About OMICS Group

OMICS Group International is an amalgamation of Open Access publications and worldwide international science conferences and events. Established in the year 2007 with the sole aim of making the information on Sciences and technology 'Open Access', OMICS Group publishes 400 online open access scholarly journals in all aspects of Science, Engineering, Management and Technology journals. OMICS Group has been instrumental in taking the knowledge on Science & technology to the doorsteps of ordinary men and women. Research Scholars, Students, Libraries, Educational Institutions, Research centers and the industry are main stakeholders that benefitted greatly from this knowledge dissemination. OMICS Group also organizes 300 International conferences annually across the globe, where knowledge transfer takes place through debates, round table discussions, poster presentations, workshops, symposia and exhibitions.

About OMICS Group Conferences

OMICS Group International is a pioneer and leading science event organizer, which publishes around 400 open access journals and conducts over 300 Medical, Clinical, Engineering, Life Sciences, Pharma scientific conferences all over the globe annually with the support of more than 1000 scientific associations and 30,000 editorial board members and 3.5 million followers to its credit.

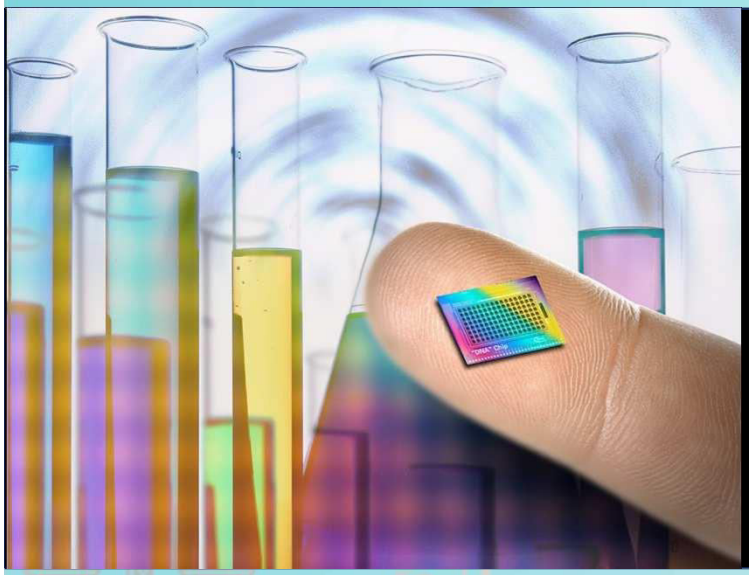
OMICS Group has organized 500 conferences, workshops and national symposiums across the major cities including San Francisco, Las Vegas, San Antonio, Omaha, Orlando, Raleigh, Santa Clara, Chicago, Philadelphia, Baltimore, United Kingdom, Valencia, Dubai, Beijing, Hyderabad, Bengaluru and Mumbai.

Orofacial muscle activity acquired in the natural environment of subjects with TMD

L.M. Gallo

Center of Dental Medicine, University of Zurich, Switzerland

Laboratory of Physiology and Biomechanics of the Masticatory System



3rd International Conference and

Biosensors & Bio

OMICS Group

Accelerating Scientific Discovery

August 11-13, 2014 San Antonio,

San Antonio TX, August 11th, 2014

Clinic KFS-KAB: structure



Orofacial pain clinic

D. Ettlin
M. Brügger
N. Dos Matos
M.Y. Hou
K. Komossa
N. Lukić
M. Meier
I. Sommer
B. Steiger

Physiology & biomechanics

L.M. Gallo
M. Čadová
V. Colombo
S. Erni
O. Schätti
E. Studer
D. Waldvogel

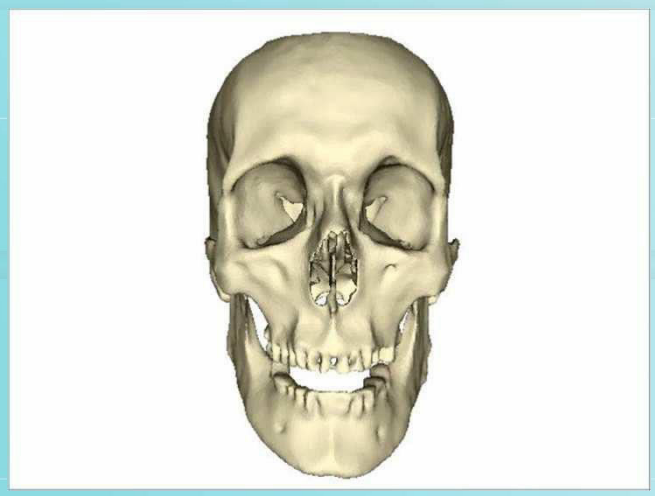
Removable prosthodontics

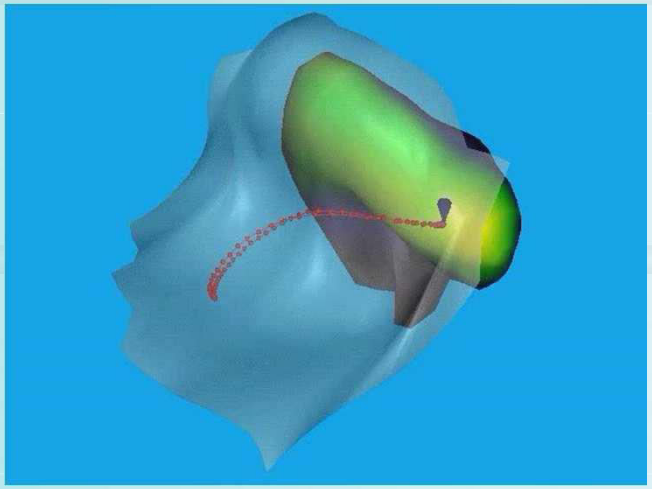
B. Ernst
B. Bartl
R. Cesca
P. Guzzi
N. Günthart
F. Helbling
E. Mühlemann
R. Picchi

Geriatrics & special care

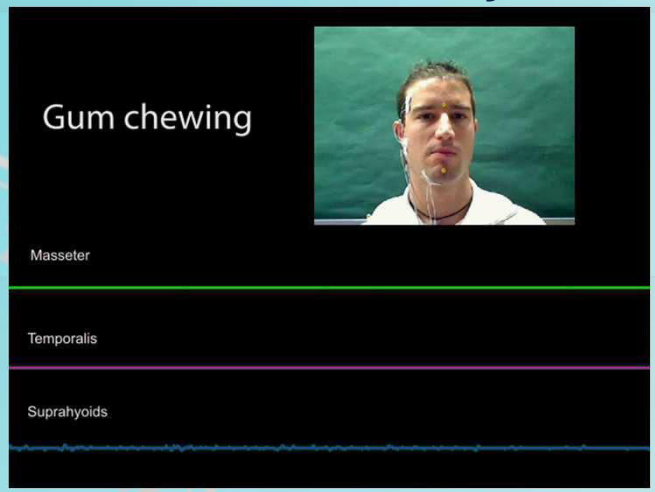
I. Nitschke
A. Altan
S. Boroumand
M. Bucher
T. Casanova
G. Egli
M. Kreissl
J. Kunze
B. Maas
A. Stillhart
C. Szabo

Physiology & biomechanics research

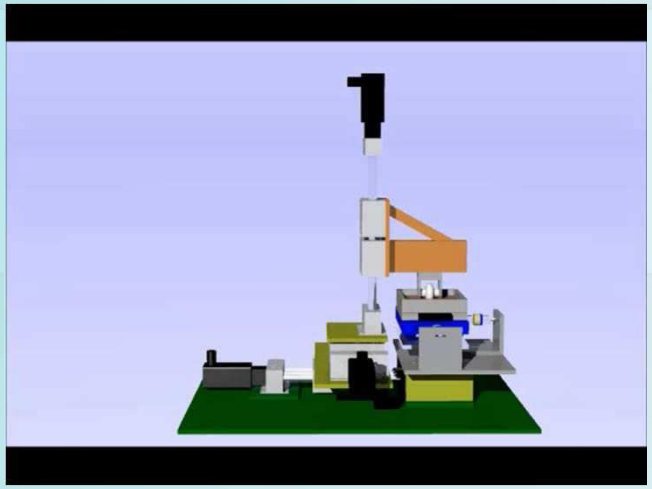




dynamic stereometry



muscle physiology



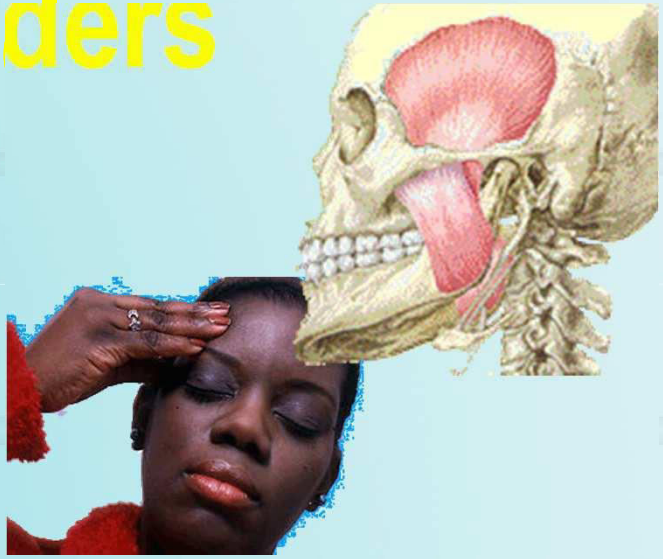
cartilage plowing

Masticatory disorders





1. Limitations of jaw mobility



2. Pain and stiffness of the masticatory muscles and of the TMJ



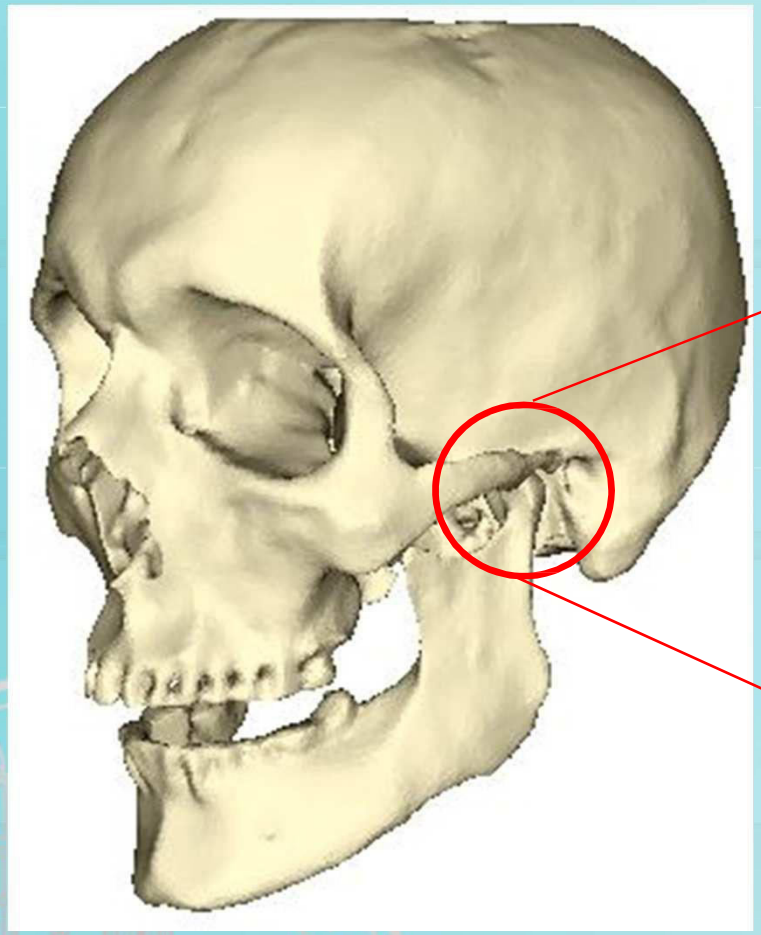
3. TMJ sounds

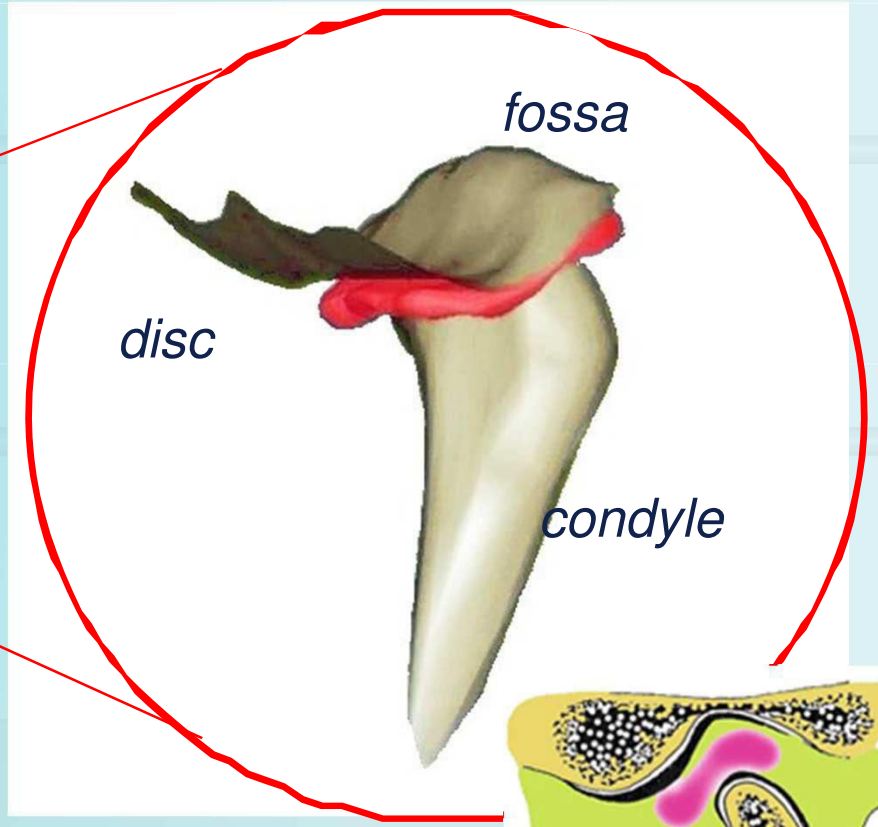
Questions

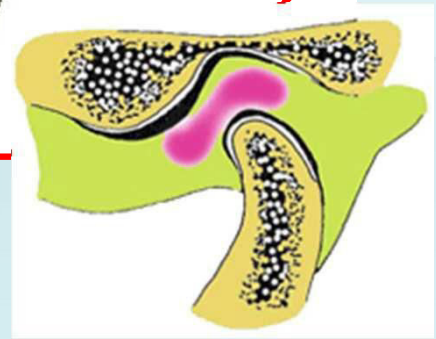
Portable acquisition and analysis of orofacial muscle activity is of particular interest, *e.g.*

- for the study of TMD,
- for the study of orofacial pain,
- and also for identifying subjects at risk of fracturing dental reconstructions.

