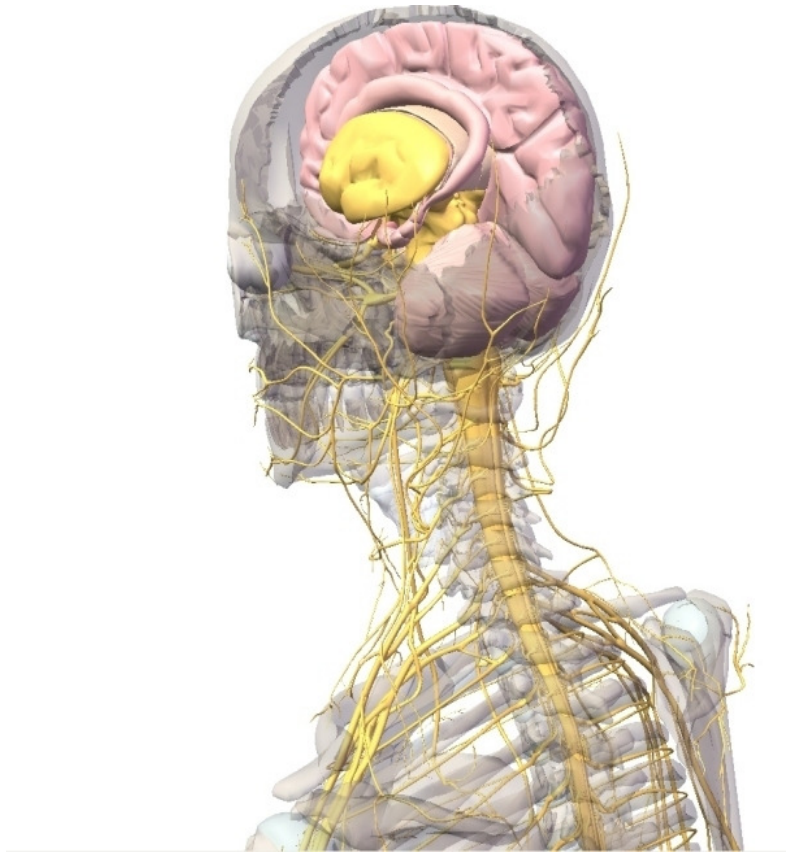
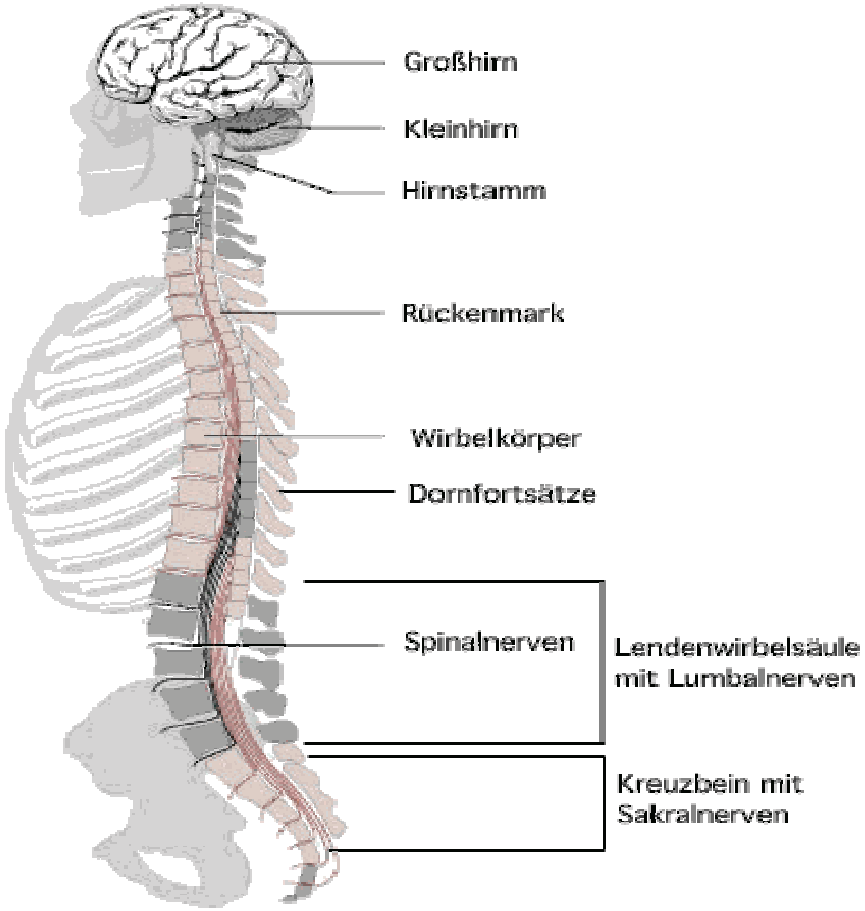
Fatigue et régénération de la motricité fine

DR. BENEDIKT LAUBER, MACOLIN, 25.10.2017

- Aperçu système nerveux
- Fatigue
- Impact de la fatigue sur la performance
- Entraînement de la motricité fine

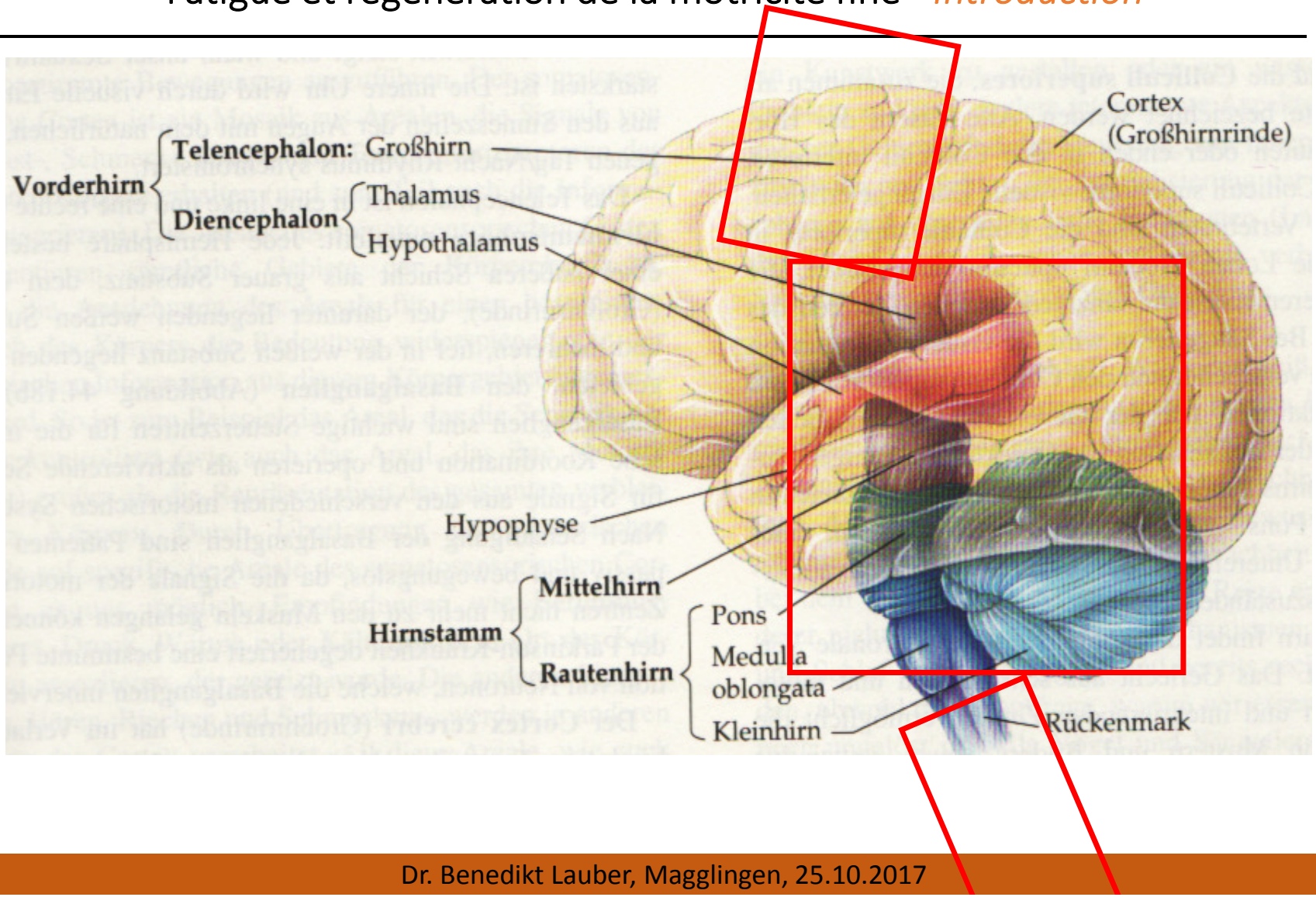
Fatigue et régénération de la motricité fine - *Introduction*





www.medizin-netz.de

Fatigue et régénération de la motricité fine - *Introduction*



Fatigue et régénération de la motricité fine - *Introduction*

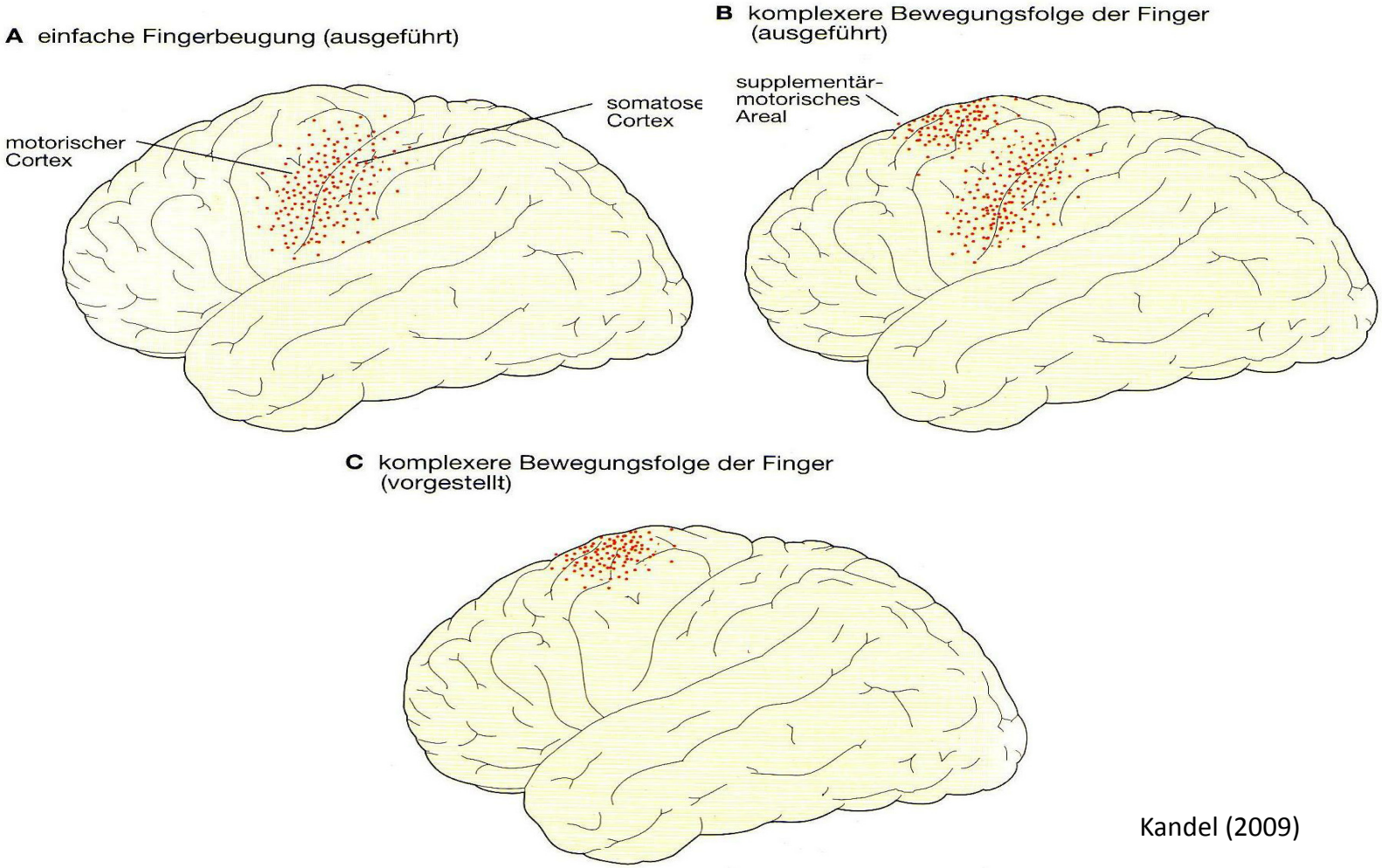
„Drei Klassen von Bewegungen“ (vereinfacht)

