

Music Teachers National Association **2018 National Conference**



Preventing Overuse and Curing Injuries: A Neurological-Psychological Perspective from a Physician-Flutist

Eckart Altenmüller

Institute of Music Physiology and Musicians' Medicine (IMMM)
Hannover University of Music, Drama and Media



eckart.altenmueller@hmtm-hannover.de
www.immm.hmtm-hannover.de

Structure

- Introduction
- Why Music?
- Music as a powerful driver of brain plasticity
- Topics of the Seminar – some “teasers”

What is difficult in making music?

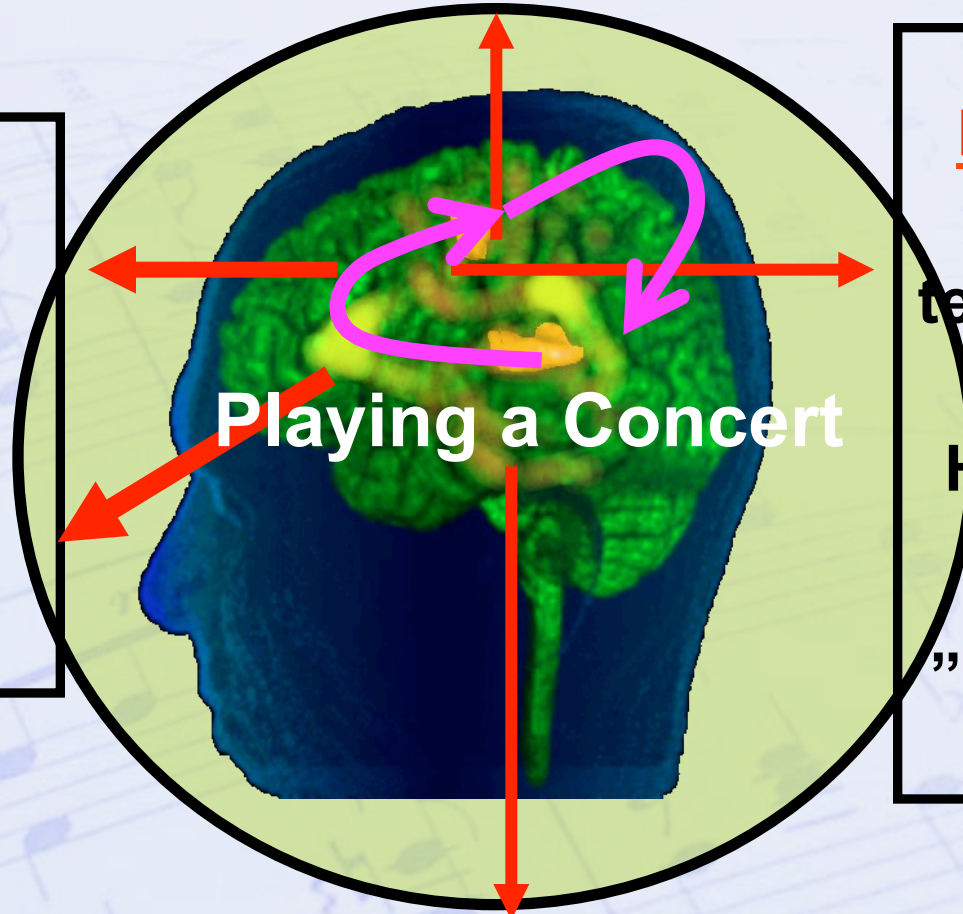


Movement: Complexity, speed of motor executive functions without an upper limit under rigorous control of the auditory system

Society:

presumed expectations of audience controlability

My future!



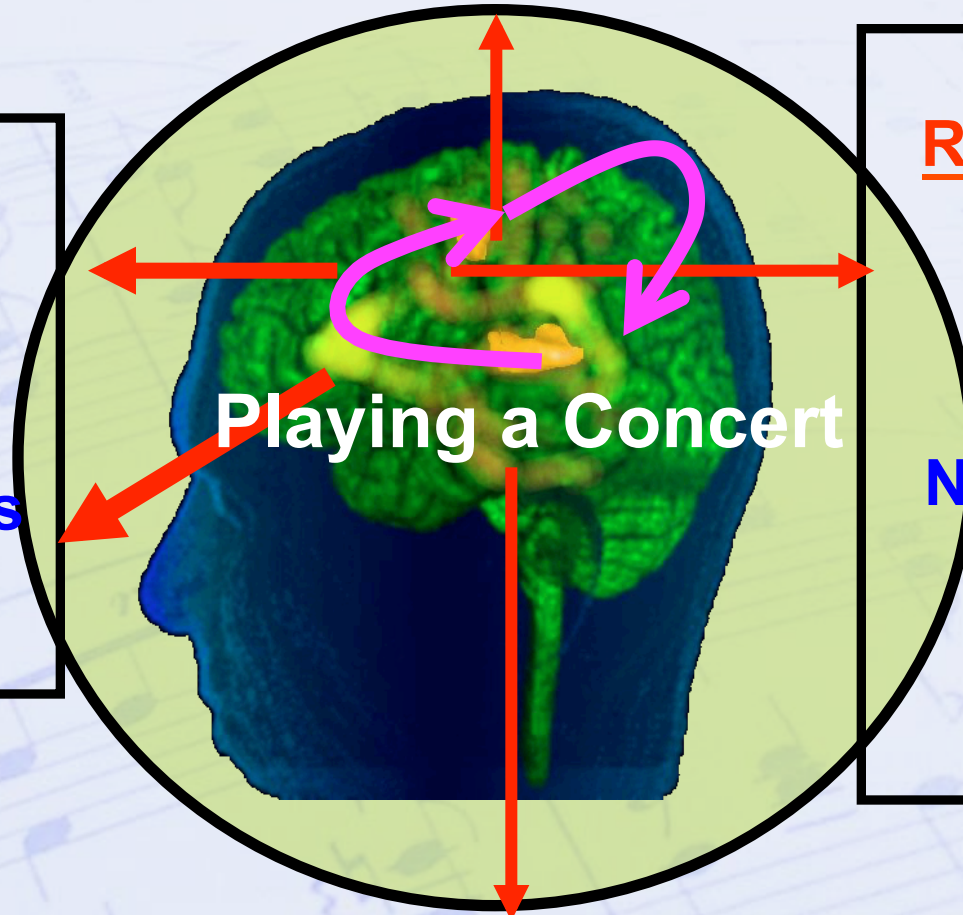
Reproduction:

predefined temporo-spatial constraints
High memory demands
„Error-culture“

Emotions: joy, chills, anxiety
artistic dedication

Movement: Repetitive long term practice,
behavioral shaping, temporo-spatial precision

Society:
My future!
Inner Peace:
Serotonin
Connectedness
Oxytocin



Reproduction:

Arousal:
Adrenalin
Noradrenalin

Emotions: Joy: Dopamin,
Endorphins, Fear: HPA-Axis

Practice is a prerequisite for excellence: 10 years - 10000 hours-rule of expertise

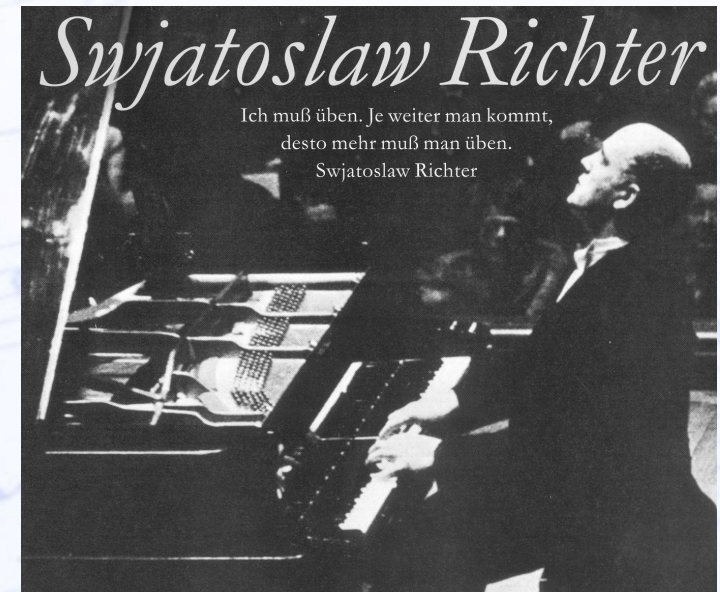
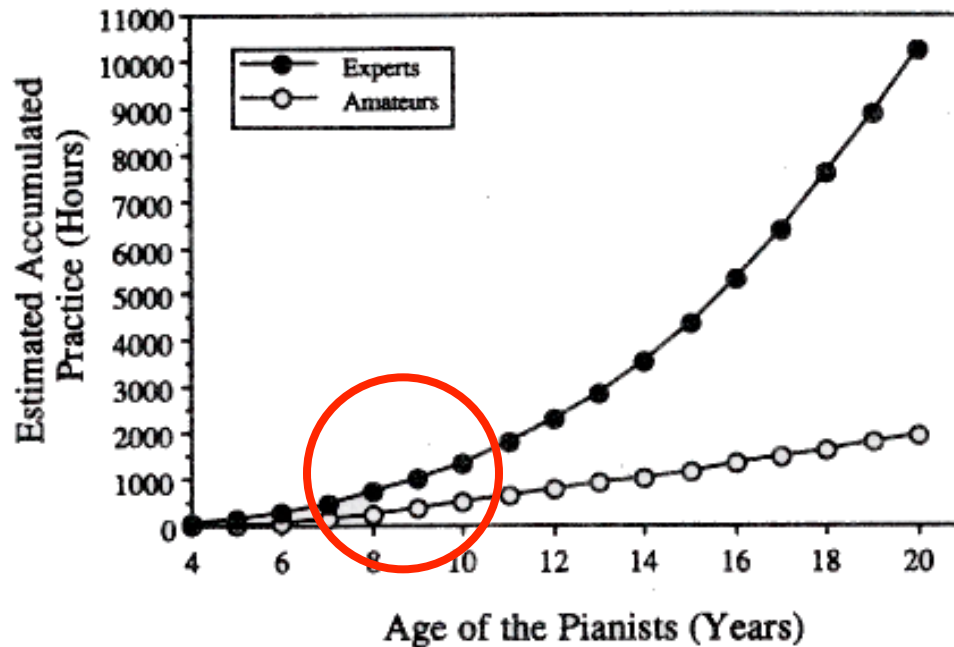
Psychological Review
1993, Vol. 100, No. 3, 363-406

Copyright 1993 by the American Psychological Association, Inc.
0033-295X/93/\$3.00

