behind)

Participant preparation

1. Participant welcomed to the lab
2. Explain procedure/give overview of procedure to participant
    a. Participant will be asked to demonstrate good use and misuse of the self
        i. For misuse, you can demonstrate what you've seen or your conception of what constitutes poor use of the self
    b. Tell participant you will tell them when to place and remove their hands from the keyboard (to ensure participant doesn't place and immediately remove hands from the keyboard)
    c. Let participant know you will be tapping the pressure mat with a wand to sync the timeline with the other measurement devices, so don't be alarmed
    d. Remind participant they are free to stop at any point for a break or to withdraw from the study
3. Participant completes consent form

4. Participant completes brief questionnaire
5. **Take blank pressure mat recording while participant fills out the forms**
6. Allow participant to get changed if they have not already done so
    a. Remind participant to put their hair up to prevent covering C7 marker
    b. Cover any reflective spots on clothes with painter's tape
7. Place markers on participant
    a. Headband
        i. Markers further apart at the front, bottom edge goes across glabella
        ii. Markers closer together on the back, headband goes across external occipital protuberance
        iii. Headband sits behind ear
    b. Tragus of right ear
    c. C7 (possibly under clothes, use magnet)
    d. T5 (between bottom of scapulae) (under clothes, use magnet)
    e. T10 (under clothes, use magnet)
    f. L3 (between PSIS) (under clothes, use magnet)
    g. Posterior superior iliac spine (PSIS) (under clothes, use magnets)
    h. Sacrum (above clothes)
    i. Left and right greater trochanters of the femur (above clothes)
    j. Left arm
    k. Right arm (can make this one higher to differentiate between right and left sides)

Test session procedure

1. Participant steps onto platform
2. Begin recording with video cameras
3. Participant adjusts seat height and distance from keyboard
    a. Tell participant, "Before you sit, you are free to adjust the seat height and distance from the keyboard."
    b. Participant adjusts the seat
4. *Quiet sitting task*
    a. Participant sits on the bench

b. Once participant has adjusted the seat, tell them, “Please have a seat in the middle of the bench and keep your hands on your lap.”
c. Direct participant to sit in the middle of the bench if they were not centred (use middle marker on the mat to make sure participant is sitting in the middle)
d. Start VICON and walk to pressure mat
e. *Good use condition*
    i. **When you get to the pressure mat**, tell participant, “Please demonstrate good use as you sit. Keep your hands on your lap and keep looking in front of you.”
    ii. Tap pressure mat on sensor 4 firmly, one hand underneath the mat for support
    iii. Measure for 30 seconds (do not need to chat with AT as we just want to get their measurements for good use…we don’t need them to demonstrate their habitual posture)
        1. Time the 30 seconds
        2. **Remain near the pressure mat**, but keep wand out of sight of cameras
        3. After 30 seconds are up, wave the wand to indicate end of the condition
f. *Misuse condition*
    i. Tell participant, “Thank you. Please remain seated on the bench. Now, could you please demonstrate misuse as you sit. Keep your hands on your lap and keep looking in front of you.”
    ii. Wave the wand to indicate start of condition
    iii. Measure for 30 seconds
        1. Time the 30 seconds
        2. **Remain near the pressure mat**, but keep wand out of sight of cameras
        3. After 30 seconds are up, wave the wand to indicate end of the condition
g. Stop taking measurements with pressure mat and VICON

5. *Raising hands to keyboard task*
    a. Start VICON and walk to pressure mat
    b. Make sure participant is still centred on the bench
    c. Tell participant, "From now on, when I say "go," please do the action I ask you to do. Don't forget to wait until I say "go.""
    d. *Good use condition*
        i. Tell participant, "When I say "go," please place your hands in front of you on the keyboard while demonstrating good use. Please leave your hands on the keyboard when you get there."
        ii. Tap pressure mat on sensor 4 firmly, one hand underneath the mat for support
        iii. Say "go"
        iv. **Wait before giving next instruction**
        v. After participant has placed hands on keyboard and has paused for a second, say, "When I say "go," please place your hands back in your lap."
        vi. Say "go"
    e. *Misuse condition*
        i. Tell participant, "The next thing you will do is place your hands in front of you on the keyboard while demonstrating misuse of the self. Please leave your hands on the keyboard when you get there."
        ii. Wave the wand to indicate start of condition
        iii. Say "go"
        iv. **Wait before giving next instruction**
        v. After participant has placed hands on keyboard and has paused for a second, say, "When I say "go," please place your hands back in your lap."
        vi. Say "go"
    f. Stop taking measurements with pressure mat and VICON
6. *Lateral motion task*
    a. Put cards on the keyboard
        i. Red at the bottom, blue card in the middle, green at the top
    b. Start VICON and walk to pressure mat

c. Make sure participant is still centred on the bench

d. *Good use condition*

    i. Tell participant, "When I say "go," please touch your hands first to the red card, then the blue card, and then to the green card while demonstrating good use. Please leave your hands on the green card when you get there."

    ii. Tap pressure mat on sensor 4 firmly, one hand underneath the mat for support

    iii. Say "go"

    iv. **Wait before giving next instruction**

    v. After participant has arrived at the green card at the top of the keyboard and has paused for a second, say, "When I say "go," please touch your hands first to the green card, then the blue card, and then to the red card while demonstrating good use. Please leave your hands on the red card when you get there."

