Examining the effects of Timani exercises on sitting posture, ease of playing, physical discomfort, and performance in professional violinists, and exploring their experience of the intervention

A randomised controlled trial

By

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Abstract

This dissertation examines the effects of specific Timani exercises on sitting posture, ease of playing, physical discomfort, and performance in professional violinists, and explores participants' experiences of the intervention. As playing-related problems are common among musicians, especially violinists, it is vital to find adequate methods to treat their underlying causes. Current strategies, for the most part, are not proficient, lacking high-quality evidence to support their effectiveness. A recent study found that Timani, a somatic method for musicians that combines expertise in functional body mechanics as well as music performance, can have beneficial effects on physical outcomes and performance quality. Building on this exploratory study, the current research takes a more detailed look at specific Timani exercises, adopting a multi-strategy methodology including both self-report and observational data. A mixed, true-experimental, repeated-measures design was employed, randomising 19 participants into either the Timani or control group. Both groups received an hour-long intervention, aiming to improve sitting stability and posture as well as ease and comfort in playing. Surveys were used to collect quantitative self-report data, pre and post intervention, as well as qualitative feedback from the Timani participants, both after the intervention and after a seven-day follow-up period. In addition, recordings from before and after the intervention were rated on postural and performance quality by six external evaluators. Although no significant effects were found in the small sample of this study, the quantitative data revealed clear trends, illustrated by medium and large effect sizes, suggesting that the exercises might have positive effects on seated playing posture, ease of playing, physical discomfort, and self-reported performance. These trends will need to be investigated in a study with a larger sample. Furthermore, findings from the qualitative data showed that participants experienced the Timani exercises as interesting and relevant to their playing, as they had positive effects on musical and physical outcomes, and increased their understanding of playing-related body mechanics and anatomy. Within the one-hour Timani session, they learnt the exercises well enough for them to be effective when done at home without the teacher, with participants reporting a positive impact on multiple levels of their playing after the seven-day follow-up. The perceived relevance and relatively immediate impact on performance and musculoskeletal health might contribute to continued engagement with the exercises over time, with potential implications for the prevention and reduction of playing-related musculoskeletal disorders. The long-term impact of Timani would need to be investigated in future, longitudinal studies.

Contents

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Introduction and literature review

Playing a musical instrument is among the most complex and challenging tasks that a human body and brain can perform (Steinmetz et al., 2010; Williamon, 2004). The training required to achieve and maintain the highest possible level of performance can place exceedingly high demands on the musculoskeletal system (Steinmetz et al., 2010), exposing musicians to a range of musculoskeletal health problems (Cruder et al., 2018). Performance-related musculoskeletal disorders (PRMDs), often defined as 'pain, weakness, lack of control, numbness, tingling, or other symptoms that interfere with your ability to play your instrument at the level you are accustomed to' (Zaza et al., 1998, p. 2016), are common among musicians. Reported lifetime prevalence rates in professional musicians vary from 62-93%, with the neck and shoulders found to be the most frequently affected anatomical areas (Kok et al., 2016).

Violinists seem to be particularly susceptible to developing PRMDs (Baadjou et al., 2016; Zaza, 1998). For example, Argus et al. (2020) found that 84.6% of the professional violinists in their study experienced musculoskeletal pain in the past 6 months. Specific risk factors for violinists have been cited, including the static, asymmetric position with both arms elevated and the repetitive movements required for playing the instrument, as well as long playing hours (Ackermann et al., 2012; Kok et al., 2016; Wilke et al., 2011). Although overuse is often thought of as an important associated factor (Maric et al., 2019), in the current literature, misuse (i.e., biomechanical factors and postural impairments) is often considered as a main risk factor for injury in musicians (Moraes & Antunes, 2012; Rousseau et al., 2022; Steemers et al., 2022).

Posture, ease of playing, physical discomfort, and performance

Postural problems are a common occurrence among musicians (Blanco-Piniero et al., 2017); Araújo et al. (2009) found preventable postural flaws in all violinists of their sample, putting them at increased risk of experiencing PRMDs. Crucially, they are more frequently observed in seated, rather than standing, performance

(Blanco-Piniero et al., 2015). A potential explanation for improper posture comes from a study by Steinmetz et al. (2010), which demonstrated impaired function of the postural stabilisation systems in the vast majority of musicians experiencing PRMDs. Especially among string players, deficits in the deep stabilising muscles of the lumbopelvic area (e.g., the transverse abdominis muscle) were commonly found, with the potential of triggering compensatory movement patterns of superficial muscles in other parts of the body. In particular, the shoulder girdle is highly susceptible to pain and dysfunction in the absence of muscular stability (Steinmetz et al., 2010).

Conversely, optimal posture allows musicians to interact with their instrument with maximum biomechanical efficiency while expending minimum energy (Klein-Vogelbach et al., 2010, as cited in Blanco-Piniero et al., 2015). This is widely recognised as being important for instrumental technique (Ackermann, 2021) and can result in the ability to maintain ease while playing (Shoebridge et al., 2017). Ease of playing is a valuable factor that can have both musical and physical outcomes. By freeing up the musician to focus on the music, it can lead to superior performance quality, a less commonly discussed but important effect of optimising body use (Baadjou et al., 2017; Blanco-Piniero et al., 2017; Chan & Ackermann, 2014). Physically, the ability to play with less effort and the reduced biomechanical strain can be linked to a decrease in playing-related pain and discomfort (Shoebridge et al., 2017). As PRMDs can have considerable emotional, occupational, social, and physical effects (Zaza et al., 1998) and may even lead to the premature termination of musicians' careers (Ackermann et al., 2012), finding effective ways to treat their underlying causes is imperative.

Limitations of current practice and research

Even though the issue around musicians' musculoskeletal health has long been recognised, musicians' posture continues to be a major problem (Shoebridge et al., 2017). Critically, systematic reviews revealed similar numbers of PRMDs in 2016 (Kok et al., 2016) as in 1998 (Zaza). As such, one might conclude that the current preventive and treatment strategies are not proficient. Ackermann et al. (2022) highlight the greatly variable quality of preventive and clinical care, and further state that performing artists are, often rightly, concerned that health professionals do not adequately comprehend the complex requirements of their artistic profession. Instrumental teachers, on the other hand, generally lack the necessary knowledge to help instil healthy and sustainable playing posture and habits (Farruque & Watson, 2016; Norton, 2016), basing their tuition on personal experience and teaching tradition, rather than evidence-based concepts (Clark et al., 2016).

Positively, there has been increasing interest in performers' health, reflected, for example, by the educational and prevention courses frequently offered by musical institutions (Laseur et al., 2023). However, even though certain methods are popular and widely believed to be effective in supporting musicians in their musculoskeletal health (Laseur et al., 2023), recent systematic reviews on posture, musculoskeletal health, and performance in musicians reported a lack of high-quality research on the topic (Blanco-Piniero et al., 2017; Laseur et al., 2023). Major methodological limitations were found in the reviewed research, including a high risk of bias. Although the quality of research should be enhanced to be able to offer evidence-based strategies for improving musicians' musculoskeletal health, some valuable findings can be extrapolated from the existing literature.

Research findings

Evidence suggests that programmes including a muscle strengthening component are the most likely to be effective in reducing musculoskeletal complaints in musicians, rather than Alexander Technique (Klein et al., 2014) or exercises focusing on mobility, such as yoga (Laseur et al., 2023). Ideally, for instrumentalists, strength training should target the muscles that are important for playing their specific instrument (Wilke et al., 2011).

Moreover, given that postural flaws were mainly observed in musicians who were playing, rather than posing (Blanco-Piniero et al., 2015), a direct link to playing technique might be assumed. Therefore, it is deemed vital to tailor any intervention to the particular needs of the musician (Yang et al., 2021), including the specific technical and physiological demands of playing the instrument (Steinmetz et al., 2010). Additionally, evidence-informed interventions should offer physical examination that includes the observation and analysis of posture and movement patterns *while playing* (Kok et al., 2016; Steinmetz et al., 2008), as well as the identification of the muscles that would benefit from more activation or control (Chan & Ackermann, 2014).

Lastly, as musicians' primary concern is the quality of their performance (Shoebridge et al., 2017), they might be more motivated to engage with practical, instrument-specific exercises aimed at optimising their instrumental technique and the quality of their playing, rather than focusing solely on injury prevention (Ackermann et al., 2002; Stanhope, 2018). Consequently, effective training would ideally target both the musician's health and the quality of their performance (Wilke et al., 2011).

Although these findings suggest that optimised posture and body mechanics should be implemented in a dynamic playing context, not much practical advice is given on how to achieve this (Détari & Nilssen, 2022). One recent study suggests that the somatic method 'Timani' might fill this gap and meet many of the above-mentioned challenges and needs (Détári & Nilssen, 2022).

Timani

Timani, a recently established method for musicians, is based on a deep understanding of playing-related anatomy and movement, as well as the needs and motivations of musicians. Created by Tina Margareta Nilssen, a pianist, massage therapist, personal trainer, yoga teacher, and Kinetic Control Therapist, Timani aims to improve performance and performance-related body mechanics. It provides an analytical tool to identify playing-related, compensatory movement patterns, and uses targeted, practical exercises to change any less effective habits into more functional and sustainable ones, directly integrating the newly learnt coordination into instrumental playing. The over 100 Timani exercises, along with an explanation of the relevant anatomy, are designed to help overcome, and understand, any challenges related to discomfort, pain, and injury, as well as to sound production and technical issues, ultimately enhancing musical performance. Timani is developed specifically for and taught by musicians, bridging the gap between performer and health professional.

A first larger-scale study on Timani found benefits of the method on performance-related body mechanics, playing posture, and instrumental technique, leading to superior performance and a decrease in musculoskeletal discomfort (Détári & Nilssen, 2022). However, given the exploratory nature of the study, certain limitations could be found; a mainly qualitative approach was adopted with a small sample of students playing all instruments, resulting in only self-report data, and a variety of exercises was chosen for the participants during the sessions, which were held online. The researchers therefore recommended for future studies to employ more objective, quantitative measures, to narrow down the scope of the inquiry to specific instruments and exercises, and to look at the effects of Timani on musicians of different professional levels.

Professional musicians might be harder to recruit than students (Kelleher et al., 2013), as illustrated, for example, by the fact that only roughly a third of the studies in the systematic review by Laseur and colleagues (2023) involved professionals rather than students. However, different challenges might face professional players that are worth signposting, and their data could give insight into workplace-related issues (Kelleher et al., 2013). In relation to posture, professional violinists are mostly required to sit during orchestra or chamber music engagements (Spahn et al., 2019), whereas students might stand more during practice or lessons, resulting in distinct postural challenges. Additionally, unlike other elite performers (e.g., dancers or athletes), musicians typically cease to receive individual instruction, including technical feedback, upon becoming professional (Chan & Ackermann, 2014). Critically, as professionals, their livelihoods might be affected by injury (Guptill, 2011); it is thus vital to find adequate ways to support them.

Given the discussed shortcomings of current practices and research on musicians' musculoskeletal health, as well as the limitations of the previous study on Timani, it is timely to investigate the method more rigorously, focusing on specific exercises in a sample of professional violinists. This dissertation therefore sets out to answer the following research questions:

- What are the effects, if any, of specific Timani exercises on seated playing posture, ease of playing, physical discomfort, and performance in professional violinists?
- What are their experiences of the intervention?

Methodology and methods

Reflexive note

As a Timani teacher in training, it was not possible for me to conduct this research free from bias. Below, I explain the decisions I made designing the study in order to minimise my influence on the results and be as objective as possible, particularly for the quantitative part of the research. Within the chosen methodology outlined below, I have further attempted to minimise my interference by not partaking in the intervention or rating of participants. Instead, several external professionals with no direct connection to Timani were asked to be involved.

For the qualitative part of the project, I have tried to stay conscious of my role in the study and the ways in which I might influence the research. Considering that "the researchers' beliefs, theories or assumptions influence every step in the process of research" (Burnard, 2006, pp. 144–5), careful thought was put into the many decisions in this process, including what method to employ, and what types of questions and wordings to use. Additionally, being aware of my active role in the interpretation, I have repeatedly checked my analysis against the original data. My supervisor and advisor were there to check over the analyses and guide me in this process.

Epistemology

Now that it is clear *what* we want to know, it is important to consider *how* we can know. Different epistemological perspectives offer different philosophies about the generation of knowledge, leading to different methodological decisions. Within post-positivism, it is assumed that one objective truth exists about reality, while acknowledging that our observations and interpretations of it will always be imperfect. Constructionism, on the other hand, is based on the idea that reality is not something fixed, existing as separate from us human beings. Rather, it is socially constructed *by* us. Different parts of this research adhere to different epistemologies.

Based on experience and previous research (Détári & Nilssen, 2022), a top-down, post-positivist framework was used to answer the first research question. Using this approach results in findings that are, as much as possible, unaffected by individual bias. Whilst every effort was made to strive towards objectivity, post-positivism (as opposed to positivism) recognises that one can never truly be objective. This may be especially true when measuring complex variables, like music performance and movement patterns.

To answer the second research question, a constructionist framework was employed to capture the participants' experiences of the intervention. The knowledge generated emerged from the data (bottom-up), interpreted by the researcher.

Using both post-positivist and constructionist approaches, the research is pragmatic, motivated by the desire to find effective ways to help musicians play and feel better. The research questions are rooted in real-life situations and the aim is to present the answers to these questions to fellow violinists, musicians, and teachers, so that they can consider transferring any potentially beneficial strategies into their own practices.

Methodology

Following the pragmatic epistemological framework justified above, a concurrent multistrategy design, combining both quantitative and qualitative methodologies, was applied. The exploratory study on Timani (Détári & Nilssen, 2022) employed a multistrategy approach, with strong qualitative elements. Building on that research, this current study emphasises the quantitative strategy, while maintaining a qualitative aspect.

Quantitative methodology, in line with the post-positivist framework, aims to be as objective and unbiased as possible by collecting accurate data in a controlled setting. Designing the research this way, the goal is to be able to generalise the outcome of the first research question to a wider population.

Being only the second large-scale study on this relatively new method, the participants' lived experience of the intervention was also of interest, hence the decision to address the second research question in a mainly qualitative way. A further aim of the qualitative strategy was to include phenomena that might not show up in the quantitative data. After merely 60 minutes of learning a potentially completely new approach, it was anticipated that not all the subtleties of change might be observable or accurately reflected in numbers. Qualitative methods were considered to add more nuance to the data, allowing participants to express their experiences, and what they meant, in their own words.

Methods

According to the discussed epistemology and methodology, the quantitative methods for this research must aim at capturing the objective truth as much as possible. Ideally, the methods should also be capable of collecting both quantitative and qualitative data, with minimal influence from the researcher.

Within the quantitative methodological strategy, an experiment was deemed the most appropriate way to address the first research question, testing the hypothesis that Timani exercises are effective in improving posture, ease of playing, physical discomfort, and performance in professional violinists. A mixed, true-experimental, repeated-measures design (see Figure 1) was chosen, randomising the participants into an experimental (Timani) and a control group (independent variables). Conducting a true experiment allowed for the identification of a causal relationship between the Timani intervention and the quality of participants' posture, ease of playing, physical discomfort and performance (dependent variables). This was done in a controlled setting, isolating and testing effects that may be generalisable to a wider population. The full experimental protocol can be found in Appendix I.

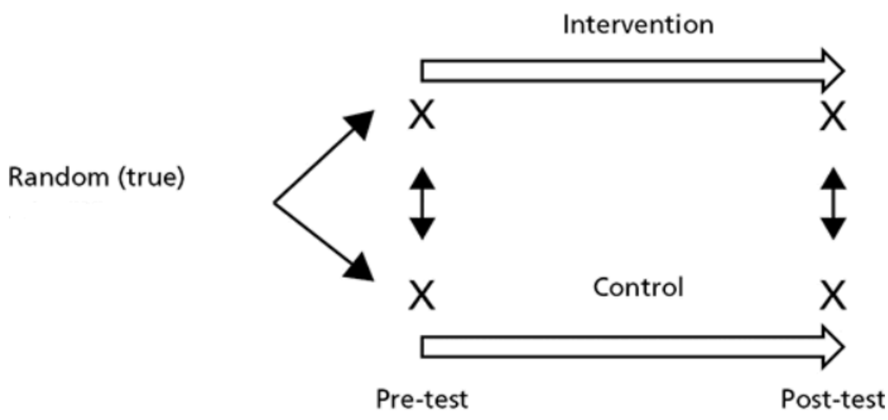


Figure 1. The structure of a mixed, true-experimental, repeated-measures design. Source: Williamon et al. (2021), p. 216

To answer both research questions, surveys were used to collect the different types of data: quantitative and qualitative self-report data, as well as quantitative observational data from the assessment of pre and post intervention audio and video recordings by six external experts. For the qualitative data, opting for surveys including fixed, open questions (rather than interviews, for example) eliminated any subconscious reactions or comments from the researcher, with the aim of minimising influence on participants. Finally, surveys have the ability to collect both quantitative and qualitative data and were therefore considered an appropriate and efficient tool.

Materials

Data collection was divided into three phases, using six different questionnaires: two questionnaires for all participants (phase one), two additional questionnaires for only the Timani group (phase one and two), and two for the external evaluators (phase three).

Phase one: questionnaires for participants

- The Musculoskeletal Pain and Interference Questionnaire for Musicians (MPIIQM; Berque et al., 2014) is a validated questionnaire, containing items on basic demographic data and performance-related pain and problems. The MPIIQM is the most complete and widely used tool for assessing musculoskeletal complaints in professional musicians (Cygańska & Kaczorowski, 2024), allowing for comparison with other studies. With Berque's permission, small adjustments to the demographics questions were made to fit the sample; the main part of the survey remained unchanged. To gather more information, self-constructed questions were added, focusing on the participants' prior experience of working with the body and their thoughts and strategies regarding the physical aspect of playing (*questionnaire one*).
- *Questionnaire two* was used to collect self-report data, asking participants to rate different aspects of their playing (musical, postural, and physical) on a sliding scale from 0 (very poor) to 100 (very good) with a neutral mid-point.

- *Questionnaire three* (only Timani group) contained closed and open, qualitative questions (11 in total) about participants' experiences of the session and the exercises.

Phase two: follow-up

- The follow-up questionnaire (*questionnaire four*) similarly comprised six items, both quantitative and qualitative, regarding engagement with the material and perceived outcome.

Phase three: questionnaires for expert observation

- The Postural Observation Instrument (POI; *questionnaire five*), adapted from Blanco-Piniero et al. (2015), contained eight items relating to posture, including spinal curvature, and the alignment of the shoulders and pelvis. This questionnaire was slightly adjusted to fit the sample and the study (i.e., violinists in a seated position). Evaluators were asked to rate the different aspects on a sliding scale from 0-100 with 50 being the score for optimal, physiological posture. Physiological (seated) posture in the context of musical performance was described as: '1) maintenance of the spine, and of the head-trunk unit, along the "axis of gravity", i.e. the vertical axis through the relevant centre of gravity (that of the head, trunk and arms if sitting; [and] 2) total freedom of the arms to play the instrument' (Blanco-Piniero et al., 2015, p. 566). The POI is considered the most comprehensive tool for visually assessing posture (Rousseau et al., 2023).
- *Questionnaire six* consisted of three items relating to performance (sound quality, musical expression, and timing/rhythm/articulation). A sliding scale from 0 (very poor) to 100 (outstanding) was used.

In questionnaires five and six, recordings were linked to or embedded for the external panels to evaluate. A full description of the process of recording, editing, and sharing can be found under 'Procedure' below.

Apart from the MPIIQM and POI, all questionnaires were self-constructed. To check timing and understanding, all of the questionnaires were piloted by multiple musicians in the same age range as the sample. Shortly before running the intervention, the surveys were sent out again for piloting using the online survey platforms, ensuring that everything was working as intended.

Questionnaires were administered digitally, with the exception of the MPIIQM's body chart question, which was provided on paper for practical reasons. Questionnaires one, three and four were delivered through Microsoft Forms. Questionnaires two, five and six (those containing sliding scales and video/audio samples) were administered on the Qualtrics XM website. All questionnaires can be found in Appendix II.

Timani session

Participants in the experimental Timani group received a 60-minute Timani session.

A typical Timani session starts with a conversation in which the student answers questions related to their experience, wishes or potential issues around physical comfort, playing technique, or musical performance. Afterwards, the student will play and receive: 1) a short anatomical analysis of their current movement patterns and related musical outcome, 2) targeted, practical movement exercises (usually one to three per session) for re-training muscular coordination and enhancing movement control and proprioception, with the aim of getting closer to the desired musical and physical result presented in the initial conversation, and 3) direct implementation of the new activation into their playing, with awareness of both musical performance and physical sensation.

The exercises do not require any particular equipment or physical contact with the student. Instead, they are executed with conscious awareness of a muscle, body part, or movement, exploring new potential within the musician's body that can help support more effortless music making. None of the exercises are meant as medical treatment or replacement thereof.

The exercises

Six Timani exercises were pre-chosen for this study: three for stability in sitting and sitting posture ('Seated shuffle', 'Iliacus' and 'Transverse abdominis' exercises) and three for relaxation and improved coordination of the arms and shoulders (the 'Bottle exercise', 'Bouncy with arms' and 'Back arm-line push-off' exercises).

The 'Seated shuffle' exercise aims to increase sensory awareness of the sitting bones (ischial tuberosities) and activate deep postural muscles (mm. multifidus and psoas major). It is performed by moving the knees and upper legs backwards and forwards in a shuffling motion while sitting on the correct part of the sit bones, influencing the alignment of the spine and head, and the functioning of the shoulders and arms. To maintain pelvic alignment, the 'Iliacus exercise' could be used as it activates muscles responsible for hip flexion (mm. psoas major and iliacus). In the 'Transverse abdominis differentiation exercise', the transverse abdominis muscle is consciously engaged with the goal of creating more core stability and facilitating free shoulder and arm movement.