Our main interest: the TMJ

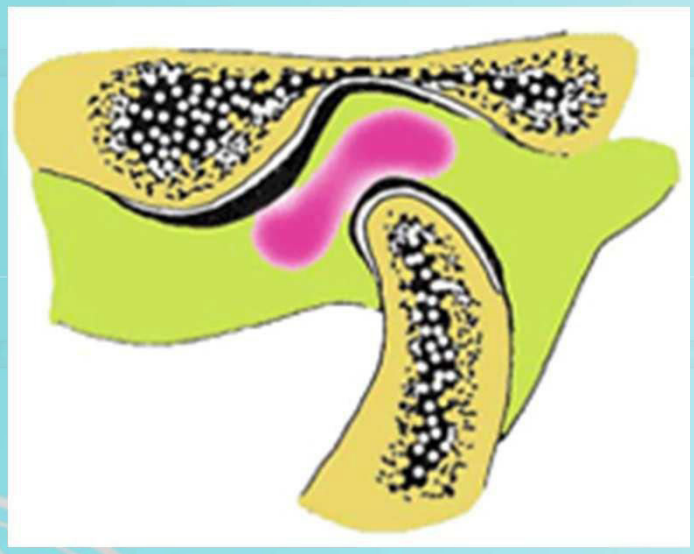


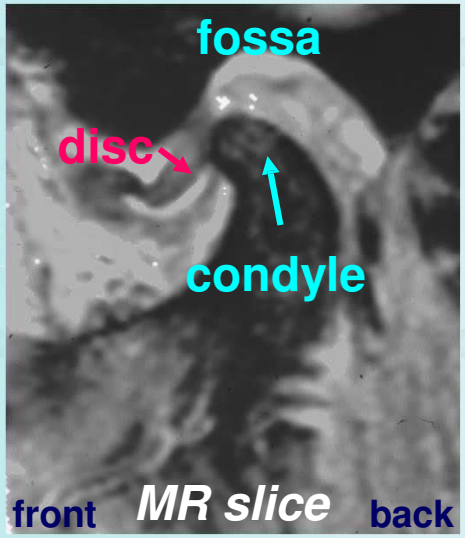




(Fibro)cartilage

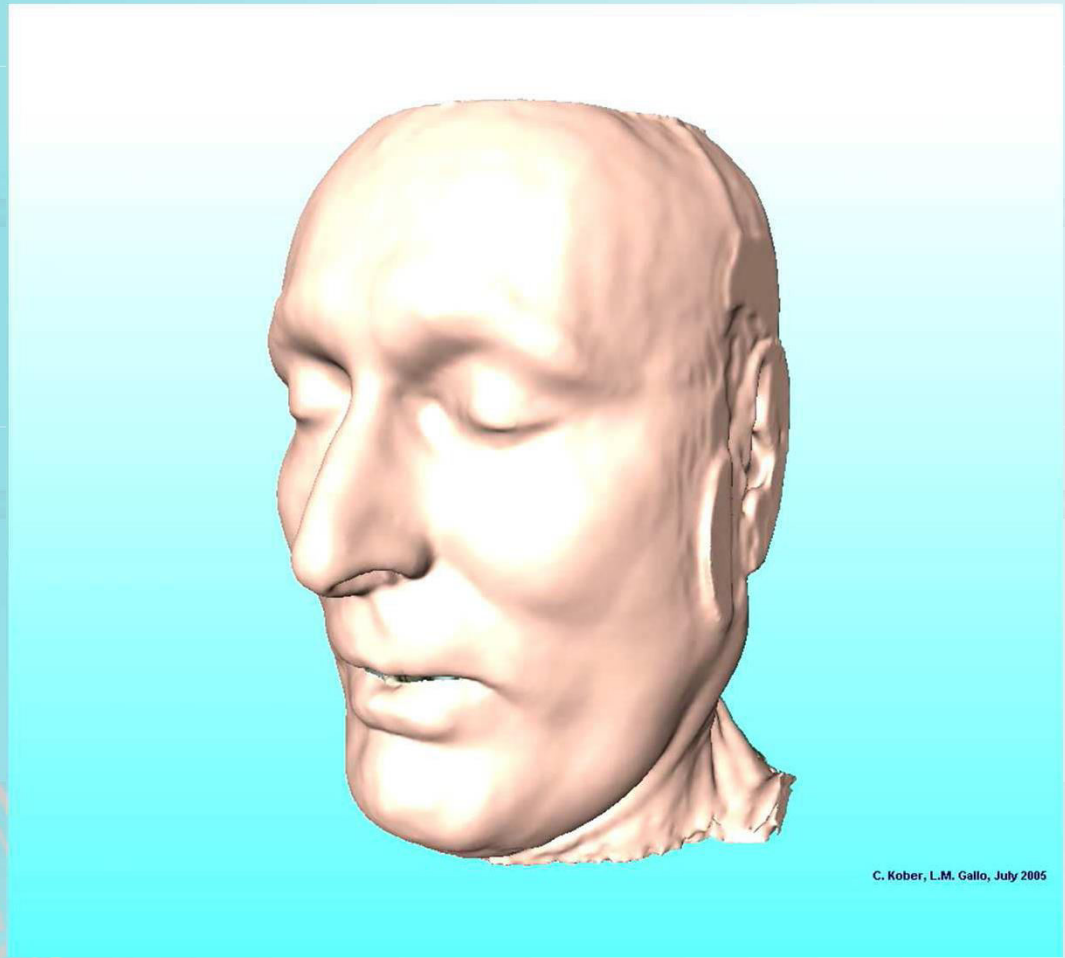
Discopathy



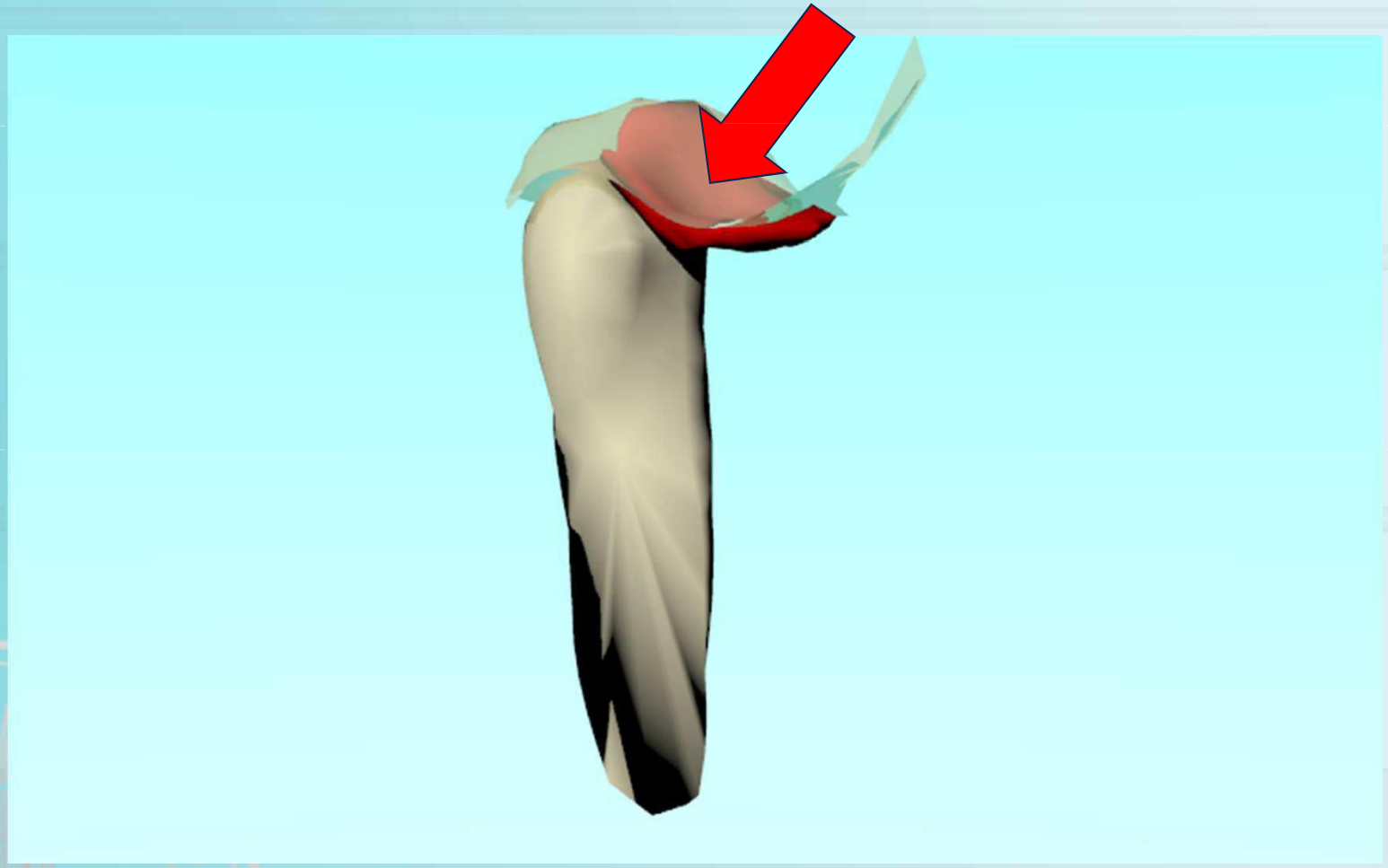


Irregular motion due to disc displacement

Masticatory muscles: lines of action

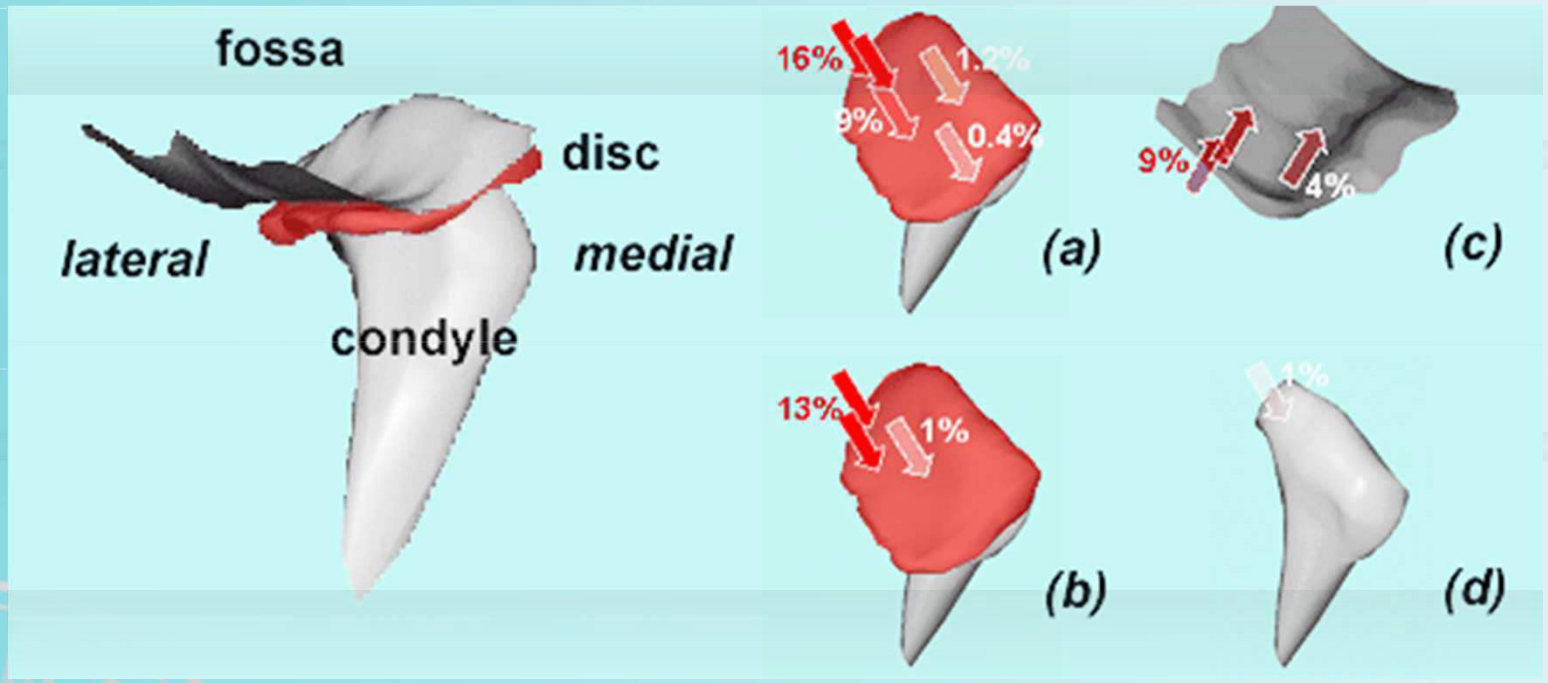


TMJ disc compression



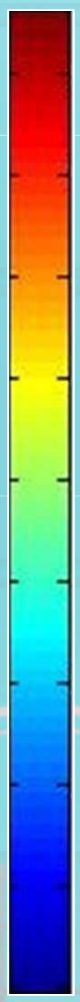
Joint reaction force

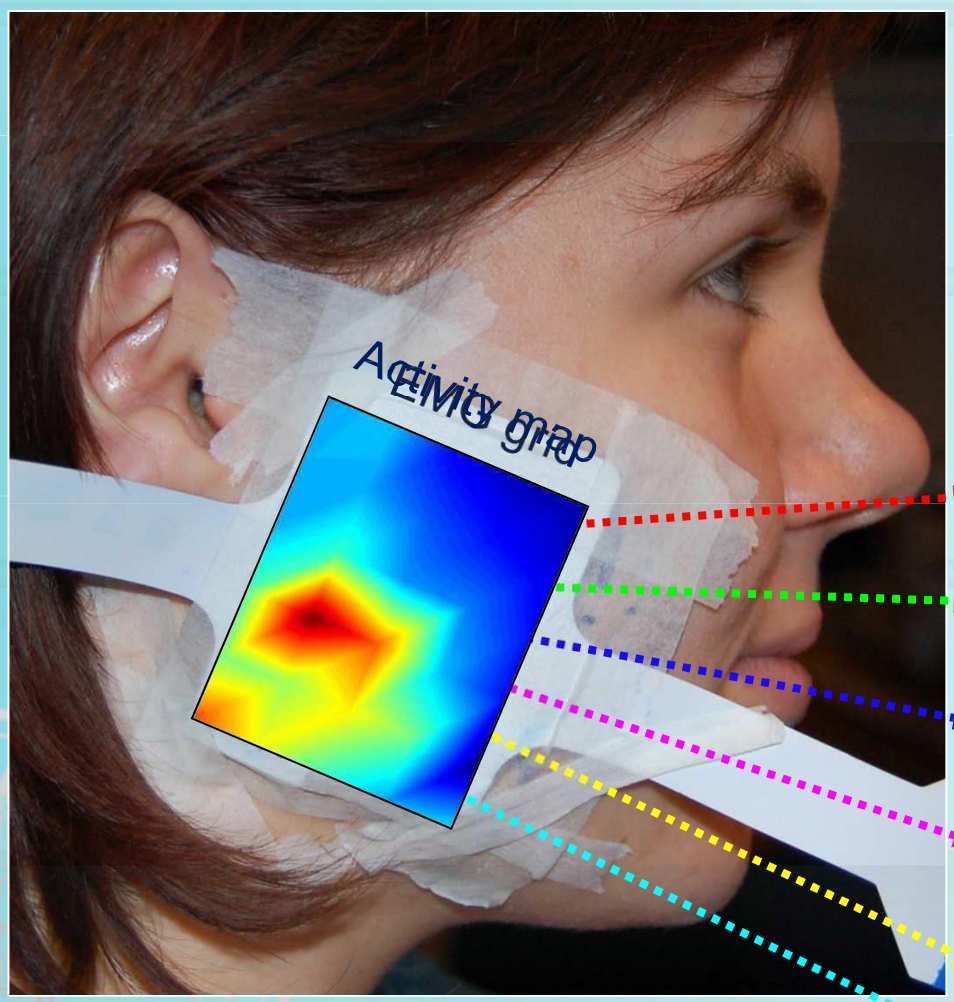
TMJ disc perforations and lesions



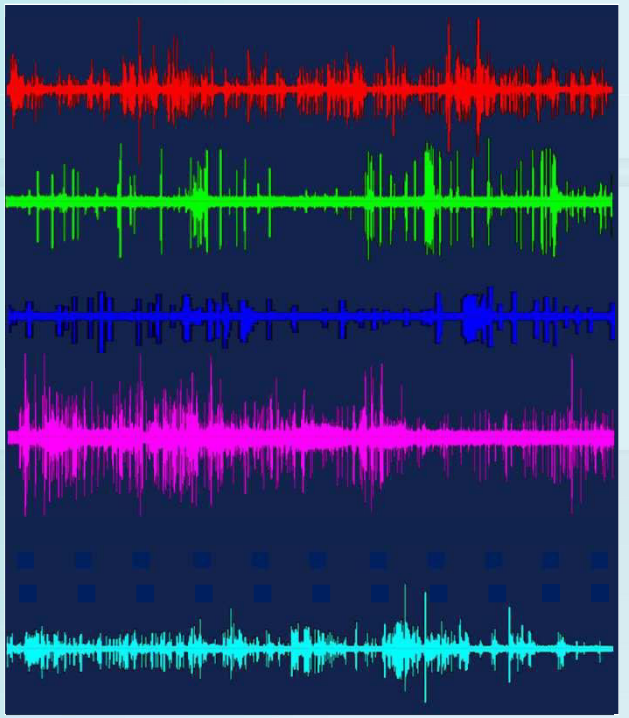
- ***(a)*** Jergenson MA, Barton JM. The occurrence of TMJ Disc Perforations in an Aging Population. *J Dent Res* 77 SI:1272, 1998.