    vi. Say "go"

    vii. **Wait before giving next instruction**

    viii. After participant has arrived at the red card at the bottom of the keyboard and has paused for a second, say, "Please remove your hands from the keyboard."

e. *Misuse condition*

    i. Make sure participant is still centred on the bench

    ii. Tell participant, "Thank you. Now when I say "go," you will touch your hands first to the red card, then the blue card, and then to the green card while demonstrating misuse of the self. Please leave you hands on the green card when you get there."

    iii. Wave the wand to indicate start of condition

    iv. Say "go"

    v. **Wait before giving next instruction**

    vi. After participant has arrived at the green card at the top of the keyboard and has paused for a second, say, "When I say "go," please touch your hands first to the green card, then the blue card, and then to the red card while demonstrating misuse. Please leave your hands on the red card when you get there."

vii. Say "go"

viii. **Wait before giving next instruction**

ix. After participant has arrived at the red card at the bottom of the keyboard and has paused for a second, say, "Please remove your hands from the keyboard."

f. Stop taking measurements with pressure mat and VICON

g. Remove cards from the keyboard

7. *Reading task*

   a. Start VICON and walk to pressure mat **with the pages participant will read**

   b. Make sure participant is still centred on the bench

   c. *Good use condition*

      i. Tell participant, "You will now read a short excerpt from a Shakespeare/Molière play out loud. Please demonstrate good use as you read and please leave your hands on your lap during this time. Start reading out loud when I say "go.""

      ii. Put pages on the music stand

      iii. Tap pressure mat on sensor 4 firmly, one hand underneath the mat for support

      iv. Say "go"

      v. Participant reads the excerpt out loud

         1. **Remain near the pressure mat**, but keep wand out of sight of cameras

         2. After participant finishes reading, wave the wand to indicate end of the condition

      vi. Remove pages

   d. *Misuse condition*

      i. Tell participant, "Thank you. You will now read another short excerpt from a Shakespeare/Molière play out loud. Please demonstrate misuse as you read and please leave your hands on your lap during this time. Start reading out loud when I say “go.””

ii. Put pages on the music stand

iii. Wave the wand to indicate start of next condition

iv. Say “go”

v. Participant reads the excerpt out loud

1. **Remain near the pressure mat**, but keep wand out of sight of cameras
2. After participant finishes reading, wave the wand to indicate end of the condition

e. Stop taking measurements with pressure mat and VICON

f. Remove pages

8. Stop video recording
9. End test session

a. Participant leaves platform

b. Remove markers

c. Thank participant for coming in to participate in the study

Appendix C

Consent Form for Pianists

Title of the study: The effects of the Alexander Technique on the postural habits of pianists

Principal Investigator: Grace Wong
Department of Human Kinetics
University of Ottawa

Co-Researcher: Dr. Gilles Comeau
Department of Music
University of Ottawa

Invitation to participate: I am invited to participate in the abovementioned research study conducted by Grace Wong.

Purpose of the study: The objective of this study is to examine whether the perceived effectiveness of the Alexander Technique can be accounted for through the external observation of posture and movement at the piano.

Participation: I:

a. Am 18 years of age or older;
b. Have completed training at an RCM Grade 9 level or its equivalent OR am currently studying piano as my major instrument in university OR have studied piano as my major instrument in university;
c. Have had no more than two private (one-on-one) sessions in the Alexander Technique.

My participation will consist of completing a few general questions regarding my piano playing history. I will play a C-major scale at bpm=104 in sixteenth notes. I will also play m. 1 – 12 of *Sonatina in C Major, op. 36, no. 3, First Movement* by Muzio Clementi. I will also sight read a short excerpt. Markers will be placed on the following locations: external occipital protuberance; glabella; tragus of the right ear; spinous processes of C7, T5, T10, and L3; sacrum; posterior superior iliac spines; and greater trochanter of the right and left femur. Video recordings will be taken throughout the testing session. This session has been scheduled for (date) at a University of Ottawa laboratory and will take approximately 45 minutes to complete. This process will be repeated again in one hour. In the following week, the test session will be repeated only once. I will also participate in 10 private lessons in the Alexander Technique, with each lesson lasting approximately one hour. Following lessons in the Technique, I will return to complete a post-test and after another four weeks, I will return for a final test session. I will answer some questionnaires during these tests. Both the post-test and final test session will take approximately 45 minutes each.

Risks: My participation in this study may result in my feeling slightly tired after the testing session due to playing. I may also feel slightly anxious while playing the piano. I have received assurance from the researcher that every effort will be made to minimize these risks (i.e. I may take a break if I need to, I can stop participating at any time without fear of reprisal or ill treatment).

Benefits: My participation in this study will benefit the piano playing community and the music community in general. There has been little quantitative research conducted concerning the observable effects of the Alexander Technique on postural aspects of piano playing. The focus of this study is to determine if there are quantitatively observable changes in piano performances after training in the Alexander Technique. Should this project demonstrate that there are positive results concerning postural aspects of performance, the music society would be provided with a quantifiably proven way to examine and improve on playing posture.

