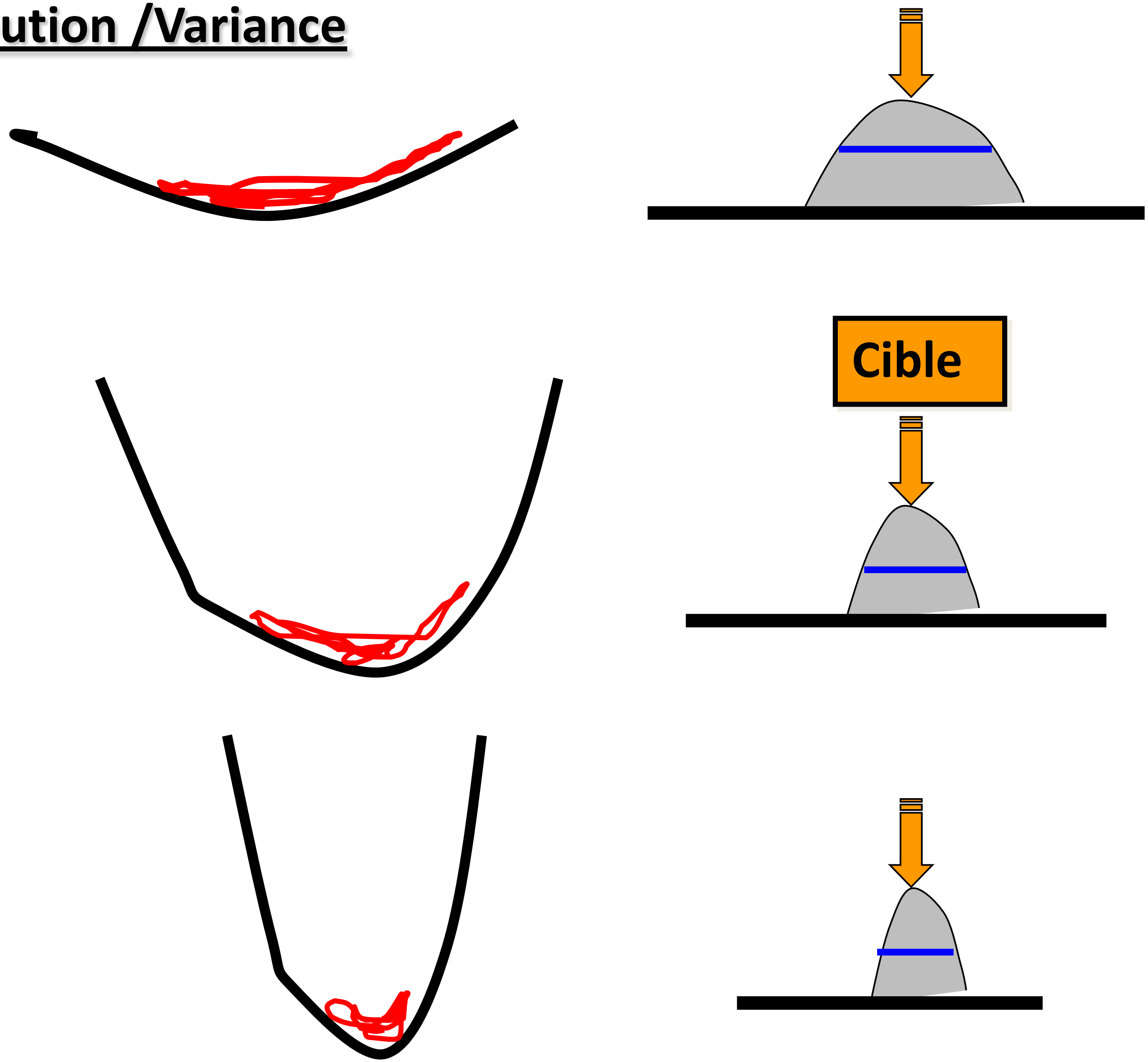
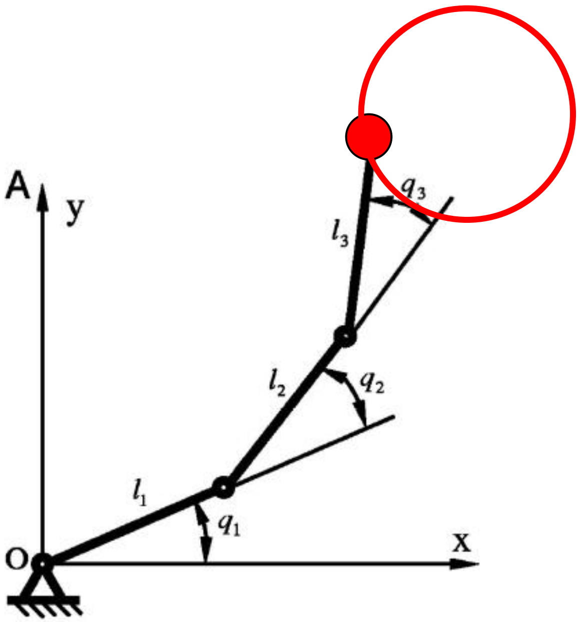
Stabilité /Distribution /Variance