- ***(b,c,d)*** Oberg T, Carlsson GE, Fajers CM. The temporomandibular joint. A morphologic study on a human autopsy material. *Acta Odontol Scand* 29:349-384, 1971.

Heterogeneous muscle contractions





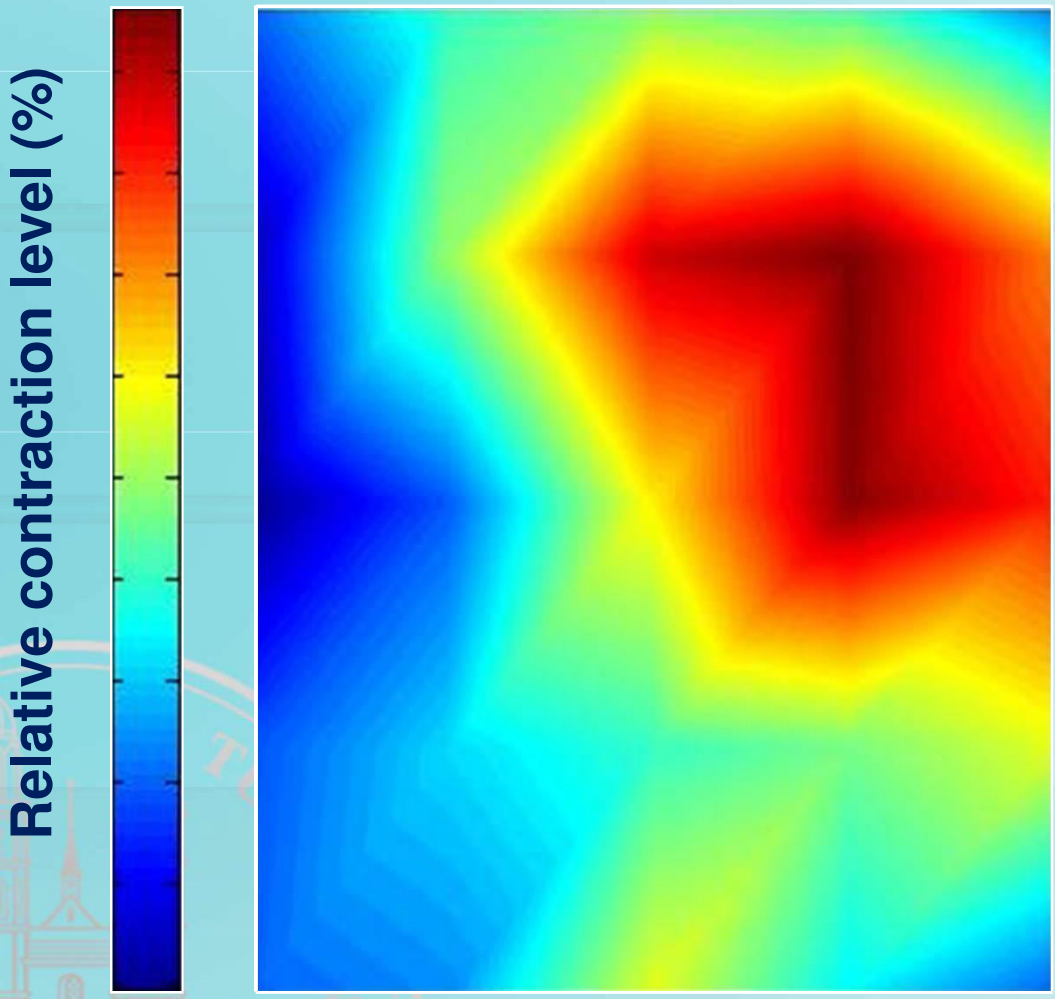




Multichannel high-density surface EMG

Farella et al., 2009 in preparation

Heterogeneous muscle contractions



Activity map



Left Right



Effects of parafunction



Muscle hyperactivity & bruxism

Muscle hyperactivity - especially of the jaw closers – can result in overloading of the orofacial structures with consequent damage and pain.

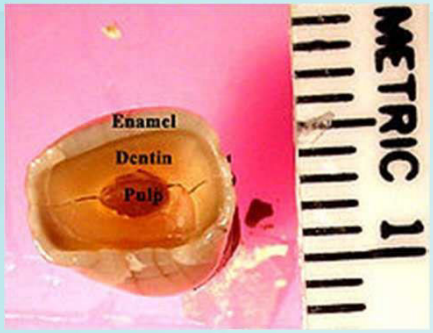
Bruxism

Marie and Pietkiewicz. La Bruxomanie. Rev Stomat 14:107-116, 1907.

