


TRAMA *TRAINING in Motion Analysis*

Second Course "Motion Analysis and clinics: why to set up a Motion Analysis Lab ?"

TRAMA Project

January 14 - 17th 2008

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Karolinska Institutet








The experience of the Movement and Gait Analysis Lab at the Department of Neurobiology, Care Science and Society, Karolinska Institutet, Stockholm, Sweden.

Research,
Teaching,
Clinical investigations

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Experimental research:

With focus on the control of basic motor abilities as gait, balance and voluntary movements in children and adults with normal and impaired motor control

Clinical investigations

Sitting analysis (pre/post surgery) in children with neuromuscular and syndrome related spine deformity.
Gait analysis (pre/post surgery, intervention) patients with ACL, CP

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Examples of experimental research studies

Elderly

Background: Gait initiation (GI) is a phase of walking during which falls are often provoked.

Question :
Do physically active elderly display alterations in gait initiation?

Exp. setup
2 CCD cameras (18 markers), 4 EMG ankle muscles, 4 AMTI force plates lowered in 8 m walk way, Traffic light

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Analysis:

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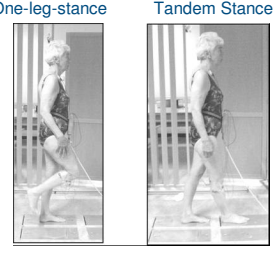
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Background : The clinical One-leg stance test is a measure considered to assess postural steadiness in a static position with common underlying notion that a better postural steadiness, i.e. less force variability, gives longer time spending in OLS, i.e. better balance!

Question :
How does postural steadiness during one-leg stance change over time

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One-leg-stance Tandem Stance

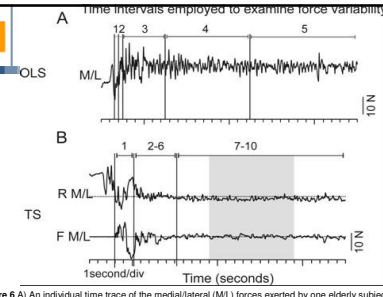


Experimental setup
4 force plates
4 EMG (ankle muscles bilaterally)

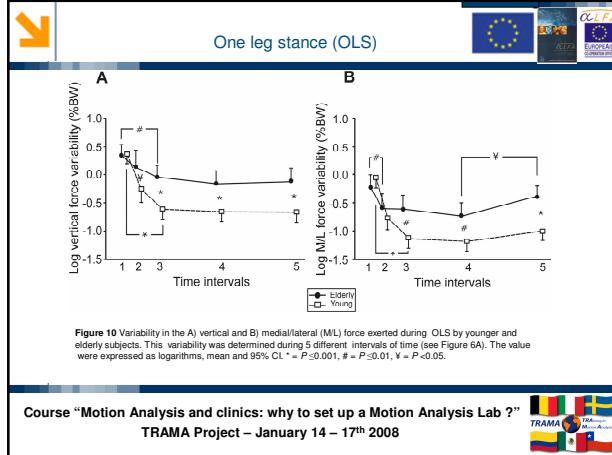
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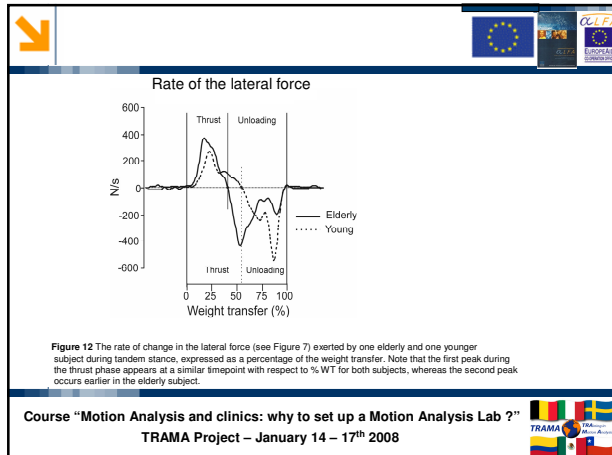
Figure 6 A) An individual time trace of the medial/lateral (ML) forces exerted by one elderly subject performing one-leg stance (OLS). The amplitude of the force is expressed in Newtons (N). The variability in the ML force beneath the stance leg was analyzed in terms of the mean standard deviation during the following five time intervals: 1 = 0-0.49 s; 2 = 0.5-0.99 s; 3 = 1-1.49 s; 4 = 1.5-1.99 s; and 5 = 2-3.0 s.