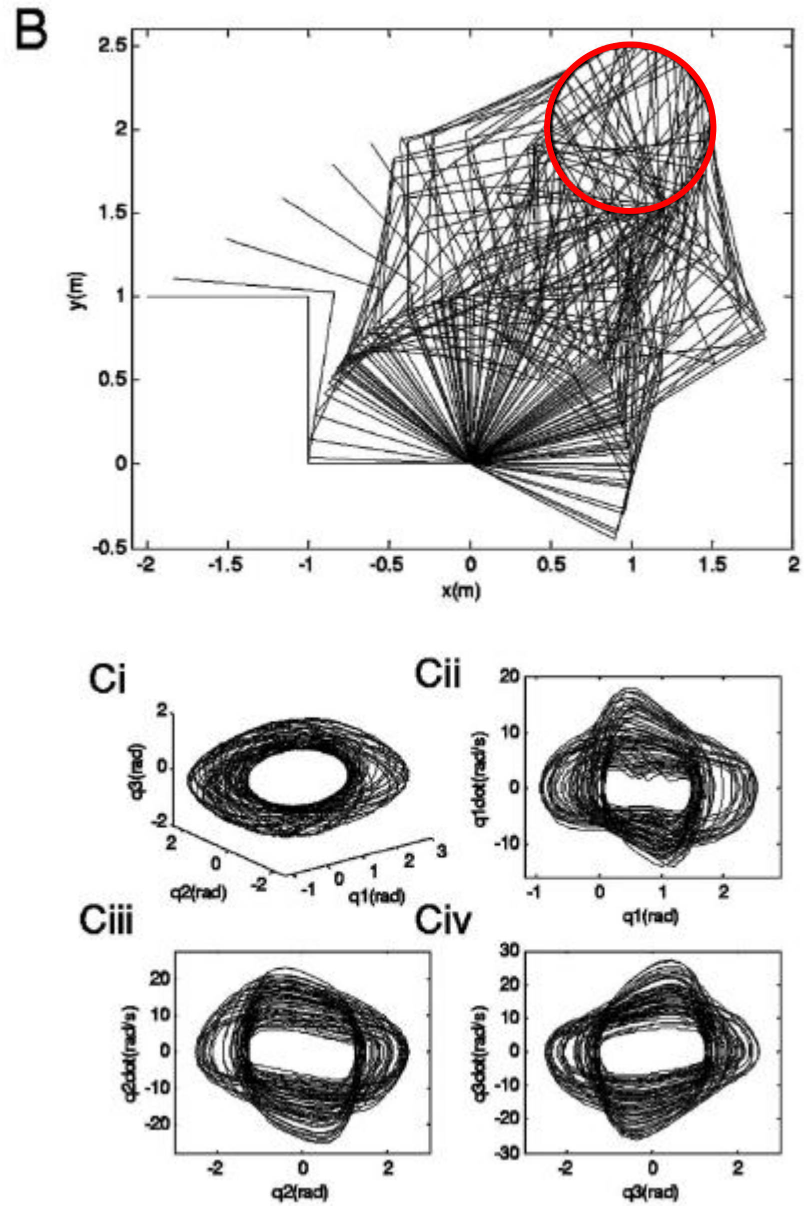
Stable +

Stable ++

Stable +++





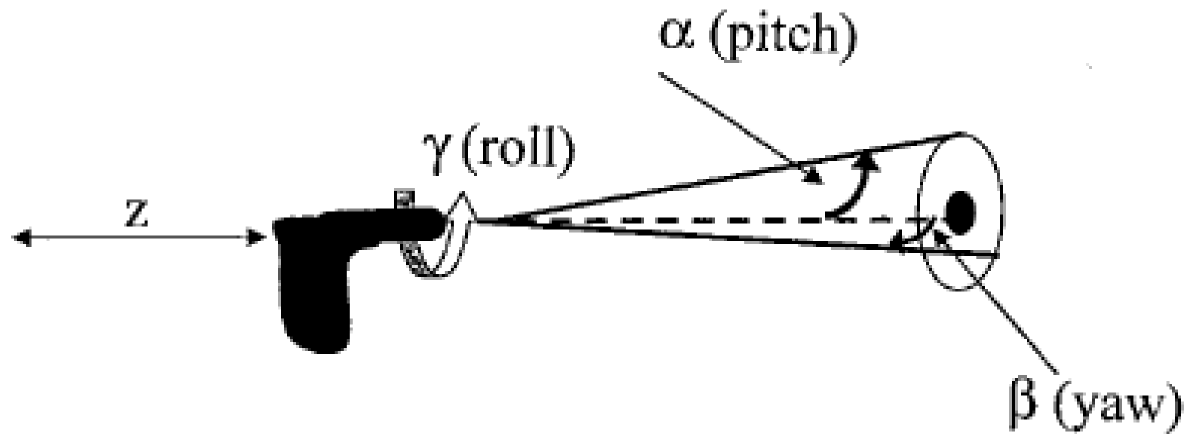


Applications pour le mouvement biologique ???

Controlling chaotic robots with kinematical redundancy

Li Li[a] and Zhaohui Liu

CHAOS **16**, 013132 (2006)



β, α affectent le résultat (but)

γ, Z n'affectent pas le résultat

J. P. Scholz · G. Schöner

Hypothèse :

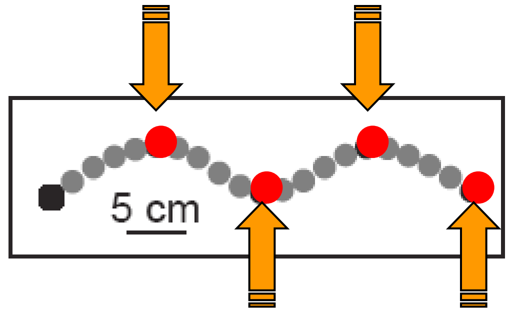
- Le système “contrôle” (stabilise) seulement ce qui est nécessaire

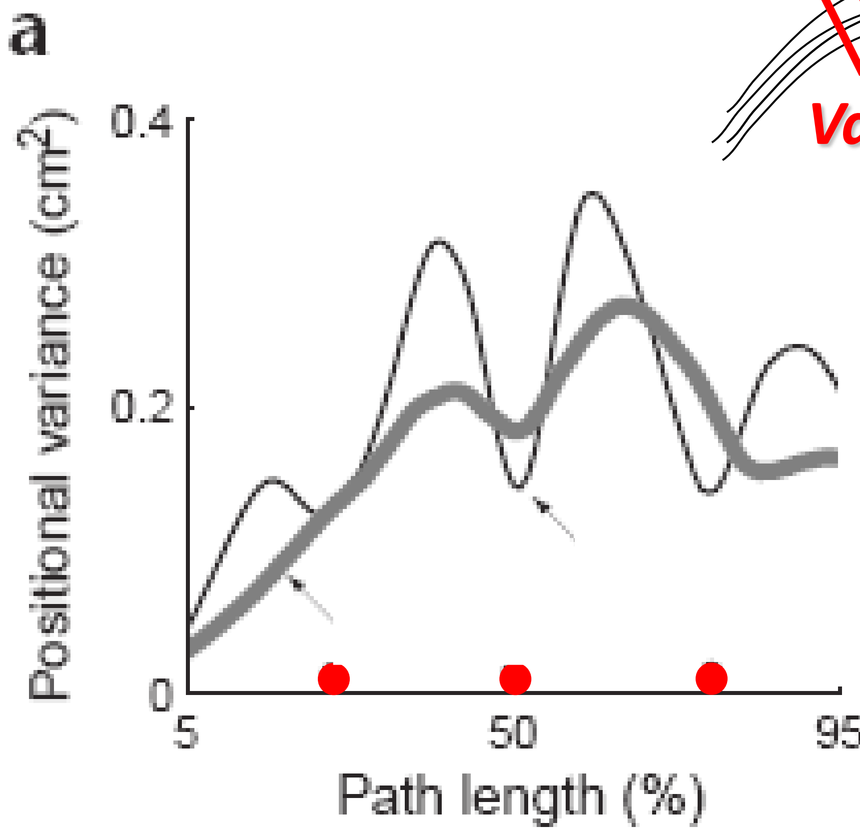
- Les variables qui n’affectent pas le but sont “moins” contrôlées