The Role of Deliberate Practice in the Acquisition of Expert Performance

K. Anders Ericsson, Ralf Th. Krampe, and Clemens Tesch-Römer

K. ERICSSON, R. KRAMPE, AND C. TESCH-RÖMER



Psychological Review 100, 1993

Clearly: Quality of practice plays a role

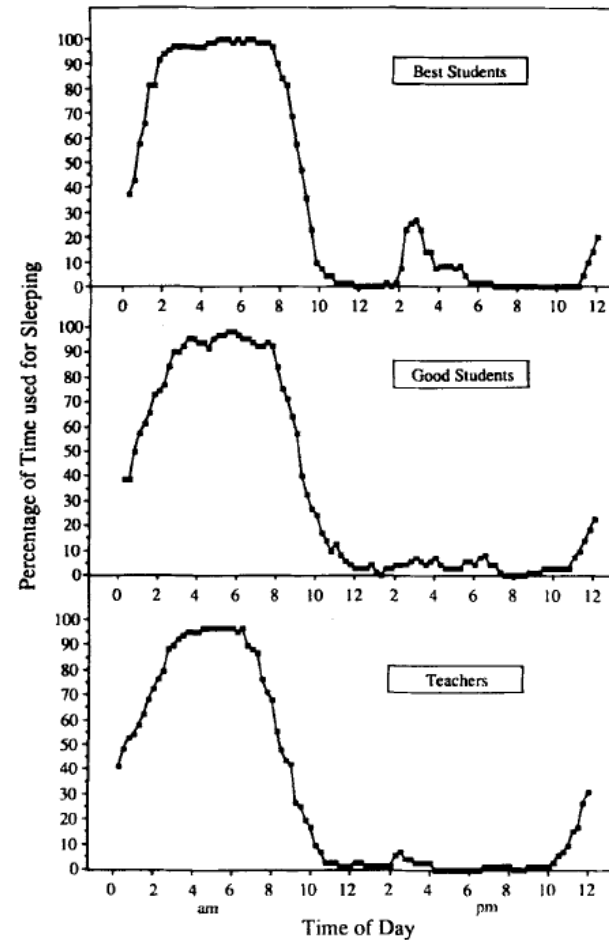
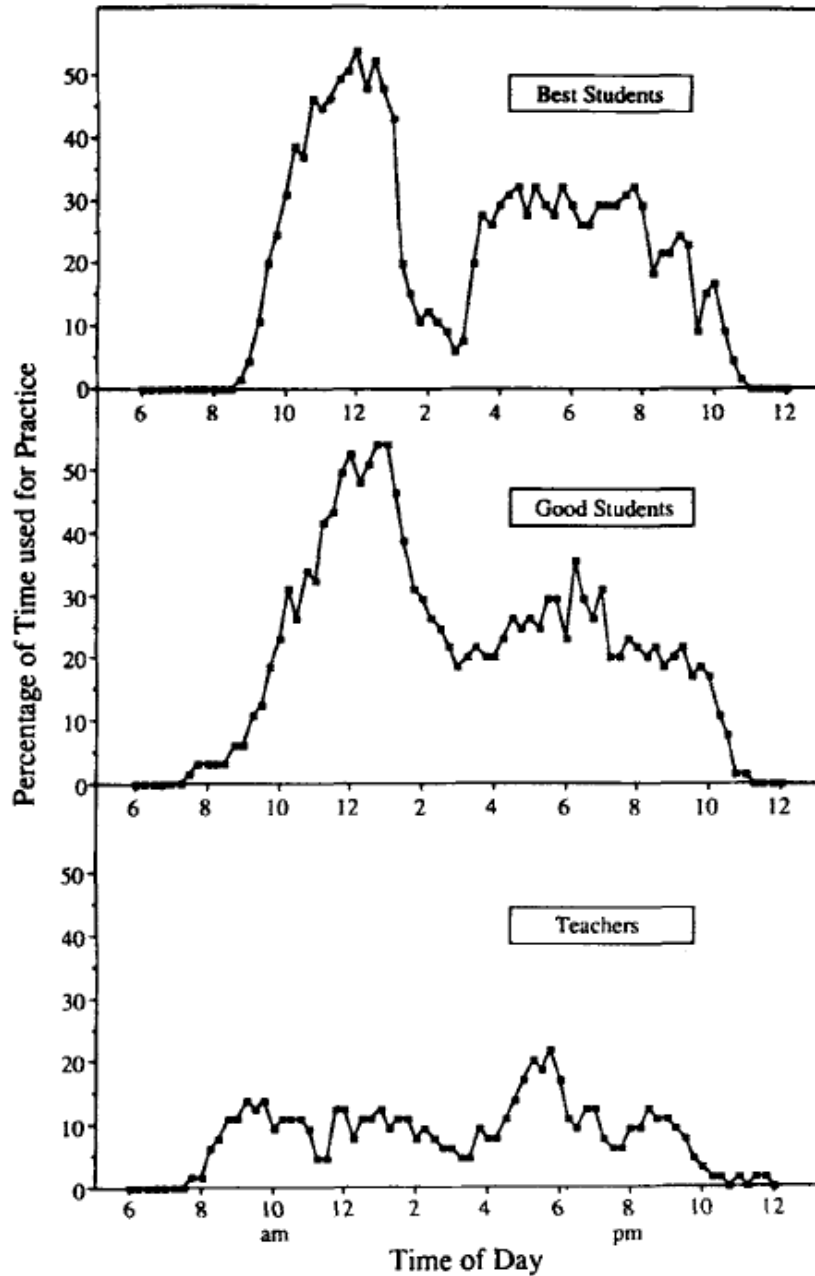
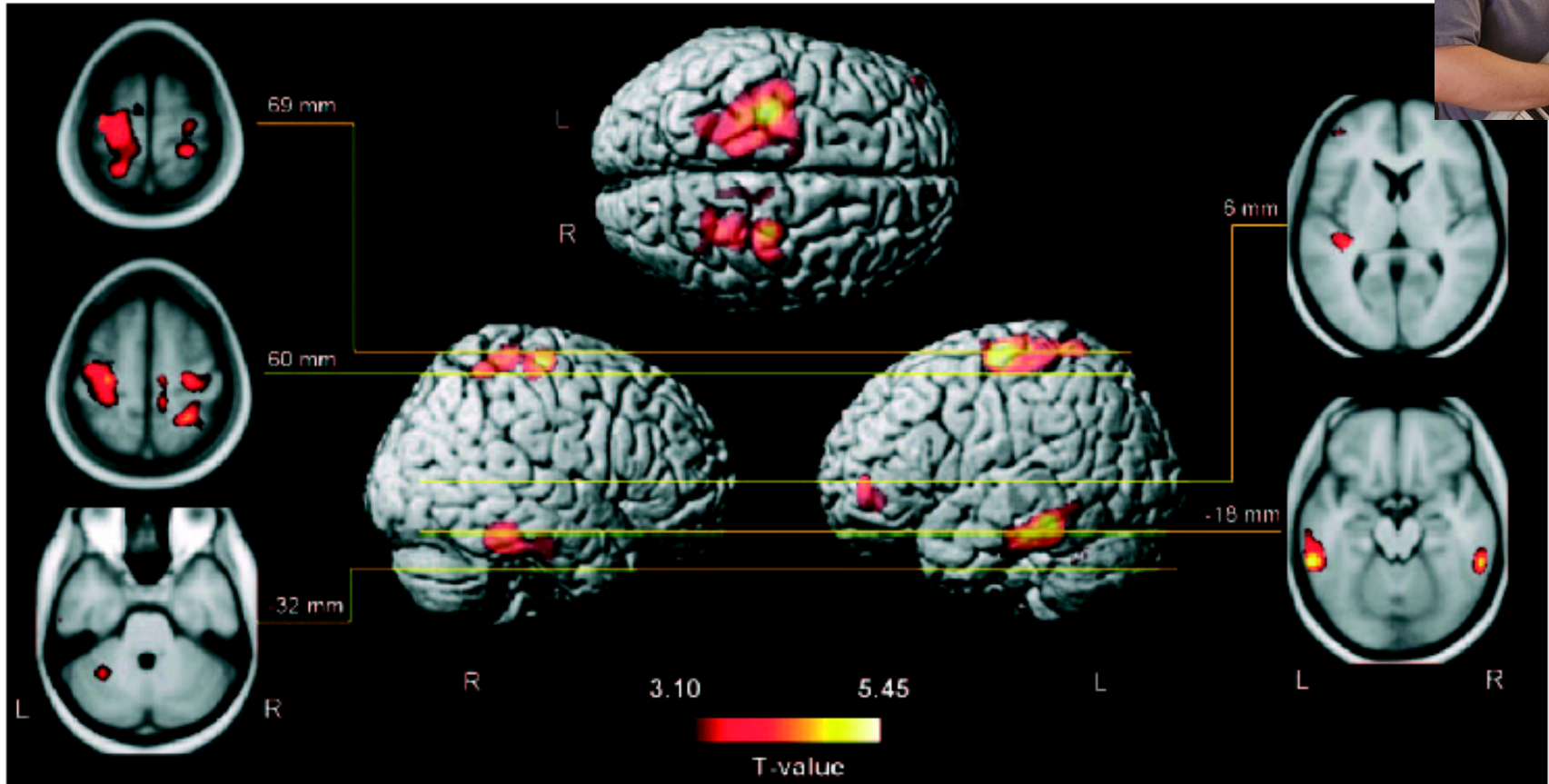


Figure 4. Proportion of time used for sleeping as a function of time of day for the best violinists (top panel), the good violinists (middle panel), and the music teachers (bottom panel).

Differences in Grey matter in Musicians

(Voxel-Based-Morphometry, Gaser und Schlaug 2003)



Brain regions demonstrating a positive correlation between musical expertise and enlargement of grey matter volume
20 Musicians, 20 Amateurs, 40 non-Musicians (only male)

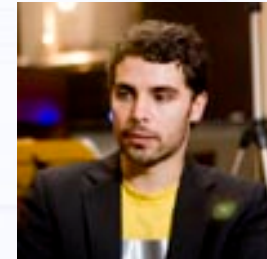
Making Music as a powerful driver of neuroplasticity



Felix Klieser, 17 years old:
Sporadic Amelia
..always wanted to play horn!

Scholz, D. et al. in preparation,

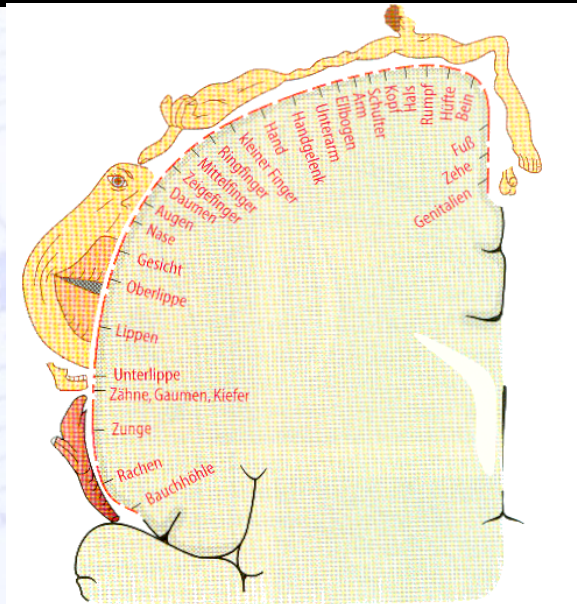
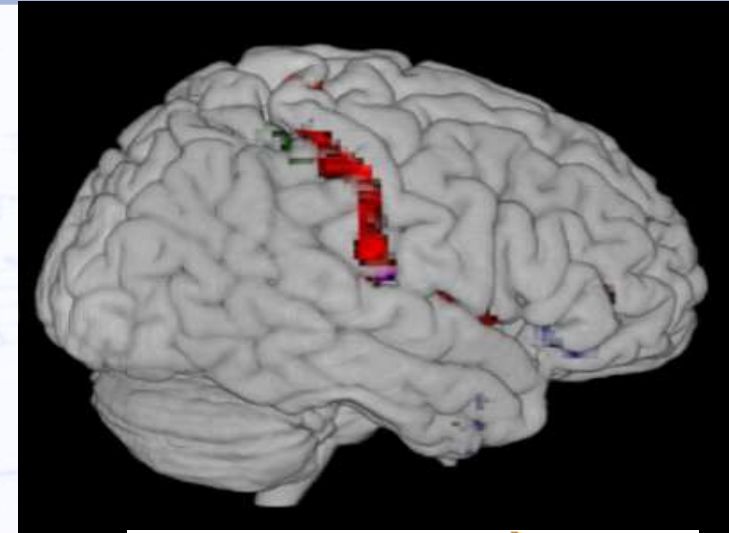
Mozart:
Concerto for
French Horn



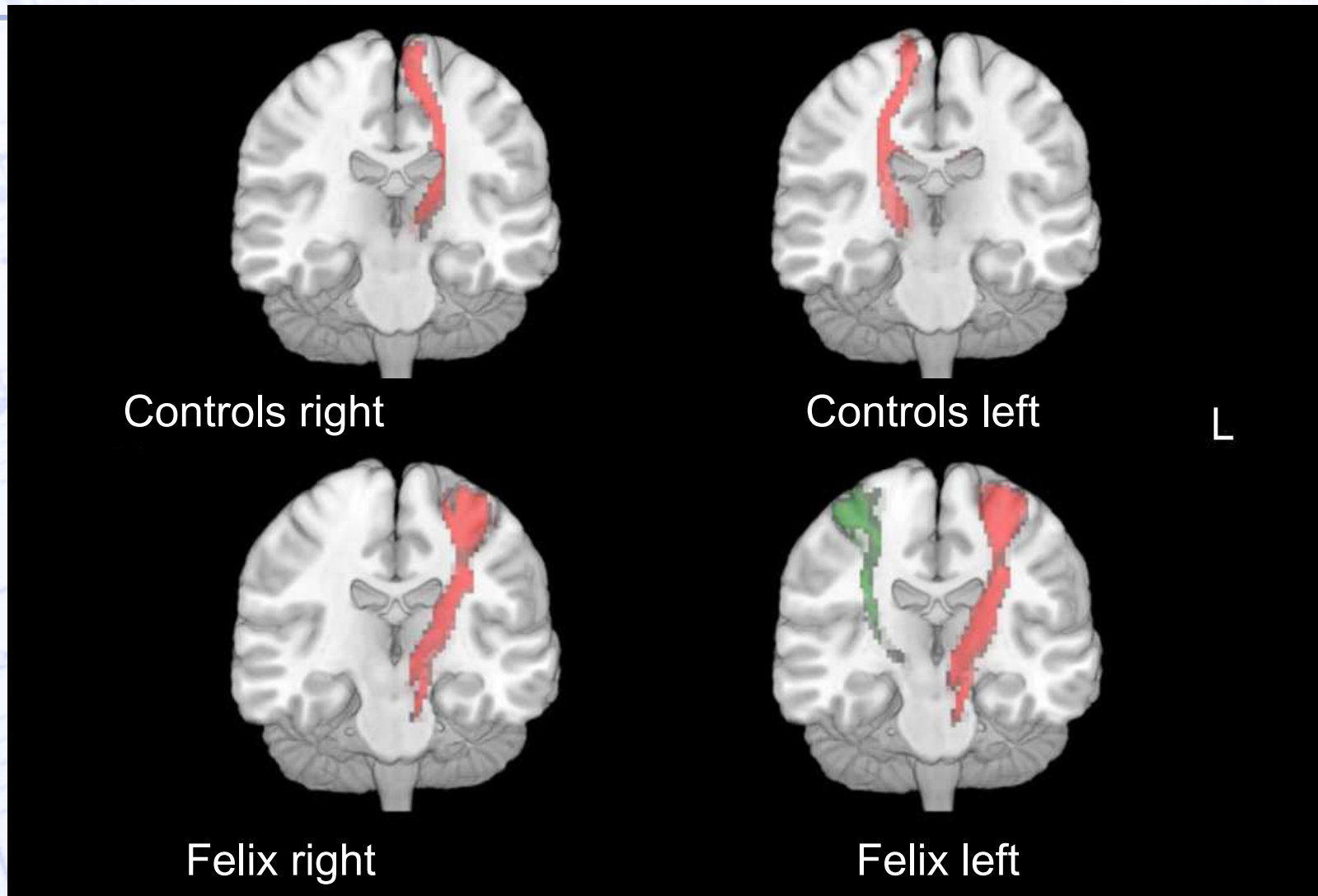
Daniel Scholz



Thomas Münte
Bahram Muhammadi



Probabilistic Tractography of the motor tracts during plantar-flexion



Scholz D, Münte TF, Mohammadi B, Altenmüller E, in preparation

Obviously, things are complex:

it seems that inverse „metaplasticity“ plays a role:

Early optimization! (see also work of V. Penhune et al.)