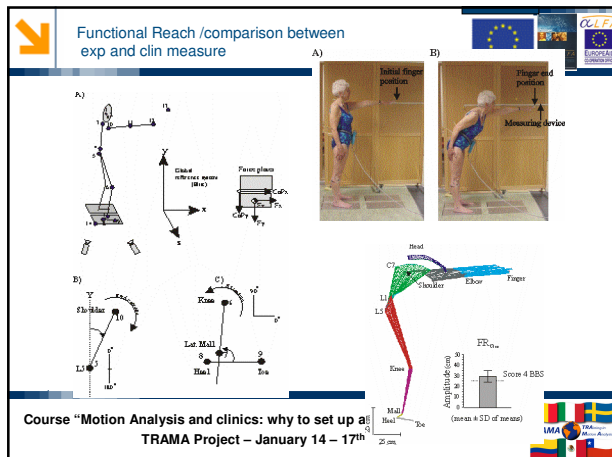
B) Individual time traces of the ML forces exerted by the rear (R) and front legs (F) of one elderly subject performing tandem stance (TS). The traces begin when this subject is standing with his feet side-by-side. Thereafter, the changes in force associated with placement of the front foot on the force plate in front of the force plate under the rear foot are shown. Time interval 1 extended from the onset of change in the vertical force on the plate beneath the front leg until the front foot had been completely placed and this vertical force attained a plateau. The remaining time was then divided into five 1-s intervals (intervals 2-6) followed by four 5-s intervals (interval 7-10). The gray area represents analysis of the 10-s static phase.



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A/P displacement of CoP

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Sit-to-walk in old people with fear of falling


Background: The transfer from sitting to standing, walking is important for independent mobility and independent living.

Question:

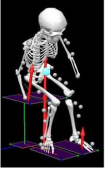
How do old people (>70 years of age) with a fear of falling perform the sit-to-walk task?

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Exp. setup
38 markers, 2 AMTI force plates on the sit device and 2 AMTI force plates lowered in the walk way.

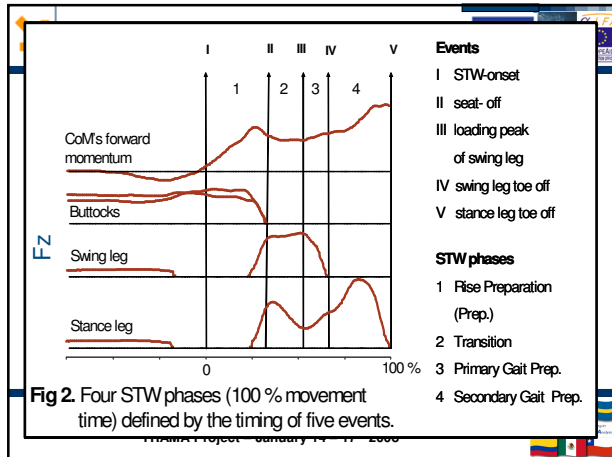


Analysis: focus on temporal sequencing and amplitude scaling between CoM momentum and GRFs.

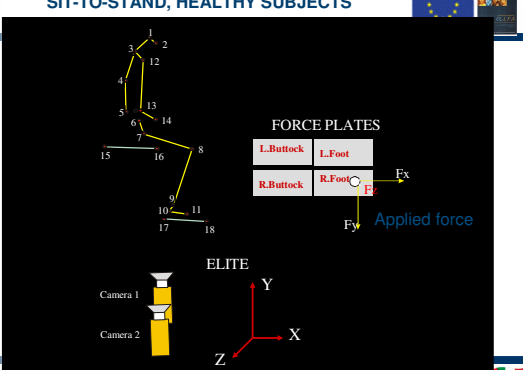


Same setup for investigation of StW in subjects with stroke

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SIT-TO-STAND, HEALTHY SUBJECTS



FORCE PLATES

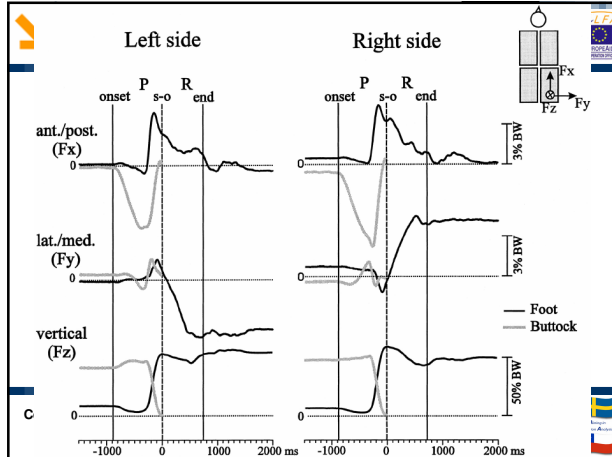
- L. Buttock
- L. Foot
- R. Buttock
- R. Foot