- Conséquences : D’un essai à l’autre, des solutions sensiblement distinctes sont “sélectionnées”

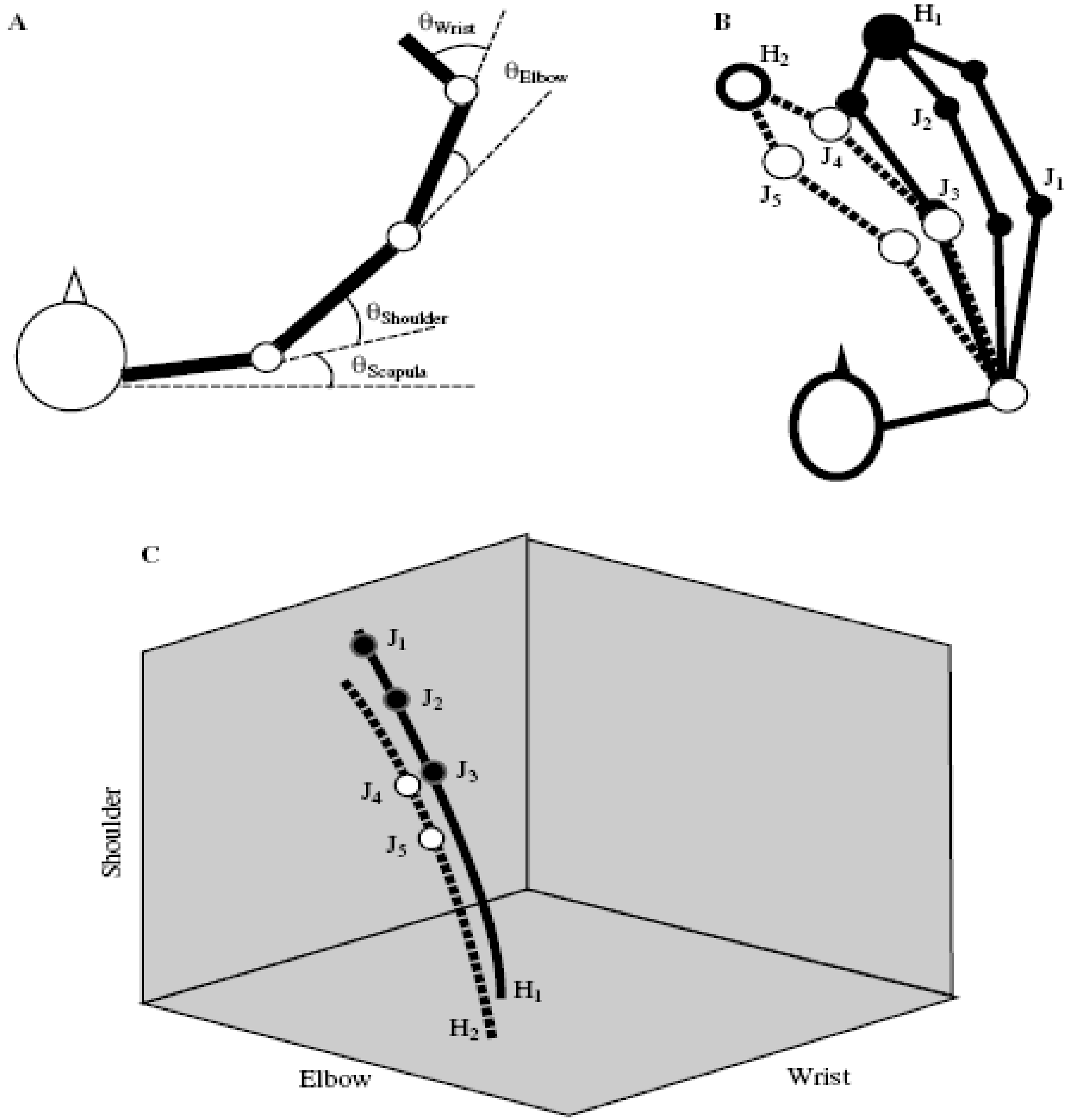
J. P. Scholz · G. Schöner

Cibles :





Todorov


A
θWrist
θElbow
θShoulder
θScapula
B
H1
H2
J1
J2
J3
J4
J5
C
J1
J2
J3
J4
J5
H1
H2
Shoulder
Elbow
Wrist

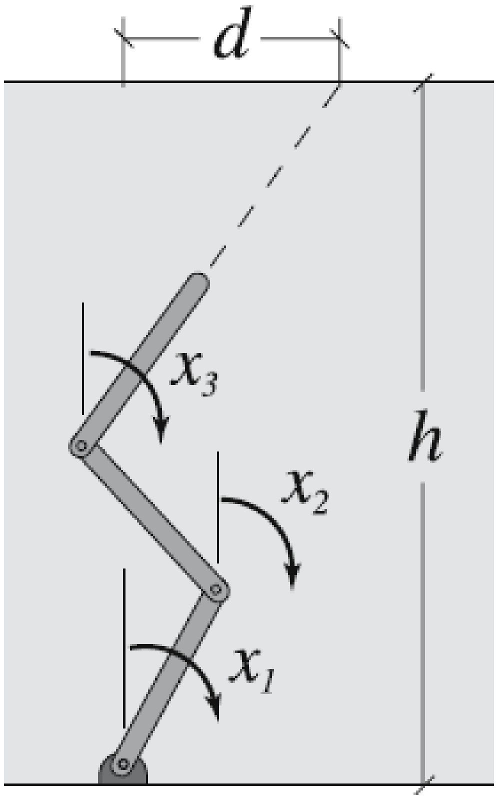
Plus précisément :

- La stabilité contrecarre le bruit seulement quand c'est nécessaire
- Cette stabilité peut être interprétée parfois comme le produit d'un contrôle (CNS), mais aussi sans référence explicite au concept de contrôle.

