Master Tronc commun
2018
UE5 E4 Développement et apprentissage

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02/02 JL 18-20h
07/02 HS 10h à 12h
14/02 HS 10h à 12h
21/02 HS 10h à 12h
07/03 HS 10h à 12h
28/03 JL 18-20h
14/03 AC 18-20h
21/03 AC 18-20h
04/04 JL 18-20h
18/04 JL 18-20h

MOODLE

Master Tronc commun 2018 UE5 E4 Développement et apprentissage
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Accueil / ► Faculté des Sciences et Techniques des Activités Physiques et Sportives (STAPS) / ► Développement et apprentissage / ► Généralités / ► Supports de cours J Lagarde

Généralités- Définitions

Apprentissage : Une tradition institutionnelle, rationaliser l'enseignement, mais une question fondamentale/ pas seulement les staps…

Adaptation : unique au vivant, définit le vivant. Très étonnant.

- Apprentissage : changement relativement permanent permettant la performance face à un problème nouveau. L'apprentissage moteur est une série de processus associés à la pratique ou à l'expérience, conduisant à des changements relativement permanents de la capacité à répondre (à une situation).

- Adaptation : changement transitoire face à la nouveauté

- Thèmes associés :

Mémoire(s) : La permanence relative de l'adaptation du comportement repose sur l'existence, la formation, d'un « support », d'une trace (métaphore de la plaque de cire), d'un « stockage » (métaphore informatique).

- Plasticité, développement, ré- apprentissage (réadaptation), adaptation à des déficiences.

- Tests comportementaux : amélioration des performances, changements dasn l'organisation du mouvement , transfert, rétention

Mémoire ?

Gerald Edelman,Giulio Tononi (2000) A Universe Of Consciousness: How Matter Becomes Imagination

Comment la matière devient conscience. Odile jacob

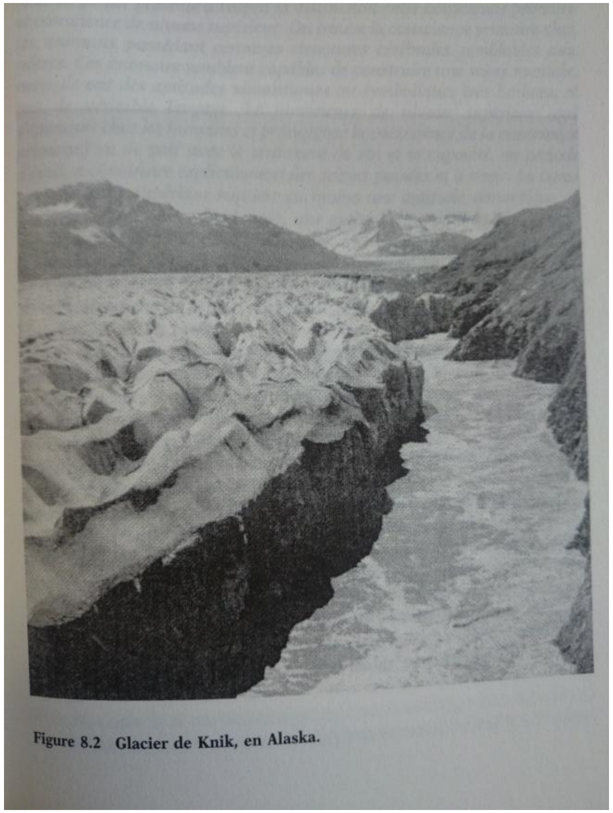

Figure 8.2 Glacier de Knik, en Alaska.

CHAPITRE 8

La mémoire non représentationnelle

La mémoire est une composante centrale des mécanismes cérébraux produisant la conscience. On considère en général qu'elle correspond à l'inscription et au stockage d'informations. Mais qu'est-ce qui se trouve stocké ? Est-ce un message codé ? Quand on le « déchiffre », quand on se le remémore, est-il le même ? Ces questions renvoient au postulat général selon lequel ce qui est stocké prendrait la forme d'une représentation. Ce chapitre adopte en fait le point de vue opposé, qui va avec notre perspective sélectionniste : la mémoire est non représentationnelle. Nous la considérons comme l'aptitude d'un système dynamique façonné par la sélection et qui n'est plus capable de répéter ou de supprimer un acte mental ou physique. Cette vision nouvelle de la mémoire peut être illustrée par une comparaison géologique : la mémoire s'apparente plus au brassage et au refroidissement qui ont lieu dans un glacier qu'à une inscription sur un rocher.

Memory traces in dynamical systems

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To perform nontrivial, real-time computations on a sensory input stream, biological systems must retain a short-term memory trace of their recent inputs. It has been proposed that generic high-dimensional dynamical systems could retain a memory trace for past inputs in their current state. This raises important questions about the fundamental limits of such memory traces and the properties required of dynamical systems to achieve these limits. We address these issues by applying Fisher information theory to dynamical systems driven by time-dependent signals corrupted by noise. We introduce the Fisher Memory Curve (FMC) as a measure of the signal-to-noise ratio (SNR) embedded in the dynamical state relative to the input SNR. The integrated FMC indicates the total memory capacity. We apply this theory to linear neuronal networks and show that the capacity of networks with normal connectivity matrices is exactly 1 and that of any network of N neurons is, at most, N. A nonnormal network achieving this bound is subject to stringent design constraints: It must have a hidden feedforward architecture that superlinearly amplifies its input for a time of order N, and the input connectivity must optimally match this architecture. The memory capacity of networks subject to saturating nonlinearities is further limited, and cannot exceed $\sqrt{N}$. This limit can be realized by feedforward structures with divergent fan out that distributes the signal across neurons, thereby avoiding saturation. We illustrate the generality of the theory by showing that memory in fluid systems can be sustained by transient nonnormal amplification due to convective instability or the onset of turbulence.

Fisher information | fluid mechanics | network dynamics

Critical cognitive phenomena such as planning and decision-making rely on the ability of the brain to hold information in short-term memory. It is thought that the neural substrate for such memory can arise from persistent patterns of neural activity, or attractors, that are stabilized through reverberating positive feedback, either at the single-cell (1) or network (2, 3) level. However, such simple attractor mechanisms are incapable of remembering sequences of past inputs.

More recent proposals (4–6) have suggested that an arbitrary recurrent network could store information about recent input sequences in its transient dynamics, even if the network does not have information-bearing attractor states. Downstream readout networks can then be trained to instantaneously extract relevant functions of the past input stream to guide future actions. A useful analogy (4) is the surface of a liquid. Even though this surface has no attractors, save the trivial one in which it is flat, transient ripples on the surface can nevertheless encode information about past objects that were thrown in.

This proposal raises a host of important theoretical questions. Are there any fundamental limits on the lifetimes of such transient memory traces? How do these limits depend on the size of the network? If fundamental limits exist, what types of networks are required to achieve them? How does the memory depend on the network topology, and are special topologies required for good performance? To what extent do these traces degrade in the presence of noise? Previous analytical work has addressed some of these questions under restricted assumptions about input statistics and network architectures (7). To answer these questions in a more general setting, we use Fisher information to construct a measure of memory traces in networks and other dynamical systems. Traditionally, Fisher information has been applied in theoretical neuroscience to quantify the accuracy of population coding of static stimuli (see, e.g., ref. 8). Here, we extend this theory by combining Fisher information with dynamics.

The Fisher Memory Matrix in a Neuronal Network

We study a discrete time network dynamics given by

$$\mathbf{x}_i(n) = f([\mathbf{W}\mathbf{x}(n-1)]_i + \mathbf{v}_i s(n) + z_i(n)), \quad i = 1 \ldots N. \qquad [1]$$

Here a scalar, time-dependent signal $s(n)$ drives a recurrent network of N neurons (Fig. 1*B*). $\mathbf{x}(n) \in \mathcal{R}^N$ is the network state at time n, $f(\cdot)$ is a general sigmoidal function, $\mathbf{W}$ is an $N \times N$ recurrent connectivity matrix, and $\mathbf{v}$ is a vector of feedforward connections from the signal into the network. We keep $\mathbf{v}$ time independent to focus on how purely temporal information in the signal is distributed in the N spatial degrees of freedom of the network state $\mathbf{x}(n)$. The norm $\|\mathbf{v}\|$ sets the scale of the network input, and we will choose it to be 1. The term $\mathbf{z}(n) \in \mathcal{R}^N$ denotes a zero mean Gaussian white noise with covariance $\langle \mathbf{z}_i(k_1)\mathbf{z}_j(k_2)\rangle = \varepsilon\delta_{k_1,k_2}\delta_{i,j}$.

We build upon the theory of Fisher information to construct useful measures of the efficiency with which the network state $\mathbf{x}(n)$ encodes the history of the signal. Because of the noise in the system, a given past signal history $\{s(n-k)|k \geq 0\}$induces a conditional probability distribution $P(\mathbf{x}(n)|\mathbf{s})$ on the network's current state. Here, we think of this history $\{s(n-k)|k \geq 0\}$as a temporal vector $\mathbf{s}$ whose kth component $\mathbf{s}_k$ is $s(n-k)$. The Fisher memory matrix (FMM) between the present state $\mathbf{x}(n)$ and the past signal is then defined as

$$\mathbf{J}_{k,l}(\mathbf{s}) = \left\langle -\frac{\partial^2}{\partial_{\mathbf{s}_k\partial\mathbf{s}_l}} \log P(\mathbf{x}(n)|\mathbf{s}) \right\rangle_{P(\mathbf{x}(n)|\mathbf{s})}. \qquad [2]$$

This matrix captures [see supporting information (SI) *Appendix*] how much the conditional distribution $P(\mathbf{x}(n|\mathbf{s})$ changes when the signal history $\mathbf{s}$ changes (Fig. 1). Specifically, if one were to perturb the signal slightly from $\mathbf{s}$ to $\mathbf{s} + \delta\mathbf{s}$, the Kullback Leibler divergence between the 2 induced distributions $P(\mathbf{x}(n|\mathbf{s})$ and $P(\mathbf{x}(n)|\mathbf{s} + \delta\mathbf{s})$ would be approximated by $(\frac{1}{2})\delta\mathbf{s}^T\mathbf{J}(\mathbf{s})\delta\mathbf{s}$ (*SI Appendix*). Thus the FMM (Eq. **2**) measures memory through the ability of the past signal to perturb the network's present state. In this work, we will focus on the diagonal elements of the FMM. Each diagonal element $J(k) \equiv \mathbf{J}_{k,k}$ is the Fisher information that $\mathbf{x}(n)$ retains about a pulse entering the network at k time steps in the past. Thus, the diagonal captures the decay of the memory

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Author contributions: S.G., D.H., and H.S. performed research; and S.G. and H.S. wrote the paper.

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-Définition du problème : Qu'est ce que l'apprentissage ?

Apprentissage social, techniques transmises, création invention, recherche de ***solutions***.

Des solutions ? A quels problèmes ?

- Découvrir- établir- former les bonnes formes corporelles (coordinations) et les bonnes relations entre perception (de l'environnement, du corps) et mouvement.

- Les bonnes formes corporelles (coordinations) : L'organisation du geste
- La perception :

1) Trouver l'information (apprentissage perceptif; radiologie, escalade); pb spatial et temporel: Quelle est la bonne information ?
2) Utiliser l'information pour adapter la coordination à l'objectif, à l'environnement.

- La bonne information est celle qui permet de réguler…
- Information pour la décision, vs. information pour le mouvement

Ex. : Loi de Hick vs. Loi de Fitts (évènements vs mouvement de pointage)

3) Sources multiples : vision de ma main et du monde, X proprioception de mon bras, X perception par le système vestibulaire des accélérations de la tête : les sources sont confrontées par le SNC, « intégrées », et comme le mouvement génère de l'information, ceci permet de « coller » perception et mouvement.

possible that B61 may also be responsible in part for the angiogenic activities of other proinflammatory factors.

