Original Paper

Musicians' Physiotherapy: When to start and where to stop?

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Abstract

In this paper I will elucidate several perspectives on musicians' PT and their impact on music and motor learning. It will be discussed, which competencies must be acquired by a PT to become a Musicians' PT and what a musician can expect to get from such specialized treatment. It will be stressed, which strategies might be employed to implement the use of metacognitive techniques while practicing, as well as to heighten body awareness or to render one's musical intention as precise as possible before choosing a motor program for playing.
The interdisciplinarity of Musicians' PT has great potential as well as potential risks - of which all involved parties need to be aware. From my own perspective as a - formerly injured and fully rehabilitated - musician, as a music educator, researcher and musicians' physiotherapist I will describe the role of a Musicians' PT working in close collaboration with the musician/patient, his/her teacher, medical personnel and others in a university setting. This might help musicians to decide when to seek advice or treatment and for therapists what topics to tackle and which ones to spare.

Introduction

Freshmen majoring in Music often look back on thousands of hours of instrumental practice once they enter university-level training. They have gathered a great amount of musical knowledge and skills in order to play their instruments and convey musical meaning. For becoming an expert in a given field, Ericsson et al. (1993) describe a framework, requiring about 10 years or an equivalent of 10.000 hours of practice of a task. They state that in "…most domains of expertise, individuals begin in their childhood a regimen of effortful activities (deliberate practice) designed to optimize improvement" (p. 363). Already then, the occurrence of playing-related musculoskeletal problems, both symptoms (PRMS) and disorders (PRMD) is frequent in children (for an overview see Ranelli et al. 2008: as much as 67% for PRMS and 30% for PRMD. also Ranelli et al. 2011).
In (early) instrumental education, "healthy" playing strategies or a sensitive approach to the body in order to prevent overuse or injury are still not stressed sufficiently. This might be partly due to the fact that teaching is largely based on personal experience of individuals rather than on a profound body of knowledge of physiological aspects of playing. Many music schools aim at introducing music physiology courses into their curricula, but such classes are far from being offered ubiquitously.
In case of playing problems, students/instrumentalists might turn to their teachers and receive some help by developing a compendium of strategies which help to alleviate symptoms.

Options might be changing one's posture, changing behavioral aspects of playing, practice patterns or aspects of "technique", and the recommendation to enrol in body awareness classes etc.
But even in expert musicians of international caliber, which are *not* suffering from playing-related problems, some aspects of playing technique or practicing habits might be sub-optimal or might present potential health risks. This also stands for methods of practicing or for habits of regeneration after playing.
Since the knowledge on playing-related risk factors and interacting practicing and teaching methods is still scarce, there is a need to further investigate such risk factors for different instruments and skill levels. Based on such findings, best practice rules on prevention and rehabilitation of injuries should be established. In sports medicine and education, there is a large body of expertise which could be used to model new approaches towards a healthier planning of practice, towards the optimization of instrumental technique, and towards the prevention and rehabilitation of playing-(un)related injuries in musicians.

The bridging link between professions

Musicians' Physiotherapists could add perspectives of motor control and learning and training sciences to music education. A specialized "Musicians' PT" can offer valuable assistance in the analysis of biomechanical stressors that might have lead to symptoms, he or she can shed light on anatomical aspects of playing, might assist in the optimization of playing technique and rehearsing habits, as much as help achieving the optimal rehabilitation of a given injury and show possibilities to preventng new injury.

In order to treat musicians, a PT must be knowledgable about specific terminology in music (education), about instrument specific playing techniques and stressors, playing-related disorders, aspects of performance practice and associated strains, just to name a few. I will now highlight different aspects of work in Musicians' PT, from the perspective of a musician, then music educator, and last, from a general PT specializing in Musicians' PT.

Musicians' needs: musical intention + technical execution = adequacy of playing

Every professional musician tries to achieve highest proficiency in playing fast, repetitive, highly skilled movements (just as many athletes), but in addition, needs to "load" those movements with musical intention. This kind of musical meaning interacts with motor performance - no pure instrumental "motor" task will be adequate if musical meaning has not been planned ahead or together with the motor program.

Motor proficiency can be analyzed in different frames in time. Theoretically, during practice each note needs to be prepared (dotted phase of the large circle in figure 1a, for didactic purposes it can be colored in red), played (solid line phase in figure 1a, if colored: green). Then it is played and concurrently judged for its previously defined characteristics (broken line phase in figure 1a, if colored: blue). This represents the lowest level of hierarchy. Each individual note is then grouped into motives (small circles in figure 1b, representing intermediate level), phrases (higher level) and entire movements (meta level). For each level, different strategies apply for preparation, execution and control/quality assurance. This "cycle of playing" can be related to Miall and Wolperts concept of "forward models", by which motor programs are being planned, computed and executed (see Miall & Wolpert 1996, Neural Networks, and figure 2). Each phase might give raise to optimization, specification of previosly defined parameters, or hightened awareness of movement quality, tension or sound.