βρυγμός = gnashing of teeth



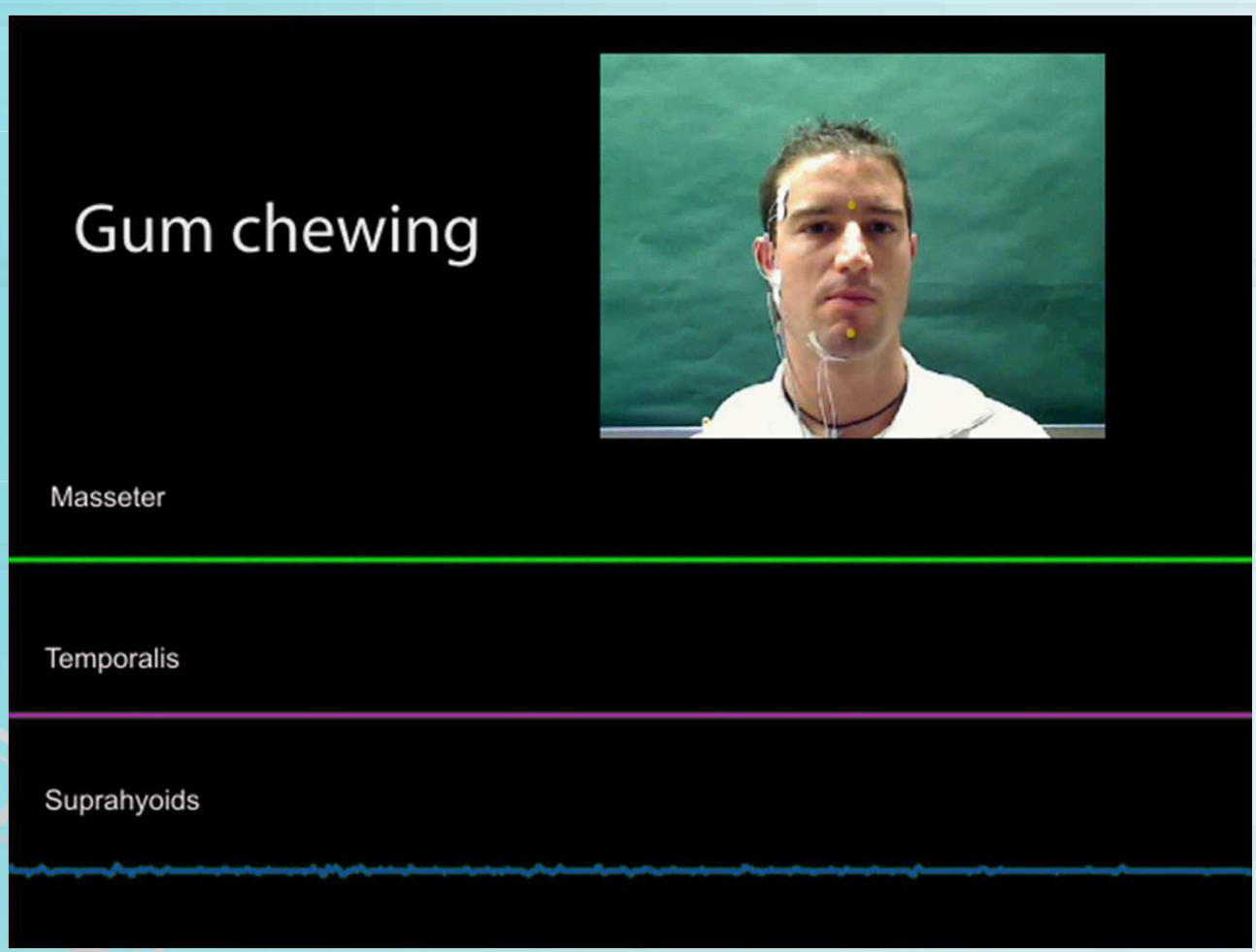




Biosignal recorders

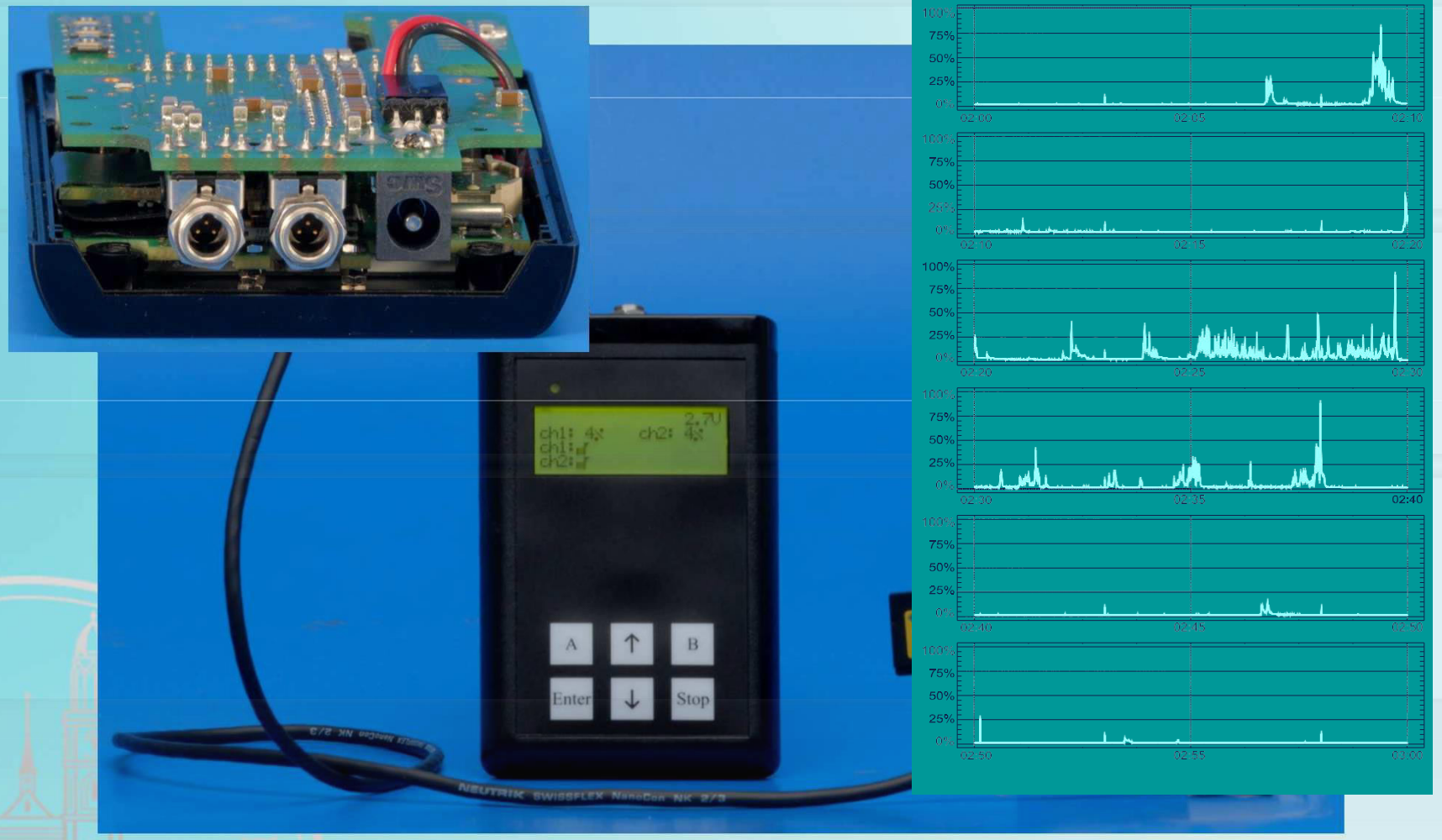
For this reason, we have being developing portable multichannel bio-signal recorders to be worn in the subjects' natural environment.

Portable EMG recording system



Muscle activity in the natural environment

Portable EMG recording system

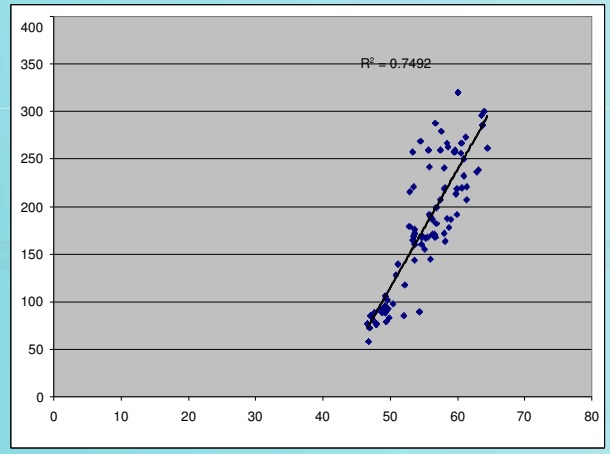


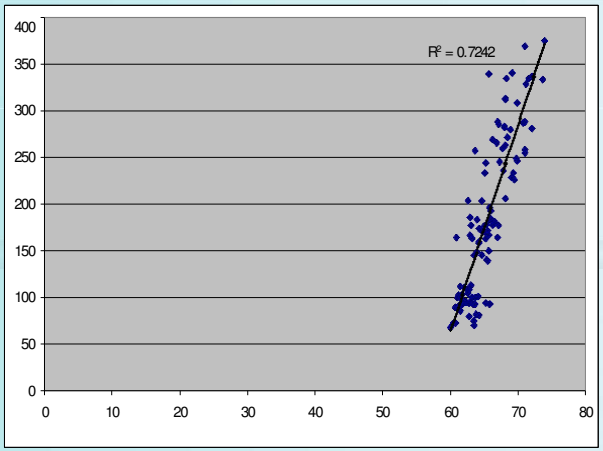
Muscle activity in the natural environment

Reproducibility of force vs. EMG

Trial 1 | **Trial 2**

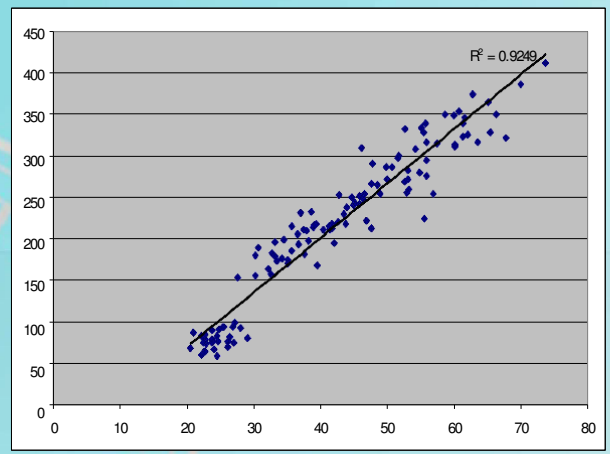
Subject 1

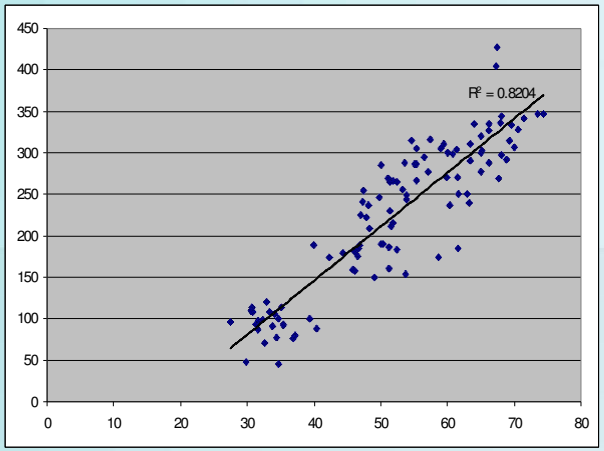




force [N]

Subject 2



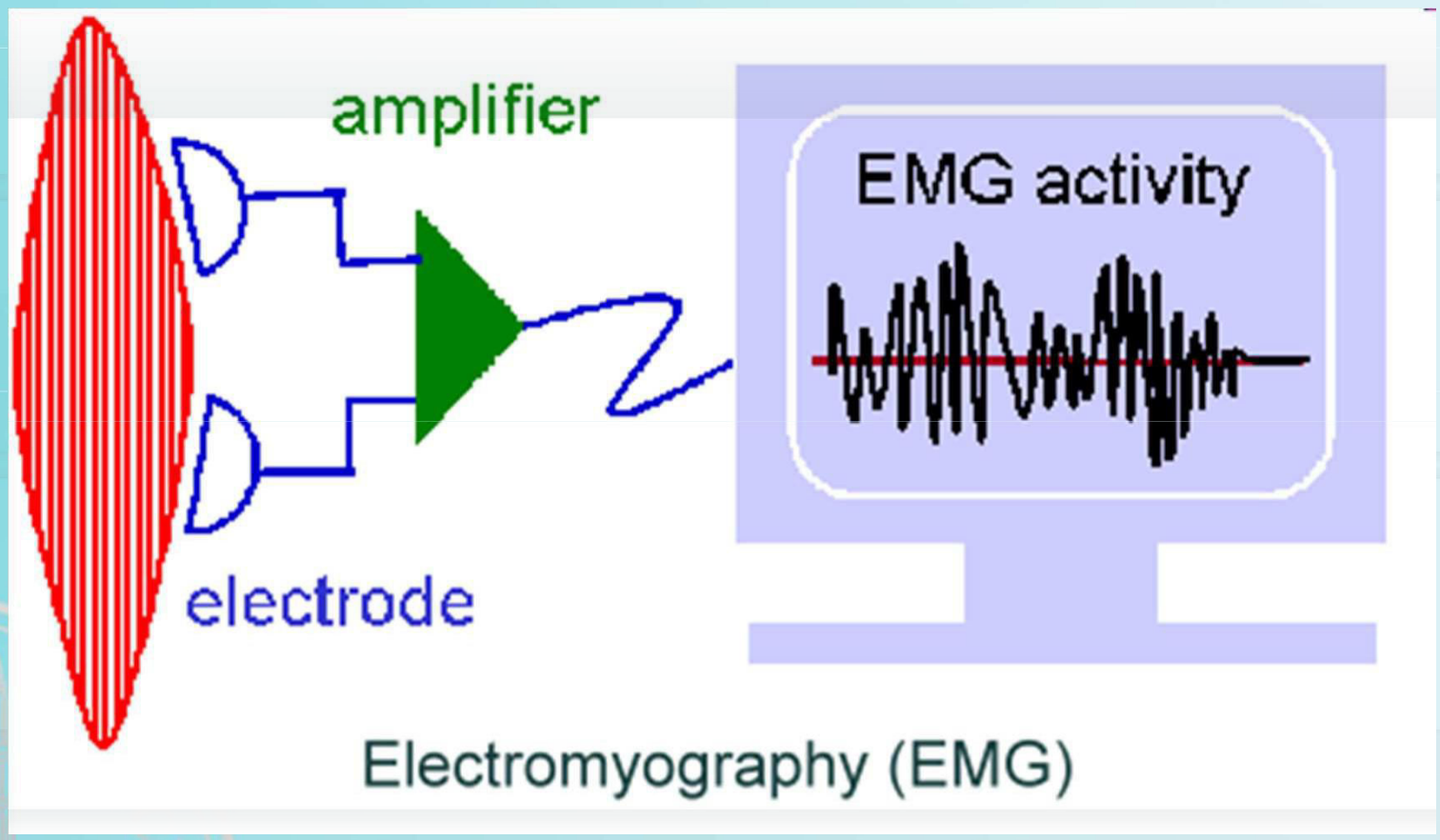


EMG [mV]

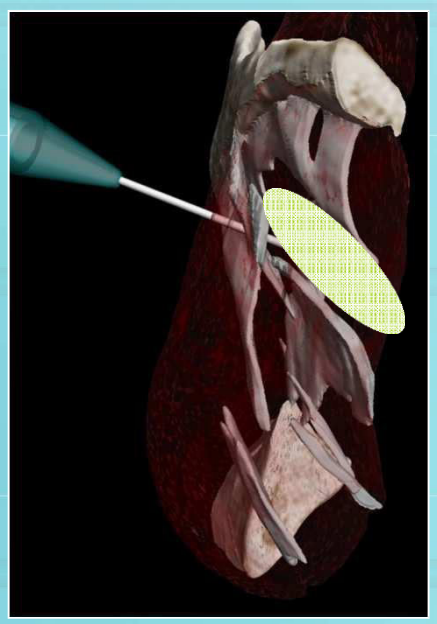
Signal acquisition

They have mostly relied on the use of surface and/or indwelling electrodes for EMG as well as the use of accelerometers to record head and body movements.

