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

TRAMA Project

January 14 - 17th 2008

Ana Bengoetxea
LNMB-ULB

The search of temporal coordination sequences in complex movements

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- Dans la rééducation nous donnons beaucoup d'importance aux amplitudes articulaires (ex: prothèse de genou- gagner amplitude entre 0° et 120° minimum)
- Mais en plus d'une amplitude correcte un autre aspect important du mouvement est la coordination temporelle, et celle-ci devient de plus en plus importante que le nombre de segments impliqués dans le mouvement augmente.
- Un bel exemple est le développement des stratégies neuro-motrices chez l'enfant

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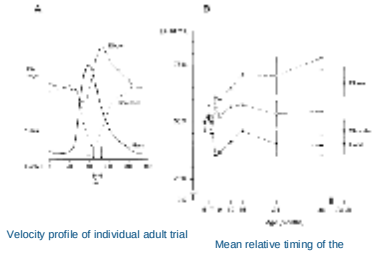
Relative timing of peak endpoint and proximal joint velocity during development of reaching



Velocity profile of individual adult trial

Mean relative timing of the three temporal events across age

- Temporal onset of peak hand velocity is stable and adult-like since 24 months of age
- Temporal onset of peak velocity of shoulder and elbow are stable since 24 months
- But the timing of proximal joint peaks remain delayed with respect to the adult

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- This is an example showing the significance of the relative timing between limb segments for the performance of multi-joint movements
- Which method can we use to extract and quantify the temporal sequences of muscular synergies underlying the multi-joint coordination?

Cross-correlation function (CCF)

The CCF between two signals, e.g. d1 and d2 (EMG or velocity data), was defined as:

$$CCF_{d_1 d_2}(t) = \frac{1}{T s_1 s_2} \int_0^T (d_1(t) - m_1)(d_2(t+t) - m_2) dt$$

where m_1 and s are the mean value and the variance of d1 and τ is the lag between the two functions, expressed in ms. When the signals d1(*t*) and d2(*t*) are statistically correlated their CCF displays a peak (a significant CCF maximum) or a trough (a significant CCF minimum) at the abscissa τ^*. Positive values of τ^* denote a time lead of d1(*t*) relative to d2(*t*), whereas negative values denote a time lag.

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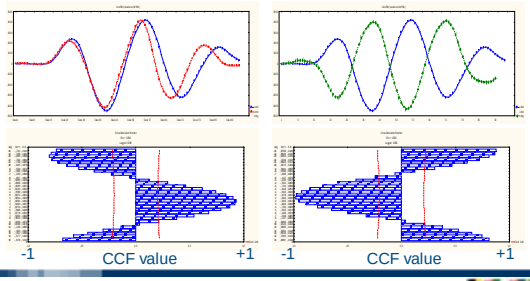
Two signals In Phase

Two signals Out of Phase



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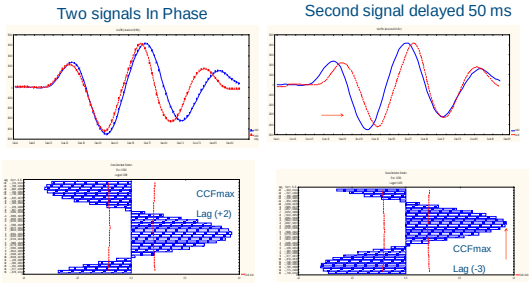
Two signals In Phase

Second signal delayed 50 ms



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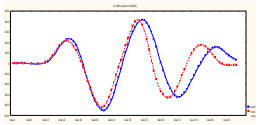
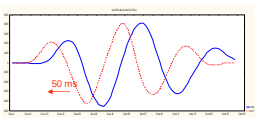
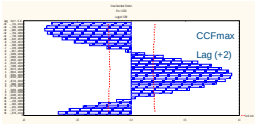
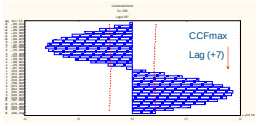
Two signals In Phase

