FOCAL DYSTONIA: AN UNDERSTANDING FOR THE PIANO TEACHER

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As piano teachers we all come across students who have varying degrees of discomfort while playing. Pedagogically, it is possible to notice and correct pianistic habits that may be causing pain. Less obvious however, are the painless irregularities which can emerge in a technique and which may lead to future pianistic problems such as focal dystonia, a devastating neurological condition that usually ends a performing career. This paper aims to increase awareness of this condition and to suggest ways in which teachers can assist in its prevention.

Piano playing at an advanced level involves intensive practice in order to obtain and maintain high-quality performance. Musical performance requires control of strength, pressure, intensity, speed and independence of movement, together with the ability to reproduce these exact movements instantaneously when in a stressful situation. It is highly goal-orientated and requires numerous repetitions of fine motor coordination skills, which have to be continued and maintained throughout the life of a performer (Rosset-Llobet and Pascual-Leone, 2010).

Since the advent of the recording industry, the demands on the musician for total accuracy, while taking the risks required in bringing a performance to life, have escalated. There is the perceived need for more and more practice to achieve the perfection in a live performance that compares with the standards of a compact-disc recording (Altenmüller and Jabusch, 2010). With the increased competition and the demands of the economic climate in the last fifty years, musicians are required to practise longer hours and to produce results within shorter time frames than ever before. Children often begin their studies before the age of five and are sometimes expected to accomplish demanding repertoire even before they reach the teenage years. This accelerated learning may mean that less time is spent on the step-by-step methodical technical training that was considered the norm a hundred years ago. It seems that the goal is often to accomplish the most difficult pieces as soon as possible in order to dazzle the audience. As the musical journey continues, pressure to meet these expectations intensifies, placing greater and greater demands on the developing musician.

Unless the body maintains movement patterns that are biomechanically sound, the musician is at risk of injury (Wilson et al., 1993). A devastating example of this is focal dystonia. Unlike occupational overuse syndrome or repetitive strain injury, focal dystonia is usually a painless condition which manifests itself in an incoordination or cramping (involuntary flexion or extension) of the fingers, making the high level of control required for concert performance impossible (Altenmüller, 1998, Lim et al., 2001). It results from

highly practised repetitive activities and usually affects only one hand, often involving just two or three specific fingers. The fingers can cramp or curl under the hand, a dystonic finger may be difficult to lift or may shoot out in an uncontrollable way, and fingers simply refuse to obey instruction. It is task-specific (Frucht, 2004, Lim et al., 2001), generally does not influence other unrelated activities and is absent at rest (Wilson et al., 1993). At first musicians simply notice that a hand is not working properly, resulting in subtle unevenness in fast passages or irregularity of trills, and therefore they tend to practise harder and harder in an attempt to overcome the difficulty (Altenmüller and Jabusch, 2010, Wilson et al., 1993). However, the more they practise, the worse the symptoms become until sufferers are forced to abandon playing at a professional level (Frucht, 2009). At this point musicians usually seek medical help but are often misdiagnosed and not understood.

It was not until the 1980s that focal dystonia or musician's dystonia, as it is now often called, was recognised as a condition. Prior to that time, these irregularities were thought to be psychological, even described as 'piano failure' by Dr Poore (Poore, 1887) who also suggested that '*the hand had forgotten its cunning'*.

For years Schumann's hand injury was thought to have been caused by his efforts to improve his technique with a special machine, the *Cigarrenmechanik* (Lederman, 1999). However, after analysing Schumann's diaries, de Yebenes (1995) and Altenmüller (2006, Altenmüller, 2005) show conclusively that Schumann was suffering from focal dystonia. The third finger of his right hand would drop uncontrollably to the keyboard and the machine with its sling was developed to try and prevent this from happening.

One of Schumann's desperate efforts to play resulted in the composition of his *Toccata* Op. 7, a highly virtuosic piece involving rapid alternation of the thumb and the fifth finger with the index finger and the ring finger of the right hand with almost no use of the middle finger. It is thought that Schumann would have been able to play this piece because it did not trigger the cramping associated with focal dystonia.