Surface electrodes



Indwelling electrodes



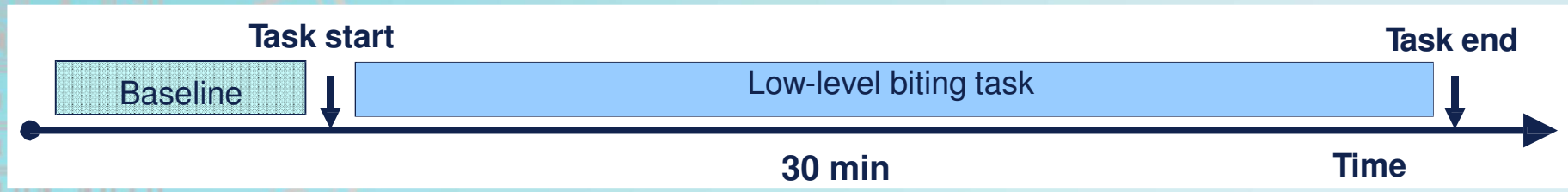






Three-channel intramuscular EMG signals

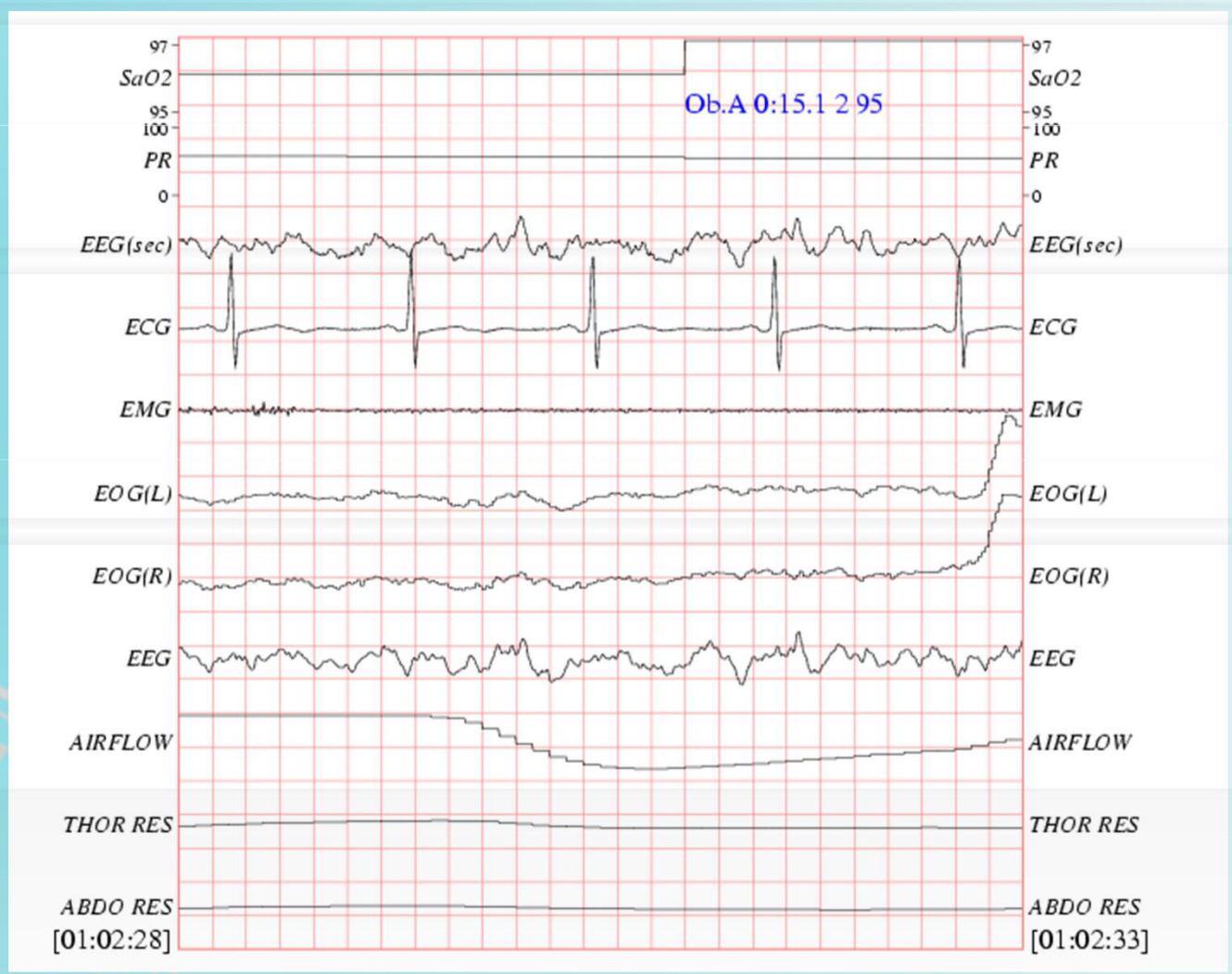




Data analysis

Due to the large data throughput of the new recorder generation, signal analysis can be cumbersome and time consuming.

Polysomnography



Analysis strategies

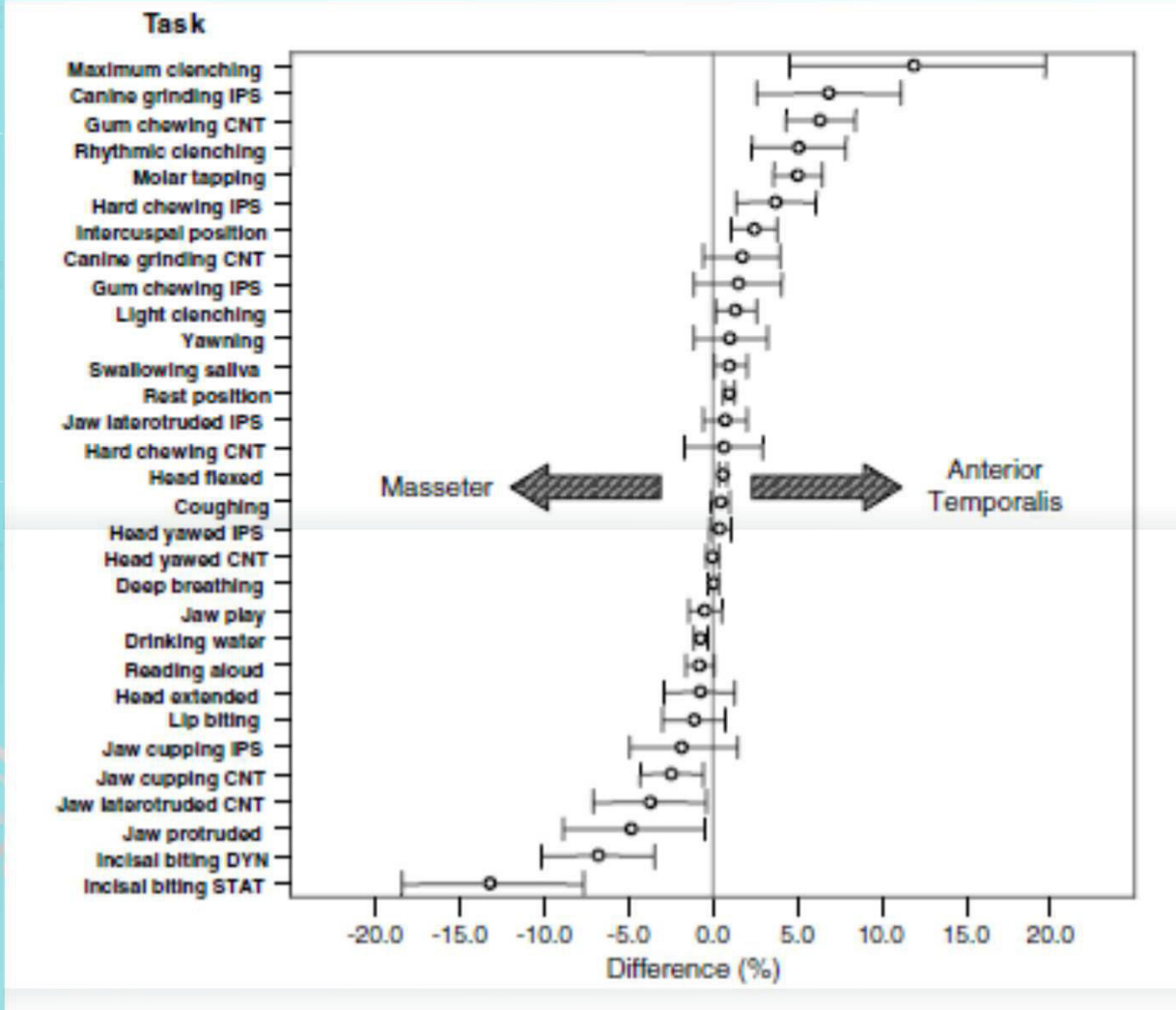
Data reduction or compression as well as online pattern recognition are some of the techniques that we have adopted in the past.

Information to extract

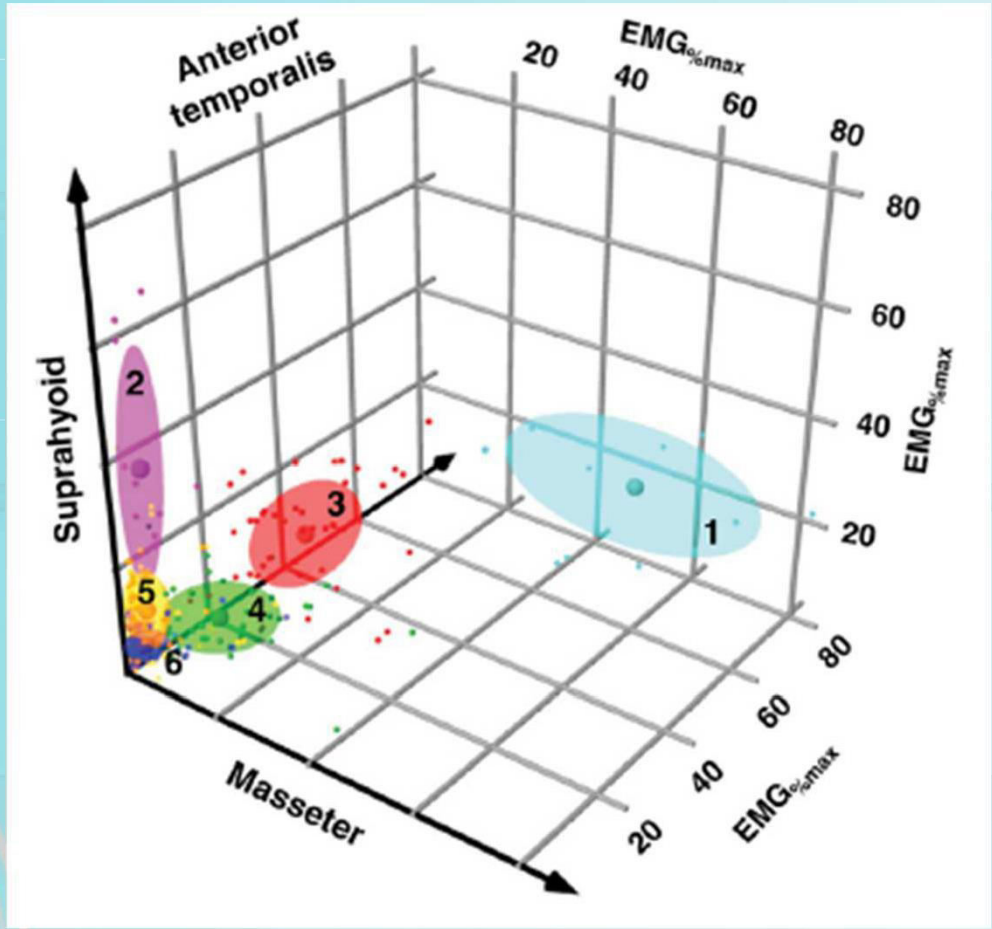
Gain information on

- type of oral tasks performed
- muscle fatigue
- chewing behavior
- para-function