Confidentiality and anonymity: I have received assurance from the researcher that the information I will share will remain strictly confidential. I understand that the contents will be used only for the purposes of this study and that my confidentiality will be protected. Anonymity will be protected through alphanumerical identification. Any personal information collected (e.g., name, gender) will only be used in the context of this study and the consent form containing this information will be kept securely and removed from the laboratory at the end of testing sessions so that it will not be possible to link me to the data collected. Video data collected will only be associated with the alphanumerical identification assigned to my recordings and will be securely stored. Only selected people directly involved with the research project will have access to the data during this time. Any data collected for this project will be used for this project only.

Conservation of data: The data collected (personal information, consent form, answers to general questions, video and audio recordings) will be kept in a secure manner (kept under lock and key, password protected on laptop). All data will be kept for an indefinite length of time.

Compensation: I will not receive any form of compensation for participating in this study.

Voluntary participation: Participation in this study is strictly voluntary and I have the right to refuse to answer any questions during this session without fear of reprisal or ill treatment. I can choose to withdraw from the study at any time while the experimental session is being conducted. After the testing sessions, I will not be able to withdraw from the study since it will not be possible to identify the data associated with me. I do not have to provide any reason or justification to withdraw.

Acceptance: I, ____, agree to participate in the above research study conducted by Grace Wong of the School of Human Kinetics, Faculty of Health Sciences, University of Ottawa.

□ I agree to allow video recordings of my test sessions (i.e., recordings taken in the laboratory) to be shown in future presentations. I understand that the protection of my identity cannot be guaranteed should I agree to have my recordings shown (optional).

If I have any questions about the study, I may contact Grace Wong or Dr. Gilles Comeau.

If I have any questions regarding the ethical conduct of this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, Tabaret Hall, 550 Cumberland Street, Room 154, Ottawa, ON K1N 6N5
Tel.: (613) 562-5387
Email: ethics@uottawa.ca

There are two copies of the consent form, one of which is mine to keep.

Participant's signature: Date:

Researcher's signature: Date:

Demographic and Background Questionnaire for Pianists

First Name:	Last Name:
Gender:	Year of Birth:
Email (optional):	
Playing history Number of years playing piano: Highest grade/level achieved (e.g., RCM Grade 9): Post-secondary institution(s) at which you studied piano: On average, how many hours a day do you practice: On average, how many days a week do you practice:	
Have you ever had sessions in the Alexander Technique before? Yes / No If yes, how many sessions did you have? Were they individual lessons or group sessions?	
Have you ever had sessions in other somatic methods (e.g., Feldenkrais Method, Body Mapping, etc.)? Yes / No If yes, what was the name of the method and how many sessions did you attend/how long have you studied the method?	

Appendix D

Protocol for Pianists

Preparation prior to test session

1. Calibrate motion capture system
2. Clear all previous test pressure mat data from SD card
3. Position keyboard and bench on platform (make sure music stand is attached to keyboard)
    a. Cover or mask any reflective surfaces on the keyboard
    b. Make sure keyboard is aligned with grey slab on platform
4. Position pressure mat on the bench and tape it to the bench
    a. Make sure middle of the mat and the middle of the bench are aligned
    b. Make sure there are no reflections
        i. Mask cameras if there are any reflections or cover the reflective parts
5. Position the video camera
    a. Mark position of the camera on the floor with masking tape or painter's tape

Participant preparation

1. Participant welcomed to the lab
2. Explain procedure/give overview of procedure to participant
    a. Participant will be asked to sit, raise hands to keyboard, play a scale, sight read, play a piece with three different levels of expressivity
        i. Normal, deadpan, exaggerated
    b. Tell participant you will tell them when to place and remove their hands from the keyboard (to ensure participant doesn't place and immediately remove hands from the keyboard)
    c. Let participant know you will be tapping the pressure mat with a wand to sync the timeline with the other measurement devices, so don't be alarmed
    d. Remind participant they are free to stop at any point for a break or to withdraw from the study
3. Participant completes consent form (at first baseline session only)
4. Participant completes demographic questionnaire/post-intervention questionnaire

5. **Take blank pressure mat recording while participant fills out the forms**
6. Allow participant to get changed if they have not already done so
    a. Remind participant to put their hair up to prevent covering C7 marker
    b. Cover any reflective spots on clothes with painter's tape
7. Place markers on participant
    a. Headband
        i. Markers further apart at the front, bottom edge goes across glabella
        ii. Markers closer together on the back, headband goes across external occipital protuberance
        iii. Headband sits behind ear
    b. Tragus of right ear
    c. C7
    d. T5
    e. T10
    f. L3
    g. Posterior superior iliac spine
    h. Sacrum
    i. Left and right greater trochanters of the femur
    j. Left and right arms (can make one higher than the other to differentiate between right and left sides)
8. Ask participant to tuck shirt in
    a. Arrange so that it doesn't clump in the back, or just tuck in at the front and sides

Test session procedure

1. Participant steps onto platform
2. **BEGIN RECORDING WITH VIDEO CAMERA**
3. Participant adjusts seat height and distance from keyboard
    a. Tell participant, "Before you sit, you are free to adjust the seat height and distance from the keyboard."
    b. Participant adjusts the seat
    c. MAKE SURE PARTICIPANTS ARE PERPENDICULAR TO KEYBOARD