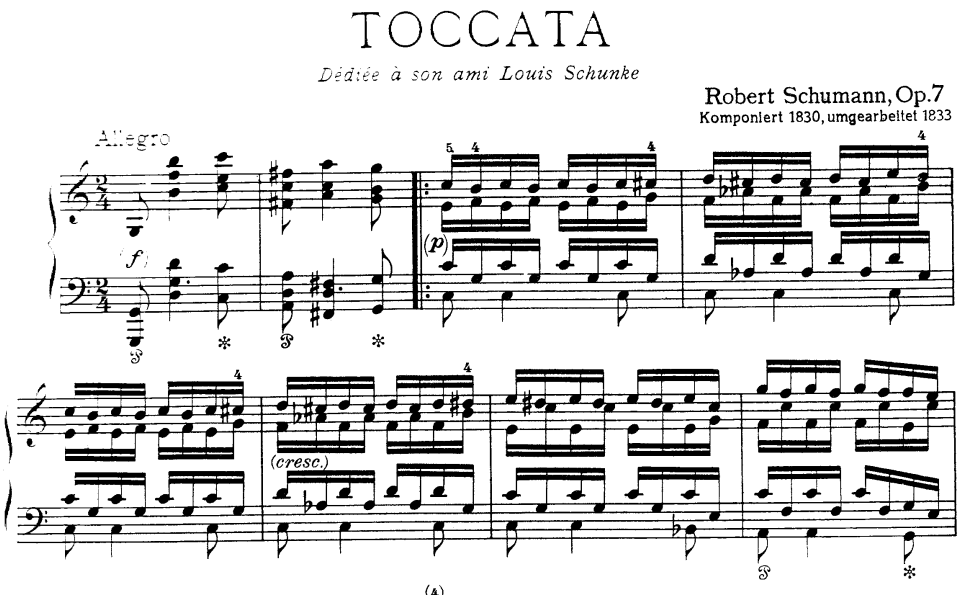

Figure 1: The opening of Schumann's *Toccata* Op. 7

Other famous pianists, for example, Glenn Gould, also displayed undiagnosed symptoms that may have indicated focal dystonia. However, it was only following Gary Graffman's famous article *Doctor can you lend an ear* (Graffman, 1986) that the condition began to be taken seriously. When Graffman and Leon Fleisher (who had been unable to play for almost 30 years) publically acknowledged their symptoms, many similar stories were unearthed, doctors started to realise the severity of the condition and performing arts medicine was born. Since then, neurologists and doctors have become much more aware of the complexity of musical performance.

Neurologist Eckart Altenmüller states:

> *Music performance at a professional level is one of the most demanding tasks for the human central nervous system; It involves the precise execution of fast and, in many instances, extremely complex physical movements under continuous auditory feedback (Altenmüller, 2003).*

The prevalence of focal dystonia may be as high as one in 100 professional musicians (Altenmüller, 2003, Altenmüller and Jabusch, 2009, Jabusch and Altenmüller, 2006) and it is thought that 10,000 performing musicians worldwide may be affected (Bronson, 2004). It mostly occurs when musicians have a highly established level of performance and is not usually seen during skill acquisition (Charness et al., 1996). It is more common in males (83%)(Altenmüller, 2003) and is most prevalent in pianists and guitarists (Altenmüller,

1998, Lim et al., 2001). In pianists and guitarists focal dystonia most commonly affects the right hand, probably because of the specific demands on the right hand in both instruments (Frucht, 2004). However, it can also affect brass and wind players, who can lose control of their embouchure or find that their fingers stick on the keys. String players can also be affected, most commonly by a cramping of the left hand on the fingerboard or by an involuntary flexion of the bowing thumb. It is more common in violinists than double bass players, where the distance between the fingers is greater (Conti et al., 2008), and it may even occur in the playing of one instrument and not in another (Altenmüller, 2003, Tubiana, 2000). The consequences are devastating for a musician, as it threatens the identity of the sufferer and often results in the end of a performing career (Frucht, 2004, Lim et al., 2001, Schuele and Lederman, 2004). In other walks of life focal dystonia is known to affect golfers, where it has been known as the 'yips', and it has been seen for many years in 'writer's cramp'.