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2. H. Shao, A. Pandey, M. Seldin, K. S. O'Shea, V. M. Dixit, *J. Biol. Chem.* **270**, 5636 (1995).
3. The B61-Ig chimera was made with the following primers generated by polymerase chain reaction: 5′ primer with a custom Nhe I site (underlined), CCG CGG CTA GCT GAT CGC CAC ACC GTC TTC TGG AAC AGT, and a 3′ primer with a Bam HI site (underlined), CTC GGG ATC CCT GTG ACC GAT GCT ATG TAG AAC CCG CAC. The control-Ig chimera was made as described (*19*). The amplified fragments were digested and cloned into Nhe I– and Bam HI–cut CD5-IgG1 vector [A. Aruffo, I. Stamenkovic, M. Melnick, C. B. Underhill, B. Seed, *Cell* **61**, 1303 (1990)]. The Ig chimeras were purified from pooled supernatants of transfected 293T cells as described (*19*).
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6. HUVECs were grown in 2% fetal bovine serum (FBS) without any exogenous growth factors for 48 hours prior to all of the following assays. The cells were metabolically labeled for 8 hours with ^{35}S-cysteine and ^{35}S-methionine as described [A. W. Opipari, M. S. Boguski, V. M. Dixit, *J. Biol. Chem.* **267**, 12424 (1992)]. Cells on 100-mm dishes were lysed on ice in lysis buffer containing 1% NP-40, 50 mM tris, and 150 mM NaCl in the presence of protease inhibitors [leupeptin (5 μg/ml), aprotinin (5 μg/ml), soybean trypsin inhibitor (50 μg/ml), and pepstatin (5 μg/ml)] for 30 min. The cells were then scraped, clarified by centrifugation, and the supernatants incubated overnight with the indicated antibody or chimera (10 μg per immunoprecipitation); 50 μl of a 50% slurry of protein A–Sepharose were added and the samples were incubated for 1 hour and then washed three times in lysis buffer. Sample buffer containing 2% β-mercaptoethanol was added, the samples were boiled for 5 min, and the eluted proteins were resolved on 10% SDS-polyacrylamide gels. To deplete Eck, we incubated the samples with 20 μg of anti-Eck followed by addition of protein A/G-Sepharose. In vitro kinase assays were done as described (*8*).
7. For immunoblotting, the cells were lysed in lysis buffer containing 1% NP-40, 50 mM tris, and 150 mM NaCl in the presence of protease inhibitors. Orthovanadate (1 mM) was included for Figs. 1C and 3A. After blocking overnight in 1% bovine serum albumin (BSA) in tris-buffered saline containing 0.1% Tween (TBS-T) at 4°C, the filter was incubated with anti-Eck (*8*) or 4G10 antibody to phosphotyrosine (UBI) at a concentration of 1 μg/ml. Bound primary antibody was visualized with the ECL kit (Amersham). Reprobing to detect Eck protein was done as described [A. Pandey, D. F. Lazar, A. R. Saltiel, V. M. Dixit, *J. Biol, Chem.* **269**, 30154 (1994)].
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10. Angiogenic activity was assayed in the avascular cornea of F344 female rat eyes (Harlan Laboratories, Madison, WI) as described (*20*). Briefly, each sample was combined with an equal volume of sterile Hydron casting solution (Interferon Sciences, New Brunswick, NJ), and 5-μl aliquots were pipetted onto the surface of 1-mm diameter Teflon rods (Dupont Co.) glued to the surface of a glass petri dish. The resulting pellets were air-dried in a laminar hood and refrigerated overnight. Just before implantation, the pellets were rehydrated with a drop of lactated Ringers solution and then placed in a surgically created intracorneal pocket ~1.5 mm from the limbus. Corneas were observed for a period of 7 days; the animals were then perfused with a colloid carbon solution and the corneas removed, flattened, and photographed.
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12. Chemotaxis was assayed as described (*14, 21*). Briefly, we prepared chemotaxis membranes (Nucleopore, 5-μm pore size) by soaking them sequentially in 3% acetic acid overnight and for 2 hours in gelatin (0.1 mg/ml). Membranes were rinsed in sterile water, dried under sterile air, and stored at room temperature for up to 1 month. Bovine adrenal gland capillary endothelial (BCE) cells, maintained in gelatin-coated flasks in Dulbecco's modified Eagle's medium (DMEM) with 10% FBS were used as target cells. Twenty-four hours before use, BCE were starved in DMEM with 0.1% BSA. Twenty-five microliters of cells suspended at a concentration of 1 × 10^6 cells/ml in DMEM with 0.1% BSA were dispensed into each of the bottom wells. A chemotaxis membrane was positioned on top of the bottom wells, and the chambers sealed, inverted, and incubated for 2 hours to allow cells to adhere to the membrane. Chambers were then reinverted, and 50 μl of test medium were dispensed into the top wells and reincubated for an additional 2 hours. Membranes were fixed and stained with Diff-Quick staining kit (Baxter Diagnostics Inc., McGraw Park, IL) to enumerate membrane-bound cells and cells that had migrated through the membrane to the opposite surface.
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17. Quiescent HUVECs were then treated with TNF-α (500 U/ml) or TNF-α plus anti-B61 (20 μg/ml, 30 min before addition of TNF-α and 3 and 5 hours after addition of TNF-α) and grown for 8 hours in 1% BSA (Fig. 3A). Eck was immunoprecipitated with anti-Eck (*8*) and antiphosphotyrosine immunoblotting was done as described (*7*). Polyclonal antibody to B61 was raised against recombinantly expressed human B61 and then affinity purified.
18. Quiescent HUVECs were treated as in (*17*) and then metabolically labeled for 8 hours in the presence of 1% BSA. Cell lysates were incubated with anti-B61 (3E6) (*2*) or anti-Eck (*8*) for 2 hours at 4°C. Immune complexes were precipitated by the addition of protein A/G-Sepharose, washed three times in lysis buffer, dissolved in SDS sample buffer, resolved by SDS–polyacrylamide gel electrophoresis under reducing conditions, and subjected to autoradiography.
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22. We thank AMGEN for providing anti-Eck and anti-B61. We especially thank R. Lindberg for helpful discussions. We acknowledge the assistance of I. Jones and K. O'Rourke in the preparation of this manuscript. Supported by National Institutes of Health grant DK 39255 to V.M.D. and HL 39926 to P.J.P. R.M.M. is supported by Public Health Service grants PO 1AI331890004, P50AR417030003, MO 1RR000420758, and P60AR20557 and is a Pew Scholar in the Biomedical Sciences.

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How Baseball Outfielders Determine Where to Run to Catch Fly Balls

Michael K. McBeath,* Dennis M. Shaffer, Mary K. Kaiser

Current theory proposes that baseball outfielders catch fly balls by selecting a running path to achieve optical acceleration cancellation of the ball. Yet people appear to lack the ability to discriminate accelerations accurately. This study supports the idea that outfielders convert the temporal problem to a spatial one by selecting a running path that maintains a linear optical trajectory (LOT) for the ball. The LOT model is a strategy of maintaining "control" over the relative direction of optical ball movement in a manner that is similar to simple predator tracking behavior.

Even recreational baseball outfielders appear to know virtually from the moment of bat contact where to run to catch a fly ball. In this task, the ball's approach pattern renders essentially all major spatial location and depth cues unusable until the final portion of the trajectory. Cues such as stereo disparity, accommodation, image expansion rates, and occlusion help to guide final adjustments in the interception path (*1, 2*). During most of the task, the only usable information appears to be the optical trajectory of the ball (the changing position of the ball image relative to the background scenery). Conceivably, outfielders could derive the destination from an assumed projected parabolic trajectory, but research indicates that observers are very poor at using such a purely computational approach (*3*). In addition, factors such as air resistance, ball spin, and wind can cause trajectories to deviate from the parabolic ideal (*1, 4*).

One proposed model is that outfielders run along a path that simultaneously maintains horizontal alignment with the ball and maintains a constant change in the tangent of the vertical optical angle of the ball, $\tan \alpha$ (Fig. 1) (*5–9*). As the ball rises, $\tan \alpha$ increases, but at a rate that is a function of the running path selected. If the fielder runs too far in (so that the ball will land behind him), $\partial(\tan \alpha)/\partial t$ will increase. If he runs too far out (so that the ball will land in front of him), $\partial(\tan \alpha)/\partial t$ will decrease. The fielder can arrive at the correct desti-

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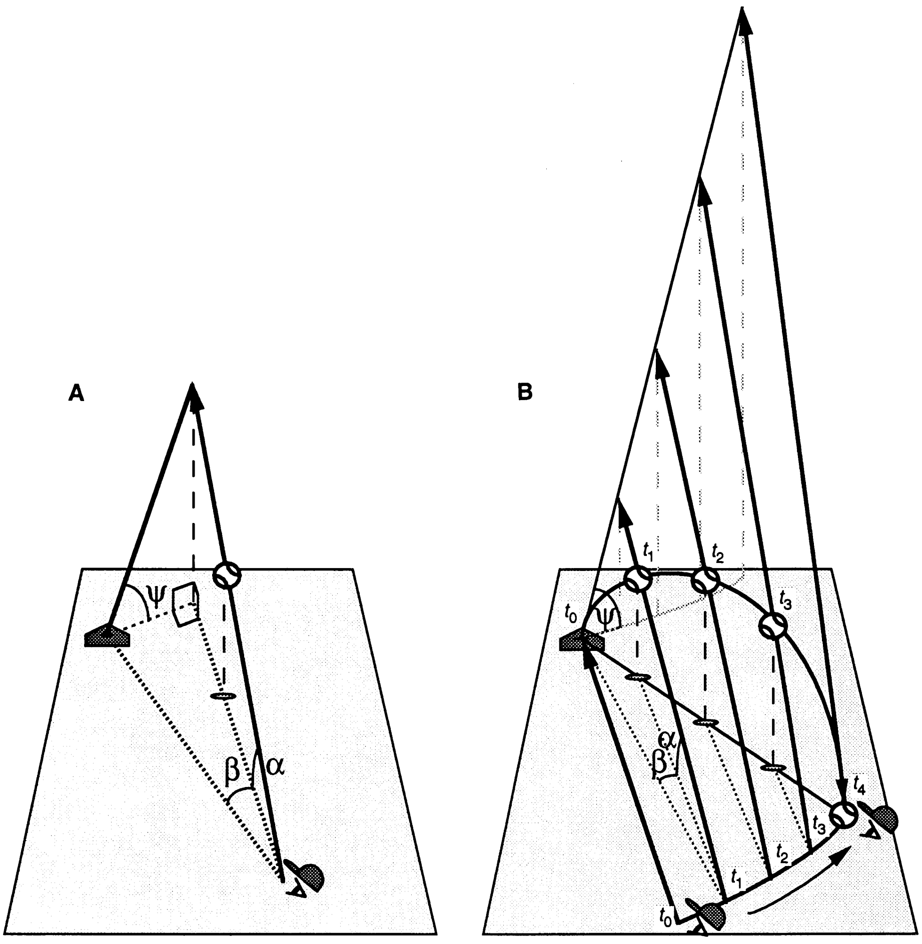
Fig. 2. The LOT model. This model specifies that fielders "control" the optical direction of ascent of the ball by adjusting their running path to null optical trajectory curvature. This keeps the image of the ball continuously ascending in a straight line throughout the trajectory. (**A**) Fielder optical angle geometry of a ball at an instant in midflight: α = vertical optical angle, β = horizontal optical angle, and Ψ = optical trajectory projection angle (angle from the perspective of the fielder that is formed by the ball, home plate, and a horizontal line emanating from home plate). The configuration of Ψ, α, and β forms a right pyramid such that $\tan \Psi = (\tan \alpha)/(\tan \beta)$. α and β are both controlled to increase continuously throughout the trajectory and are also labeled at time t_1 in (B). (**B**) Bird's-eye view of a fly ball with a running path that maintains a linear optical ball trajectory (positions shown at times t_0 through t_4). If the fielder maintains a constant increase in the lateral optical tangent, $\tan \beta$, he achieves approximate horizontal alignment with balls that are catchable. When he runs along a path so that both lateral and vertical tangents increase at a constant rate then the trajectory projection angle Ψ remains constant. Mathematically, the relation is expressed as

$$\tan \Psi = \frac{\tan \alpha}{\tan \beta} = \frac{C_\alpha f(t)}{C_\beta f(t)} = C_\Psi$$

where C_α, C_β, and C_Ψ are constants and $f(t) = t$ = time since trajectory initiation. In theory, $f(t)$ could be any monotonically increasing function, but for approximately parabolic trajectories, $f(t) = t$ leads to a relatively constant bearing and a near least energy running path. The fielder scales lateral running speed relative to his distance to home plate, which generally results in a running path that curves slightly. The resultant optical trajectory is represented behind the ball by the tilted line rising from home plate.



fielder accelerates, curves slightly beyond the ball, and decelerates somewhat as the destination point is approached.

If the ball trajectory deviates somewhat from the parabolic ideal, the LOT strategy still works. Like the OAC strategy, maintaining a LOT is an error-nulling tactic that couples fielder motion with that of the ball. The strategy therefore allows leeway to correct for perceptual error or changes in ball direction due to factors such as ball spin, air resistance, and gusts of wind.

In summary, the OAC model predicts that fielders select a running path that is straight with constant speed, resulting in a curved optical ball trajectory. The LOT model predicts that fielders select a running path that curves out with a ∩-shaped speed function, resulting in a linear optical ball trajectory.

We ran two experiments to evaluate the OAC and LOT models, each using two college students with some, but not extensive, outfield experience. In the first experiment, we mounted a video camera on a tower above and behind the fielders and videotaped their running paths. Fly balls were launched at a variety of angles at varying force from a distance of about 50 m. To optimize camera angle, balls were aimed so

