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LONDON HAND THERAPY

# The Musicians Hand

## The Working Hand

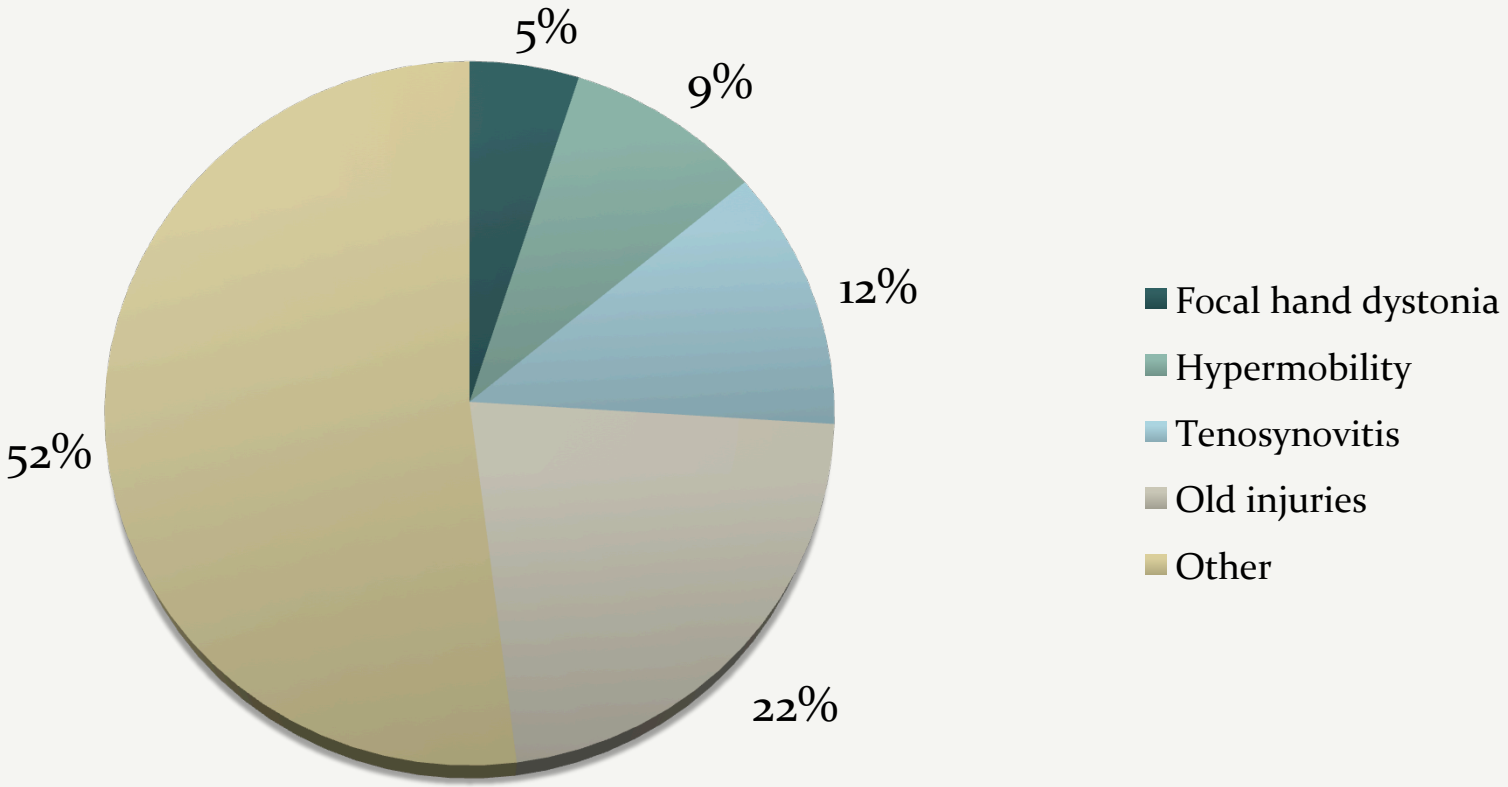
## Southampton Hand Course

## 27 June 2014

# Outline

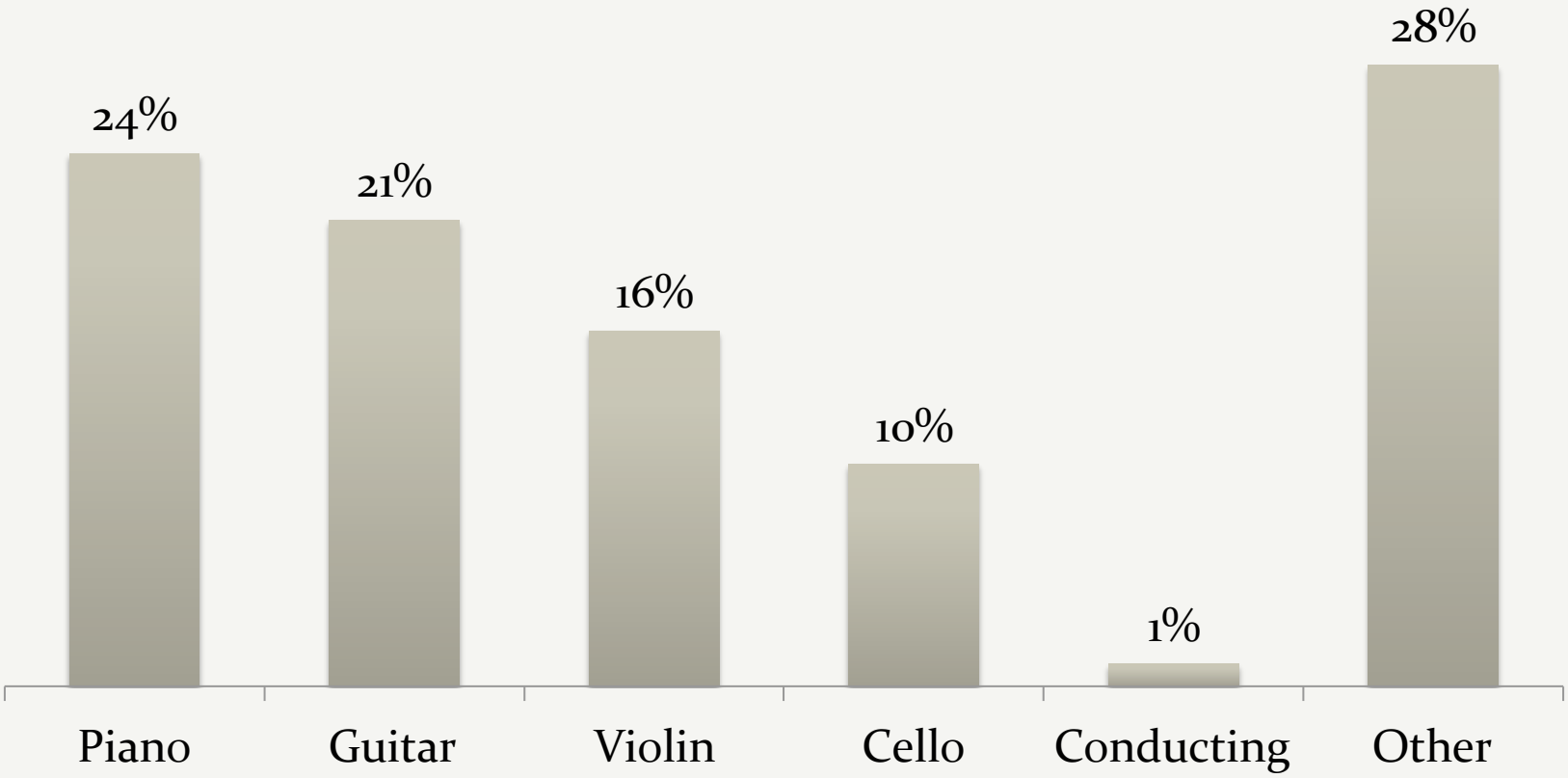
- Musicians injuries
- Assessment
- Diagnosis
- Treatments
  - Focal hand dystonia
- Current research programs
- Conclusion

# Aetiology




Wynn Parry, C.B. Managing the physical demands of musical performance. In: Williamon, A (Ed.), Musical Excellence Strategies and techniques to enhance performance, 2004: 41-60.