1. Mouvement volontaires

2. Mouvements cycliques

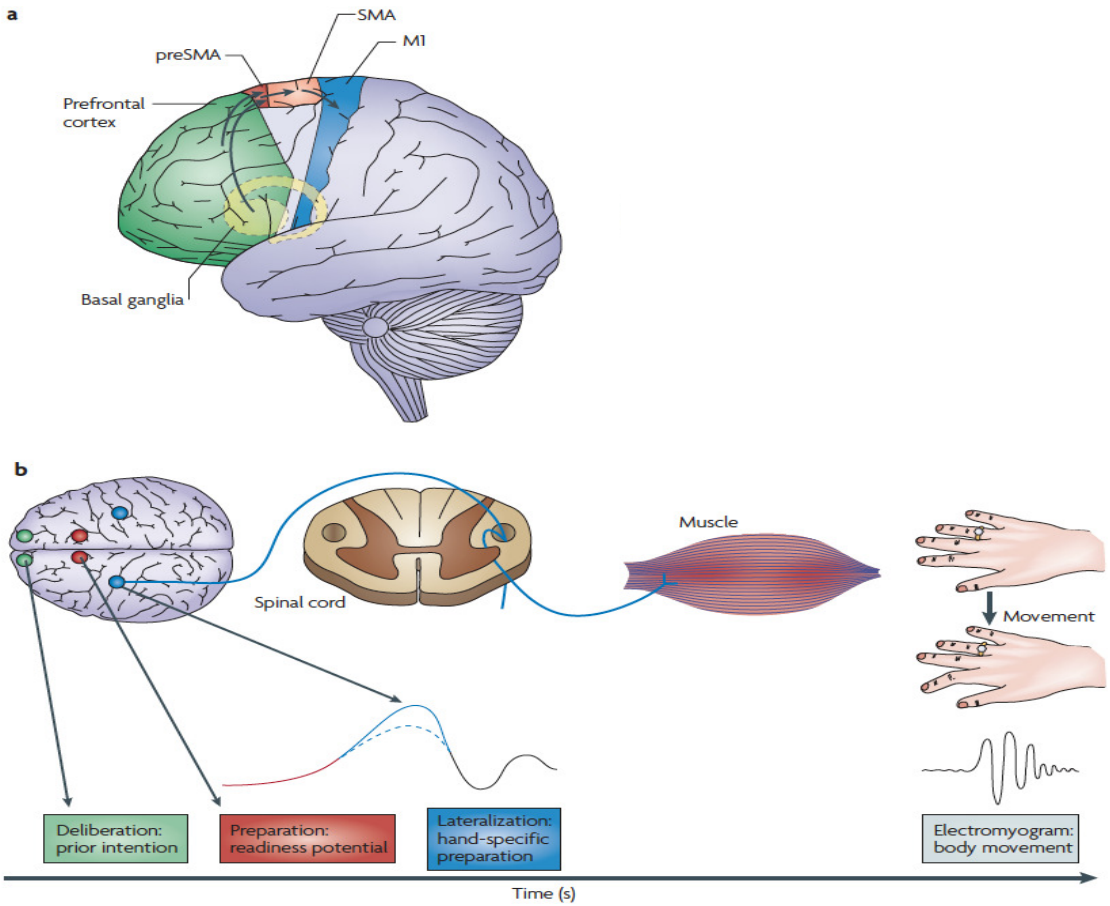
3. Mouvements réfléchissants

Fatigue et régénération de la motricité fine - *Introduction*



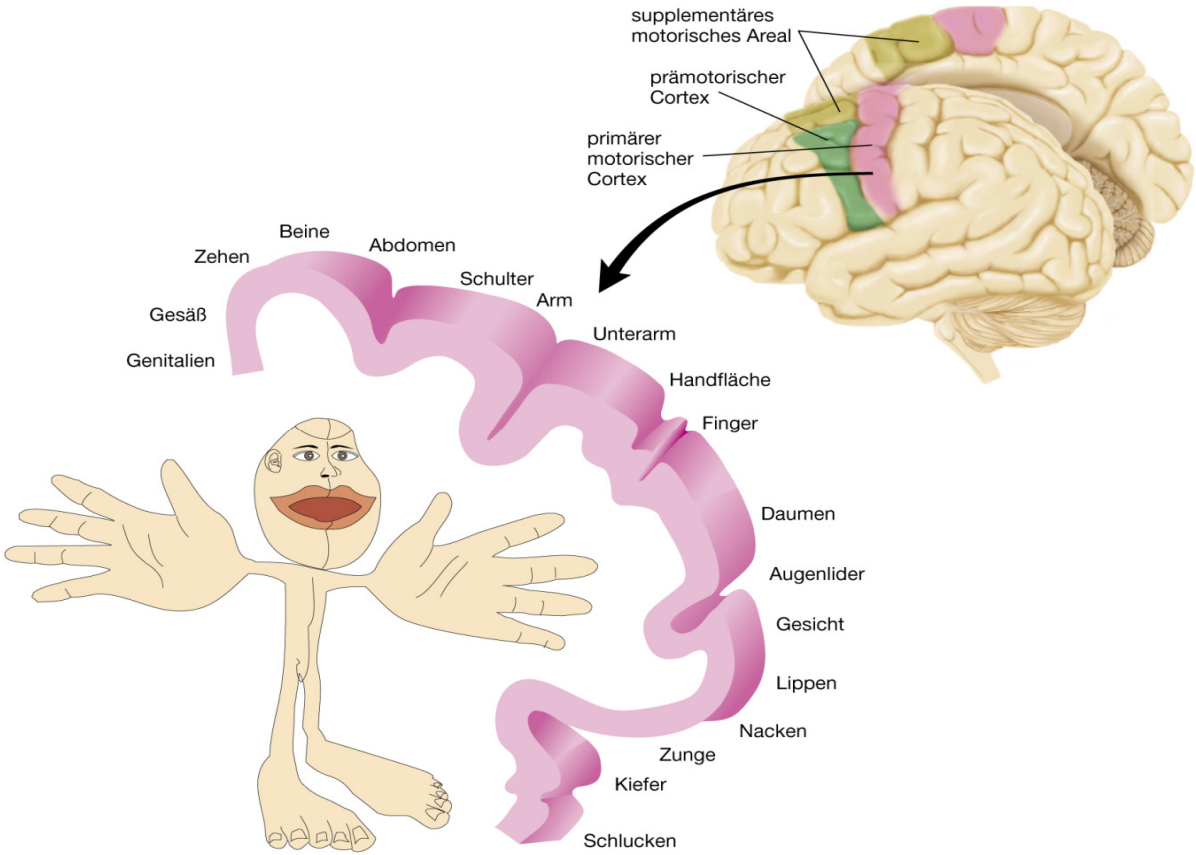
Kandel (2009)

Fatigue et régénération de la motricité fine - *Introduction*



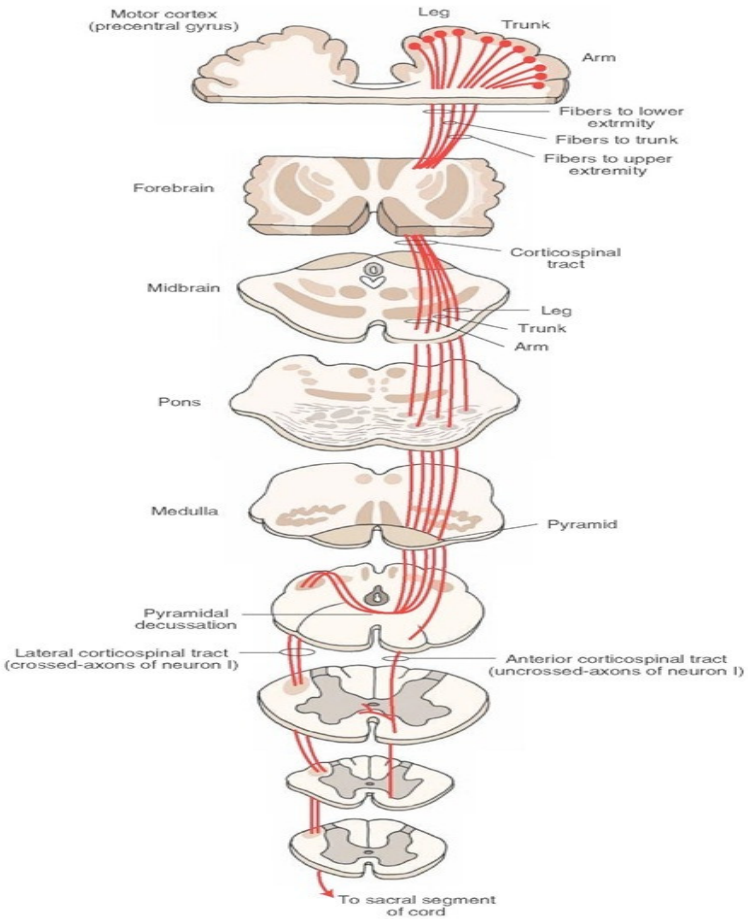
Haggard 2008

Fatigue et régénération de la motricité fine - *Introduction*



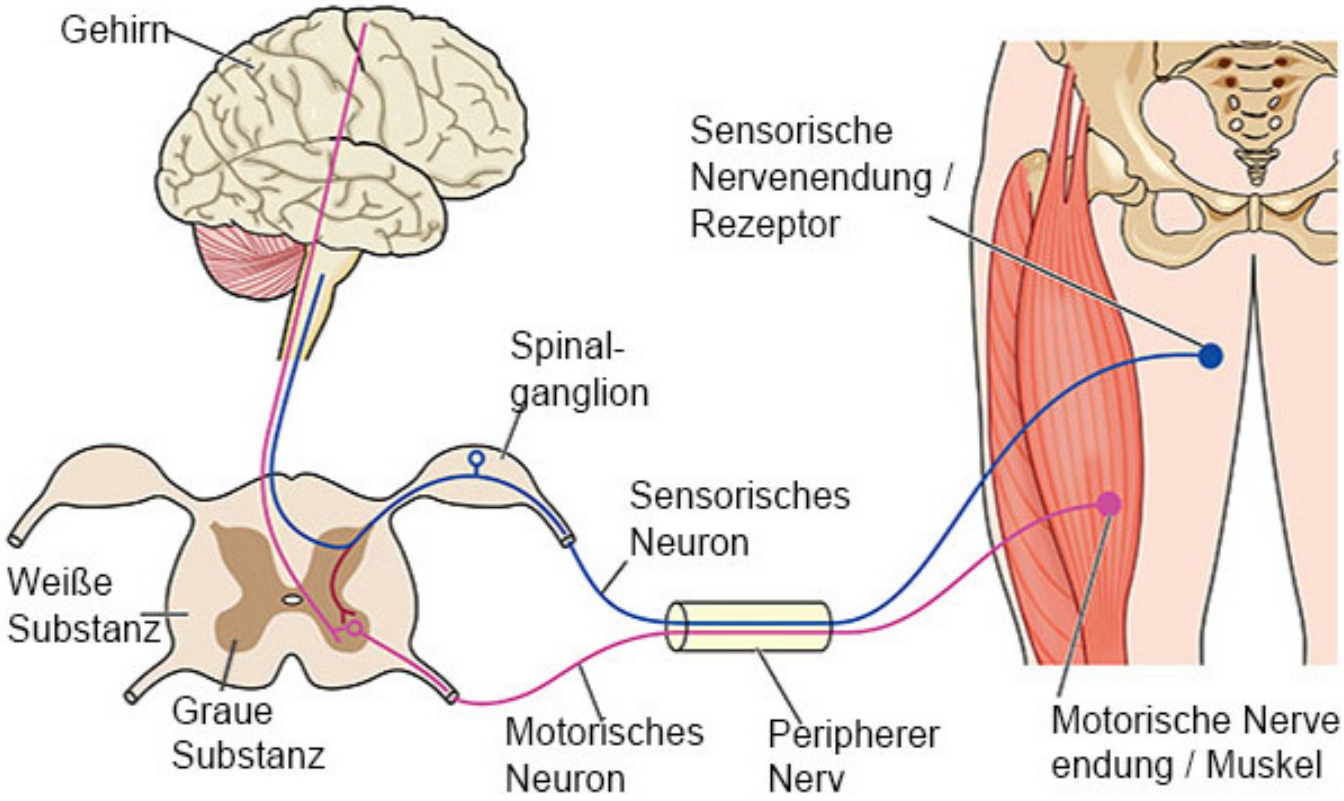
© Pearson Studium 2004

Fatigue et régénération de la motricité fine - *Introduction*



www.what-when-how.com

Fatigue et régénération de la motricité fine - *Introduction*



Fatigue et régénération de la motricité fine - *Fatigue*

Fatigue and Exercise

Fatigue and Exercise

'Intensive activity of muscles causes a decline in performance, known as fatigue. . .' (Allen&Westerblad, 2001).