The 'Bottle exercise' aims to give a sense of weight in the bow arm of a violinist through relaxing the muscles of the shoulders, arms, and wrists while maintaining muscular activation in the hand, needed for playing the instrument. The 'Bouncy with arms' exercise promotes the elastic quality of the fascia (part of the connective tissue) which can store and release kinetic energy without muscular effort. It also targets a fast activation and relaxation of the triceps brachii muscle (extensor of the elbow), both of which aim to give more efficient and effortless movements in the bow arm. The 'Back arm-line push-off' exercise activates the muscles on the backside of the arm (e.g., m. triceps brachii) that can help balance out muscular activation and offload the often-overworked biceps brachii and chest muscles in the front upper arm and chest. This can lead to more access to a sense of power and control in the bow arm movements, without 'pressing' the sound.

The full exercise descriptions (Nilssen, 2021) can be found in Appendix IV.

Control group session

The control group also had a 60-minute session. To control other confounds, the control group session was designed to mimic the Timani intervention in as many ways as possible. Both groups were led by a female musician and started with a small conversation, talking about their experiences and strategies. Guided by the facilitator, control group participants discussed their own current strategies for improving sitting posture and stability, and ease of playing in their shoulders and arms. They used the session to engage with different activities related to these topics, based on their own ideas. In case participants did not have any strategies themselves, a list of suggested activities was prepared. This list included: a YouTube video with a yoga warm-up for musicians, including some basic stretches (Music Body Mind, 2019); a meditation from the Headspace App, to feel more relaxed and grounded; a short article by Dr June Sheren about musculoskeletal complaints in orchestral musicians chosen from the BAPAM website (Sheren, 2024); and a YouTube video from the Tonebase Violin channel, discussing the physiological aspects of playing the violin with a physical therapist and musician (Tonebase Violin, 2022). In both groups, activities/exercises were interspersed with shorter moments of playing. The aim of the playing was either to implement the new coordination (Timani), or to see how participants felt and imitate the Timani session's playing time (control). Lastly, both groups were able to prepare for a moment before the second recording. Designing the control group intervention this way took away any potential placebo effect, as the control group, just like the experimental Timani group, might have felt they did something helpful.

Participants

Professional violinists, fluent in English, aged 18 or above, who have finished their music education and earn the majority of their income from playing the violin, were eligible to take part in the study. Exclusion criteria were prior experience with the Timani method and the presence of chronic pain, musician's focal dystonia, or injury that results in the inability to work, ensuring that participants could engage in the intervention without major limitations.

Convenience and snowballing sampling were employed, through private messages to the researcher's contacts (and their recommended contacts) and two social media posts in relevant group pages. 24 violinists were recruited but due to illness and scheduling difficulties, the study was completed with 19 participants who were randomly assigned to either the control (N=9) or Timani group (N=10). Demographic information of the participants is shown in Table 1 and Figure 2.

Table 1. Participant demographics.

	Control group n = 9 (47.4%)	**Timani group** n = 10 (52.6%)	**Total** n = 19
Gender			
Female	8 (88.9%)	6 (60%)	14 (73.7%)
Male	1 (11.1%)	4 (40%)	5 (26.3%)
Age [mean (SD)]	33.1 (5.33) range 26-42	35.5 (6.62) range 28-45	34.4 (6.00) range 26-45
Employment?			
No, freelance	5 (55.6%)	4 (40%)	9 (47.4 %)
Yes, employed	4 (44.4%)	6 (60%)	10 (52.6%)
Main type of work			
Orchestra playing	8 (88.9%)	8 (80%)	16 (84.2%)
Teaching	1 (11.1%)	2 (20%)	3 (15.8%)
Years violin played [mean (SD)]	26.1 (7.06) range 14-37	29.3 (6.77) range 21-41	27.8 (6.91) range 14-41
Weekly playing hours [mean (SD)]	27.9 (11.3) range 12-45	24.2 (10.3) range 3-40	25.9 (10.6) range 3-45

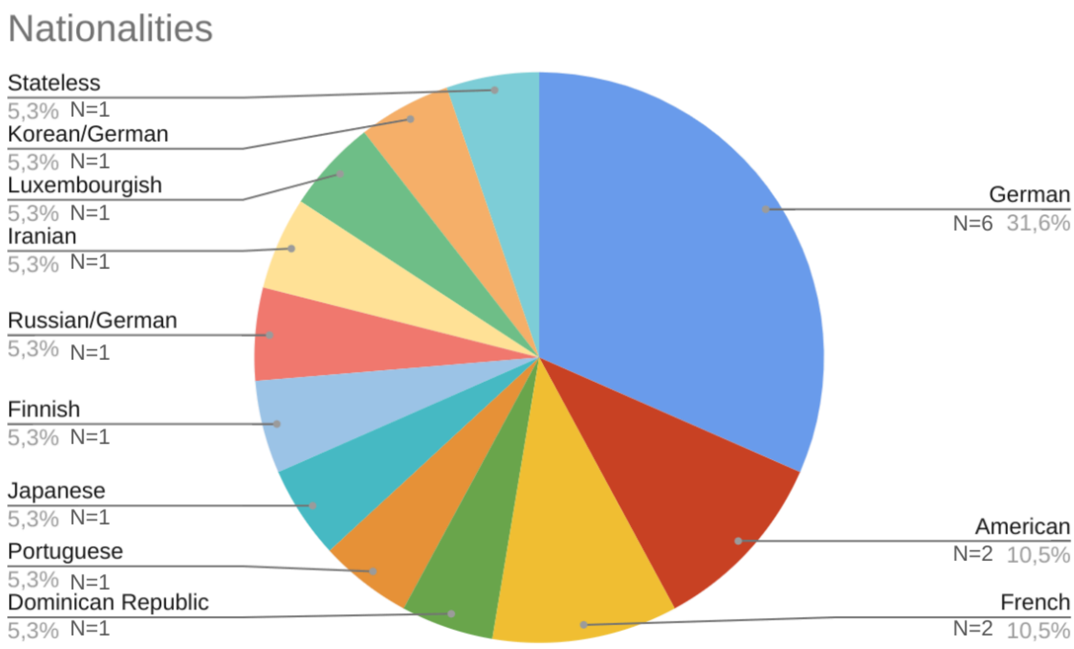


Figure 2. Nationalities of all participants.

Procedure

The RCM Research Ethics Committee granted ethical approval for this research (Appendix III), and all participants provided informed consent, either digitally or on paper.

Main data collection was performed between June 11th and June 17th, 2024 in a studio in Berlin, Germany. Participants were randomly allocated to either the Timani intervention or the control group by booking a suitable time slot on an online calendar (Doodle), without knowing which group they signed up to. Participants' presence was required once for up to two hours and 15 minutes. The control group intervention was conducted in German and English. The Timani intervention and all the questionnaires were delivered in English, with the occasional German translation by the researcher and Timani teacher. Figure 3 shows an overview of the data collection process.

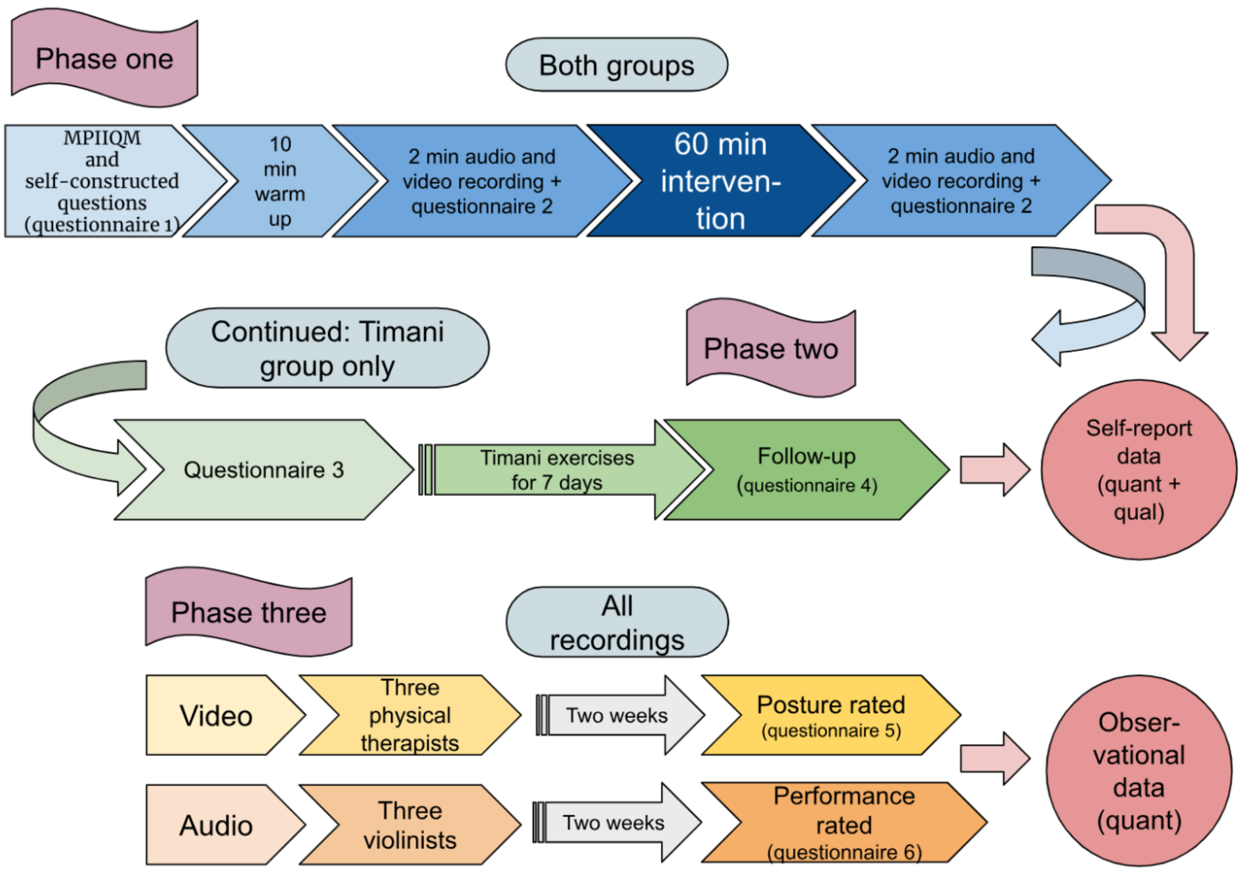


Figure 3. The process of data collection.

Questionnaires, warm up, and recording

Upon arrival, participants were asked to fill out the MPIIQM and the self-constructed questions (*questionnaire one*). This took participants 15 minutes on average. They then had the possibility to warm up for 10 minutes, after which they played a C major scale over three octaves and a short excerpt of a piece of their choice from the romantic repertoire that includes a full-sound forte passage. Seated on a height-adjustable piano stool, their playing was audio and video recorded (side and posterior view) for two minutes, using a Sony alpha 6400 video camera, an iPhone Pro 12 (4K camera setting), and a Zoom H6 Handy Recorder device. The devices were all placed on tripods, stood on the floor at about a metre's distance from the participants. The Zoom device was placed slightly higher than the violin, pointing down towards the f-holes of the instrument to catch more of the instrument's sound than the room acoustic, which was relatively resonant. Fabrics were hung on the wall and door to try to dampen the sound (see Figure 4 for the set-up). All efforts were made to keep the camera angles the same for all recordings. For the video recording, participants were requested to wear something that made it possible to see their posture and movement clearly, within their personal comfort zone. After playing, participants took about three to five minutes to fill out a questionnaire (*questionnaire two*), rating different aspects of their playing.

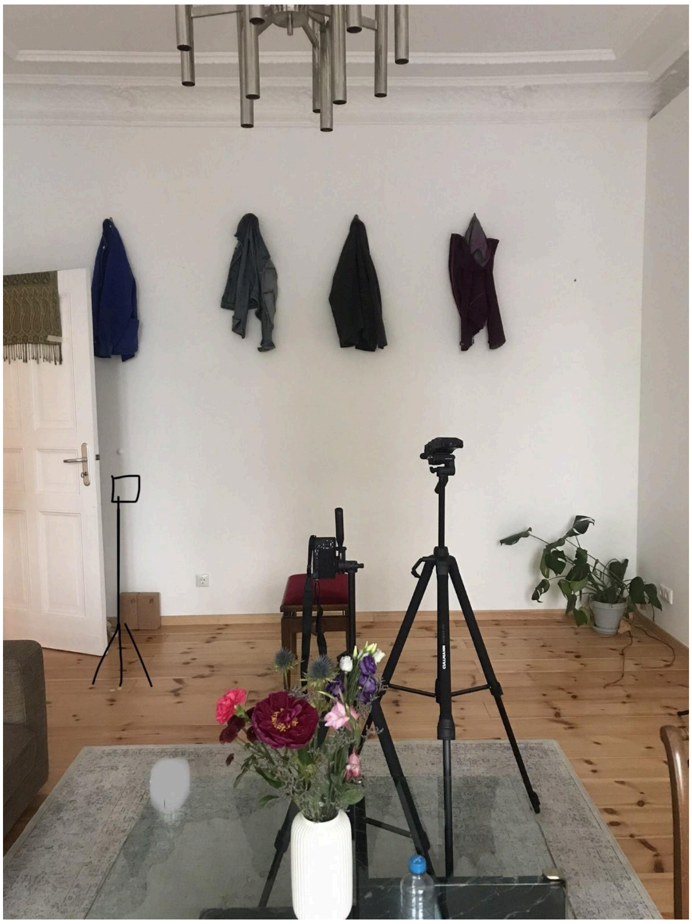


Figure 4. The set-up for the recordings, pre and post intervention. On the left: the tripod and iPhone capturing the back view are drawn onto the picture; the spot is marked with tape on the floor. In the middle: the Sony alpha 6400 video camera recording the side view. On the right: the Zoom H6 Handy Recorder, pointing towards where the violin would be.

Intervention

The intervention itself provided the participants with one 60-minute session. The control group had a session (see Materials) guided by an experienced violinist, a member of the Deutsches Symphonie-Orchester Berlin since 2015. The participants in the control group were offered a free Timani session to be scheduled after the intervention.

The Timani group received a Timani lesson from a certified Timani teacher. The Timani teacher chose which of the pre-chosen exercises were most suitable for the individual participants, much like in a standard Timani session. A printed description of the exercises was given to the participants and sent digitally after the session (see Appendix IV).

Recording and questionnaires

After the intervention, all participants were asked to repeat the same procedure as before, i.e., play the scale and the same short excerpt in a seated position while being recorded, and fill in the same questionnaire (*questionnaire 2*) rating the different aspects of their playing. Additionally, the Timani participants filled out a short questionnaire (*questionnaire three*) regarding their experiences with the Timani lesson. This took around five minutes to complete. All participants had the chance to have a debrief before they left.

Follow-up

Finally, the Timani group was requested to do the short exercises they learnt in the session for the next seven days, after which they were sent an online follow-up questionnaire (*questionnaire four*). Like in a real-life setting, the Timani teacher's email address was provided after the intervention, in case questions arose during the week.

External evaluations

To complement the self-report data, the video and audio recordings were sent to two external panels: one rating the playing posture and one rating the performance of all participants, pre and post intervention. The posture panel consisted of three experienced physical therapists, based in Belgium, Singapore and Austria, who are specialised in working with musicians. The sound panel comprised three experienced violinists (a retired conservatoire teacher, an international soloist/chamber musician, and an acclaimed concertmaster/orchestral musician), based in the Netherlands, Germany and England, respectively. The evaluators were specifically chosen to be from different backgrounds, to avoid a potential over-emphasis on one particular tradition or school of thought.

Recordings

The recordings of all participants were numbered randomly and pre and post recordings were ordered randomly using an online randomiser (randomiser.org). Additionally, since evaluations tend to become more positive when made later in a sequence (O'Connor & Cheema, 2018), and to mitigate the effects of potential survey fatigue, the order of participants and pre/post recordings was different for all evaluators.

Recordings were edited using Adobe Premiere Pro 2024 software. For the videos, the side view and posterior view recordings were trimmed, synchronised and collated side by side into one video. Additionally, faces were blurred and brightness was adjusted. To avoid bias due to the quality of the performance, the audio was removed. Pre/post or post/pre recordings of each participant were put into one single video or audio sample, with a short black screen in between, so that the evaluators might easily compare the two recordings if so desired. To clarify what recording was playing, numbers were inserted (see Figure 5).

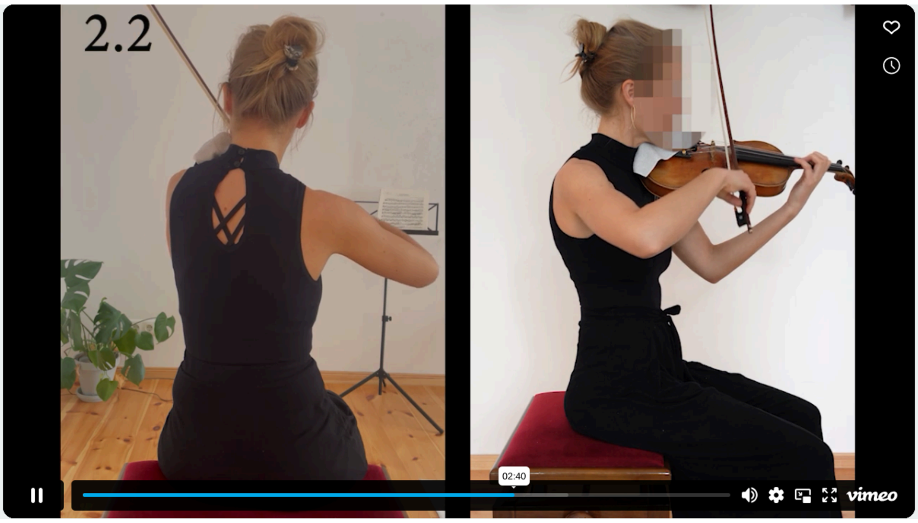


Figure 5. Two screenshots of the video sample of participant 2. Upper picture: minute 00.17 shows recording 2.1. Lower picture: scrolled forward to minute 02:40, showing recording 2.2.

The samples were uploaded to Vimeo for a limited time, password-protected and not downloadable. Audio recordings were linked to and videos were embedded in the questionnaires, relating each set of questions to a single video or audio sample of one participant. Evaluators were able to press a ‘Save and continue’ button after rating each participant.

The panels were told that all recordings were in a random order and that the numbers they saw had no meaning. The panel of violinists was requested to listen to the samples using (noise-cancelling) headphones and all evaluators were given two weeks to fill out the online questionnaires (*questionnaires five and six*).

Data preparation and analyses

Quantitative data

Several data points were missing from the questionnaire responses. One participant forgot to answer the following question: ‘Have you had pain/problems that have interfered with your ability to play your instrument at the level to which you are accustomed during the last month (four weeks)?’ Since this participant answered ‘yes’ to the next question regarding pain/problems in the last seven days, it was assumed they meant to answer ‘yes’ to the forgotten (four weeks) question. Furthermore, another participant answered ‘yes’ to being a freelancer, but used the text box to clarify that they were not sure because they were on a temporary contract. After checking the official employment status of musicians on temporary orchestra contracts in Germany, it was concluded that they were in fact not a freelancer at that moment in time, and their answer was changed to ‘no’. Items regarding physical discomfort were repeatedly left blank by participants. As the marker was left at its default spot (0 = none at all), signifying no discomfort, these items were left out of the analyses. Only sites of discomfort, where change could potentially occur, were relevant to the study.

All items were rated on a 0-100 scale, with 100 being the ideal score in most cases; for the items relating to physical discomfort, 0 marked the absence of discomfort (i.e., the optimal score). Moreover, as the optimal score of the POI was 50 (out of 100), those data were normalised by calculating the difference to 50, multiplying by two (to match the 0-100 scale), and finally reverse scored.

All quantitative data were grouped into four categories according to the different dependent variables ‘posture’ (10 items), ‘ease of playing’ (six items), ‘physical discomfort’ (eight items), and ‘performance’ (nine items) (see Appendix V for how the data were grouped).

For every participant, means were calculated for each variable, one pre intervention and one post intervention. For 'posture' and 'performance', these consisted of self-report scores as well as external ratings, which were equally weighted as to not favour one over the other. All statistical analyses were done using Jamovi software (version 2.3.80.0). Normality and reliability checks were performed before running separate mixed-factorial ANOVAs for all the variables (see Results).

Qualitative data

Data from the MPIIQM and the included self-constructed questions are reported descriptively. To answer the second research question, open-ended responses to the post-intervention questionnaire *(questionnaire three)* were analysed per question using a thematic approach, summarising key features of the data. For closed questions and wherever not enough data was provided to draw out themes (e.g., *questionnaire four)*, responses are reported descriptively, highlighting commonalities across participants' responses where possible (indicated by stating the number of participants who mentioned a certain phenomenon).

Figure 6 shows an overview of the research design.