# Nonspecific Musculoskeletal Problems




Wynn Parry, C.B. Managing the physical demands of musical performance. In: Williamon, A (Ed.), Musical Excellence Strategies and techniques to enhance performance, 2004: 41-60.
N= 539

# Research

- 41% organic lesion, 4% require surgery
- 50% ↑ playing time, change technique & repertoire
- 40% suffered technical problems
- 19% suffered stress & anxiety

Butler & Winspur, 2009
Winspur, 2003
Wynn Parry & Winspur, 1997

# Athletes Compare to Musicians

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- Rapid, complex and co-ordinated movements
- Perform to limits of abilities
- No medical team or masseurs
- Less than ideal postures
- Noise, poor facilities, tours, alcohol & drugs


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Marshall
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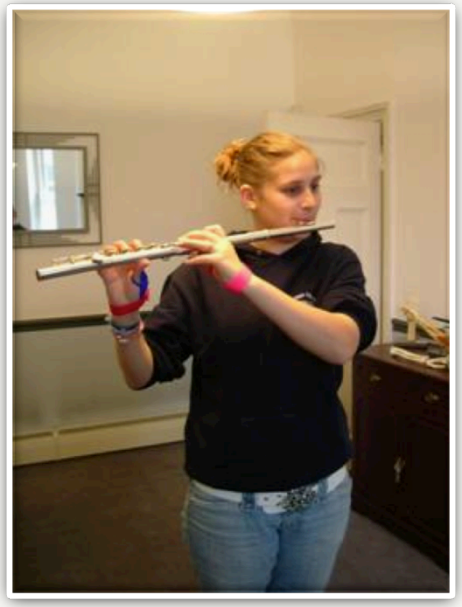
# Assessment

- Whole body examination
- Any deformities and PMH
- Assess on the instrument
- Instrument history
- Correlation between hand & arm pain and hypermobility*
- Provide a diagnosis
- Instigate treatment ASAP
- Return to instrument ASAP



* Branfonbrener, 1990

# Specific Conditions

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- Misuse and overuse
- Tendonopathies
- RA and OA
- Neck and shoulder strain
- Hypermobility
- Dystonia

# Treatments

- Patient education
- Ice
- Compression
- Electrotherapy
- Splinting
- Exercise
- Sensory re-education
- Postural re-education
- Acupuncture
- Taping
- Ergonomic advice
- Activity modification
- Biomechanical considerations
- Relaxation training
- Breathing
- Myofascial release
- Nerve glides
- Injections
- Surgery

# Focal Hand Dystonia

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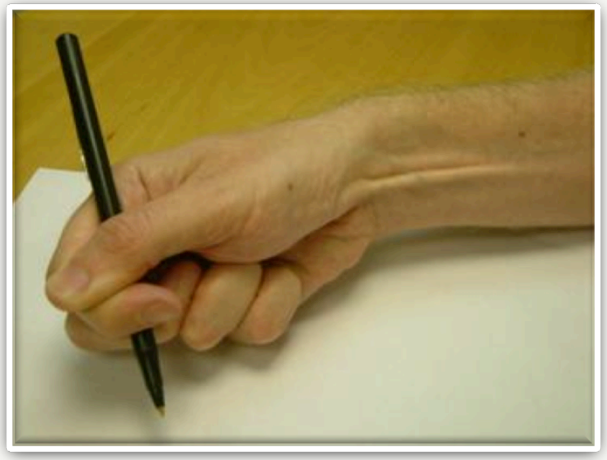
## Definition

Involuntary prolonged muscle contractions → sustained twisting postures of the affected body part(s) (Fahn,1998)

## Classifications

- Age of onset
  - early <28years
  - late >28years
- Aetiology
  - Primary (Idiopathic)
  - Secondary (Symptomatic)
- Symptom distribution
  - generalised, hemi, segmental or focal



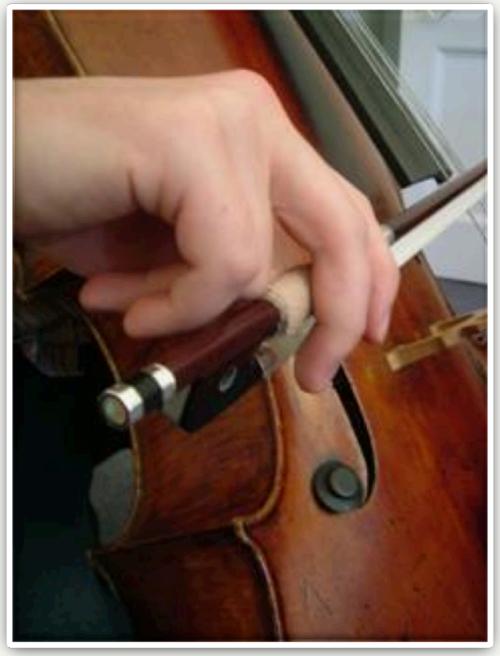
Writer's cramp

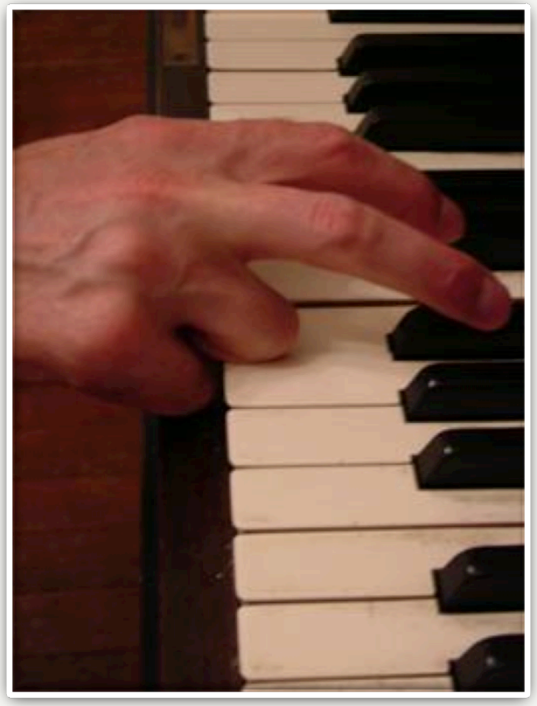
Embouchure dystonia

# Musician's Dystonia

- Incoordination
- Task specific
- Late onset
- Focal
- Primary
- Painless

Kanakovic & Shale, 1989; Lederman, 1991; Branfronbrener, 1995; Frucht et al., 2001; Altenmüller 2003; Butler et al., 2006





**FHD in musicians showing motor incoordination in pianist's & cellist's right small & ring fingers**

# Are Musicians Movements Special?

- High level of training
- Repetitive patterns
- High temporal & spatial precision
- Sensory & auditory feedback control
- Emotional content
- Do specific movements produce specific brains?