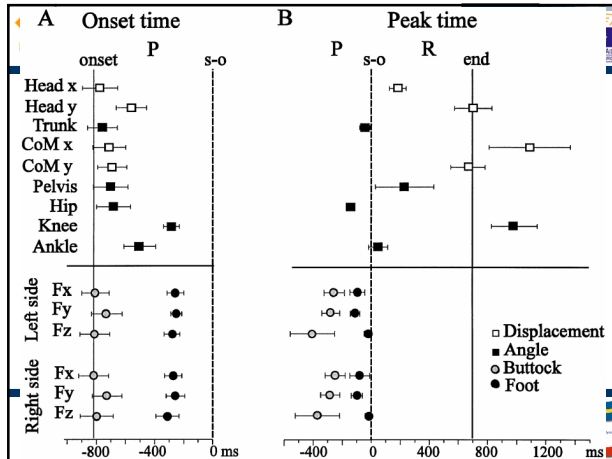
Applied force: F_x , F_y

ELITE

Camera 1, Camera 2

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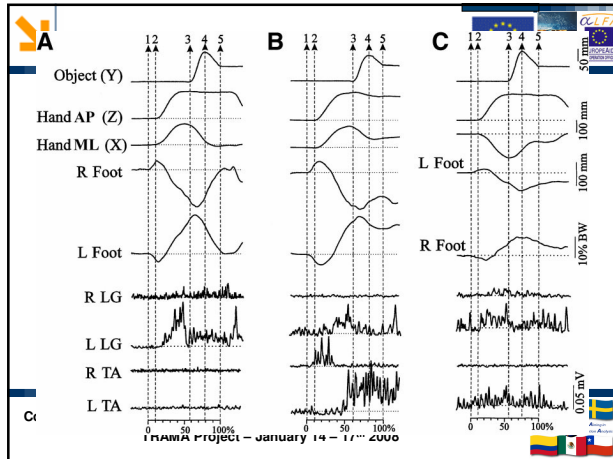


Stroke
Reaching-lifting task

Fig. (A) Schematic drawing of the experimental setup. Note the different 3-dimensional reference coordinates for kinematics and forceplates.

(B) Time traces (1 trial) of object, wrist, and GRF. Show the 5 events providing temporal reference points: (1) loading onset, (2) hand movement onset, (3) object lift onset, (4) time of object peak height, and (5) object placing end. Movement time (100%) was defined as between event 1 and 5. Abbreviation: AP, anterior-posterior

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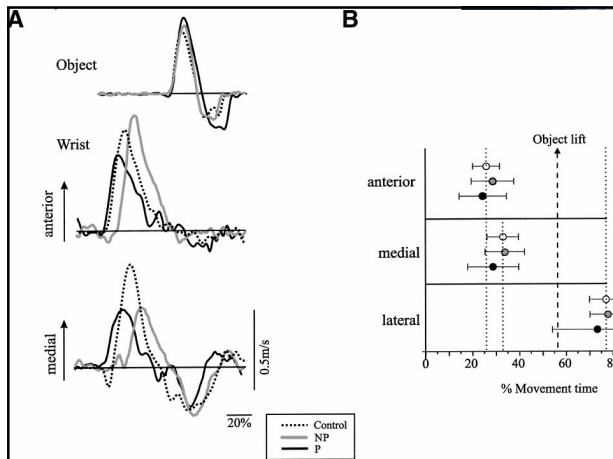
Single time traces of hand path, vertical GRF beneath both feet and ankle muscle electromyograms are shown for a right-hand task in (A) 1 control, (B) 1 stroke subject with right hemiparesis, and (C) for nonparetic lefthand task.

(B) Scale bars are on the right. Positive going traces follow the 3-dimensional coordinates in figure 1A. Numbers 1-5 indicate the temporal events (fig 1B). Abbreviations: AP, anterior-posterior; ML, mediolateral; R, right; L, left.