Second signal led 50 ms

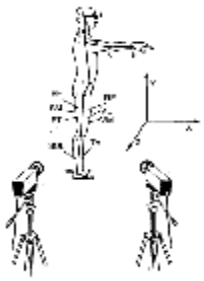








Extraction of the motor strategy underlying multi-joint lower limb movements



- 11sujets sains
- 3 instructions:
  1. Flexion sans frein
  2. Flexion avec frein final
  3. Mi-Flexion
- Analyse du mouvement le plus rapide de chaque instruction

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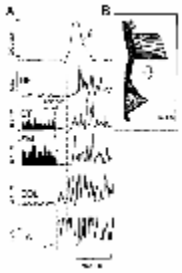

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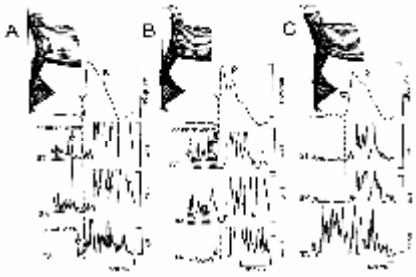

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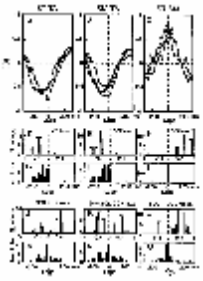

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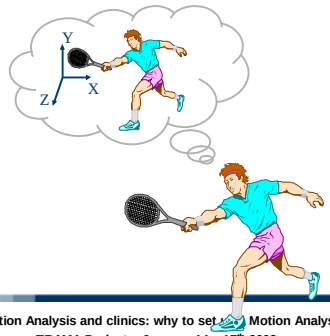
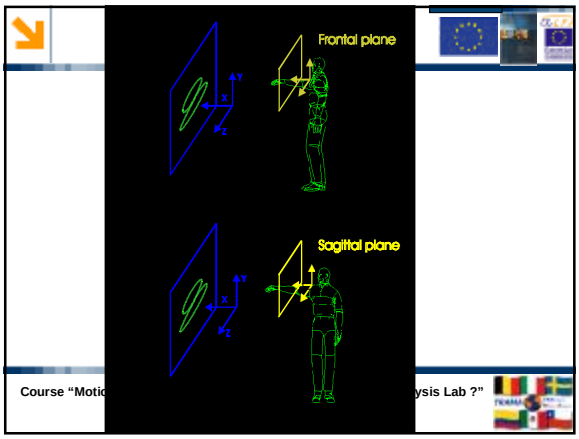
Extraction of the muscular synergies underlying multi-directional upper limb movements




Frontal plane
Sagittal plane
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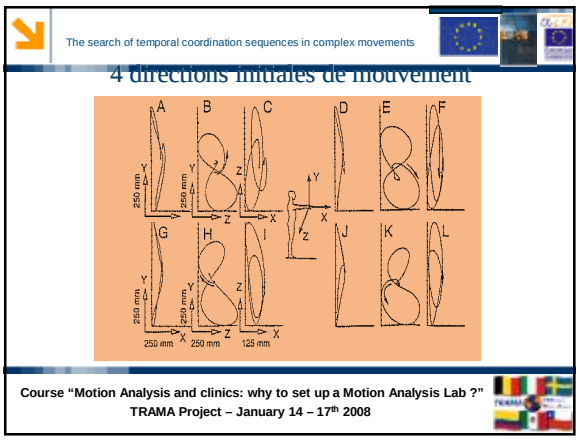
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4 directions initiales de mouvement
A
B
C
D
E
F
G
H
I
J
K
L
250 mm
250 mm
125 mm
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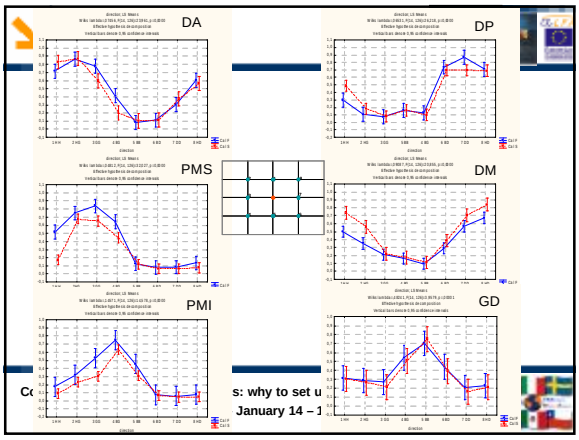
DA
DP
PMS
DM
PMI
GD
s: why to set u
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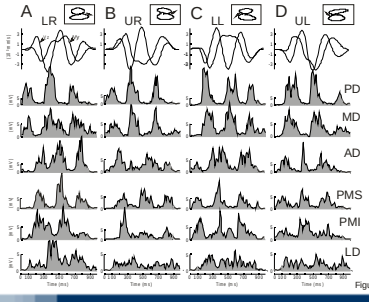