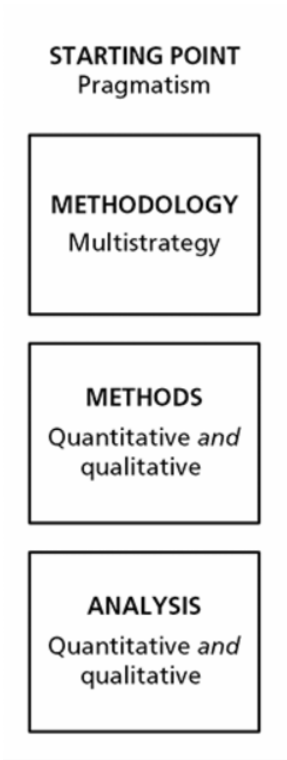


Figure 6. An overview of the research design. Source: Williamon et al. (2021), p. 25

Results

MPIIQM

The data from the MPIIQM revealed a life-time prevalence of PRMDs of 84.2% in this sample. In total, a third of the participants (31.6%) experienced current pain or problems. The left side of the neck and shoulder were mostly affected, interfering, amongst other things, with participants' enjoyment of life and ability to play as well as they would like. The full results of the MPIIQM are reported descriptively in Tables 2 and 3.

Table 2. The number of participants reporting pain/problems that interfere with their ability to play the instrument at the level to which participants are accustomed.

	Control group n = 9 (47.4%)	**Timani group** n = 10 (52.6%)	**Total** n = 19
Participants reporting lifetime pain/problems	7 (77.8%)	9 (90%)	16 (84.2%)
Participants reporting recent (12 months) pain/problems	6 (66.7%)	7 (70%)	13 (68.4%)
Participants reporting recent (4 weeks) pain/problems	0	6 (60%)	6 (31.6%)
Participants reporting current (7 days) pain/problems	0	6 (60%)	6 (31.6%)

Table 3. Pain location, intensity, and interference of the six participants who reported pain/problems in the last 4 weeks or 7 days, rated on a scale of 1-10.

Location of pain/problems:	**Frequency**
Left side of neck	4 x
Left shoulder	3 x
Left upper arm	2 x
Left hand	2 x
Left lower arm	1 x
Back of neck	1 x
Right shoulder	1 x
Left hip/lower back	1 x
Lower back both side	1 x
Backsides of both upper legs	1 x
Lateral side of left leg	1 x
Left foot	1 x
	1 x
	1 x
	Ratings (Means and (SD))
Pain intensity	**1 = no pain, 10 = pain as bad as you can imagine**
Worst pain	5.25 (2.22) range 3-8
Least pain	1.25 (0.50) range 1-2
Average pain	2.75 (0.96) range 2-4
Pain right now	1.50 (1.00) range 1-3
Interference of pain/problems with:	**1 = does not interfere, 10 = completely interferes**
Mood	5.17 (2.79) range 2-9
Enjoyment of life	5.83 (2.56) range 3-9
	1 = no difficulty, 10 = unable
Usual instrumental technique	3.67 (2.42) range 1-7
Playing the instrument	4 (2.28) range 2-7
Playing as well as participant would like	5.50 (2.88) range 2-10

Self-constructed questions

Somatic methods and playing-related body mechanics and anatomy

Most participants (84.2%) reported having previous experience with somatic methods, most commonly with Alexander Technique (See Figure 7).

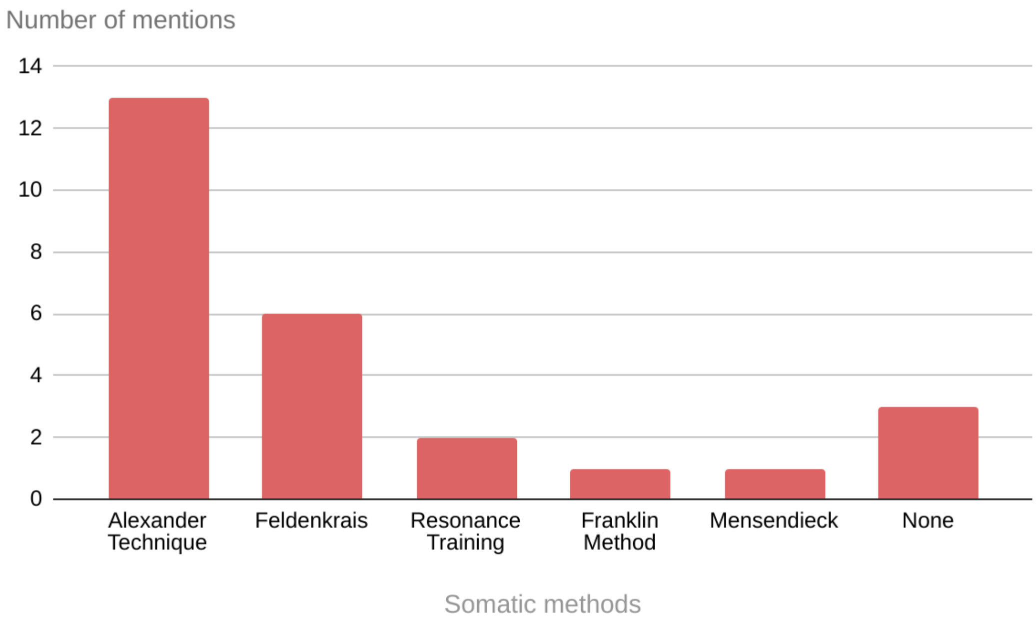


Figure 7. The somatic methods which participants reported having experience with, including how often each method was mentioned.

The length of that experience varied greatly, ranging from only two sessions to 16 years (see Figure 8). These methods mainly taught the participants about posture (N=5) and increased their awareness (N=4). Furthermore, the relationship between different parts of the body was mentioned, as well as ‘how posture and breathing affect everything’. Two participants mentioned learning principles of Alexander Technique, such as how ‘our learned responses interfere with the natural movement’. Lastly, the importance of stretching/flexibility (N=2) and ‘having deep muscles’ (N=1) were reported.

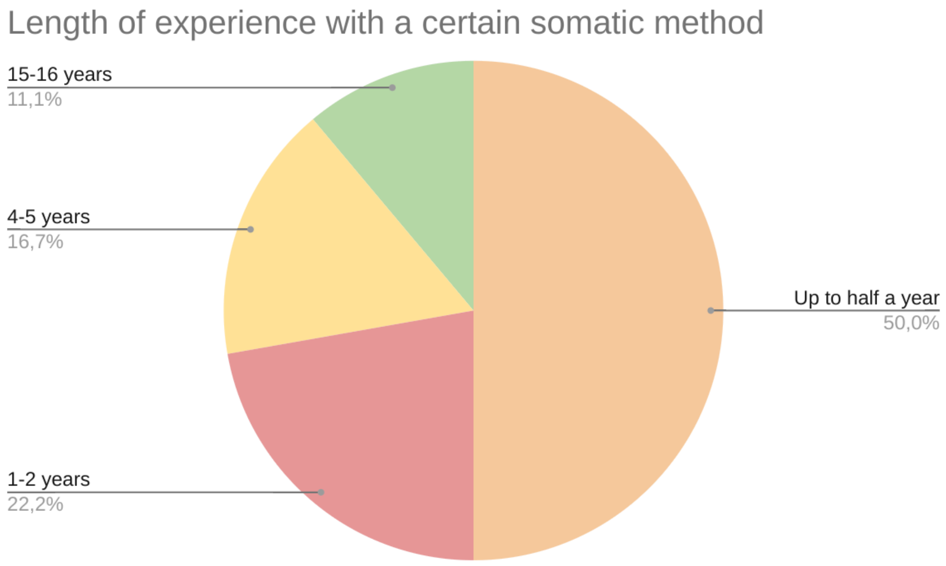


Figure 8. Length of time participants have had experience with a certain somatic method.

Only 36.8% percent of participants received instruction regarding playing-related body mechanics and/or anatomy offered by their educational institution. To the question 'What is the most important thing you learnt?' participants gave varied responses, from general information about muscles and fascia, to more practical tips on breathing while playing or relaxation between playing sessions. Similarly, only one third (31.6%) of participants were educated about playing-related body mechanics and/or anatomy by their instrumental teacher. This instruction was mostly focused on relaxation (N=3), for example by using gravity or the weight of the body. One participant's teacher talked about 'how the muscles work and which ones are being stressed during performance'.

Sports, warm-up, and strategies for dealing with discomfort

All but one participant (94.7%) reported doing sports to some degree, ranging from four times per month to daily (see Figure 9). Running and yoga were the most popular; generally, sports aimed at improving cardio or flexibility were more frequently mentioned than strength focused exercise (see Figure 10).

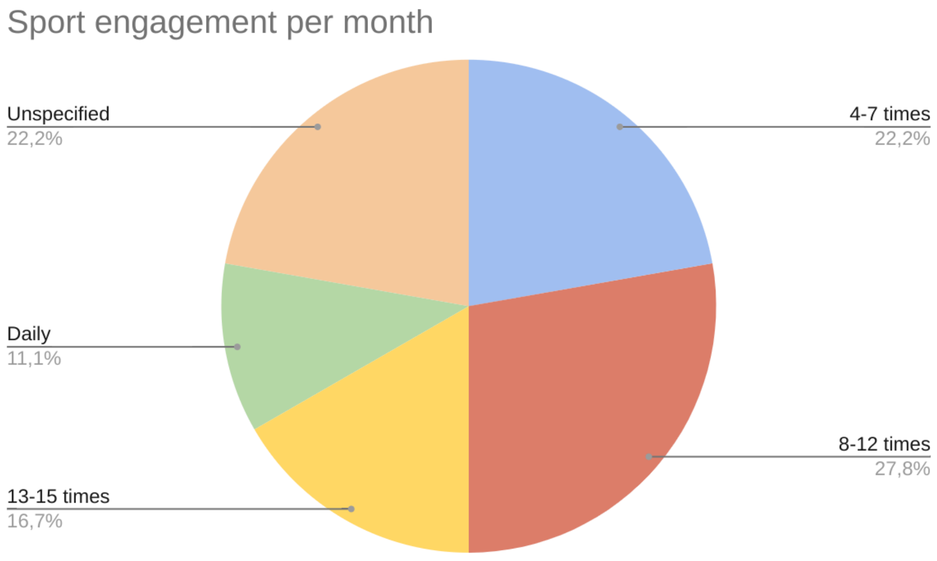


Figure 9. The number of times participants engage in sports per month.

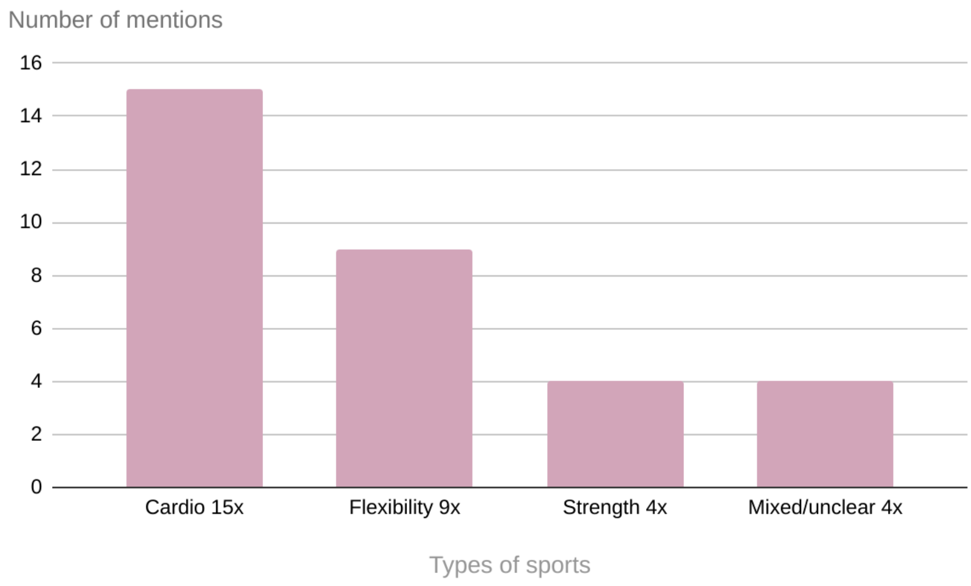


Figure 10. The different sports categorised in type of sports, including how often each category was mentioned.

All participants felt that exercising helps their playing in some way, mainly by providing mental benefits (N=6) such as concentration and mental sharpness, as well as relaxation and enjoyment. Increased awareness (N=3) of their bodies also helps them to relax physically, reducing muscle tension (N=4) and creating a more grounded feeling (N=1). Moreover, increased muscle strength (N=3) was reported as a positive effect of exercising, along with a more stable and improved posture (N=2), and less pain (N=3). Finally, participants reported better stamina (N=3), with all the above positively contributing to their playing.

In relation to violin playing more specifically, 42.1% of participants stated they physically prepare for playing their instrument, primarily by using different relaxation methods (N=4), including mantras and meditation, or lying down on the floor or shakti mat. Warming up the hands (N=3) and stretching the arms and shoulders (N=3) were also frequently mentioned. Other participants reported 'awakening' their body by visualising the pelvic region (N=1) or 'rolling out the feet' (N=1). One participant said they engage in a muscle strengthening activity to prepare for playing, doing squats with elastic bands.

Only one out of 19 participants does not experience discomfort in their shoulders or arms during or after playing. Of the remaining 18 violinists, roughly two-thirds (68.4%) have strategies to deal with their physical discomfort *outside* of playing; they predominantly mention stretching (N=6) or doing yoga exercises (N=2). Other activities range from using massage (N=2) and osteopathy (N=1), to simply shaking out the arms (N=1). During playing, only 50% feel that they have strategies to deal with their discomfort. These mainly focus on letting go and relaxing specific parts of the body (N=6). Other strategies include trying to improve posture (N=1) or consciously thinking about the shoulder blade providing stability (N=1).

Lastly, when asked what part of their body, if any, they usually focus on while playing, participants' answers varied widely, from their fingers to their feet (see Figure 11). The top half of the body (from the diaphragm up) was mentioned more often (N=18) than the bottom half (N=13).

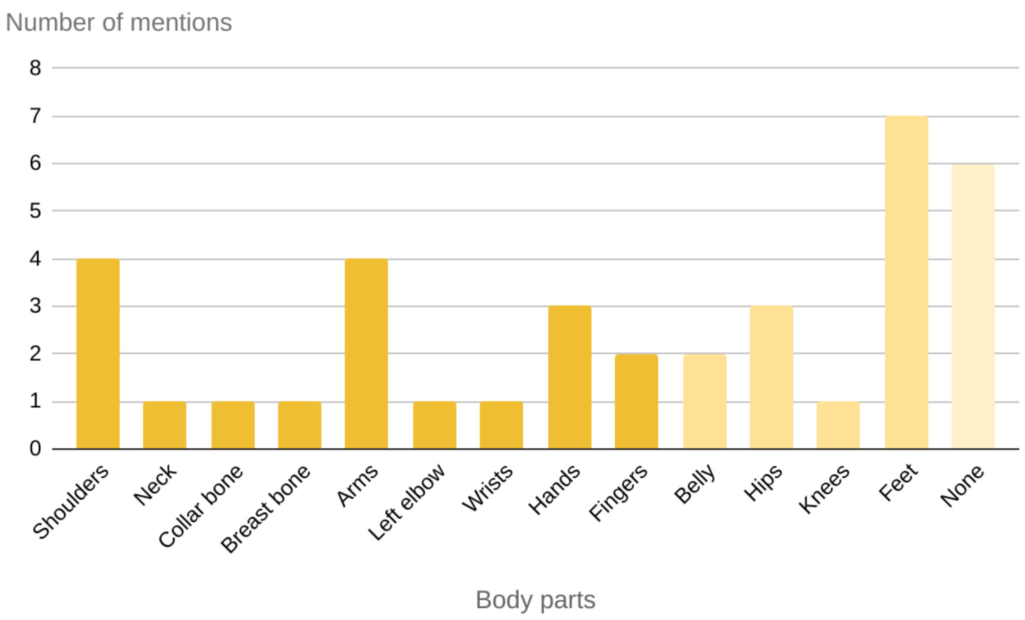


Figure 11. The body parts that participants focus on while playing, including how often each body part was mentioned.

Posture

In participants' descriptions of good sitting posture while playing, having both feet on the floor was the most frequently stated (N=8), followed by an upright position (N=7). Two participants mentioned sitting on the sitting bones; some thought it best to sit on the front of the chair (N=3), while others thought somewhere in the middle (N=1) or with the pelvis right against the back of the chair (N=1). One participant focused on relaxation ('the back should be relaxed') while others mentioned the importance of being active and dynamic, with free movement (N=3). Further, some participants emphasised the balance between being upright and relaxed (N=4), described as 'effortless, without tension but naturally upright' (N=1), having both stability and flexibility (N=1). Finally, for one participant, good posture is 'anything that visibly seems natural and intuitive'. Having a good playing posture is very important to all participants, however, they are not equally aware of their own sitting posture while playing (see Figures 12 and 13).

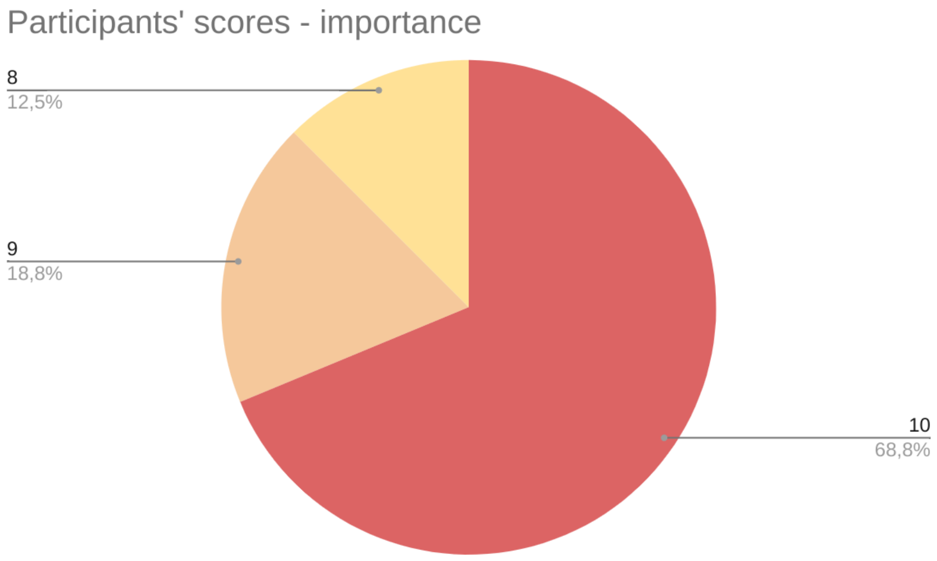


Figure 12. Participants scoring how important good sitting posture is to them on a scale from 1 (not important at all) to 10 (very important). The mean score is 9.32.

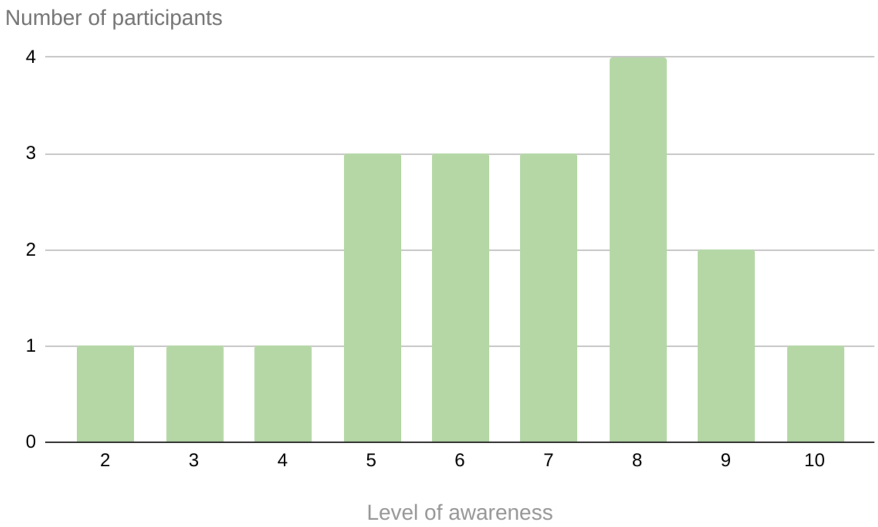


Figure 13. Participants reporting how aware they are of their own sitting posture while playing, rated on a scale from 1 (not aware at all) to 10 (very aware). A score of 8 was selected most often (N=4).

Furthermore, even though participants have ideas about what good posture is and stress its importance, all but one participant get uncomfortable whilst playing in a seated position. The discomfort was reported to arise after varying lengths of time (see Figure 14), with some violinists specifying that it depends more on what kind of chair they sit on (e.g., height or cushioning) or how much space they have.

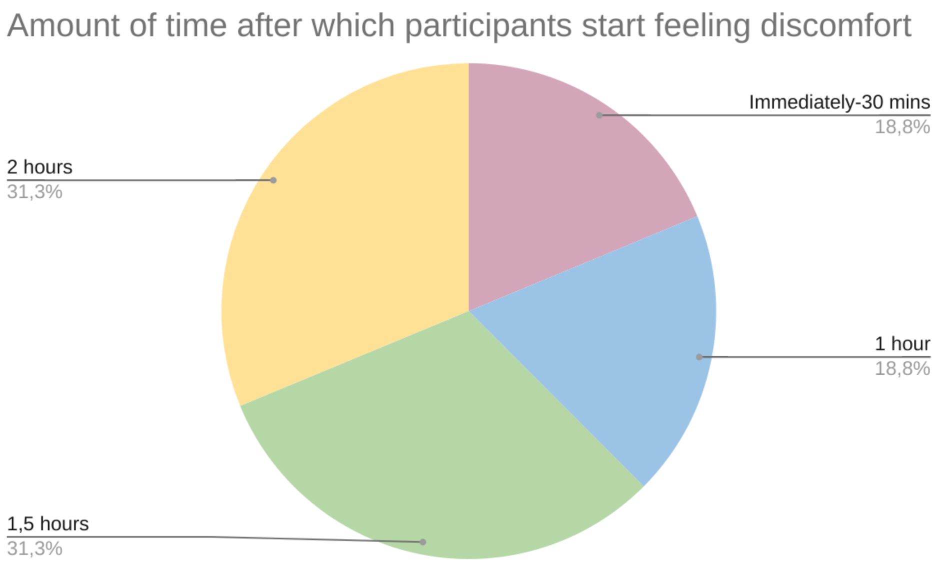


Figure 14. The amount of time after which participants start to feel discomfort while sitting to play.