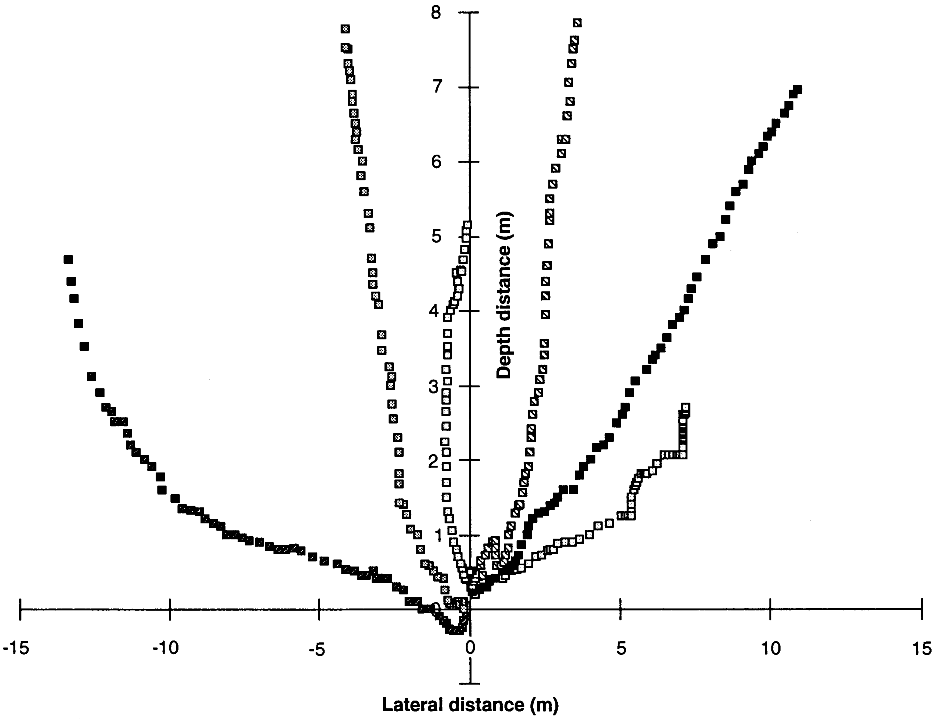
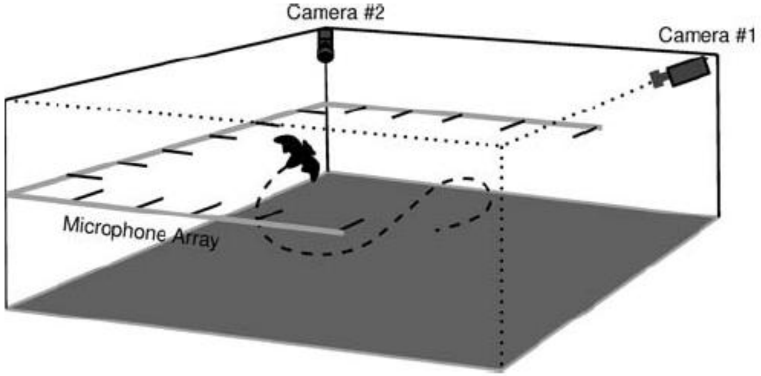
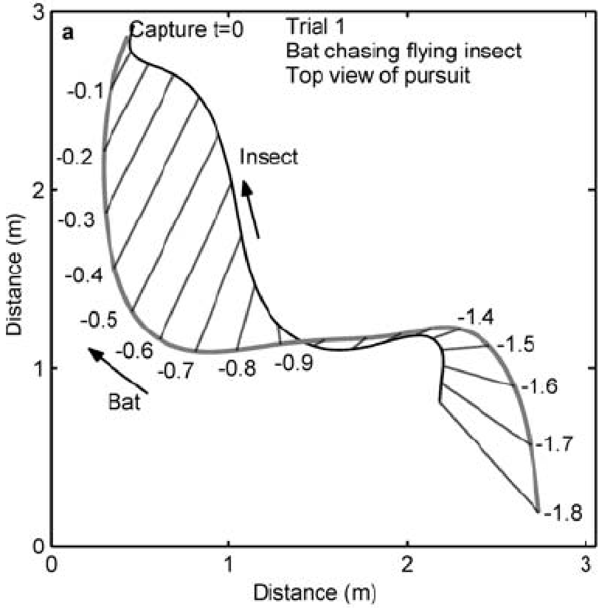


Fig. 3. Results of running path experiment. Top view of typical running paths with the origin and similarly patterned squares indicating initial and subsequent fielder positions at 1/30-s intervals. The observed running paths usually curve slightly and vary in speed as predicted by the LOT model.

Exemple de découverte de solutions perception- action : chauve souris et salto arrière





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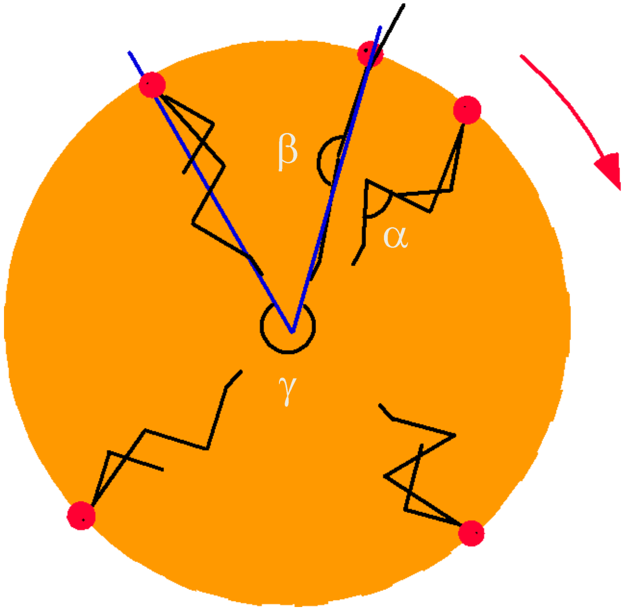
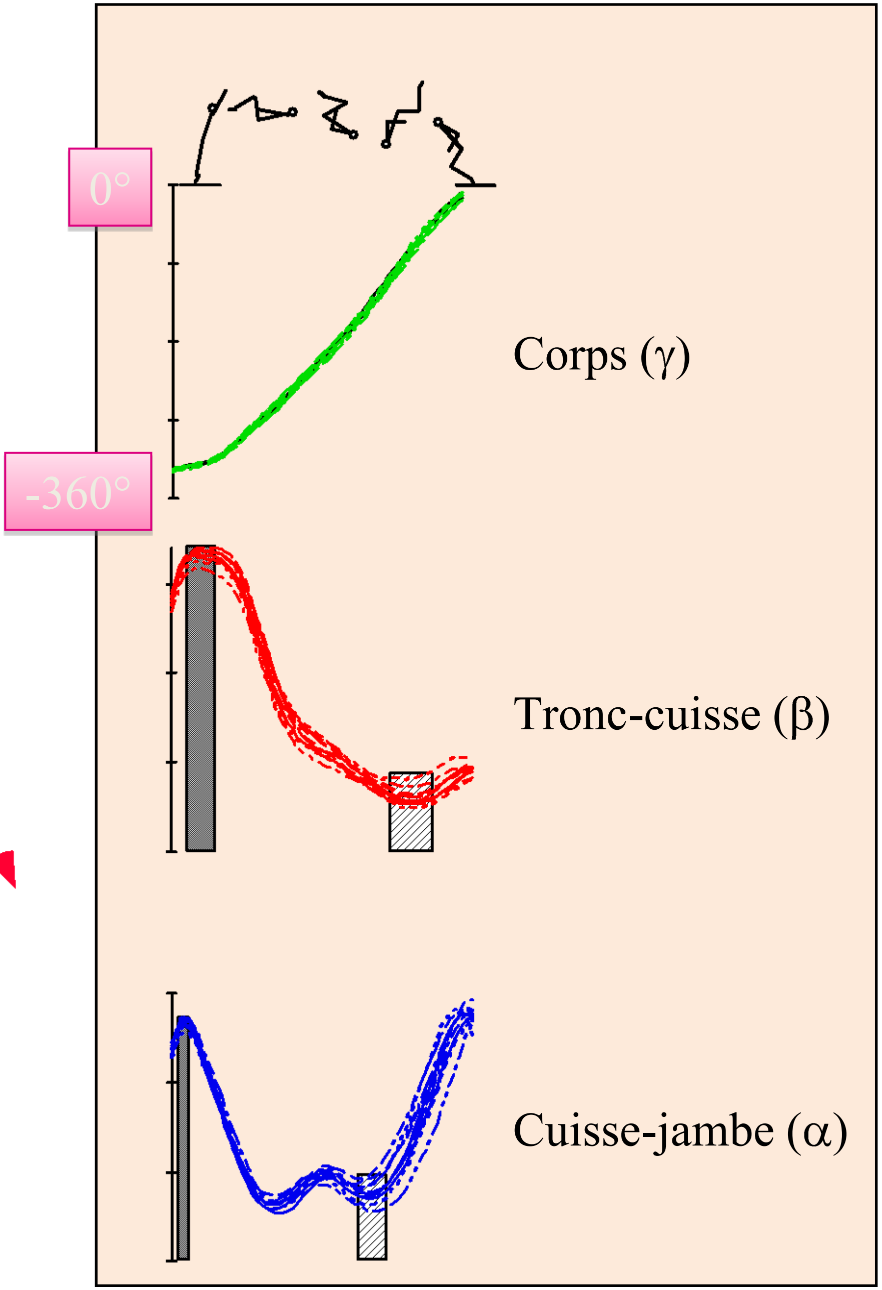


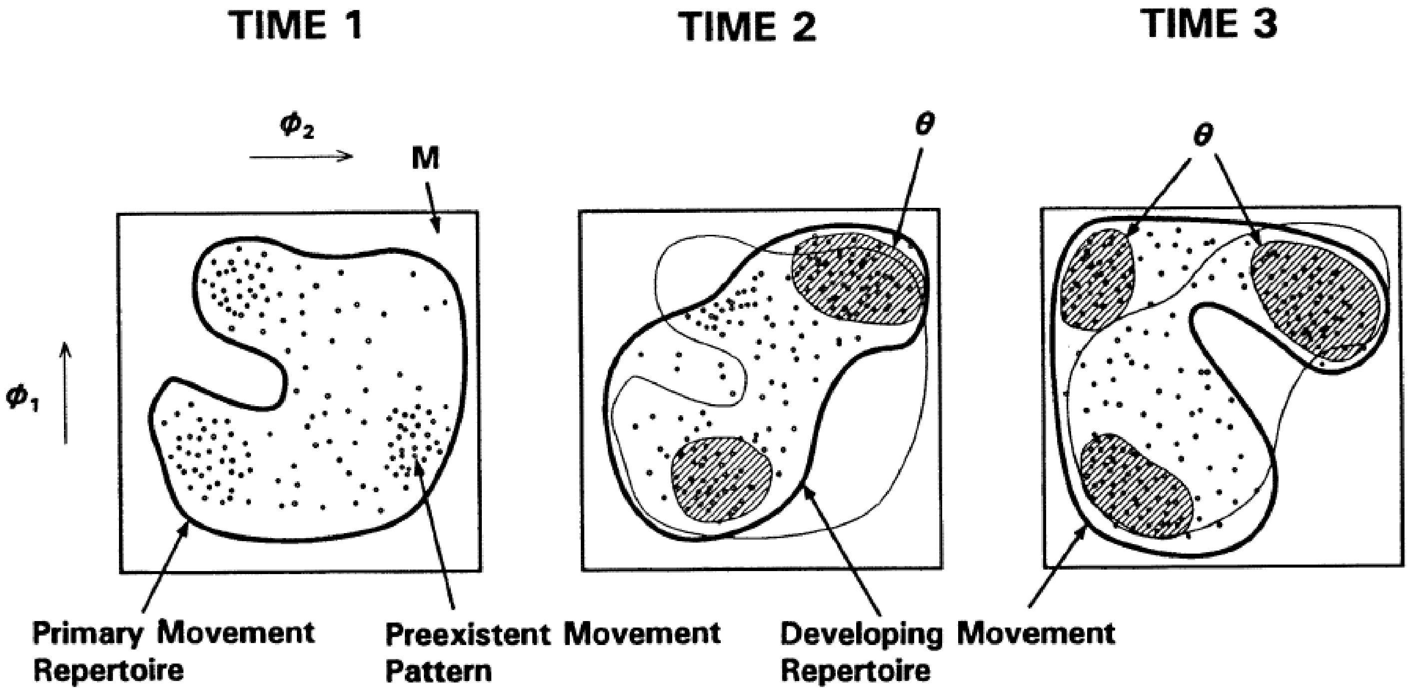


Bardy & Laurent (1998)

Recherche de solutions dans un espace de grande dimension…

Par essai- erreur, par imitation, par guidage, par consignes (réduction de la dimension de l'espace de recherche (apprentissage supervisé))
→ sélection d'une solution et d'une autre, stabilisation d'une solution +- efficace.
Reproduction- répétition- pratique, constitution d'une « mémoire ».

« Darwinisme neural » Edelman : Sélection de ce qui marche, pré requis : La variation entre les répétitions, entre les tentatives.
Sans *variation*, pas de choix/ pas de sélection, pas d'évolution… pas de progrès, pas d'apprentissage.



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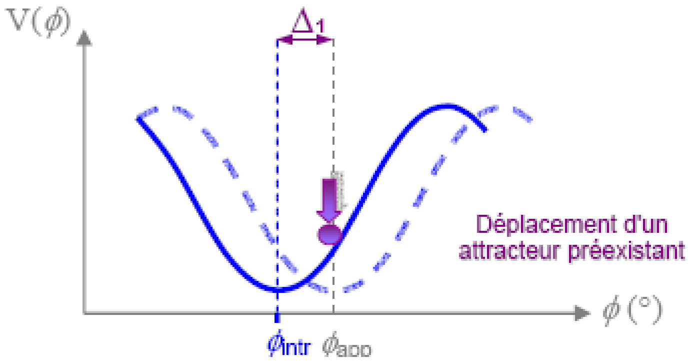
L’ancien et le nouveau :

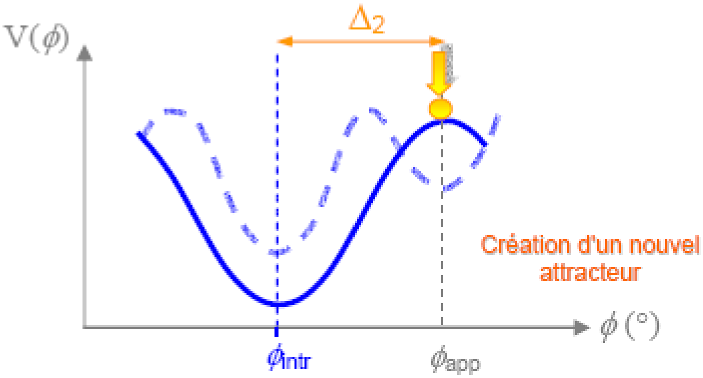
Répertoire de solutions. Unités, primitives de mouvement, métaphores d’une syntaxe, d’une grammaire (Noam Chomsky, Grammaire générative, langage) : Combinaison, création, séquences (affinage des liaisons), associations, mise en parallèle (synchrones).