Focal dystonia is thought primarily to be due to a blurring of the digital representations in the cerebral cortex (Byl et al., 1996, Elbert, 1998). In focal dystonia, the areas in the brain responsible for the movement of adjacent fingers have become enlarged, due to overuse, and can overlap (Elbert, 1998). The brain's ability to change during the process of learning a skill is known as plasticity. This plasticity of the central nervous system has also been seen in the enlarged areas associated with the four fingers of the left hand in violinists, but without the overlapping or smearing (Elbert et al., 1995). Focal dystonia rarely occurs during initial development of instrumental technique but more often when the musician is at the peak of his career, indicating that it is not because of the motor learning itself, but rather because the process has become corrupted (Frucht, 2004, Frucht, 2009). It usually occurs after years of practice at the skill of playing an instrument (Candia et al., 2003), most commonly in the fourth decade of life (Altenmüller, 2003, Brandfonbrener, 1995, Jabusch et al., 2005, Lederman, 1991). The fact that it is possible for most musicians to engage in hours of practice at an instrument without problems of this kind means that repetition *per se* is not the cause. This suggests that the cortical alterations seen in focal dystonia may be associated not just with overuse but also with misuse.

Although doctors have tried a number of protocols to treat focal dystonia, complete recovery is rare. In a study of 144 musicians treated over an eight-year period, Jabusch et al. (2005) found that only in exceptional cases did these instrumentalists return to their former level. For therapy to be successful in helping a sufferer to return to the concert platform, virtually 100% recovery is required (Frucht, 2004). In a review of 113 musicians seen between 1985 and 2002, Brandfonbrener and Robson (Brandfonbrener and Robson,

2004) reported that no patient had reported symptoms resolving or improving significantly. More encouraging results have been reported by Jabusch et al.(2005), with 54% of patients reporting long-term improvement. However, Schuele and Lederman (2004) estimate that more than half of affected sufferers are forced to end their careers. More recently, treatments at the *Institut de Fisiologio I Medicina de l'Art-Terrasa* in Barcelona have reported improvements in 44% out of 89 patients, with 39% reporting complete recovery after an average of 15 months (Rosset-Llobet and Fabregas-Molas, 2010). All of these therapies involve other treatment modalities and while results have been achieved, methods of retraining at the instrument have not been scientifically documented.

The development of focal dystonia is thought to be closely connected with the amount and intensity of practice, and stress due to the need to meet professional standards (Altenmüller and Jabusch, 2010, Jabusch et al., 2005). Sufferers of focal dystonia often describe instances of excessive practice undertaken prior to the development of the condition (Lederman, 2002). When preparing for an important performance a musician will often practise without physical awareness because of focus on the music itself. Then it is easy for physical distortions to occur in order to produce a desired musical result and for these to become ingrained as a way of playing that is less than biomechanically ideal. The musician is particularly vulnerable when trying to learn a piece in a hurry for a pending concert or competition, where excessive force and speed is often used in order to accomplish technically demanding repertoire in a short space of time (Tubiana, 2000).

Before the onset of focal dystonia the musician may experience a lack of facility, fatigue or pain, particularly when playing difficult pieces and at first it may be restricted to problems with a certain passage (Jankovic and Ashoori, 2008, Tubiana, 2003b). These movement abnormalities persist regardless of the musician's efforts to correct them by practice (Wilson, 2000).

The most common symptom in pianists with focal dystonia is unwanted flexion of the fourth and fifth fingers, which makes it difficult to play scales or arpeggios evenly, and to voice or play octaves and chords without sounding unwanted extra notes (Hochberg and Hochberg, 2000). An extension of some fingers can also be seen, which is often the result of the musician trying to prevent the dystonic finger's tendency to curl (Jankovic and Ashoori, 2008). Most musicians become aware of physical problems through pain. However, in most cases musician's dystonia is painless (Hochberg and Hochberg, 2000, Lederman, 1991).

Many musicians are reluctant to report playing difficulties even to musical colleagues, and furthermore, dystonic problems are often incorrectly diagnosed (Conti et al., 2008).

Pianist Gary Graffman wrote:

> Nobody wants a wounded pianist. There is an oversupply of healthy ones. Admitting difficulties is like jumping, bleeding into piranha-filled waters (Graffman, 1986).

Although the pathophysiology of focal dystonia involves the cerebral cortex, my hypothesis is that the way the body works at the instrument is pivotal in the development of this condition. Most piano pedagogues will stress the need to relax, but without specific instruction as to how it is possible to play with minimum tension, this instruction can be misunderstood.