All participants think that their sitting posture or postural stability impacts playing comfort, as well as performance quality. They mostly reported effects on sound (N=10), including sound quality and projection, and to a lesser extent on perceived pain (N=3). According to some participants, good posture and stability can help to feel more grounded and less tense, allowing the arms and hands to move more freely (N=1) and the fingers to be more efficient (N=1). Other effects include more energy, power and confidence, along with ‘free musical movement’, increased ‘naturalness of playing’, and flexibility.

Lastly, of the 73.7% of participants who have a preference for either sitting or standing while playing, only two violinists prefer to sit. Those with a preference for standing (85.7%) felt that it gives them more freedom of movement (N=8), as well as ‘better contact with [their] feet’ (N=1), and ‘more stability from the ground’ (N=1).

Intervention activities

Tables 4 and 5 list the activities that were chosen in the control and Timani group, respectively. Less than half of the control group participants ended up using their own strategy; mostly the activities from the prepared list were used. The Timani teacher chose between two and four exercises per participant. The Sitting shuffle and Transverse abdominis differentiation (seated) exercises were done by everyone. Two of the participants used the full hour to learn these two exercises in depth and did not do any exercise for the arms and shoulders.

Table 4. Activities in the control group, including yoga warm-up (N=7), reading BAPAM article (N=5), breathing exercise (N=5), meditation (N=4), watching YouTube video (N=2), Mensendieck, Resonanzlehre (Resonance Training), Feldenkrais, yoga nidra, bodymapping (N=1). Participants’ own ideas, rather than from the list of proposed activities, are highlighted in italics.

Control group participants #	**Activities**
1	Mensendieck exercises, video
2	Resonanzlehre (Resonance Training), yoga warm-up, breathing exercise, video
3	Yoga warm-up, breathing exercise, article, meditation
4	Meditation, brea thing exercise, article
5	Feldenkrais, yoga warm-up, article, meditation
6	Yoga warm-up, breathing exercise
7	Yoga warm-up, article, yoga nidra
8	Yoga warm-up, breathing exercise, bodymapping
9	Yoga warm-up, article, meditation

Table 5. Overview of the exercises done by the participants in the Timani group, including Sitting shuffle (N=10), Transverse abdominis differentiation (TvA), seated (N=10), Back arm-line push-off (N=5), Bottle exercise (N=3), Bouncy with arms (N=1). No one did the Iliacus exercise in this study.

Timani group participants #	Exercises
1	Sitting shuffle, TvA seated, Bottle exercise
2	Sitting shuffle, TvA seated, Bottle exercise, Back arm-line push-off
3	Sitting shuffle, TvA seated, Bottle exercise
4	Sitting shuffle, TvA seated, Bouncy with arms
5	Sitting shuffle, TvA seated
6	Sitting shuffle, TvA seated, Back arm-line push-off
7	Sitting shuffle, TvA seated, Back arm-line push-off
8	Sitting shuffle, TvA seated, Back arm-line push-off
9	Sitting shuffle, TvA seated, Back arm-line push-off
10	Sitting shuffle, TvA seated

Quantitative data

Before running tests to examine the first research question, the quantitative data were subjected to several checks.

Normality checks

The data for three of the outcome variables (‘posture’, ‘ease of playing’, and ‘performance’) were found to be normally distributed ($p > .05$), as measured using a Shapiro–Wilk test. However, the ‘physical discomfort’ data deviated significantly from a normal distribution ($p < .05$). Since mixed-factorial ANOVAs do not have a non-parametric alternative, the parametric test was run with all the data.

Reliability checks

Cronbach’s alpha

Cronbach’s alphas for the ‘posture’, ‘ease of playing’, ‘physical discomfort’, and ‘performance’ items were calculated with both pre and post intervention data, showing sufficient internal consistency (> .70) of the items within each of the four outcome variables (see Table 6).

Table 6. Cronbach's alpha scores for all outcome variables, pre and post intervention.

	Pre	**Post**
Posture (10 items)	.73	.73
Ease of playing (6 items)	.71	.96
Physical discomfort (8 items)	.82	.92
Performance (9 items)	.88	.91

Interrater reliability

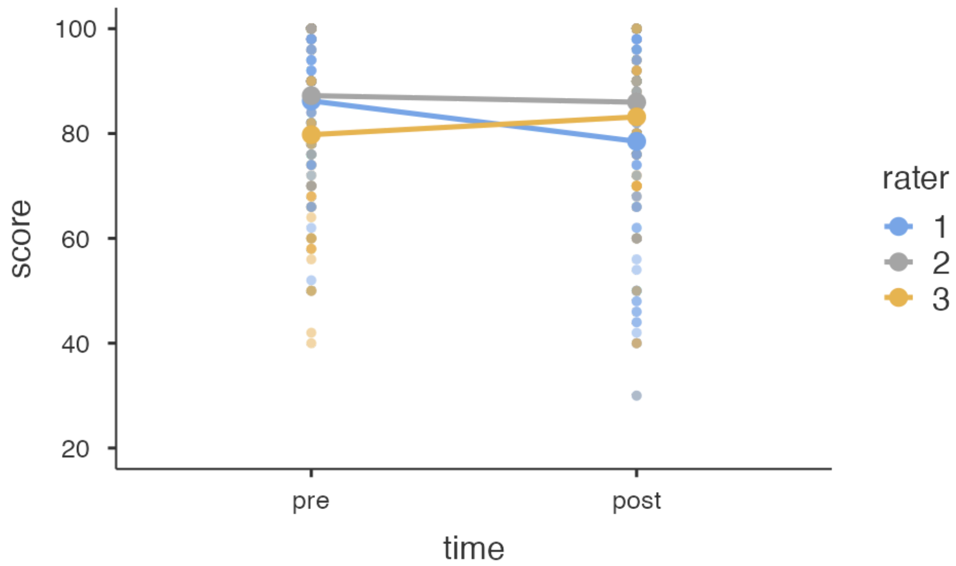
To investigate the consistency between the external evaluators' ratings, interrater reliability was assessed for both the 'posture' and 'performance' variables, calculated as the intraclass correlation coefficient (ICC) statistic. ICC scores were found to be low for both panels (scores under 0.40 are considered poor), whether looking at how they rated participants or individual items (see Table 7). This indicates that they rated each participant and each item very differently from each other, resulting in little consistency in their ratings (see Figure 15 and 16). The results of the observational data may therefore not be reliable and should be interpreted with caution.

Table 7. ICC scores for the reliability of evaluators' ratings of participants and items.

	Participants	**Items**
Posture panel	0.10	0.02
Performance panel	0.32	0.00

POSTURE

Control group



Timani group

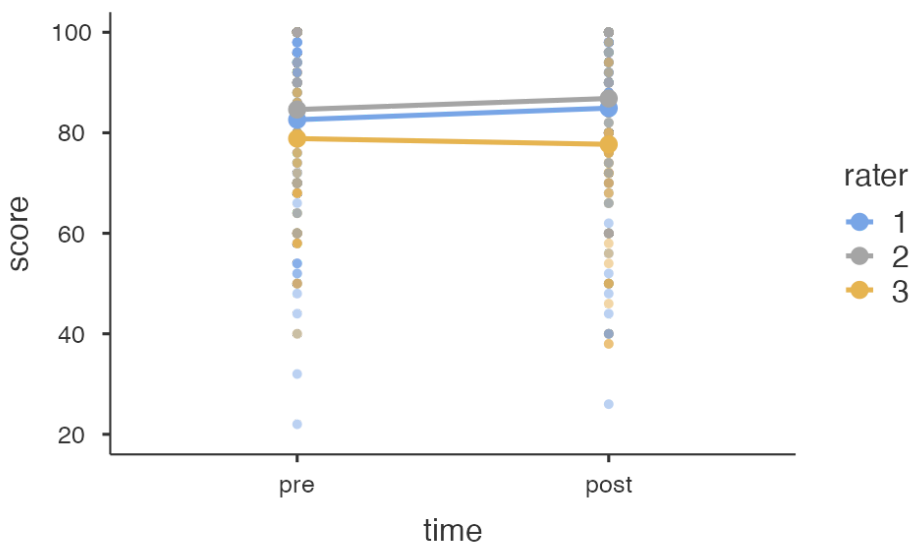
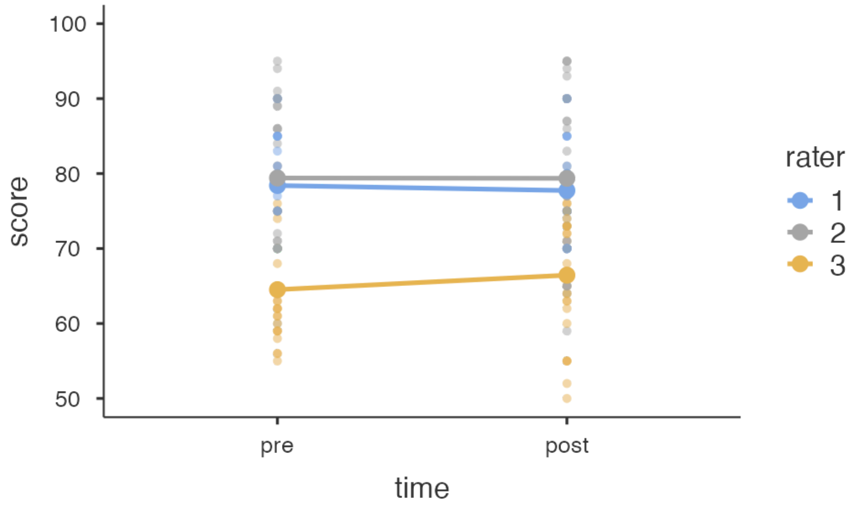


Figure 15. Graphs showing the ratings of the three different evaluators rating posture. The top graph represents the control group, the bottom graph the Timani group.

PERFORMANCE

Control group



Timani group

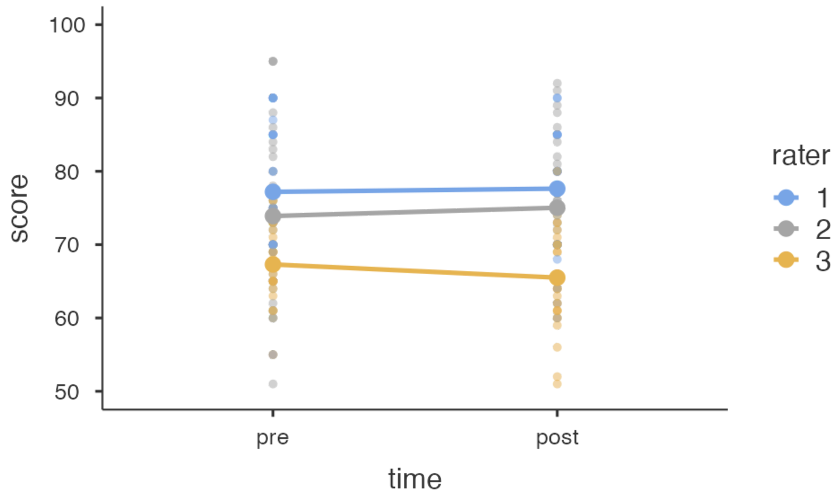


Figure 16. Graphs showing the ratings of the three different evaluators rating performance. The top graph represents the control group, the bottom graph the Timani group.

Main analyses

To address the first research question, separate mixed-factorial ANOVAs were run to test the effects of the Timani intervention on participants' posture, ease of playing, physical discomfort, and performance, as well as the sub-categories of self-report scores and external ratings. Following a Bonferroni correction for multiple comparisons, only effects p <.006 (p < .05 / 9) were considered significant. The test outputs can be found in Appendix VI, including the within-subjects and between-subjects effects of the mixed-factorial ANOVAs. In the results outlined below, only interaction effects are reported.

Posture

Postural deficits were seen in all participants, as assessed by the external evaluators, and participants themselves scored their posture only slightly higher than the neutral mid-point of 50 (M=55.3). A mixed-factorial ANOVA revealed a non-significant, large effect of the Timani intervention on participants' posture, compared to control ($F_{1,17}$ = 3.74, p = .07, ηp^2 = .18), such that the 'posture' scores of the Timani participants went up descriptively more after the intervention than those of the control group (see Figure 17).

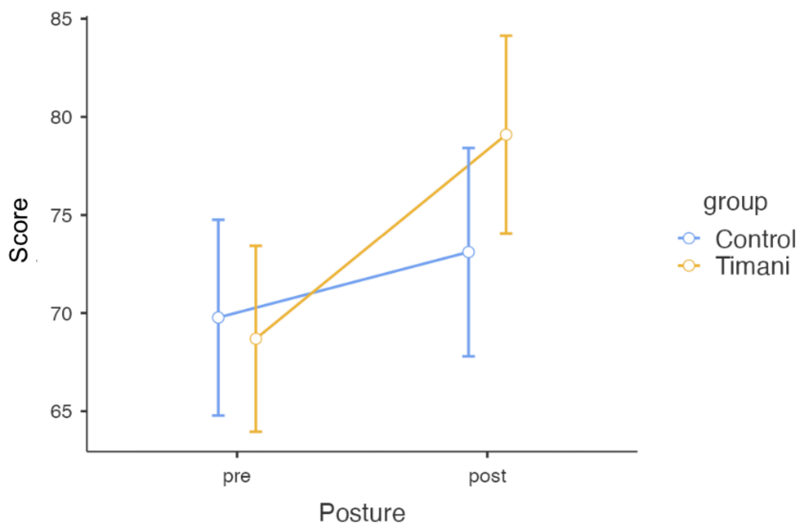


Figure 17. Graph showing control group and Timani participants' mean scores for posture, pre and post intervention.

When investigating the sub-categories of self-report and observational data, mixed-factorial ANOVAs showed a bigger effect of the Timani intervention on the self-report scores, than on the external ratings of posture: A non-significant, *large* effect was found ($F_{1,17}$ = 2.70, p = .12, ηp^2 = .14) on the self-report scores, where a non-significant, *medium* effect ($F_{1,17}$ = 1.3538, p = .26, ηp^2 = .07) could be observed in the external ratings. Notably, control group participants' posture was evaluated as getting descriptively worse, whereas the posture of the Timani participants improved slightly, according to the external evaluations (see Figure 18). All 'posture' descriptives can be found in Table 8.

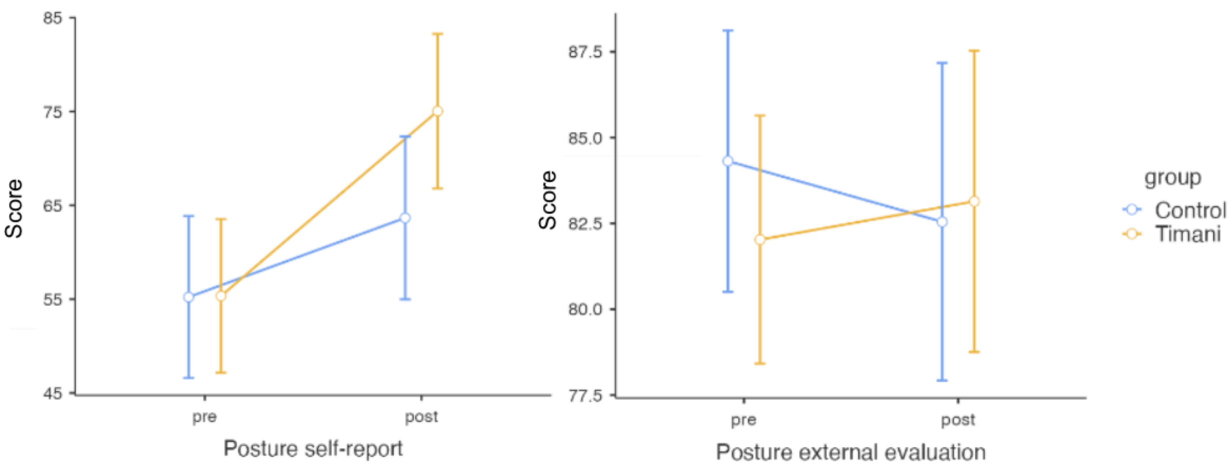


Figure 18. Graphs showing self-report and external evaluation mean scores of both groups for 'posture', pre and post intervention.

Table 8. Means and (standard deviations) of participants' 'posture' scores: self-report, observational and both combined, equally weighted.

	Pre	**Post**	**Difference**
Posture all			
Control	69.8 (8.14)	73.1 (7.65)	+ 3.3
Timani	68.7 (6.01)	79.1 (7.46)	+10.4
Posture self-report			
Control	55.2 (12.7)	63.7 (12.2)	+8.5
Timani	55.4 (11.9)	75.0 (12.5)	+19.6
Posture external observation			
Control	84.3 (7.39)	82.5 (7.97)	-1.8
Timani	82.0 (2.63)	83.1 (5.03)	+1.1

Overall, no significant effect of the Timani intervention was found on participants' posture scores. Nevertheless, a certain trend could be detected, such that participants' posture improved descriptively more after the Timani intervention compared to control, particularly as experienced by the violinists themselves.

Ease of playing

Next, the 'ease of playing' data were subjected to a mixed-factorial ANOVA. With a Bonferroni-corrected significance cut-off of $p < .006$, this showed a non-significant, large effect of the Timani intervention on participants' ease of playing compared to control ($F_{1,17} = 5.44$, $p = .03$, $\eta p^2 = .24$), such that violinists' ease of playing improved comparatively more in the Timani group (see Figure 19). 'Ease of playing' scores are listed descriptively in Table 9.

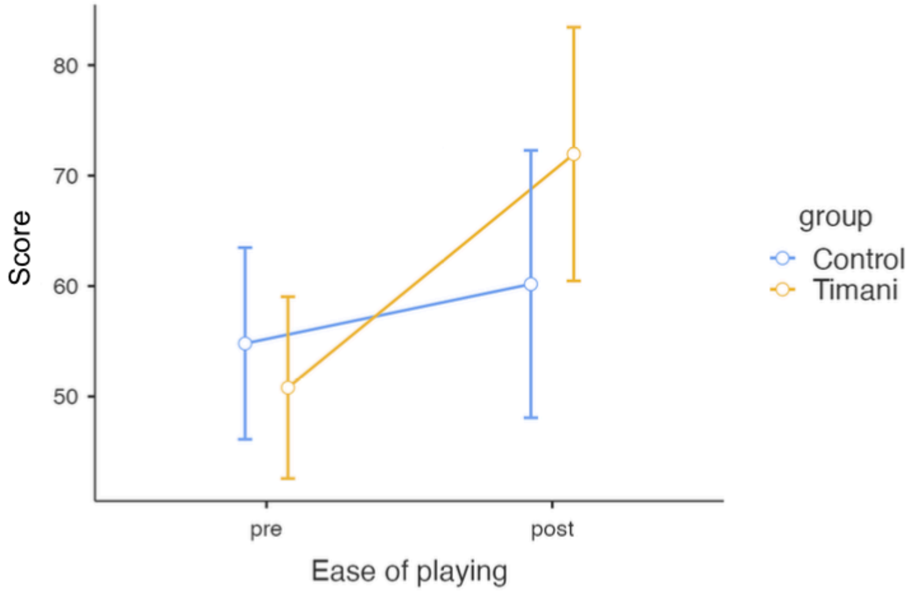


Figure 19. Graph showing control group and Timani participants' mean scores for 'ease of playing', pre and post intervention.

Table 9. Means and (standard deviations) of participants' 'ease of playing' scores.

	Pre	**Post**	**Difference**
Control	54.8 (13.0)	60.2 (14.4)	+ 5.4
Timani	50.8 (11.7)	72.0 (19.4)	+ 21.2

Even though no significant effect was found, a clear trend could be observed, supported by a large effect size, suggesting an increase in participants' ease of playing after the Timani intervention.

Physical discomfort

All participants experienced physical discomfort while playing. Investigating the impact of the Timani intervention on participants' level of physical discomfort, a mixed-factorial ANOVA revealed a non-significant, large effect ($F_{1,17}$ = 2.74, p = .12, ηp^2 = .14), such that Timani participants experienced descriptively less discomfort after the intervention than the control group (see Figure 20 and Table 10). Since these data were not normally distributed, this result needs to be interpreted with caution.

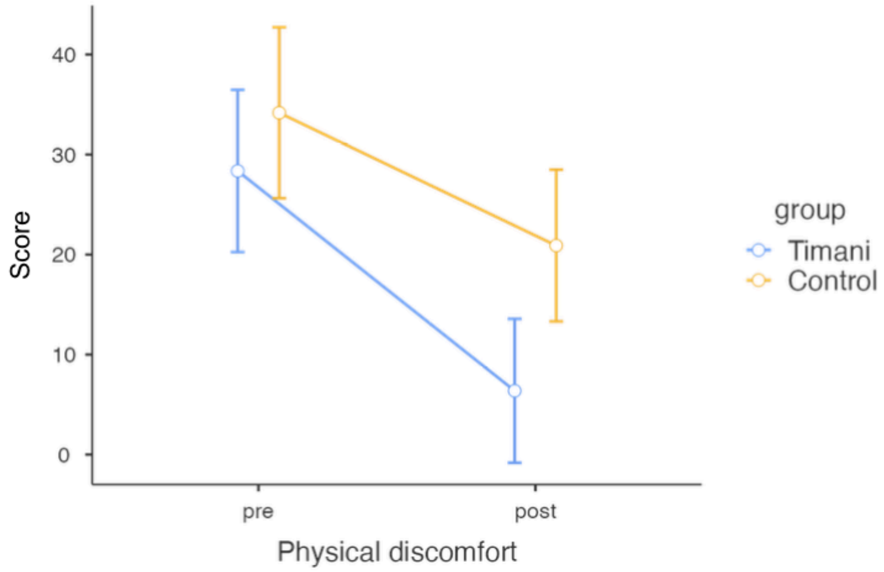


Figure 20. Graph showing control group and Timani participants' mean scores for 'physical discomfort', pre and post intervention. Note: this graph shows the Timani scores in blue and control scores in yellow, opposite to the other graphs.