The Hannover – Barcelona Study with

Lucia Vaquero, Karl Hartmann, Nuria Rojo

Thomas Münte, Bahram Mohammadi and Antoni Rodriguez-Fornells

Methods: Voxel based morphometry and tensor based morphometry

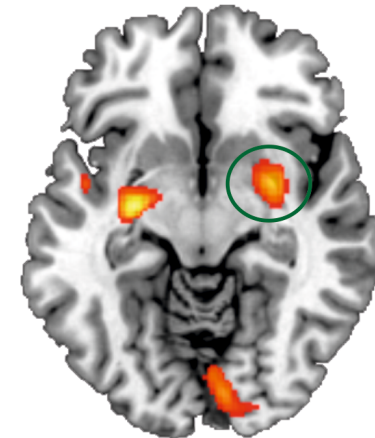
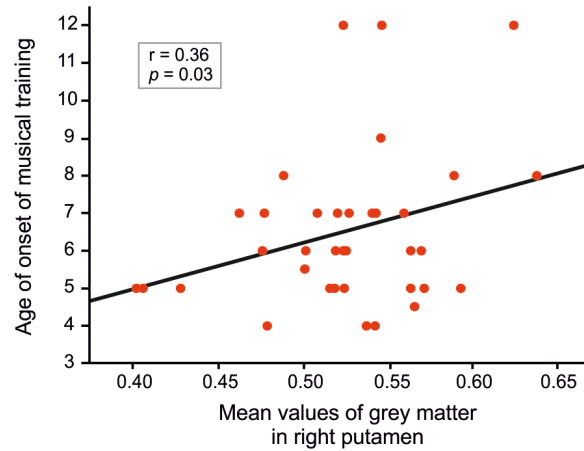
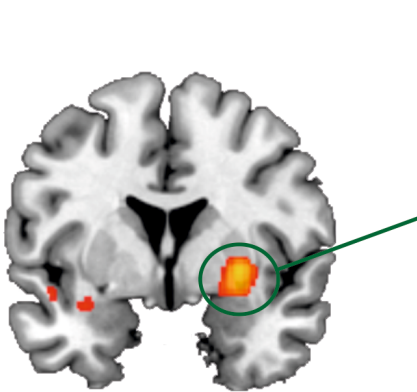
Really outstanding pianists, half of them started before age 6,5

Table 1. Main characteristics of the sample of musicians.

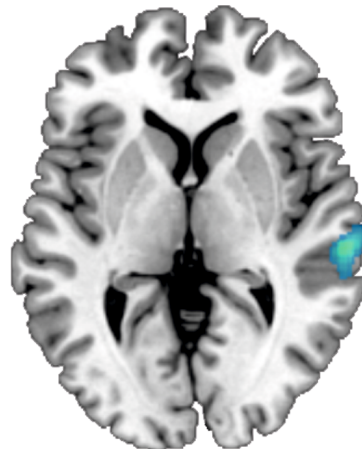
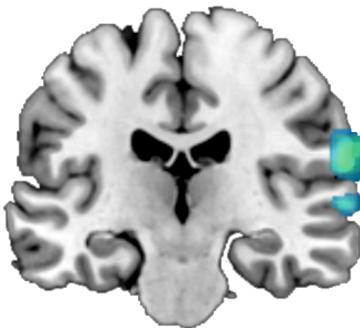
Characteristics	Subjects
<i>n</i>	36
<i>Mean age</i>	24.36 (s.d. 4.40)
<i>Ethnics</i>	27 caucasian, 9 asian
<i>Gender</i>	19 women, 17 men
<i>Mean age of exposure</i>	6.5 (s.d. 2.08)

....but it is not so simple. Signs of early economization

Regions in which Pianists show **more** grey matter than Non-musicians

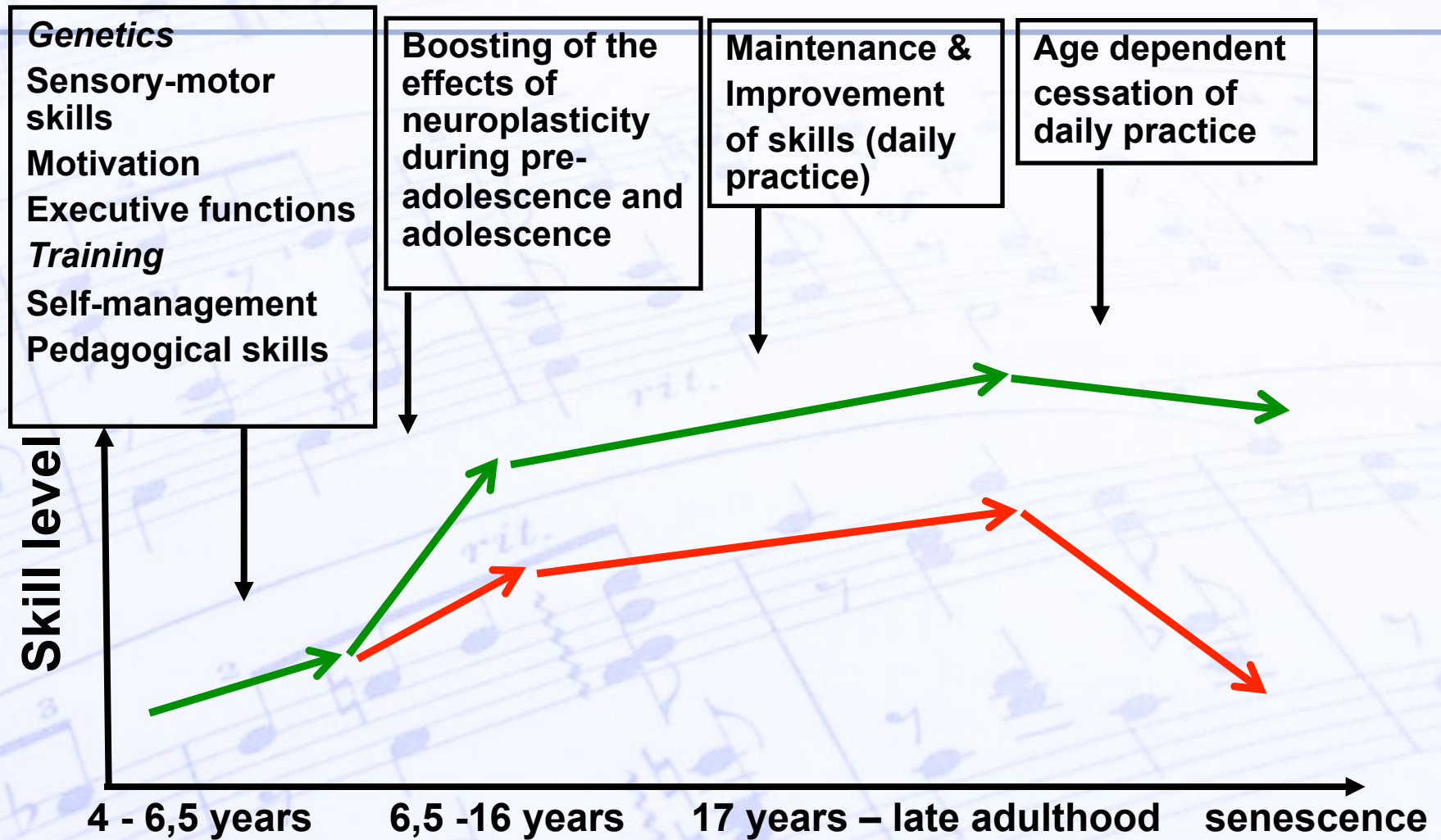


Regions in which Pianists show **less** grey matter than Non-musicians



Vacquero et al. NeuroImage 2016

A model of acquisition of skilled movements



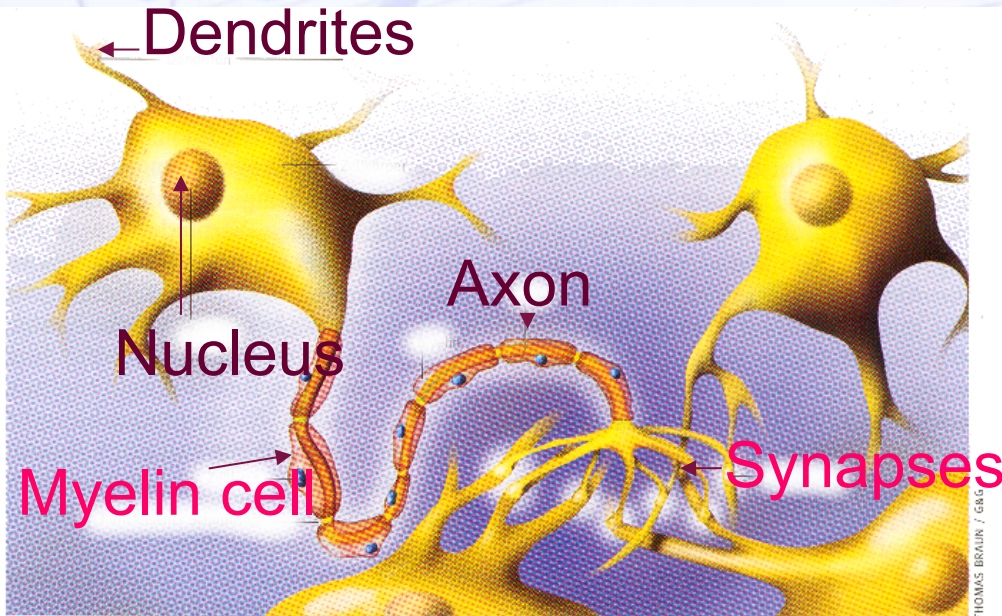
Early start of musical skill acquisition (before age 6,5)

Late start of musical skill acquisition (after age 6,5)

Music making is a strong stimulus for Neuroplasticity:

Plasticity:

*Functional and structural adaptation
of the nervous system to (extensive)
processing of relevant (mostly
complex) stimuli*



Seconds
Minutes
Days
Weeks
Months
time

- 1.) Efficiency of Synapses
- 2.) Recruitment of Neurons
- 3.) Amount of Synapses
- 4.) Amount and size of Dendrites
- 5.) Amount and size of Neurons
- 6.) Degree of Myelination
- 7.) Interaction with glial tissue and capillarisation of brain tissue

What drives these plastic changes?

Complex and relevant Stimuli

Frequent Stimulation

Proper Duration of Stimulation

Consistency without being boring

Attention and Arousal (*adrenalin and serotonin*)

Motivation and Reward (*dopamin and endorphins*)

Sense of meaningfulness (*oxitocin*)

Five „specialties“ in musician's medicine

1. Start of „professional activity“ during childhood
(Self definition through musicianship)
2. Activity linked to pleasure and strong emotions
(Anxieties when professional activity seems compromised)
3. Working at mental and physical limits
(Minimal deficits have negative impact on performance)
4. Controllability of activities through the auditory system
(Extremely high societal pressures)
5. Frequently unfavorable ergonomics
(heightened prevalence of overuse and pain-syndromes)

What kind of patients do we see?

1994-2017: 11916 Patients

60% Pain syndromes (mostly playing related
“myofacial” chronic pain)

14% Movements disorders (*mostly focal Dystonia, but
also focal Tremor, PD, HC, rare MD*)

6% Nerve compression syndromes

3 % Other neurological disorders

8 % Anxiety disorders (mostly performance related)

4 % Hand–Surgery patients

5 % Others (Oto-Rhino-Laryngology, Psychiatry etc.)

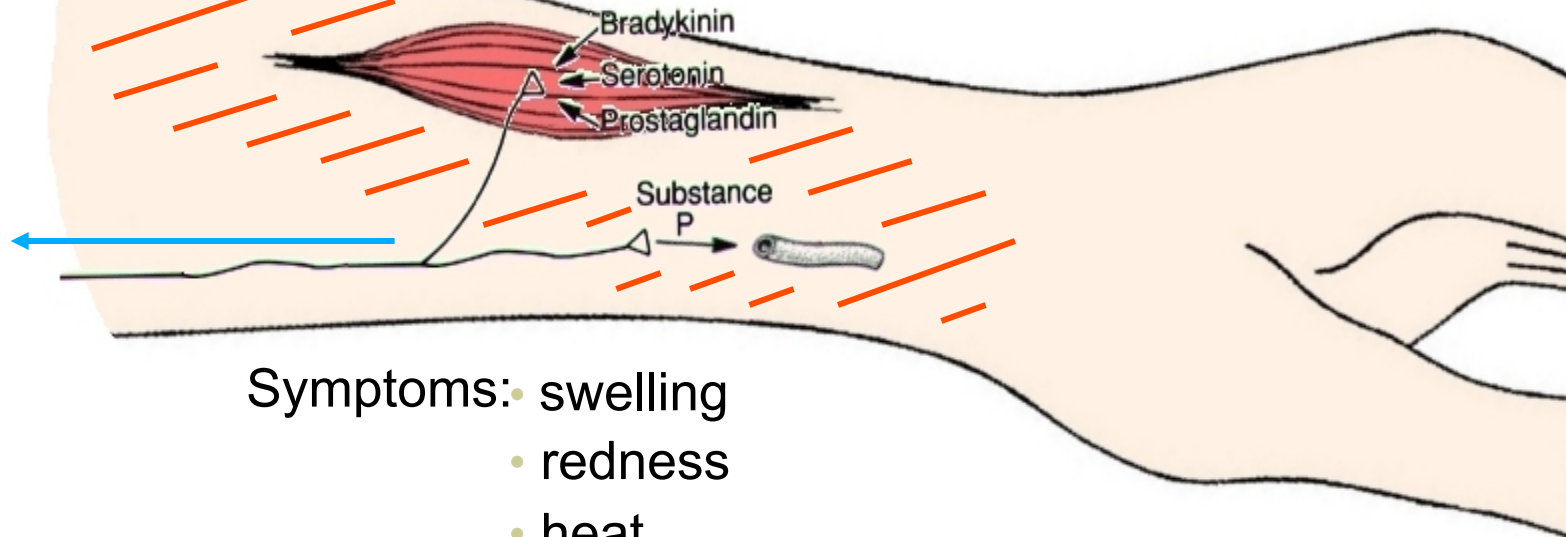
What is his problem?