# Sensory Tricks

**Coban & Blu-Tack bow 'build-up' to ↑ proprioceptive awareness**

**Cellist utilising latex glove as a sensory trick**

# Epidemiology

N= 144

Professional musicians = 2-10%

Mean age of onset = 33 years

Male : Female = 2-6 : 1 ← male

**Position**

51% soloists

17% tutti orchestral players

17% music teachers

15% students

good players

**Instrument**

28% keyboard

26% woodwind

20% plucked instruments

15% bowed string instrument

11% brass

hard workers

**Type of music**

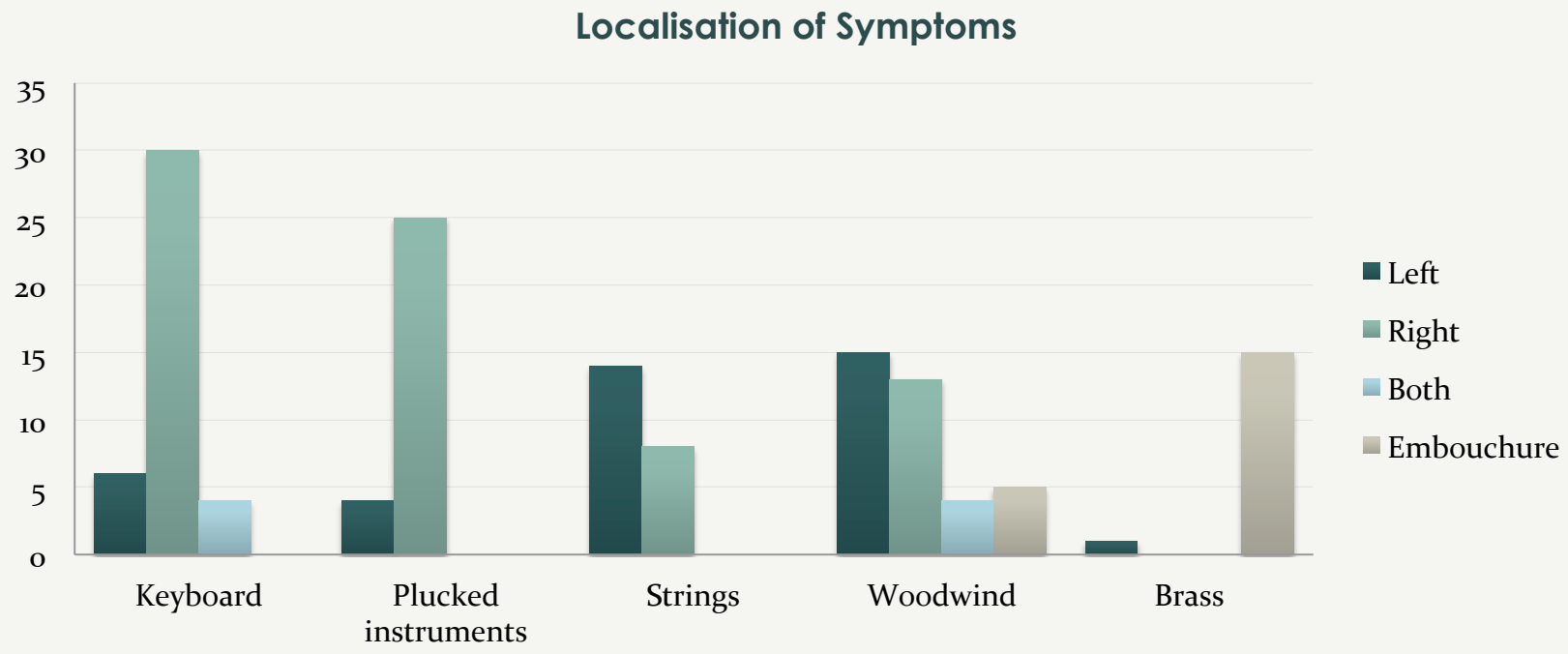
95% classical

4% pop

1% jazz

performance constraints

# Symptom Manifestation




| | | |
|---|---|---|
| **Where** | 86% | focal hand dystonia (80% unilateral) |
| | 14% | embouchure |
| **When** | 66% | only when playing instrument |
| | 34% | additional difficulties |
| **Movement** | 97% | flexion of single/several fingers |

Jabusch et al., 2006

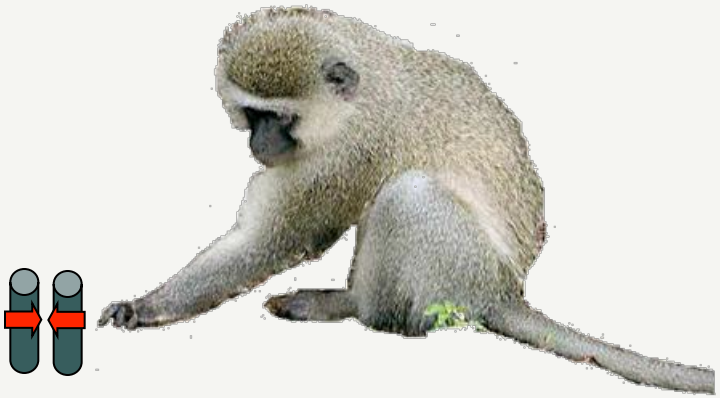
# Pathophysiology

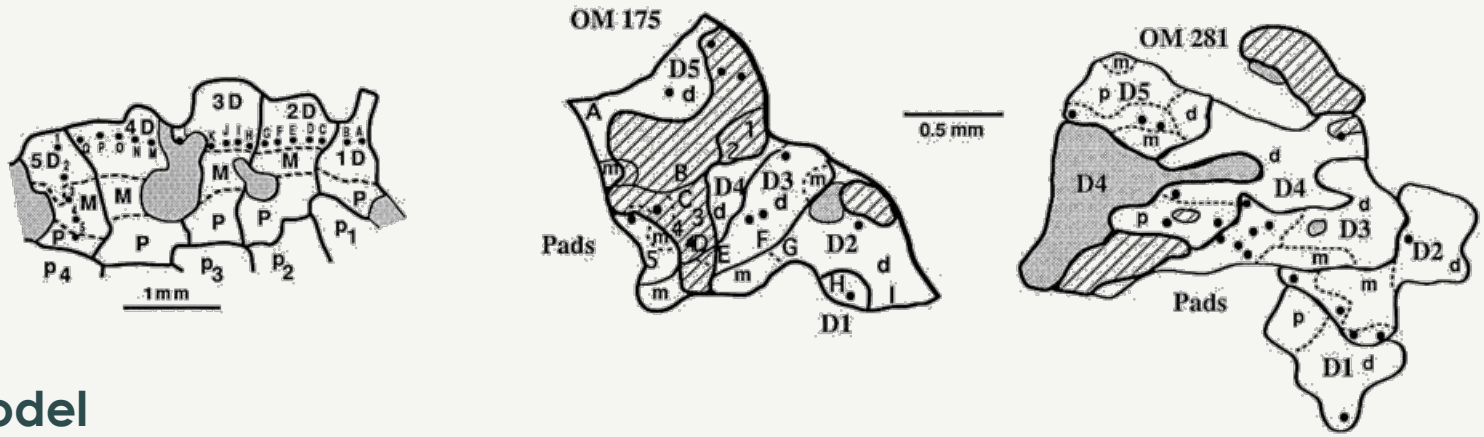
Few studies specifically on musician's dystonia