(REACHING, LIFTING TASKS DURING STANDING AFTER STROKE, Kusoffsky et al. Arch Phys Med Rehabil Vol 82, May 2001)

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Legend for previous slide

(A) Reaching and object velocity are shown for a single trial of 1 control and 1 stroke patient (NP and P hand). Object traces are aligned to onset of object velocity and the hand velocity traces are aligned to hand movement onset. Scale base indicates percentage of movement time. (B) Velocity peak time in anterior, medial, and lateral direction shown as percentage of movement time. Group mean \pm 6 SD is shown. E, Control; NP, P.

(Kusoffsky et al. Arch Phys Med Rehabil Vol 82, May 2001)

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STROKE

Effects of weight shift training on CoP displacement during
* reaching tasks, * gait, and * gait initiation

Measures: pre training, after 3 weeks intensive training, after 12 weeks without training (retention)

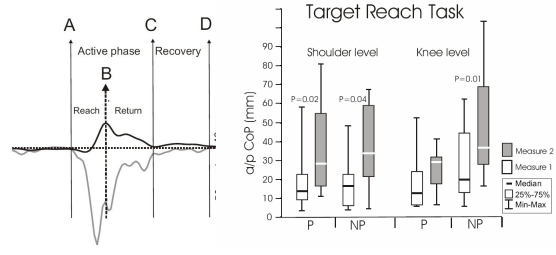


Fig 1a. Fig 1b. Fig 1c.
Photographs courtesy of Andersson (1), Karolinska Institute, Stockholm, Sweden (2005-2006).

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Target reach task – arm distance to different pointing heights

(P. Tsaklis et al. in manuscript)



Target Reach Task

Shoulder level: $P=0.02$, $P=0.04$

Knee level: $P=0.01$

Legend: Measure 2 (grey), Measure 1 (white), Median (line), 25%-75% (box), Min-Max (whiskers)

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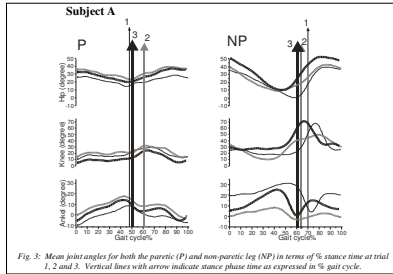


Changes in gait kinematics between measures



Davis protocol for gait analysis

(P. Andersson et al in manuscript).



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Lifting from floor task



- Healthy subjects
- Women with back pain after pregnancy
- Nilsson-Wikmar (Thesis 2003)
- Commissaris et al 2002

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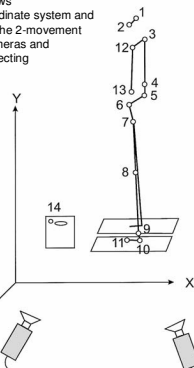




The experimental setup. Subject stands with each foot on a force platform, the box in front of her.



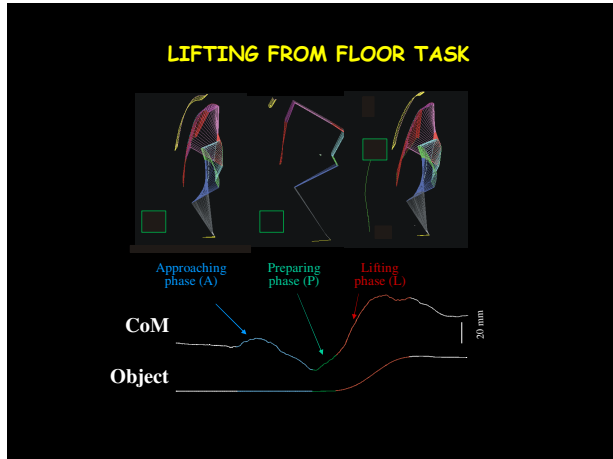
Schematic shows the ELITE coordinate system and the position of the 2-movement registration cameras and the 14 light-reflecting markers.