4. *Quiet sitting task*
    a. Participant sits on the bench
    b. Once participant has adjusted the seat, tell them, “Please have a seat in the middle of the bench and keep your hands on your lap.”
    c. **DIRECT PARTICIPANTS TO SIT IN THE MIDDLE OF THE BENCH** if they were not centred (use middle marker on the mat to make sure participant is sitting in the middle)
    d. Start VICON and walk to pressure mat
    e. **When you get to the pressure mat**, tell participant, “Remain seated on the bench. Keep your hands on your lap and look in front of you.”
    f. Tap pressure mat on sensor 4 firmly, one hand underneath the mat for support
    g. Stand in front of participant and chat with them for a while to get them to demonstrate their habitual sitting posture (need at least 10 seconds)
    h. Stop taking measurements with pressure mat and VICON
        i. No need to wave the wand, just stop the recording
5. *Raising hands to keyboard task*
    a. Start VICON and walk to pressure mat
    b. Make sure participant is still centred on the bench
    c. Tell participant, “From now on, when I say “go,” please do the action I ask you to do. Don’t forget to wait until I say “go.””
    d. Tell participant, “When I say “go,” please place your hands in front of you on the keyboard. Please leave your hands on the keyboard when you get there.”
    e. Tap pressure mat on sensor 4 firmly, one hand underneath the mat for support
    f. Say “go”
    g. **Wait before giving next instruction**
    h. After participant has placed hands on keyboard and has paused for a second, say, “When I say “go,” please place your hands back in your lap.”
    i. Say “go”
    j. Stop taking measurements with pressure mat and VICON
6. *Lateral motion task*
    a. Start VICON and walk to pressure mat

b. Make sure participant is still centred on the bench
c. Tell participant, “When I say “go,” please play a C+ ascending scale and leave your hands on the keyboard when you get to the top. Start from the bottom C and go to the top C.”
d. Tap pressure mat on sensor 4 firmly, one hand underneath the mat for support
e. Turn on the metronome
f. Say “go”
g. Turn off the metronome
h. Participant plays ascending scale
i. **Wait before giving next instruction**
j. After participant has arrived at the top position and has paused for a second, say, “When I say “go,” please play a C+ descending scale starting from where you are all the way to the bottom C. Leave your hands on the keyboard when you get to the bottom.”
k. Say “go”
l. Participant plays descending scale
m. **Wait before giving next instruction**
n. After participant has arrived at the bottom position and has paused for a second, say, “Please remove your hands from the keyboard.”
o. Stop taking measurements with pressure mat and VICON

7. *Sight reading task*
    a. Start VICON and walk to pressure mat **with the sight reading piece**
    b. Make sure participant is still centred on the bench
    c. Tell participant, “You will now sight read **m. ___ - ___**. Please wait until I say “go” to begin.”
    d. Put music on the music stand
    e. Tap pressure mat on sensor 4 firmly, one hand underneath the mat for support
    f. Say “go”
    g. Participant sight reads the excerpt
    h. Stop taking measurements with pressure mat and VICON
    i. Remove music

8. *Playing task*
    a. Start VICON and walk to pressure mat **with the Clementi piece**
    b. Make sure participant is still centred on the bench
    c. *Normal condition*
        i. Tell participant, “You will now play m. 1-12 of this Clementi *Sonatina*. Please play it as you normally would. That is, play it like you would for a peer, for a teacher, or in a performance. You can put your hands back on your lap when you’re done. Please wait until I say “go” to begin.”
        ii. Put music on the music stand
        iii. Tap pressure mat on sensor 4 firmly, one hand underneath the mat for support
        iv. Say “go”
        v. Participant plays the excerpt
    d. *Deadpan condition*
        i. Make sure participant is still centred on the bench
        ii. Tell participant, “You will now play m. 1-12 of this Clementi *Sonatina*. Please play it in a deadpan manner. That is, play it with as little expressive features as you possible can. You can put your hands back on your lap when you’re done. Please wait until I say “go” to begin.”
        iii. Say “go”
        iv. Participant plays the excerpt
    e. *Exaggerated condition*
        i. Make sure participant is still centred on the bench
        ii. Tell participant, “You will now play m. 1-12 of this Clementi *Sonatina*. Please play it in an exaggerated manner. That is, play it while exaggerating all the expressive features you can think of. You can put your hands back on your lap when you’re done. Please wait until I say “go” to begin.”
        iii. Say “go”
        iv. Participant plays the excerpt
    f. Remove music from the stand

g. Stop taking measurements with pressure mat and VICON

9. Stop video recording

10. End test session

    a. Participant leaves platform

    b. Remove markers

    c. Thank participant for coming in to participate in the study

Appendix E

Post-Intervention Self-Evaluation Questionnaire for Pianists

1. How often are you aware of your posture and patterns of movement while playing?

   Never Rarely Sometimes Frequently Always

2. Do you think you play with good posture after having had lessons in the Alexander Technique?

   1 2 3 4 5

   No Somewhat Yes

3. How often do you focus on applying principles in the Alexander Technique while playing?

   Never Rarely Sometimes Frequently Always

Frequency of Alexander Principle Application for Pianists

During a typical practice session, how often did you apply what you learned in the Alexander Technique to your playing?

1	2	3	4	5	6	7	8	9	10
Never									Always

How did you apply the Alexander Technique to your playing?