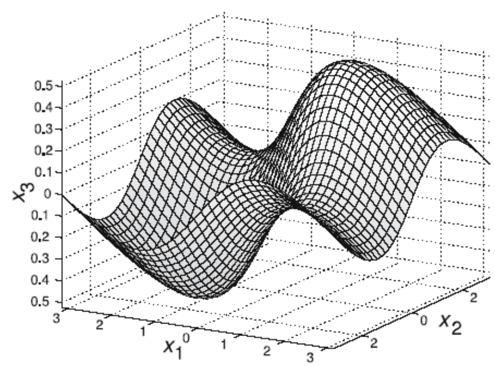
- Il existe une méthode pour distinguer les configurations articulaires qui affecte le but et celles qui ne l'affectent pas

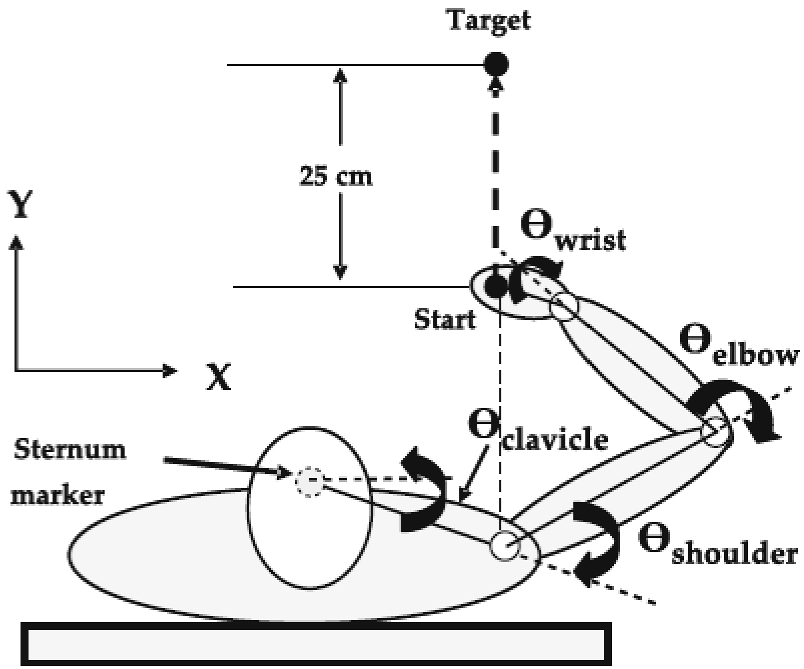
Application

Analyse de la variance guidée par un modèle



Modèle géométrique direct





$$\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} l_1 \cdot \cos(\theta_1) + l_2 \cdot \cos(\theta_1 + \theta_2) + l_3 \cdot \cos(\theta_1 + \theta_2 + \theta_3) + l_4 \cdot \cos(\theta_1 + \theta_2 + \theta_3 + \theta_4) \\ l_1 \cdot \sin(\theta_1) + l_2 \cdot \sin(\theta_1 + \theta_2) + l_3 \cdot \sin(\theta_1 + \theta_2 + \theta_3) + l_4 \cdot \sin(\theta_1 + \theta_2 + \theta_3 + \theta_4) \end{bmatrix},$$

4. The nullspace of the Jacobian matrix was then computed in Matlab, based on the mean joint configuration across trials at each normalized time point, to obtain a linear estimate of a subspace in joint space in which all joint combinations would be consistent with the 2D hand position corresponding to this mean joint configuration value. In this procedure, it is presumed that the CNS tries to achieve this mean value of the performance variable.

$$0 = J(\bar{\theta}) \cdot \varepsilon, \tag{4}$$

where $\bar{\theta}$: Mean joint configuration, ϵ: Nullspace of Jacobian.

Variation du but [X Y] ←→ variations 3 articulations

Matrice Jacobienne :

$$
\begin{aligned}
x &= l_1 \cos(\theta_1) + l_2 \cos(\theta_2) + l_3 \cos(\theta_3) \\
y &= l_1 \sin(\theta_1) + l_2 \sin(\theta_2) + l_3 \sin(\theta_3)
\end{aligned}
$$

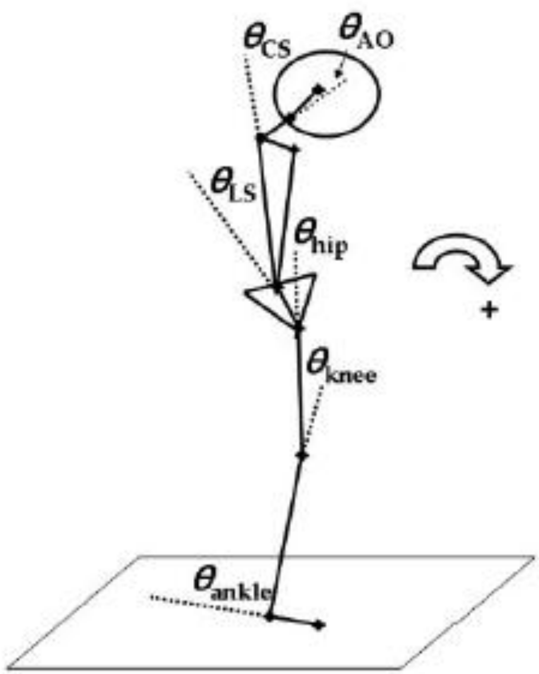
$$
J(\theta) = \begin{bmatrix} \partial x / \partial \theta_1 & \partial x / \partial \theta_2 & \partial x / \partial \theta_3 \\ \partial y / \partial \theta_1 & \partial y / \partial \theta_2 & \partial y / \partial \theta_3 \end{bmatrix}
$$