'Performing a motor task for long periods of time induces motor fatigue, which is generally defined as a decline in a person's ability to exert force.' (Loriste*t al. 2002).*

'. . .CNS administration of caffeine increased treadmill run time to fatigue. . .' (Davis *et al. 2003).*

'. . .a fatiguing task was performed with the muscles of the left hand until the muscles were exhausted.' (Edgley &Winter, 2004).

'Fatigue is known to be reflected in the EMGsignal as an increase of its amplitude and a decrease of its characteristic spectral frequencies.' (Kallenberg *et al. 2007).*

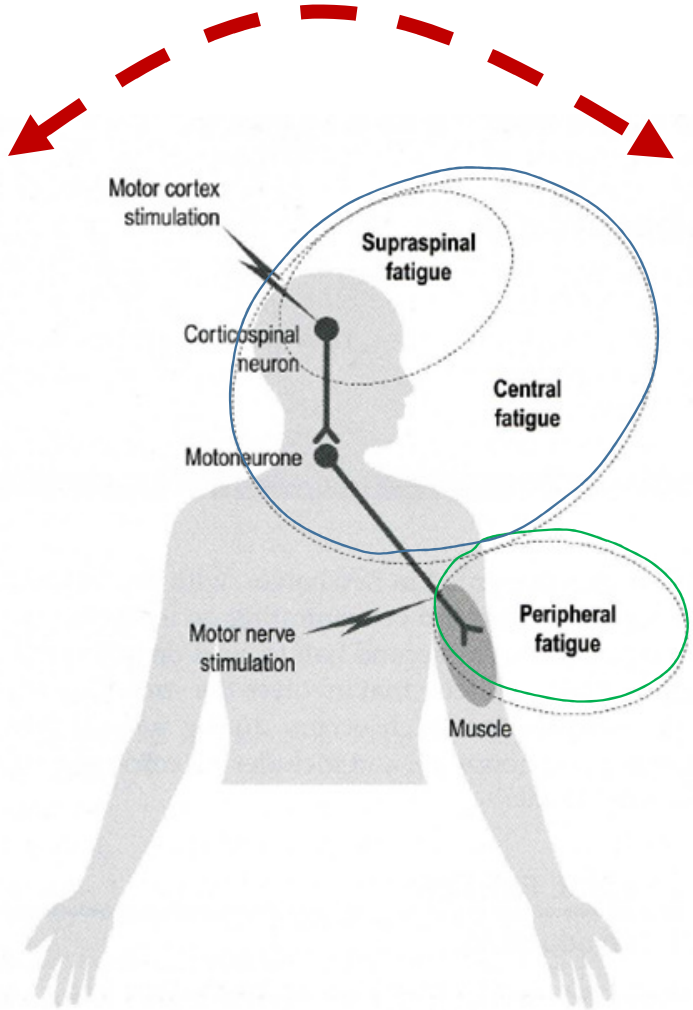
'. . .the sensation of fatigue is the conscious awareness of changes in subconscious homeostatic control systems. . .' (St Clair Gibson *et al. 2003).*

'The primary purpose of the study was to use functional magnetic resonance imaging (fMRI) to determine the association between feelings of mental fatigue and blood oxygen level dependent (BOLD) brain responses during a mentally fatiguing cognitive task.' (Cook *et al. 2007).*

From: Enoka&Duchateau 2008

Peripheral

refers to events occurring at or distal to the neuromuscular junction (Taylor 2008)

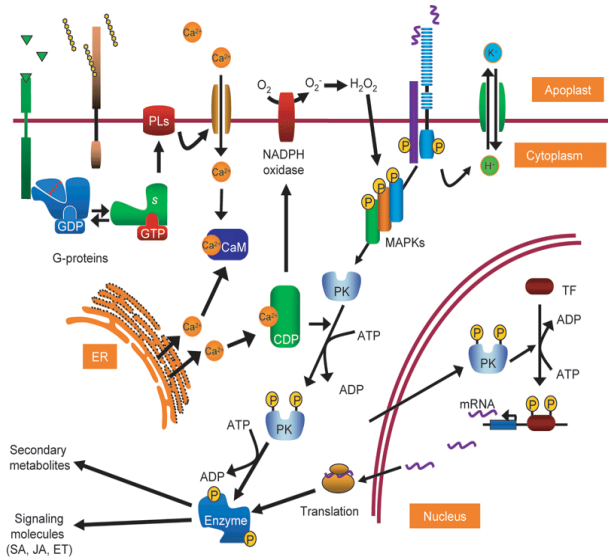


Central

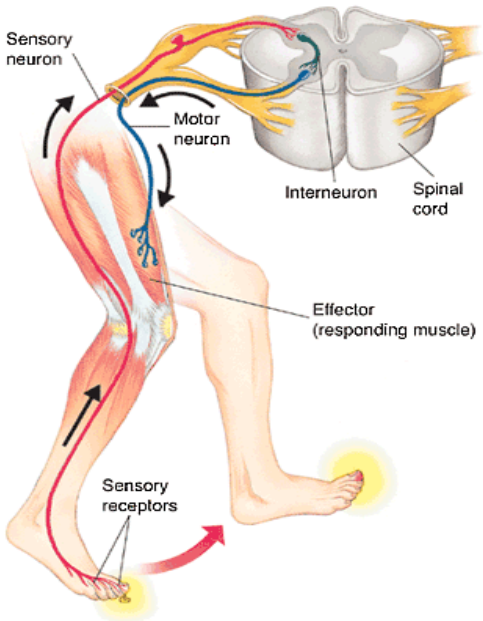
involves events occurring in the brain and spinal cord (Kirkendall 1990)

Fatigue and Exercise

Accumulation of metabolites



Inadequate motor commands



Fatigue et régénération de la motricité fine - *Fatigue*

Central Fatigue:

- Spinal Fatigue:
- Supraspinal Fatigue:

Def:
…progressive reduction in voluntary activation of muscle during exercise….
(Gandevia 2001)

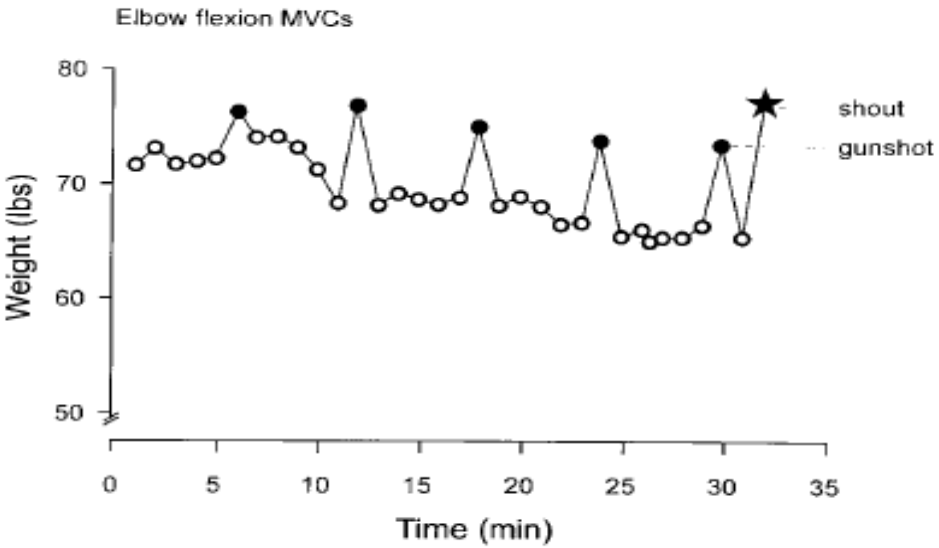
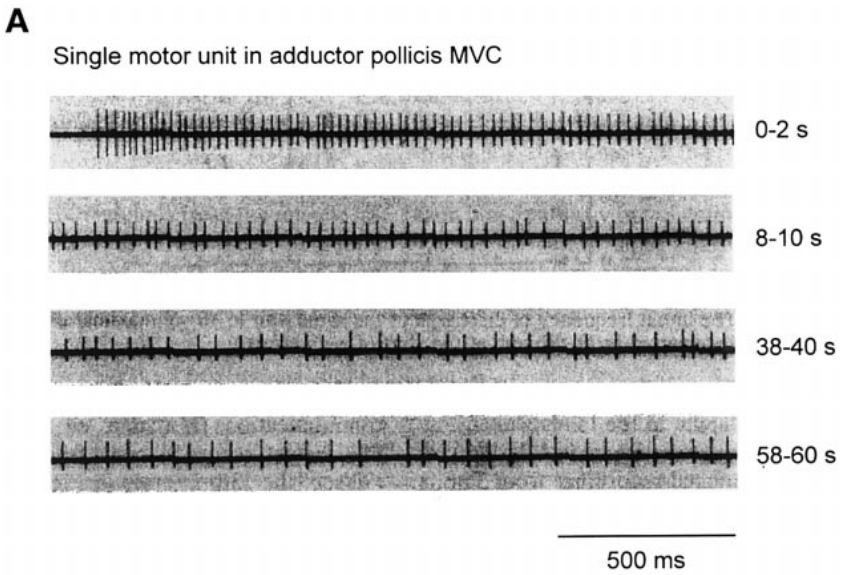
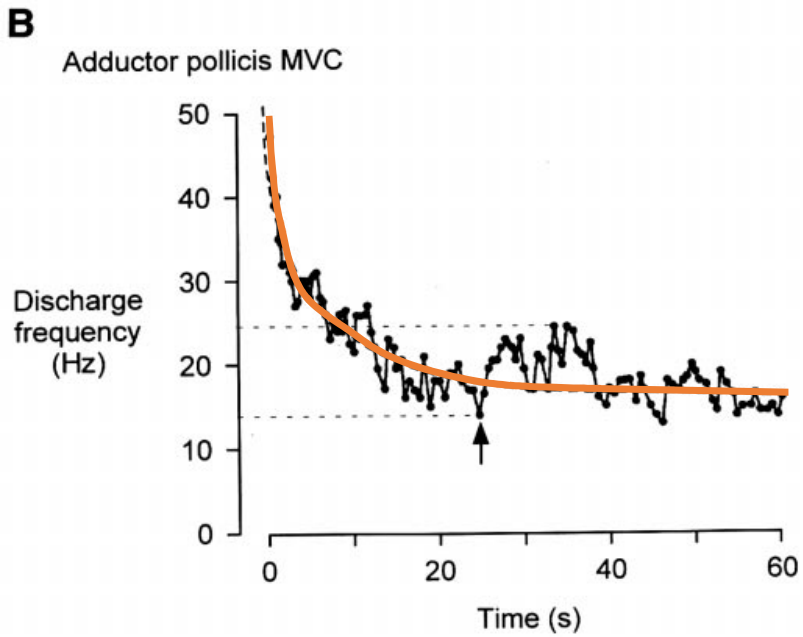


FIG. 2. Classical study of factors affecting maximal voluntary strength. Mean value for brief MVCs of elbow flexors made at 1-min intervals by 10 subjects. Control contractions (open circles), contractions preceded by an unexpected gunshot (solid circles), and a final contraction (star) in which the subject shouted are shown. [Redrawn from Ikai and Steinhaus (354).]