Technical development often begins with mindless playing of scales, used to 'warm up' the fingers. However, a 'warm-up' is pointless if the body then begins to play in a way that is 'out of balance'. Piano playing at concert level is highly repetitive. A study of a pianist by surgeon Dr. James Paget revealed 72 finger movements per second (Critchley, 1977). A Liszt *étude* can demand 1800 repetitions per minute (Munte et al., 2002), and any professional musician is required to play up to 20-30 notes per second (Tubiana and Camadio, 2000).

Moreover, the complex movements of fingers, arms, and indeed the whole body need to be performed with the utmost precision to meet the expectations of the listener. With these demands, it is of paramount importance that the whole body works in the most biomechanically efficient way possible. If the initial technique was biomechanically faulty or if the technique has gradually moved away from ideal efficiency, then such repetitive demands over time may lead to injury (Wilson et al., 1993).

Repetition plays an important part in all skill learning. Donald Hebb (Hebb, 1949) proposed that repetitive activity alters the way that neurons connect with each other: 'Neurons that fire together, wire together,' (Shatz, cited in Doidge, 2007), and this has become known as Hebbian theory. This adaptation is generally beneficial to the learning process, but if the technique has been poorly developed or inbuilt tension has not been corrected, the musician is at risk. When biomechanically unfavourable movements are repeated at high speed, muscle imbalance and overuse results. Poor posture, as well as excessive joint stiffness or hypermobility, and inaccurate sensory discrimination can also be risk factors for injury (Byl, 2006, Tubiana, 2003a, Wilson et al., 1993).

Treatments that require rest and then a return to the instrument will often result in a recurrence of the injury unless biomechanics change, as the body may 'remember' the movement pattern that caused the injury. In focal dystonia the neurological pathways that have habitually been used may no longer be functional and new pathways may need to be established.

A large part of this paper has been taken from my PhD dissertation. The aim of my PhD study was to determine whether a specific retraining program could result in improvements in the symptoms of focal dystonia in instrumentalists with this condition. Most protocols agree that self-determination, commitment, and avoidance of the dystonic movements by reducing speed and force to a level that symptoms do not occur, are essential for successful retraining (Byl, 2009, Jabusch and Altenmüller, 2006).

My hypothesis was that if physical harmony was achieved in every aspect of the technique and all unnecessary stress was removed, then movement patterns might be freed to change (and presumably to activate new neurological pathways). To recover from focal dystonia, the body needs to accept the possibility of playing with full independence of every finger, and for this to happen, I believe that the pianist must liberate every basic movement from its past learning. All movements should be reprogrammed in painstaking detail, so that the brain is deceived into thinking that the pianist is developing a new skill, similar to learning to 'walk' again. By moving in a different way, it should be possible for new neural pathways to be found. It is now widely held that because of the neuroplasticity of the brain, changes occur when learning a musical instrument (Elbert et al., 1995, Munte et al., 2002, Pascual-Leone, 2001). For recovery from focal dystonia to occur, the brain needs to be reorganised through learning to play in a different way. With concentrated and focused repetition of the biomechanically most natural movements, gradually these pathways could become the default channel of communication, resulting in the return of playing ability.

PIANISM RETRAINING

> *Musical skill depends upon movements in which the entire body participates, but is built on precise control of the smaller muscles of the arms and hands. The musician, a small-muscle athlete, is not just a big athlete in miniature. No other activity in which we engage requires that accuracy, speed, timing, smoothness, or coordination of muscular contraction exhibited in finished musical performance (Wilson, 1986).*

Performing music at a professional level is one of the most demanding human endeavours (Munte et al., 2002). Excellent pianistic skill requires more than technique: it encompasses the complete art of making music at the piano and this can be referred to as 'pianism'. Technique at an instrument should always be seen as a means to an end: only when the physical playing becomes effortless can the musical intention be truly realised. When the body moves in harmony, physical limitations are reduced and true pianism can emerge, not simply as technique but as the art of piano playing.

Although some musicians are predisposed to the development of focal dystonia because of genetic factors or stress, I believe most injuries occur because of lack of biomechanical balance in the technique, and therefore, it is logical that a change in that way of playing is essential for recovery to be long-lasting. Very few musicians with dystonia are sufficiently aware of their own method of playing to be able to make changes on their own. The natural response to technical difficulty is to struggle against it, which further ingrains the distorted movements. Therefore in any treatment protocol, the involvement of a skilled instrumental pedagogue is essential in identifying subtle movement modifications, and implementing the change in the most systematic and gradual way possible. Every part of the playing needs to be reprogrammed, so that dystonic movement is avoided and technical balance is achieved.