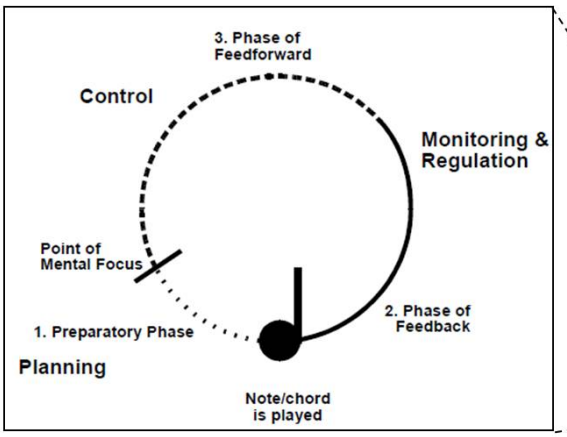
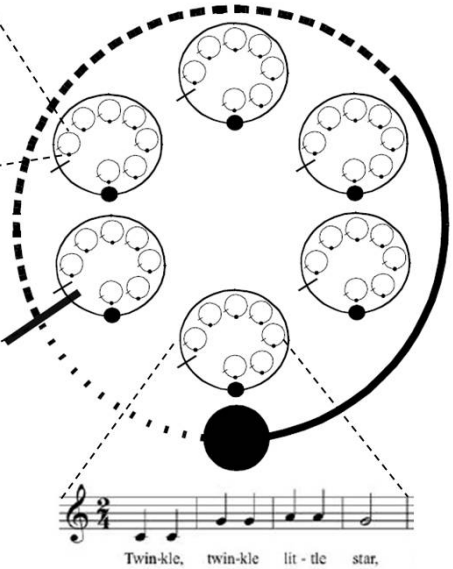


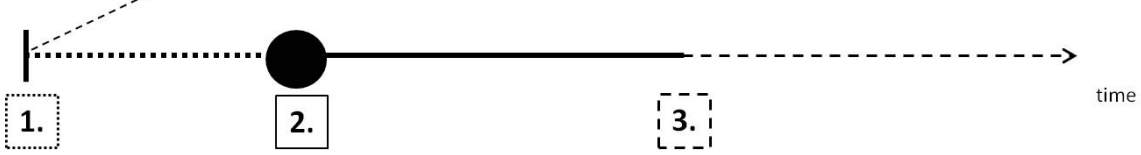
Figure 1a: Cycle of playing (Wolff 2008)
Dotted line: preparation for a given note with predefined characteristics;
solid line: phase of feedback, note is played under observance of all defined characteristics;
broken line: phase of feedforward

Figure 1b: example of multi-level chunking, representing an entire song



Twinkle twinkle little star – fractal schema

Figure 1c: Acting in time = cycle of playing



Multi-level timing

In order to play in a meaningful and coherent way, a musician does not only need to play the right note at the right time, but needs to be aware of the inherent structure of a piece, musicological details, style, genre, among other factors, i.e. he or she must follow a canon of "accepted" and overcome performance practice which then needs to be enhanced by very personal - at best unique qualities which make his/her performance outstanding.

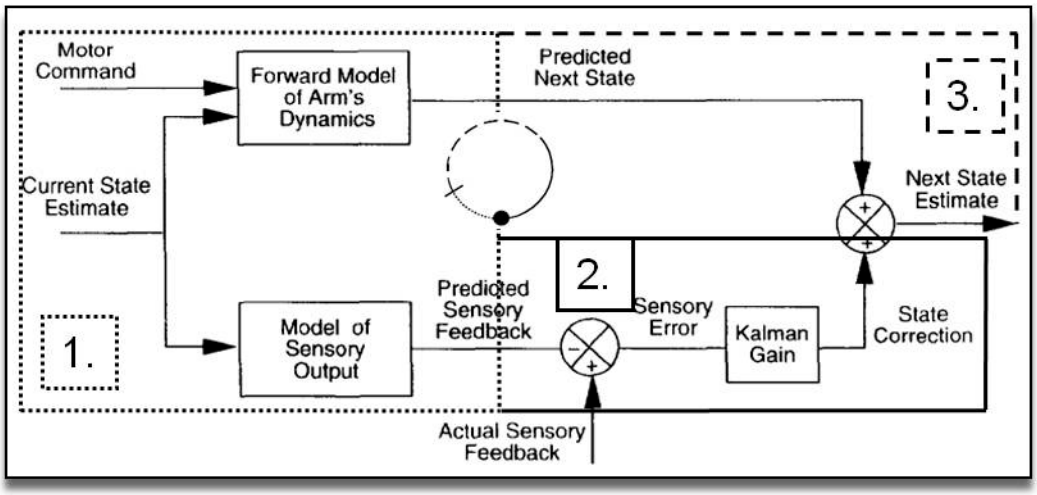


Figure 2: The "cycle of playing" in conjunction with the concept of "forward models" by Miall and Wolpert (1996, Neural Networks)

As a "golden rule" one could say that each note/motif/phrase/movement needs a custom tailored musical - and successively - motor design, which is then learned, consolidated, to be executed in a perfect, reproducable and optimal way.
Musicians can be guided towards finding their own technical solution to any given passage. This is possible by defining key parameters which interact at a given passage. Playing must be prepared by imagining how body and movement will feel while moving (musicians need to become aware of predicted motor dynamics and sensory output), and the actual outcome of playing is then compared to the predicted state (see figure 3).