____

____

____

____

____

____

____

____

____

Appendix F

The Relationship Between Pianists' Perceptions and Posture Following Lessons in the Alexander Technique

The Alexander Technique (AT) is a somatic method by which its students are taught to alter the way they move to enhance day-to-day activities, including playing an instrument (Conable & Conable, 1995; Klein et al., 2014). Due to the lack of specialised care for musicians, these professionals sometimes turn to alternative methods such as the AT to treat playing-related disorders. However, few studies have shown that the AT is effective in altering aspects of music performance such as posture and respiration (Klein et al., 2014). There is even less research concerning pianists in particular as many studies choose to focus on other instrumentalists and vocalists. Of the available research concerning the AT and pianists, evaluations of the effectiveness of the AT on pianists' performance is often conducted in the form of interviews, questionnaires, and external assessments (i.e., assessments made by a third party).

Armstrong (1975) studied how lessons in the AT affected nervousness during piano performance. Eight college pianists participated in the study and were divided into experimental and control groups with four participants in each group. All pianists were video recorded while playing a musical excerpt for a small audience. A questionnaire was given to the pianists following their performance asking whether they considered nervousness to be a problem during performances, if they had methods of coping with nervousness during performances, and whether they were nervous while playing that day. Participants were also provided with a checklist to indicate which parts of their bodies experienced muscular tension. Following the initial performance, participants in the experimental group received four to six private lessons in the AT over the course of six weeks. Each lesson was approximately 30 to 45 minutes in length. All participants returned for the final video recording session in which the pianists again performed in front of a small audience. The control group was given a questionnaire similar to the first one that was administered to them following their first performance. The experimental group was given a questionnaire that asked if they felt the AT had an impact on decreasing nervousness during performances. The results of this study showed that pianists who had participated in the AT lessons felt less nervous during their second performance and that they believed the Technique helped them to cope with nervousness. Based on visual observation, Armstrong reported that those who had taken lessons appeared to be "less [stiff]" (p. 45) in their upper extremities and neck during their final performance.

Kaplan (1994) conducted a series of in-depth interviews with six pianists who had studied the AT. Analysis of these detailed discussions revealed that pianists studied the AT because they experienced pain and/or excessive muscular tension while playing. Learning the AT helped these pianists to realize that piano playing involved the whole body and not just the upper extremities. However, some pianists found it difficult to constantly focus on applying the AT to their playing because of the complexity involved in piano playing. Nevertheless, pianists developed a heightened awareness of their body and its importance in playing the piano. The AT also became a tool to help them analyse their activity and determine if they needed to reduce the amount of muscular tension involved.

In Santiago's (2004) study, the effect of the AT on musical performance in 20 young piano students aged 10 to 14 was researched. Participants were randomly assigned to either the control group or the experimental group with a total of 10 students in each group. Prior to the intervention, students' piano teachers filled out observation forms about their own students regarding posture at the piano, muscular tension, and musical quality. These forms were comprised of rating scales and were repeated once a week for four weeks. In addition, a pre-intervention video recording was made of each participant playing two pieces assigned to them by their teacher. Students in the experimental group then received 15- to 20-minute AT sessions during their piano lessons over the course of eight weeks. Students in the control group received 15- to 20-minute sessions about mythology. Following the intervention period, all students were video recorded again playing the same pieces. Recordings were watched by teachers who taught these students as well as external examiners including other piano teachers, three doctors, and four AT teachers. Results of this study showed that the AT helped students to "improve their posture and coordination [and] decrease their levels of tension and excessive movements" (p. 224).

Loo and colleagues (2015) researched the effect that the AT had on muscular tension in undergraduate piano performance students. All pianists who participated reported experiencing excessive muscular tension prior to beginning the study. A pre-intervention questionnaire was given to the participants in which they were to rate the amount of tension they felt in specific parts of their bodies on a scale. Following 14 weekly group lessons, participants again rated themselves on the same scale. The findings of this study showed that pianists felt that excessive muscular tension was significantly reduced following lessons in the AT.

All these studies provide important insights into how the AT influences piano performance. Specifically, the AT appears to have an effect on reducing performance anxiety, reducing muscular tension, and improving posture. Most of the evaluations conducted in these studies were self-reports which provides valuable information about how participants perceive themselves following lessons. However, there is little to no research that compares participants' perceptions of changes to objective measurement of changes. Do participants detect when changes have happened and do those perceptions agree with physical, objective changes? To date, no single study has collected data on how participants feel following lessons in the AT in addition to making objective measurements concerning physical changes that may occur. This present study has gathered self-reports from participants concerning how they regard themselves following lessons in the AT as well as recording physical changes that have taken place. In light of how the AT focuses on the relationship between the head, neck, and trunk, this study has asked pianists questions about their posture and has calculated the difference in postural angles along the axial skeleton before and after the AT intervention. The purpose of this study was to determine if there is a correlation between pianists' perception of their posture and changes in their postural angles following lessons in the AT.

Method

Participants

Fifteen pianists (12 females, 3 males) between the ages of 18 and 71 participated in this study. All participants were required to be playing at Level 9 or higher, based on the standards of the Royal Conservatory of Music, or currently studying piano at a university level at the time of data collection, or had studied piano at a university level prior to data collection. This was to ensure all participants were capable of playing at a high level. In addition, participants must not have had more than two private (one-on-one) sessions in the AT to prevent biasing the data.