Signs of Central Fatigue: decline in MN discharge frequency



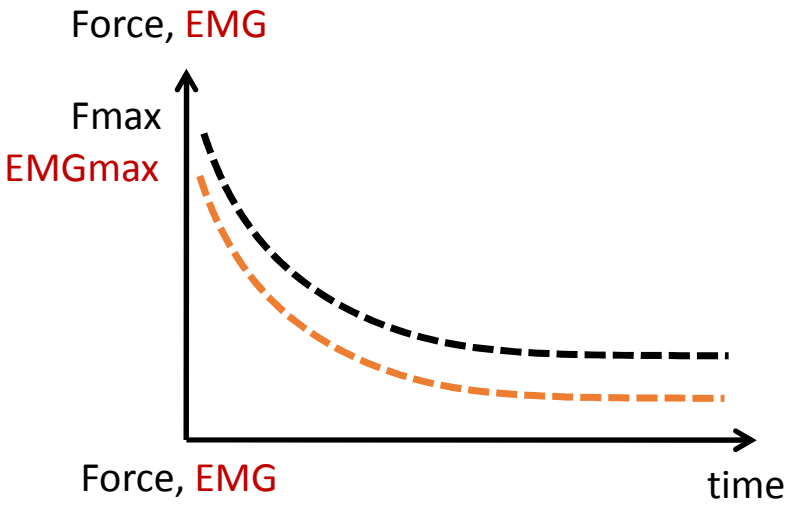
Gandevia 2001



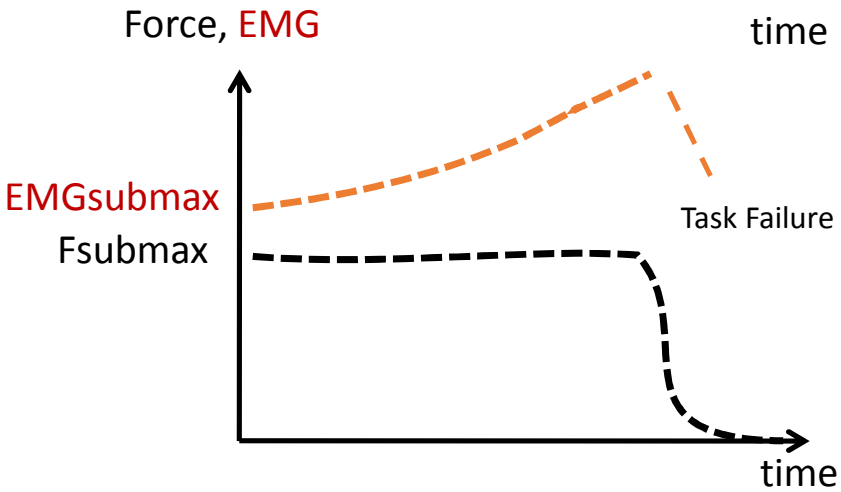
Gandevia 2001

Signs of Central Fatigue

Max. Effort

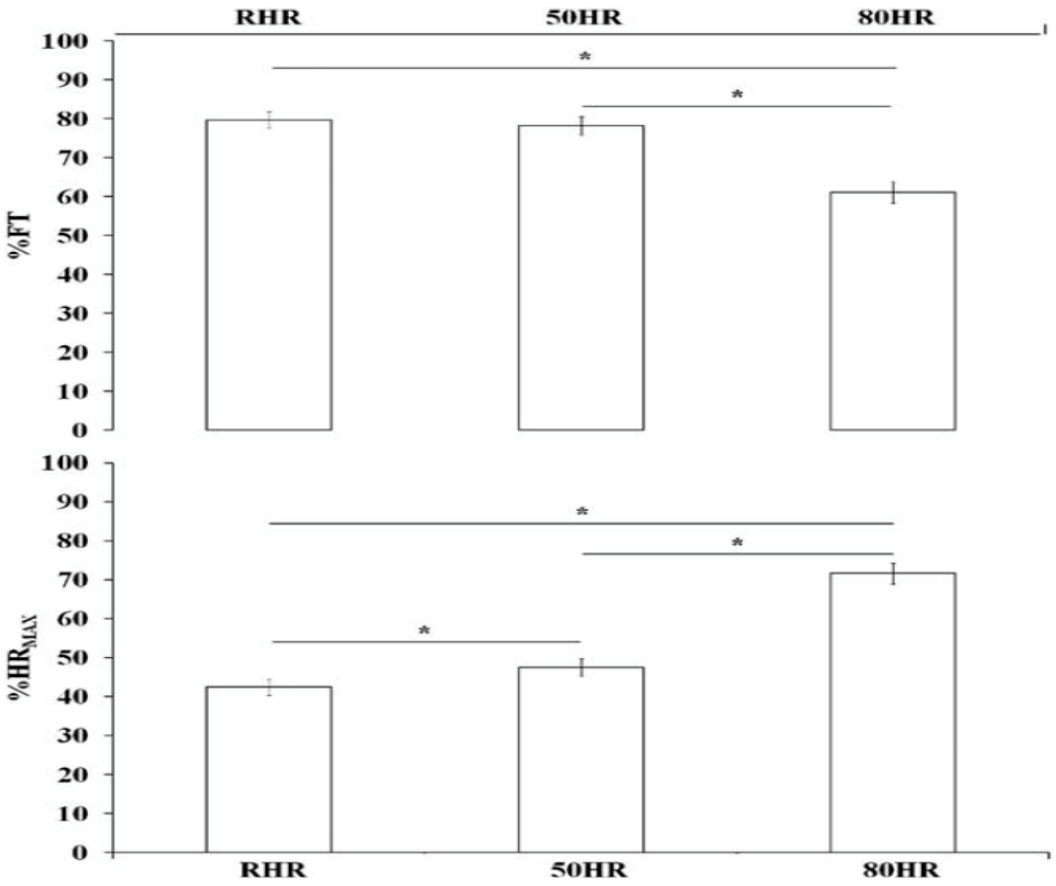


submax. Effort



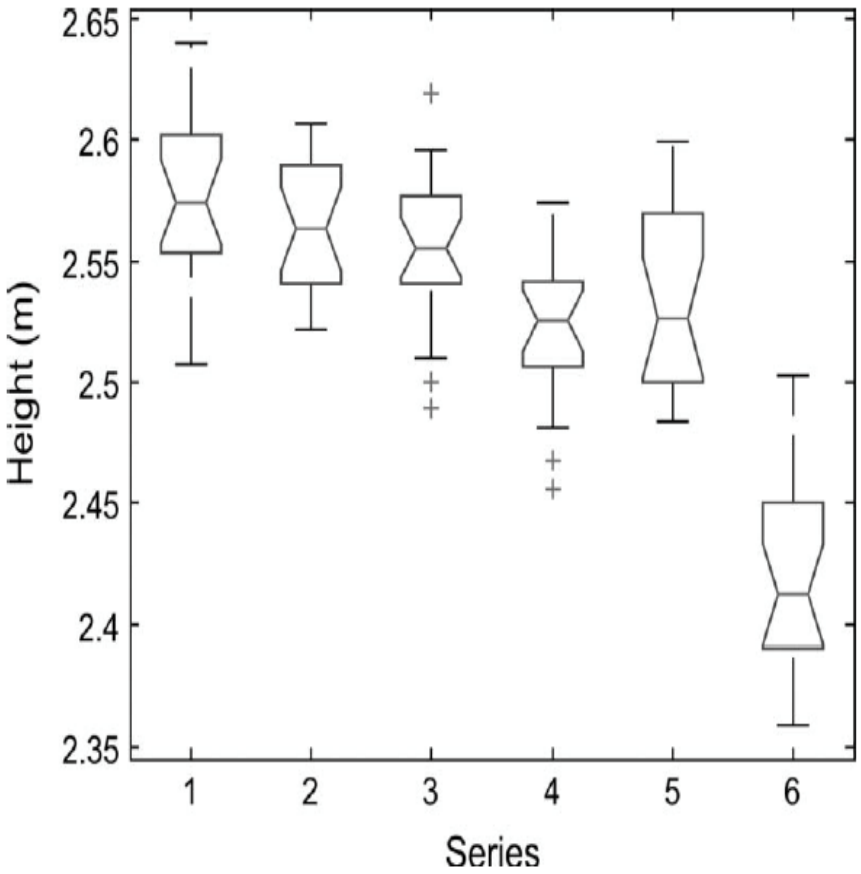
Fatigue et régénération de la motricité fine – *Disciplines sportives*

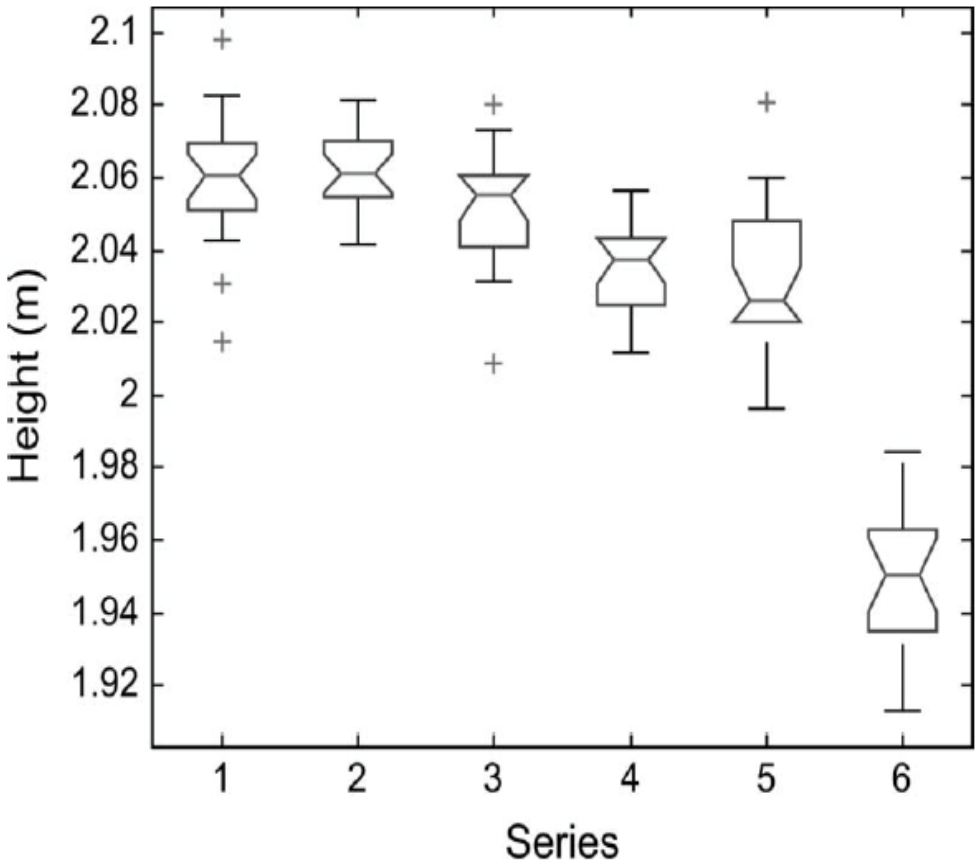
Fatigue et régénération de la motricité fine – *Basketball*



Padulo et al. 2014

Fatigue et régénération de la motricité fine – *Basketball*





Erculj et al. 2009

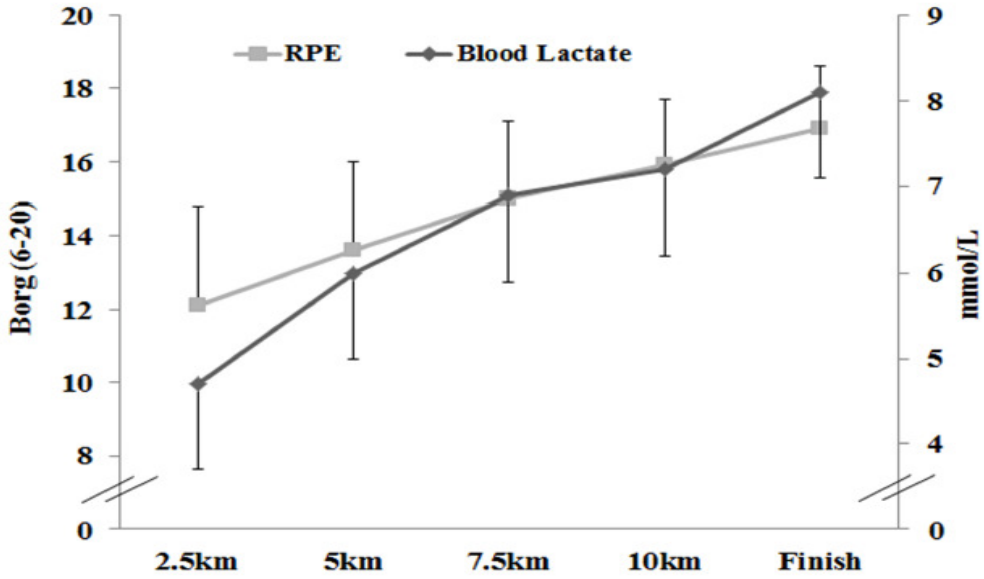
Fatigue et régénération de la motricité fine – *Biathlon*

International Journal of Sports Physiology and Performance, 2017, 12, 377-384
http://dx.doi.org/10.1123/ijspp.2016-0195
© 2017 Human Kinetics, Inc.