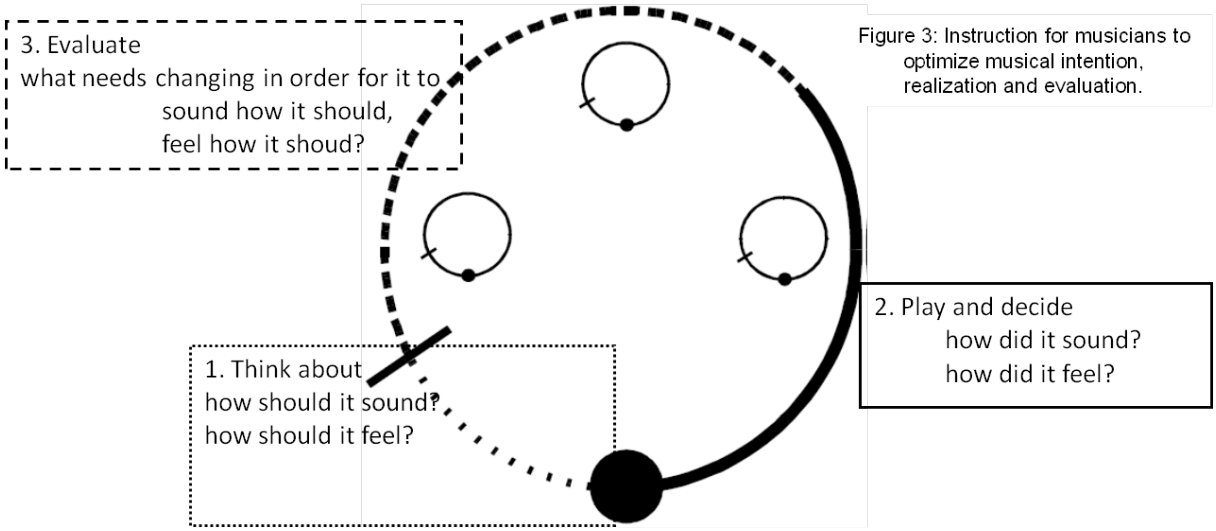


Figure 3: Instruction for musicians to optimize musical intention, realization and evaluation.

This procedure can be employed with musicians of all levels. It just needs adaptation to the individual skill, age-related understanding and goal which is pursued, as well as each playing difficulty, to each piece, any given moment during practice etc. The teacher and/or Musicians' PT must take into account, that different levels of expertise will prompt a different number of parameters to be monitored at a time (figure 4).