- Lack of inhibition on many levels of the nervous system
  - Spinal cord ↓ reciprocal inhibition
  - Motor system ↓ intracortical inhibition
- Impairment of sensory integration
  - Spatial discrimination impaired
  - Abnormal motor activation by sensory input
- Loss of somatotopic organisation in sensory/motor areas

➔ Complex sensorimotor network problem

Rosenkranz et al., 2005 Beradelli., 1998






## Model

Attended repetitive behaviours generates aberrant sensory representations

- Interfere with motor control
- Abnormal motor control strengthens sensory abnormalities

# Byl Model of Focal Hand Dystonia in Humans

sensorimotor integration fails

induces motor incoordination

→ disorganisation in sensory cortex

Most musicians are **not** affected!

Repetitive movements

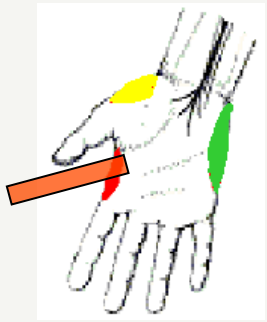
Sensory-motor feedback loop impaired

Rosenkranz et al., 2005

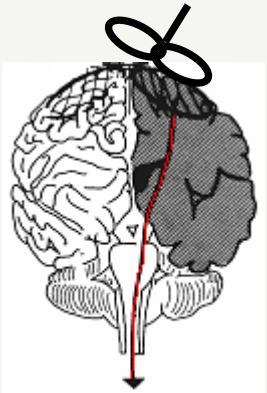
doi:10.1093/brain/awh402 *Brain* (2005), **128**, 918–931

# Pathophysiological differences between musician's dystonia and writer's cramp

Karin Rosenkranz,[1] Aaron Williamon,[2] Katherine Butler,[3] Carla Cordivari,[4] Andrew J. Lees[4] and John C. Rothwell[1]

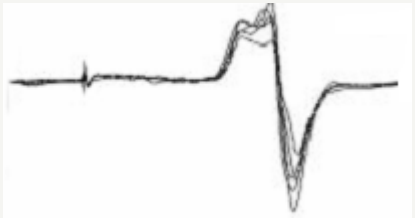


**Muscle vibration**



**Excite layers of cortex**

**Pre-vibration**



**With vibration**

# Results

- Healthy non musicians
  - Sensory input had effect on motor output
  - less significant results than that of healthy musicians

- Healthy musicians
  - spread of activation to nearby functionally related muscle
  - musical practise leads to **beneficial** adaptation

- Musician's dystonia
  - activation spreads too far
  - **mal-adaptation** begins to interfere with movement rather than assist it

- Writer's cramp
  - sensory input has **no effect** on motor output
  - sensory input/movement feedback plays smaller role in pathophysiology

Results mentioned in Jabusch et al., 2006

# Conclusions and Further Ideas

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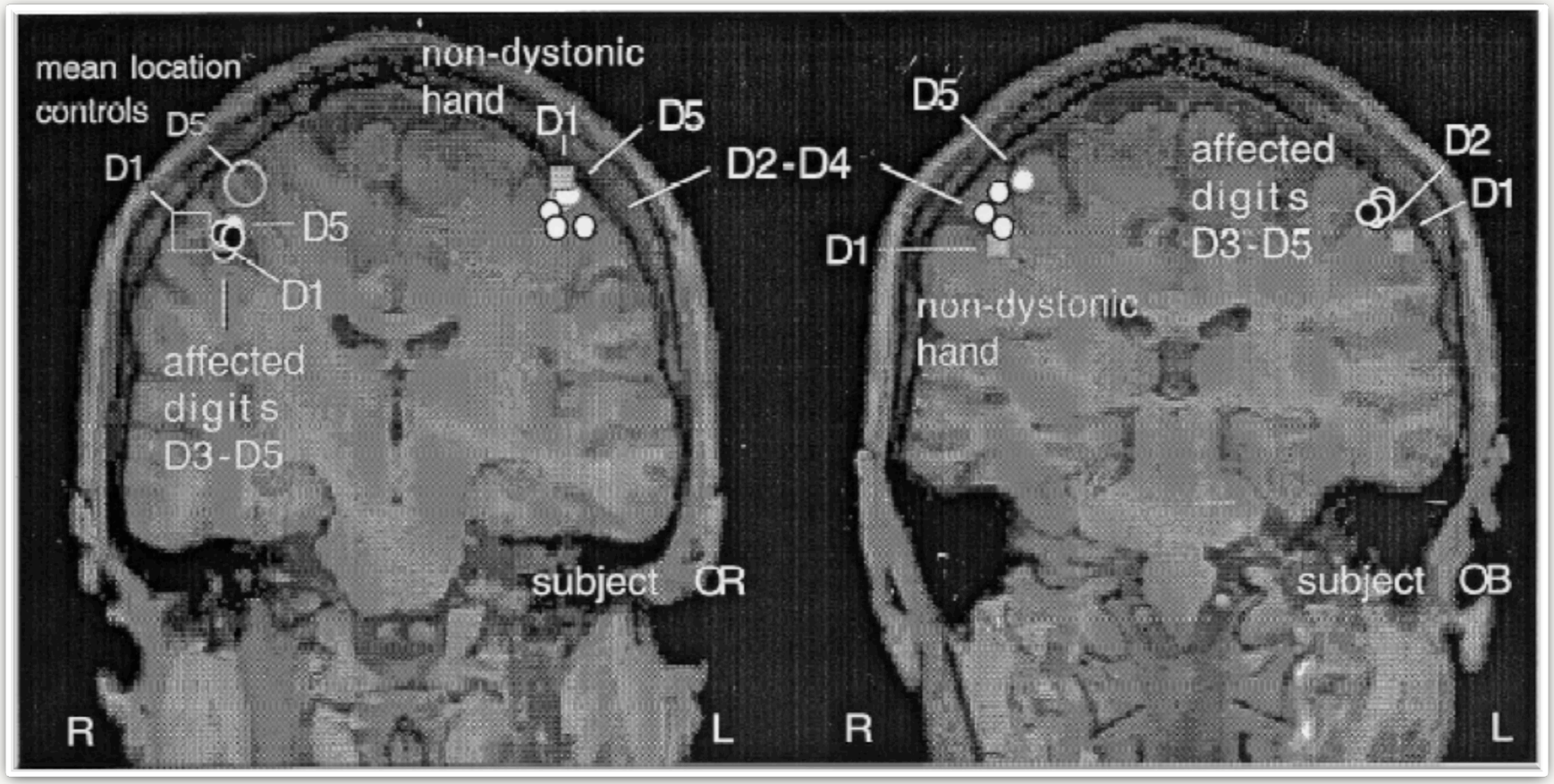
- Musical practice in healthy musicians → beneficial changes in organisation of motor cortex
- In MD these beneficial changes progress too far and begin to interfere with movement rather than assist it.
- Sensory input had no effect on motor output in patients with WC
- **Is MD a form of training-induced dystonia?**
- Does an **initial beneficial adaptation** of sensorimotor organisation **progress too far** → problems in targeting motor commands?