Human Kinetics
ORIGINAL INVESTIGATION

Factors Discriminating High From Low Score Performance in Biathlon Shooting

Gerold Sattlecker, Michael Buchecker, Christoph Gressenbauer, Erich Müller, and Stefan J. Lindinger



Sattlecker et al. 2017

Fatigue et régénération de la motricité fine – *Biathlon*

	Descriptive Statistics		LDA		
	High score	**Low score**	***R***	***P***	***F***
Rest shooting					
trigger coefficient (a.u.)	0.53 ± 0.26	0.51 ± 0.25	.00	.997	0.00
shoulder_mean (N)	67.03 ± 22.58	39.48 ± 20.95	.71	.014*	7.35
shoulder_SD (N)	0.10 ± 0.04	0.09 ± 0.06	.08	.787	0.08
rifle_SD_X (mm)	0.39 ± 0.26	0.61 ± 0.34	–.41	.133	2.46
rifle_SD_Y (mm)	0.40 ± 0.24	0.39 ± 0.12	.00	.991	0.00
rifle_MV (mm/s)	7.98 ± 4.63	8.41 ± 2.24	–.07	.787	0.08
score (rings)	9.27 ± 0.17	8.81 ± 0.21			
Load shooting					
trigger coefficient (a.u.)	0.49 ± 0.23	0.54 ± 0.26	.06	.848	0.04
shoulder_mean (N)	64.23 ± 21.86	61.39 ± 26.24	–.12	.720	0.13
shoulder_SD (N)	0.16 ± 0.08	0.16 ± 0.06	–.10	.768	0.09
rifle_SD_X (mm)	0.60 ± 0.21	0.75 ± 0.29	.49	.159	2.15
rifle_SD_Y (mm)	0.54 ± 0.13	0.73 ± 0.21	.82	.024*	6.06
rifle_MV (mm/s)	12.56 ± 3.11	16.42 ± 5.66	.63	.072	3.63
score (rings)	8.93 ± 0.25	8.08 ± 0.24			

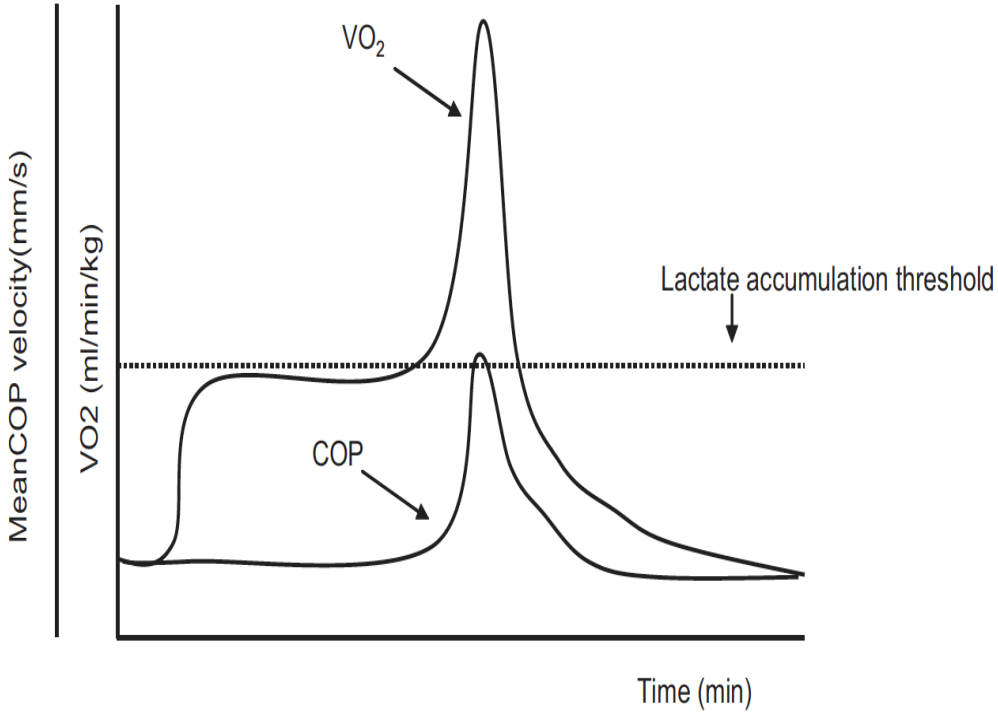
Sattlecker et al. 2017

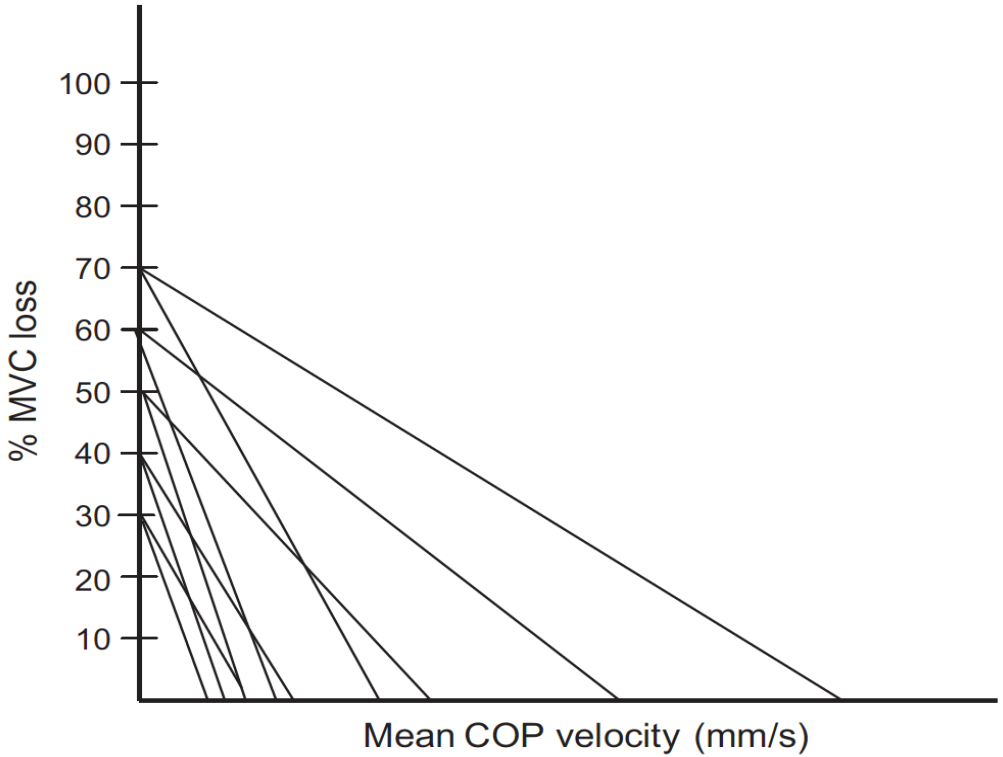
Fatigue et régénération de la motricité fine – *Biathlon*

	Descriptive Statistics		LDA		
	High score	**Low score**	***R***	***P***	***F***
Rest shooting					
trigger coefficient (a.u.)	0.68 ± 0.45	0.84 ± 0.46	.18	.418	0.69
shoulder_mean (N)	18.77 ± 9.34	26.13 ± 23.72	.21	.350	0.92
shoulder_SD (N)	0.08 ± 0.03	0.13 ± 0.08	.43	.060	3.97
rifle_SD_X (mm)	1.32 ± 0.40	1.66 ± 0.37	.41	.069	3.70
rifle_SD_Y (mm)	1.34 ± 0.35	1.51 ± 0.59	.18	.422	0.67
rifle_MV (mm/s)	17.51 ± 3.80	22.20 ± 6.26	.46	.046*	4.52
COP_SD_X (mm)	0.26 ± 0.11	0.38 ± 0.15	.46	.048*	4.45
COP_SD_Y (mm)	0.44 ± 0.10	0.64 ± 0.22	.61	.010**	7.99
COP_MV (mm/s)	5.40 ± 0.96	7.90 ± 2.43	.69	.005**	10.12
score (rings)	7.23 ± 0.41	5.84 ± 0.75			
Load shooting					
trigger coefficient (a.u.)	1.10 ± 1.30	1.04 ± 0.76	–.03	.910	0.01
shoulder_mean (N)	24.74 ± 15.33	20.82 ± 17.36	–.14	.580	0.32
shoulder_SD (N)	0.15 ± 0.07	0.12 ± 0.07	–.18	.463	0.56
rifle_SD_X (mm)	2.17 ± 0.57	2.31 ± 0.51	–.14	.586	0.31
rifle_SD_Y (mm)	2.05 ± 0.29	2.70 ± 1.75	.30	.234	1.51
rifle_MV (mm/s)	28.52 ± 4.11	34.40 ± 12.00	.38	.140	2.36
COP_SD_X (mm)	0.51 ± 0.14	0.64 ± 0.19	.47	.069	3.71
COP_SD_Y (mm)	0.76 ± 0.24	0.70 ± 0.25	–.15	.550	0.37
COP_MV (mm/s)	11.85 ± 2.44	12.76 ± 2.89	.20	.436	0.63
score (rings)	6.20 ± 0.65	4.40 ± 0.72			

Sattlecker et al. 2017

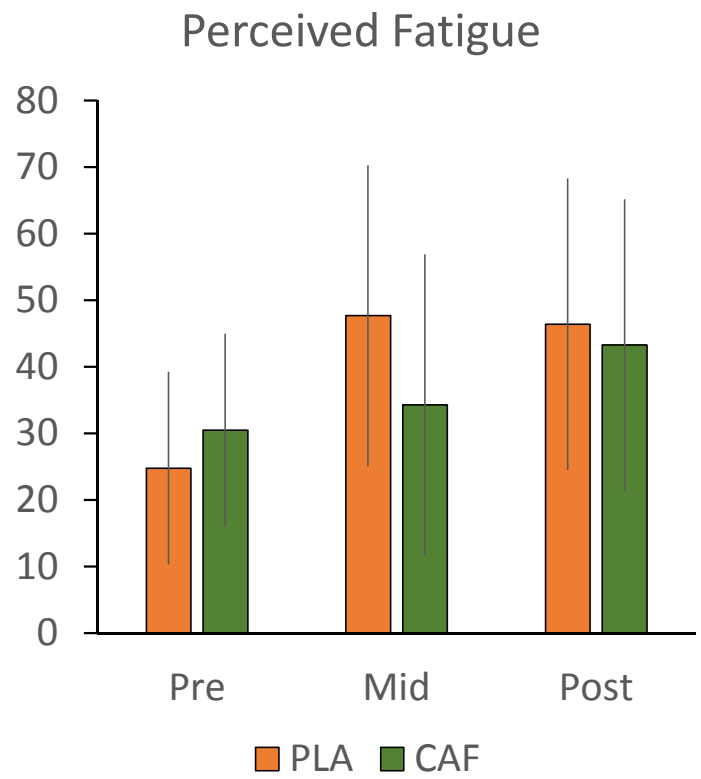
Fatigue et régénération de la motricité fine – *Introduction*