Pain-Mechanisms in the „Overuse-Syndrome“

Overuse of the musculoskeletal system causes

- local inflammation including
- release of pain mediators



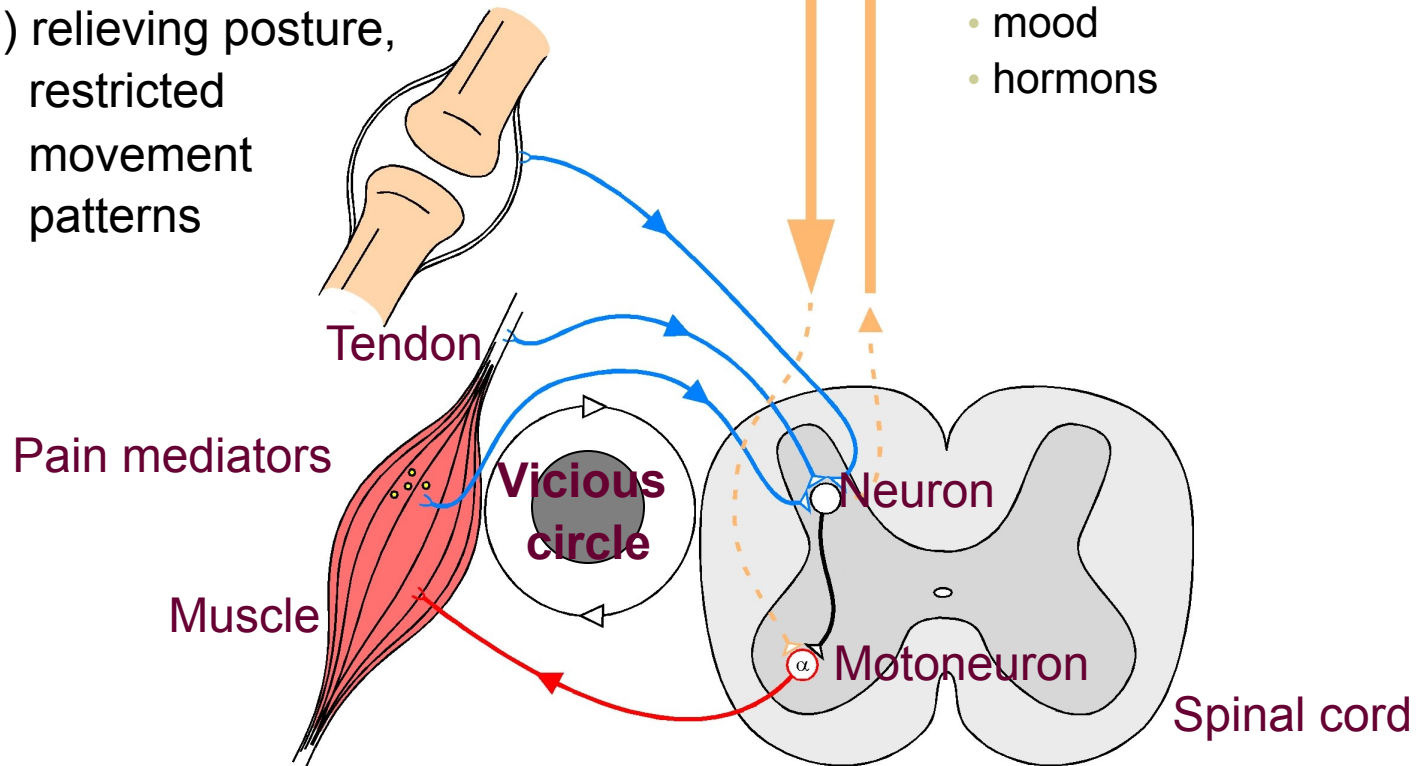
- Symptoms:
- swelling
 - redness
 - heat
 - impaired function
 - pain

Chronification of pain:

Persisting neuronal signals

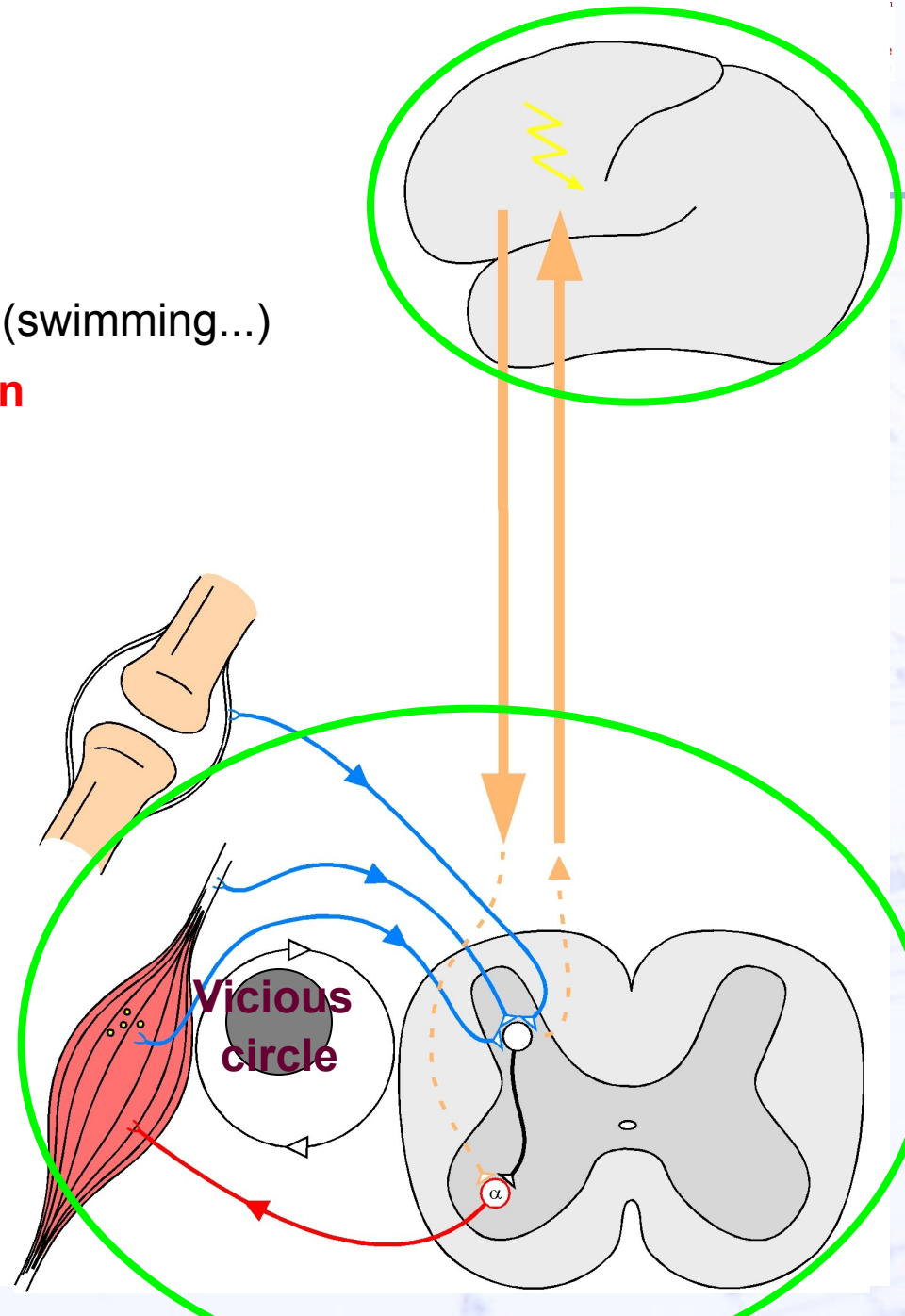


- 1) Down-regulation of pain threshold
- 2) Association: Instrument = Pain
- 3) Impression of disaster
- 4) relieving posture, restricted movement patterns



Recovery:

- 1) Understand the mechanism
- 2) Up-regulation of pain threshold (swimming...)
- 3) Learn to play music without pain
- 4) Practice Strategies
Mental Practice - Pedagogy
- 5) physical therapy
- 6) physiotherapy, body awareness
- 7) medication
- 8) detect and avoid external triggers
 - problems with the instrument
 - manual strain in everyday life
 - schedule overload
 - psychological strains, social situation



Musicians' Dystonia
is a loss of motor control
of skilled movements necessary
for instrumental playing

Prevalence amongst
musicians: 1-2 %

However: Large “dark number”

Prevalence other hand- dystonias:
0,08%-0,004%

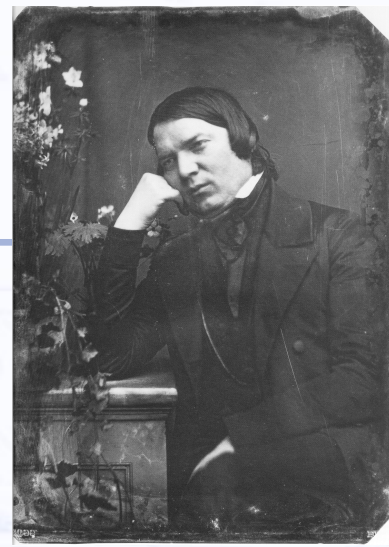
It is still an unresolved problem.
It remains difficult to treat.
It is highly disabling.



Work conducted together
with Dr. Andre Lee

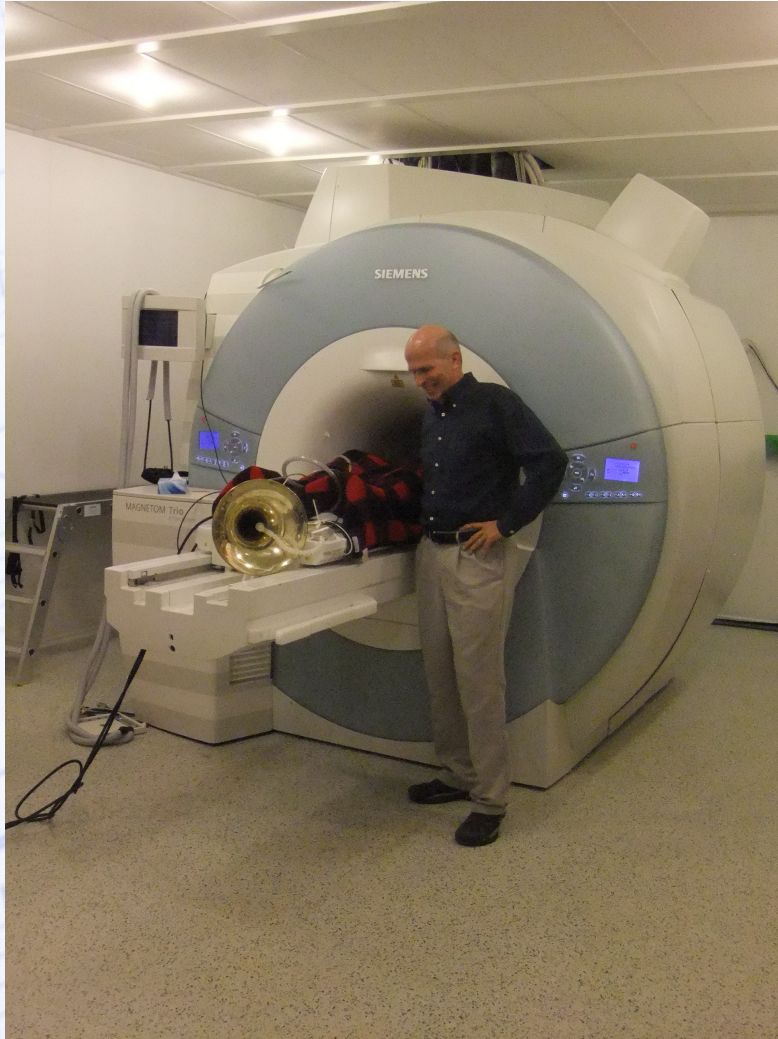
Some motor disturbances are very subtle and even temporary

Schumann's disease!



Schumanns' symptoms.....and his strategy to overcome
Aus: Altenmüller 2006 in: Altenmüller et al. Oxford University Press

What is “Embouchure Dystonia”?