Figure 3

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Figure 4

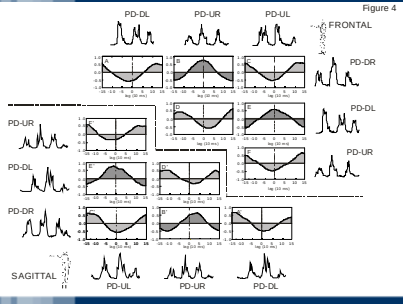

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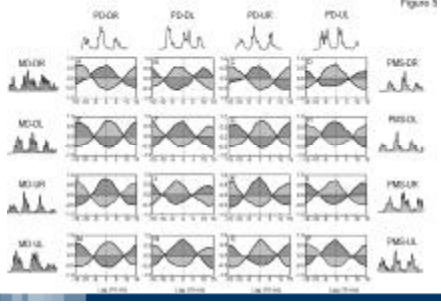
Figure 5



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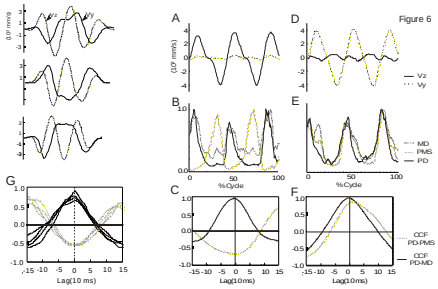

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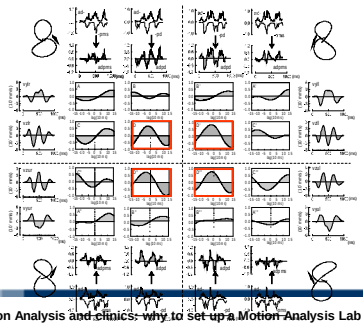

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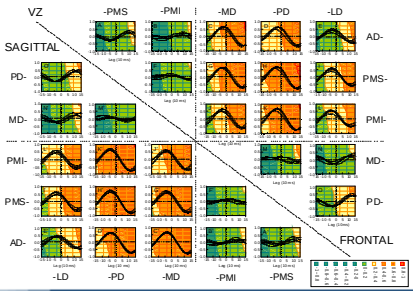

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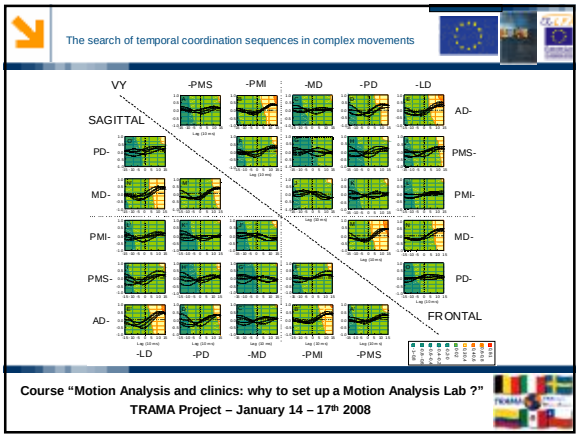
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VY
-PMS
-PMI
-MD
-PD
-LD
SAGITTAL
AD-
PD-
PMS-
MD-
PMI-
PMI-
MD-
PMS-
PD-
AD-
FRONTAL
-LD
-PD
-MD
-PMI
-PMS
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