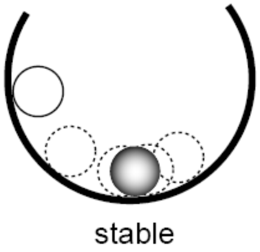
Préalable (disponible) et le nouveau : influence mutuelle, coopération ou compétition.

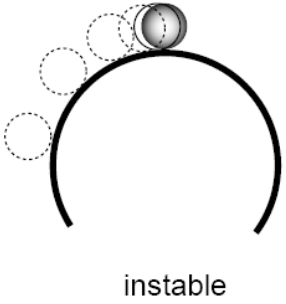
« Two routes of learning »

Pré- existant vs. tâche (objectifs et contraintes) → et création de nouvelles solutions

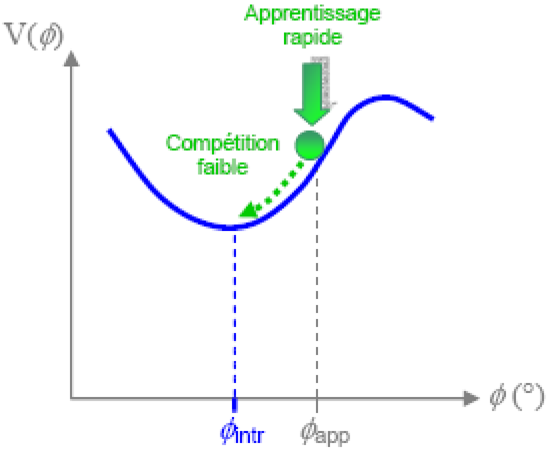


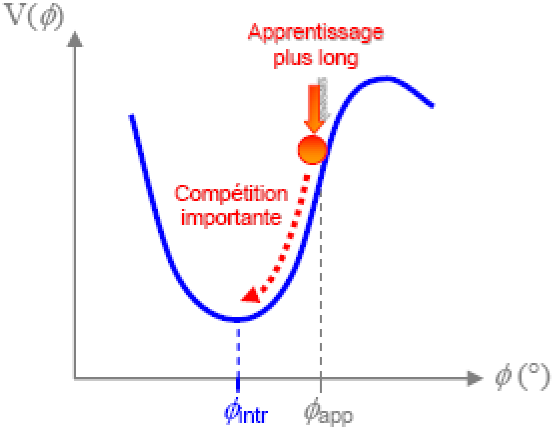






Zanone & Kostrubiec 20004





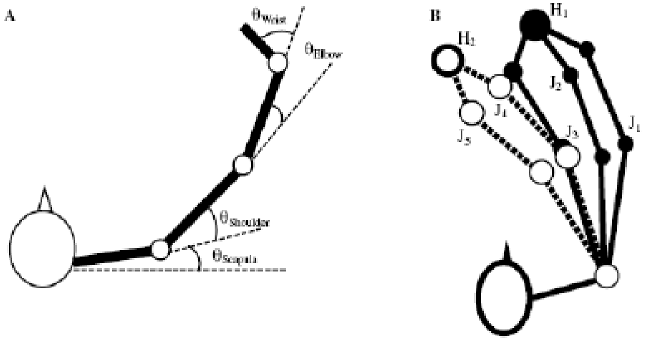
Compétition entre pré- existant et nouveau/ objectif


Nikolai A. Bernstein

Gels des degrés de libertés → dégel des degrés de liberté

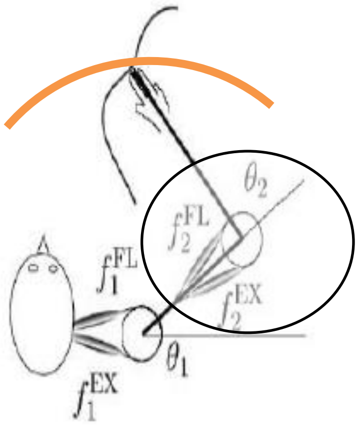
N. Bernstein (1967), The co- ordination and régulation of movements

1) Redondance



✓Plusieurs solutions, réduire la dimension du problème

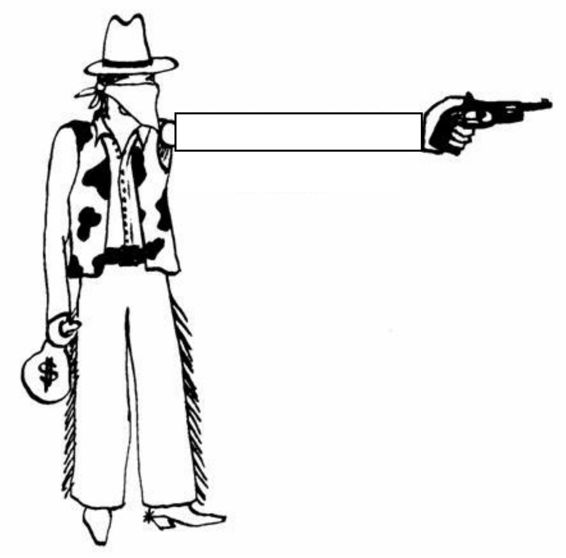
2) Rigidité articulaire : co-contraction



✓Immobiliser des articulations en augmentant la *raideur* (forte contraction simultanée des agonistes et antagonistes)

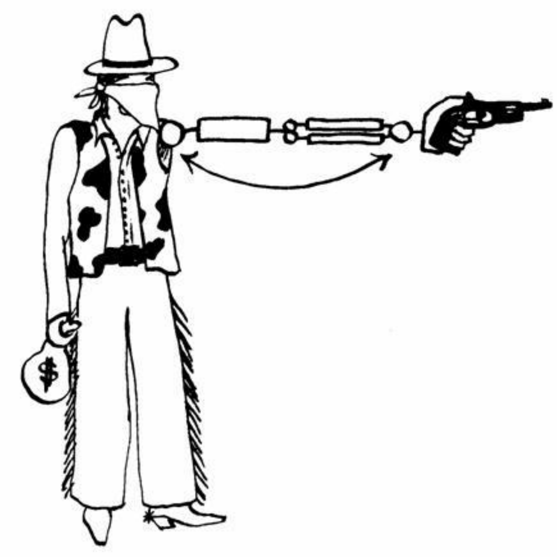
Novice

Freeze all joints

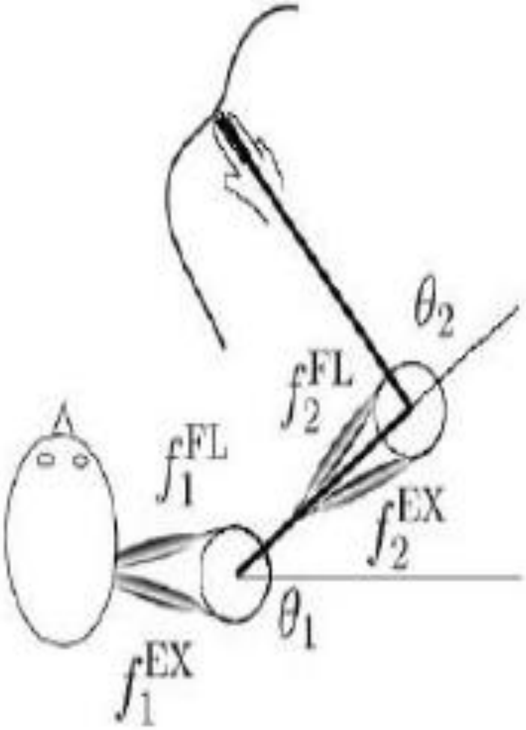


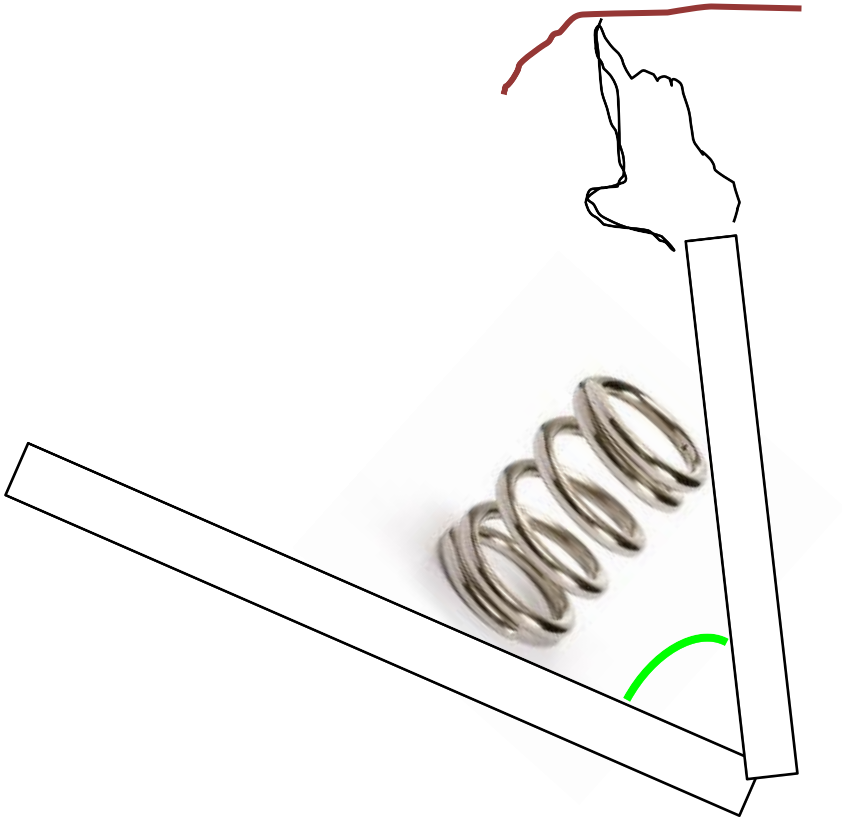
Expert

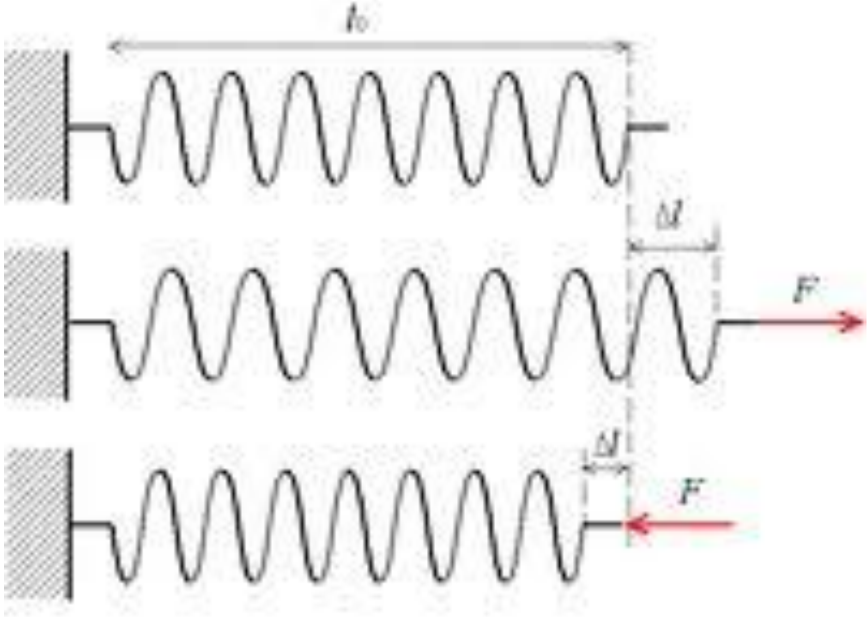
Coordinative structure
Compensation

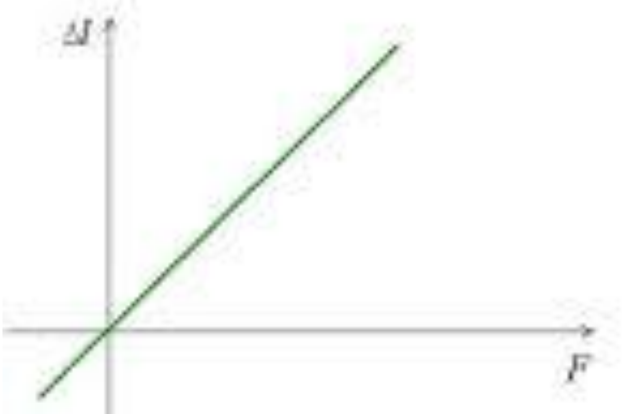


Results


θ_2
f_2^{FL}
f_1^{FL}
f_2^{EX}
θ_1
f_1^{EX}







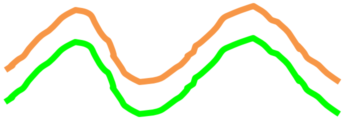
F = k x (Delta L)
k : N/m

Gel :

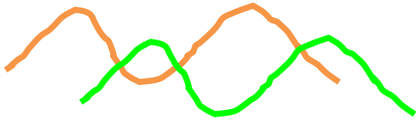
- Des articulations actives et des articulations passives (*raideur*)… couplage mécanique local

Dégel :

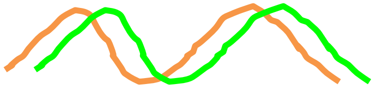
- Toutes les articulations sont actives et co- ordonnées (couplage neuro musculaire spinal, cérébral)
- Utilisation de la redondance
- Synchronisation (Flexion- Flexion), anti-synchronisation (Flexion- Extension), selon la tâche, des activations musculaires