The studies for my PhD involved five pianists and a cellist. All improved without other simultaneous medical intervention, and the results were verified using scientific method. Three were able to continue professional playing, with one returning to a full-time career as a soloist.

Central to my retraining method was the belief that the body must move in a way that is as biomechanically perfect as possible. Every aspect of the playing needed to be subtly adjusted in each session and understood by the subject, so that new technical principles could be applied to the playing of every musical composition. The goal of retraining in each case was to rid the technique of unnecessary tension and to make the playing as biomechanically sound as possible.

By removing stress from the technique of each subject, and establishing biomechanically ideal movement patterns, each subject was able to minimise the effects of dystonia. With every aspect of the technique working in physical harmony, movement patterns were freed to change and so to activate new neurological pathways. The focus was on the whole person and how the dystonia affected them not only physically but psychologically. As in the work of Chamagne (2003), the aim was to achieve muscle balance throughout the

body, not merely looking at the dystonic movements, but understanding how the rest of the body had contributed to the overall instrumental technique.

In all subjects I was able to identify areas of tension that may have contributed to the dystonia and be part of the aberrant learning discussed by Nancy Byl (2006). Each element of technique needed detailed analysis, breaking down each action to its smallest components and perfecting each movement slowly before trying to increase speed or play sequences of notes. This involved releasing every movement after playing, the constant adjusting of fingers, hands and arms to enable the body to return to a position as near to its mid range of motion as possible, particularly after any passage requiring stretches or unnatural hand positions. This release applies to every note or chord, as any tension permitted to remain will affect the remaining notes in a passage.

Details of the retraining method that was found to be beneficial for all subjects can be found in my PhD, *Focal Dystonia in Pianists: a Way to Recovery Through Retraining.*

Although recovery from focal dystonia is possible, it requires epic patience from both the sufferer and the retrainer. It is hugely time-consuming and requires enormous commitment and belief in the possibility of recovery. It would be so much better if this devastating injury could be prevented altogether. I believe that minor symptoms may be relieved with pedagogical intervention and so hopefully prevent the later occurrence of more serious injury. Further research is needed in this area, but there is little doubt that injury is less likely when an instrumental technique is based on optimum biomechanics.

Since beginning this research into focal dystonia, several students have presented to me with specific technical issues that indicate some evidence of fatigue, lack of coordination or unnatural movements. While none were diagnosed as having focal dystonia *per se*, there is the possibility that these problems could compound over time, preventing the player from having freedom to play. By addressing these minor problems with simple exercises and adjustments of alignment, it was possible to alleviate these symptoms and in all cases to enable the pianist to continue playing without the interference of unwanted movement. Therefore, it is important to be able to recognise pianistic irregularities and have the tools with which to correct them.

Posture

A balanced way of sitting is essential, where the height of the stool is adjusted for each body, establishing core support so that the arms can move freely from the shoulders and the elbows. It is particularly important to avoid tension in the wrist and static positions of ulnar or radial deviation. Injury is less likely when there are fewer deviations from the neutral position and when these are held for shorter time increments (Brown, 2000). In octaves and chords, held stretches should be minimised with the impression that the notes open the hand, which is then minutely released between repeated chords (Taubman, 1984).

Balanced finger joints

Balanced use of finger joints is of prime importance in maintaining an injury-free technique. Many of our students have unstable joints, which can be trained right from the earliest lessons with very simple exercises. The longer the habit is left the harder it is to change. Brandfronbrener (2002) has shown that joint laxity is a significant risk factor for arm and wrist pain in musicians. In Ortmann's landmark book on the physiological basis of piano technique, he recognises that the joints should move through their mid-range in order to produce maximum accuracy with minimum fatigue (Ortmann, 1962). In contrast to the relaxation schools, he proved that coordinated movement at the piano required a balance between insufficient and excessive fixation. This balanced fixation requires all finger joints to be stabilised so that the load is shared, as when one joint is not functioning well others tend to overcompensate. This can be seen when one joint begins to protrude excessively, or when extraneous and unnatural looking finger movements become part of the technique.

The support of the fifth finger needs particular care. Classical piano repertoire often requires greater projection of the upper voice in order to define clearly the melody; it is here [the upper register of the piano] that the strings are shortest and less resonant. Therefore, the player often has to use extra weight in the weakest part of the hand. A child's hand requires careful build up of the ulnar side in order to develop the support of the MCP joints particularly of the fifth finger, so that the projection of the upper voice does not stress the musculature.