Matrice des dérivées partielles

$$
J(\underline{\Theta}^0 = \begin{bmatrix} -l_1 \sin(\Theta_1^0) & -l_2 \sin(\Theta_2^0) & -l_3 \sin(\Theta_3^0) \\ l_1 \cos(\Theta_1^0) & l_2 \cos(\Theta_2^0) & l_3 \cos(\Theta_3^0) \end{bmatrix},
$$

$$\begin{bmatrix} dx \\ dy \end{bmatrix} = J(\theta) \begin{bmatrix} d\theta_1 \\ d\theta_2 \\ d\theta_3 \end{bmatrix} = 0$$

$$J(\Theta^0) \cdot \varepsilon = 0$$



The geometric model relating the CM_{AP} position to the joint configuration, with origin at the ankle is

$$\begin{aligned}
d_{\text{CM-AP}} = {} & M_{\text{shank}}{*}[d_{\text{shank}}{*}l_{\text{shank}}{*}\cos(\pi-\theta_{\text{ankle}})] + M_{\text{thigh}}{*}[l_{\text{shank}}{*}\cos(\pi-\theta_{\text{ankle}}) \\
& + d_{\text{thigh}}{*}l_{\text{thigh}}{*}\cos(\pi-\theta_{\text{ankle}}+\theta_{\text{knee}})] + M_{\text{pelvis}}{*}[l_{\text{shank}}{*}\cos(\pi-\theta_{\text{ankle}}) \\
& + l_{\text{thigh}}{*}\cos(\pi-\theta_{\text{ankle}}+\theta_{\text{knee}}) + d_{\text{pelvis}}{*}l_{\text{pelvis}}{*}\cos(\pi-\theta_{\text{ankle}}+\theta_{\text{knee}}+\theta_{\text{hip}})] \\
& + M_{\text{trunk}}{*}[l_{\text{shank}}{*}\cos(\pi-\theta_{\text{ankle}}) + l_{\text{thigh}}{*}\cos(\pi-\theta_{\text{ankle}}+\theta_{\text{knee}}) + l_{\text{pelvis}}{*}\cos(\pi \\
& -\theta_{\text{ankle}}+\theta_{\text{knee}}+\theta_{\text{hip}}) + d_{\text{trunk}}{*}l_{\text{trunk}}{*}\cos(\pi-\theta_{\text{ankle}}+\theta_{\text{knee}}+\theta_{\text{hip}}+\theta_{\text{LS}})] \\
& + M_{\text{neck}}{*}[l_{\text{shank}}{*}\cos(\pi-\theta_{\text{ankle}}) + l_{\text{thigh}}{*}\cos(\pi-\theta_{\text{ankle}}+\theta_{\text{knee}}) + l_{\text{pelvis}}{*}\cos \\
& (\pi-\theta_{\text{ankle}}+\theta_{\text{knee}}+\theta_{\text{hip}}) + l_{\text{trunk}}{*}\cos(\pi-\theta_{\text{ankle}}+\theta_{\text{knee}}+\theta_{\text{hip}}+\theta_{\text{LS}}) \\
& + d_{\text{neck}}{*}l_{\text{neck}}{*}\cos(\pi-\theta_{\text{ankle}}+\theta_{\text{knee}}+\theta_{\text{hip}}+\theta_{\text{LS}}+\theta_{\text{CS}})] + M_{\text{head}}{*}[l_{\text{shank}}{*}\cos \\
& (\pi-\theta_{\text{ankle}}) + l_{\text{thigh}}{*}\cos(\pi-\theta_{\text{ankle}}+\theta_{\text{knee}}) + l_{\text{pelvis}}{*}\cos(\pi-\theta_{\text{ankle}}+\theta_{\text{knee}}+\theta_{\text{hip}}) \\
& + l_{\text{trunk}}{*}\cos(\pi-\theta_{\text{ankle}}+\theta_{\text{knee}}+\theta_{\text{hip}}+\theta_{\text{LS}}) + l_{\text{neck}}{*}\cos(\pi-\theta_{\text{ankle}}+\theta_{\text{knee}}+\theta_{\text{hip}} \\
& +\theta_{\text{LS}}+\theta_{\text{CS}}) + d_{\text{head}}{*}l_{\text{head}}{*}(\pi-\theta_{\text{ankle}}+\theta_{\text{knee}}+\theta_{\text{hip}}+\theta_{\text{LS}}+\theta_{\text{CS}}+\theta_{\text{AO}})] \quad (3)
\end{aligned}$$

where $\theta_{\text{ankle}}, \ldots, \theta_{\text{AO}}$ are the externally defined joint angles; $l_{\text{shank}}, \ldots, l_{\text{head}}$ are the lengths of the respective segments calculated from the static calibration trial; $d_{\text{shank}}, \ldots, d_{\text{head}}$ are the percentages of the segment lengths from the distal end where the mass of that segment lies; and $M_{\text{foot}}, M_{\text{shank}}, \ldots, M_{\text{head}}$ are the proportion of total body mass for each of these segments, both estimated from Winter (1990).