Table 10. Means and (standard deviations) of participants' 'physical discomfort' scores.

	Pre	**Post**	**Difference**
Control	34.20 (14.0)	20.9 (12.4)	+ 13.3
Timani	28.4 (10.2)	6.38 (9.08)	+ 22.02

The Timani group reported less physical discomfort pre intervention than the control group (see Table 10). This favoured the control group to show more improvement in their scores. As the total disappearance of discomfort in a particular anatomical area was seen in both groups (see Figure 21), the total number of discomfort sites was considered a valuable additional measure of discomfort.

A mixed-factorial ANOVA found a non-significant, large effect on the number of areas in which participants felt discomfort ($F_{1,17}$ = 6.15, p = .02, ηp^2 = .27), such that participants experienced a larger decrease in discomfort sites after the Timani intervention than after the control group intervention (see Table 11). Again, this result needs to be interpreted cautiously, given the non-normal distribution of the data (see normality checks).

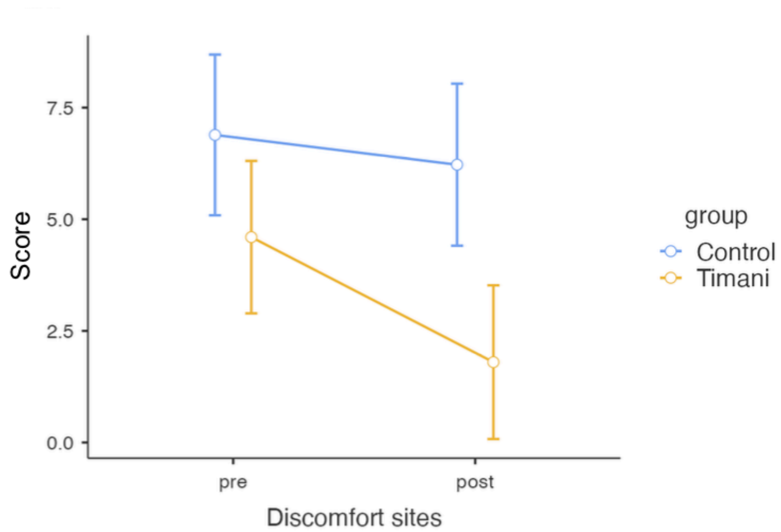


Figure 21. Graph showing control group and Timani participants' number of discomfort sites, pre and post intervention.

Table 11. Participants' discomfort sites: numbers, means, and standard deviations.

	Pre (*N*)	**Post (*N*)**	**Difference**
Control	62	56	-6 (9.68%)
Timani	46	18	-28 (60.87%)
	Pre (Means and (*SD*))	**Post (Means and (*SD*))**	
Control	6.89 (1.76)	6.22 (2.17)	-0.67
Timani	4.60 (3.10)	1.80 (2.90)	-2.80

To sum up, the results show a positive impact of the Timani intervention on participants' physical discomfort. Although not significant when running the parametric mixed-factorial ANOVAs, a clear trend could be observed, indicating a decrease in participants' physical discomfort after the Timani intervention.

Performance

Lastly, a mixed-factorial ANOVA revealed a non-significant, medium effect on performance ($F_{1,17}$ = 1.52, p = .23, ηp^2 = .08), such that participants' overall performance scores went up descriptively more in the Timani group, compared to control (see Figure 22).

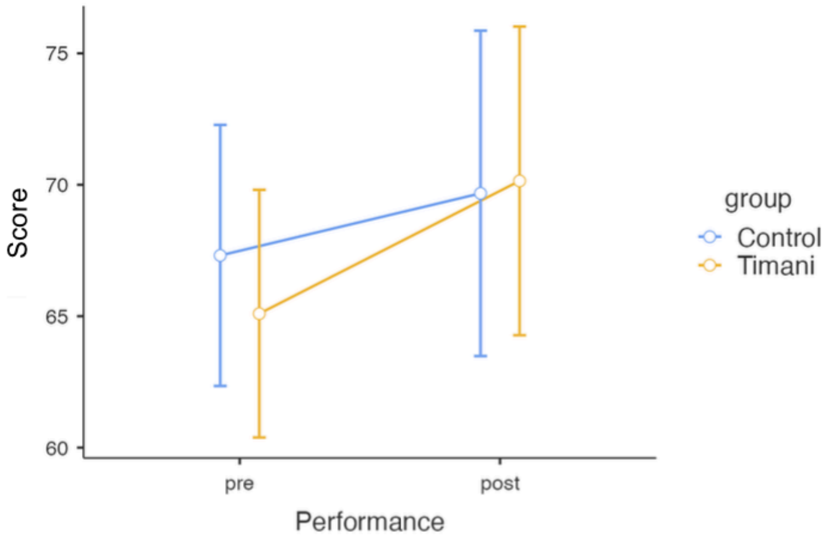


Figure 22. Graph showing control group and Timani participants' mean scores for 'performance', pre and post intervention.

Crucially, a difference between self-report and external ratings can be observed. A non-significant, large effect of the Timani intervention on *self-report* performance scores was found ($F_{1,17}$ = 2.46, p = .14, ηp^2 = .13), such that self-report ratings improved descriptively more for the Timani participants than the control group. A non-significant, small effect on *external ratings* of performance ($F_{1,17}$ = 0.2585, p = .62, ηp^2 = .02) was found; although in this case the control group scores went *up* after the intervention, and the Timani participants' evaluations went *down* slightly (see Figure 23 and Table 12).

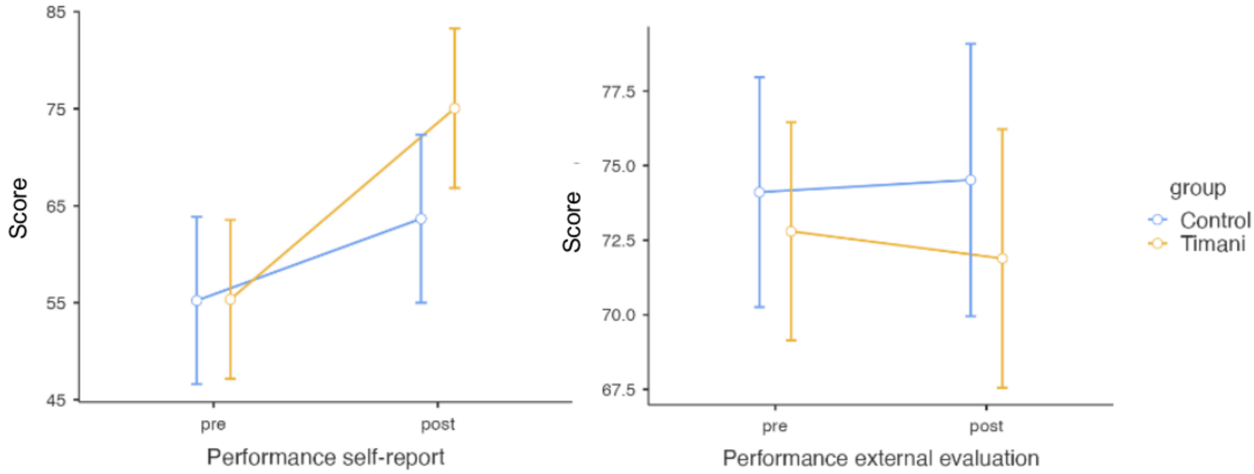


Figure 23. Graphs showing self-report and external evaluation mean scores of both groups for 'performance', pre and post intervention.

Table 12. Means and (standard deviations) of participants' 'performance' scores: self-report, external evaluation and both combined, equally weighted.

	Pre	**Post**	**Difference**
Performance all			
Control	65.6 (8.48)	68.5 (11.1)	+2.9
Timani	62.4 (6.29)	69.9 (9.41)	+7.5
Performance self-report			
Control	57.1 (12.9)	62.4 (16.3)	+5.3
Timani	51.9 (12.7)	67.4 (21.8)	+15.5
Performance external evaluation			
Control	74.1 (4.64)	74.5 (7.62)	+0.4
Timani	72.8 (6.12)	71.9 (5.30)	-0.9

On the whole, although the performances of participants in the Timani group were rated comparatively less well after the intervention, an increase of 'performance' scores could be observed in the Timani participants' self-report. However, the measured effect was found to be non-significant.

Power analyses

Given the small sample and medium/large effect sizes, power analyses were conducted using G*Power 3.1. With a Bonferroni corrected significance criterion of α = .006 and power = .95, the minimum sample sizes required to achieve a significant finding were calculated (see Table 13).

Table 13. Power analyses for the different variables, including the numbers used to calculate the estimated sample sizes.

	Effect size ηp^2	**Converted into effect size Cohen's *f***	**Correlation among repeated measures (Pearson's *r*)**	**Estimated sample size for same design (α = .006)**
Posture	.18	.47	.35	**34**
Ease of playing	.24	.56	.45	**22**
Physical discomfort (scores / sites)	.14 * / .27 *	.40 / .61	.54 / .78	**32 / 12**
Performance self-report	.13	.39	.24	**54**

*Note: these effect sizes were taken from the mixed-factorial ANOVAs which were run with the non-normally distributed data.

Based on these calculations, the results, although not significant, might be interpreted as potentially meaningful, signifying that Timani exercises could have a positive effect on violinists' posture, ease of playing, physical discomfort, and subjective performance quality. The calculated sample sizes will allow for future researchers to properly investigate these trends.

Qualitative data

Post intervention questionnaire

The post intervention questionnaire revealed that all participants experienced a positive effect from doing the Timani exercises. The biggest effects they reported experiencing can be divided into three themes: physical, musical, and psychological/kinesthetic effects. Examples of the physical effects include more freedom (‘right and left arm felt way more free’), relaxation, better posture, and easier and more efficient movement. On a musical level, participants reported easier sound production, bigger sound, and better sound projection. Lastly, comments about increased awareness, feeling grounded, and more self-confidence were grouped under the theme ‘psychological/kinesthetic effects’.

From the answers to the question ‘What effect was the most surprising to you?’ different themes emerged: effortlessness, power, and freedom. These sometimes slightly overlapped (‘How powerful I felt without exerting much effort’; ‘That I was moving less, yet felt more free’). Participants reported that the freedom they gained allowed them to create more variety in their sound or listen better. Outside of these themes, a few comments stood out. One participant mentioned feeling better contact with the string, while two others brought up connections they found surprising: the relationship between the sit bones and the arm/shoulder, and the connection between the core muscles and relaxation in playing (‘that my muscles in the belly help me to relax during playing (I always thought, they should be loose)’).

All ten participants reported learning something new in the Timani session. The most interesting thing they learnt had mostly to do with functional anatomy (‘clarifying the purposes of anatomy’), or more specifically with the sitting bones (‘how important the sitting bones are’) and the effects of feeling them on the chair (‘the relationship between myself and the earth’). Furthermore, all participants reported that the exercises were relevant to them in addressing the following themes: physical and musical aspects, and increasing their understanding. These partly overlap with the themes of the biggest perceived effects discussed above. On a physical level, participants found the exercises relevant because they improved their posture ‘in a critical but constructive way’ and made playing easier on their body, for example by helping the shoulders to relax. Musically, participants highlighted the relevance of the exercises by stating they made them sound better, helped them to play musical phrases as intended, and provided more connection to the instrument and music making. Finally, the increased understanding of the body and its functions felt relevant to both their own playing and their teaching.

All of the participants stated having learnt the exercises well enough to do them at home and could imagine doing them in the future. When asking for other effects that hadn't been mentioned, one participant reported feeling happy due to 'a direct correlation between physical well-being and psychological'. Another shared that the exercises made their posture feel unusual, leading to less ease and control and consequently lower ratings of their own playing post intervention. To finish, some participants shared some last thoughts, which were either about wanting to learn more (N=2) ('I'd be interested to learn more other exercises if just an exercise to adjust my sitting changes how I feel and play so noticeably'), or about wanting other people to learn these exercises too and feel like they did (N=2) ('I hope that every people have this feeling like me this time'). Additionally, participants expressed finding the session inspiring, helpful, and interesting (N=1 each). See Table 14 for an overview of the different themes.

Table 14. The different themes listed per question.

Question	**Themes**
Biggest effects?	Physical, musical, psychological/kinesthetic effects
Most surprising effects?	Effortlessness, power, freedom,
Most interesting?	Functional anatomy, sitting bones
Relevant because it addressed?	Physical aspects, musical aspects, increased understanding

<u>Follow-up questionnaire</u>

In the seven days after the intervention, all participants managed to do the exercises at home. More than half (N=6) reported doing them daily, one participant did them five times, and the three others practised them three times in total. Over half (N=6) of the participants stated that they found it easy to integrate the exercises into practice/playing, but one person specified that it did require the planning of extra time to fit into their schedule. Two participants described how it took them a couple of days until it got easier and how it takes time to completely implement the new coordination in concerts. Others (N=3) found it harder, partly because it required active thinking. Of those, one participant reported having had a busy week, thus finding it difficult to find time to integrate the exercises regularly, and lacking concentration while doing them. One last participant also had not had much time to practise but reported doing the exercises at work and still seeing a benefit ('Although I was only able to practise the exercises at work, I've noticed I haven't had back pain all week').

Apart from the violinist who reported a lack of time and concentration, all participants found positive effects of doing the exercises by themselves (see Figure 24). As shown in Table 15, most of them experienced benefits on multiple levels. All ten participants stated they would consider taking another Timani lesson.

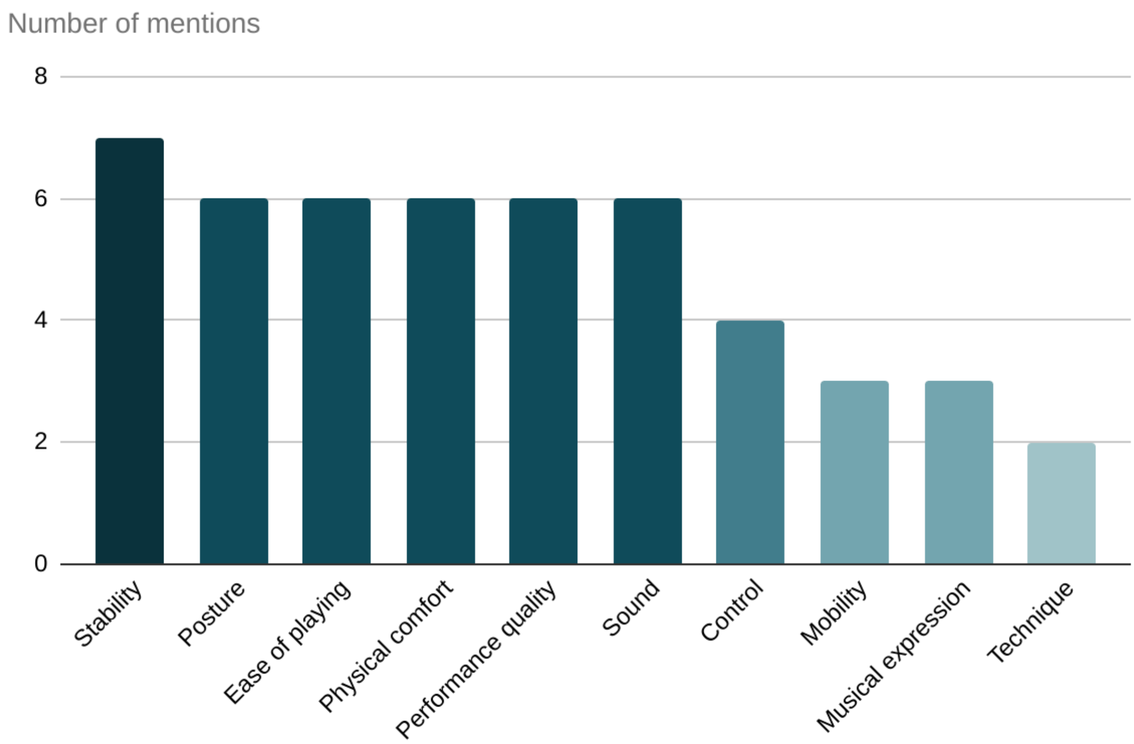


Figure 24. The different aspects in which participants experienced a positive benefit after doing the exercises in the seven days after the intervention, including how often each effect was selected.

Table 15. The reported effects categorised into the different outcome variables (levels), including how often each level was selected and how many levels were selected in total. (Note: the effects were categorised in the same way as the questionnaire items.)

Participant #	**Posture** (N = 2)	**Ease of playing** (N = 4)	**Physical comfort** (N = 1)	**Performance** (N = 3)	**Total of categories selected**
1	1	2	x	x	2
2	2	4	1	3	4
3	2	3	1	1	4
4	2	x	x	x	1
5	x	x	1	1	2
6	2	x	1	2	3
7	2	1	x	3	3
8	x	1	1	2	3
9	2	4	1	3	4

In sharing any last thoughts, participants mainly reported wanting to learn more exercises to 'discover new possibilities' and wishing other musicians to learn it too ('this work is crucial for every musician!'), similar to the post-intervention responses. Furthermore, one participant shared how to them, the exercises felt natural and intuitive:

> *'I also appreciated that it was natural, and catered to our intuition about our bodies, as it definitely didn't make me overthink playing, it made everything much more direct as an experience.'*

Lastly, mental benefits were highlighted by one other participant, stating:

> *'To focus on muscle groups that had never been pointed out to me before has been helpful, not only for my playing (bringing a new sense of physical ease), but also for my mental preparation (it is refreshing, almost a relief, to focus on something new). It has already benefited me and I am grateful.'*

In conclusion, participants experienced the intervention as relevant, interesting, and beneficial to their playing, mostly highlighting positive musical, physical, and psychological effects and an increased understanding of playing-related anatomy.

Moreover, the exercises were generally easily done without the teacher and implemented into individual practice, resulting in a positive impact on multiple aspects of their performance after the seven-day follow-up.

Discussion

This research examined the effects of specific Timani exercises on sitting posture, ease of playing, physical discomfort, and performance in professional violinists, and explored their experiences of the Timani session. Based on previous research and experience, it was hypothesised that the Timani exercises would have beneficial effects on all four aspects. This hypothesis could be confirmed with the qualitative data, but the quantitative data did not show significant effects in the small sample of this study. Nevertheless, a clear trend was apparent in the quantitative data, such that the Timani participants' sitting posture, ease of playing, physical comfort, and (self-report) performance improved descriptively more after the intervention, compared to control, illustrated by medium and large effect sizes. Blinded experts, on the other hand, rated the Timani participants marginally worse. Given the low reliability of the external evaluations, some results need to be interpreted with caution.

The qualitative data gave more insight into the experienced effects of the intervention, addressing the second research question. Participants found the intervention interesting and relevant, reporting positive effects on musical, physical, and psychological levels of their playing, including more freedom, effortlessness, and power. Moreover, participants gained an increased understanding of playing-related functional anatomy and body mechanics. Within the one-hour session, they learnt the exercises well enough to repeat them without the teacher, with most participants finding it easy to implement them into their practice. Doing the exercises at home generally resulted in positive outcomes, affecting multiple aspects of their playing related to posture, ease of playing, physical comfort, and performance.

Even though the quantitative results were found to be non-significant, the findings are worth considering, given the medium and large effect sizes and qualitative feedback. Below, the observed trends and outcomes will be discussed according to the different outcome variables.

Posture

Good sitting posture while playing was deemed very important by the participants in this study, as they thought it could influence their playing quality and comfort. However, despite stating clear ideas on what optimal sitting posture is, most participants reported getting uncomfortable while playing seated in their everyday professional life. Crucially, postural flaws were observed in all participants, corroborating findings from other studies (Araújo et al., 2009; Blanco-Piniero et al., 2015). According to one evaluator, ‘playing the musical piece amplified the playing position shown whilst playing the scale’ (Evaluator 3). This emphasises the importance of assessing posture not only while performing, as opposed to posing without the instrument (Blanco-Piniero et al., 2015; Eijsden-Besseling et al., 1993), but also of including an expressive musical piece and not merely a scale or etude, as seen in some studies (e.g., Shan & Visentin, 2003; Wolf et al., 2017). After the Timani intervention, both external evaluators and participants themselves found that playing posture had improved. The positive qualitative feedback and observed positive trends in posture are similar to the results reported in Détári & Nilssen’s (2022) study, which found that Timani can improve dynamic posture while playing.

It is important to point out that the focus of the chosen exercises was not in the first place to improve posture, but rather provide more stability and enhance function by connecting to the sitting bones and activating deep core muscles, which consequently resulted in better posture. The sitting bones (ischial tuberosities) are known to be the main points of support in a seated position (Harrison et al., 1999). As they are part of the pelvis (ischium), changing what part of the sitting bones one sits on will automatically affect the pelvic tilt (Mahadevan, 2018). In turn, since the pelvis is connected to the spine, this has a direct influence on the alignment of the spine, and of the head on top of it (Berthonnaud et al., 2005). Furthermore, activating the transverse abdominis muscle in the lumbopelvic stabilising system, one of the body’s postural stabilising systems, will increase postural stability, allowing, amongst other things, for the maintenance of proper posture while playing (Steinmetz et al., 2010). Notably, the sitting bones were brought up only twice in participants’ descriptions of good sitting posture, whereas having both feet on the ground was the most frequently mentioned. This might highlight a misconception, given that participants reported getting uncomfortable in their usual way of sitting and felt positive effects after doing the sitting exercises.