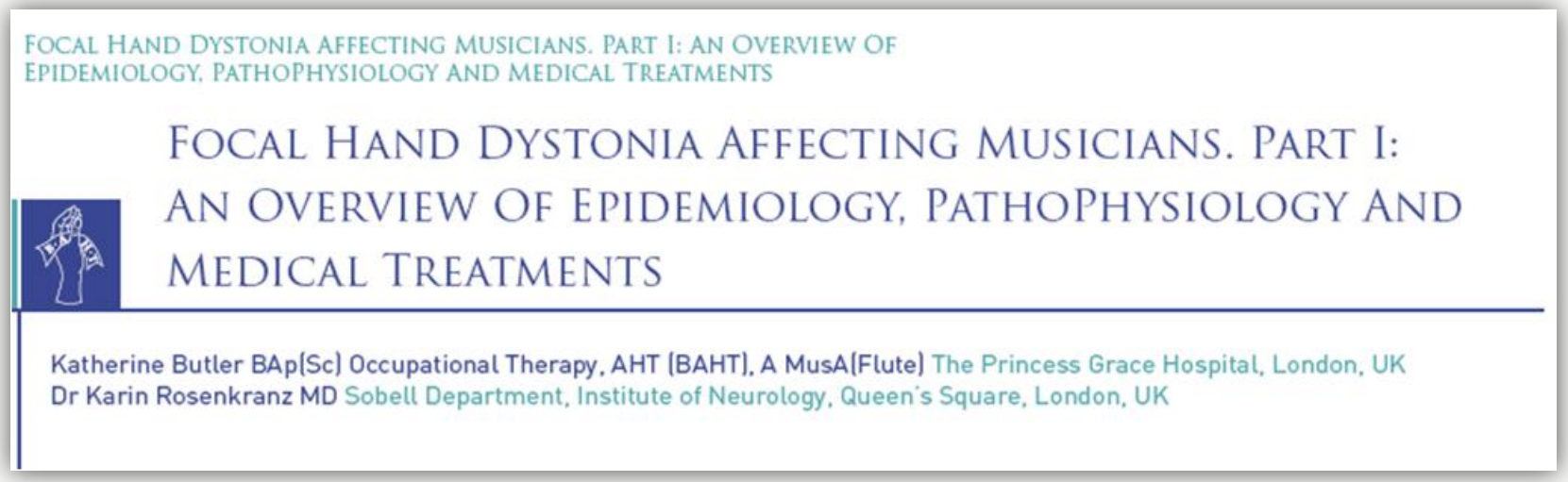
# Pathophysiology
# Disorganisation of sensory cortex




Elbert et al., 1998

# Musician's Dystonia


# Treatments for Musicians



FOCAL HAND DYSTONIA AFFECTING MUSICIANS. PART I: AN OVERVIEW OF EPIDEMIOLOGY, PATHOPHYSIOLOGY AND MEDICAL TREATMENTS

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FOCAL HAND DYSTONIA AFFECTING MUSICIANS. PART II: AN OVERVIEW OF CURRENT REHABILITATIVE TREATMENT TECHNIQUES

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# Medical Based Treatments

- Oral medications
  - Do not cure FHD, palliative treatment, side-effects limit use
- Botulinum toxin (Botox) injections
  - Not first treatment option for musicians, associated weakness of nondystonic muscles (Priori et al., 2001), injection treats muscle over activity not affected motor co-ordination (Cole et al., 1991)
- Surgery
  - Contraindicated (Winspur, 1998), severe cases with thorough planning (Marion, 1999), surgeon with extensive training and experience (Singer & Weiner, 1995)

# Rehabilitative Treatment Options

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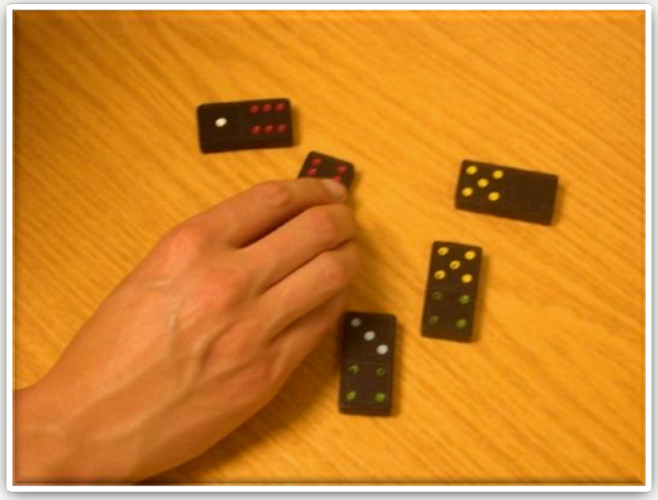
- Sensory re-education
- Sensory motor retuning
- Limb immobilisation
- Slow-down exercise therapy
- Proprioceptive training
- Multidisciplinary approach
- Instrument modification
- Prevention

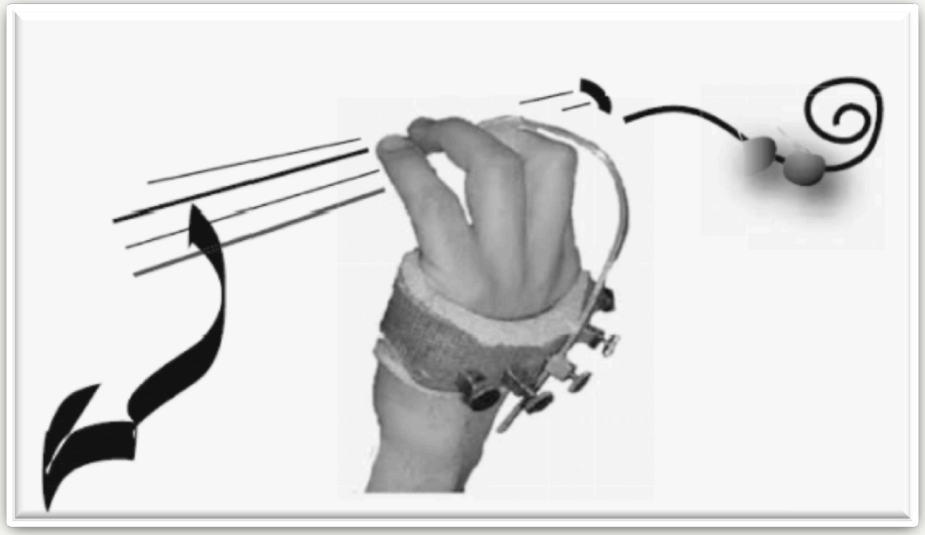
# Sensory Re-education

- Learning based restoration of hand representation
(Byl et al., 1996)
- Activities include: identification, discrimination, matching objects (Byl, McKenzie, 2000), vibration sensitivity, manipulating embossed letters
(Byl & McKenzie, 2000; Byl & Topp, 1998)