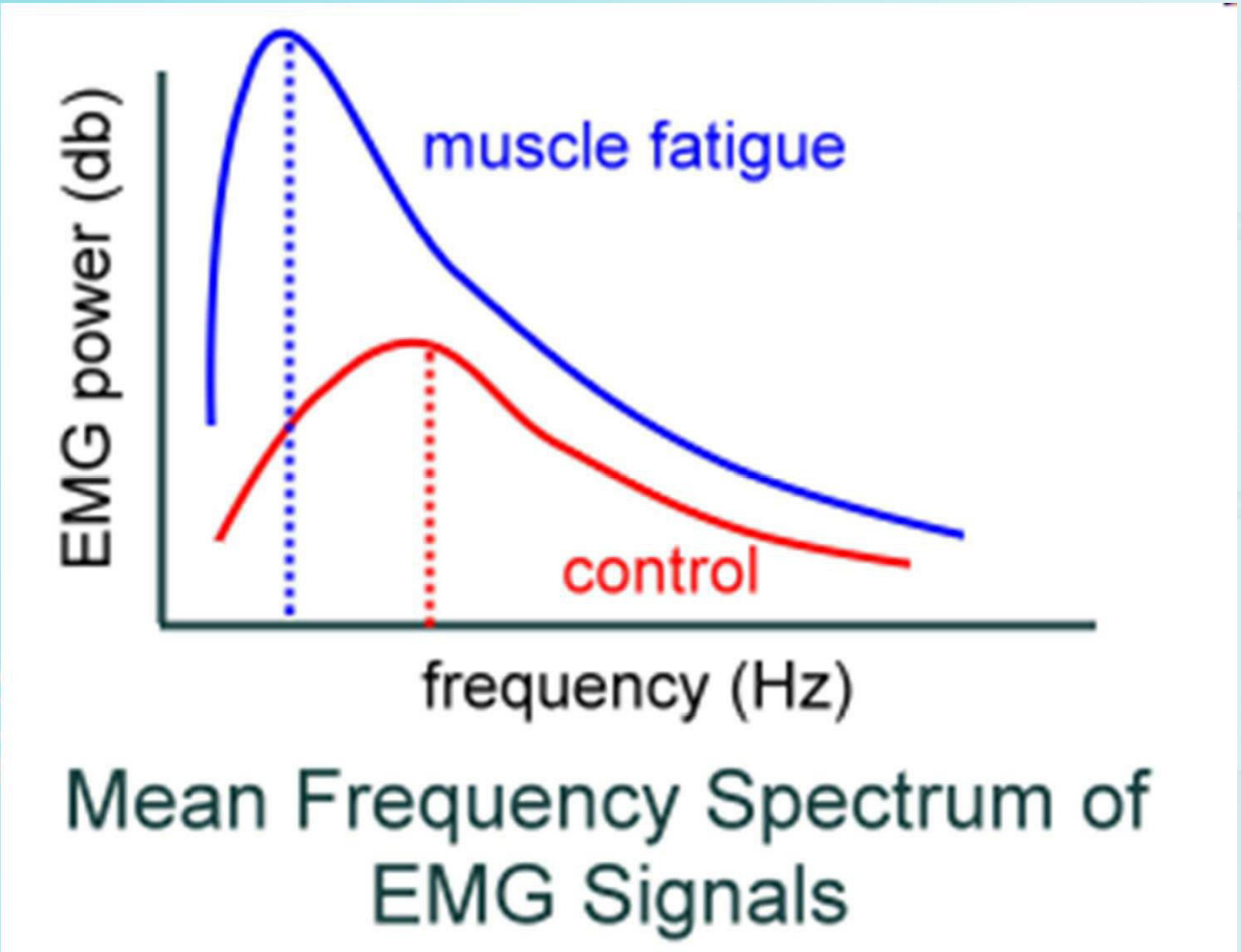
Characterization of activities



Characterization of activities

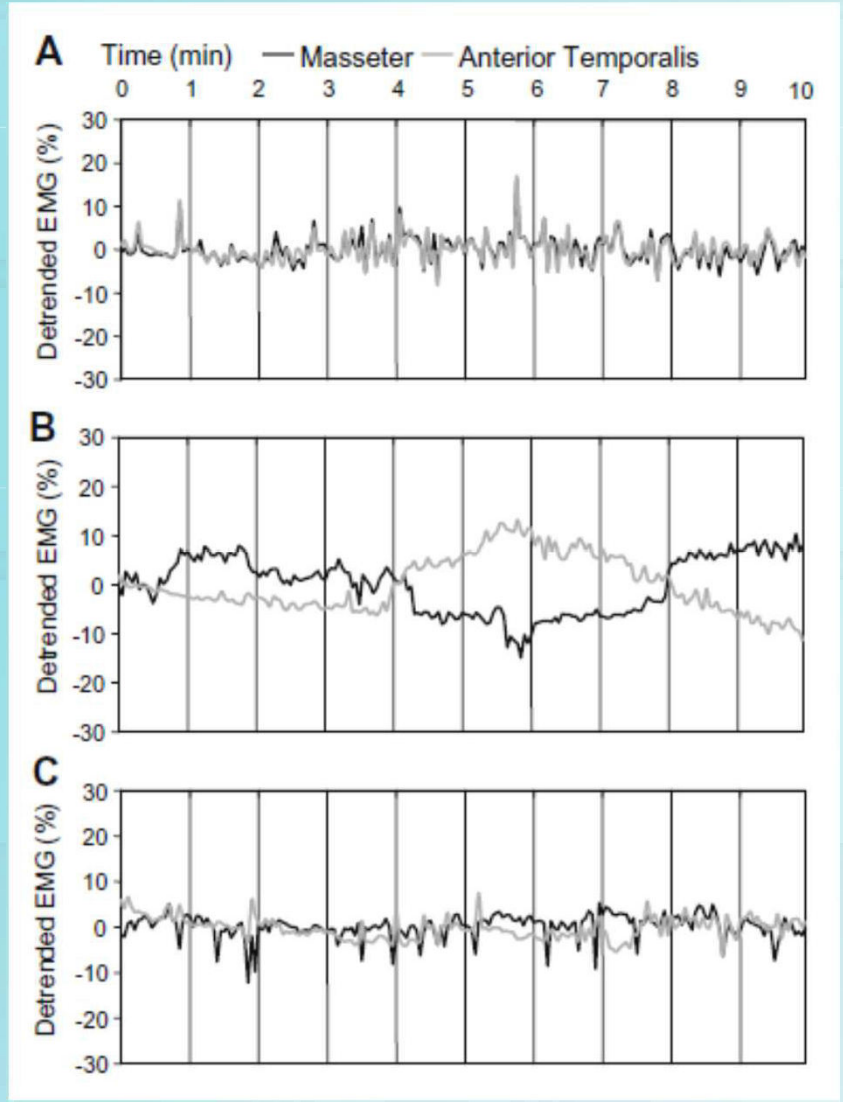


Muscle fatigue



Mean Frequency Spectrum of EMG Signals

„Rotation“ effects



Information to extract

Techniques used:

- episodes counting
- signal form decomposition
- signal demodulation
- FFT
- time-frequency representation

Occlusal splints



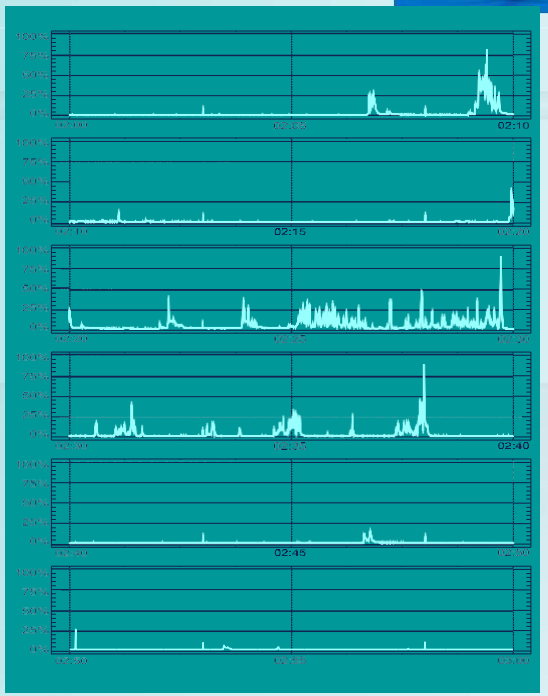




Episodes counting

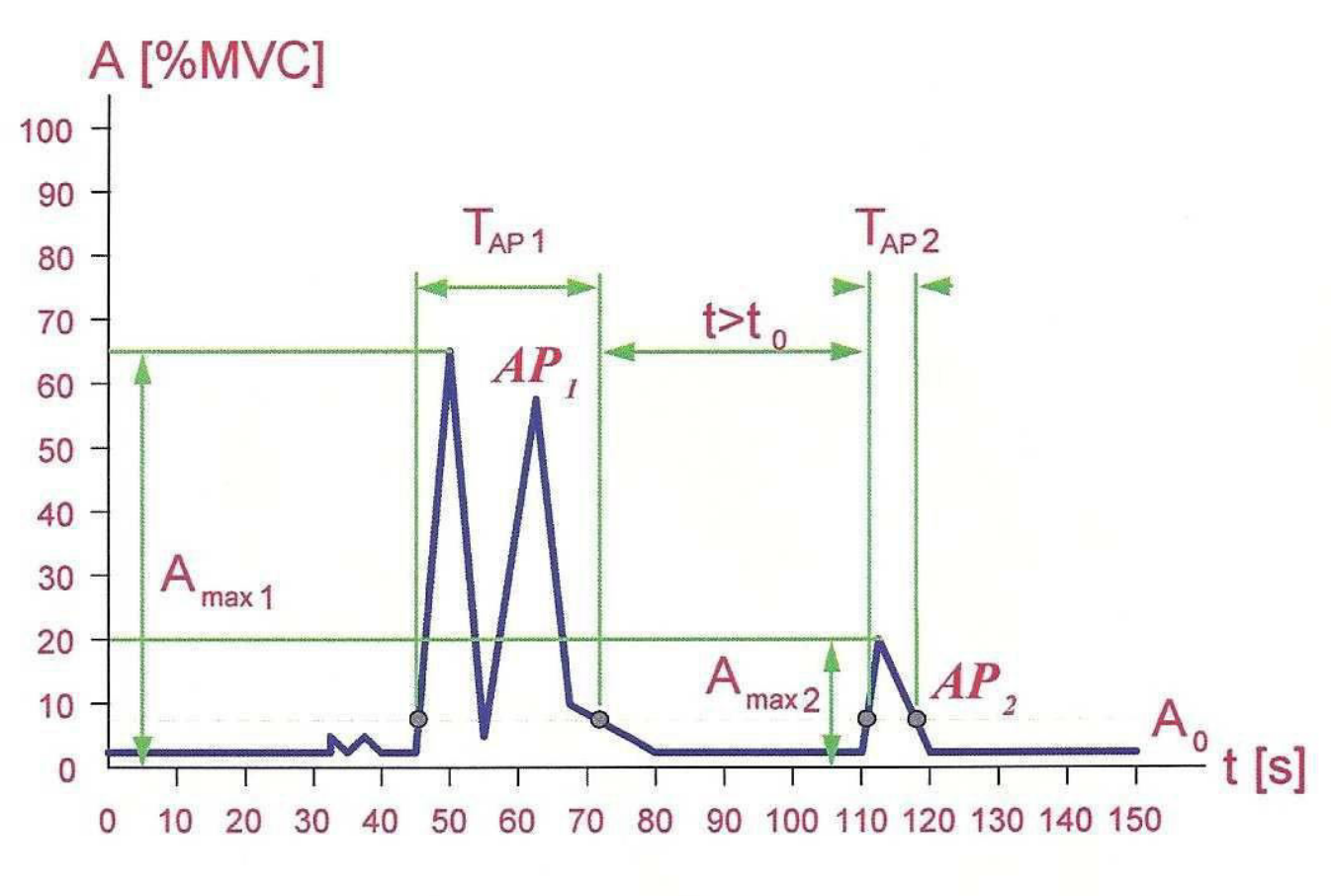
- 13 asymptomatic subjects (6 f, 7 m, aged 18–45 years)
- RDC/TMD criteria
- natural environment
- portable recorders
- masseter muscle
- 2kHz sampling frequency
- gain 1500 ×
- splints 3 mm thick
- 3 nights without, 3nights with splint
- MVC recording





Data analysis

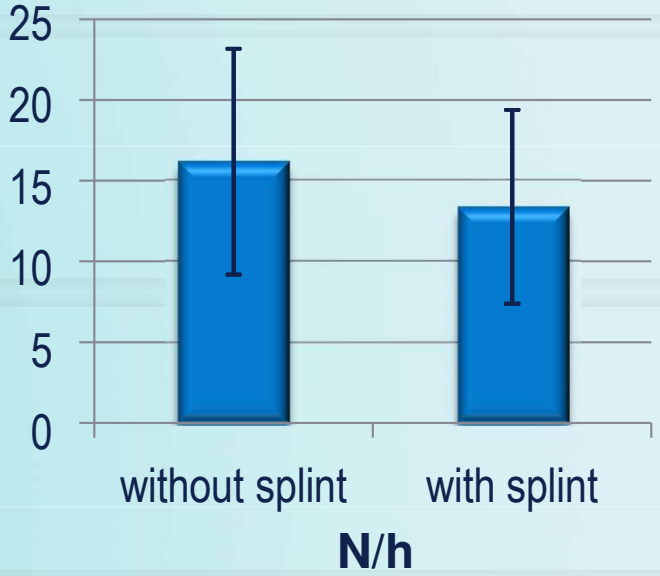
- activity periods (AP)
- t_0 = 5s
- number
- amplitude
- duration
- energy