In an attempt to include more objective data, the study employed external evaluations of posture. However, these were found to be inconsistent among evaluators, as also seen in other research (Ackermann & Adams, 2004). Even though the blinding process would have reduced bias, compared to the self-report measure, evaluators' views on participants' posture were naturally still subjective. This was potentially aggravated by the fact that 'some candidates were inconsistent in their overall posture as they moved quite freely' (Evaluator 3), requiring evaluators to make a personal call on which posture to choose as the average for their rating. Further contributing to the difficulty in rating reliably is the fact that good playing posture itself is hard to define (Rousseau et al., 2023), especially in movement (Krasnow et al., 2001).

Apart from the inconsistency in the external ratings, the observed difference between the self-report scores and these ratings of posture might be due to several other factors, such as the above-mentioned fact that evaluators were blinded, and participants were not, increasing their risk of bias. Moreover, after merely one session of working on coordination and stability it would hardly be surprising for any potential changes in posture not to be easily visible, even though they might feel very different to the musician. In fact, both scores reflect separate things, as the external evaluators rated how musicians' posture *looked,* and musicians reported how their posture *felt*. Although it seemed valuable to include external evaluators in this study, the question that arises is whether self-report, i.e., how musicians feel, might be of equal or higher importance, especially given the difficulty in defining and evaluating good playing posture.

Shoebridge et al. (2017) recognised this gap between health professionals' and musicians' perceptions of posture, stating that no model of optimal playing posture existed that reconciled music performance with biomechanical concerns. They consequently interviewed music educators, physiotherapists, and Alexander Technique teachers to come up with a definition of optimal posture for musicians, combining their respective expertise. Participants in their study rejected the idea of posture as merely body position. Instead, they concurred that optimal posture can be defined as efficient coordination that allows for the best performance with minimal strain, emphasising function as its focus. This confirms Timani's approach to look beyond body positions, and instead focus on optimising function, enabling improved musical and physical outcomes.

Ease of playing

One associated quality of optimal posture is the ability to maintain ease while playing (Shoebridge et al., 2017). Even though the goal of some somatic methods is to create ease and freedom in movement (Valentine et al., 2022), not many studies have focused on ease, or effortlessness, in musicians. For example, none of the controlled trials in Klein and colleagues' systematic review (2014) used ease of playing, or a similar term, as an outcome measure. Many studies on interventions for musicians focus on playing-related pain; whilst this is crucial, it leaves other important aspects of playing out of the equation. The absence of pain does not necessarily indicate that playing feels comfortable and that one can easily express oneself. Enhancing effortlessness in playing might lead musicians, including those who don't experience pain, to achieve their performance goals more easily. It can result in increased comfort and resilience, allow movement, and free up the musician to focus on the music itself, enhancing their ability to listen (Shoebridge et al., 2017).

Along with improved quantitative 'ease of playing' scores, all of the above positive effects were reflected in the qualitative data of the present study. Interestingly, at baseline, participants reported preferring standing over sitting, as also found in other research (Spahn et al., 2019), primarily because they felt standing gave them more freedom. However, after doing the exercises, more freedom was reported as one of the biggest as well as most surprising effects. Since most violinists are required to sit during playing (Spahn et al., 2019), this is a valuable outcome.

Recruiting the deep stabilising muscles of the trunk can help avoid compensatory activation of more superficial muscles in the upper extremities, releasing unnecessary tension and allowing for freer movement (Steinmetz et al., 2010). Furthermore, embodied knowledge of functional anatomy, leading to an accurate body image, has been linked to minimising effort (Buchanan & Hays, 2014;

Valentine et al., 2021). After the session, participants highlighted learning about functional anatomy as one of the most interesting things they learnt in the Timani session, indicating an openness and appreciation for the topic. Crucially, participants in this study were not taught much about anatomy during their education, and if their instrumental teacher talked about playing-related anatomy or body mechanics, they mostly instructed them to focus on muscle relaxation.

The new awareness and coordination did not feel effortless or easy for everyone straight away, with one participant reporting it felt unusual and out of control. This phenomenon was also seen by other researchers. For example, participants in Baadjou and colleagues' study (2017), who were taught to play in a new posture, mentioned feeling odd at first, but added that the feeling diminished over time. According to Shoebridge et al. (2017), feeling 'wrong' does not necessarily mean a change is not constructive, as a new approach is likely judged based on pre-existing behavior and might just be unfamiliar at first.

Importantly, aside from the aforementioned musical and physical effects, ease of playing has been linked to a reduction in biomechanical strain, associated with decreased risk of injury (Shoebridge et al., 2017).

Physical discomfort

Results from the MPIIQM showed that 84.2% of the violinists in the present study experienced performance-related musculoskeletal pain or problems. This lifetime prevalence, as well as the point prevalence of 31.6%, appear similar to other recent studies on professional musicians using the same questionnaire (e.g., Berque et al., 2016; Panebianco, 2021). Moreover, these are within the reported ranges of 62-93% and 9-68%, respectively, of Kok and colleagues' systematic review (2016). Critically, despite reporting pain levels of up to eight out of 10 in the last week, all participants were professionally active as violinists, as per inclusion criteria. This highlights a tendency of musicians to downplay the impact of their injuries (Stanhope, 2018) and continue playing even when facing serious playing-related problems (e.g., Gasenzer et al., 2017).

All participants in this study, also those who reported no current playing-related pain, experienced physical discomfort to a certain extent while playing. This finding is hard to put into the context of other research, since not many studies investigated physical discomfort, rather than playing-related pain, in musicians. Since playing with physical discomfort is associated with increased risk of injury over time (Shoebridge et al., 2017; Stanhope, 2018), it is important to investigate. The decrease of discomfort found in this study corroborates the results of Détári & Nilssen's (2022) research on Timani.

Crucially, the chosen Timani exercises focused on activation rather than relaxation. For example, activating the back arm-line, a fascial line that includes the triceps brachii muscle, can contribute to movement and stability (Myers, 2009). By enhancing proprioception, engaging certain muscles, and increasing stability, often overworked muscles are able to relax (Baadjou et al., 2017; Steinmetz et al., 2010), leading to increased physical comfort. Chan et al. (2014) found that an evidence-based exercise program, integrating proprioception enhancement and the strengthening of muscles that can support playing, significantly reduced perceived exertion and effort while playing, linked to excess muscle tension and playing-related pain. Given that strength training, rather than relaxation techniques, were found to be most effective in preventing playing-related injury (Laseur et al., 2023), participants' own focus on physical relaxation as a strategy for warming up as well as dealing with discomfort in playing might not be beneficial.

Critically, those violinists who suffered from PRMDs reported that their pain/problems interfered with their ability to play as well as they would like, highlighting a link between physical wellbeing and performance. In fact, all the previously discussed aspects (improved posture, enhanced function and awareness, ease of playing, and increased comfort) have been linked to performance quality (Dora, 2019; Shoebridge et al., 2017).

<u>Performance</u>

Along with reported improved posture, ease of playing, and physical comfort, participants experienced better performance outcomes after the Timani session, stating they felt they could play musical phrases as intended and experienced better sound production. This feedback aligns with findings from Détári & Nilssen's study on Timani (2022), which reported that the enhanced posture and body mechanics resulted in superior performance. However, in the quantitative data, the current study found a discrepancy between perceived improvements in performance by the musicians and observers, as also seen in other research (Baadjou et al., 2017). Although participants were asked to score the performance of their second recording, their memory of how they played and felt in the session could have affected their ratings, whereas external evaluations were based solely on the recordings. This could explain the difference and can be supported by the positive feedback participants gave in their qualitative responses, reflecting on the effects on performance of the Timani exercises in general.

Additionally, it is likely that participants did not perform to the best of their ability in the post-intervention recording. Consolidating newly learnt motor skills requires repetition and time (Song, 2009), as also demonstrated by the comment of one participant who found doing the exercises easier after practicing for two-three days. Moreover, their performance could have been affected by any potential pressure they felt to execute the new movements correctly for the recording, and their ability to cope with that situation. Needing more time to implement the newly learnt coordination into performance contexts was highlighted by one of the participants at the seven-day follow-up. Other researchers thought that even a study duration of three to four months might be too short for participants to incorporate new skills into their playing in such a way that their performance could be observably improved (Klein et al., 2014).

Other potential reasons for the lower external ratings of the second recording might be that, with the focus on new sitting and bowing coordination, violinists played more out of tune or wrong notes. Although evaluators were not requested to rate intonation or note accuracy, their habitual tendency to be critical of those exact aspects might have subconsciously influenced their scores.

Generally, music performance is a complex process that is not easy to evaluate (Blanco-Piniero et al., 2017; Klein et al., 2014). Results from assessments are subjective interpretations that have been said to be more often related to the characteristics of the evaluators than to the performances themselves (Wesolowksi et al., 2015). The lack of reliability in performance ratings, as seen in this study, has been discussed repeatedly in the past (Thompson & Williamon, 2003; Waddell, 2018). Automatic assessments can be made but are often limited to assessing different qualities of sound (e.g., Dora et al., 2019; Giraldo et al., 2019). As no reliable method currently exists for rating performance in all its complexities (including timing and musical expression), we should question whether external observation is more valuable than musicians' self-assessment. Since musicians know their own playing and musical goals better than anyone else, their own judgement needs to be taken seriously.

Control group

Most of the scores of control group participants also improved after the intervention. During their intervention, they either used their own tried and tested strategies, or engaged in relaxing activities that could have increased their embodied awareness and calmed their nervous system. These might have led them to play better and feel more positive about their second performance. In turn, it is possible that their posture became less optimal (as seen in the external ratings) as they were potentially 'too' relaxed physically, lacking muscular activation for supported playing. Alternatively, being more at ease, they might have been less aware of and worried about being observed, affecting their behaviour. A similar phenomenon has been seen in a study looking at clarinetists learning a new way of sitting (Baadjou et al., 2017). Participants in the control group, who were asked to sit in their habitual way, saw their posture worsening over time, whereas the experimental group did not.

Pedagogical approach

The trends and results discussed above were observed after merely one 60-minute Timani session. Within this time, participants seemed to have learnt the exercises well enough for them to be effective when done at home without a teacher. Participants' reports of positive effects on multiple levels of their playing might be due to the interrelatedness of the different aspects (Davies, 2018). By focusing on function, Timani exercises aim for more effortlessness and enhanced performance, whilst thereby improving posture and physical comfort in playing (see Figure 25).

Figure 25. A diagram of how the different aspects might influence each other. The middle arrows (posture, comfort, ease of playing) can all be skipped separately, such that function could also affect ease of playing directly, for example.

Functional approaches like these, directly applicable and relevant to performance, have been recommended for enhancing engagement and motivation in injury prevention, including improving posture (e.g., Shoebridge et al., 2017; Stanhope, 2018). Some other methods, like Alexander Technique, usually focus on everyday tasks initially, moving onto music specific movements only later (Valentine et al., 2021). This requires that students take multiple lessons, and hence increases the risk that they lose interest. Furthermore, the 'hands-on' approach of Alexander Techniqe described by Valentine and colleagues might stand in the way of practicing effectively at home as a beginner.

Additionally, as 'challenging habits' has been stated as a major barrier to optimal posture (Shoebridge et al., 2017), principles of behaviour change ought to be included in interventions for musicians (Evans et al., 2024). Shoebridge et al. (2017) proposed several strategies for retraining movement in a way that might challenge habits effectively: 'working with and without the instrument'; 'providing alternative strategies for coordination'; 'teaching correct body mapping; and providing strategies the musician is responsible for, contributes to, and can work with independently' (p. 8). Since musicians are often not aware of their own posture, as also seen in this study, strategies need to be employed that provide cognitive as well as sensorimotor points of reference (Shoebridge et al., 2017). Timani integrates all of the above in a functional and practical pedagogical approach that has been found to be highly effective (Détári & Nilssen, 2022), combining expertise on both musical and biomechanical levels,

These pedagogical tools and their quick and positive effects on multiple levels might have motivated participants to engage with the exercises regularly for the week after the intervention and give enthusiastic qualitative feedback on the Timani intervention and exercises.

Limitations and further research

Certain limitations of this study need to be addressed. Firstly, during the running of the intervention, several mistakes occurred: in both groups, one participant needed to be recorded twice, due to technical and personal failure; one of the violinists in the Timani group forgot, and was not reminded, to take their jumper off for the second recording, making it more difficult to assess posture; and one Timani session ended up being slightly longer than the others, as the timer was not set appropriately. All of these might have affected the results in some way.

The sample presented additional limitations. To start with, it consisted of mostly women in a relatively small age range (28-45), making it harder to extend the findings to the wider population. Moreover, the limited number of participants, due to the scope of the research, might have obscured potential statistically significant results.

Some of the participants might have been aware of my connection to Timani. Although this was not discussed with participants before the intervention, any knowledge they had of my involvement with the method could have influenced their responses. The inability to blind participants in a study such as this might have led to further bias. However, since control group participants also engaged in potentially beneficial activities, this was partly controlled for.

The employment of convenience and snowballing sampling led to a non-random sample; violinists with an interest in musicians' health were naturally more likely to volunteer two hours of their time, possibly resulting in biased data. Lastly, the fact that more participants in the Timani group experienced current playing-related pain/problems might have impacted the results. However, even though they reported more pain/problems in the MPIIQM, the Timani group were found to have lower discomfort scores and a lower number of discomfort sites compared to the control group.

Other limitations can be found in the way the interventions were designed. For example, the fact that two different people ran the two groups could have affected participants. However, having the Timani teacher run the control group was thought to increase the risk of bias, and was therefore decided against. Further, since it is likely that the study attracted participants with performance-related problems or at least an interest in the topic of the research, it is possible that the strategies they had developed over the years were fully integrated and functioning well. Additionally, the Mensendieck exercises that were used by one control group participant were in some ways comparable to Timani exercises. Whilst having such a similar and strict control group intervention diminished the likelihood of identifying significant changes in the Timani participants, it simultaneously made the design more rigorous. Lastly, as not all participants engaged in exactly the same exercises or activities, it is difficult to conclude precisely what led to the observed changes. However, a typical Timani session is always tailored to the individual. Pre-choosing six exercises meant that the teacher had to stick to the plan when participants might have benefited from a different approach. Whilst not ideal, this was deemed a good compromise.

Another major flaw of the study is the way participants' playing was measured. As previously mentioned, asking Timani participants to acquire a new skill and perform it straight away under pressure did not give them the best chance to show what they learnt; they might not have managed to perform the skill at all or were so focused on the newly learnt coordination that other parts of their playing were affected negatively. This might have skewed the results in favour of the control group who did not learn a new motor skill. However, the qualitative data still give a good insight into the experiences of the intervention, aside from the recording. Challenges associated with the reliability of the external ratings have already been discussed in detail. The collection of both quantitative and qualitative data, as well as self-report data and external observations is considered a strength of the study, providing multiple perspectives as well as chances to reflect on their meanings and relevance.

In the future, researchers could consider different ways of measuring and assessing musicians' playing. This could be done by giving participants multiple attempts to record, of which one is chosen by the participants to be assessed. Alternatively, by recording the whole session and only rating participants' pre and post exercise playing, the pressure to ‘perform’ can be taken away entirely. The assessment of posture could be enhanced by including diagrams of the different postural aspects, to standardise the evaluations. Ideally, however, this process would be automised by using specialised equipment and computer software, as seen in other studies (Rousseau et al., 2023).

More research is needed to investigate the observed trends with a larger sample, including more male participants and a wider age-range. Moreover, future studies could explore the effects of Timani in other populations, using different exercises and instrument groups, and explore the long-term effects by employing a longitudinal design.

Conclusion

In an attempt to find effective ways of dealing with musicians’ musculoskeletal health, this dissertation aimed to investigate the impact of Timani exercises in a rigorous way. Even though the quantitative results showed no significant effects of the Timani session on participants’ sitting posture, ease of playing, physical discomfort, and performance, positive trends could be observed. Given the medium and large effect sizes and the positive qualitative feedback, these could be considered as potentially meaningful. Participants experienced the intervention as interesting and relevant, as it had beneficial effects on physical and musical aspects of their playing, and enhanced their understanding of playing-related anatomy and body mechanics. By focusing on function, as well as on activation over relaxation, the exercises allowed participants to improve their performance, gaining more freedom and power with less effort. Generally, the exercises were easily learnt and implemented into participants’ practice during the follow-up week, with positive effects on multiple levels of playing, highlighting the effectiveness of the pedagogical approach. The perceived relevance and positive physical and musical outcomes might have a beneficial impact on participants’ ongoing engagement with the exercises, with possible implications for the prevention and reduction of PRMDs. More research is needed to examine these trends in a larger sample, as well as to explore the long-term impact of Timani.

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Appendix I: Experimental protocol

Rough times, based on 9.30 start

Preparation: print body charts, exercise descriptions, consent forms, one PIS.

Before each participant: new questionnaire opened, hotspot on laptop, glass of water for participant and Tina/Ella, Sony and Zoom recording devices switched on, open windows for fresh air when there's time.

9.30 Participant enters, Elvira welcomes

09.35 Start questionnaire on laptop (10-20 minutes)
Elvira stays in room for questions (reading, writing in notebook)

09.50 Warm up 10 minutes
Instructions:
After warm-up there will be a knock, then a recording
Playing seated facing wall, they can adjust height of seat
Elvira leaves room, puts 10 min timer on, texts Tina/Ella for 10 min cue

10.00 End of warm-up
Tina/Ella arrives, leaves key in door, and gives Elvira phone after putting it on flight mode (after ca 30 min after start of appointment)
Elvira knocks and goes in
Instructions:
Take off jumpers/cardigans, put hair up
What to play, there will be a knock when time is up

Elvira checks if chair and stands are in their marked places. Puts phone in stand, turns on audio recorder, video camera and phone. After closing door, participant can start whenever they're ready.

10.05 Recording
Elvira puts timer on for 2 min when participants starts playing and taps on metronome to check and save their tempo for the scale.
Knock on door when 2 min+ have passed. Enter, thank them, turn off all recording devices. Participant can put violin down.

10.10 Questionnaire on laptop (3 min)
Elvira stays in room for questions

10.15 Elvira introduces Ella/Tina. Intervention (after more or less 45 min after start of appointment).
Elvira tells Ella/Tina the start time, they note it down/ set timer for end of session.
Elvira leaves, takes key.

11.10 Elvira comes back, leaves key in door again, but doesn't yet enter room (Ella/Tina can hear Elvira come back)

11.15 End of intervention. Tina gives exercise descriptions to participant. Ella/Tina come back out, then Elvira enters.
Instructions:
Take off jumpers, put hair up.
What to play, there will be a knock when time is up.
Play the metronome so participant remembers the tempo they played the first time.

Elvira checks if chair and stands are in their marked places. Puts phone in stand, turns on audio recorder, video camera and phone. After closing door, participant can start whenever they're ready.

11.20 Record again
Elvira sets 2 min timer when participant starts playing. Knocks and goes in after 2+ minutes. Takes phone from stand and gives back to Ella/Tina.

11.25 Ella/Tina can go, take key (until ca 30 min after start new appointment, there will be a 10 min cue by text)
Questionnaire 2 (3 min)

11.30 Control group: end and chat. Timani group: questionnaire 3 (ca 5 min) and chat.

11.45 start over

At end of day:
Charge video camera if necessary, check if Zoom has enough battery power, transfer recordings to laptop, open windows for fresh air.

Appendix II: Questionnaires

QUESTIONNAIRE 1 (< 5 minutes)

Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians MPIIQM - adapted

1. What is your age? ____________ years

2. Gender:
0 Male
0 Female
0 Prefer not to say
0 Other _______

3. What is your nationality?

4. For how many years have you played your instrument? ______________ years

5. On average, how many hours per week do you spend playing the violin?
__________________ hours per week

6. You are a violinist, what is your main job activity?
0 Mainly performing in orchestra
0 Mainly performing chamber music
0 Mainly performing as a soloist
0 Mainly teaching
0 Other ________

7. Are you a freelancer?

0 Yes 0 No

Playing-related musculoskeletal problems are defined as "pain, weakness, numbness, tingling, or other symptoms that interfere with your ability to play your instrument at the level to which you are accustomed". This definition does not include mild transient aches and pains.