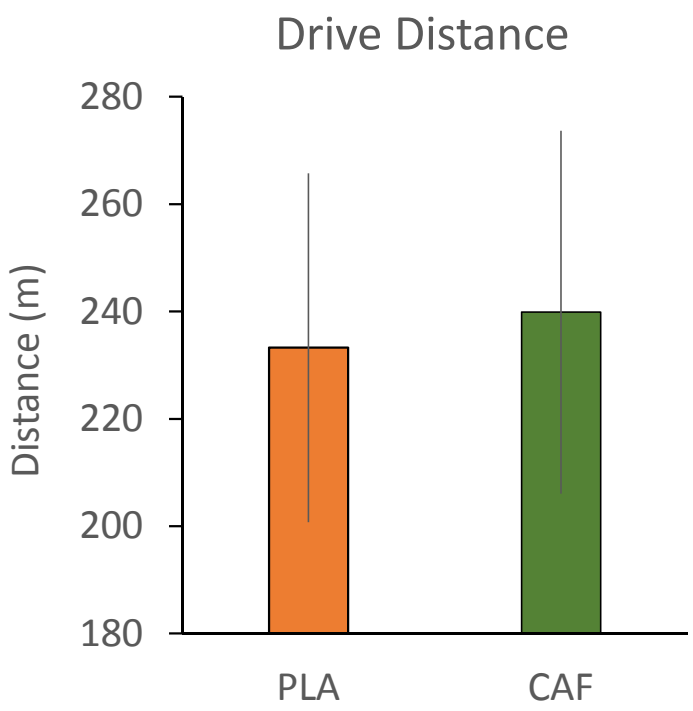


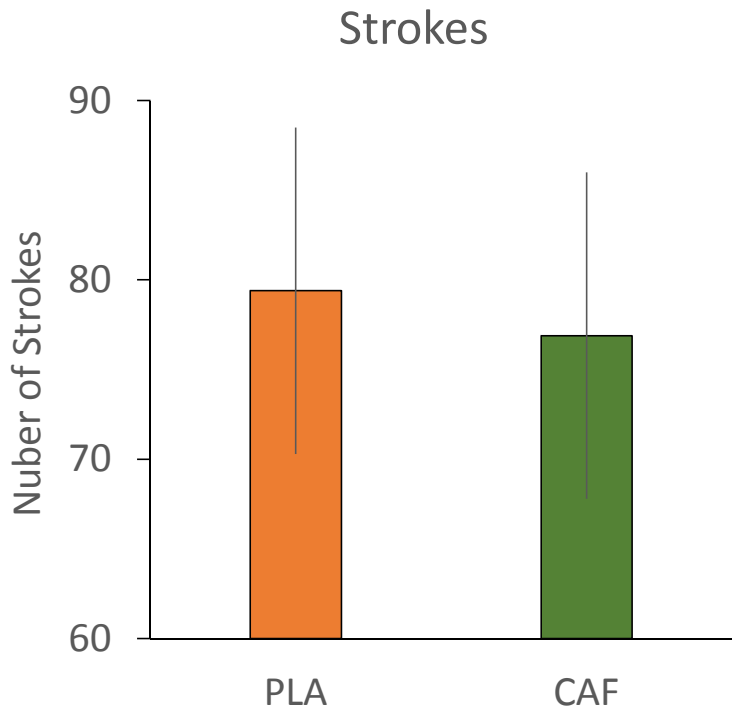


Pillard et al. 2012

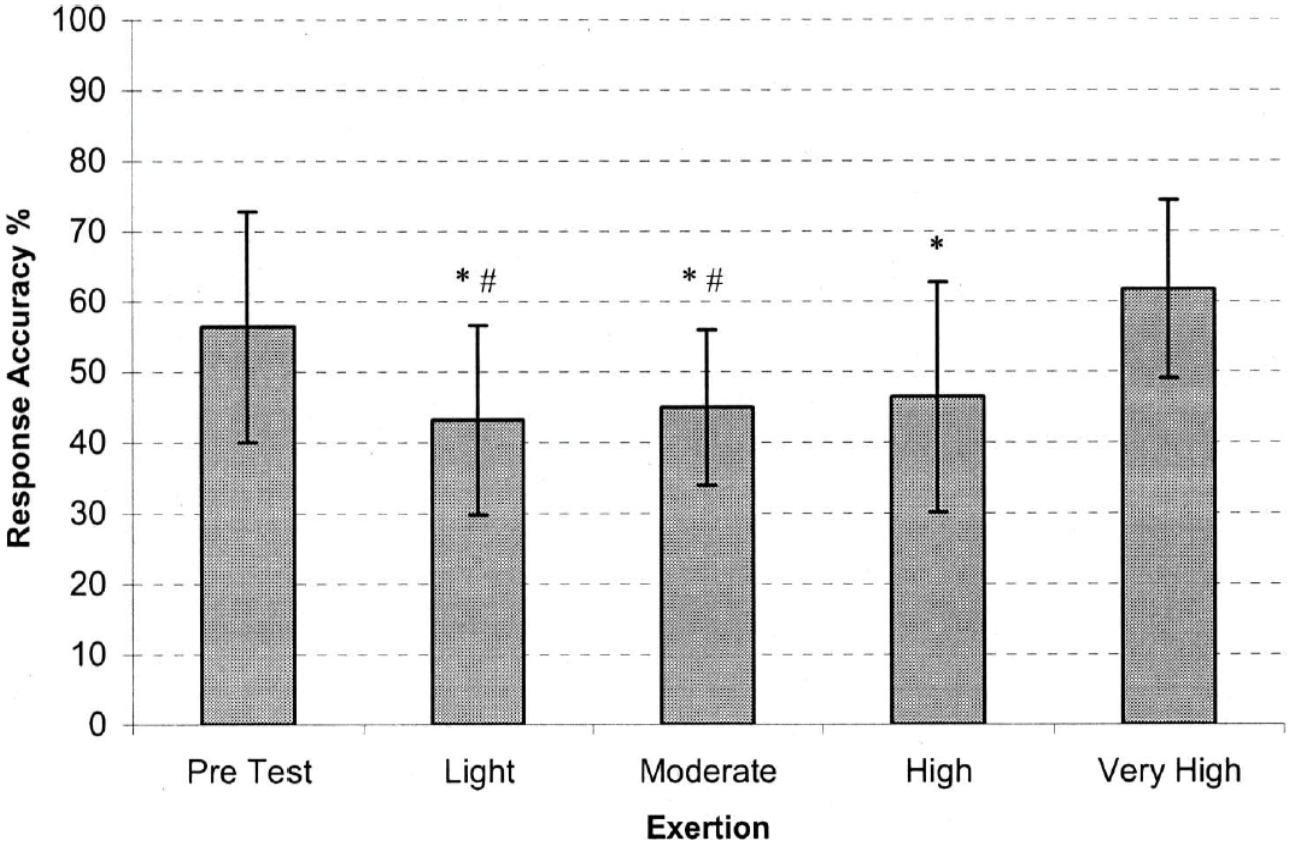
Fatigue et régénération de la motricité fine – *Golf*





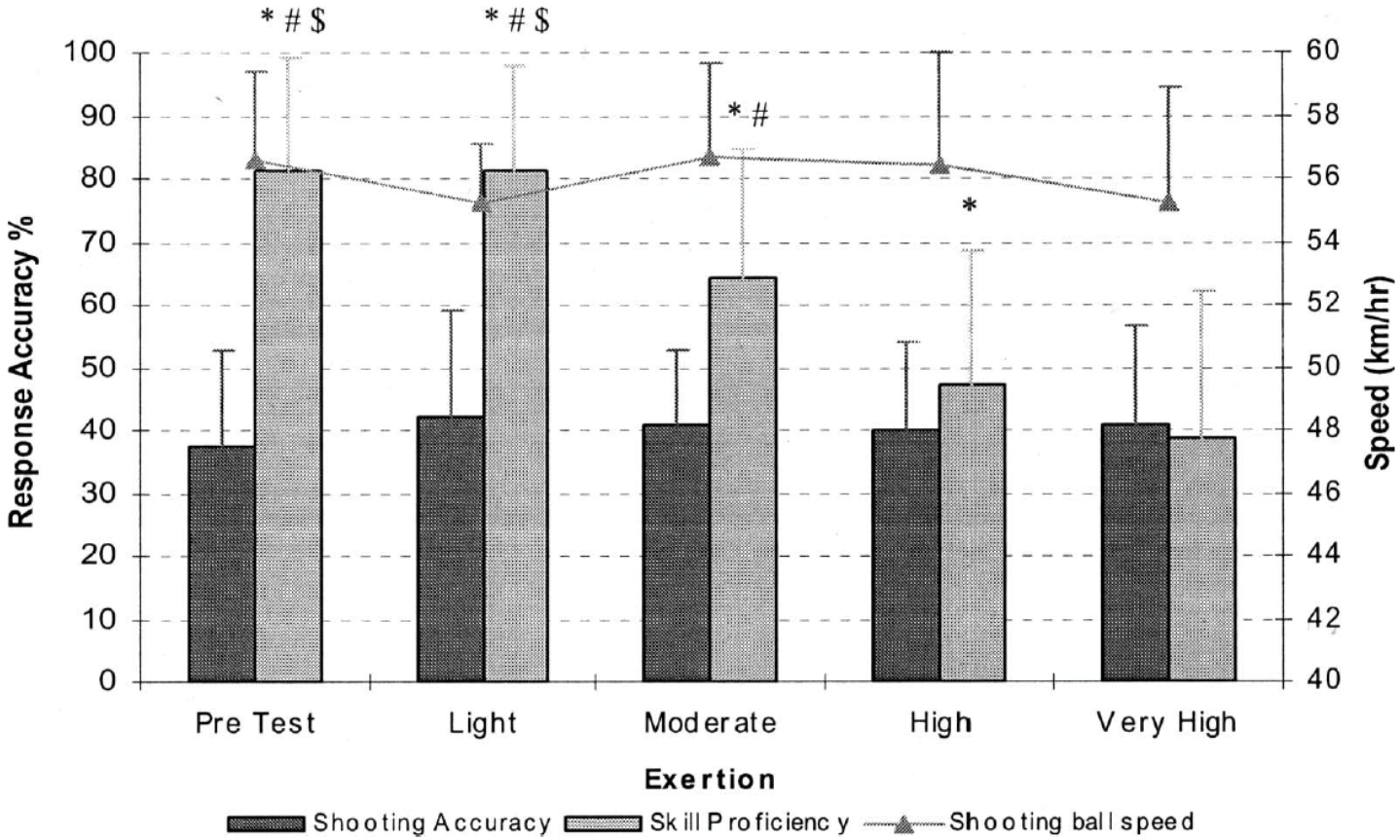


Fatigue et régénération de la motricité fine – *Water polo*



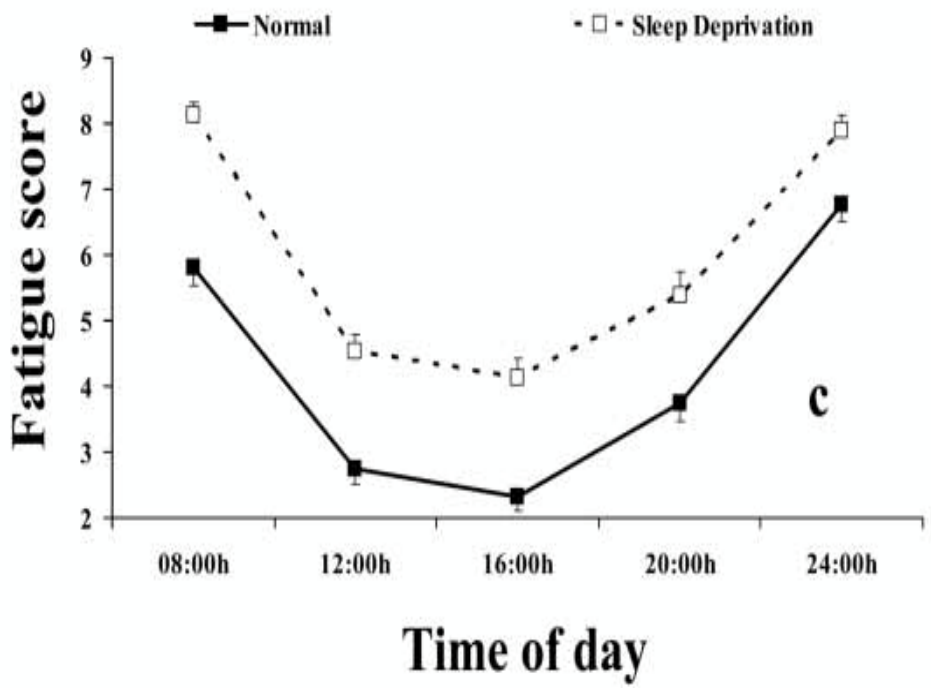
Farrow et al. 2006

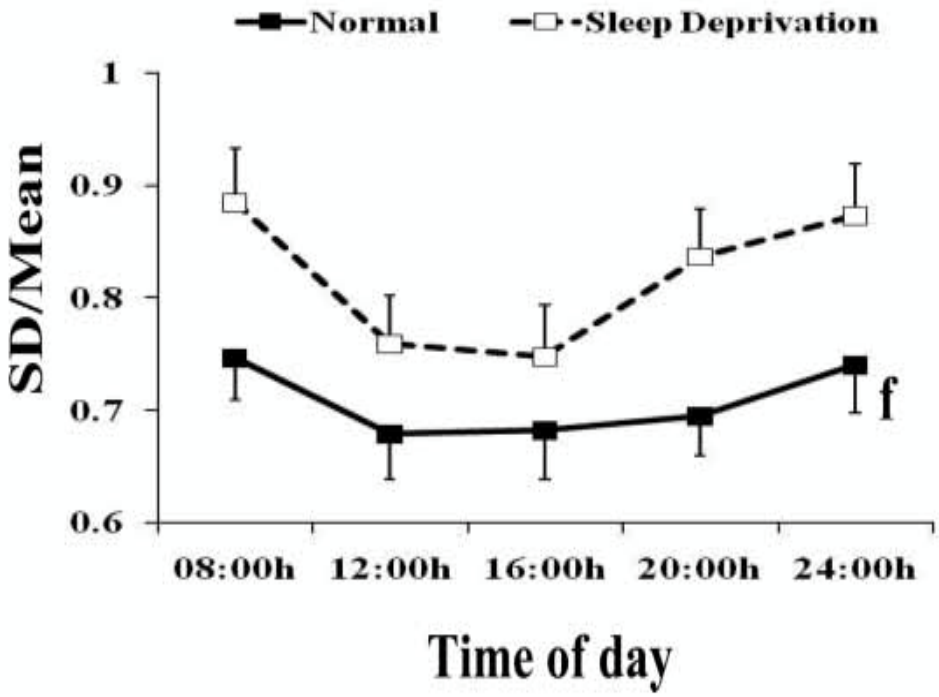
Fatigue et régénération de la motricité fine – *Water polo*