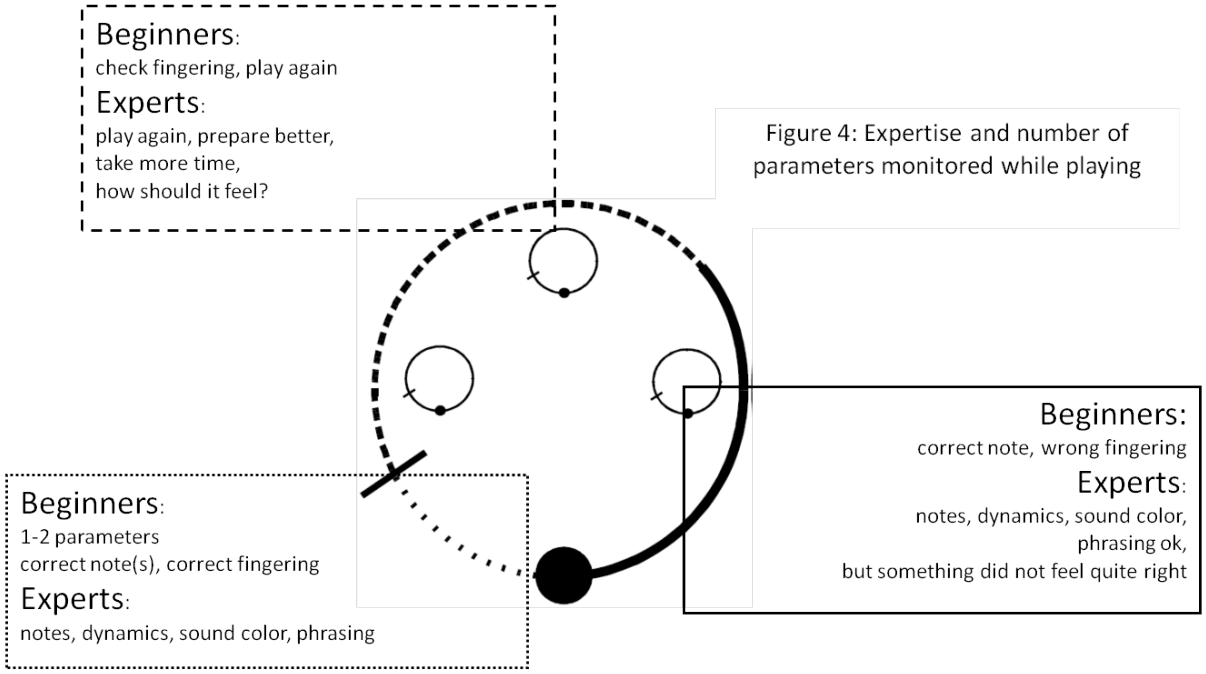


Figure 4: Expertise and number of parameters monitored while playing

Task specificity

Acquiring instrumental technique requires thousands of hours of training, but this training is rarely custom-tailored to the individual and to the task (a Baroque piece for piano needs a different kind of warm-up, fingering, phrasing, use of arm weight than a piece by Brahms or Stockhausen). Most musicians would play the odd scale in a rather fast tempo, some "easy" pieces and then proceed to different kinds of repertory without having adjusted their warm-up to the piece they are intending to practice. The notion to warm-up in a specific and task-oriented manner is not tought in early music education.

Many music educators administer technical exercises that have been handed down from one teacher generation to the next. There is a great body of "natural" knowledge about instrumental technique, as displayed by treatises by C.P.E. Bach, Türck, Quantz, Czerny, Brahms, Cortot etc. But many exercises are limited, be it by factors such as instrumental make-up/mechanics, specific style of the time of invention or a certain "school" represented by the composer/teacher. More thourough analyses of technical parameters and their influence on musculoskeletal problems have only been carried out in the recent past, investigating biomechanical effects in certain instruments, stresses on certain structures or effectiveness of exercises in certain practicing schemes (see Roset-Llobet et al. 2000, Fjellman-Wiklund et al. 2003, Bragge et al. 2006, Moraes et al. 2012).

Long range planning

Very few musicians use long-term practicing schedules which oversee more than a few weeks or months (as opposed to athletes which might have goals for personal improvement ranging over several years). Practice might be scheduled by the day, might be spontaneous ("I'll do an hour of Bach first, and then see how I feel"; "Oh - I forgot to prepare for the next rehearsal…now I have to do 4 hours of this or that…") and is rarely prepared by specifying distinct parameters which need to be focussed on, checked upon, analyzed etc. It is beneficial to become aware of different goals while practicing, depending on ultra-short to long-term time scales (see figure 5).

Musicians rarely use methods of evaluation such as practicing diaries or visual representations of practice goals and achievements. Since several years, it has become easier to use video or audio equipment to monitor practicing success, but this has not become a standard procedure for all musicians.

Scheduling practice and rest

Many musicians are often unable to plan their practice for times of the day which are in tune with their biorhythm, individually optimal learning capacities or medically advisable periods of rest. During the years of study, more and more focus lies on academic achievements and practicing is bound to happen in between lectures. Practicing opportunities are often lacking the proper setting: rooms at school might not be available, they might lack basic ergonomic requirements or provided instruments might be in a bad condition. Thus, musicians might practice when fatigued, without breaks for meals or on hazardous instruments.

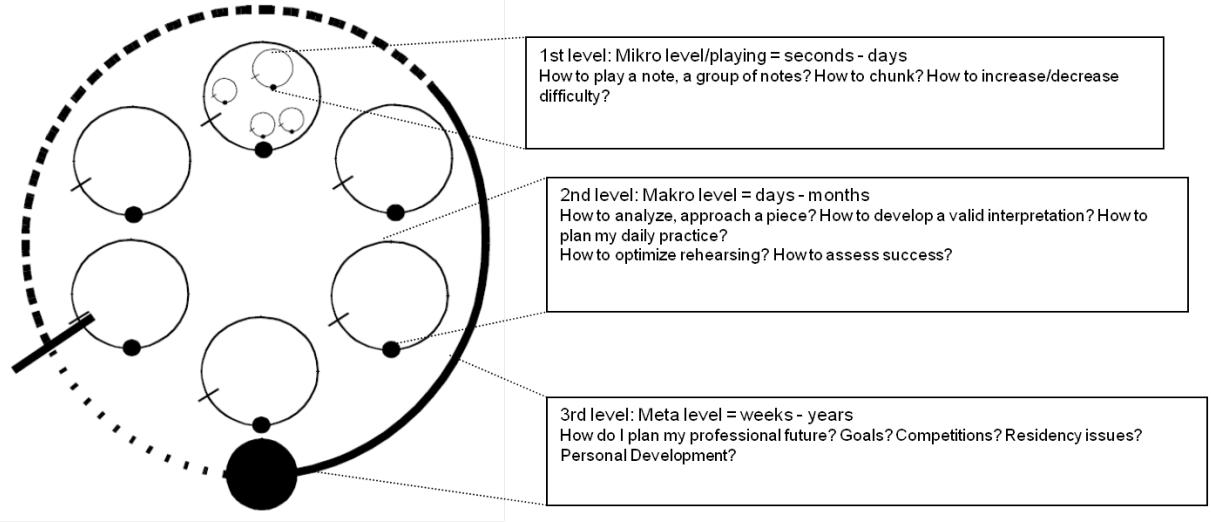


Figure 5: Visualization of different learning phases, such as a B.A. program of 6 semesters; note: each of the different-level processes occur simultaneously