8. Have you ever had pain/problems that have interfered with your ability to play your instrument at the level to which you are accustomed?
0 Yes 0 No

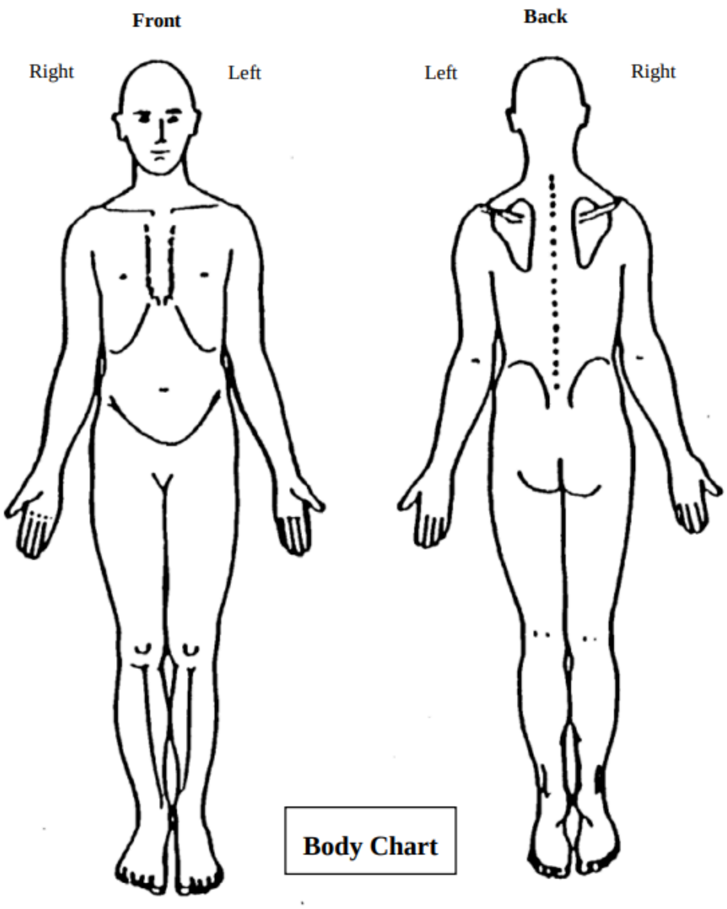
9. Have you had pain/problems that have interfered with your ability to play your instrument at the level to which you are accustomed during the last 12 months?
0 Yes 0 No

10. Have you had pain/problems that have interfered with your ability to play your instrument at the level to which you are accustomed during the last month (4 weeks)?
0 Yes 0 No

11. Currently (in the past 7 days), do you have pain/problems that interfere with your ability to play your instrument at the level to which you are accustomed?
0 Yes 0 No

If your answer to questions 8 and/or 9 is YES, please continue. Otherwise stop here, and hand your survey back.

12. On the body chart, SHADE IN each of the areas where you experience pain/problems. Put an X on the ONE area that HURTS the most.



The next four questions relate ONLY to PAIN.

Please answer with reference to the ONE area that you marked with an X on the body chart. Otherwise go to Question 15.

13. Please rate your pain by circling the one number that best describes your pain at its worst in the last week.

0 1 2 3 4 5 6 7 8 9 10

No pain Pain as bad as you can imagine

14. Please rate your pain by circling the one number that best describes your pain at its least in the last week.

0 1 2 3 4 5 6 7 8 9 10

No pain Pain as bad as you can imagine

15. Please rate your pain by circling the one number that best describes your pain on average in the last week.

0 1 2 3 4 5 6 7 8 9 10

No pain Pain as bad as you can imagine

16. Please rate your pain by circling the one number that tells how much pain you have right now.

0 1 2 3 4 5 6 7 8 9 10

No pain Pain as bad as you can imagine

The remainder of the survey relates to both PAIN and/or PROBLEMS.

For each of the following, circle the one number that describes how, during the past week, pain/problems have interfered with your:

17. Mood

0 1 2 3 4 5 6 7 8 9 10

Does not interfere Completely interferes

18. Enjoyment of life

0 1 2 3 4 5 6 7 8 9 10

Does not interfere Completely interferes

For each of the following, during the past week, as a result of your pain/problems, did you have any difficulty (please circle ONE number):

19. Using your usual technique for playing your instrument?

0 1 2 3 4 5 6 7 8 9 10

No difficulty Unable

20. Playing your musical instrument because of your symptoms?

0 1 2 3 4 5 6 7 8 9 10

No difficulty Unable

21. Playing your musical instrument as well as you would like?

0 1 2 3 4 5 6 7 8 9 10

No difficulty Unable

<u>Open questions</u>: (<10 minutes)

1a With which of these somatic methods, if any, do you have any previous experience?

Multiple answers possible

0 Alexander Technique

0 Feldenkrais

0 Mensendieck

0 Body Mapping

0 None (go to Q2)

0 Other...

1b If you selected one or more methods, how long did you practice the method(s) for?

1c What is the most important thing you learnt?

2a Have your instrumental teachers taught you about the body mechanics and/or anatomy related to your playing and instrumental technique?

0 Yes 0 No (go to Q3)

2b If so, what is the most important thing you learnt?

3a Has anyone else during your education taught you about the body mechanics and/or anatomy related to your playing and instrumental technique?

0 Yes 0 No (go to Q4)

3b If so, what is the most important thing you learnt?

4a Do you do any sports?

This can include low impact exercise like chi gong, tai chi, yoga.

0 Yes 0 No (go to Q5)

4b If so, what do you do and, on average, how many times per month?

4c Do you think it helps with your playing in any way?

0 Yes 0 No (go to Q5)

4b If so, in what way?

5a Do you do anything to physically prepare (i.e., warm up) for playing?

0 Yes 0 No (go to Q6)

5b If so, what do you do and why?

6a If you experience tension or discomfort in your shoulders or arms during and/or after playing, do you have any strategies for dealing with it?

0 Yes

0 No (go to Q7)

0 I don’t experience tension or discomfort in my shoulder or arms during and/or after playing (go to Q7)

6b If so, what are your strategies

- **during playing?**

Open text box: ___________

0 None

- **outside of playing?**

Open text box: __________

0 None

7 What part of your body, if any, do you usually focus on when you practise or perform?

Open text box:

0 None

8a How would you describe good sitting posture in playing?

8b How aware are you of your own sitting posture while playing?

1 2 3 4 5

Not aware at all Very aware

8c How important is it to you to have good sitting posture while playing?

1 2 3 4 5

Not important at all Very important

9a Do you sometimes get uncomfortable sitting while playing?

0 Yes 0 No (go to Q10)

9b If so, after how much time sitting, on average, do you start getting uncomfortable?

10a Do you expect that your sitting posture and postural stability can have an impact on performance quality and/or playing comfort?

0 Yes 0 No (go to Q11)

10b If so, in what way?

11a Do you have a preference for sitting or standing while playing?

0 Yes 0 No

11b If so, what do you prefer and why?

QUESTIONNAIRE 2 for Pre – Post intervention (< 3 minutes)

Related to your playing just now, how do you rate:

Using a sliding scale

____

I I I

Very poor Neutral Very good 0 I don't know

1. Your playing posture?
2. Your feeling of postural support/stability?
3. Your feeling of postural mobility?
4. Your feeling of control in playing?
5. The efficiency of your movements?
6. The mobility in your shoulders and arms?
7. General ease of playing?
8. The relaxation and weight of your bow arm?
9. The quality and control of your bow changes?
10. The quality and control of your sound?
11. Your sound projection?
12. Your dynamic range?
13. Your ability to produce a powerful sound without excessive muscle tension?
14. Your ability to musically express yourself as you intended?
15. The overall quality of your performance?

On a sliding scale from 0 (none) to 100 (severe), how much discomfort did you feel in your:

Shoulders

right / left

Neck

right side / left side

Arms

right / left

Back

upper / lower

QUESTIONNAIRE 3 (only for the Timani group) (< 10 minutes)

After the intervention, right after Questionnaire 2

1a Did you experience any effect from doing the exercises?
0 Yes 0 No (go to Q2)

1b If so, what was the biggest effect you noticed?

1c What effect was the most surprising to you?

2a Did you learn anything new?
0 Yes 0 No (go to Q3)

2b If so, what was the most interesting thing you learnt?

3a Were the exercises relevant to you?
0 Yes 0 No (go to Q4)

3b If so, in what way?

4 Do you feel like you learnt the exercises well enough to repeat them by yourself (with the help of a written description)?

0 Yes 0 No

5 Can you imagine using the exercises in the future?
0 Yes 0 No

6 Were there any other effects of the intervention that haven't been mentioned in this questionnaire?

7 Is there anything else you would like to share about this experience?

QUESTIONNAIRE 4 (only for the Timani group, follow up after seven days) (< 5 minutes)

1 How often did you do the exercises?

2 How easy was it to incorporate the exercises into your practice/playing?

3a Did you notice any positive effects of doing the exercises?
0 Yes 0 No

3b If so, select on which aspect of your playing you felt a positive effect:

Multiple answers possible

0 Sound

0 Ease of playing

0 Posture

0 Stability

0 Control

0 Mobility

0 Musical expression

0 Technique

0 Physical comfort

0 Performance quality

0 Other...

4 Would you consider taking another Timani lesson in the future?
0 Yes 0 No

5 Is there anything else you would like to share?

QUESTIONNAIRE 5 for the external panel looking at posture

Adapted from Blanco-Piniero et al. (2015)

On a sliding scale, how do you rate:
e.g. Overall posture:

____

Rigid	Physiological	Slumped

1) Overall posture

- Rigid: tense, with excessive muscular rigidity and forward pelvic tilt.

- Physiological: 1) maintenance of the spine, and of the head-trunk unit, along the vertical axis through the centre of gravity 2) total freedom of the arms to play the instrument.

- Slumped: spine curving forward, chest sunken, with backward pelvic tilt.

2) Location of the axis of gravity in a sagittal plane

- Forward-shifted: the weight of the sitting body on the back of the legs, in front of the ischium.

- Physiological: the weight of the body rests on the ischium.

- Backward-shifted: the weight of the sitting body behind the ischium.

3) Pelvic attitude

- Forward-tilted: exaggerated lumbar curvature (hyperlordosis), with hypotonic abdomen and buttocks; the pubis lies below the anterior iliac spines.

- Physiological: the pubis and anterior iliac spines lie in the same horizontal plane.

- Backward-tilted: reduced lumbar curvature, the pubis lying above the anterior iliac spines.

4) Dorsal curvature

- Excessive: back hunched, with excessively separated shoulder blades.

- Physiological: respectful of the natural curvature of the spine.

- Insufficient: back flat, with excessively close shoulder blades.

5) Alignment of the head in sagittal planes

- Forward: neck and face pushed forward.

- Physiological: neck muscles relaxed, head well balanced on the spine.

- Backward: neck stretched, generally with chin tucked in, compressing the throat.

6) Frontal plane of the shoulders

- Forward: the frontal plane containing the shoulders is brought forward, separating the shoulder blades excessively.

- Physiological: shoulders in line with the trunk.

- Backward: shoulders brought back, shoulder blades too close together.

7) Transverse plane of the shoulders

- Shrugging: shoulders raised towards the ears, trapezius, levator scapulae and rhomboid muscles contracted.

- Physiological: shoulders relaxed, respecting the natural distance between shoulders and ears.

- Sloping: shoulders pressed down, downward rotation of the scapulae.

8) Lateral tilt of the shoulders

- Tilted: left shoulder higher than the right.

- Physiological: both shoulders in the same transverse plane.

- Tilted: right shoulder higher than the left.

QUESTIONNAIRE 6 for the external panel rating performance:

On a sliding scale from 0 (very poor) to 100 (outstanding), how do you rate:

1. Sound quality (incl., resonance, control, consistency)
2. Musical expression (incl. musical direction/phrasing, dynamics)
3. Timing, rhythm, articulation

Appendix III: Ethical approval

ROYAL COLLEGE OF MUSIC London

Royal College of Music Research Ethics Committee

CERTIFICATE OF APPROVAL

This certificate confirms that the application made by

Elvira van Groningen
Dr Anna Détári

to the RCM Research Ethics Committee was **APPROVED.**

Project title:

Exploring the effects of specific Timani exercises on sitting posture, performance and perceived ease of playing in professional violinists, and examining their experience of the intervention.

Date approved: 03.05.2024

Signed: Date: 03.05.2024

Dr Mary Stakelum
(Chair of RCM Research Ethics Committee)

Reference number: 240316

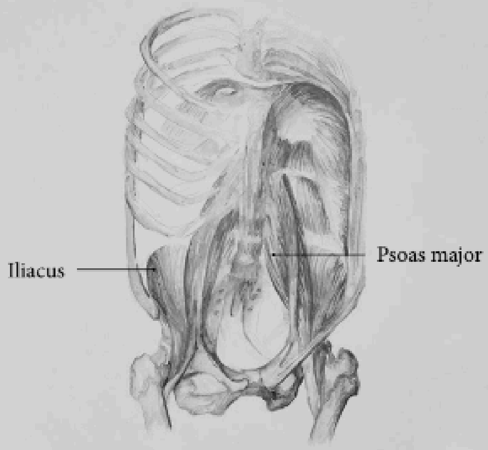
Appendix IV: Timani exercise descriptions

From: Nilssen, T. M. (2021). *Unleashing the potential of the musician's body.* GIA Publications, Inc. Shared with permission.

2. The iliacus exercise–an easier way to access pelvic alignment

The iliacus muscle lies deep in the body. It covers the inside of the hip bones like a fan (***Figure 10-2-1***) and is one of the body's main hip flexors. In our modern society, we spend a lot of time sitting. That means our hips are in a flexed position for many hours every day. Despite this, we often struggle to properly flex the hip joint, and, in my experience, many people become increasingly slumped as they age, partly because of this. When we lack control of our hip flexion, this movement can be quite uncomfortable and cause strain if we try to sit in a good position while playing or singing. Musicians often get tired in the middle of their backs, trying to hold themselves upright. When we slouch, our hip is less flexed than when we sit upright, and we lose the benefits of accessing the full function of both our pelvic position and the muscles involved in creating it.

Figure 10-2-1.



The purpose of the iliacus exercise is to develop our hip flexion so it feels more natural to choose a better sitting position without strain. This requires good function and strength in the iliacus muscle; it needs to be able to provide support and good proprioceptive input from the hip joint, combined with allowing the body to release unnecessary tension in the joint at the same time.

This exercise can also improve our standing posture, since we, as musicians, often have our hips too far forward when we stand, which results in passive lengthening of the hip flexors (including the iliacus). This changes how gravitational forces affect the body. You'll see more on hip alignment in the standing like a mountain exercise in Chapter 11 on standing.

If this exercise is too difficult because of the angle of the hip joint, you can widen the angle by sitting on a higher chair, or put a stack of books on your chair. As you progress, you can eventually sit at the height where you normally play. I recommend keeping the angle in the hip joint no less than 90 degrees when playing your instrument. This means keeping the knees at the height of your hip joint or lower so the blood flow and nerve signals to the legs and feet aren't restricted as you play or sing.

Figure 10-2-2

Figure 10-2-3

Figure 10-2-4

Step by step:

1.
Sit on your sit bones (see the previous exercise, finding your sit bones, for placement), not too far back on the chair, with your knees and legs parallel and your feet flat on the floor (***Figure 10-2-2***). It's important to practice this exercise with the thighs pointing straight ahead (to target the right muscles), but you can adjust your leg position to what feels more natural for you when you go to play.

2.
Put your right hand on your right iliac crest (the upper part of the hipbone, ***Figure 10-2-3***) and your left hand on the spinous processes of the lumbar spine—the small bony protrusions sticking out from the spine in your lower back (***Figure 10-2-4***). Keep your hands in this position throughout the whole exercise so you can feel if there's any movement there as you start lifting the leg (***Figure 10-2-5***).

3.
Lift your left leg, making sure the pelvis and spine stay in exactly the same position throughout the exercise. If you can, lift the leg to 30 degrees above horizontal (***Figure 10-2-6***).

4.
Slowly put your left leg down and repeat three to five times.

5.
Then, keep your hands in the same position and lift your right leg—again making sure your pelvis and spine don't move as you lift, and repeat three to five times, very slowly. Your leg should feel heavy if you're using the right muscles to lift.

Figure 10-2-5

Figure 10-2-6

Figure 10-2-7

Tips and tricks:

- Make sure you're not compensating with any movements of the pelvis or spine. This could be leaning to one side when lifting the leg, rotating the pelvis, or tilting the pelvis backward by flexing the spine as you lift the leg. The purpose of holding your hands on those two points is to be sure this isn't happening.

- Also, look at your leg to make sure it doesn't rotate—the knee moving out and the foot moving in (***Figure 10-2-7***). If you rotate, you'll primarily engage other muscles than the iliacus muscle.

- To help with lifting the leg higher: Use your hands to help passively lift your leg to the end of your range of motion (***Figure 10-2-8***), release the hands slowly, and slowly lower the leg; this strengthens the iliacus eccentrically. That means the muscle is active but releasing gradually. When you master this, you can add some extra resistance as you lower the leg by pushing against the thigh as you gradually release it down (***Figure 10-2-9***).

- Make sure your pelvis and spine stay in exactly the same position throughout the exercise.

- Keep your thighs parallel. If your legs are more than hip-width apart, you'll be using other muscles and not primarily strengthening the iliacus.

- If the exercise is too hard to do—meaning you can't lift your leg without any compensations—try to sit higher to increase the angle in your hip joint (***Figure 10-2-10***).

Figure 10-2-8

Figure 10-2-9

Figure 10-2-10

After doing the exercise, try this: First, just slouch in your chair. Then move from the slouched position to sitting up straight—not by tilting the pelvis forward but by engaging the back muscles and pushing the breastbone upward. Can you feel how this restricts your breathing and how tiring this position would be after just a few minutes? Now try to move from the slouching position by tilting the top of the pelvis forward so the spine effortlessly follows; the result is in an upright posture without overly tensing the back muscles.

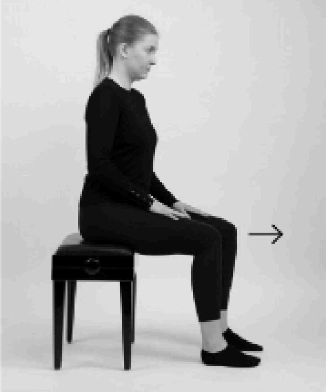
3. Sitting shuffle

As musicians, we need stability, support, and power as well as relaxation to play and sing. When we get support from the right places in our body, we tend to *feel* more relaxed, even though we're still using muscles to hold ourselves upright to play. If we're playing technically demanding repertoire, music with high intensity of emotion, or pieces with big jumps or quick changes, we usually need more support or muscular engagement. It's possible to get it by actively using the contact between the chair and the sit bones, which is what you'll learn in this exercise. The sitting shuffle exercise[56] also gives proprioceptive input to the brain, which improves general coordination. Many musicians experience mental benefits and less stress—including in concert situations—when they get more signals from the body about its contact with a surface (for example, a chair) because proprioception and exteroception are improved. Personally, I use this to focus at the beginning of a concert if I need to calm down.

Figure 10-3-1.

Figure 10-3-2.

Figure 10-3-3.



Step by step:

1.
Sit firmly on your sit bones on a level, hard surface, such as a classic piano stool (like we worked on in the finding your sit bones exercise) (***Figure 10-3-1***).

2.
Push your left knee straight forward (***Figure 10-3-2*** and ***10-3-3***), then the other, back and forth about 10 times with one or two seconds on each sit bone at a time. This should create a movement of the pelvis where you're taking turns rotating one side of the pelvis forward and then the other.

3.
Feel how the movement pushes the sit bone down and your upper body upward to sit tall. When you're pushing one knee forward, you want the sit bone on the same side to dig into the chair; as a result, you want to see a lengthening of your spine upward from that point.

4.
Let the body follow naturally without actively moving the torso.

5.
After going back and forth 10 to 12 times, stop the movement and sense into how it feels to sit now. Do you feel more weight on the chair and more contact between the sit bones and the surface of the chair?

Implementing the sitting shuffle into your playing

- Find your favorite sit bone (the one you feel most comfortable sitting on). Move and hold the knee on the same side forward (without tensing up in the hip joint) so your preferred sit bone digs into the chair (***Figure 10-3-2***).

- Lift your instrument or arms and feel the extra weight in this sit bone created by that movement.

- Do the same with your other sit bone and see how that feels.

Figure 10-3-4. Top
Figure 10-3-5. Bottom

. While playing, go back and forth slowly—maybe a bar of music per leg to begin with.

. See if you can use this movement to create the phrasing and sound you want. Imagine that the musical initiative can come from the sit bones (***Figure 10-3-4***) instead of tensing up and stabilizing in other areas of the body (like the shoulders) or by leaning back (***Figure 10-3-5***) or by pushing the ribs forward by tensing up the muscles along the spine.

. As you get used to actively engaging the sit bones, allow your body to naturally express the music, with gestures and movements starting from the sit bones rather than, for example, flexing and extending the spine alone. This way, it won't be a separate movement but a part of your overall expression.

Advanced

. Instead of pushing the knees forward, focus on slightly increasing the contact between the chair and the sit bones, either one by one or both at the same time, without necessarily performing the full movement of pushing the knee forward.

. Feel your body rising up from the sit bones.

. Try this while playing.

. To avoid excessive tension in the hip, loosen your hip joints by swinging your knees out to the side and back inward a few times.

1. The bottle exercise

This exercise is an excellent way to gain a better sense of weight and relaxation in the arm. Musicians sometimes hold tension in the shoulders and arms unconsciously and, therefore, can't consciously let it go. Through this exercise, your body can become more accustomed to letting this tension go, and you can start accessing the full weight of your arm on a regular basis. This will be beneficial in playing your instrument by creating a greater sense of relaxation and weight in your shoulders and arms, without losing the strength in your fingers.

By having you focus on holding the bottle firmly while moving your wrist, this exercise is great for differentiating between activating the hand and finger muscles and, at the same time, having a flexible wrist. Use a bottle that's small enough for you to get a good grip on it.

Figure 12-1-1.

Figure 12-1-2.

Figure 12-1-3.

Step by step:

Note: Do this with a friend/colleague/teacher

1.
Sit on a chair while your friend stands beside you holding a bottle. Sit in an active but effortless position on your sit bones, as if you were preparing to play your instrument.

2.
Grab the bottle with one hand and wrap your palm around it, making sure the base of your hand is in contact with the bottle, too (***Figure 12-1-1***), not just your fingers and mid-palm (***Figure 12-1-2***). It might help to have your thumb pointing slightly upward to get a better grip.

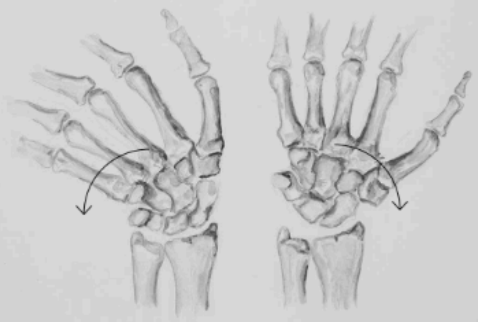
3.
Have your friend hold the top part of the bottle and lift it up. As they do so, allow them to carry the weight of the bottle and your arm. You should maintain your grip with your hand while relaxing all the muscles in your shoulder and arm.