Real-time MRI
30 „frames per second“

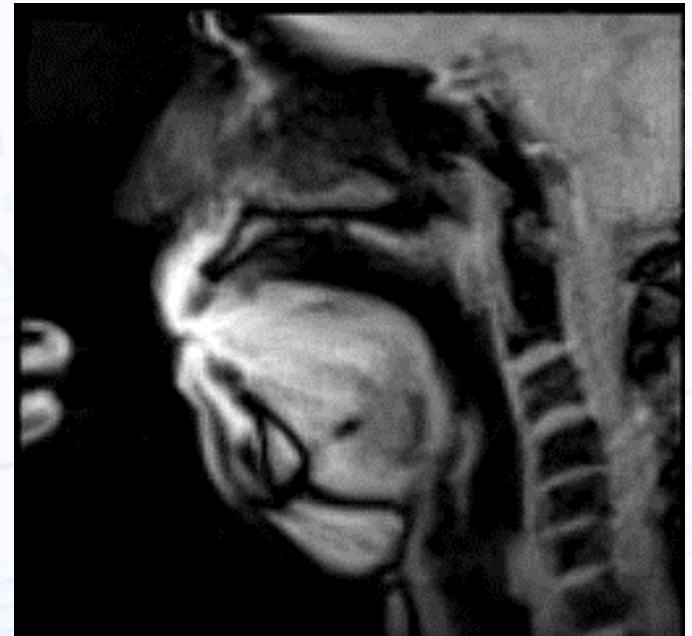
Jens Frahm,
Eckart Altenmüller,
Peter Iltis, Erwin Schoonderwaldt
MPI für Biophysikalische Chemie,
Göttingen



Embouchure Dystonia



Berliner Philharmoniker



Patient with Dystonia

Ittis et al. Medical Problems of Performing Artists 2016

Risk factors: short summary

(n = 356 musicians with dystonia) :

Classical musicians:	84 %
Males:	78 %
Young: start prior age 40	85 %
Soloists:	51 %

Certain instruments: Guitar>Piano>Flute

Speed and accuracy of movements

Anxiety and exaggerated perfectionism

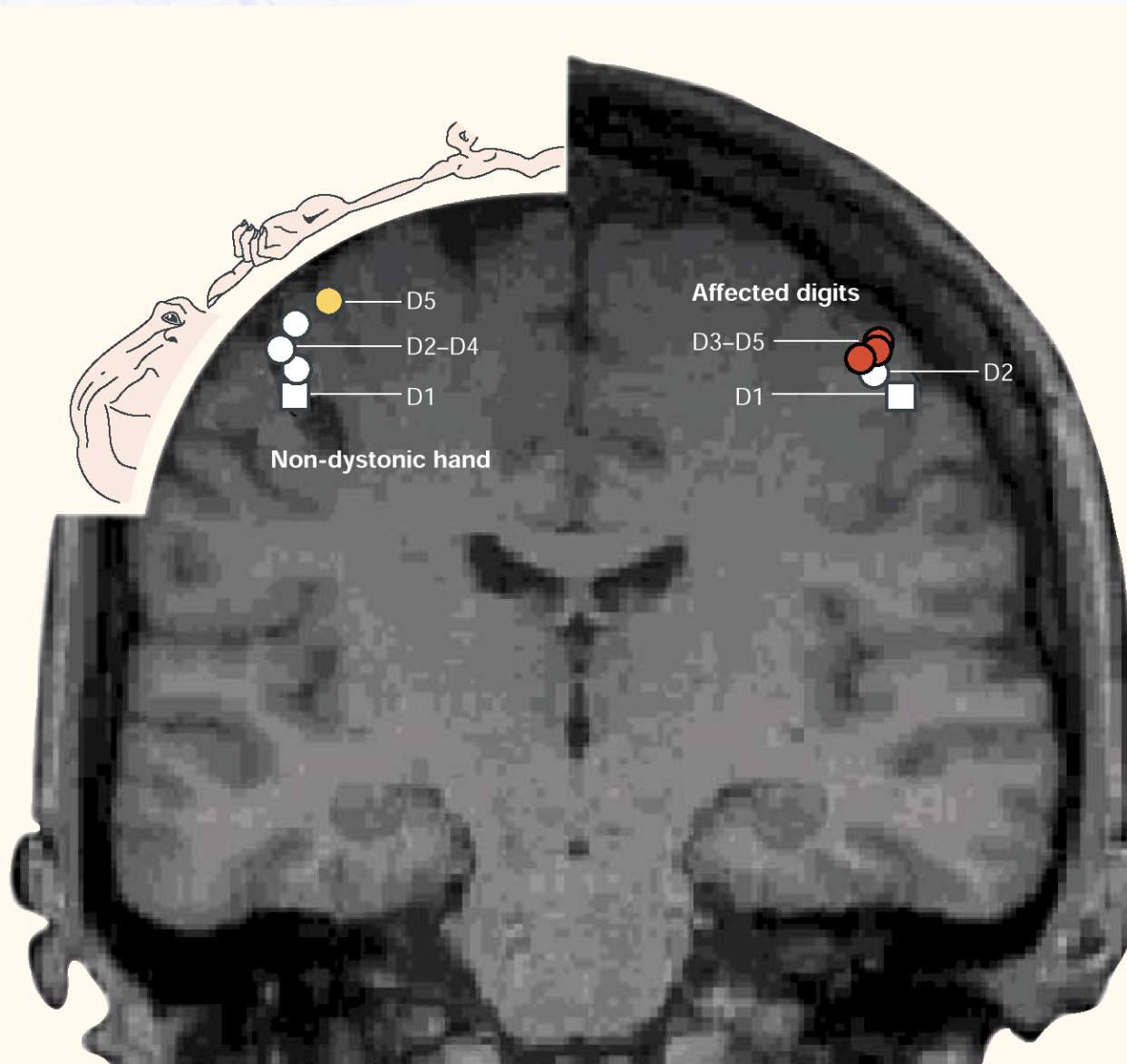
Late start of training (older than 9 years)

Unfavourable biomechanics and chronic pain

Genetics (35% of musicians)



Blurring of sensory-motor “representations” in the brain may be one possible cause of focal dystonia

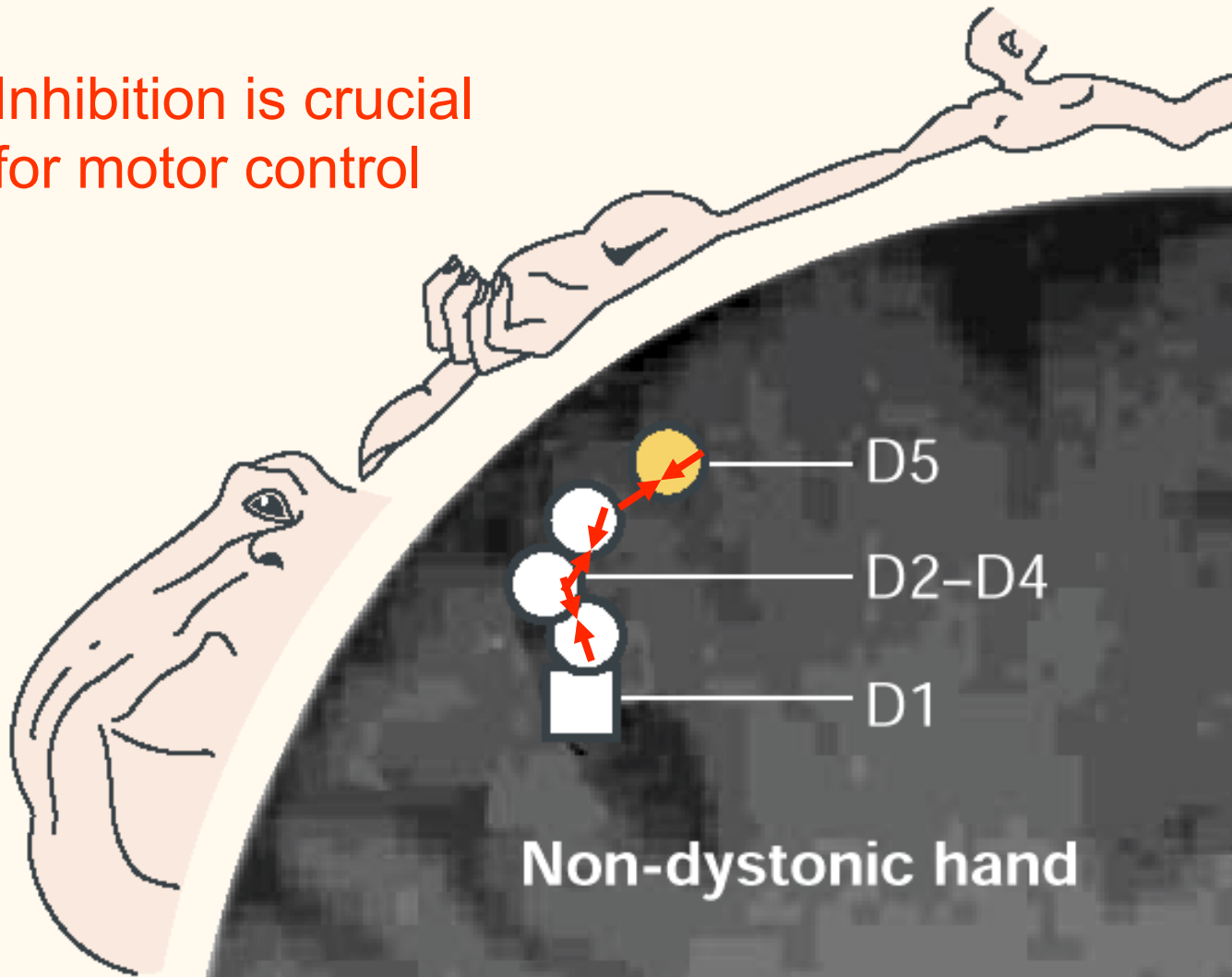


From:
Elbert T, Candia V,
Altenmüller E. and
Pantev C, et. al.
NeuroReport 1998
9: 3571-3575

Modified in:
Münte TF, Altenmüller
E, Jähnke, L,
Nat. Neurosc. Rev.
2002, 3: 473-478

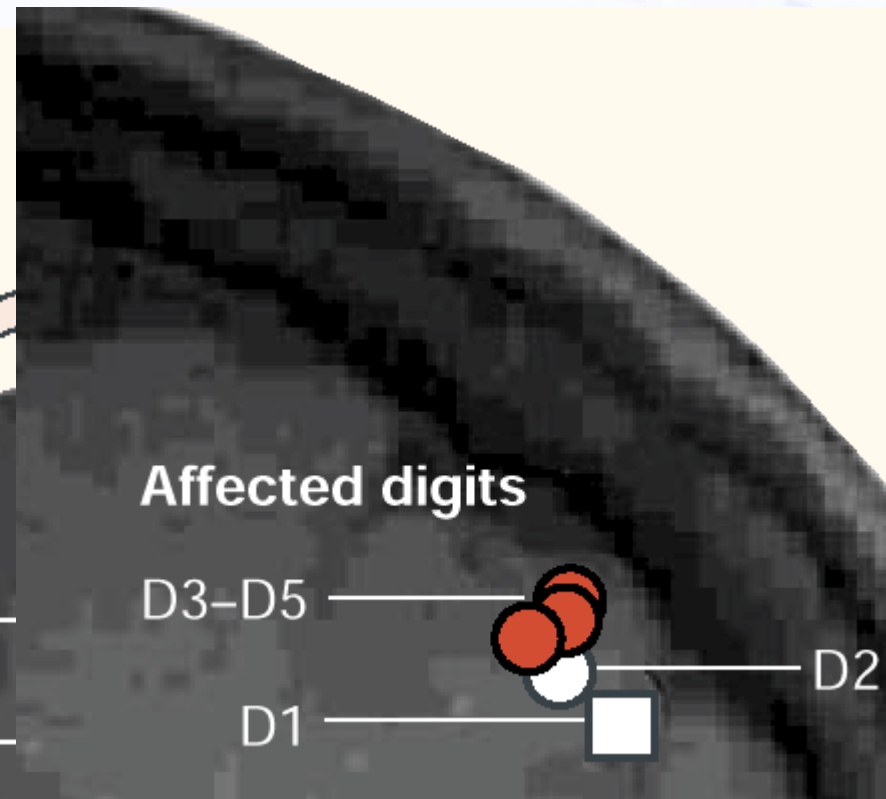
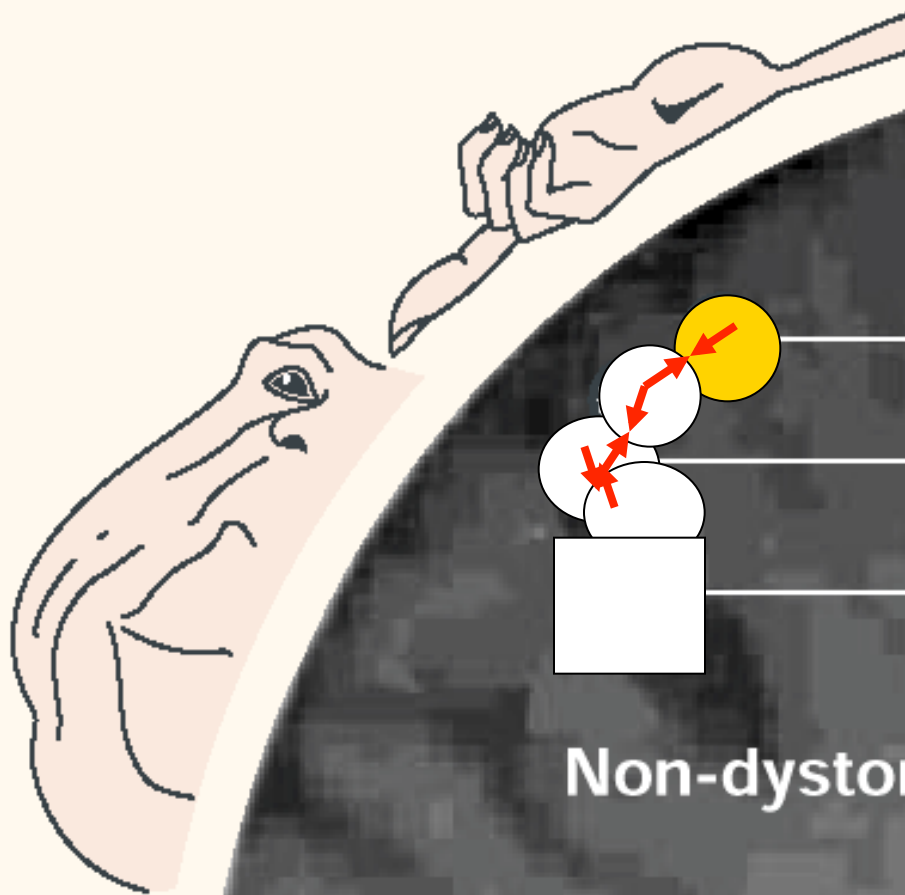
Blurring of sensory-motor “representations” in the brain may be due to lack of lateral inhibition