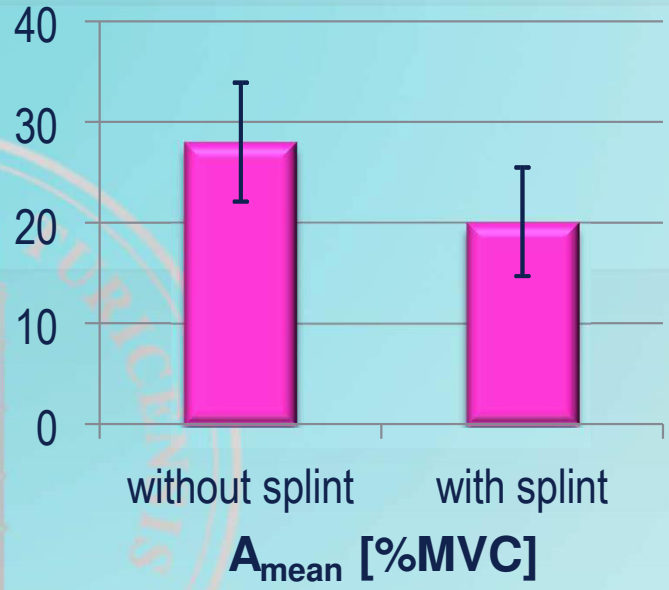


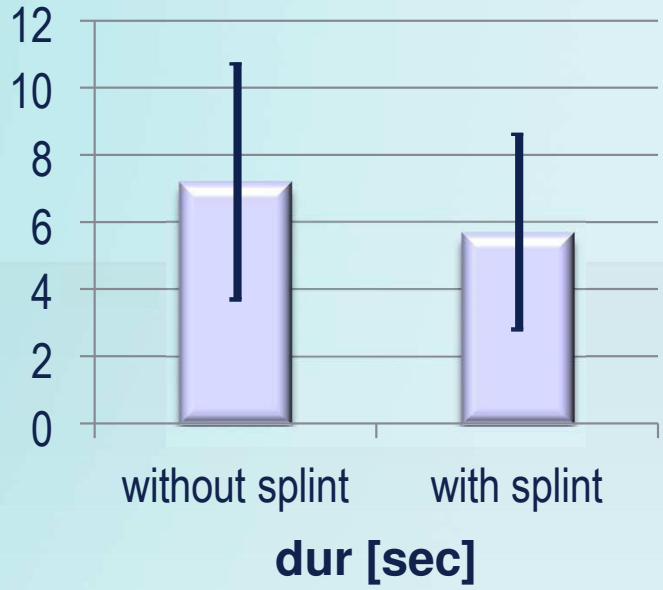
Gallo *et al.*, *J Dent Res*, 1999

Occlusal splints - Results

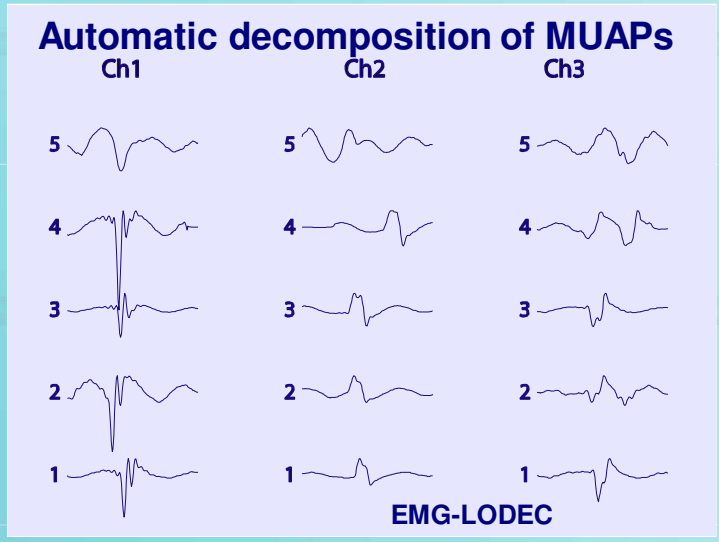
- MVC: 382 ± 60 N
- N/h of AP from 16.2±7.0 to 13.4±6.0
- mean amplitude from 28.0±5.9 to 20.1±5.4 %MVC
- duration from 7.2±3.5 to 5.7±2.9 sec
- Wilcoxon: $p<0.05$

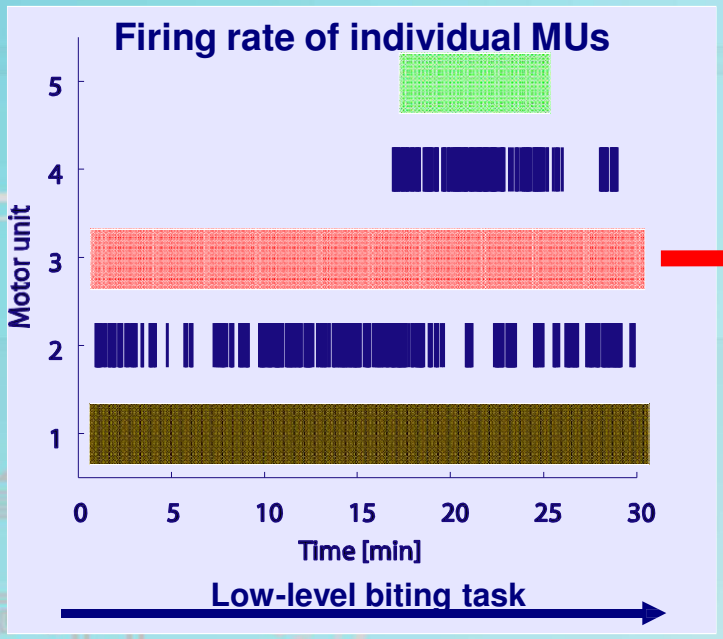


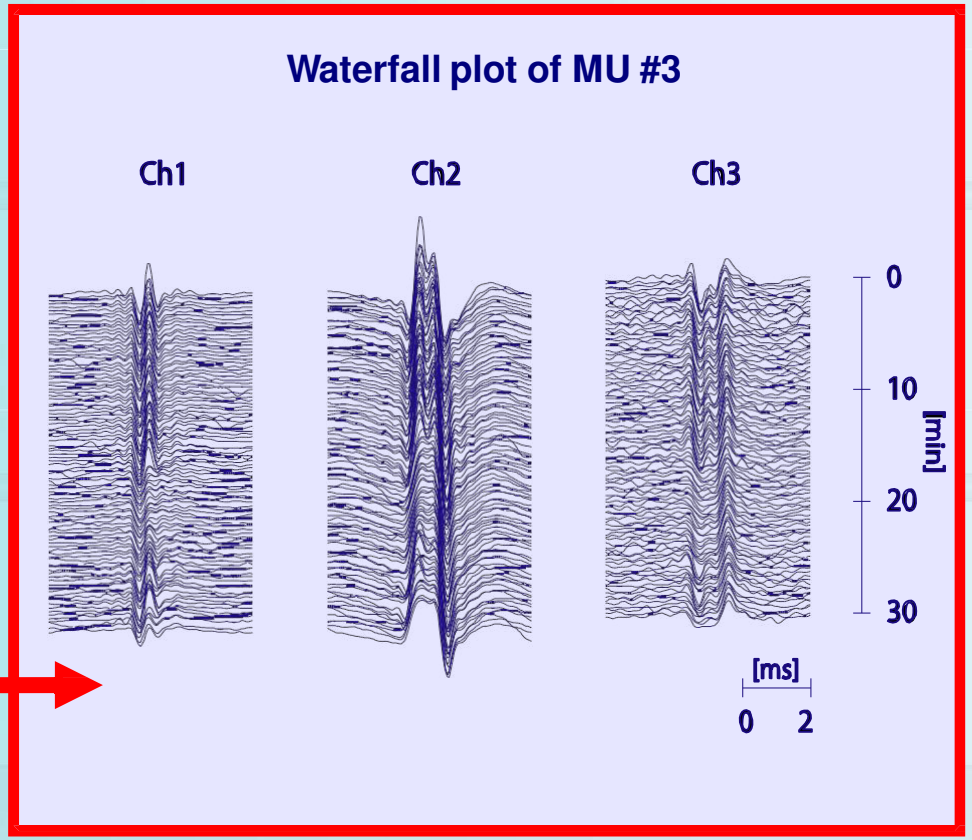




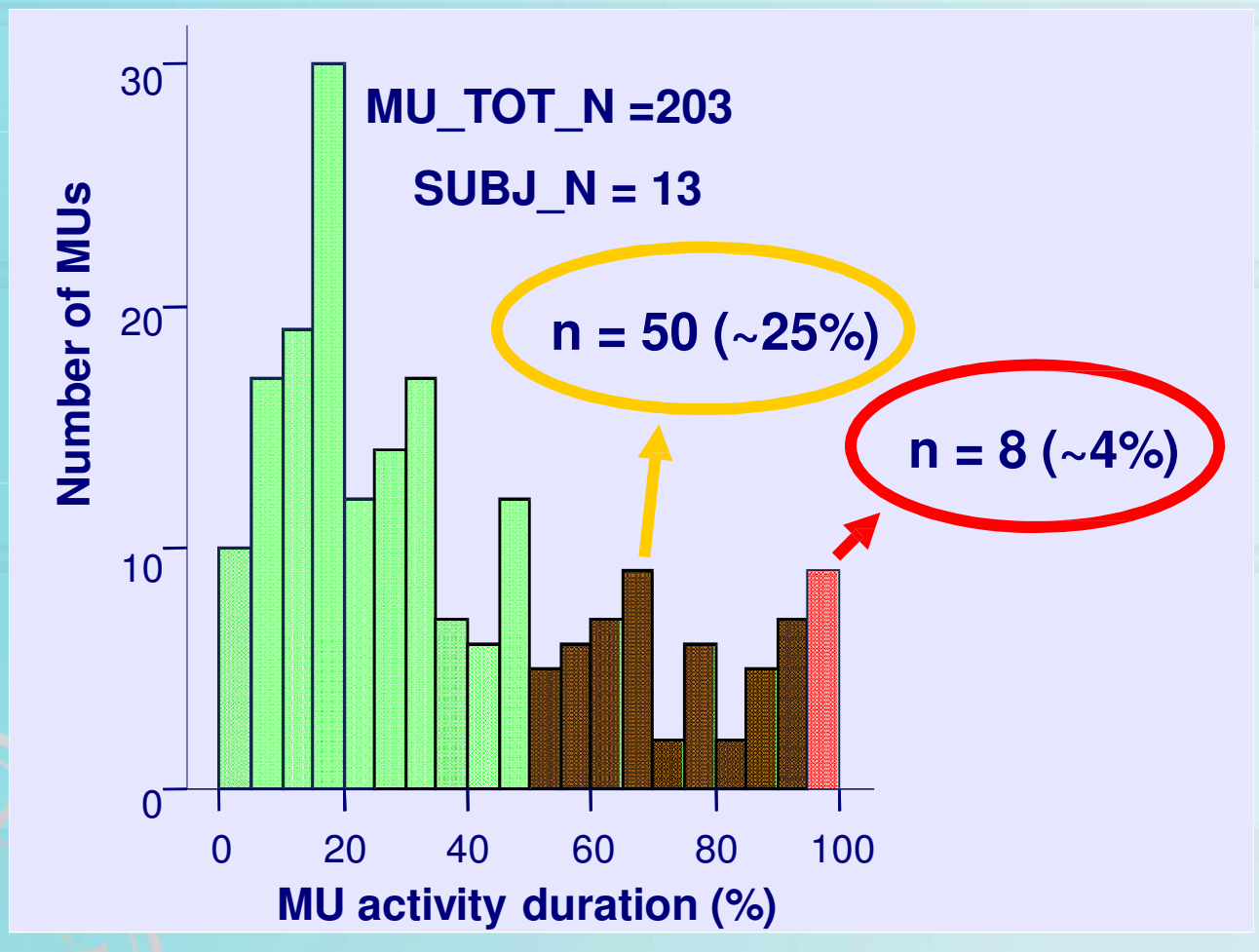
Signal form decomposition





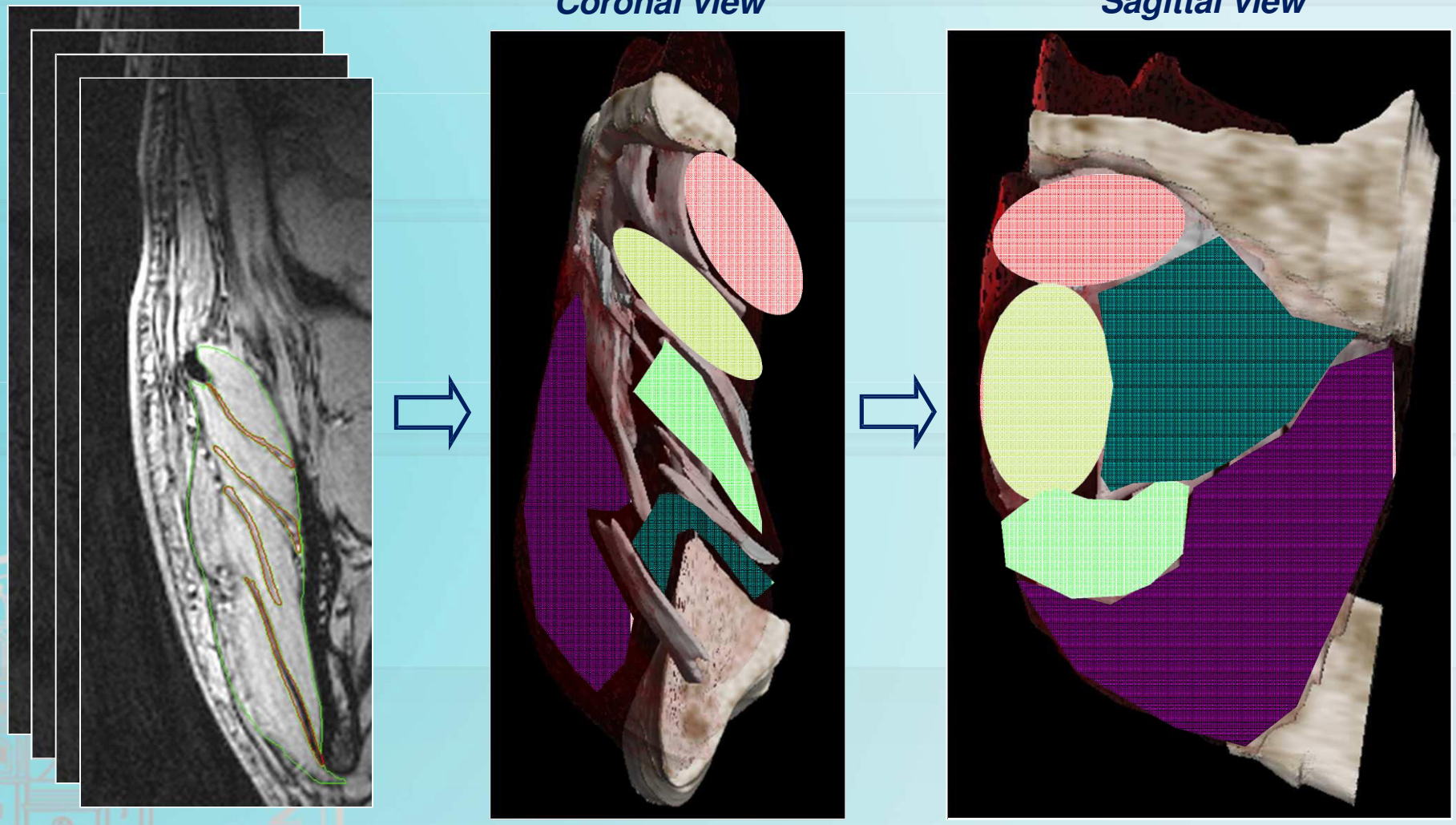


Duration of masticatory MUs activity



The majority of MUs in the masseter muscle is sporadically active during prolonged low-level load, but some of them (~4%) are continuously active