Work load

Musicians practice several hours a day - depending on requirements of their instruments. In addition, they might have rehearsals in chamber groups or orchestras, instrumental lessons or other projects, class recitals, gigs and so on. The nature of fast and repetitive, highly skilled movements can be a source for overuse (Byl et al. 1996, Barr and Barbe 2002). Some structures heavily loaded in playing are also stressed during ADL activities (typing, lifting etc.).

Musicians playing in orchestras are confronted with rehearsal times, scheduled concerts or even touring which involve many hours of playing, sometimes without time to practice difficult passages individually (for an overview, see Ackermann 2002). In addition, the musical intention of a conductor limits the individual musicians' freedom to personally interpret the music in accordance to one's own emotions and bodily prerequisites. This is adding to the difficulty of playing a piece with optimal motor proficiency.

Mental prerequisites

For many musicians, "practicing" only means the time spent at their instrument. Few musicians can clearly state which goals they have for a certain passage, what their key parameters are which make up the intended musical outcome or how those key parameters interact. Sometimes, more time is spent playing than seeking the optimal musical expression, first. Only if a musician is certain about musical content, the appropriate technical means can be chosen to achieve this expression.

But not only the shaping of musical intention is paramount to optimal performance; mental strength, self-efficacy, belief in one's own ability to perform in different context are neglected aspects in the education of musicians. With athletes it has long been acknowledged that mental readiness to perform at one's highest capability is also part of training. Mental practice does not only include imagining to play a certain piece at a given moment, but also to think about individual mental and physical abilities, skills, needs, strength and weaknesses, possible strategies to alter one's habits.

There is a need to analyze the music to be played, but also one's learning and practicing strategies and mental preparation for certain goals set. Again - this is not necessarily part of the core curriculum in music schools.

Analysis of technical difficulty = metacognition

Musicians practice certain technical difficultes in form of excerpts from standard repertory, some of which are required in orchestral auditions. Those exerpts tend to demand highest difficulty, highest speed, over lengthy periods of time (such as 2 pages of spiccato in pp) etc. Some colleges of music now offer "training" sessions for orchestra auditions, but there are few courses which actually teach how to practice such "nasty" passages. There is a lack of strategies to safely tackle such pieces; this way, practice might inflict more stress than necessary. Useful strategies might encompass the analysis of key components of a given piece, strength and weaknesses, decision-making on one's own musical intention how to present this piece. Furthermore, the breaking-up of individual playing components = chunking and segmenting musical motifs and phrases etc., strategies of blocked vs. random practice are useful as practicing regimens which pay tribute to bodily needs. Thus, learning processes can be structured in a neurophysiologically meaningful way. The analysis and reflection of one's own habits - both in "normal" live and in practicing/playing (metacognition, see Flavell, 1979) is a key component towards understanding how to practise wisely without hurting the body.

Body awareness

Many musicians spent a large amount of their lives at their instrument, leaving little space for recreational sport or body awareness activities. Yet, body awareness and kinaesthetic sense are a core prerequisite for playing an instrument professionally. Moreover, many instruments inflict postural imbalances which are bound to be potential risk factors for performance related symptoms/disorders. In early instrumental education, body awareness is rarely stressed in a way that a musicians learns to be comfortable while playing. Playing is stressfull, practicing might induce pain and pain does not necessarily lead to a change in strategy or technique. Thus, many musicians have learned to accept pain or discomfort as a necessary evil while striving for their best performance.

The injured musician

Whether or not the injury is playing-related, a musician can return to playing as soon as no medical contra-indications persist. But even in phases of immobilization of a limb/body part, a musician can work with his/her instrument, leaving out the affected body part or adapting the difficulty of parameters of playing according to the injury. In the (early) recovery phase, the Musicians' PT can assist optimizing general parameters of playing, using the instrument as a recovery tool. Handling the instrument while observing all contra-indications might also alleviate stress induced by being forced to refrain from normal practice.
When traumatic injuries occur, rehabilitation must also encompass a general assessment of playing, in order to optimize the entire system and reduce stress in the affected body region(s). Playing related injuries migth require a more detailed look at instrumental technique and biomechanics of the affected body part.
Again, musicians benefit from gaining insights into anatomical and (patho) physiological aspects of their injury, healing processes, as well as the assessment of one's own skills, coping mechanisms and successiv adjustment of goals during the recovery period.