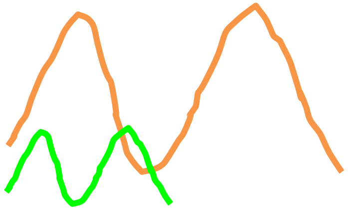
Flexion- Flexion



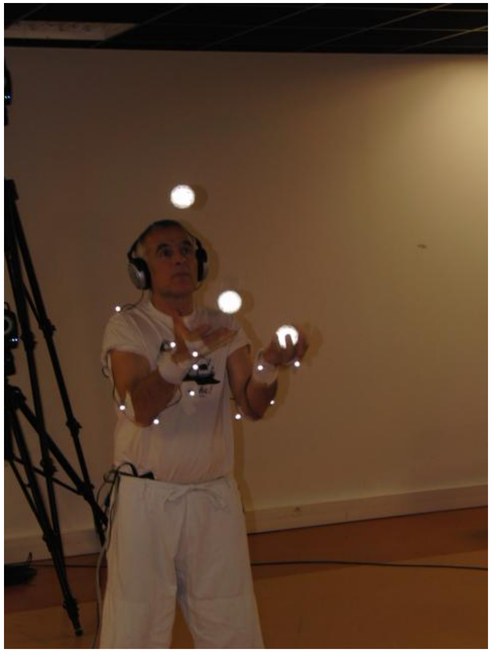
Flexion- Extension

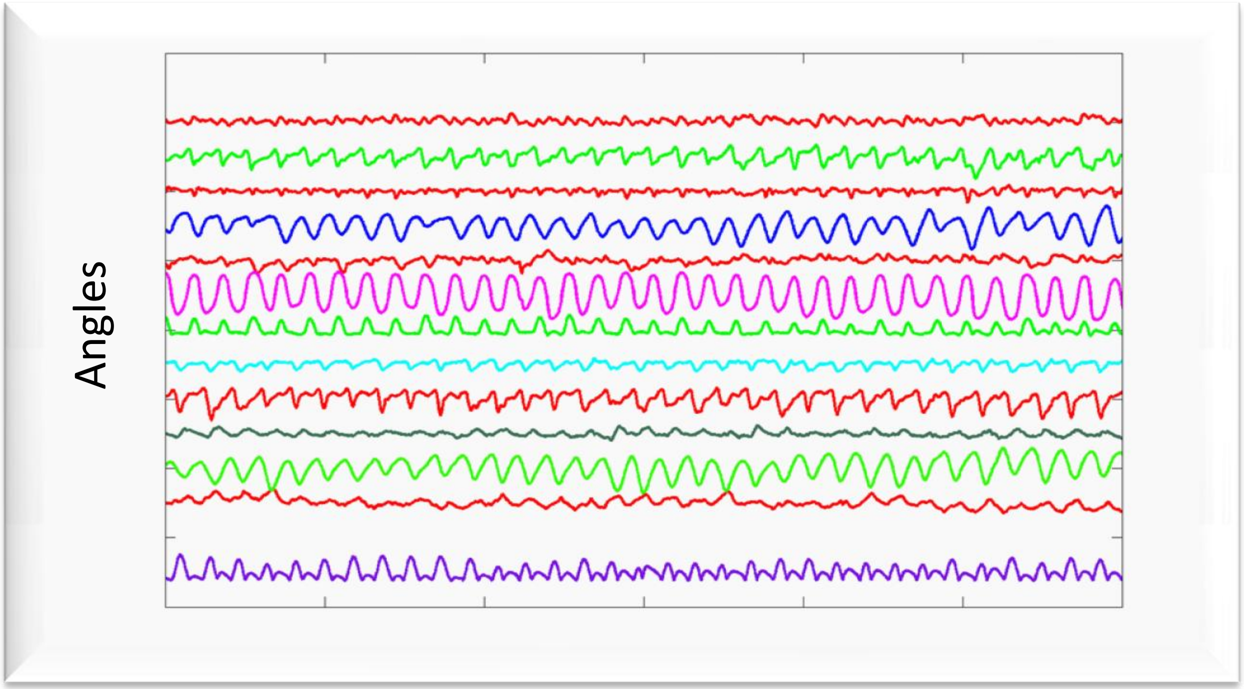


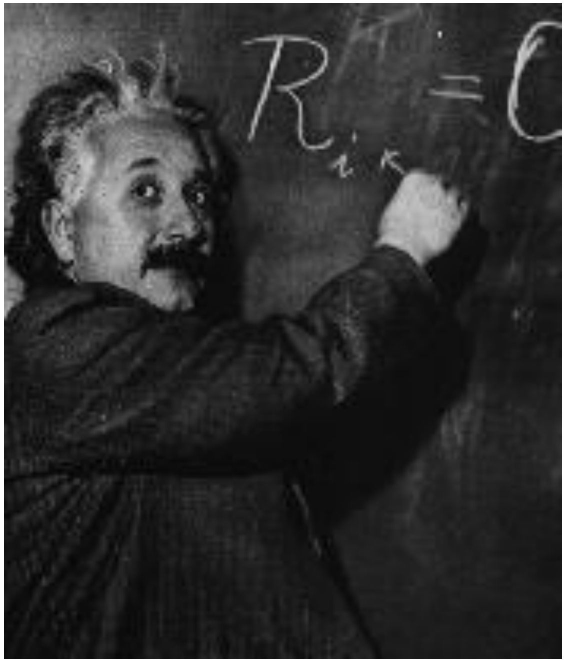
Déphasage



Durée, vitesse, amplitude, force




Angles
Temps

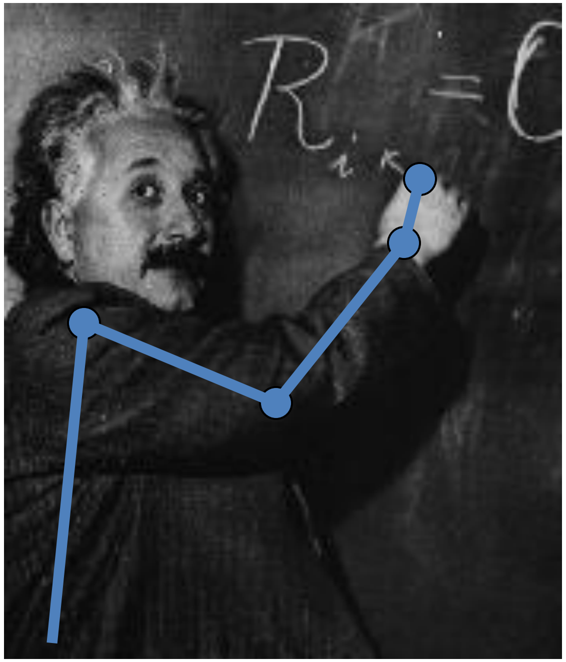


Newell & van Emmerik (1989)

Signature on a vertical board, performed with the dominant hand or the non-dominant hand

Analysis of correlations between the vertical displacements:

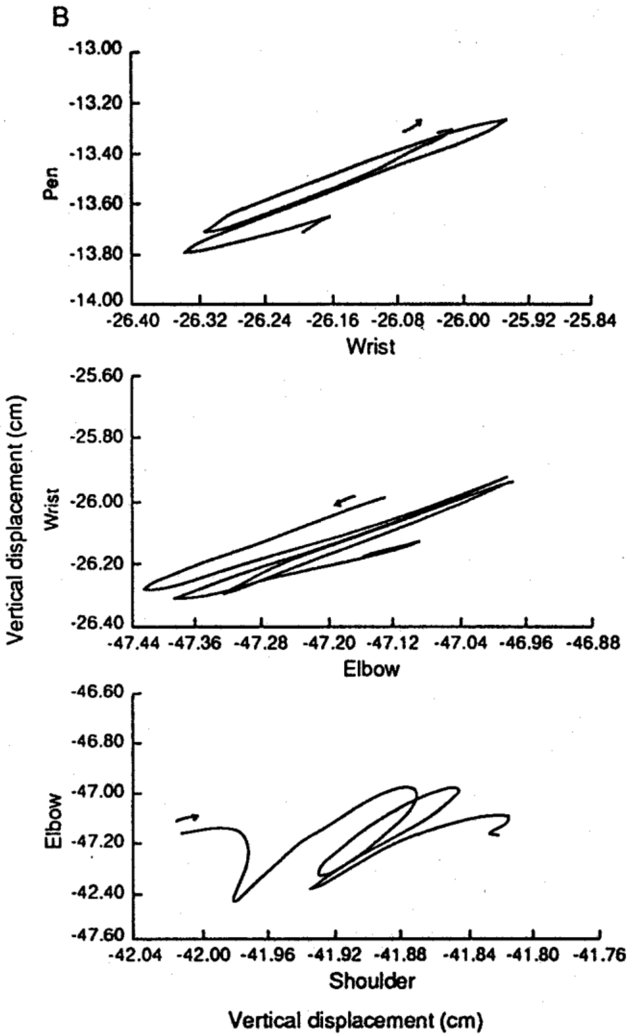
- pen/wrist,
- wrist/elbow,
- elbow/shoulder



pen/wrist

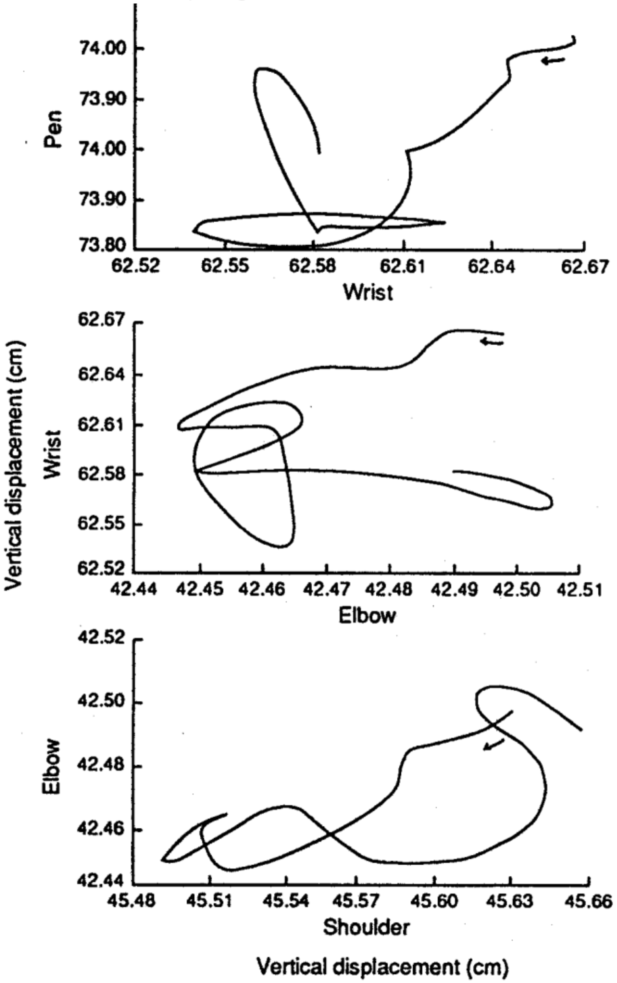
wrist/elbow

elbow/shoulder



non-dominant hand

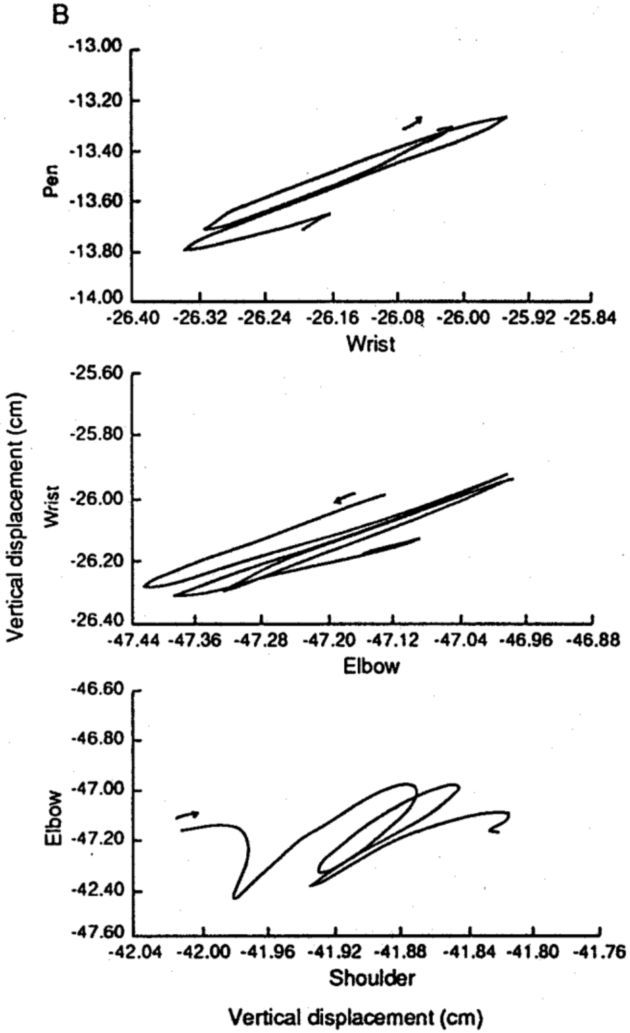
Newell & van Emmerik (1989)