Inhibition is crucial
for motor control



Blurring of sensory-motor “representations” in the brain may be due to lack of lateral inhibition

Effects of plasticity



Affected digits

D3-D5

D1

D2

Non-dystonic hand

Sensory-motor triggering factors

- workload
- instrument
- technique
- late start

- extra-instrumental burdens
 - e.g. handedness
- biomechanical obstacles
- controllability of actions

genetics

Motor fatigue → overuse

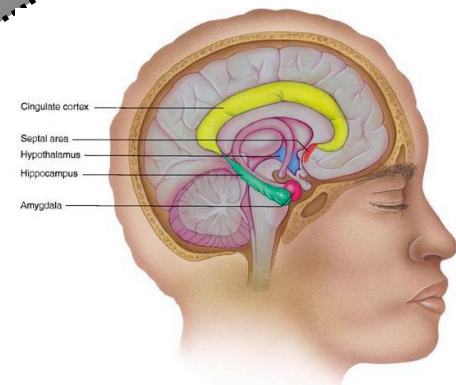
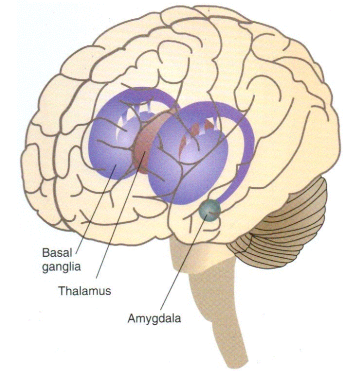
Dynamic stereotype → Musician's dystonia → Dystonic cramp

Choking under pressure

- *anxiety*
- *perfectionism*
- *constraints*
- *stresses*

- *reinvestment*
- *over-focusing*
- *cognitive interference*

genetics



Psychological triggering factors

Altenmüller, Ioannou, Raab, Lobinger 2014, Progress in Motor Control,

Treatment Options in Musicians with Motor Disturbances

Ergonomic
Adaptations

Electrophysiological
Stimulation

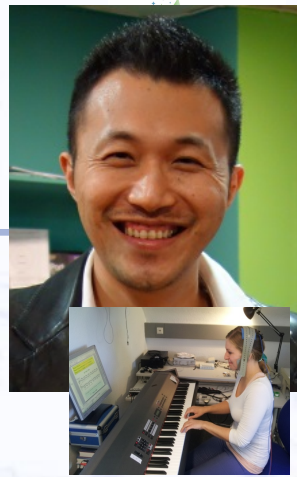
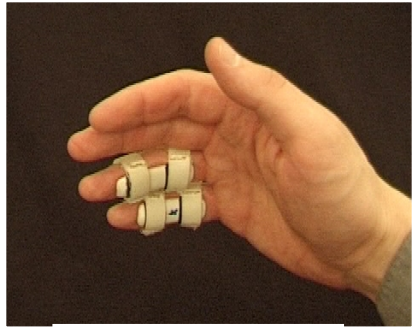
Sensory Tricks

Botox-
Injections

„Sensorimotor
Retuning“

e.g. V. Candia,
e.g. K. Zeuner

Pharmacology,
e.g.
Trihexiphenidyl



Pedagogical
„Retraining“

Where would you inject?



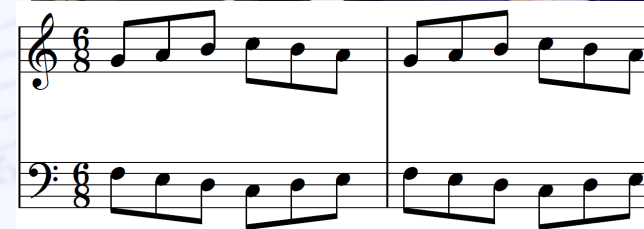
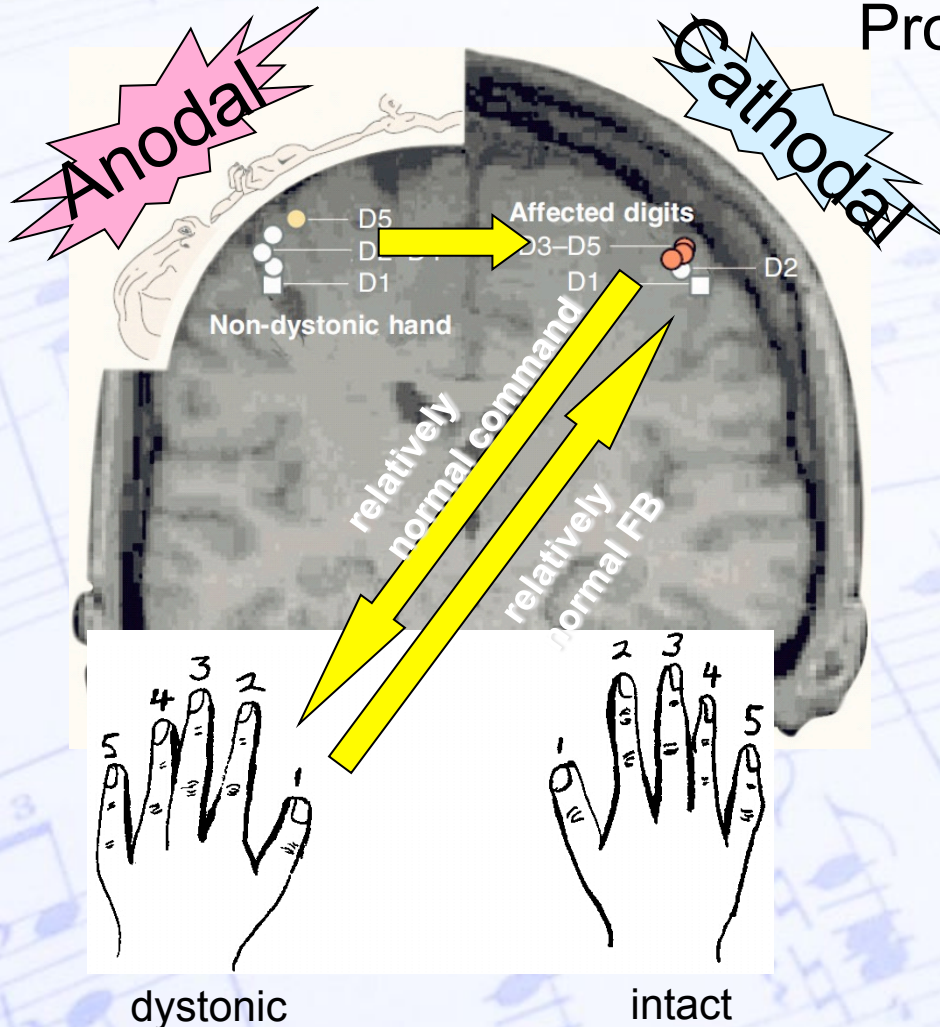
Before



After

tDCS with bihemispheric stimulation: *anodal: depolarizing – cathodal: hyperpolarizing*

Prof. Shinichi Furuya



Task: **In-phase** bimanual finger movements



Before



After

Why do we need Music Physiology and Musicians Medicine?

We want to support:

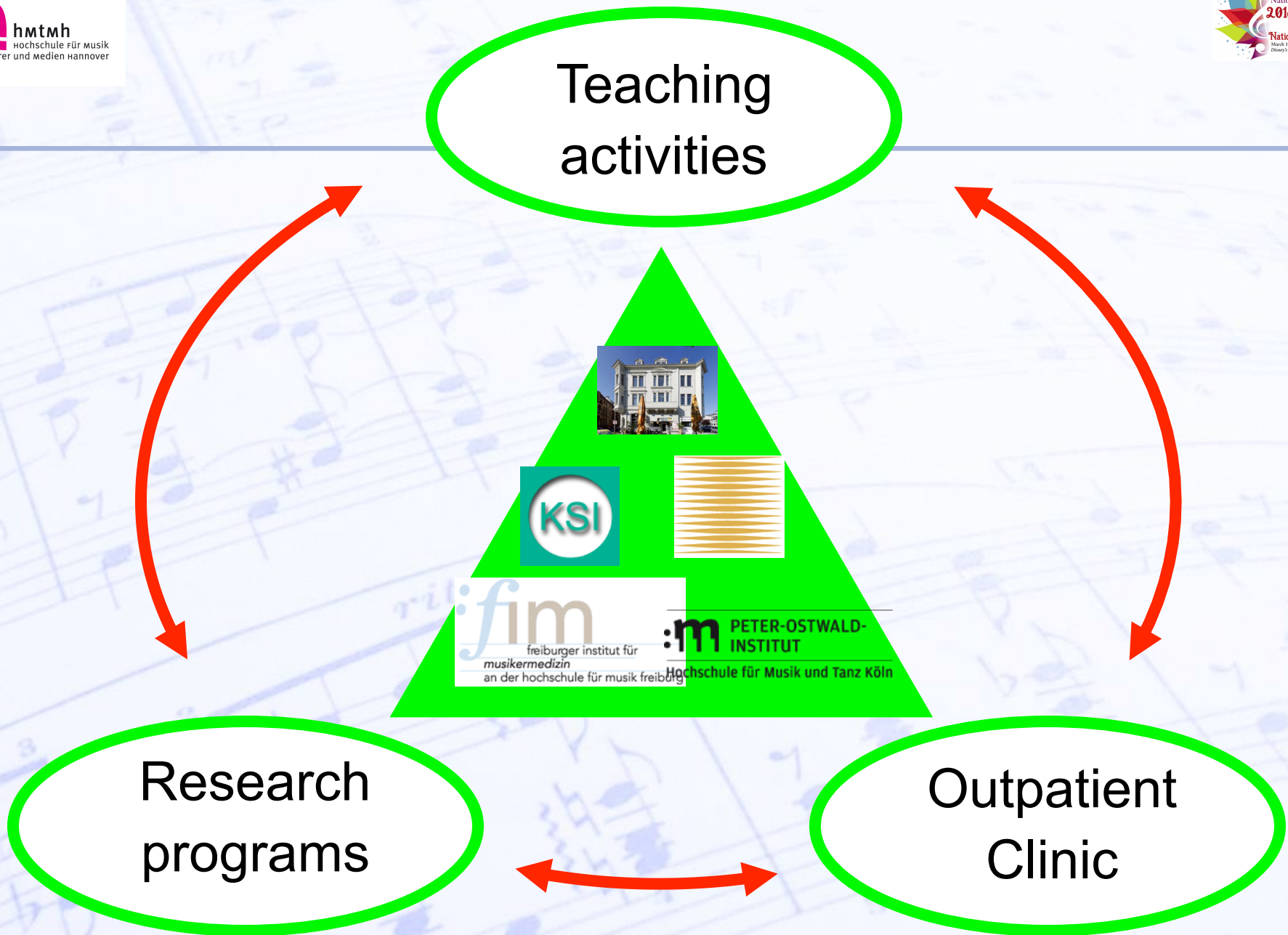
- Joy of Music Making – for everybody
- Full development of the individual's artistic potentials
- Knowledge of the bodily and mental basis of Music making
- Prevention of unnecessary stressors
- Dealing with unavoidable stressors
- Improvement of working conditions for musicians
- Best treatment of diseased Musicians
- Establishment of „culture of knowledge“
- Networks – networks - networks

Prevention in Music Academies

- 25% of beginner students start their studies with pain deteriorating their performance
- 68-88% of music students have at least once during their studies medical problems caused by music making
- 45% of music students seek professional help because of these medical conditions

From: Spahn C. et al. 2002, 2004, MPPA





Lecture: Music Physiology

Feldenkrais

Mental
Training

Stage fright
coaching

Health Program
for Music Students
concept
Winter-Term
2016/2017

Breathing-/ Voice-
Speech education

Outpatient clinic for
music students

Yoga
body awareness

Counseling

Auditions-Training

External
Physiotherapy

External: Sports/
Psychological Counseling

DIE KÖRPERLICHEN UND GEISTIGEN GRUNDLAGEN DES MUSIZIERENS

(Prof. Dr. med. Altenmüller, Dr. med. Andre Lee)