# Sensory Motor Retuning (SMR)

- Valuable treatment technique for pianists and guitarists (Candia et al., 2002)
- Alters movement patterns



# Limb Immobilisation

- Motor fatigue → transient improvement in dystonic symptoms due to cortical plastic changes
  (Priori et al., 2001; Pesanti et al., 2004)

# Slow-Down Exercise Therapy

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- 20 pianists with FHD

- Treatment has five steps
  1. Choose piece that causes FHD
  2. Reduce performance speed until no dystonic movement evident
  3. At slow tempo rehearses piece for ½ hour/day for 2 weeks
  4. After 2 weeks ↑ speed by 10%, if symptoms do not appear continue to practice at this tempi, if dystonic movement appears ↓ speed
  5. After 2 weeks gradually ↑ speed by another 10%

Sakai, 2006

# Neurology, 2008

## Sensorimotor reorganization by proprioceptive training in musician's dystonia and writer's cramp

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C. Cordivari, MD
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**ABSTRACT**

**Objective:** The sensorimotor organization (SMO) of the motor hand area is abnormal in focal hand dystonia and likely contributes to symptom manifestation. In healthy subjects SMO is changed by training with proprioceptive stimulation. Here we test whether similar interventions reverse the abnormal SMO in musician's dystonia and writer's cramp. If so, they could be developed for therapeutic application.

**Methods:** In six non-musicians, six professional musicians, six patients with musician's dystonia, and six patients with writer's cramp, SMO was explored by measuring changes in short-interval-intracortical-inhibition (SICI) during short periods of hand muscle vibration before and after two training types: AttVIB, involving attention to 15 minutes vibration of the abductor pollicis brevis (APB); and AttIndex, involving attention to subtle cutaneous stimulation of the index finger.

**Results:** In healthy non-musicians, baseline SMO is spatially differentiated: SICI is reduced in projections to the vibrated, but enhanced to the non-vibrated muscles. Here AttVIB increased and AttIndex reduced the effect of subsequent APB-vibration on SMO. In healthy musicians, baseline SMO is less differentiated. AttVIB reinstated a more differential SMO pattern while AttIndex attenuated the effect of APB vibration. In focal hand dystonia, SMO is completely dedifferentiated. AttVIB tended to restore a more differential SMO in musician's dystonia but not in writer's cramp while AttIndex failed to induce any changes in both groups.

**Conclusion:** The intervention effect depends on the pre-interventional sensorimotor organization (SMO). In focal hand dystonia, particularly in musician's dystonia, it is possible to retrain an abnormal SMO toward a more differential pattern, which has potential implications for therapy.

*Neurology*® 2008;70:304–315

**GLOSSARY**

**ADM** = abductor digiti minimi; **aMT** = active motor threshold; **ANOVA** = analysis of variance; **APB** = abductor pollicis brevis; **AttIndex** = vibration intervention with attention drawn on subtle electrical stimuli applied to the skin overlying the lateral base of the index finger; **AttVIB** = vibration intervention with attention drawn onto subtle changes of vibration frequency; **BFM** = Burke-Fahn-Marsden; **FDI** = first dorsal interosseus; **FHD** = focal hand dystonia; **MEP** = motor evoked potential; **SICI** = short-interval-intracortical-inhibition; **SMO** = sensorimotor organization; **TMS** = transcranial magnetic stimulation.

Abnormalities within and between the sensory and motor systems have been described in patients with focal task-specific hand dystonia, such as writer's cramp or musician's dystonia.[1-7] Previously, we probed the sensorimotor organization (SMO) of the motor cortical hand area with a paradigm that tests the influence of short periods of proprioceptive stimulation (muscle vibration) to small hand muscles on the excitability of motor cortical projections back to these muscles.[8,9] In healthy subjects, there is a very specific pattern of organization in which vibration of a muscle increases the excitability of motor cortical projections to the vibrated muscle, while at the same time reducing the excitability of projections to non-vibrated muscles.[8]

# Neurology, 2008

**'Sensorimotor reorganisation by proprioceptive training in musician's dystonia and writer's cramp'**

The results showed that:

- Healthy non-musicians baseline SMO is spatially differentiated
- Healthy musicians baseline SMO is less differentiated
- In FHD SMO is completely dedifferentiated

Therapy implications:

- It is possible to retrain an abnormal SMO toward a more normal pattern
- Does prolonged application of proprioceptive training improve hand motor function in FHD?

# The Journal of Neuroscience, 2009

The Journal of Neuroscience, November 18, 2009 • 29(46):14627–14636 • 14627

*Behavioral/Systems/Cognitive*

## *Regaining Motor Control in Musician's Dystonia by Restoring Sensorimotor Organization*

**Karin Rosenkranz,[1,2] Katherine Butler,[3] Aaron Williamon,[4] and John C. Rothwell[1]**
[1]*Sobell Department of Motor Neuroscience and Movement Disorders and* [2]*Department of Clinical and Experimental Epilepsy, UCL Institute of Neurology, London W1N 3BG, United Kingdom,* [3]*London Hand Therapy, London W1H 5TF, United Kingdom, and* [4]*Royal College of Music, London SW7 2BS, United Kingdom*

***Professional musicians are an excellent model of long-term motor learning effects on structure and function of the sensorimotor system. However, intensive motor skill training has been associated with task-specific deficiency in hand motor control, which has a higher prevalence among musicians (musician's dystonia) than in the general population. Using a transcranial magnetic stimulation paradigm, we previously found an expanded spatial integration of proprioceptive input into the hand motor cortex [sensorimotor organization (SMO)] in healthy musicians. In musician's dystonia, however, this expansion was even larger. Whereas motor skills of musicians are likely to be supported by a spatially expanded SMO, we hypothesized that in musician's dystonia this might have developed too far and now disrupts rather than assists task-specific motor control. If so, motor control should be regained by reversing the excessive reorganization in musician's dystonia. Here, we test this hypothesis and show that a 15 min intervention with proprioceptive input (proprioceptive training) restored SMO in pianists with musician's dystonia to the pattern seen in healthy pianists. Crucially, task-specific motor control improved significantly and objectively as measured with a MIDI (musical instrument digital interface) piano, and the amount of behavioral improvement was significantly correlated to the degree of sensorimotor reorganization. In healthy pianists and nonmusicians, the SMO and motor performance remained essentially unchanged. These findings suggest that the differentiation of SMO in the hand motor cortex and the degree of motor control of intensively practiced tasks are significantly linked and finely balanced. Proprioceptive training restored this balance in musician's dystonia to the behaviorally beneficial level of healthy musicians.***