Educators's concerns

In instrumental education, many problems are solved with great mastery and musicianship on both sides, musician and teacher. But some concerns playing an instrument - such as difficult "technical" passages - are approached by using fairly general strategies. Frequent strategies employed in piano education would be practicing each hand separately, starting to play fast passages very slowly and gradually speeding them up, playing scales in dotted rhythms, playing each passage a given number of times, playing from the start for any number of repetitions (this is just to name a few common, rather uninspired methods of practicing; without doubt, many musicians use quite elaborate strategies while practicing).
In the training of instrumental educators, most often courses are offered which discuss the instrument-specific teaching literature, well-known "schools", compendiums of etudes and the like. But there are few educational offers which actually tackle overarching methodologies of approaching difficult passages or pieces. Generally, little is known about learning principles, neurological processes of (motor) learning, benefits of structuring practice (grouped vs. random practice), task specific learning or consolidation of the things learned etc. Therefore, educators usually draw back on their own practicing expertise and on things handed down by their own teachers.
With more back-ground knowledge on anatomical and physiolgocial processes in general learning and motor control and learning, educators would be able to structure their student's learning in a meaningful way and avoid potentially harmful behavior. Knowledge generated in sports medicine, training sciences and sports psychology could be used when especially adapted to the needs of instrumental education and would help to optimize musical learning processes.

Instrumental educators and health promotion

An educator with special knowledge concerning musicians' health needs to be aware of general anatomical and physiological aspects of playing an instrument, in addition to specific aspects of playing his/her own instrument and similar instruments (i.e. violin/upper strings). He/she knows basic principles of learning, motor control, neurophysiological aspects of playing, practicing physiology, hearing, posture off and on the instrument and movement optimization. He/she focusses on educational strategies for optimizing practicing and playing environments, on how to enhance learning and consolidation and how to become aware one's own musical intention. An instrumental educator promotes health by instructing students how to chose the appropriate, optimal, adequate technical means on the instrument to realize one's musical intention. The educator guides towards individual practicing and playing habits

which suit the musicians physical and mental capacities and abilities. An specialized PAM-instrumental educator is able to respond to playing difficulties, bodily or mental problems which a student might present with during instrumental instruction. He or she can offer first measures towards solving problems, such as seeking physiological solutions in playing technique, posture, ergonomic aids and the like. A specifically trained instrumental educator knows about risk factors associated with playing the specific instrument, common conditions suffered by the specific group of musicians and basic rules of conduct in case of injury. He/she is aware of his/her own limitations to give advise in case of (suspected) injury and knows about referral options within a PAM network.

In training, the specializing educator cooperates with Musicians' PTs, trying to optimize playing behavior in different settings. As an instrumental educator he/she has assessed his/her own playing habits in search for potentially adverse playing mechanisms, routines etc. The own playing behavior has been reviewed in special sessions (educator and Musicians' PT) in order to learn more about treatment approaches, options or in order to gain insight in physiologically motivated changes in one's own behavior. The educator communicates with both students and medical personnel, being able to use anatomically and physiologically unambiguous terminology.

A specialized educator has basic knowledge about body awareness techniques available, about practicing methodology, kinaesthetic awareness and movement (re-) training. He/she has acknowledged pertinent publications from all related fields.

Several educational offers cover some of the topics listed above, though no accredited (degree) courses are available at music college level. Again, internships can be arranged in several PAM-centers with PTs specializing in the treatment of musicians.

List of relevant topics for educators specializing in musicians' health
1. Training of perceptive skills, instrumental technique; treatment options 2. Functional instrument-specific anatomy and physiology 3. Physical and instrumental assessment and movement analysis 4. Instrument-specific pathology; prevention/rehabilitation 5. Joint internship with Musicians' PTs, attending instrumental lessons or masterclasses 6. Basic principles of motor control and learning, training principles 7. Awareness of limitations during teaching: when to referr a student to medical specialists 8. Ergonomic aids, hearing protection, overuse protection 9. Mental health, social aspects of playing in different contexts, stage anxiety 10. Nutritional science, rest, relaxation, recreational measures, sports

Table 1: Topics for educators

Musicians' PT: prerequisites and qualifications

In addition to any prior training in specific treatment methods or techniques, a Musicians' PT must be knowledgable about specific needs, problems, frequent bodily and mental problems associated to or inflicted by playing a musical instrument. This also involves work-related stressors for musicians depending on the level of proficiency, instruement/genre/style played, position held (such as orchestral musician vs. freelance vs. soloist etc.) and the like. Musicians' PTs are specifically trained to analyze playing behavior and practicing habits in order to optimize certain aspects of playing or practicing as well as to rehabilitate musicians once an injury (whether playing-related or unrelated) has occurred. They plan, monitor and evaluate playing behavior and practice regimen according to the musicians' goals, musical intention, task specific requirements and social components which are associated with performing.

Musicians' PTs have observed musicians in ecologically valid playing and practicing environments. They are able to communicate with musicians and instrumental educators by understanding and using common musical terminology.