pen/wrist

wrist/elbow

elbow/shoulder



dominant hand

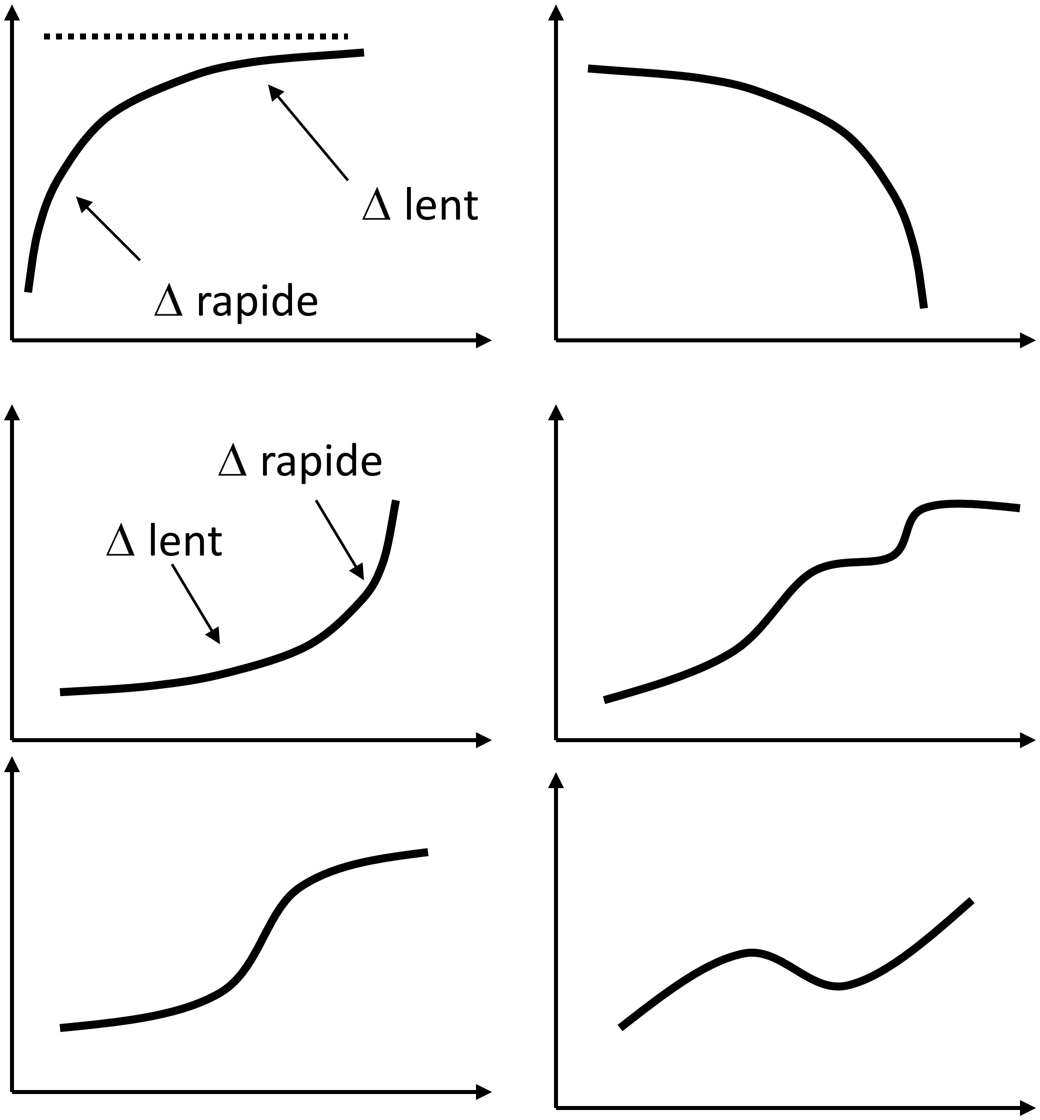
non-dominant hand

Newell & van Emmerik (1989)

Paradoxe de la plasticité : changer mais garder une permanence.

Faire des pauses (un processus de fond plus lent se met en place)
Oublier pour sélectionner, dormir pour mémoriser.

Courbes d’apprentissage (up- down), progression- régression, différence individuelle massives.



- Non linéaire

performance plafond

- Courbe d’accélération négative

Loi générale

- Courbe d’accélération positive

Certaines phases, habiletés morpho

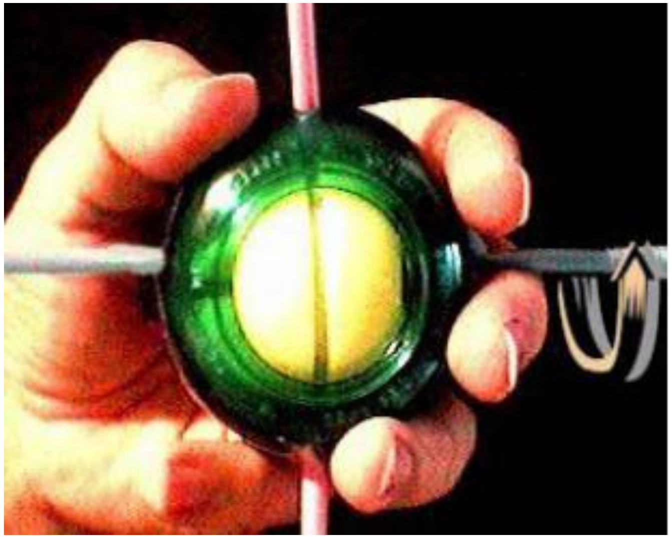
- Courbe en S

- Courbe de décélération

Y - erreur

- Plateau

- Phases de régression



(Liu & Newell, 2015)

Liu, Y-T., & Newell, K. M. (2015). S-shaped motor learning and non-equilibrium phase transitions. <u>Journal of Experimental Psychology: Human Perception and Performance,</u> <u>41</u>, 403-414.

In Liu and Newell (2015) we examined the hypothesis that S-shaped motor learning as reflected in the task outcome is a product of a transition in the movement coordination dynamics as a function of practice acting as a control parameter. Participants practiced 50 trials per day for as many days (1-20) as required to reach the task criterion of success that was followed 1 week later by a retention test. All participants improved the task performance but there were 2 subgroups of patterns of change including S-shaped learning (Fig 2). The enhanced variability prior to the transition and the distinct modes revealed

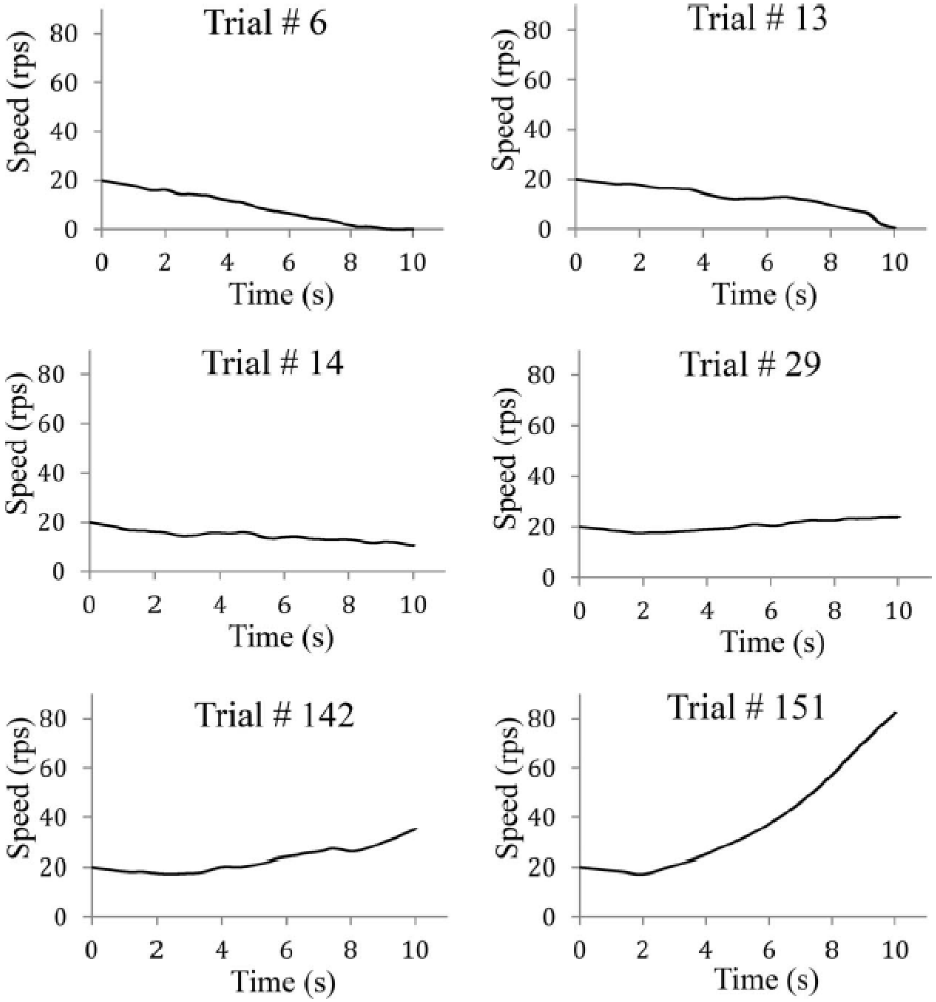


Figure 2. Progression of the task dynamics reflected in the speed profile of progressive trials from an example participant. Each panel represents a single trial. The corresponding performance measure of the average angular accelerations are: −2.0, −1.96, −0.94, 0.37, 1.52, and 6.23 rps/s for Trial 6, 13, 14, 29, 142, and 151, respectively.

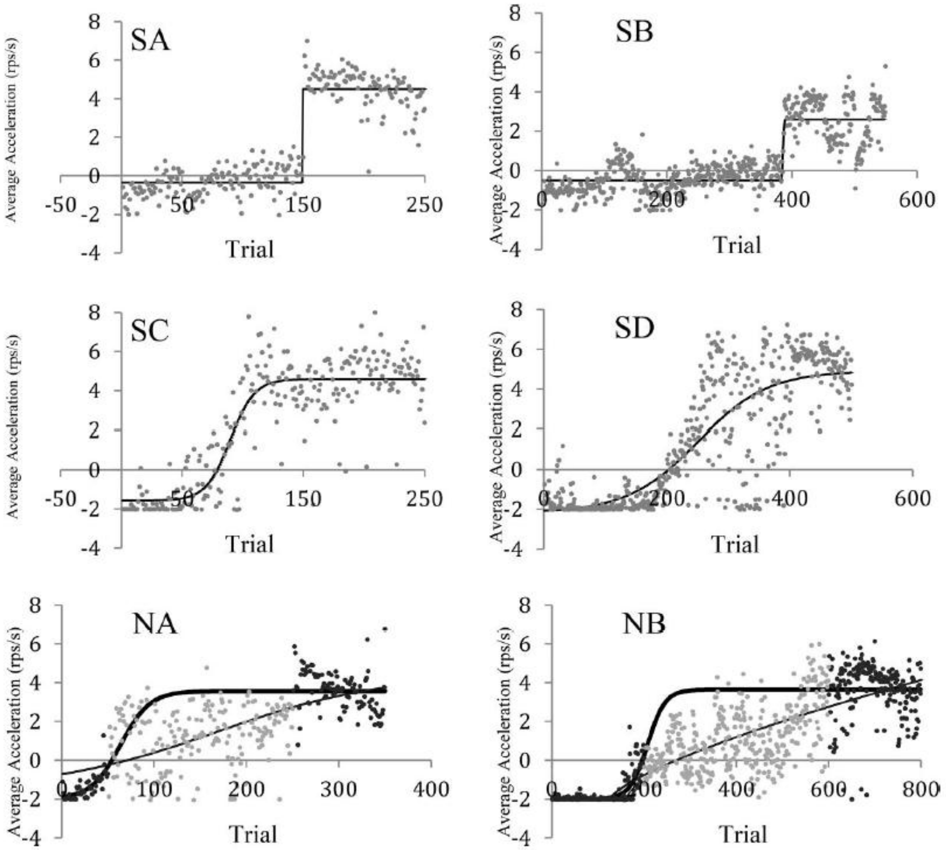
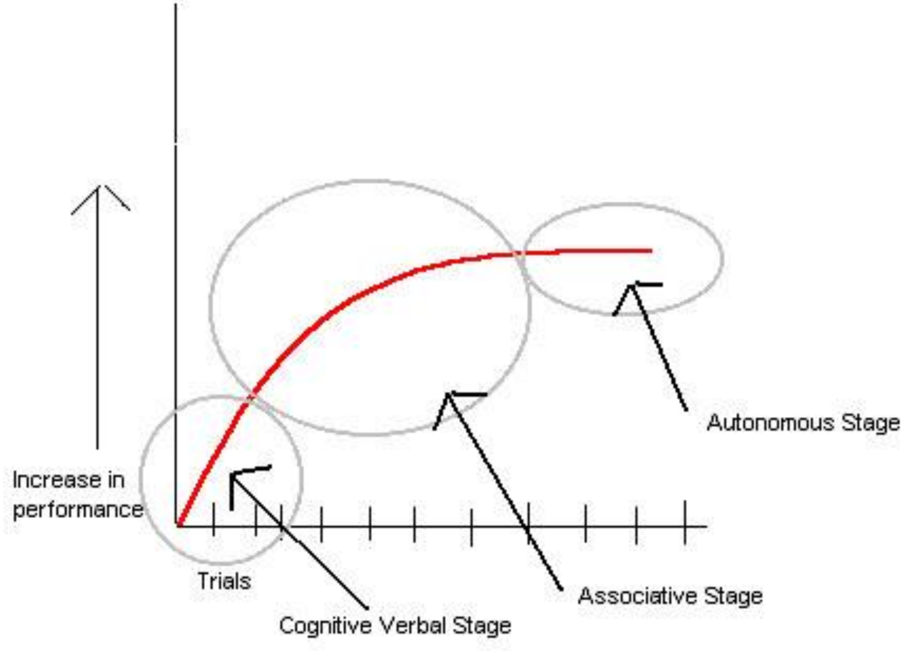


Figure 6. Example sigmoid function fit to the individual practice performance. Panels SA and SB represent the abrupt performance jumps during practice; panels SC and SD are examples of smooth change of performance. Panels NA and NB are examples of individual practice performances where the prolonged transition period and the following further improvement result in poor sigmoid function fit (the thin curves). The S-shape curves (the thick curve) reappear as the fitting function after removing the prolonged transition trials (the light dotts).