Procedure

A total of three baseline measurements were collected prior to the beginning of the AT intervention. Reflective markers were placed on the tragus of the right ear; the spinous processes of C7, T5, T10, and L3; the sacrum; the left and right greater trochanters of the femur; and the posterior side of participants' left and right forearms (i.e., palm facing down) approximately 7 to

10 centimetres above wrist joint. A headband with four reflective markers was placed on participants' heads with two markers at the front indicating the glabella and two markers at the back indicating the external occipital protuberance. After placing the markers on the participants, pianists then sat on a height-adjustable bench in front of a digital piano (Yamaha Digital Piano P-255). They were permitted to adjust the distance of the bench from the piano as well as the height of the bench. A series of five tasks were performed in a randomized order. Each time participants returned for a measurement session, the order of the tasks was randomized again. Positional data of the reflective markers were recorded using a 7-camera VICON Nexus motion capture system (Oxford Metrics) at 100Hz.

Following the baseline measurements, pianists received 10 private AT lessons over the course of two weeks. Participants returned to the lab for a post-test following their lessons. At the post-test, participants were asked to complete a questionnaire concerning their perception of their own posture after having taken lessons. The questionnaires were composed of rating scales that asked participants if they were aware of their posture and movement while playing, if they thought they played with good posture after having had lessons in the AT, how often they focused on applying principles of the AT while they played piano in general, and how often they focused on applying principles of the AT in a typical practice session. An open question asked how participants applied principles of the AT to their playing. The procedure for the baseline measurements was then repeated after participants completed the questionnaire.

Tasks

Pianists completed the following tasks at their measurement sessions:

- Quiet sitting
- Raising their hands onto the keyboard and off
- Playing a scale
- Sight reading
- Playing an excerpt from a pre-selected piece

Participants were not informed of when the quiet sitting task was being recorded to avoid alterations in posture stemming from the knowledge that they were being measured. Participants were told when to raise their hands and place them onto the keyboard and when to remove them. The scale playing task involved playing a legato, bi-manual, ascending and descending C-major scale in sixteenth notes at 104bpm that spanned the entire length of the keyboard. Sight reading involved playing an excerpt from a musical piece that pianists had never seen before. All participants played the same selection, but the piece was changed for each measurement session. Pianists received the excerpt for the playing task prior to the first baseline measurement to familiarize themselves with the score. They were to play mm. 1-12 of Muzio Clementi's *Sonatina in C Major, op. 36, no. 3, First Movement* and they were to play it in three different expressive conditions (i.e., deadpan, projected, and exaggerated). In the deadpan condition, participants were to play with little to no change expressive features (e.g., tempo, dynamics). In the projected condition, they were to play the piece as they would for a teacher, colleague, or performance. In the exaggerated condition, participants were to exaggerate expressive features (e.g., tempo, dynamics). These conditions were given to ensure that any changes in spinal posture were not the result of musical expression (Thompson & Luck, 2011).

Data Collection

The following angles were calculated based on the positional data of the reflective markers. All measurements were taken from the right side of the body in the sagittal plane:

- Craniovertebral angle: formed by connecting the tragus and C7, relative to the horizontal
- Head tilt: formed by connecting the glabella and external occipital protuberance, relative to the horizontal
- Head-neck-trunk angle: formed connecting the tragus, C7, and the greater trochanter of the right femur
- Trunk angle: formed by connecting C7, T10, and the greater trochanter of the right femur
- Thoracic angle: formed by connecting C7, T5, and T10
- Thoracolumbar angle: formed by connecting T5, T10, and L3
- Lumbar angle: formed by connecting T10, L3, and the sacrum

For the purposes of analysis, only the responses for the questions "Do you think you play with good posture after having had lessons in the Alexander Technique?" and "During a typical practice session, how often did you apply what you learned in the Alexander Technique to your playing?" were taken. The question "How often are you aware of your posture and patterns of movement while playing?" was vague and did not specify at what point in time participants were aware of their posture and movement (i.e., before or after lessons in the AT). The responses for the question "How often do you focus on applying principles in the Alexander Technique while playing?" did not vary enough to provide a range of data that was sufficient for analysis.

For the question concerning whether participants felt they played with good posture following lessons in the AT, participants rated their response on a scale from 1 to 5 (1 = no, 3 = somewhat, 5 = yes). For the question concerning how often participants applied principles of the Technique to their playing in a typical practice session, pianists rated their answers on a scale from 1 to 10 (1 = never, 10 = always).

Data Analysis

The difference between mean baseline postural angles and post-test postural angles were calculated. A previous study (Wong et al., 2022a) showed that it was possible to take the mean of three baseline measurements to provide a summary of a pianist's typical playing posture. Outliers, those with a *z*-score greater than 1.96 or less than -1.96, were found and Winsorized prior to running a Pearson correlation analysis using SPSS. A value of $p \leq .05$ was considered statistically significant. An initial analysis revealed that the two questions had a correlation of .759, indicating that the two independent variables (i.e., participants' feelings concerning their posture and how often they applied principles of the AT) were similar (i.e., asking the same question in two different ways). Because the two variables were alike, a composite was made in which the two variables were combined. The Pearson correlation analysis was run again following the creation of the composite variable.

Results

The statistical results for correlations between self-report measures and changes in postural angles in the quiet sitting task are found in Table A1. No significant correlations were found.

Table A1

Correlation Between Self-Report Measures and Changes in Postural Angles During Quiet Sitting

Angle	*r*	*p*
Craniovertebral angle	0.13	0.631
Head tilt	-0.06	0.826
Head-neck-trunk angle	0.13	0.654
Trunk angle	0.07	0.811
Thoracic angle	0.16	0.575
Thoracolumbar angle	-0.07	0.791
Lumbar angle	0.24	0.393

Note. *r* is the Pearson correlation. $p \leq .05$ indicates significant correlation.