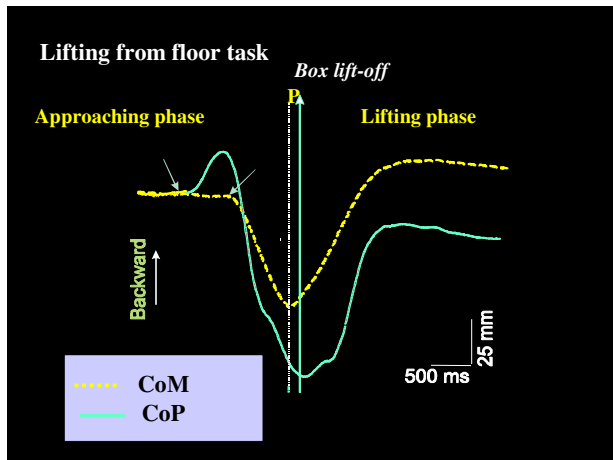


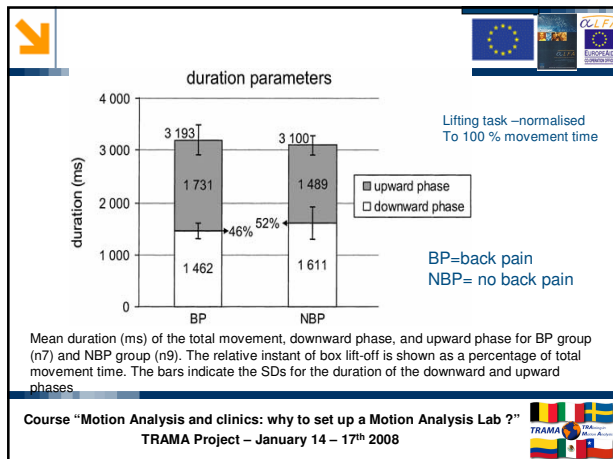
Cours

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Transfer from bed to wheelchair in subj, with SCI

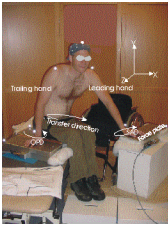


Figure 1 Experimental set-up for a transfer from table to wheelchair showing three force plates: one beneath the buttocks and the other two beneath the trailing and leading hands. Arrows indicate the torque direction of vertical force (M_z) beneath the trailing and leading hands as well as the direction of the lower body transfer movement. The 3D room reference coordinates for the kinematics in this set-up are indicated. Abbreviations: SAD indicates a torque direction beneath the hand in same direction as that of the transfer, while OPD indicates the opposite direction

Kinematics and GRFs from 3 force plates

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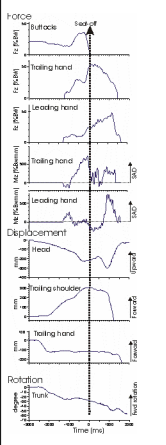


Figure 2 Time traces of a single trial of one subject illustrating the different parameters analyzed. The vertical force signals F_z (expressed in %BW) generated beneath buttocks and hands as well as the torque of vertical force M_z (expressed as %BWmm) of vertical displacement of head and anterior/posterior displacement of trailing hand and trunk rotation. Arrows indicate direction of traces moving in a positive direction. One trial for one subject illustrates the different parameters analyzed. Vertical line indicates seat-off and is defined as time zero. Coordination of body movement and arm forces. (EB Forslund et al 2007, Spinal Cord)

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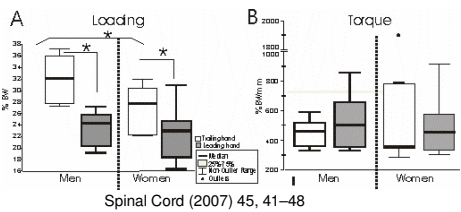



Figure 4 Box and Whisker plots of group median of the mean amplitude of individual means of loading on the trailing and leading hand (a) and peak torque amplitude (b)

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Cerebral Palsy



The Standing Shell *a body shaped orthosis*

- Compensates for impaired body geometry
- Ankle joint angles <math>< 90^\circ</math> deg
- CoM projection in front of ankle joints
- Support base equal to feet area

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Setup: Kinematics, EMG, GRFs