Farrow et al. 2006

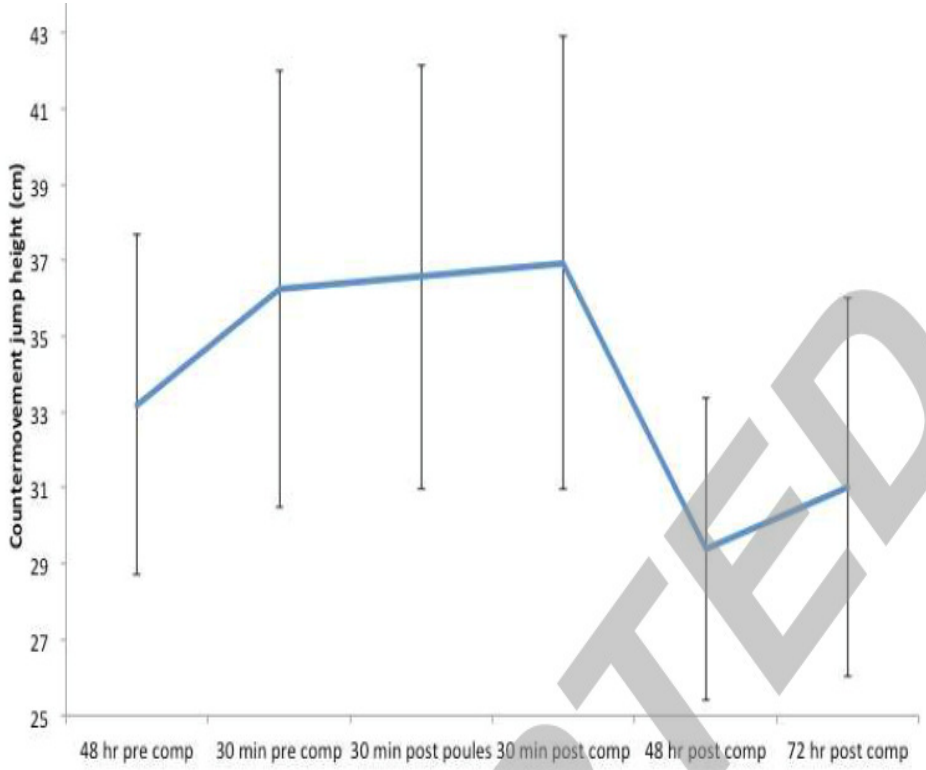
Fatigue et régénération de la motricité fine – *Jeu de fléchettes*

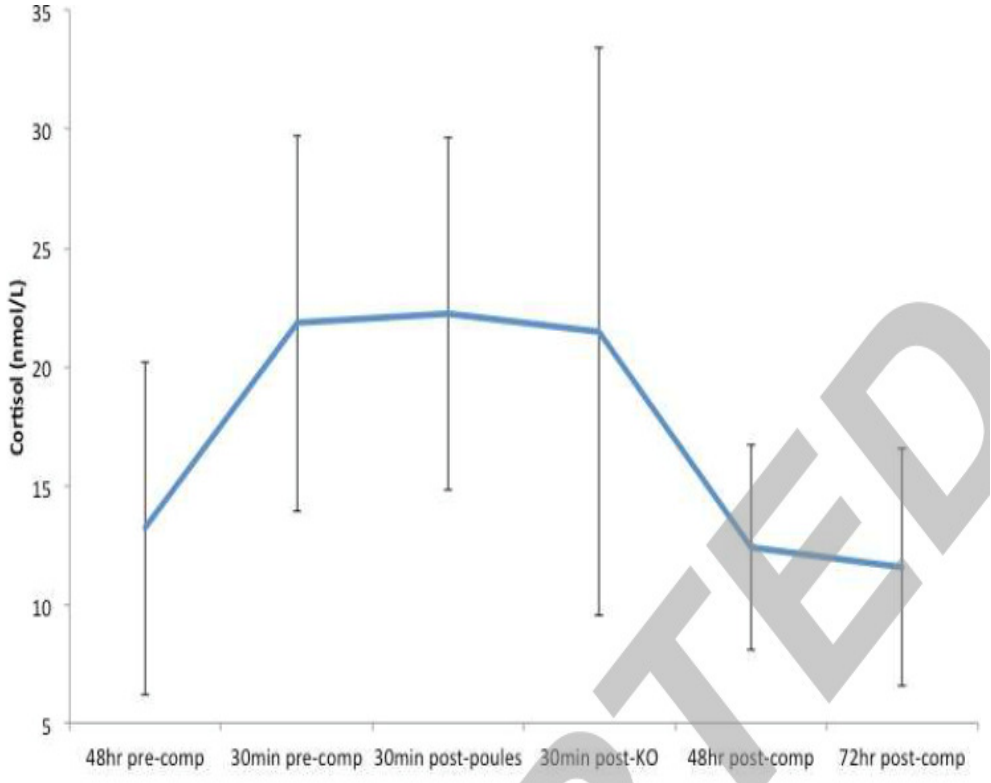




Edwards et al. 2006

Fatigue et régénération de la motricité fine – *Escrime*

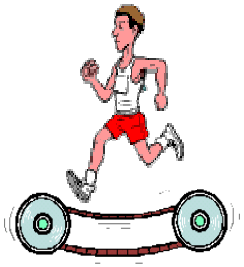




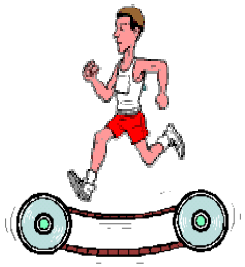
Tuner et al. 2017

Fatigue et régénération de la motricité fine – *Apprendre*

- Timing
- Intensité
- Type de charge

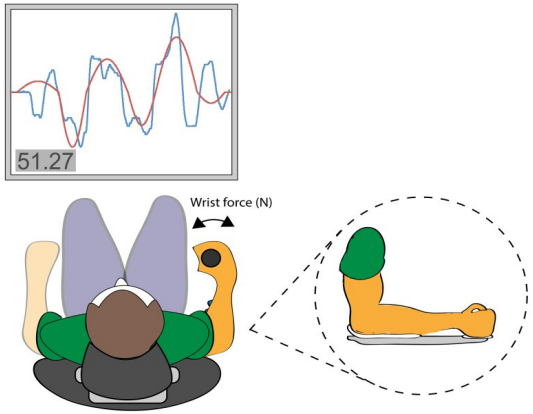


Stimulus d'apprentissage → **Mémoire à court terme** → **Consolidation** → **Mémoire à long terme**



- Influence du stress physique *aigu*
- Lien temporel *direct*

Fatigue et régénération de la motricité fine – *Timing*



+

PRE-EXAMINATION
Graded exercise protocol (VO_2 peak and blood lactate)

MAIN EXPERIMENT

AT baseline
(1x10 trials)

Randomization
Groups matched by age and fitness level (VO_2 peak)

CON	PRE	POST
20 min relaxed in bed	20 min of intense cycling	3x5 min of practice AT
3x5 min of practice AT	3x5 min of practice AT	20 min of intense cycling

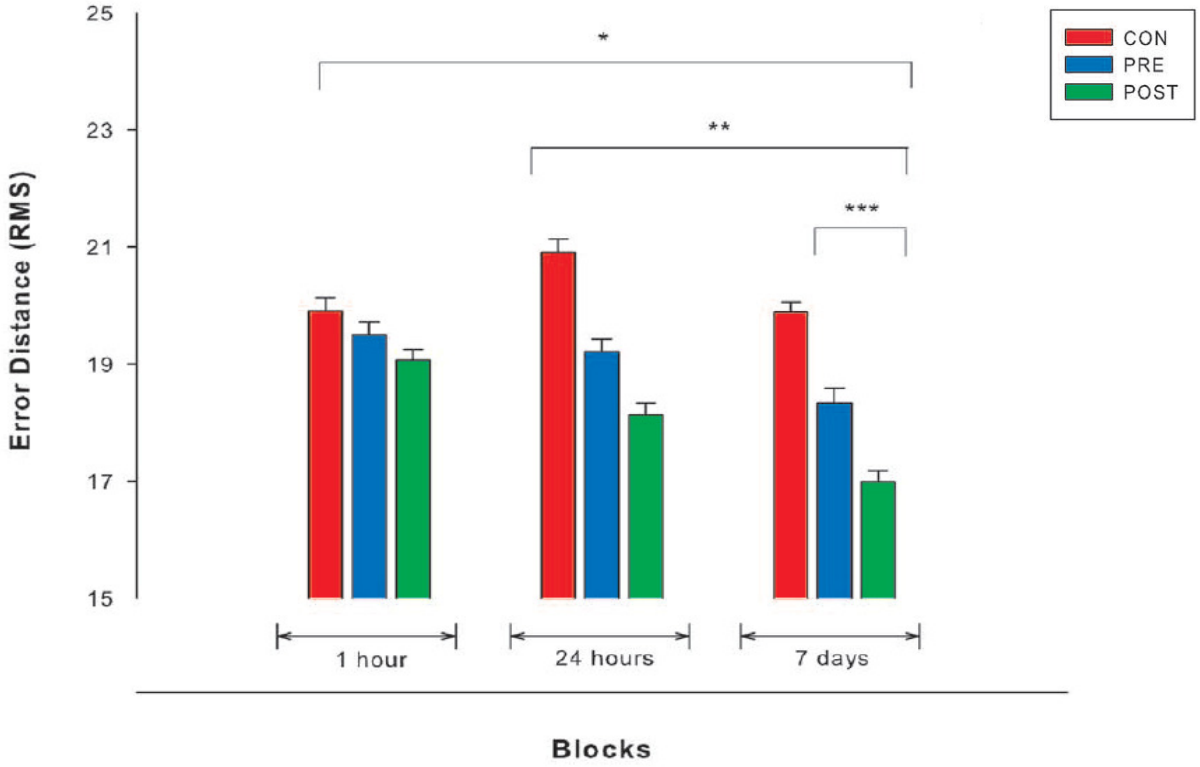
Retention AT 1 hour after practice
(1x5 min)

Retention AT 24 hours after practice
(1x5 min)

Retention AT 7 days after practice
(1x5 min)

Roig et al. 2012

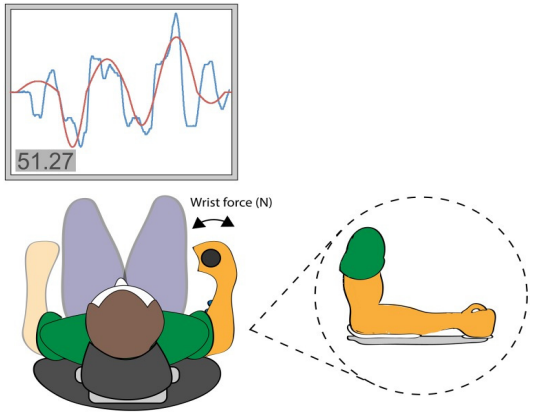
Fatigue et régénération de la motricité fine – *Timing*