### *Introduction*

*Intensive motor training induces structural and functional changes in the brain (Kleim et al., 2004; Rosenkranz et al., 2007b) but has also been associated with the development of focal hand dystonia, a task-specific disorder of hand motor control (Byl et al., 1996). Professional musicians are an excellent human model for long-term motor training, since most of them started playing at a very early age and the structural and functional changes observed in their brains depend on the age at which their musical training commenced (Gaser and Schlaug, 2003; Bengtsson et al., 2005; Rosenkranz et al., 2007a). Interestingly, the prevalence of focal hand dystonia among professional musicians (musician's dystonia) is higher than in the general population (Nutt et al., 1988; Altenmüller, 2003). Although some experimental findings in focal hand dystonia (Stinear and Byblow, 2004; Quartarone et al., 2006) are similarly observed in healthy musicians (Rosenkranz et al., 2007a) and therefore do not distinguish pathological from physiological reorganization, others show that structural and functional brain reorganization progressed from healthy musicians to musicians affected with focal hand dystonia (Elbert et al., 1995, 1998; Rosenkranz et al., 2005). One sensitive parameter is the integration of experimentally induced proprioceptive input from the hand muscles in the motor cortex [sensorimotor organization (SMO)], which we developed in previous studies (Rosenkranz and Rothwell, 2003). While healthy nonmusicians show a characteristic differential pattern of SMO, with reduced intracortical inhibition in projections to the vibrated muscle and increased intracortical inhibition in "surrounding" projections to the nonvibrated ones, this pattern was less well differentiated in healthy musicians and lost in musician's dystonia (Rosenkranz et al., 2005). Given the importance of proprioceptive input for motor learning (Pavlides et al., 1993), the changes observed in healthy musicians are likely to have developed during musical skill learning and to support performance at the highest level. However, in musician's dystonia, this reorganization might have gone too far such that it interferes with motor control rather than assists it (Rosenkranz et al., 2005).*

*If this association between the amount of sensorimotor reorganization and the level of motor control holds true, reversing the excessive reorganization in musician's dystonia toward the pattern seen in healthy musicians should reestablish motor control.*

*We have shown previously that a 15 min intervention with proprioceptive stimulation, which required the subjects' attention to be focused on the vibration, changes the SMO in musician's dystonia and makes it more similar to that seen in healthy musicians spontaneously (Rosenkranz et al., 2008). Here, we crucially expand these findings by investigating whether restoring a*

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*This work was supported by the Dystonia Medical Research Foundation, the Bachmann-Strauss Dystonia & Parkinson Foundation, and the Medical Research Council.*
*Correspondence should be addressed to Dr. Karin Rosenkranz, Department of Clinical and Experimental Epilepsy, UCL Institute of Neurology, 33 Queen Square, London W1N 3BG, UK. E-mail: k.rosenkranz@ion.ucl.ac.uk.*
*DOI:10.1523/JNEUROSCI.2094-09.2009*
 *0270-6474/09/2914627-10$15.00/0*

# The Journal of Neuroscience, 2009

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## 'Regaining motor control in musician's dystonia by restoring sensorimotor organisation'

Subjects (N=24):

- 6 healthy non musicians
- 8 healthy professional pianists
- 8 professional pianists affected by FHD

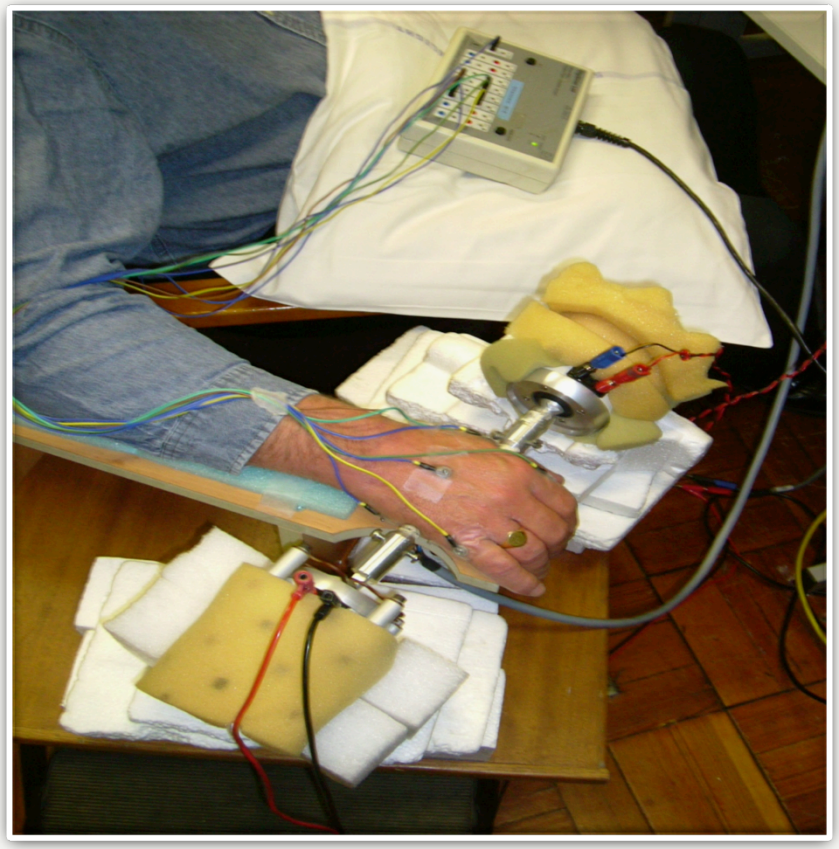
Intervention:

- Proprioceptive training (15 minutes of repeated cycles of muscle vibration of 2 seconds on, 2 seconds off) was applied in equal amounts to either APB, FDI or ADM muscles in random order. Subjects has to discriminate subtle changes of vibration frequency occurring during the vibration period.

Results:

- 15-minutes of proprioceptive input restored SMO in pianists with MD to a pattern seen in healthy pianists.
- Task specific motor control improved significantly and objectively (MIDI piano) and behavioral improvement was significantly correlated to the degree of SMO reorganisation.

# Proprioceptive Training



**Muscle vibration**

**TMS pulse in vibrated and other hand muscles**

# Piano Performance Test

Play 10 cycles of 5 finger exercises on musical instrument digital interface (MIDI) piano following metronome set at 200bpm. Loudness and musical notation were measured and assessed.