It is highly beneficial to have prior experience in playing an instrument. Musicians' PTs are capable to enable musicians to become more aware of playing mechanisms, of components which interact when playing and to guide musicians towards their optimal performance. This involves applying techniques from music methodology and didactics, sports sciences, training sciences, cognitive sciences and learning psychology when trying to influence musically guided motor behavior. Musicians' PTs are able to plan, assist in and oversee the rehabilitation of playing (un-)related injuries, observing all medical contra-indications, facilitating early functional retraining at the musicians' instrument, designing specific exercise programs at the instrument and structure functional retraining using and adopting specific musical repertory to the stage of recovery. Musicians' PTs use additional measures such as 3D-kinematography, video, feedback-devices in order to aid optimization or rehabilitation efforts.

List of topics for a specialist training "Musicians' PT"	
Part/ Content	Topics
A) Music - Main instrument - Similar instrument - Basic musicology - Basic performance practice - Methodology of general and music instruction - Methodology of main instrument Internship: teaching of main instrument (observation only)	 - Basic playing technique(s), ergonomics aids - Similarities within instrumental group - Genres, styles, different techniques - Performance related stressors, specialties - Didactics, teaching of different tasks - Instrument specific teaching Analysis of parameters in music instruction; health relevant analysis
B) Musicians' PT Basics - Anatomy in vivo - Biomechanics of playing - Relevant physiology and instrument specific patho-physiology - Performance ananlysis and diagnostics - Medical problems of distinct instruments - Principles of instrument-assisted diagnostics (3D-kinematography etc.) - Methodology of research - Motor control and learning, - Movement analysis - Principles of Musicians' PT (as opposed to Sports PT) - Musicians' assessment off and at the instrument - PT techniques (MT, lymphatic drainage etc.) - Psychology of Music and Sports - Nutritional science - Clinical studies - Pain management - Evidence based PAM	 - Anatomy playing the instrument - Biomechanical stressors - Key issues, injury patterns - Movement analysis in different settings/genres - Assisted movement diagnostics - Acknowledging existing research, shortcomings - Acknowledging motor control research - Conventional methods of playing anaylsis - Special needs in terms of musical intention interacting with body mechanics - Charts and assessment tools from all fields involved - Furthering existing skills - Comparison/adaptation of Sports psychology - Impact of nutrition while on tour etc. - Planning and carrying out clinical research - Interventive measures
C) Injury Prevention, body awareness instruction, rehab concepts and techniques - Development of instrument specific prevention and rehabilitation concepts - Movement anaylsis internship - Movement (re-)education internship - Internship at PAM center/clinic - Documentation of internships	- Patient-centered and instrument-specific prevention and rehab measures - Use of different measurement systems - Use of different (re-)training concepts - Application of knowledge in real-life settings - Knowledge of pertinent research - Scientific documentation

Table 2: CME-course topics for PTs

In addition to basic training as a PT, to specialist training in certain techniques and concurrent CME training as requested by most boards/associations of PT, Musicians' PTs have spent considerable time with musicians in real-life settings, such as orchestras during intense rehearsal periods, touring etc.
Musicians' PTs have experience observing musicians during their daily practice, their instrumental lessons while interacting with teachers or chamber music partners.
Newly training PTs need to seek internships at Musicians' PT centers or clinics in order to observe the clinical management of the injured musician in different contexts, plan rehab schemes, and follow through different stages of recovery.
At present, there is still little consensus about rules of best practice. There are no established accredited curricula to obtain a certification as a Musicians' PT. But several centers are specialized in treating musicians and internships can be arranged on a personal basis. Conferences - such as in Osnabrück 2012 - help to get an overview over existing programs. The body of research which has been initiated by physiotherapists is continuously growing and needs to be collected and acknowledged by all professional groups involved.

Roles of a Musicians' PT

The PT posseses a broad knowledge on anatomy, physiology, biomechanics, physiological movement patterns etc. As an external observer of musical learning processes, the specialized PT might be able to join expertise with the musician and instrumental educator and act like a speaking exteroceptor to the musician, asking questions relating to the musicians' emotions, goals, troubles, helping to bring about awareness about the musicians' musical intention, awareness of own technical skills or deficits, posture, a lack of/ too much tension in a certain body region, a lack of stability or difficulties in coordination etc. Ergonomical aspects can be assessed as well as aspects of planning practice, rest and recovery, using findings from training physiology, motor control and learning research or learning psychology.
This way, many playing-related difficulties can be solved with a Musicians' PT actually not being a musician him- or herself. But there might be instrument-specific questions which can only be solved with a deep insight into playing the given instrument. For example, the PT should only change fingerings in intricate pieces or change parameters like bowing mechanics or embochure, if he/she knows what he/she is doing. This kind of intervention might be restricted to those individuals, who have substantial experience with the given instrument and possibly degrees in both PT and music. Moreover, a Musicians' PT needs to be aware of the timing of interventions: If a musician needs treatment on tour, any intervention needs to be carefully measured in order not to disturb that night's performance.