Finger lifting

Lifting the fingers high was thought to strengthen the fingers in much of the teaching in the nineteenth and early-twentieth centuries. However, since high vertical finger movement is generated from the digital extensors in the forearm, this practice was generally unhelpful and did not always develop the speed and agility intended. When the

fingers are excessively curled and lifted individually, extensor muscles are working against flexor muscles, which is impossible to do without tension. I believe that lifting the finger is not necessarily damaging and is an important part of release, as long it is not an individuated movement, and other non-playing fingers are free to lift together in a coordinated way.

Independence exercises

Finger independence exercises involving holding keys down with some fingers while lifting others were common practice in pedagogical circles throughout the twentieth century. However, independence exercises use opposing muscle groups, with flexors working unnecessarily against extensors, and cannot be done without tension in the forearm. The fingers work best when they are free, and in most piano repertoire it is only rarely that one is required to perform this kind of action. Therefore, I believe that these exercises should be avoided in the training of young pianists.

Alignment

Ulnar deviation, where the wrist is habitually twisted towards the thumb is a common pianistic habit, possibly caused by the unequal lengths of the fingers and by the fact that the child often begins piano instruction with thumbs on middle C. If future initial tutor books were to begin with the hands an octave or two apart, this would more easily reinforce a natural playing position in the early years. Ulnar deviation is potentially injurious (Wilson et al., 1993), but can easily be corrected as long as the pianist uses the length of the key when approaching black notes, and when playing on white notes allows the thumb to hang away from the keyboard while not in use.

Radial deviation (twisting the wrist towards the fifth finger) has been observed as a risk factor for dystonia in the work of Teresa Dybvig (2007), and can be corrected by releasing the elbow and allowing the fingers to move between the black keys. Radial deviation can occur in descending arpeggios where many pianists raise the elbow when crossing over the thumb, but this often leads to a lack of alignment in subsequent notes because the elbow fails to release. A biomechanically more natural way is to allow the thumb to release and soften as the other fingers cross over, thereby avoiding raising the elbow.

Hand position

Often the span of notes required is far wider than is natural for some hands, and therefore it is important to release from the stretched position, avoiding static hand positions wherever possible, so that muscles do not become stressed and endurance is possible. Before a note is played each finger should be as closely aligned to the axis of the key as

possible, by using lateral movement of the wrist. This means that each note has its own position and implies a departure from the development of a fixed hand position so often taught in the early stages of training. Rosset I Llobert (2010) suggests that the musician should strive to work out ways to minimise the effort required to pass between notes. This can be achieved by avoiding set hand positions, by constantly adjusting the position of the wrist in order to align the finger with the note prior to playing, and by releasing from that position immediately afterwards.

Avoiding excessive curling

My belief is that the hand works best when the fingers are softly curved, as is the case when the arm hangs loosely beside the body, and this is the position to establish when raising the hand to the keyboard. Playing with fingers that are too curled can result in the joints flexing excessively and may lead to the cramping often seen in pianists suffering from dystonia.

Release

Although hand size has been investigated as a potential risk factor for pianistic injury (Wilson et al., 1993) and reduced-sized keyboards have now been developed in order to reduce the strain on the pianists with small hand span (Yoshimura and Chesky, 2009), I believe that the problem of a small hand is often compounded by lack of understanding about release. Unless the hand is taught to release immediately after stretching over wide hand spans, the stress generated by such complex and awkward repetitive movements at speed may be a significant factor in the development of focal dystonia (Wilson et al., 1993).

Key-bedding

Once the sound is heard, extra pressure on the note is unproductive. Even while holding a long note it is possible to release the pressure as otherwise the progression to the following note becomes much more difficult. Harding et al. (1989) have suggested that release should happen slightly before the key reaches the key-bed in order to prevent unnecessary pressure at the base of the key. This concurs with the theory of Dorothy Taubman, who stressed that the pianist should aim for the 'point of sound', which occurs just before the end of the motion of the key (Mark et al., 2003, Taubman, 1984).

Sound

The quality of sound is also an important tool, as when the musician simultaneously hears, understands and feels the result of a biomechanically perfect movement, it is more easily reinforced. Musicians are naturally aware of sound, which is at its best when the body is

free of unwanted tension. This is particularly important in the playing of loud chords where lack of release from the key-bed will produce a harsh tone. Therefore by encouraging sensitivity to sound we can also assist the student's body awareness.