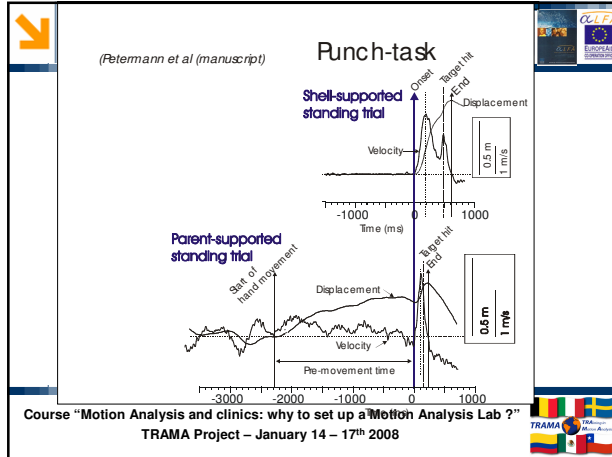
CP – GMFCS IV-V

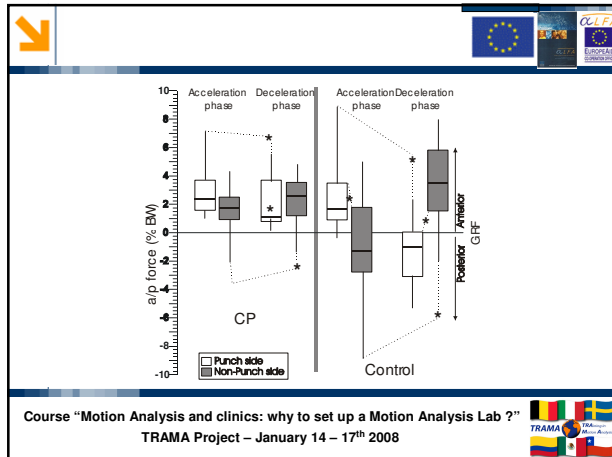
(Petermann PhD-thesis work)

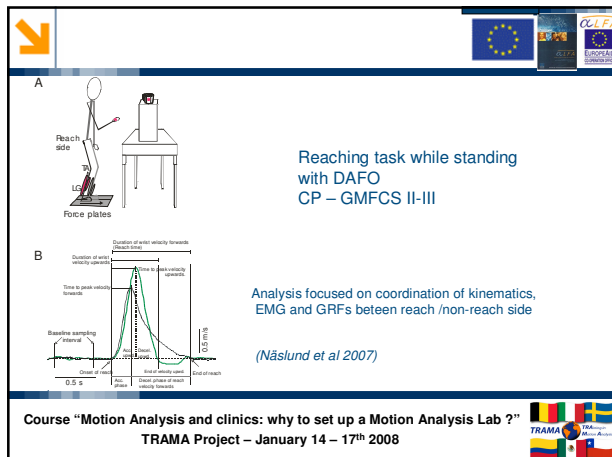
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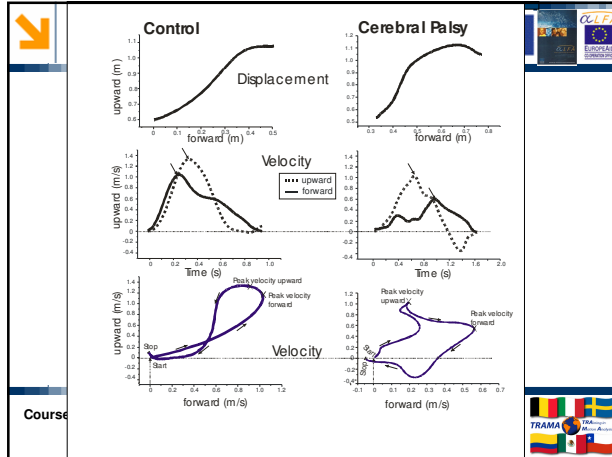
	CEREBRAL PALSY	CONTROL
Velocity (m/s)		
Running hand		
Vertical GRF (N)		
EMG (mV)		
TA		
LG		
Vertical GRF (N)		
TA		
LG		
Vertical GRF (N)		
TA		
LG		
Vertical GRF (N)		
TA		
LG		

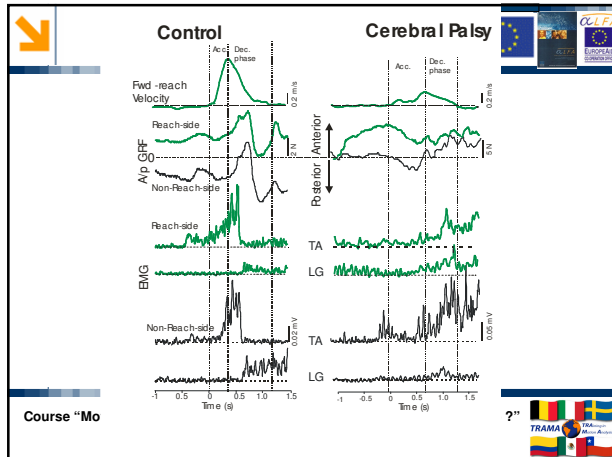
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Lab ?"
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References, illustrating different setups and analyses

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