Musicians' PT Scenarios

1. Optimization of playing in healthy instrumentalists

Here, Musicians' PTs could be called into regular practice sessions or lessons in order to offer an external perspective on some of the parameters stated above.

It would be very beneficial if each music student entering college could enroll in courses of "Supervised Practice" with a Musicians' PT in order to gain more knowledge about playing mechanisms and to enhance body awareness while playing.

2. Treatment of disorders which are not directly playing related, but impact performance

Many injuries are sustained away from the instrument but impact playing directly or indirectly. Musicians' PTs can offer solutions on how this impact can be minimized, offering ergonomic aids, temporarily altering playing posture (from standing to sitting etc.), designing exercise programs which help to alleviate adverse effects of the injury, and so on.

3. Treatment of playing-related (playing-induced) disorders

This might be the most difficult problem to treat, because many music related parameters must be taken into account. Therefore, Musicians' PTs must be knowledgable about strategies to optimize music related motor learning. It might be necessary to alter movement patterns which have been established for decades. Many musicians are very sensitive about anyone influencing their playing in such a profound way. One way is to explain basic principles of ergonomics, biomechanics and (hand/body) posture and then try to increase a patient's awareness towards certain aspects. The musician needs to find his or her own "coustum tailored" technique, he/she needs to integrate newly acquired postural control into his/her movements and learn to avoid potentially harmful movement behavior. As an external monitor, a Musicians' PT can guide, assist and accompany this difficult process of learning.

4. Team-teaching in collaboration with instrumental instructor

Many musicians (especially during their course of study) are quite dependent of their instrumental instructors, who might work following a certain school, demand special excercises or etudes to be played etc. Some might have retentions against letting other professions interfere with (or add to) their teaching. It is therefore necessary to establish a common interest in helping students learn more about their learning, their body and their movment capabilities. In a situation of team teaching, musician, teacher and Musicians' PT can develop a better understanding of different aspects of playing. Each person can add important components to the planning of playing, execution and evaluation of outcome. Thereby, expertise of musician, educator and PT can blend and lead to an embodied cognition while playing.

In master-class like situations Musicians' PTs can offer remarks on warming-up routines, preparation for stage, mental readiness before actually playing, tension in certain passages, postural alignment etc.

5. CME courses of Musicians' PTs for medical personnel

Musicians' PTs can take on an important role in secondary education courses for musicians and educators as well as for other medical professionals. They could be the bridging link between professions. Many aspects of (movement) education are part of a PT's regular treatment repertory. Specialties like sports physiotherapy offer important insights which can be adopted to Musicians' PT. If enhanced by specific musical knowledge, there is great potential for involvement in prevention or the rehabilitation of injuries.

6. Research and quality assurance

There is a need to establish evidence-based treatment schemes in Musicians' PT. General rules and regulations for best practice have to be defined, as well as curricula which would open our new specialty to a wider scientific community. Fortunately, a rising number of PT-driven research has been carried out in the last few years, though overall figures are still low (a recent (Nov 3, 2012) pubmed search for "musicians AND physiotherapy" generated 38 hits, not all of which were directly related to PT, but rather to "movement" therapies). An important part of quality assurance is the designing, implementation and evaluation of assessment methods, tools, sheets etc. This could help to make specialized knowledge available to more therapists and help to improve the care of patients.

7. Interventions within multi-disciplinary teams

Musicians' PTs can help to coordinate interventions within a multi-disciplinary team, encompassed by PAM-specialist MDs, instrumental educators, allied health-care professionals, ergonomists, orthopedic technicians etc. by carefully observing the recovery process, postural or kinetic difficulties, ergonomic mismatches of body and instrumental built etc.

8. Prevention

It would be beneficial if Musicians' PT was available from the beginner level onwards. Especially children are prone to instrument-related postural mal-adjustments, because of a frequent mismatch between instrument size and/or ergonomic aids and bodily strength/growth. Here a Musicians' PT can help to optimize posture, stress important parameters of healthy playing, intervene early if pain occurs, and supervise a meaningful scheme of playing and rest. In healthy experts, the focus of intervention will shift towards optimizing overall performance etc. In individuals with a history of prior injury, tertiary prevention is paramount.

Conclusions

Musicians' Physiotherapy has evolved out of the need to administer specialized care to musicians who suffer from traumatic injury as well as performance-related injuries.
The Musicians' PT is knowledgable about the requirements brought about by being a musician, understands musical terminology and has a basic knowledge of methodology of teaching motor skills and musical skills.
Within a multi-disciplinary team, a Musicians' PT works in the rehabilitation of injuries, interacts with both musicians and instrumental educators in order to add "health perspectives", to further preventive behavior, and to help to avoid potentially harmful behavior. Using knowledge from adjacent scientific fields, a Musicians' PT can further a musician's understanding of making music as a unity between musical intention, composition, interpretation and motor realization, that is to overcome the division between "music" and "technique" and to realize an artistic whole consisting of musical intention, self-awareness and ease of execution.

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