17. 10. Einführung in das Fachgebiet und körperliche Grundlagen des Musizierens

24. 10. Muskeln, Nerven, Sehnenscheidenprobleme

31. 10. Sensibilität und Körperwahrnehmung

7. 11. Muskelphysiologie und Trainingseffekte durch Übung

14. 11. Senso-Motorik bei Musikern

21. 11. Senso-Motorisches Lernen bei Musikern

28. 11. Mentales Üben

5. 12. Übetekniken

12. 12. Schmerzen beim Üben: Ursachen, Vorbeugung und Behandlung

29. 12. Physiologie des Gehörs

9. 1. Ursachen und Vorbeugung von Gehörschäden bei Musikern

16. 1. Psychologie für Musiker – Selbstvertrauen, Wettbewerb und Ängste

23. 1. Lampenfieber: Ursachen

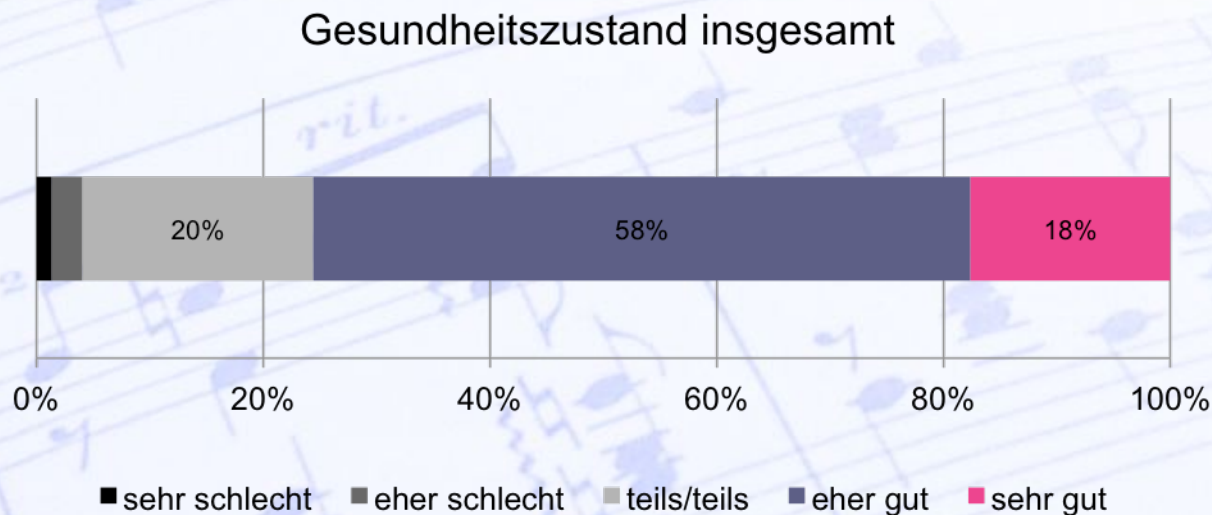
30. 1. Lampenfieber: Vorbeugung und Behandlung

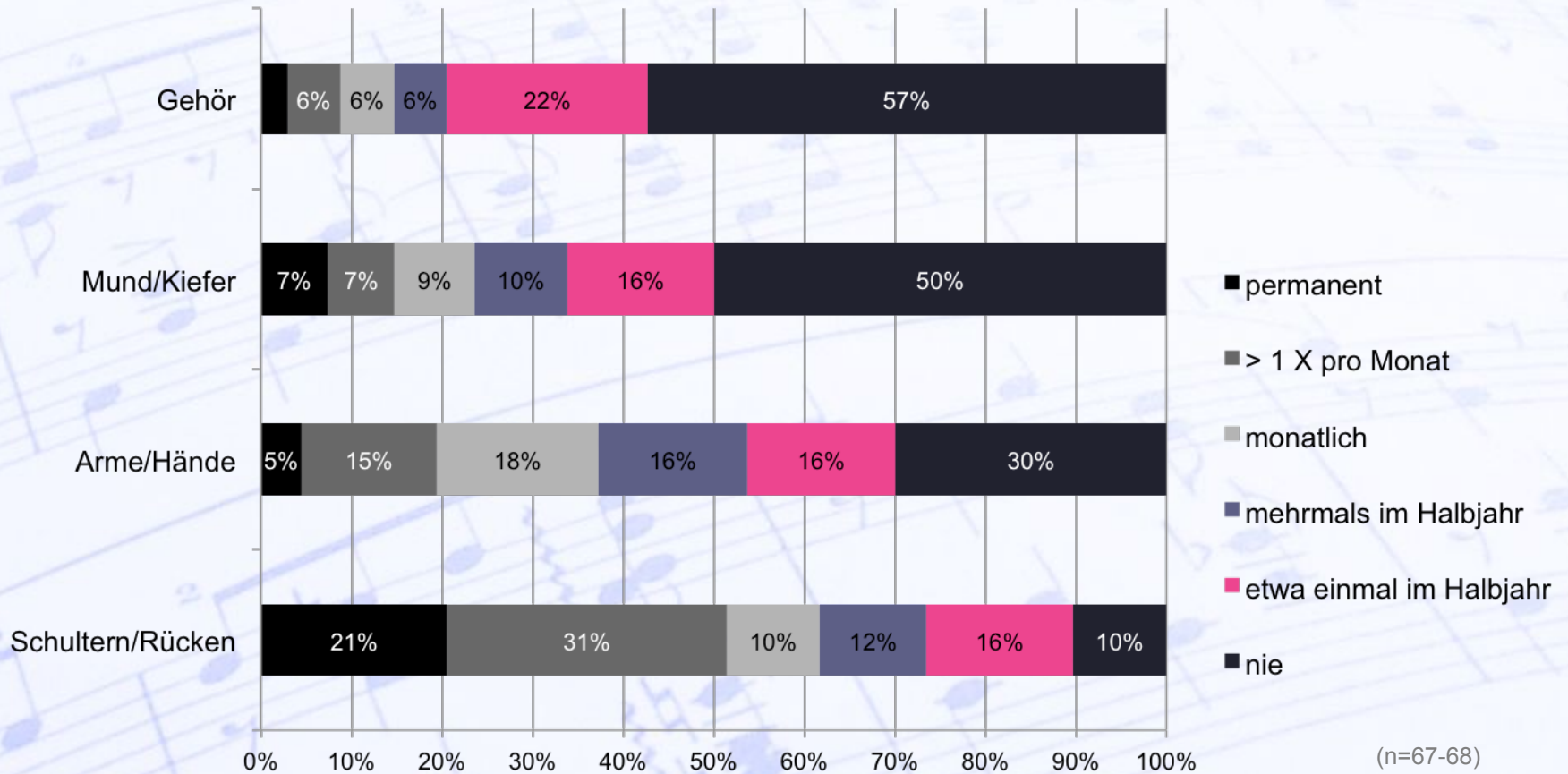
6. 2. Klausur (wird benotet und ist Grundlage der Abtestate)

13. 2. Schlußbesprechung: die 10 Weisheiten zum Semesterabschluß

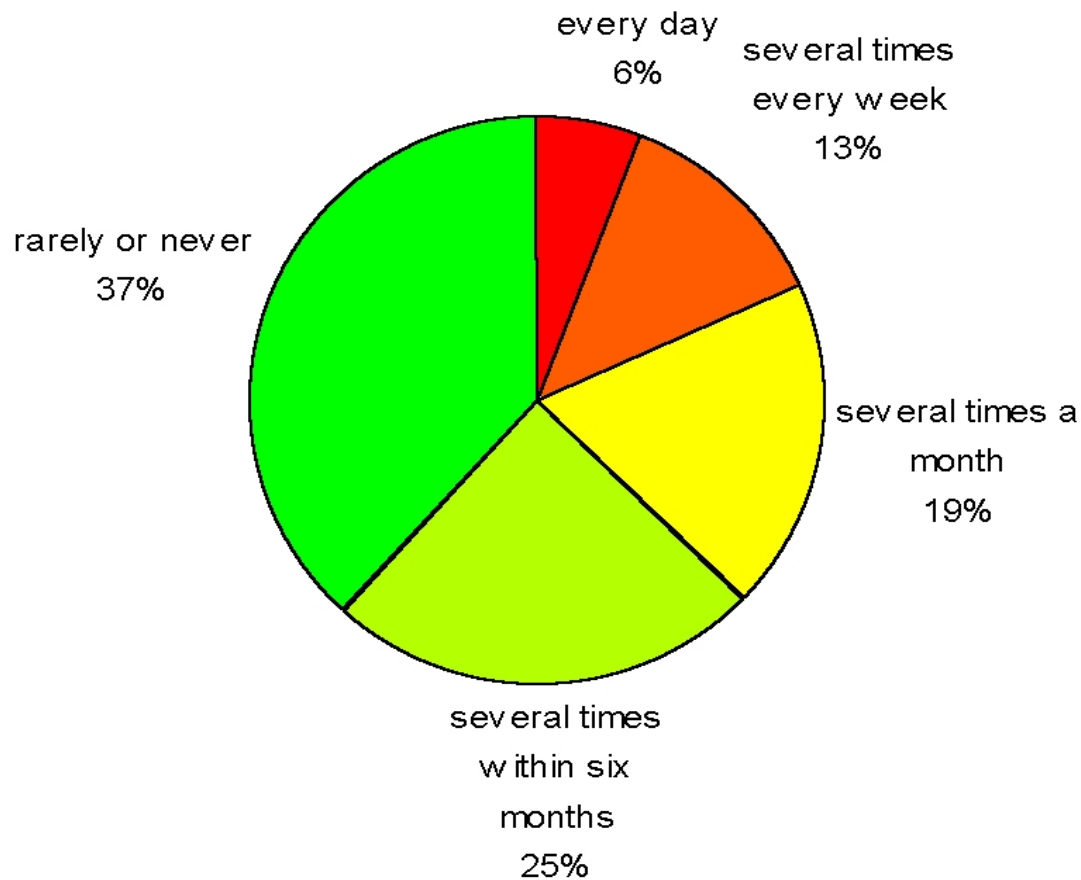
Practice strategies

- Online-Befragung von n=74 Musikstudierenden der HMTMH im zum Studienbeginn im Oktober 2017 (62% weiblich, Ø 19,9 Jahre)
- Rücklauf aktuell: 60,7%
- als Kohortenstudie über 3 Jahre geplant