The results for correlations in the raising hands task are found in Table A2. No significant correlations were found between self-report measures and postural angles.

Table A2

Correlation Between Self-Report Measures and Changes in Postural Angles During Raising Hands

Angle	*r*	*p*
Craniovertebral angle	-0.15	0.588
Head tilt	-0.27	0.325
Head-neck-trunk angle	-0.23	0.408
Trunk angle	0.06	0.826
Thoracic angle	-0.05	0.872
Thoracolumbar angle	0.01	0.977
Lumbar angle	0.21	0.449

Note. *r* is the Pearson correlation. $p \leq .05$ indicates significant correlation.

Table A3 presents the results for correlations conducted for the scale playing task. No significant correlations were found between self-report measures and postural angles.

Table A3

Correlation Between Self-Report Measures and Changes in Postural Angles During Scale Playing

Angle	*r*	*p*
Craniovertebral angle	-0.17	0.557
Head tilt	0.01	0.984
Head-neck-trunk angle	-0.02	0.930
Trunk angle	0.07	0.798
Thoracic angle	0.30	0.271
Thoracolumbar angle	0.07	0.803
Lumbar angle	0.23	0.420

Note. r is the Pearson correlation. $p \leq .05$ indicates significant correlation.

The results for correlations in the sight reading task are given in Table A4. No significant correlations were found.

Table A4

Correlation Between Self-Report Measures and Changes in Postural Angles During Sight Reading

Angle	*r*	*p*
Craniovertebral angle	0.07	0.802
Head tilt	0.05	0.849
Head-neck-trunk angle	0.06	0.827
Trunk angle	0.08	0.788
Thoracic angle	0.11	0.700
Thoracolumbar angle	-0.06	0.840
Lumbar angle	0.15	0.600

Note. r is the Pearson correlation. $p \leq .05$ indicates significant correlation.

The results for correlations in the deadpan playing task are presented in Table A5. No significant correlations were found.

Table A5

Correlation Between Self-Report Measures and Changes in Postural Angles During Playing (Deadpan)

Angle	*r*	*p*
Craniovertebral angle	-0.02	0.935
Head tilt	0.00	0.988
Head-neck-trunk angle	-0.20	0.474
Trunk angle	0.32	0.242
Thoracic angle	0.09	0.746
Thoracolumbar angle	0.11	0.685
Lumbar angle	0.26	0.344

Note. r is the Pearson correlation. $p \leq .05$ indicates significant correlation.

Table A6 gives the results for correlations found in the projected playing task. No significant correlations were found between self-report measures and postural angles.

Table A6

Correlation Between Self-Report Measures and Changes in Postural Angles During Playing (Projected)

Angle	*r*	*p*
Craniovertebral angle	0.04	0.887
Head tilt	-0.04	0.874
Head-neck-trunk angle	0.02	0.942
Trunk angle	0.18	0.527
Thoracic angle	-0.20	0.472
Thoracolumbar angle	0.01	0.967
Lumbar angle	0.32	0.250

Note. *r* is the Pearson correlation. $p \leq .05$ indicates significant correlation.

Table A7 presents the results for correlations found in the exaggerated playing task. No significant correlations were found.

Table A7

Correlation Between Self-Report Measures and Changes in Postural Angles During Playing (Exaggerated)

Angle	*r*	*p*
Craniovertebral angle	-0.20	0.474
Head tilt	0.06	0.841
Head-neck-trunk angle	-0.12	0.676
Trunk angle	0.23	0.408
Thoracic angle	0.07	0.809
Thoracolumbar angle	0.06	0.834
Lumbar angle	0.27	0.335

Note. *r* is the Pearson correlation. $p \leq .05$ indicates significant correlation.

Discussion

There did not appear to be any correlation between participants' perception of their own posture following lessons in the AT and their quantitatively measured postural change. However, this may be due to the small sample size of this study. Looking solely at the magnitudes of the correlations, there are some that are sizeable enough ($r \geq .2$) to hint at a possible correlation between perception and quantitative postural changes if this study were to be conducted again with a larger sample size. Participants' responses (see Table A8) to the open question of how they applied the AT to their playing may also offer some explanation as to why there were no significant correlations between perception of posture and quantitative measurements.

Table A8

Participant Responses Regarding How They Applied the Alexander Technique to Piano Playing

Participant	Response
1	I tried to pay more attention to sitting up and applying pressure through the length of the arm, rather than just the fingers or wrists. I tried not to slouch over or bend too much when reaching across the piano, and to keep my forearms generally level.
2	I apply it most when playing scales and also when I'm playing something that uses the ends of the piano (a Brahms Rhapsody for example). I'm never quite sure whether the A.T. lessons have actually "taken."
3	As a complete newbie I found myself unconsciously reverting back to old habits and routines more often than not. However, there were several times, particularly towards the end of the lessons that I found myself more consciously applying some of the instructions or practices. We spent quite a bit of time sitting and standing and I did definitely have more awareness of my neck, back and knees while doing so. I was also more acutely aware of where tension builds up while practicing (in my left forearm and right shoulder). At these points, again during the later days of the lessons, I would try to incorporate more of the techniques (i.e., awareness of fingertips to shoulder blades, armpits pointing in opposite directions) while continuing the practice session.