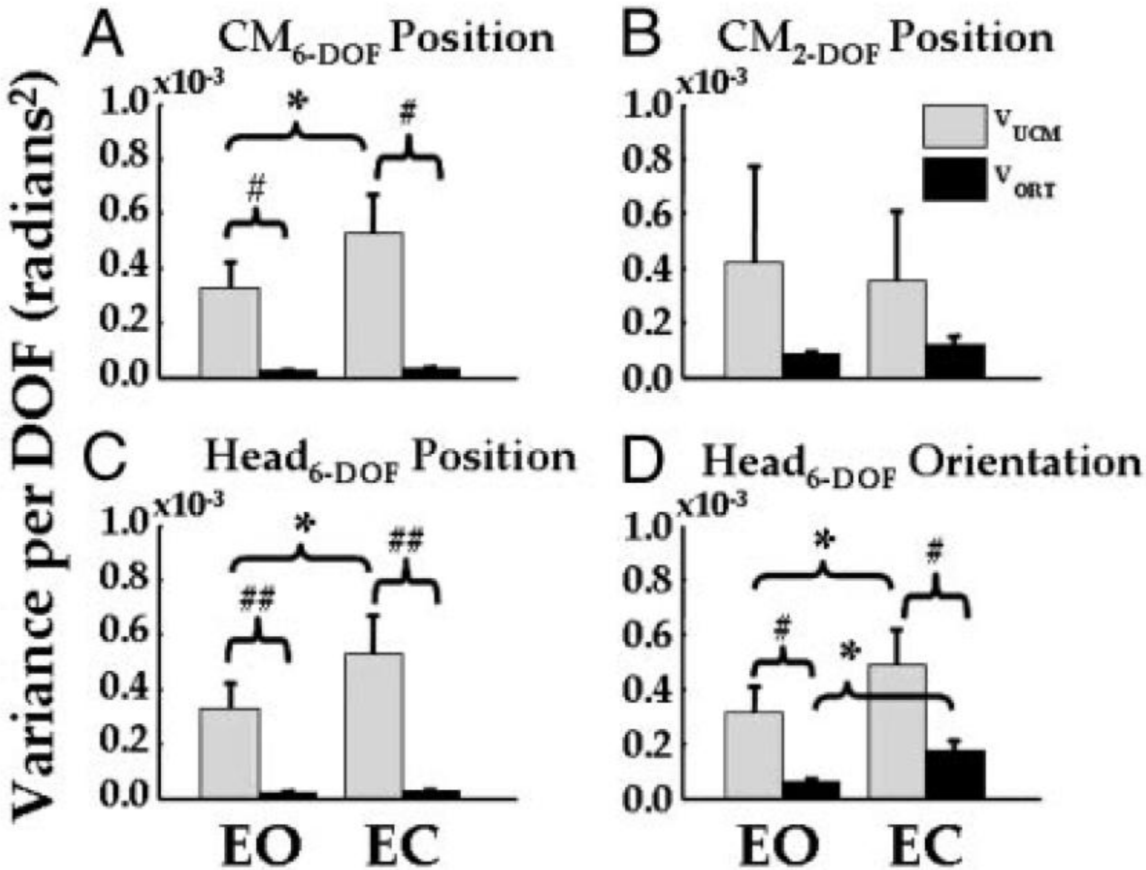


FIG. 6. Mean ± SE of joint configuration variability per degree of freedom (DOF) underlying control of the CM_{AP} position based on a 6-DOF model (*A*) and based on a 2-DOF, ankle-hip model (*B*), and control of the AP position of the head (*C*) and head's orientation in the sagittal plane (*D*), both based on a 6-DOF model. Adjacent pairs of bars represent V_{UCM} and V_{ORT} for EO condition (*left*) and EC condition (*right*). #, significant differences between V_{UCM} and V_{ORT}; *, significant differences between EO and EC; ## and **, $P < 0.01$; # and *, $P < 0.05$.

- Perception- action

PCA in studying coordination and variability: a tutorial

Andreas Daffertshofer [a,*], Claudine J.C. Lamoth [a,b], Onno G. Meijer [a], Peter J. Beek [a]

Clinical Biomechanics 19 (2004) 415–428

...

ACP

- **Réduction dimensionnelle**
- **Reconnaissance de patrons**

Trouver les directions (vecteurs propres) qui maximisent la variance quand les données N dim sont projetées; othogonalité etc

N dim donnent N composants (unit vecteurs)

$$cov(X,Y) = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{(n-1)}$$

$$C = \begin{pmatrix} cov(x,x) & cov(x,y) & cov(x,z) \\ cov(y,x) & cov(y,y) & cov(y,z) \\ cov(z,x) & cov(z,y) & cov(z,z) \end{pmatrix}$$

On peut réduire la dimensionnalité en ne gardant que N – m vecteurs, et en projetant les données sur la base formée par ces vecteurs.

Les valeurs propres représentent le degrés de dilatation/ contraction de cette projection sur chaque axes (vecteur propre, unit = 1)

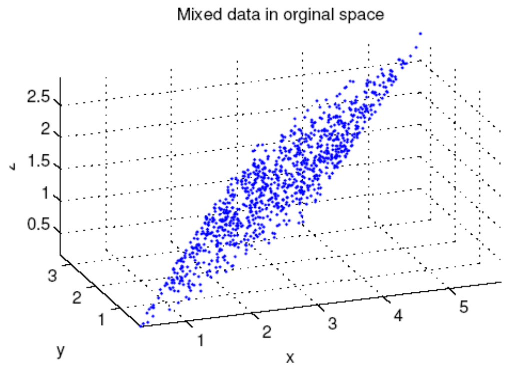
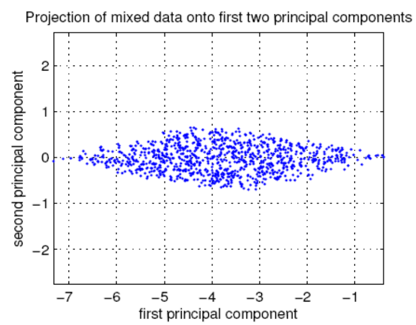
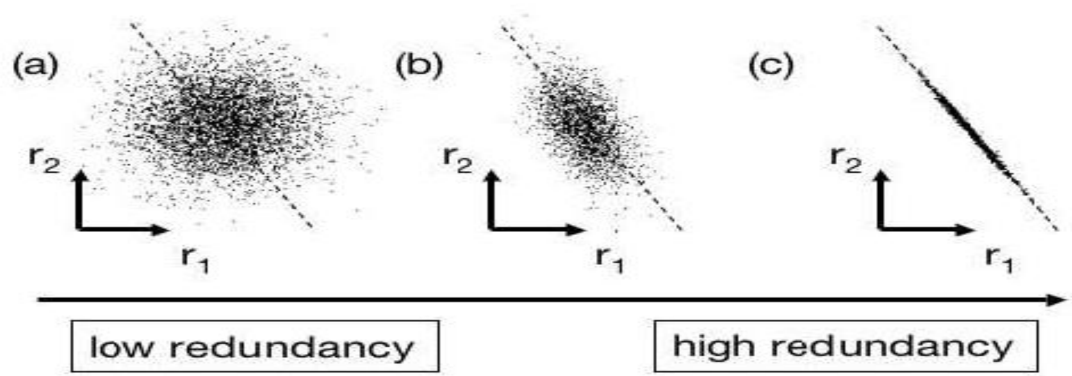


Figure 1: Original mixed data





Postural Hand Synergies for Tool Use

Marco Santello, Martha Flanders, and John F. Soechting
Neuroscience Department, University of Minnesota, Minneapolis, Minnesota 55455