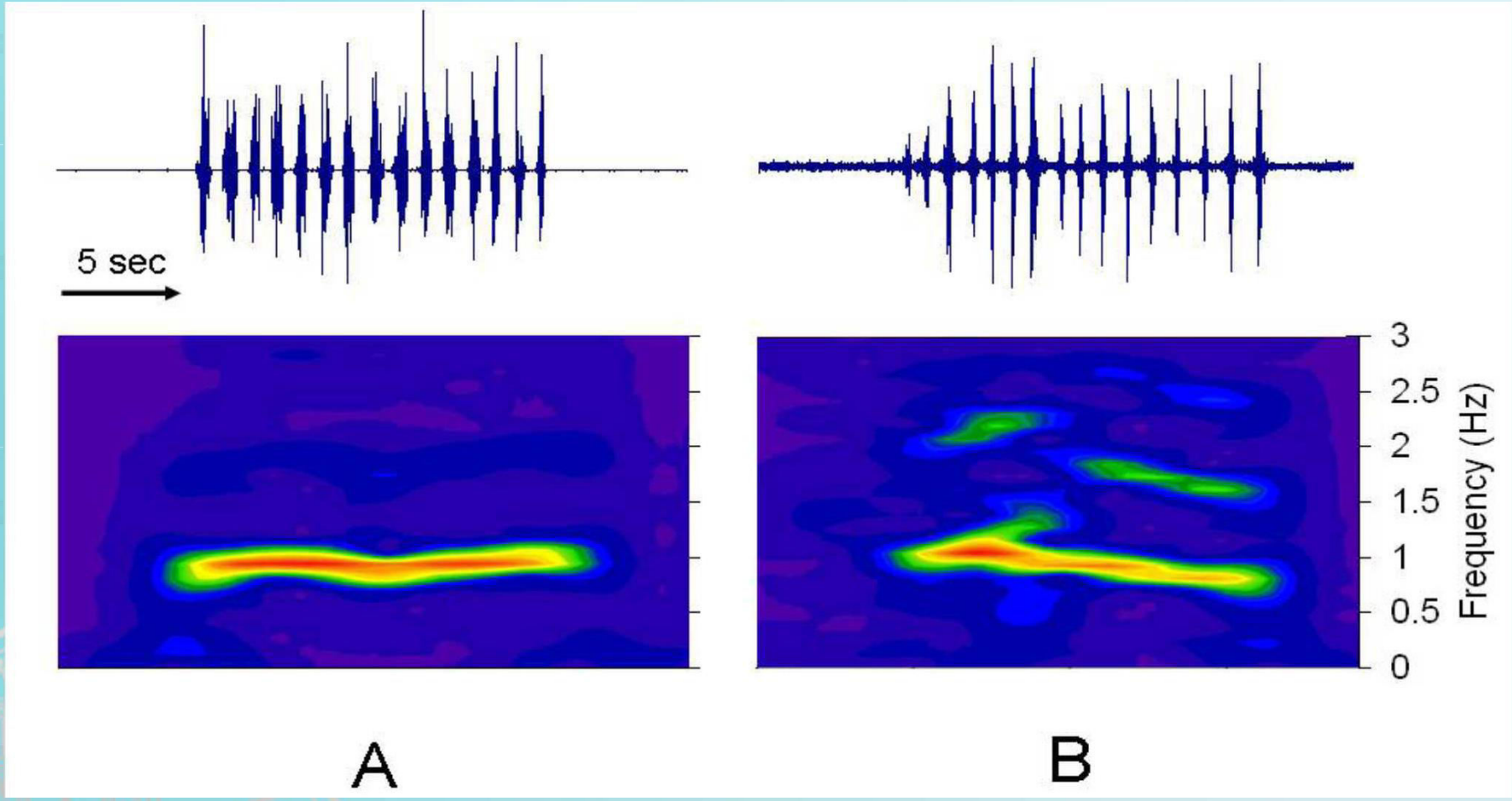
Masseter compartments



Possible consequences

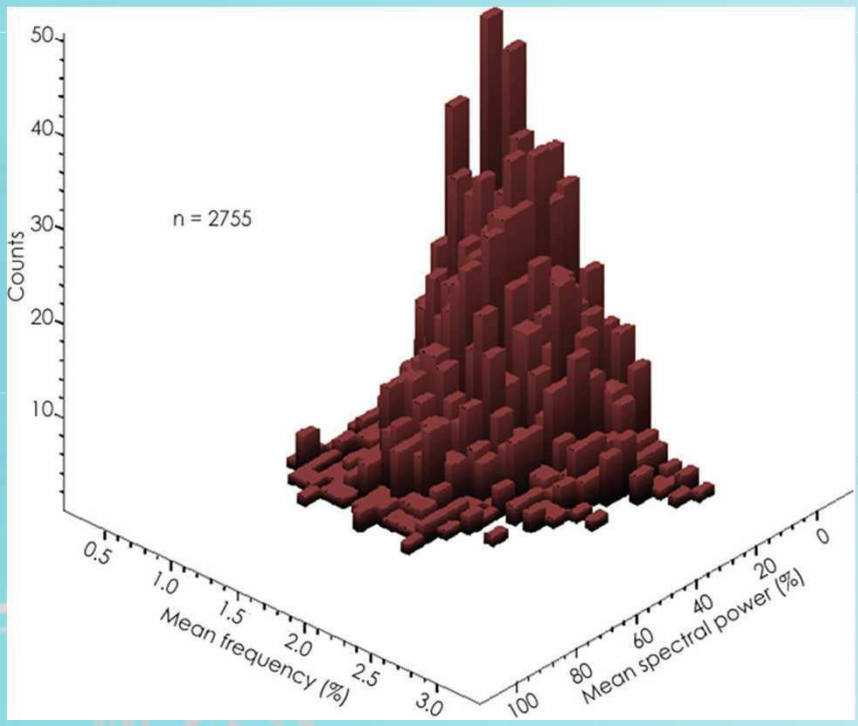
- stereotyped non-functional oral activity
- selective activation of muscle compartments
- continuos activity of a few localized MUs
- Ca^{++} accumulation
  and microlesions of muscle fibers
- drop of pH, release of ATP, and subsequent sensitization of muscle nociceptors
- masticatory muscle pain

Chewing frequency

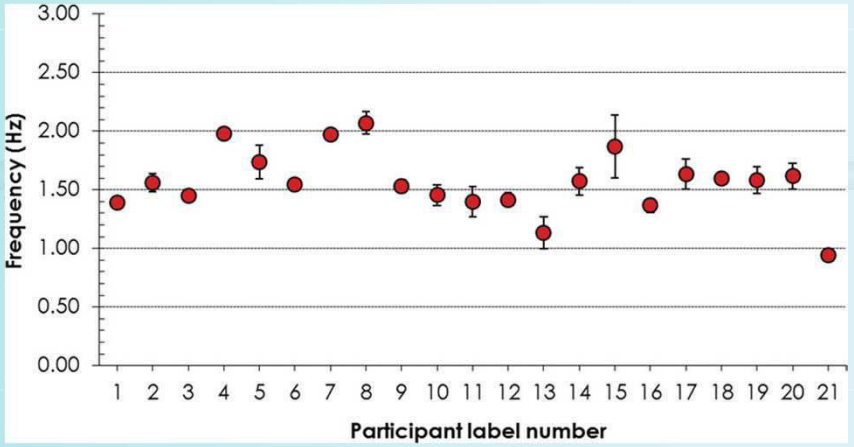


Examples of real raw EMG signals recorded during a gum chewing task (A) and during a natural chewing task (B), along with time-frequency representation of their demodulated EMG activity. The gum chewing task was performed at a constant frequency of 0.92 Hz. The natural chewing task started at a frequency of 1.12 Hz and gradually decreased to 0.87 Hz. Variation of frequency over time showed a significant ($p<0.01$) negative linear trend (-14.0 mHz/sec).

Chewing frequency



Chewing episodes obtained from all participants over 3 days



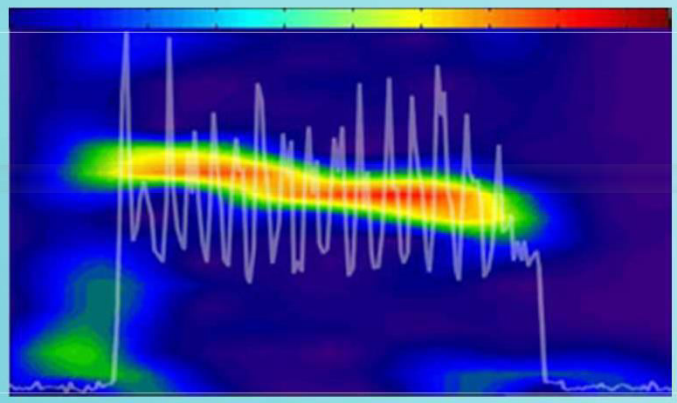
Mean chewing frequencies for each individual investigated. In general, the inter-individual variation was much greater than the intra-individual variation.

→ stability of chewing pace

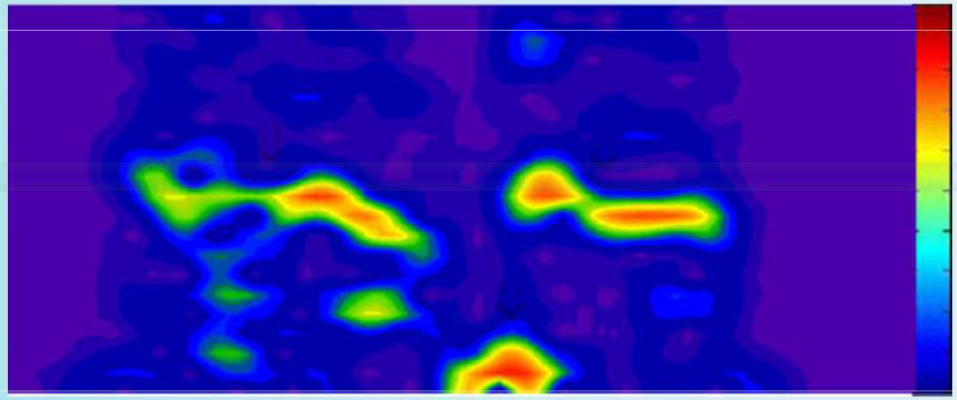
slow and fast eaters

Po JMC, Kieser JA, Gallo LM, Tésenyi AJ, Herbison P and Farella M. Time-Frequency Analysis of Chewing Activity in the Natural Environment. *J Dent Res* 2011, 90(10):1206-1210.

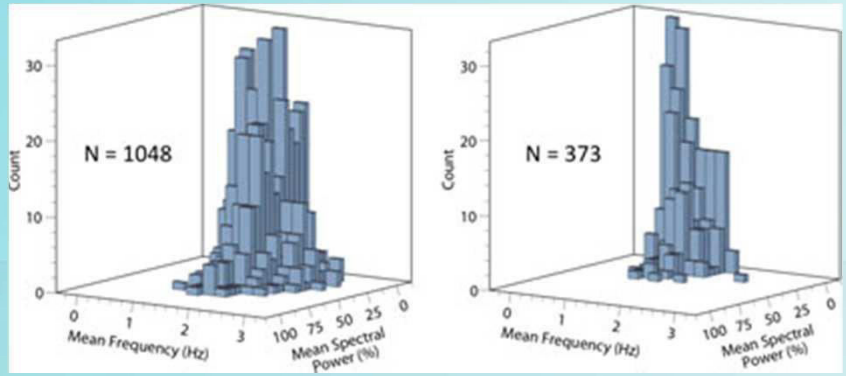
Chewing and bruxing frequency



Chewing frequency



Bruxing frequency



Chewing

Bruxing

Po JMC, Gallo LM, Michelotti A and Farella M. Comparison between the rhythmic jaw contractions occurring during sleep and while chewing. *J Sleep Res* 2013, 22:593–599.

Multimodal acquisition

Future studies will include also the use of other biosensors for the acquisition of further biological signals.


Danke!
Merci!
Thank you!
Grazie!

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