4.
Have your friend move the bottle gently and easily in different directions (***Figure 12-1-3***). Don't resist the movement or assist your friend in moving the bottle. If you do that, your friend will notice your arm becoming stiff (resisting) or lighter because it's unconsciously trying to help with lifting the bottle (assisting). Try to relax your arm more and more, allowing the movements that your friend is doing by moving the bottle around gently. See if you can sense the weight in your arm.

5.
Your friend can test the relaxation in your shoulder by moving the bottle higher and lower, to the front, and to the side of your body. The bottle should be moved slowly, and no movement should be forced.

6.
Have your friend test your elbow by moving the bottle so that your elbow flexes and extends. Then they can test your wrist by creating a sideways movement (***Figure 12-1-4***)—not up and down, as this can be uncomfortable—while you keep a firm grip on the bottle.

Figure 12-1-4.



7.
See if you can stay relaxed all the way through this exercise without losing your grip.

8.
After one or two minutes (or more if you prefer), let go of the bottle, stand up, and sense the difference between your arms. Then do this exercise with the other arm.

9.
After doing both arms, play your instrument and enjoy the relaxed feeling.

Advanced

If you have wrist tension or pain in your lower arm, releasing the wrist can be extra important. Do the exercise, and see if your wrist is able to move freely even when your palm is glued to the bottle with a firm grip. You can have your friend focus on this specifically.

3. Back arm-line push-off

This exercise offers a way to become familiar with the activation of the fascial connections going from the outside of the hand through the back of the arm to the shoulder blade. This can provide clarity about where we want to feel a connection when playing the drums, bowing, pressing a key, or even lifting our instrument. We tend to think that we only need gravity to do some of these actions, or that just being heavier in our arm should do the trick. But that's not the case. Playing an instrument requires a tremendous amount of movement control.

Gaining awareness of the muscles that extend the elbow and shoulder joints helps balance movement of the arm, so that flexion patterns don't become too dominant in your playing coordination. These extending muscles can be active and contribute even when your arms and fingers are in a flexed position. I've often observed that this exercise can loosen up a stiff or held arm and allow more access to weight, as well as increase speed, power, and sound control.

If you use your "back arm-line" (the chain of muscles that are functionally connected in the outside/back of the hand, arm, and shoulders) to push away from a surface, you'll see that the action of connecting to the surface—and, ultimately, the instrument—can help you to prevent a hunched back or head-forward pose; therefore, you can sit or stand aligned in a more effective and effortless way. The push-off connects you to the natural movement you were born to use: A combination of push-off and a sense of weight was what made you able to rise up off the floor and move as a toddler. Regaining this ability at your instrument might change your perception of contact with your instrument; this may provide more options for sound production, more access to effortless power, and increased endurance.

Step by step:

1.
Sit on a chair.

2.
Place the outside of your left hand (pinky side down, palm facing in toward the midline) on your thigh or a table (***Figure 12-3-1***). Grab your chest muscle (pectoralis major) with your right hand (see ***Figure 12-3-2*** for location of the chest muscle in your front armpit). Feel that the chest muscle remains as soft as possible throughout the exercise.

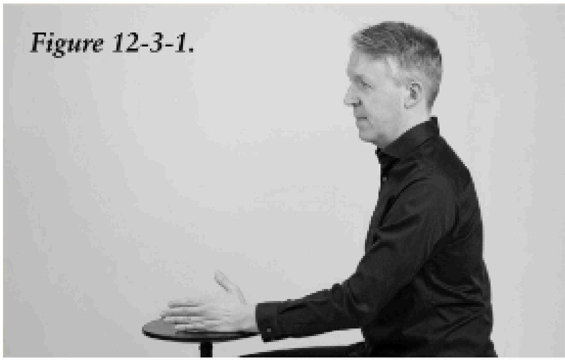


Figure 12-3-1.


Figure 12-3-2.

3.
Extend (unbend) your elbow slowly so the side of your hand pushes into the surface without moving in any direction, simply applying pressure to the surface.

4.
This pressure can either go in one direction, as a pressure that's pushing down into the surface, or it can be a push-off, where the force moves in two directions: into the surface AND up into the shoulder. This push-off is what we want to achieve. It might require some adjustments to your coordination. It can feel as though the shoulder is pushed slightly backward and up, as if you're pushing yourself away from the surface (***Figure*** **12-3-3**). Make sure that the shoulder doesn't press down (***Figure*** **12-3-4**).


Figure 12-3-3.


Figure 12-3-4.

5.
You want to be able to properly let go of tension in your chest muscles to allow your shoulder to move slightly upward. This isn't lifting the shoulder but comes from the two-directional forces created when the hand pushes into the surface. Once you've mastered that, you can experiment with decreasing this movement while still being aware of where the forces go, so you activate the same muscles but don't go as far with the shoulder.

6.
To become even more aware of what happens during this activation, use your opposite hand to feel the triceps activating on the back of the upper arm.

7.
When playing, give the triceps some attention and use it to get a sense of push-off from your instrument—for example, from the bottom of the key in loud chords, the bow against the string, the contact between the drumstick and the drum, or as you lift your wind instrument by "pushing it up" instead of lifting it (but without too much force).

8.
Make sure your awareness doesn't make you tense up your arm unnecessarily but rather allows you to access a more effortless power source. Work on the balance of weight and relaxation in your arm in combination with the activation of the push-off. In the beginning, you may experience that you use too much force, which is very common. It can take a few attempts to find the right amount of activation.

Advanced

As you do the exercise, try directing the forces so you can feel a connection all the way to your spine and down to your sit bones, feeling the forces in your sit bones (or even down to your heels if you're standing) every time you push your hand into the surface.

2. Transverse abdominis differentiation

These are specific awareness exercises for the transverse abdominis muscle that can help it regain its natural function and, therefore, contribute to better overall coordination. The transverse abdominis muscle should be able to gradually contract so that we can gain control of it and avoid tensing it up too much when it's not necessary. This exercise can be done either lying down, sitting, or standing. It might initially be easier to do this as a seated exercise because gravity will pull the belly out, and this makes it easier to see if you're relaxing or contracting the muscle. Do what feels best for you. The activation itself is the same as in the belly up and down exercise that you just did. But, in the lying down version, your body will be in a different position, so gravity will pull your viscera downward and decrease the movement you're able to observe as you activate the muscle. It's an advanced exercise that requires concentration and patience.

This exercise will help you to:

. Stimulate the natural anticipatory effect of the transverse abdominis muscle, so it activates to stabilize the torso just before a movement happens.

. Keep good air flow (for singers and winds) and support behind the musical expression (for all instruments) in a healthy way that avoids excessive tension in the shoulders, arms, throat, and embouchure.

. Differentiate the transverse abdominis from the rectus abdominis. We still use the rectus abdominis, but we need to have awareness of the difference between these two muscles to control the contraction in the transversus abdominis and get the most out of it when playing or singing.

. Train the transversus abdominis to activate in both inhalation and exhalation, rather than just in exhalation. Separating it from the breathing cycle will benefit our overall stability and ability to move with ease.

Step by step:

Lying down:

1.
Lie on your back with your knees straight or bent, whatever's most comfortable for you.

2.
Find the anterior superior iliac spine (ASIS—the most prominent bone on the front of your pelvis/hip bone—***Figure 14-0-4***) and put two fingers in the soft area of the belly just inside of it (about 1 cm or ½ inch toward the midline). This is where the transverse abdominis is most easily felt (***Figure 14-2-1***).

Figure 14-2-1.

3.
Press the two fingers into the belly close to your ASIS. This is to sense the activation of the muscle as soon as you do the exercise.

4.
Rest the other hand flat just below your navel without pressing down so you can feel what's going on in this area. You want to make sure that the belly is never pushing out but remains flat or even slightly drawn in during the different phases of the exercise. You can put a pillow under the elbow to support the arm if it's not resting comfortably on the floor in this position.

Part 1–Finding the "volume control"

1.
Relax completely in the belly.

2.
Draw your navel toward your spine by activating the transverse abdominis muscle, which you can sense as a slight contraction/hardening of the muscles under the two fingers near the ASIS. It will be as though these two fingers are being pushed out (make sure the belly button area under your flat hand isn't being pushed out, as this would put unhealthy pressure on your viscera).

3.
Gradually increase your activation of this muscle from 0% to 10% to 20% to 30%, etc., all the way to 100%, and then slowly release it to 0% again. When you're between 40% to 100%, you'll feel more of the other abdominal muscles joining in, including the rectus abdominis. Perform this only once or twice to simply get familiar with the whole range of the "volume control."

4.
Try to avoid compensations, such as lifting the chest up, tilting the pelvis, pulling the ribs down, or pushing the belly out.

5.
Keep breathing, even when the transverse abdominis is active.

Part 2–Training differentiation

1.
To exercise the lower end of the muscular engagement, activate the transverse abdominis muscle at around 20% to 30% of its maximum force (which you explored in Part 1 of this exercise) and hold for 10 seconds.

2.
Remember to breathe.

3.
Release the activation slowly and relax the muscle completely for five seconds.

4.
Repeat five times.

5.
If breathing is difficult while you're doing this, do the belly up and down exercise for a while first, or reduce how much you're activating the transverse abdominis.

Advanced–Strengthening and stabilizing

1.
Lie on your back with the soles of your feet on the floor and knees bent (***Figure 14-2-2***).

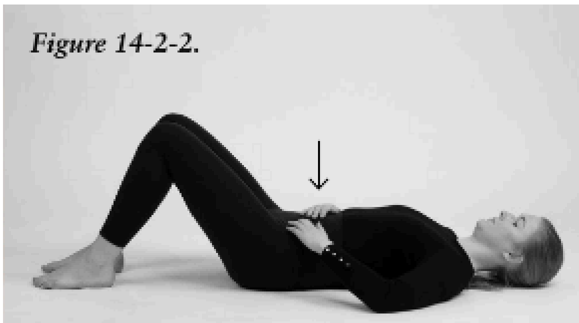


Figure 14-2-2.

2.
Find the ASIS and put two fingers in the soft area of the belly just inside of it to locate the transverse abdominis.

3.
Press in with your fingers to sense the activation of the transverse abdominis throughout the exercise.

4.
Place the other hand just below your navel without pressing. You can put a pillow under the elbow to support the arm if it's not resting comfortably on the floor in this position.

5.
Activate the transverse abdominis between 80% and 100% by slowly and gradually pulling the navel toward the spine (hollowing), as in Part 1.

6.
Lift one leg at a time approximately 5-10 cm (2-4 inches) up toward the ceiling, keeping your pelvis as still and stable as possible (***Figure 14-2-3***).

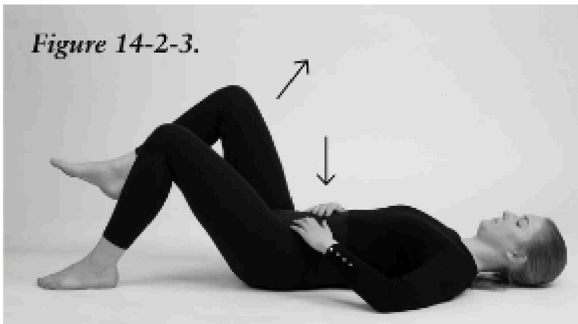


Figure 14-2-3.

7.
Make sure your pelvis doesn't tilt sideways, backward, or forward as you lift your leg (by activating the transverse abdominis and other abdominal muscles), and make sure the back of the whole ribcage is in contact with the floor. The aim is to keep the entire torso stable, and the only movement is in the hip joint.

8.
It's important that you make sure that the belly isn't bulging out as you lift, as this will indicate dominance in the activation of the diaphragm or rectus abdominis muscle instead of the transverse abdominis, which is the goal of this exercise.

Sitting:

1.
Find the ASIS (***Figure 14-0-4***) and put two fingers in the soft area of the belly just inside it/toward the midline (about 2 cm or 1 inch). This is where it's easiest to feel the transverse abdominis (***Figure 14-2-4***).

2.
Press in with the fingers.

3.
Place your other hand flat just below your navel without pressing.

4.
Release your belly out. It should feel loose and relaxed under your two fingers (***Figure 14-2-5***).

5.
Draw your navel in by activating the lower part of the transverse abdominis by about 20% to 40% and breathe normally (***Figure 14-2-6***).

6.
Relax your belly out for a few seconds.

7.
Activate the transverse abdominis again for 10 seconds while breathing normally, and then relax once more.

8.
Repeat up to ten times.

Figure 14-2-4.

Figure 14-2-5.

Figure 14-2-6.

Tips and tricks:

- **Seated shuffle variation**
  See the first of the "experiments for everyone" later in this chapter to learn how to use this muscle when playing seated.

- **Iliacus variation**
  Think about engaging the transverse abdominis muscle before you lift the leg when doing the iliacus exercise that you learned in Chapter 10.

- **Back arm-line push-off and differentiated arm-pull**
  Try to feel how you can access the transverse abdominis muscle through the back arm-line push-off and differentiated arm-pull exercises (Chapter 12). When pressing into the object or table or pulling the arm down against resistance, notice that the belly button draws in naturally automatically. If this doesn't happen automatically, you can encourage this connection and then see how this can be transferred to your instrument. The same goes for lifting the arms. The moment you begin to slowly lift them, see if you can notice a slight activation of the transverse abdominis, and use this as you start playing.

- **Standing**
  You can also do this exercise in a standing position and link the activation down to your feet. Relax your belly out. Then, slowly pull your navel in using the lower part of the transverse abdominis at about 20% to 40% activation (***Figure 14-2-7***). Keep this activation while pressing one foot and then the other into the ground. Can you feel a connection between pressing the foot into the floor and the activation of the transverse abdominis? Try to feel the connection between the push-off from the ground and your transverse abdominis muscle. You can even try this while walking on your heels.

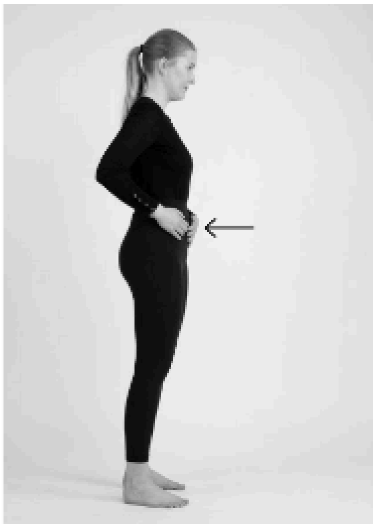


Figure 14-2-7.

Tips and tricks:

- **A simple way to access the transverse abdominis muscle**
  You can use the whole-body bouncy exercise in Chapter 11 as a quick way to naturally tune into the activation of the transverse abdominis. Put two fingers on the soft belly inside the ASIS and feel the activation of the muscle when you jump. Consciously maintain this light and natural engagement while lifting your instrument to play or preparing to sing. Don't over-tense the muscle but allow it to activate comfortably.

- Make sure your navel doesn't push outward when you try to activate the transverse abdominis. It should pull in slightly or remain in the same place. If your navel moves outward, it's an indication of activation of the diaphragm and/or the rectus abdominis muscle, not the transverse abdominis.

- Don't suck your belly in, and watch out that your chest doesn't move upward. Watch out for a hollowing of the abdomen accompanied by a lack of activation in the transverse abdominis. This is an unhealthy way to hold the body, as it creates high breathing.

- Make sure you can breathe freely throughout the exercise. If this is difficult, try activating less or do the belly up and down exercise instead.

- Avoid tilting the pelvis in any direction.

- Keep your hips aligned and not moving forward in the standing version of this exercise.

- If your ribs move down, your throat closes, or your neck tenses when you activate the transverse abdominis, this means you're overusing the rectus abdominis and diaphragm.

- If it's difficult for you to isolate the activation of the transverse abdominis from other abdominal muscles, see if it's helpful to think about engaging your pelvic floor. The transverse abdominis often acts in coordination with the pelvic floor muscles. You can engage the pelvic floor muscles by gently creating a lift between your sit bones. This may make it easier to access the transverse abdominis muscle, as these muscles are connected.

- Another way to try to access this subtle muscular activation is to imagine that your two ASIS points on your hip bones should move toward each other. They won't actually move, but the intention can be enough to get the engagement you're looking for.

- If it's difficult to differentiate the activation of the transverse abdominis by focusing on moving your navel, try imagining a point lower down—approximately 5 cm (2 inches) below your navel.

Appendix V: Grouping of the questionnaire items according to the different outcome variables

Posture (self-report and observational data):

1. Your playing posture?
2. Your feeling of postural support/stability?

+ the external evaluations (POI)

3. Overall posture
4. Location of the axis of gravity in a sagittal plane
5. Pelvic attitude
6. Dorsal curvature
7. Alignment of the head in sagittal planes
8. Frontal plane of the shoulders
9. Transverse plane of the shoulders
10. Lateral tilt of the shoulders

Ease of playing (only self-report data)

How do you rate:

1. Your feeling of control in playing?
2. The efficiency of your movements?
3. The mobility in your shoulders and arms?
4. General ease of playing?
5. The relaxation and weight of your bow arm?
6. Your ability to produce a powerful sound without excessive muscle tension?

Physical discomfort (only self-report data)

How much discomfort did you feel in your:

1. Left shoulder
2. Right shoulder
3. Left side of neck
4. Right side of neck
5. Left arm
6. Right arm
7. Upper back
8. Lower back

Performance quality (self-report and observational data):

How do you rate:

1. Your ability to musically express yourself as you intended?
2. The overall quality of your performance?
3. The quality and control of your bow changes?
4. The quality and control of your sound?
5. Your sound projection?
6. Your dynamic range?

+ the external evaluations

7. Sound quality (including resonance, control, consistency)
8. Musical expression (including musical direction/phrasing, dynamics)
9. Timing/rhythm/articulation

Appendix VI: Jamovi test outputs

Posture

Repeated Measures ANOVA - Posture all

Within Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η^2_p
Posture all	447	1	447.4	14.13	0.002	0.454
Posture all ✻ group	118	1	118.4	3.74	0.070	0.180
Residual	538	17	31.7			

Note. Type 3 Sums of Squares

Between Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η^2_p
group	57.0	1	57.0	0.753	0.397	0.042
Residual	1286.8	17	75.7			

Note. Type 3 Sums of Squares

Repeated Measures ANOVA - Posture self-report

Within Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η^2_p
Posture (self-report)	1876	1	1876	16.86	< .001	0.498
Posture (self-report) ✻ group	300	1	300	2.70	0.119	0.137
Residual	1891	17	111			

Note. Type 3 Sums of Squares

Between Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η^2_p
group	314	1	314	1.64	0.218	0.088
Residual	3256	17	192			

Note. Type 3 Sums of Squares

Repeated Measures ANOVA - Posture external evaluation

Within Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η^2_p
Posture (external evaluation)	1.01	1	1.01	0.0694	0.795	0.004
Posture (external evaluation) ✻ group	19.68	1	19.68	1.3538	0.261	0.074
Residual	247.16	17	14.54			

Note. Type 3 Sums of Squares

Between Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η^2_p
group	6.78	1	6.78	0.117	0.737	0.007
Residual	986.33	17	58.02			

Note. Type 3 Sums of Squares

Ease of playing

Repeated Measures ANOVA - Ease of playing

Within Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η^2_p
Ease of playing	1667	1	1667	15.38	0.001	0.475
Ease of playing ✻ group	589	1	589	5.44	0.032	0.242
Residual	1842	17	108			

Note. Type 3 Sums of Squares

Between Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η^2_p
group	143	1	143	0.421	0.525	0.024

Residual	5786	17	340

Note. Type 3 Sums of Squares

Discomfort

Repeated Measures ANOVA - Physical discomfort scores

Within Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η^2_p
Physical discomfort	2945	1	2945.0	44.95	< .001	0.726
Physical discomfort ✻ group	180	1	179.8	2.74	0.116	0.139
Residual	1114	17	65.5			

Note. Type 3 Sums of Squares

Between Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η^2_p
group	980	1	980	4.94	0.040	0.225
Residual	3373	17	198			

Note. Type 3 Sums of Squares

Performance

Repeated Measures ANOVA - Performance all

Within Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η^2_p
Performance	255.2	1	255.2	7.50	0.014	0.306
Performance ✻ group	51.7	1	51.7	1.52	0.234	0.082
Residual	578.3	17	34.0			

Note. Type 3 Sums of Squares

Between Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η^2_p
group	7.85	1	7.85	0.0624	0.806	0.004
Residual	2139.04	17	125.83			

Note. Type 3 Sums of Squares

Repeated Measures ANOVA - Performance self-report

Within Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η^2_p
Performance (self-report)	1053	1	1053	9.43	0.007	0.371
Performance (self-report) ✻ group	274	1	274	2.46	0.137	0.133
Residual	1786	16	112			

Note. Type 3 Sums of Squares

Between Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η^2_p
group	2.78	1	2.78	0.00653	0.937	0.000
Residual	6821.40	16	426.34			

Note. Type 3 Sums of Squares

Repeated Measures ANOVA - Performance external evaluation

Within Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η^2_p
Performance (external evaluation)	0.592	1	0.592	0.0372	0.849	0.002
Performance (external evaluation) ✻ group	4.114	1	4.114	0.2585	0.618	0.015
Residual	270.556	17	15.915			

Note. Type 3 Sums of Squares

Between Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η^2_p
group	36.8	1	36.8	0.655	0.430	0.037
Residual	955.5	17	56.2			

Note. Type 3 Sums of Squares