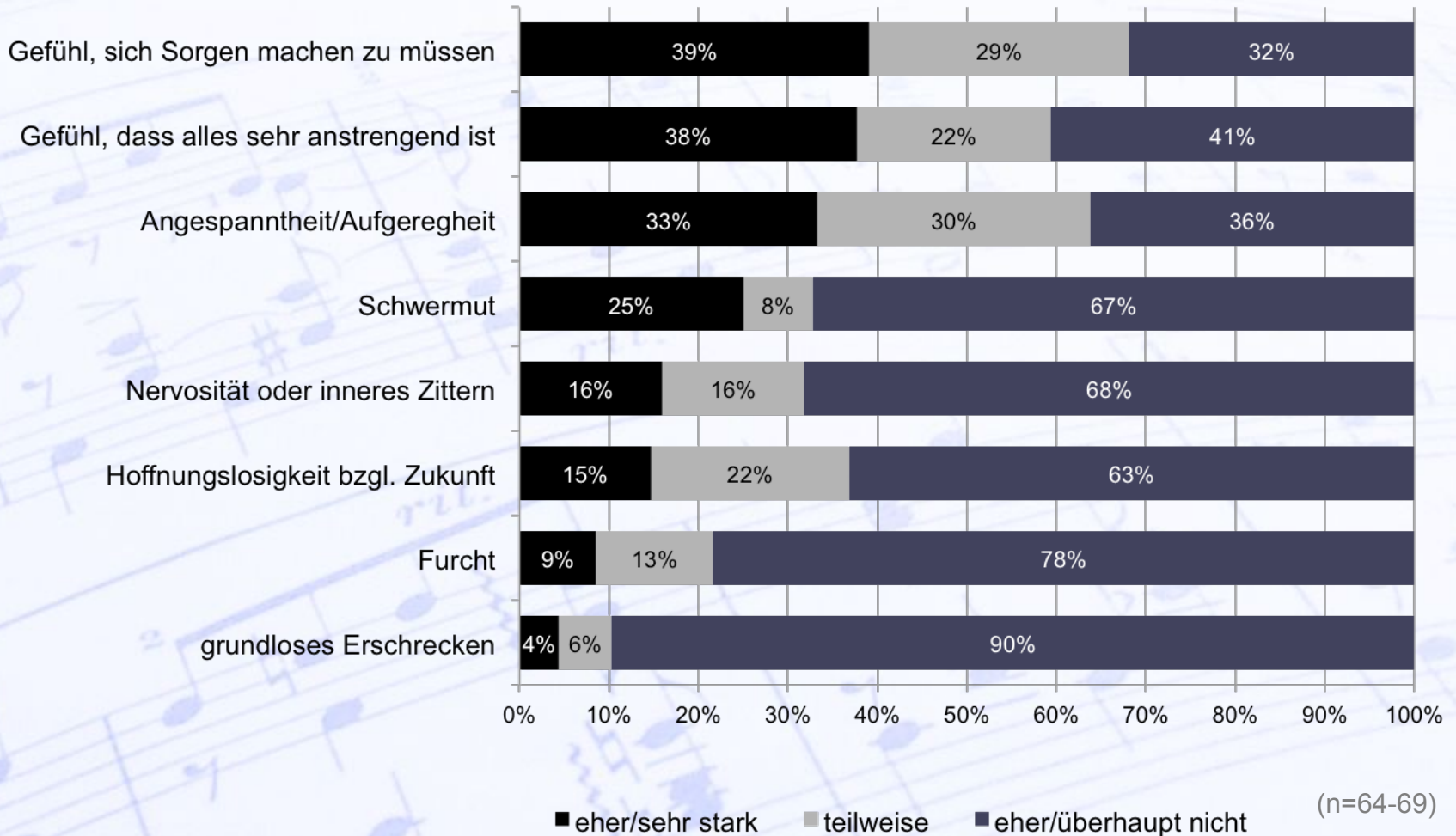




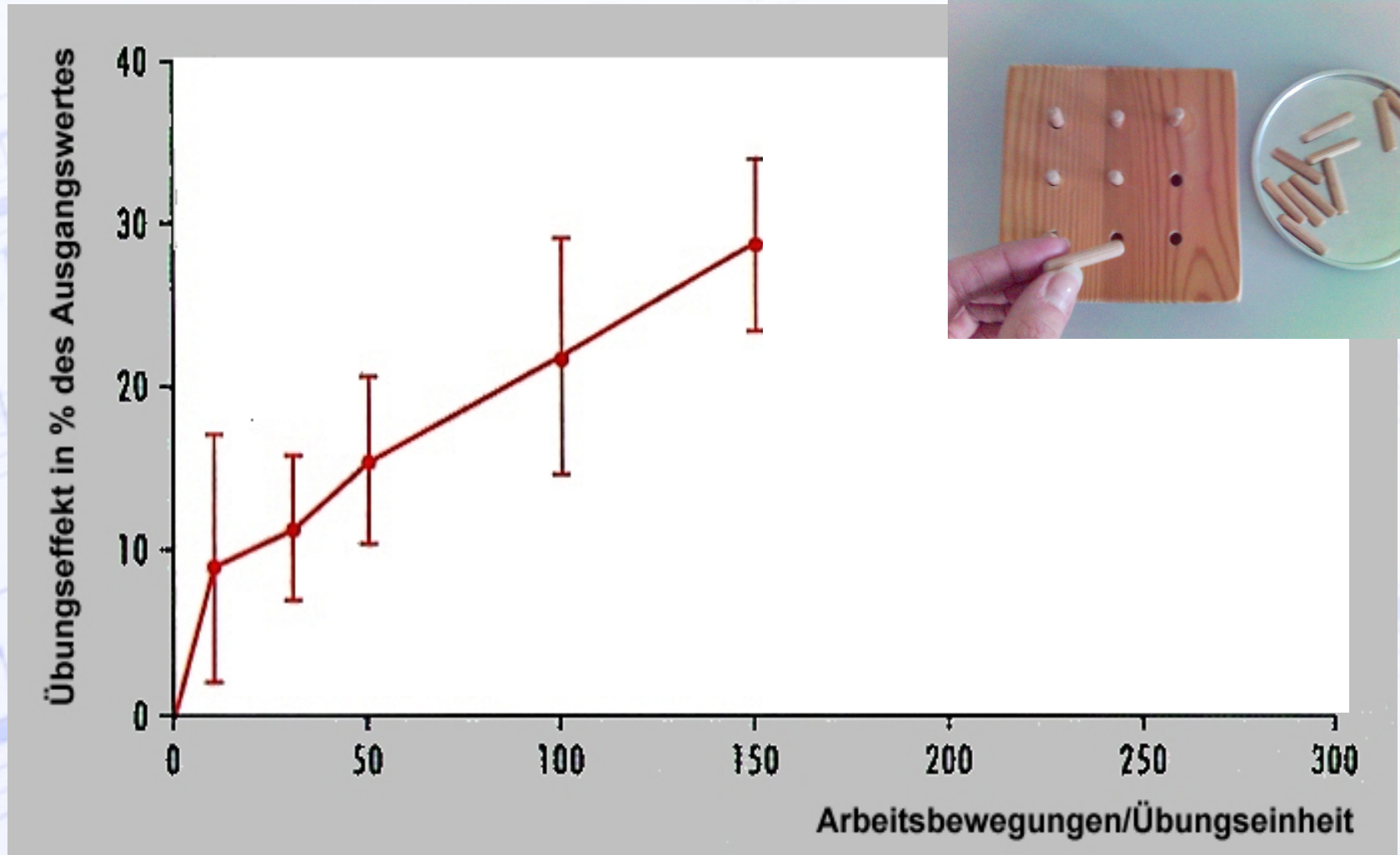
Frequency of back pain: Music students (n = 217)



Gräser S, Jabusch HC, Altenmüller E 2004

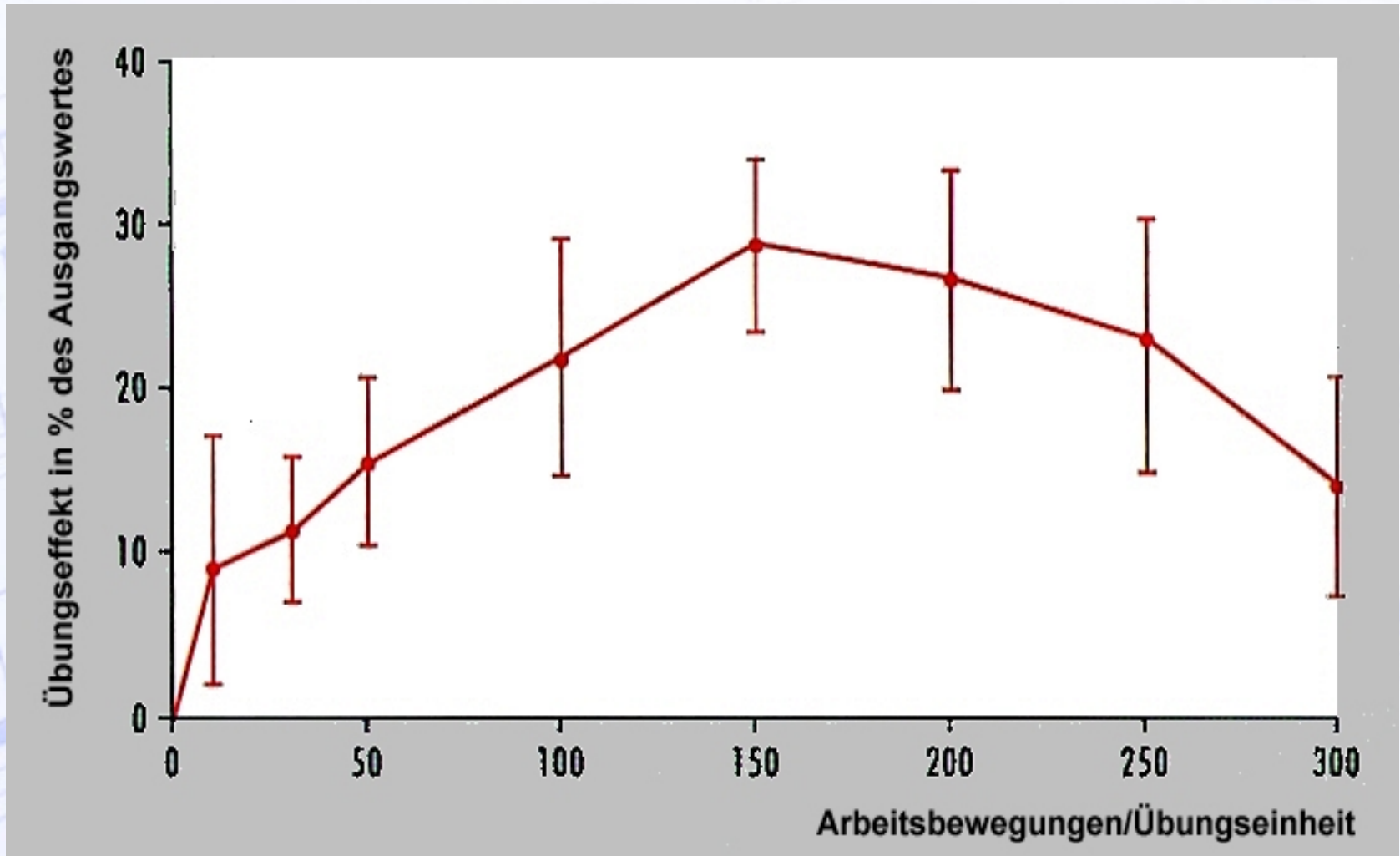


Relation between the amount of daily practice trials of skilled finger movements and improvement



(Hettinger et al. Geschicklichkeit und deren Übbarkeit. Z.Arbeitswiss.1975;29:223)

The Penelope-effect



(Hettinger et al. Geschicklichkeit und deren Übbarkeit. Z.Arbeitswiss.1975;29:223)



John Williams Waterhouse: Penelope and the suitors (1912)

Reasons for Deterioration

- 1.) Loss of motivation
- 2.) Loss of attention
- 3.) Fatigue of the muscles

Conclusion:

Try not to practice un-attentively

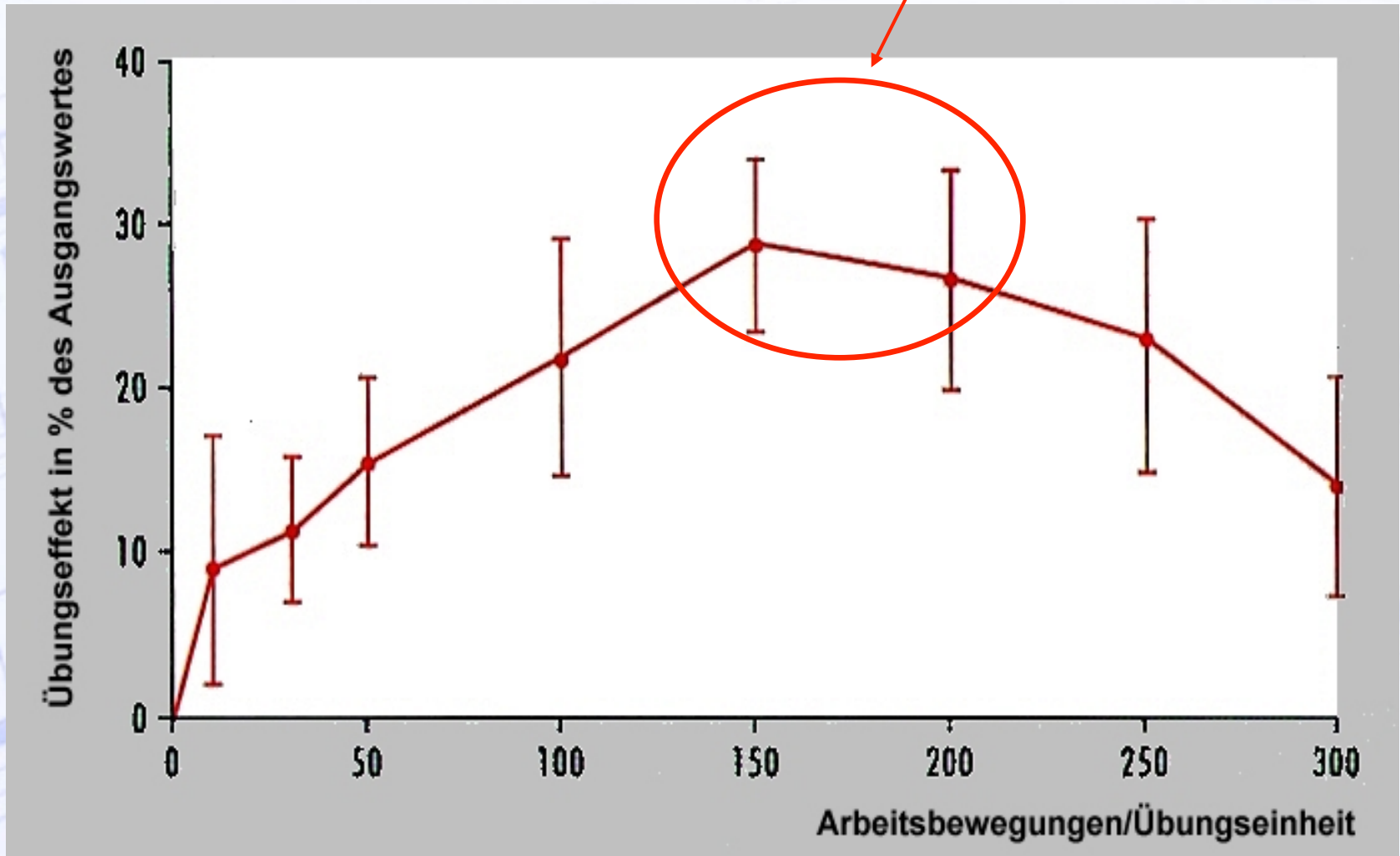
Try not to practice when fatigued

Include pauses in your practice schedule

Organize your practice schedule interestingly

The Penelope-effect

Teach the art to stop
practicing in the right moment



(Hettinger et al. Geschicklichkeit und deren Übbarkeit. Z.Arbeitswiss.1975;29:223)

What is mental practice

In the broad sense of the word:

Improvement of skill without physically playing through:

- 1.) observation
- 2.) pauses
- 3.) sleep
- 4.) undirected reasoning about the piece

In the narrow sense of the word:

A practice method in which performance of the task is imagined or visualised without overt physical practice

Experienced Mental Training: 30 minutes only reading Scarlatti



Ecossaise

The first system of the musical score for 'Ecossaise' is in 2/4 time. The treble clef staff features a melody with eighth-note patterns and fingerings 2, 4, 4, 3, 1, 2. The bass clef staff provides a harmonic accompaniment with chords and single notes. The dynamic marking *f* (forte) is present. The system concludes with a repeat sign and the word *Fine*.

The second system of the musical score continues the piece. The treble clef staff includes a triplet of eighth notes and a dynamic marking *ff* (fortissimo). The bass clef staff features a steady eighth-note accompaniment. The dynamic marking *p* (piano) appears in the middle of the system. The system ends with a repeat sign and the instruction *D.C. al Fine*.

Summary:

- 1.) Prevention starts with the first lesson
- 2.) Here, the most important person is the teacher
- 3.) Prevention has to do with personality and work behavior
- 4.) Ergonomical changes have preventive value
- 5.) Prevention must be taught to music teachers and students
- 6.) Strategies of secondary prevention should be known to therapists caring for musicians