Practice habits

Dr. Jaume Rosset I Llobert cites the way of playing as prime factor in the development of focal dystonia (Rosset-Llobet and Pascual-Leone, 2010). This includes not only biomechanical issues but also practice habits.

In a study using primates, Byl (2007) showed obsessive behaviour to be a precursor to the development of movement disorders: the animals that varied their task by using arm as well as finger movements, took breaks and performed more slowly did not develop a disorder. Similarly, incessant repetition of certain problematic passages, especially when the way of playing causes tension, can put musicians at risk. Highly motivated practisers tend not to vary the material in their practice sessions, meaning that there is too much repetition of the same physical movement. Pressure to succeed can result in excessive bouts of practice in order to achieve quick-fire results because of a looming deadline. Difficult passages that are outside the natural range of comfort are often repeated incessantly without sufficient breaks, using excessive force and speed. Practice sessions should involve not only physical but also mental and aural work (Rosset-Llobet and Odam, 2007). Different kinds of repertoire should be included in each session, using a variety of physical movements. Safe methods of practice with regular breaks are rarely taught and seldom adhered to. Stopping and evaluating the musical result between repetitions is a valuable practice tool and should be instilled into all students.

Fast practice

Most teachers understand the benefits of slow practice. Not only does this allow the fingers to be sure of their notes, but it also enables clear ideas of phrasing, dynamics and musicality. However, fast practice may also be a risk factor for injury. When pianists practise too fast the speed of consecutive finger action may exceed cerebral discrimination and this may cause blurring of the cortical map (Rosset-Llobet and Pascual-Leone, 2010).

Stress

Jabusch et al.(Jabusch and Altenmüller, 2004), have shown stress and anxiety to be risk factors for the development of focal dystonia, and this is heightened when musicians practise incessantly in order to perfect a passage. A more balanced and less competitive attitude to practice and performing needs to be established from the early years of instrumental training in order to avoid unrealistic perfectionism (Altenmüller and Jabusch,

2010). A forthcoming competition can assume far too great an importance, stretching the physical capabilities of the pianist before the basics of technique are fully developed. It is of vital importance that the early technique is established on sound foundations, so that the demands of more complex repertoire do not stress the body in later years of study and performance.

Intensity of practice

Most pianists are unaware of the risks of physical misuse. Any change of activity where the amount or intensity of practice is suddenly increased poses the greatest risk for any pianistic injury (Sakai, 2008, Wristen, 2000). An unexpected engagement or insufficient time to learn new repertoire often contributes to additional pressure on the life of the musician. With these increased demands it becomes paramount for each musician to understand how to work in a biomechanically favourable way.

It is often the highest achievers who are most at risk from injury. They are the perfectionists who are highly motivated and have great powers of concentration. At university level, constant deadlines are paramount as economics dictate shorter and shorter semesters with reduced lesson times and less individual instruction. In past generations it was possible for a student to have more than 40 lessons in a year, but now some universities advocate only 26. The result of these economic restrictions is less closely monitored practice with more pressure to succeed. The years of the 1930s when young pianists had a mentor who taught them almost daily (B. Wild, 1970, personal communication) are well gone and there has been a price to pay.

Coordinated Technique

A coordinated technique involves a balanced use of larger muscles so that the smaller muscles do not get overused. A coordinated technique also involves a balance between fixation and relaxation (Ortmann, 1962). Instability in any of the finger joints (described as joint laxity) leads to weakness in the hand and overuse of other joints or muscles, as well as leading to increased muscle tension (Brandfonbrener, 2000). This potentially injurious hand use can be corrected pedagogically, by encouraging a balanced use of the joints and muscles so that the load is shared.

However, few understand how to correct these technical faults. So often there is an inadequate awareness of biomechanically unfavourable movements in the initial learning of the instrument that might cause problems to surface years later. Ever since the time of Chopin and Liszt, various schools of technical thought have emerged to solve the problems of managing the increased key weight of the piano. This has led to some confusion about

technical training. Most teachers teach in the way that they were taught, but much that was taught in the last century was not based on knowledge of biomechanics. A number of technical practices still in use such as training with a high percussive finger action are simply dangerous (Wristen, 2000).