Table A8 Continued

Participant	Response
4	The most striking thing of Alexander Technique was that you play from the back-centred; playing from the shoulder back.
5	I think about freeing my neck to allow my head to go forward and up. I am more conscious of my sit bones and how I shift my weight from side to side. I now try to have less sideways movement with my torso and be aware of the full length of my arms from the fingertips to the shoulder blades. I also try to think about not letting my throat (front part of my neck) go forward.
6	Thought of head/neck/back relationship to improve posture. Found more weight in my fingertips by making use of whole arm all the way up to the shoulder blade in the back. Avoided tensing my neck while playing big/accented chords.
7	I keep my neck in the right position, do not lean forward my neck when playing. I rotated my body when playing the scale from lower to the higher, and keep my bottom stay on the chair. Expanding shoulder blade when playing chords.
8	The first instruction of the Alexander Technique is very useful for me. "Allow neck to be free" gives me freedom, because I used to feel pain at neck of my body. During the Alexander Technique I could learn that how I manage my body weight. I could realise how my body posture changes. I think it is very important, because as a pianist, body is my instrument. So, these experiences gave me lots of changing. I will continue taking the Alexander lesson.
9	I tried to image my body/arms not sinking in the piano but more like away from piano. I applied Alexander Technique mostly when I was practicing scales, and I focused on my body moving more like followed by my finger/arm motion. I was feeling my both feet rooted on the ground.

Table A8 Continued

Participant	Response
10	I have to keep my feet on the ground to support myself and use the strength from my lower back and bring it to my shoulders, arms and hands while playing. My back and head have to be straight and neck and hands should be loose.
11	Observing neck, back, head, arms and their relationship to one another. Readjusting when I noticed a tendency to fall back into an old habit.
12	Keep my neck "free." Try to put/allow my head to be in a better place. Think of line directed through opposite hip when playing in "extreme" range of piano keyboard.
13	The main issue I had was being able to make space in the shoulder blade and avoid using my pectoral muscles more than needed. I often had to stop playing to readjust the "spaced out" position as it always closed back up again once I started playing.
14	I begin practice by doing 5-10 minutes of constructive rest. I often practice "Monkey" if my back feels achy or tense. I always sit while thinking of maintaining head and neck alignment. I frequently think of my sit-bones and my head leading my movements, especially when leaning to either side.
15	Awareness of my posture. Relaxation and releasing the tension. Short breaks to rest and laying down. Releasing the tension on my neck.

Most of the pianists in this study mentioned focusing on their head, neck, back, shoulder blades, and arms. The head-neck-back relationship is a central principle to the AT, and it can be seen from these responses that participants have already begun to incorporate this into piano playing. A previous study (Wong et al., 2022b) found that there were statistically significant differences in postural angles relating to the head-neck-back relationship following 10 lessons in the AT. The practical application of this principle may account for the changes found. Many participants also wrote that they were more aware of tension in various parts of their bodies while they played. These answers provide interesting insights into how the AT has had an influence on how pianists approach piano playing and are similar to the findings of Kaplan’s

(1994) study in which she found that through the AT, pianists developed an increased awareness of their body during movement as well as when there was excessive muscular tension.

Besides providing a window into how the AT has an influence on what pianists think about and how they try to apply the AT while playing, these responses may also provide some explanation as to why significant correlations were not found in this study – participants simply did not focus on the exact same variables that were being quantitatively measured. However, some responses did reflect the variables that were examined in this study. For example, Participant 1 wrote about trying not slouch, which could correspond to any changes seen in the thoracic, thoracolumbar, and lumbar angles. Participant 5 tried not to push the neck forward, which could correspond with changes in the craniovertebral angle. Several participants mentioned the head-neck-back relationship, which was the basis from which postural angles for this study were chosen. Nevertheless, not every participant focused on the same ideas. If significant correlations were to be found, a larger sample size would be needed to generate similar responses across multiple participants. Another issue may have been the wording of the question. The word "posture" is quite broad, and participants may not have conceptualized it in the way it was perceived in this study. Perhaps directing participants' attention to specific parts of the body may have changed the focus of the responses that were given.

Conclusion

To date, no study has attempted to correlate self-report measures of pianists' perceptions of their own posture with quantitative, objective measurements of the same variables. This present study has collected data on the self-assessments of pianists concerning whether they feel that their posture has changed following lessons in the Alexander Technique as well as data concerning changes in postural angles. The purpose of this research was to compare participants' perceptions of their own posture with objectively measured changes in postural angles to determine if there is a relationship between perception and actual, physical changes. While no significant correlations were found due to the small sample size, the size of some of the correlations give indication that perhaps with more participants, there would be a clearer relationship between pianists' perceptions of their own posture and quantitatively measured changes in postural angles. Additionally, the responses given by some participants in an open question regarding how they applied principles of the AT indicate that some pianists were thinking about the head, neck, and back while playing. These areas of the body reflect the basis from which postural angles were chosen and measured in this study as the main principle of the AT is centred around the relationship between the head, neck, and back. Perhaps with a larger sample size, more participants would focus on this relationship while playing the piano which in turn may show a more obvious correlation between their assessment of posture and changes in postural angles. Future research in this direction should utilize larger sample sizes and possibly more specific wording when asking participants to assess their own posture.

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