The Journal of Neuroscience, December 1, 1998, *18*(23):10105–10115

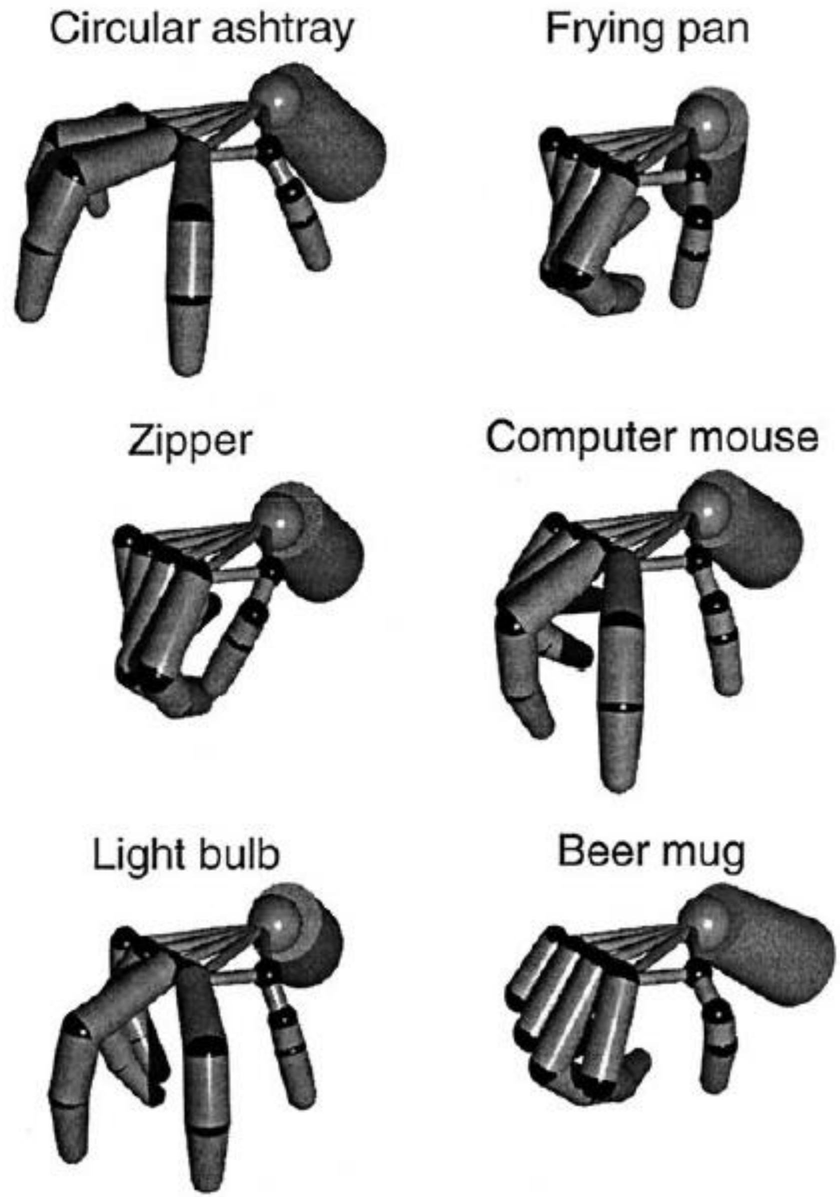


Figure 2. Hand postures for six different objects. The average hand postures produced by one subject for the six named objects have been rendered as three-dimensional images. Each of the three-dimensional images was rendered with the palm of the hand in the same orientation. Hence, the orientation as shown does not correspond to the actual orientation of the hand in space.

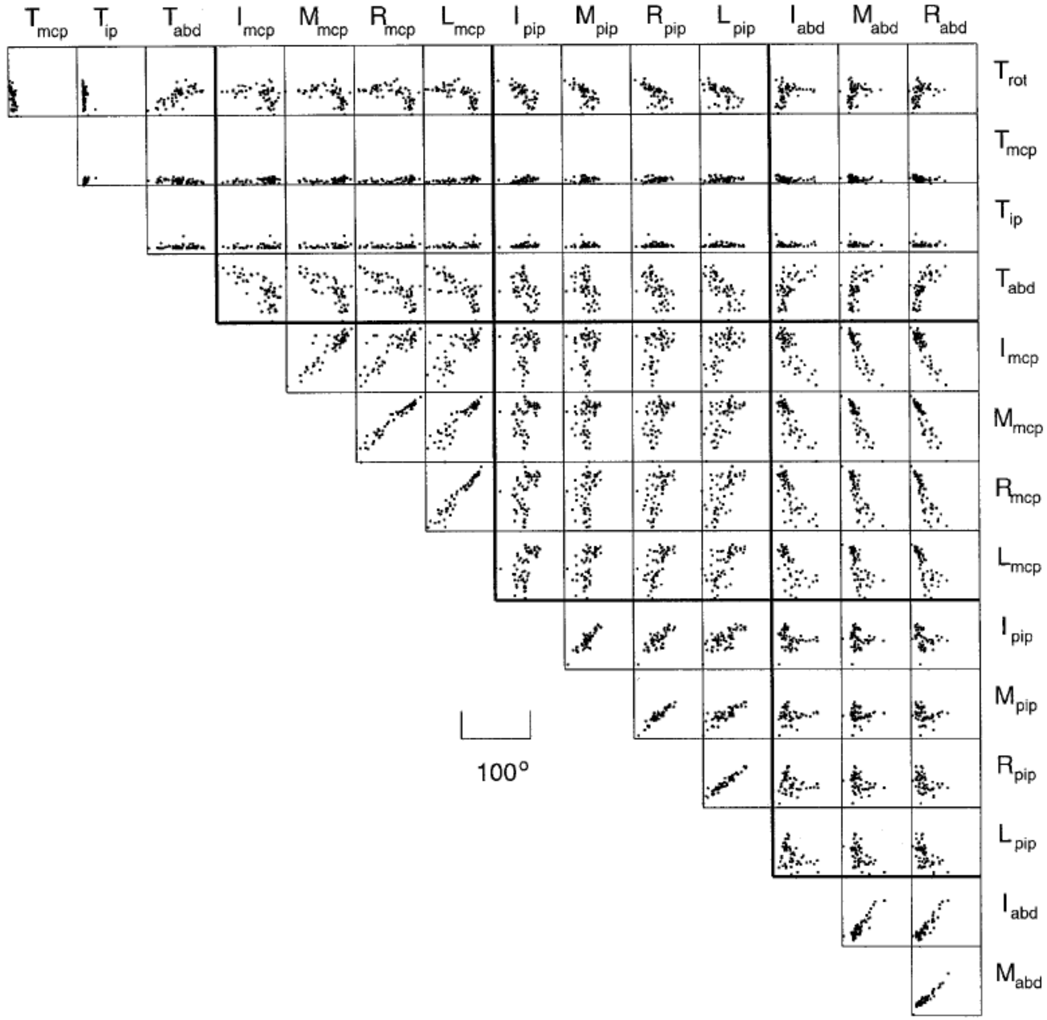


Figure 3. Patterns of covariation among the 15 joint angles of the hand. The average values of each of the joint angles for the 57 objects have been plotted against each other. The data are from one subject (M.F.). Note the strong covariation between mcp and pip angles at adjacent fingers (*outermost diagonal*), as well as the covariation between the abduction angles (*bottom three elements*) and the negative correlation between mcp and abd angles (*last three columns*).