Injury Preventative Teaching

Healthy technique is injury preventative technique. Laying the foundations takes time, and every skill should be built on the mastery of a previous skill. Unlike other instrumentalists, who tend to spend hours establishing a tone, pianists can make a sound by simply depressing a key. Therefore there is the temptation to move on to the next piece without spending the necessary time on the fundamentals. The most beautiful tone can only be achieved when the body is working in a balanced way. If demanding repertoire is assigned before technical stability is sufficiently established, the physical compromises necessary to negotiate difficulties in musical performance can create unnecessary tension. Advanced repertoire becomes impossible if the basics are not in place, and teachers need some knowledge of biomechanics in order to correct a poorly balanced technique that could lead to later injury.

Teachers need to know how to assess the danger points, how to diagnose the technical problems that arise at every stage in a developing pianist. The early warning symptoms of distorted joint positions, incoordination, fatigue or slowness in passagework need to be taken seriously and solved before moving on and causing further damage (Wilson et al., 1993). With greater awareness and understanding of the early symptoms of focal dystonia, the development of this condition can be arrested by early intervention. Pianistic injuries are usually avoidable, and it is our responsibility as piano teachers to closely monitor the way students use their hands.

Gifted students are the ones who are most reluctant to report pain or discomfort to the teacher. They are also the ones who are most likely to suffer from stress due to the physical and emotional demands they put on themselves. There is a fine line between healthy effort, achievement and over-anxiety, and this requires sensitivity on the part of the teacher. No competition is worth a damaged physique, and it is better to withdraw than suffer long-lasting injury. It is therefore extremely important for the teacher/student relationship to be such that the student is not afraid to admit to pain or lack of coordination, and also for the teacher to know when to seek medical advice.

Conclusion

My PhD thesis included a detailed description of the specific pianistic retraining technique that I have shown with scientific method to be effective in the treatment of focal dystonia. The body as a whole must be re-educated: movements are choreographed so that muscles and joints work in concert, resulting in a coordinated and balanced way of playing. Playing an instrument is not possible without some tension, but the musician must be trained to be aware of moments of tension and to release immediately, thus avoiding the build-up of unnecessary muscle activity. The most important aspects of this retraining are: postural correction, the breaking down of each action to its most elementary components, an understanding of tension and release, avoidance of radial or ulnar deviation, balanced joint support, and avoidance of static positions. However, these principles apply not just to injured pianists but to healthy ones too. By educating the body to move in a way that is as biomechanically perfect as possible, stress in the technique can be avoided and each step can be built on previous success. If incorporated into our studios, even from the earliest lessons, these principles can assist us as teachers to educate our students so that they can play for life.

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Dr Rae de Lisle, MNZM, is Associate Professor and Head of Piano at the University of Auckland. Her teaching has produced many outstanding young pianists, notably John Chen, winner of the 2004 Sydney International Piano Competition and the 2003 Lev Vlassenko Australasian Piano Competition who was taught by Rae for eleven years. Another of her students, Jason Bae was prizewinner in both the Bradshaw and Buono Competition in New York and the Perrenoud Foundation International Piano Competition and came second in the 2009 Lev Vlassenko Piano Competition. Many of her former students have now embarked upon successful musical careers in America, Europe and Asia. In 2011 she received the NICAI award for Sustained Excellence in Teaching at the University. Also in that year she received the Marie Vanderwart Memorial Award for outstanding service and commitment to fostering the love of chamber music in New Zealand.

Following eight years of study and performing in London, Rae returned to New Zealand in 1977 and for the next fifteen years was much in demand as a soloist, accompanist and chamber musician, playing throughout New Zealand, as well as in North America. She recorded regularly for radio and television in New Zealand, receiving the Mobil Award for the best classical recording in 1990. She played concertos on many occasions with the New Zealand Symphony Orchestra and most of New Zealand's regional orchestras.

In 2000 she set up the University of Auckland Academy of Music to nurture and inspire students from the ages of five to 18. She was Director of the Academy until 2005, when she resigned in order to concentrate on teaching and research at the university.

She is Artistic Director and founder of the Wallace National Piano Competition and Festival and was an adjudicator for the 2009 Singapore National Piano Competition and the 2012 Dublin International Piano Competition.

Over the past decade she has done extensive research into pianistic injuries and has completed a PhD on focal dystonia, which has led to presentations throughout the world.