Stades de l’apprentissage
Cognitif, verbal-moteur, puis associatif, puis autonome, automatique

→ Attention au contenu de l’apprentissage, ce qui est effectivement réalisé pendant chacune de ces « étapes »

Courbe d’apprentissage et diminution de l’attention investit : Définition opérationnelle et mesure : double tâche

Qu’est ce qui est appris dans ces étapes ?

1) Coordination
2) Le contrôle

(Gentile, 1998)

Optimiser le mouvement : Efficace et économique. Moindre effort (JL Lagrange).
Protection du système musculo- squelettique,

Apprentissage implicite et explicite (connaissance tacites Polany, indicible/ ineffable, non verbal : trop complexe et/ou trop rapide).
Système lent et un système rapide de la pensée (Daniel Kahneman. Nobel économie)

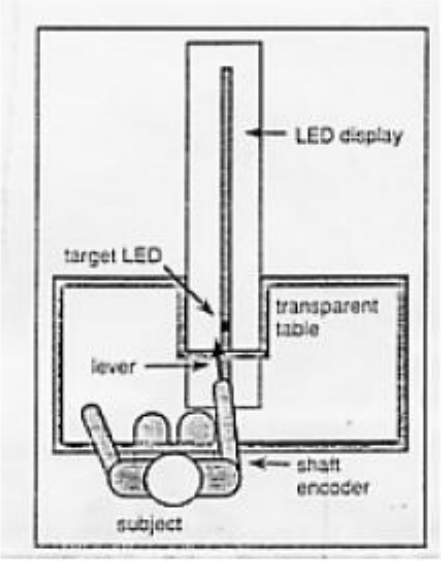
Apprentissage par la découverte ou « guidé »
Imitation : neurones miroirs, forme de gestes
Connaissance des résultats (CR)
Disposition de la connaissance des résultats : autonome ou non, +- fréquente
Réalité augmentée
Justesse de la CR (Buekers), → mesure pour le coach/entraineur/ enseignant/ré-éducateur ?

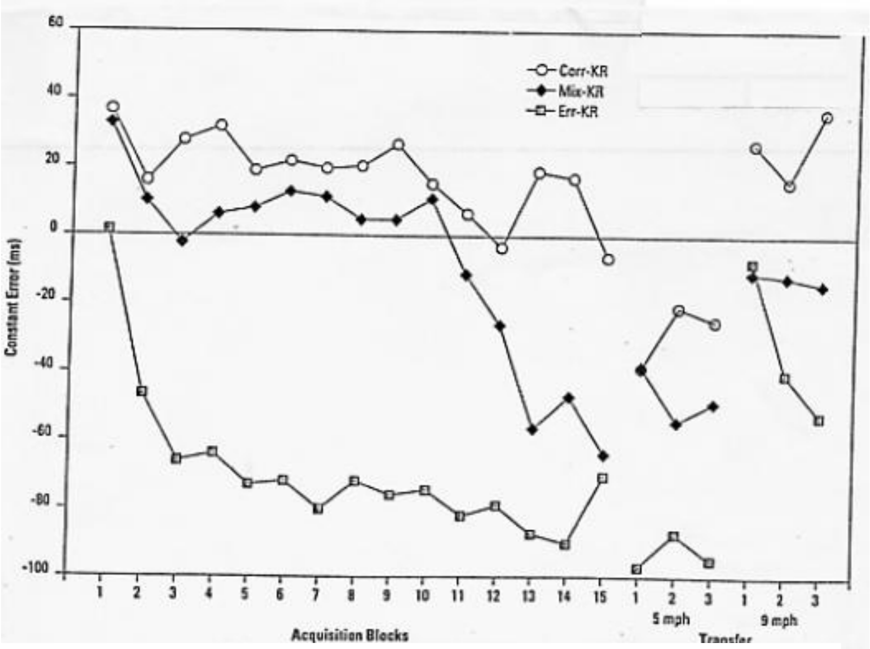
Intégration de la connaissance du résultat (CR) dans l'ajustement de la réponse motrice

Une connaissance du résultat «erronée »conduit à des réponses «erronées »

tâche d'anticipation coïncidence
Variable mesurée : erreur constante (différence entre le temps d'arrivée de la cible et du levier)
3 groupes de sujets :
Corr-KR : connaissance du résultat correcte
ERR-KR : connaissance du résultat erronée : on rajoute 100 ms à l'erreur constante : le sujet croit qu'il est plus en retard par rapport au mouvement réellement produit
Mix-KR : connaissance du résultat correcte pour les 50 premiers essais, puis erronée pour les 25 derniers

Vitesse de la cible : 7 miles/heure pendant l'acquisition et 5 miles/heure ou 9 miles/heure pendant le test de





Mcnevin, N., Magill, R. A., & Buekers, M. J. (1994). The effects of erroneous knowledge of results on transfer of anticipation timing. *Research Quarterly for Exercise and Sport, 65*(4), 324-329.

Perception du mouvement par l’observateur, intervention de l’observateur, apprentissage de l’acteur.

Observateur : Pb de « perception du mouvement biologique » (Johansson 1973)

Mouvement pluri-articulé/ 3D/ contraintes temporelles/ analyse mécanique (causes; la Terre n’est pas plate) : quoi percevoir ?
L’observateur- entraineur : un apprentissage nécessaire. Voir, reconnaître, classer, trouver des solutions, placebo…

CR tout le temps : Question de la dépendance. Détection des « erreurs » de façon autonome ?

Winstein and Schmidt (1990) demonstrated that augmented visual feedback of the limb’s movement trace (elbow angle) superimposed on a template of the required trace facilitated acquisition of a motor skill while degrading retention performance, the classic guidance effect.

The dependency on augmented visual feedback was
eliminated with two days of training by reducing the presentation
frequency of the visual feedback during the
acquisition process (Winstein and Schmidt 1990).

Huet, M., Jacobs, D. M., Camachon, C., Goulon, C., & Montagne, G. (2010). Self-controlled concurrent feedback facilitates the learning of the final approach phase in a fixed-base flight simulator. *Human Factors: The Journal of the Human Factors and Ergonomics Society*.

Changement des modes de « contrôle » perceptifs ?

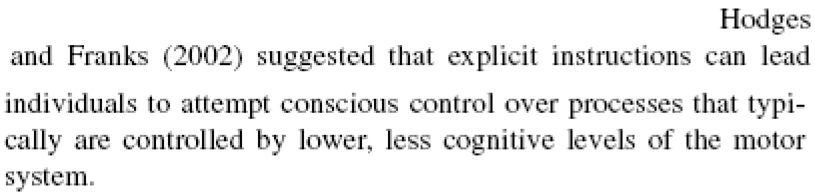
Hypothèse «classique »: avec la pratique, les informations visuelles interviennent de moins en moins dans le contrôle du mouvement, qui dépend de plus en plus des informations kinesthésiques (Fleishman& Rich, 1963; Schmidt, 1982)

Hypothèse de la «spécificité de la pratique »: le sujet apprend à utiliser de plus en plus efficacement toutes les informations dont il/elle dispose . Le contrôle du mouvement devient de plus en plus spécifique de ces informations avec la pratique. (Proteau, 1991)

Fleishman, E. A., & Rich, S. (1963). Role of kinesthetic and spatial-visual abilities in perceptual-motor learning. *Journal of Experimental Psychology, 66, 6-11.*

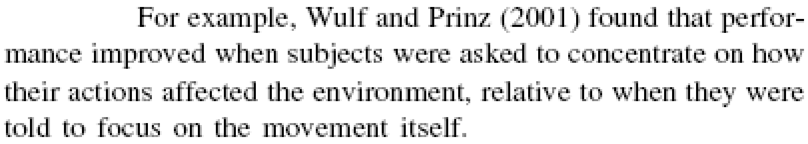
Proteau, L. (1991). On the specificity of learning and the role of visual information for movement control. In L. Proteau & D. Elliott(Eds.), *Vision and Motor Control. Amsterdam: Elsevier.*

Penser ou laisser aller : Explicite ou implicite



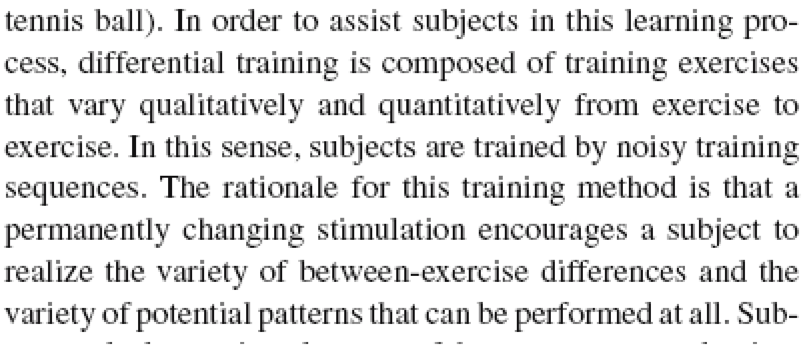
Hodges and Franks (2002) suggested that explicit instructions can lead individuals to attempt conscious control over processes that typically are controlled by lower, less cognitive levels of the motor system.

Attentional focus (Wulf)

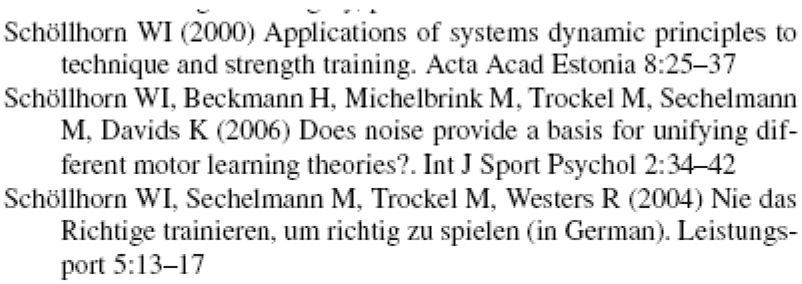


For example, Wulf and Prinz (2001) found that performance improved when subjects were asked to concentrate on how their actions affected the environment, relative to when they were told to focus on the movement itself.

Differential training



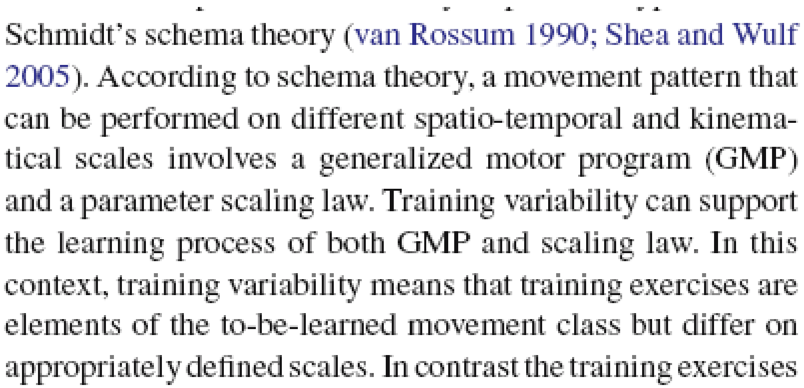
tennis ball). In order to assist subjects in this learning process, differential training is composed of training exercises that vary qualitatively and quantitatively from exercise to exercise. In this sense, subjects are trained by noisy training sequences. The rationale for this training method is that a permanently changing stimulation encourages a subject to realize the variety of between-exercise differences and the variety of potential patterns that can be performed at all. Sub-



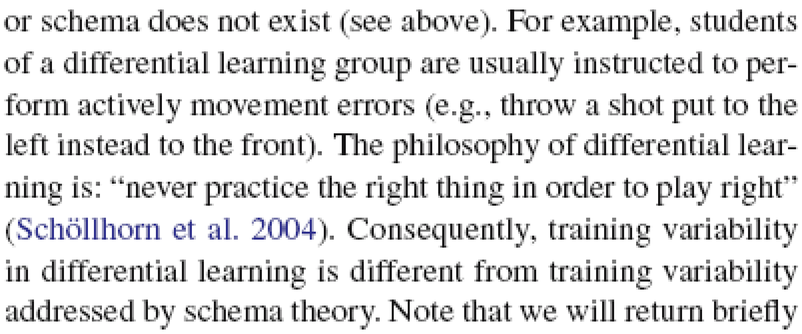
Schöllhorn WI (2000) Applications of systems dynamic principles to technique and strength training. Acta Acad Estonia 8:25–37

Schöllhorn WI, Beckmann H, Michelbrink M, Trockel M, Sechelmann M, Davids K (2006) Does noise provide a basis for unifying different motor learning theories?. Int J Sport Psychol 2:34–42

Schöllhorn WI, Sechelmann M, Trockel M, Westers R (2004) Nie das Richtige trainieren, um richtig zu spielen (in German). Leistungssport 5:13–17



Schmidt's schema theory (van Rossum 1990; Shea and Wulf 2005). According to schema theory, a movement pattern that can be performed on different spatio-temporal and kinematical scales involves a generalized motor program (GMP) and a parameter scaling law. Training variability can support the learning process of both GMP and scaling law. In this context, training variability means that training exercises are elements of the to-be-learned movement class but differ on appropriately defined scales. In contrast the training exercises



or schema does not exist (see above). For example, students of a differential learning group are usually instructed to perform actively movement errors (e.g., throw a shot put to the left instead to the front). The philosophy of differential learning is: "never practice the right thing in order to play right" (Schöllhorn et al. 2004). Consequently, training variability in differential learning is different from training variability addressed by schema theory. Note that we will return briefly

Réalité augmentée, jeux sérieux, « biofeedback »