Table 1. List of objects used in the task

1. Apple
2. Banana
3. Baseball
4. Beer bottle
5. Beer mug
6. Brick
7. Bucket
8. Calculator
9. Chalk
10. Cherry
11. Chinese tea cup
12. Cigarette
13. Circular ashtray
14. Coffee mug
15. Comb
16. Compact disc
17. Computer mouse
18. Dictionary
19. Dinner plate
20. Dog dish
21. Door key
22. Door knob
23. Drawer handle
24. Egg
25. Espresso cup
26. Fishing rod
27. Frisbee
28. Frying pan
29. Hair dryer
30. Hammer
31. Ice cube
32. Iron
33. Jar lid
34. Kitchen knife
35. Knob of a lid
36. Knob of a stove
37. Light bulb
38. Milk carton
39. Needle
40. Notebook
41. Pen
42. Playing card
43. Rope
44. Scissors
45. Screwdriver
46. Stapler
47. Sugar cone
48. Teaspoon
49. Telephone handset
50. Tennis racket
51. Toothbrush
52. Toothpick
53. Turtle
54. Umbrella
55. Wafer
56. Wrench
57. Zipper

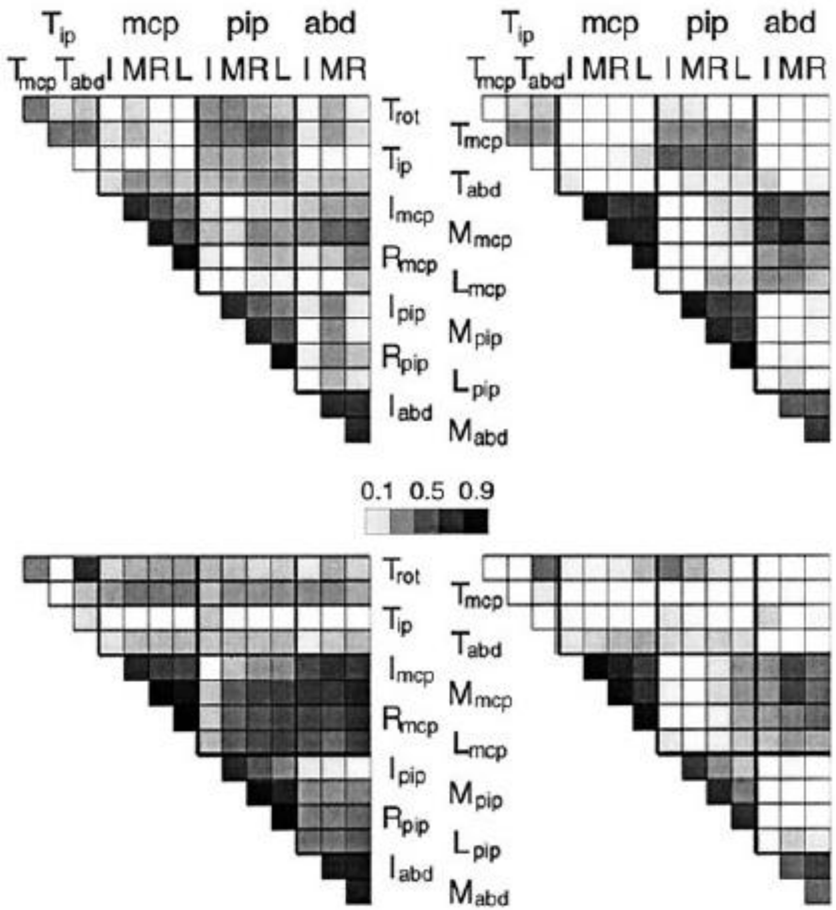


Figure 4. Coefficients of determination of the relations between joint angles of the hand. The *gray scale* in each *square* denotes the coefficient of determination (r^2) for the relation between the angles indicated in the respective column and row. All but the data for the subject whose results are presented in Figure 3 are shown. Note the general similarity in the pattern for all subjects. The r^2 values shown were computed from pooled individual trials and are highly significant ($p < 0.01$; df = 283) for values >0.02.

Table 2. Percent variance accounted for by each principal component

Subjects	PC_1	PC_2	PC_3	PC_4
FC	52.9	24.7	8.4	4.8
GB	49.5	37.6	4.8	4.6
MF	74.8	13.0	5.4	2.9
MS	79.3	10.0	5.0	2.2
UH	62.9	17.2	8.6	5.9

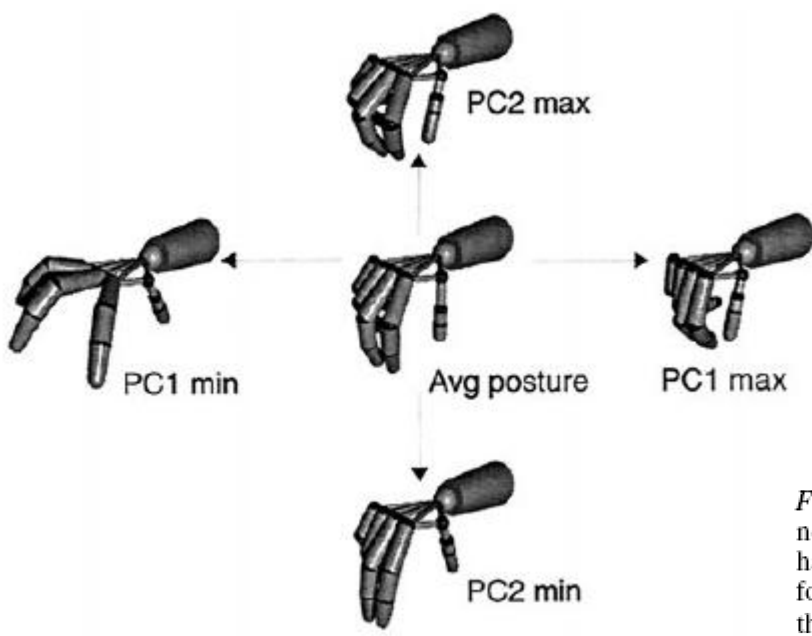


Figure 6. Postural synergies defined by the first two principal components. The hand posture at the center of the PC axes is the average of 57 hand postures for one subject (U.H.). The postures to the *right* and *left* are for the postures for the maximum (*max*) and minimum (*min*) values of the first principal component (*PC1*), coefficients for the other principal components having been set to zero. The postures at the *top* and *bottom* are for the maximum and minimum values of the second principal component (*PC2*).