Neurology 2008; The Journal of Neuroscience 2009

# Conclusions

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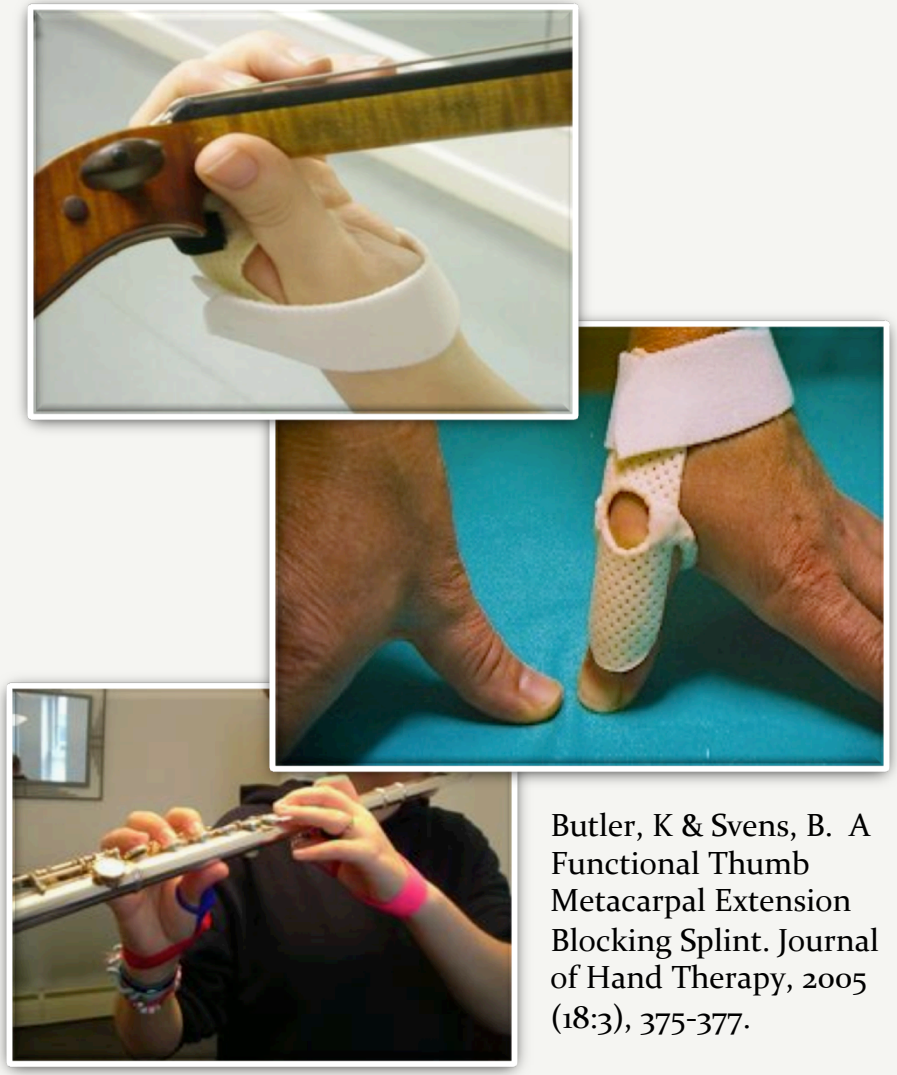
- Task specific motor control ↑ significantly & objectively (MIDI piano)
- Behavioral improvement was significantly correlated to the degree of SM reorganisation
- SMO and motor performance remained essentially unchanged in healthy musicians and non musicians
- Differentiation of SMO in the hand motor cortex and the degree of motor control of intensively practiced tasks are significantly linked and finely balanced

# Proprioceptive Training Works

*Proprioceptive training restores the balance between SMO in hand motor cortex and the degree of motor control in MD to the behaviorally beneficial level of healthy musicians*

# Multidisciplinary Approach

- No single treatment effective
  Hochberg et al., 1990
- Whole body / mind approach
  Kember, 1997; Byl, 2000; Chamagne, 2000 & Hochberg et al., 1990
- Rest
  Gowers, 1893; Poore, 1887; Hoppmann, 2001)
- Graded return to playing with psychological support
  Tubiana, 2000
- Hand therapy before pharmacology
  Hochberg et al., 1990
- Splints
  Lederman, 1998



Butler, K & Svens, B. A Functional Thumb Metacarpal Extension Blocking Splint. Journal of Hand Therapy, 2005 (18:3), 375-377.

# Current Research Projects

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1. An epidemiological study into focal hand dystonia in professional musicians: a long-term follow-up of 92 clinical cases

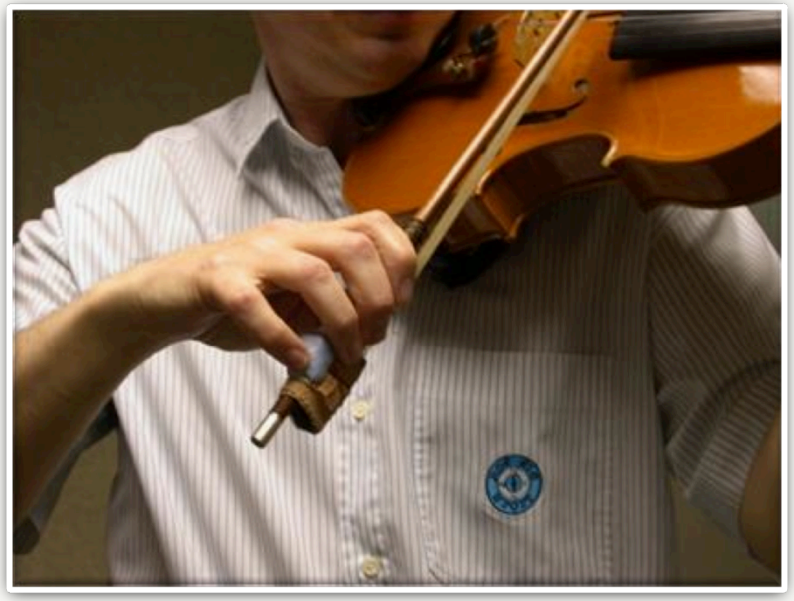
2. Epidemiology of 92 FHD patients using coded and anonymous patient questionnaire

3. Exploring the neuronal fingerprints of musician's dystonia using fMRI

4. Physical rehabilitation for task specific focal hand dystonia: A feasibility study

# Instrument Modifications

- Modifications to musical instruments can decrease FD symptoms (Hochberg et al., 1990) and increase proprioceptive awareness
- Smaller instrument, neck support, altering location or length of supports & altering bridge or string height



# Prevention of Developing FHD

LONDON HAND THERAPY

## Avoid

- Intense playing
- Instrument or technique changes
- New repertoire
- Unrelated activity or emotional stress (Sataloff et al., 1991)

## Instigate

- Sensible practice technique
- Utilise strong but flexible bodies
- Warm up & cool down
- Gradually ↑ intensity & duration of playing (Sataloff et al.,1991 & Slade et al., 1999)
- Maintain instruments (Hoppmann, 2001)
- Intersperse practice with other activities

# Return to Play Schedule

| Practice Sessions Per Day | Minutes of Playing |
|---|---|
| Two sessions Shadow Playing | 3-5 minutes |
| Two sessions On Instrument | 3-5 minutes |
| Two sessions | 5-10 minutes |
| Two sessions | 15 minutes |
| Two sessions | 20 minutes |
| Three sessions | 15 minutes |
| Three sessions | 20 minutes |

| Practice Sessions Per Day | Minutes of Playing |
|---|---|
| Four sessions | 20 minutes |
| Four sessions | 30 minutes |
| Three sessions | 45 minutes |

Start with **Simple**, **Slow** and **Soft** music.

Double minutes of playing every few days.

Drop back a level if pain is elicited.

A 5 minute break is encouraged every 20 minutes at the higher levels of playing.

Warrington, 2003

# Open Questions

- Why are only some musicians affected?
- Are there risk factors?
- Are there preventative factors?
- Could the adaptation mechanisms of the brain be used to “reverse” this process?

# Summary

- Increased focus on performing artists health
- Specialised, multidisciplinary, instrument focused approach (Warrington, J, 2003; Hochberg et al., 1983)
- Prevention is the primary aim
- Hand, arm pain and overuse are common
- Playing conditions often not good
- Rapid repeated movements required
- In FHD long term motor learning has an effect on SMO
- Intensive training ↑ likelihood of developing FHD
- There are treatment methods that can help FHD patients
- Research into effective treatments is continuing