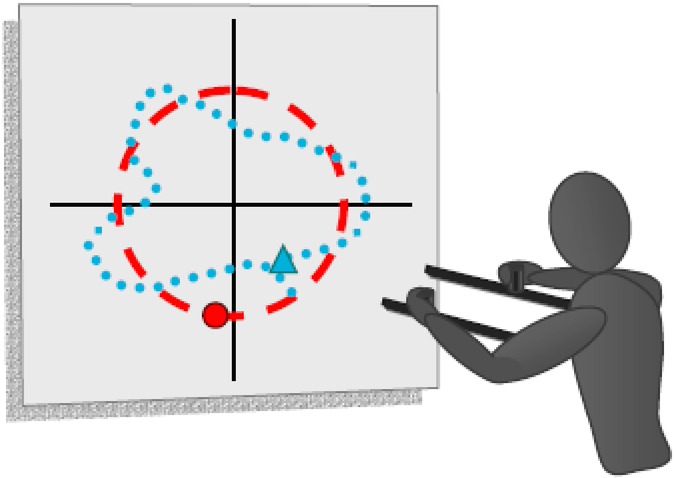
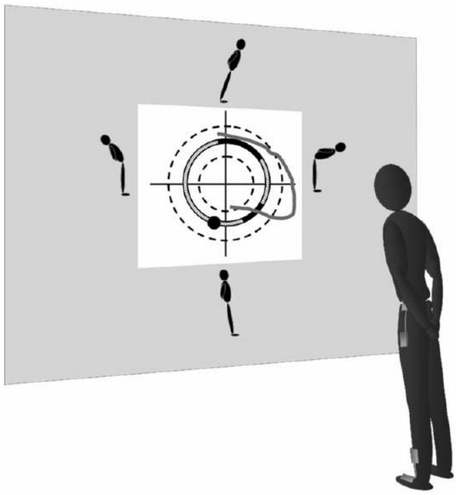
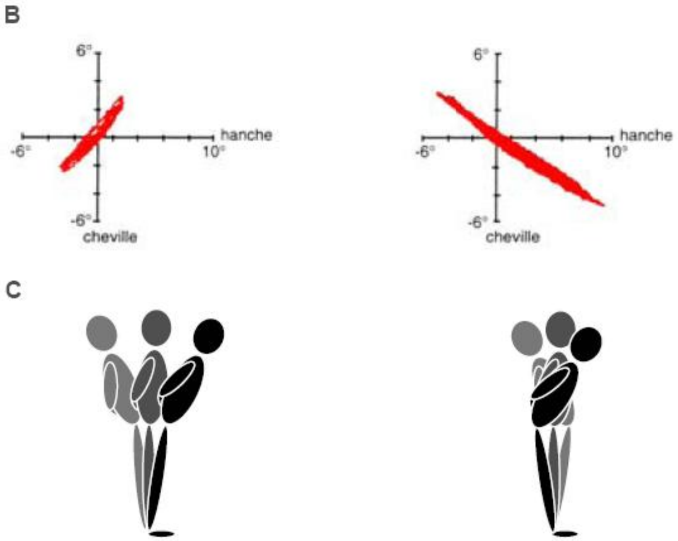
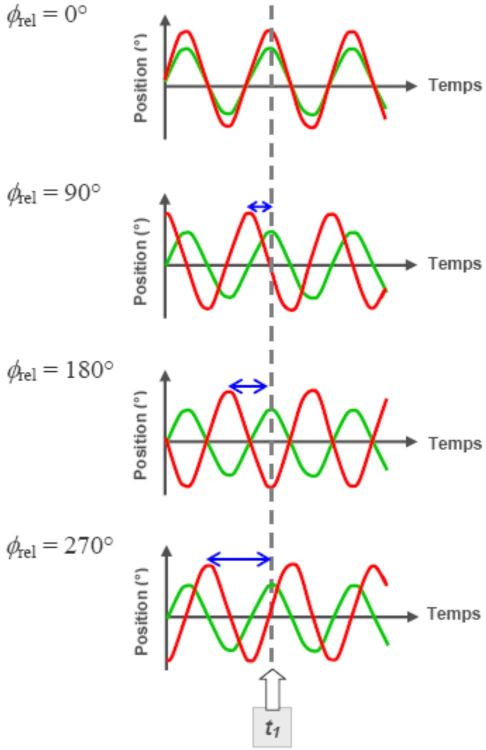


Figure 1.10. Feedback visuel donné au participant par l'intermédiaire de la figure de Lissajous. L'exemple donné ici correspond au protocole de Wenderoth, Bock et Krohn (2002) avec une tâche de flexion-extension des coudes dans le plan horizontal. Les mains déplacent des dispositifs coulissant sur l'axe antéropostérieur. Dans cette expérimentation les participants doivent coordonner les mouvements des bras droit et gauche de façon à faire correspondre le déplacement du triangle bleu au déplacement du rond rouge qui suit une forme de Lissajous invisible pour le participant. Les formes en pointillé représentent le mouvement requis en rouge (ici, une phase relative de 90°) et le mouvement produit en bleu. Elles ne sont pas disponibles pour le participant dans l'expérimentation de Wenderoth et al. (2002) mais peuvent être utilisées dans d'autres études (voir le tableau de présentation des différentes expérimentations).

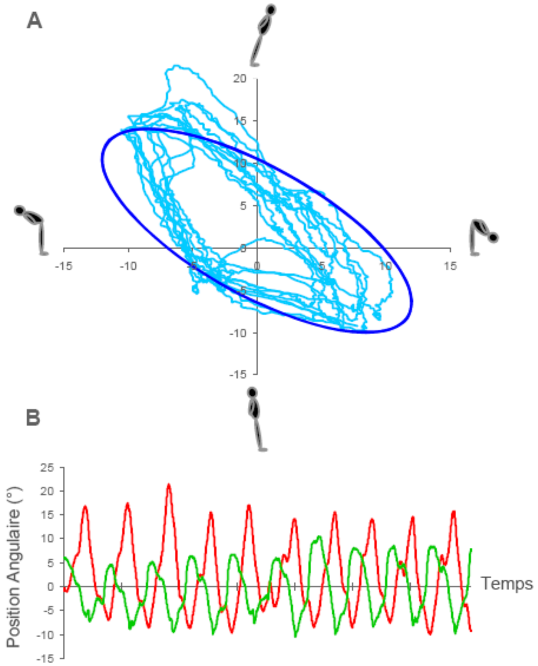


Transfer? Apprendre une relation temporelle et transférer à un ensemble





Faugloire, E., Bardy, B. G., & Stoffregen, T. A. (2009). (De) stabilization of required and spontaneous postural dynamics with learning. *Journal of Experimental Psychology: Human Perception and Performance*, *35*(1), 170.


A
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-5
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-15
-15
-10
-5
0
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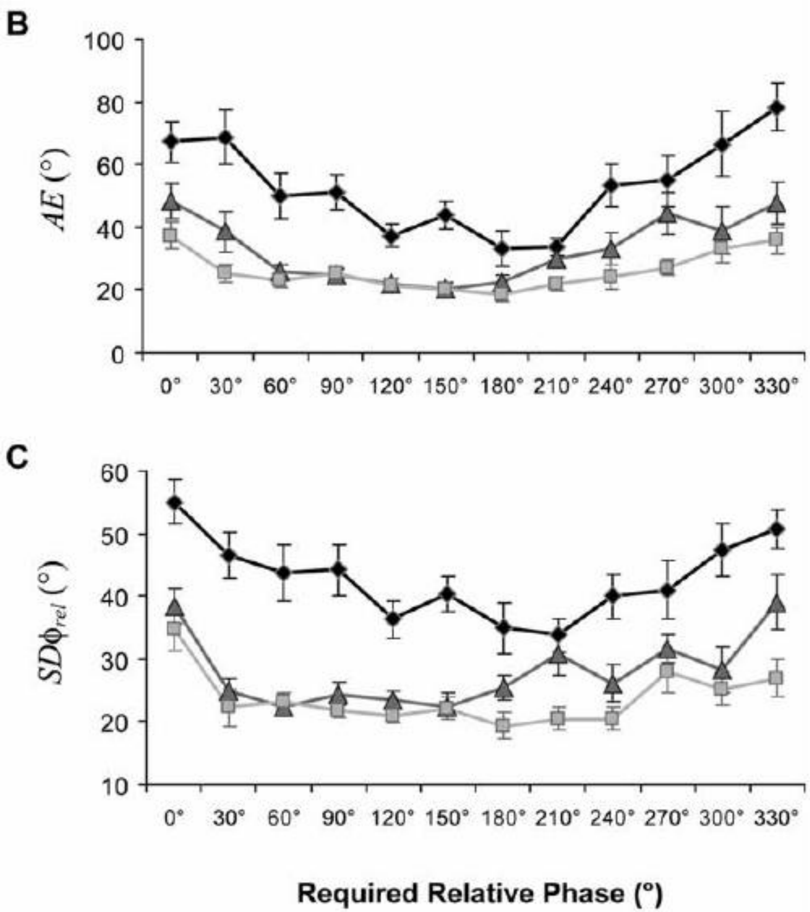
B
25
20
15
10
5
0
-5
-10
-15
Position Angulaire (°)
Temps


B
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AE (°)
0°
30°
60°
90°
120°
150°
180°
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270°
300°
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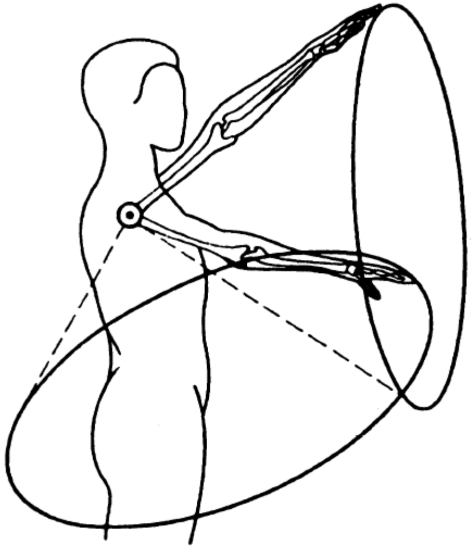
120°
150°
180°
210°
240°
270°
300°
330°
Required Relative Phase (°)

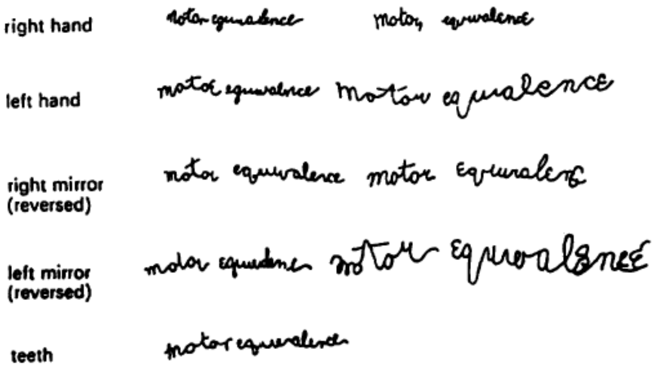
Motor equivalence

The mechanics of writing is a sequence of movements in relation to body position, not a set pattern of special groups of muscles”

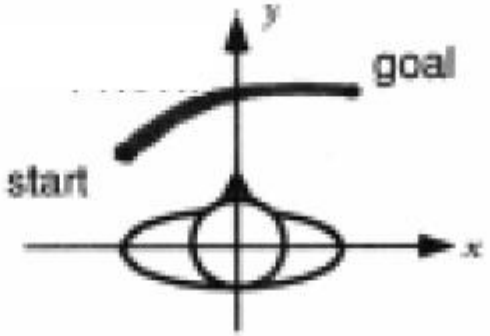
Lashley, 1942

Bernstein (1967)





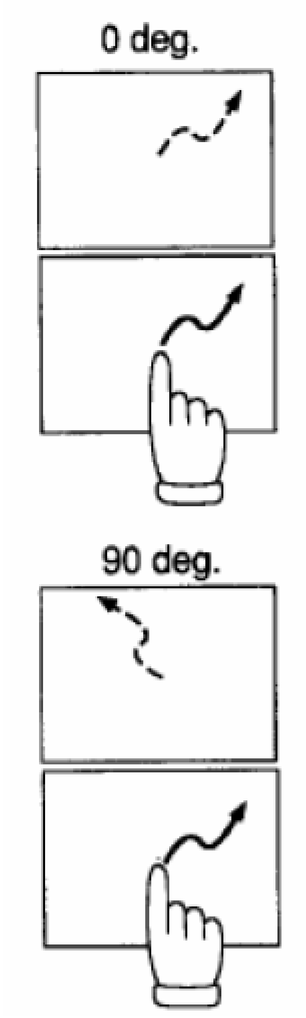
Niveau de la tâche

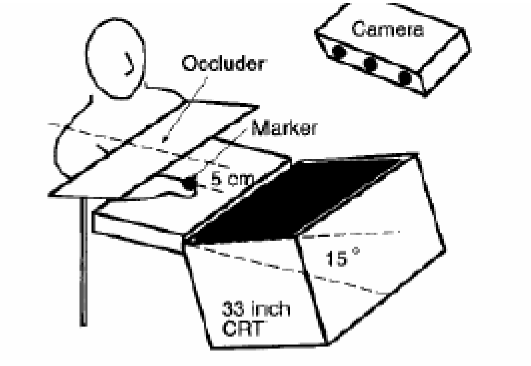


Niveau de l’effecteur

Transfert d'apprentissage intermanuel

Apprentissage visuo-moteur : rotation du feedback visuel





Imamizu & Shimojo (1995)

2 Prédictions :

1) l'apprentissage se situe au
niveau de l'espace de la tâche :
<u>Transfert intermanuel</u>

2) L'apprentissage se situe au
niveau articulaire
<u>Pas de transfert intermanuel</u>

Resultats : 100% de transfert intermanuel