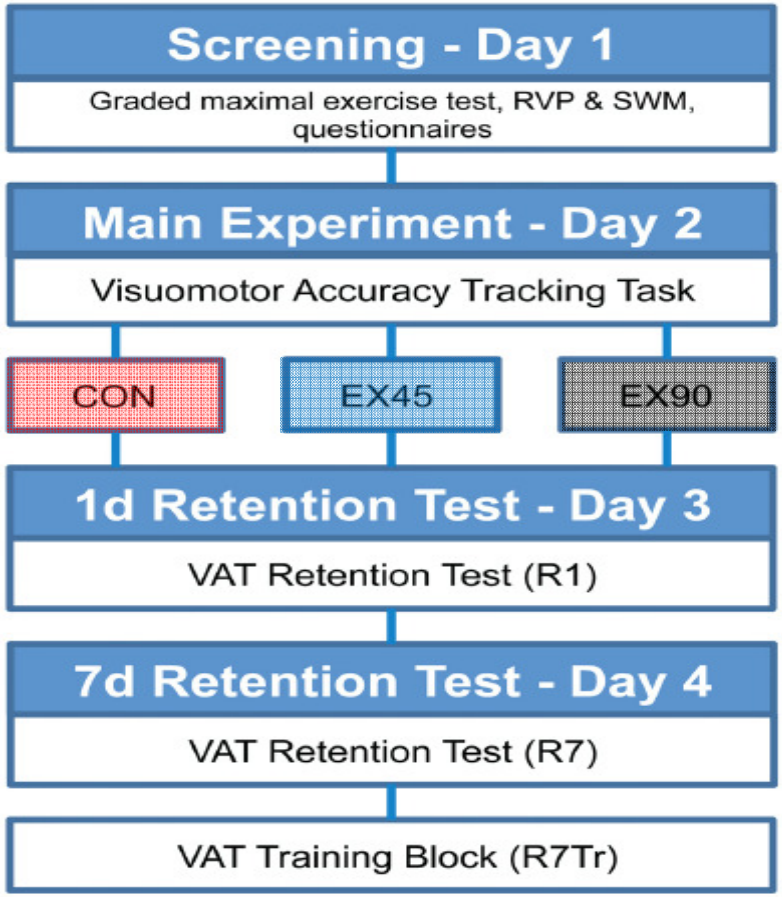
HIIT après l'apprentissage moteur favorise la consolidation

Roig et al. 2012

Fatigue et régénération de la motricité fine – *Intensité*

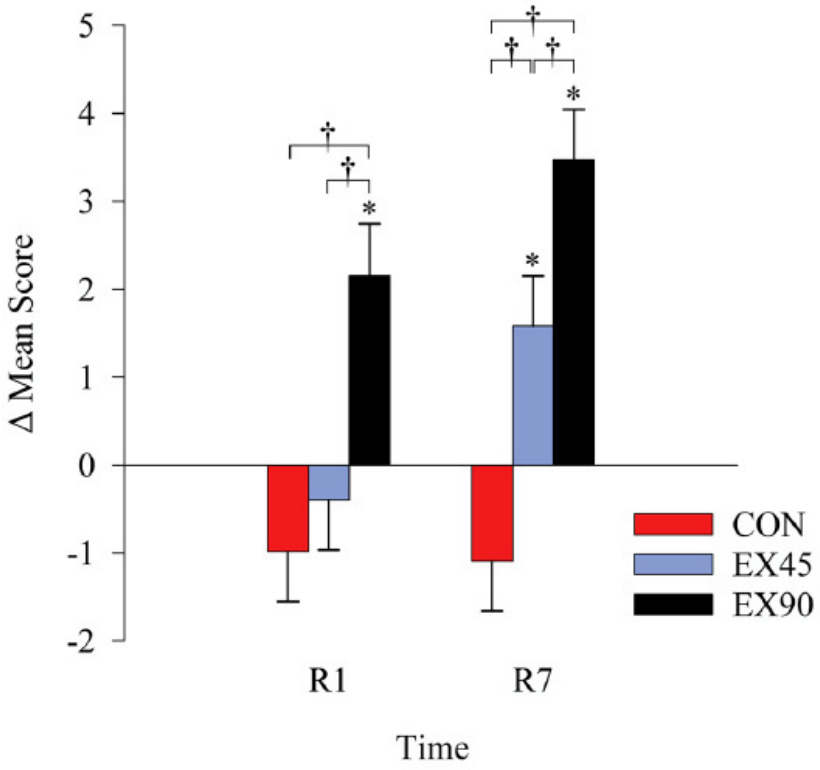


+



Thomas et al. 2016

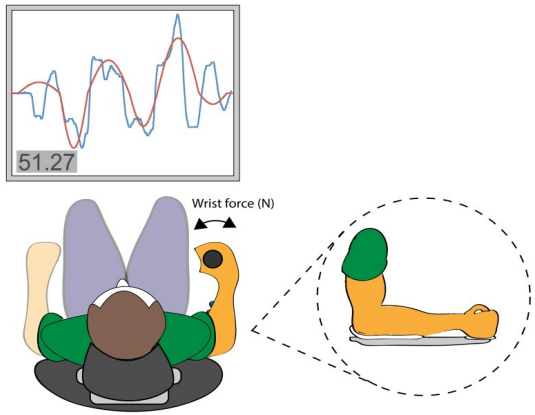
Fatigue et régénération de la motricité fine – *Intensité*



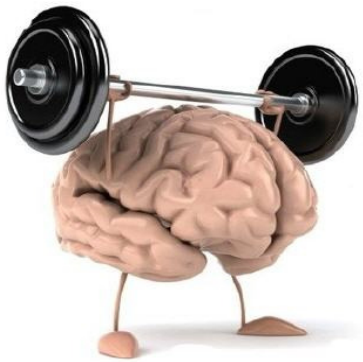
Haute intensité favorise la consolidation

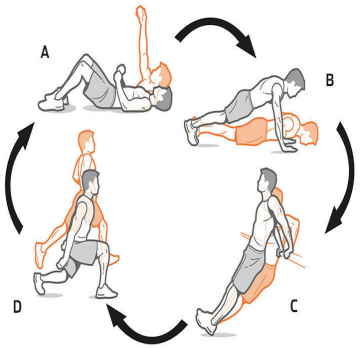
Thomas et al. 2016

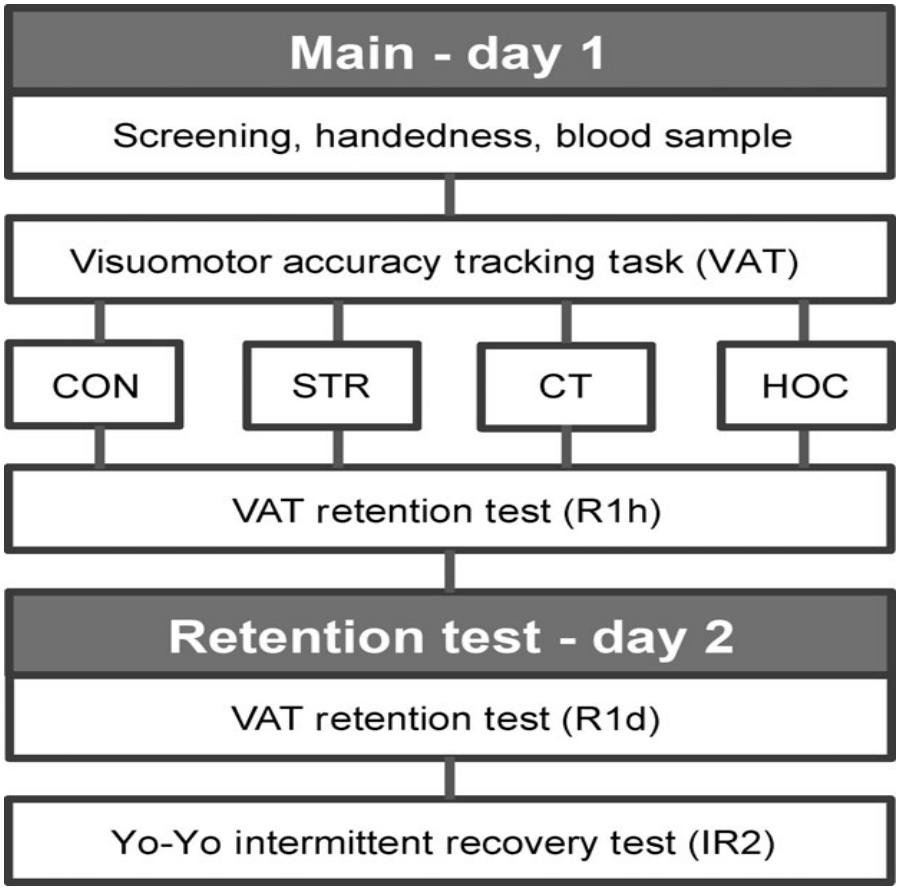
Fatigue et régénération de la motricité fine – *genre*



+

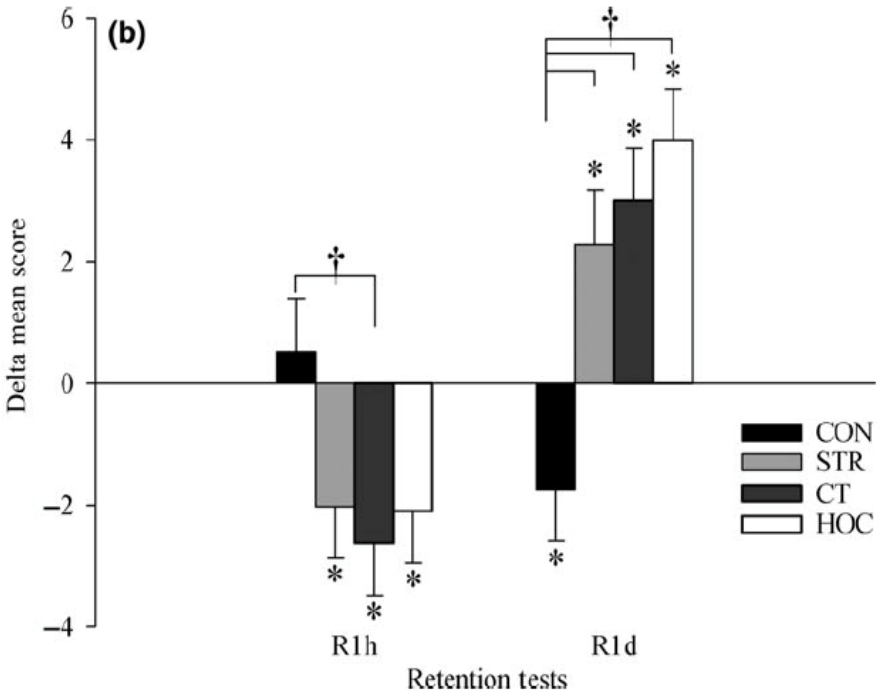






Thomas et al. 2016

Fatigue et régénération de la motricité fine – *genre*



Le type de charge influence la consolidation

Thomas et al. 2016

Fatigue et régénération de la motricité fine – *conclusion*

BDNF

NORE

Laktat

EPI

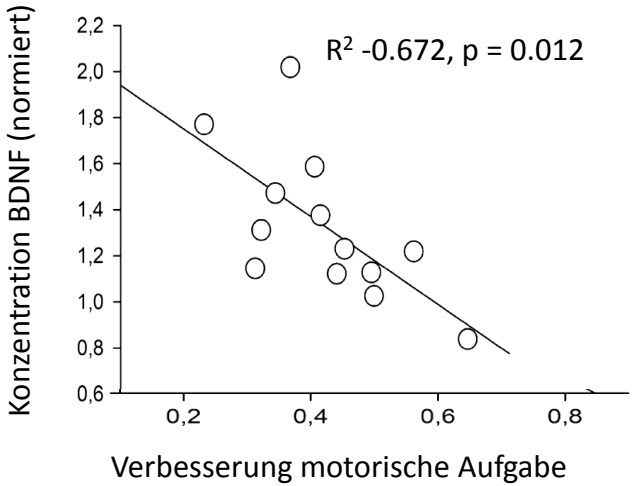
DOPA

IGF - 1

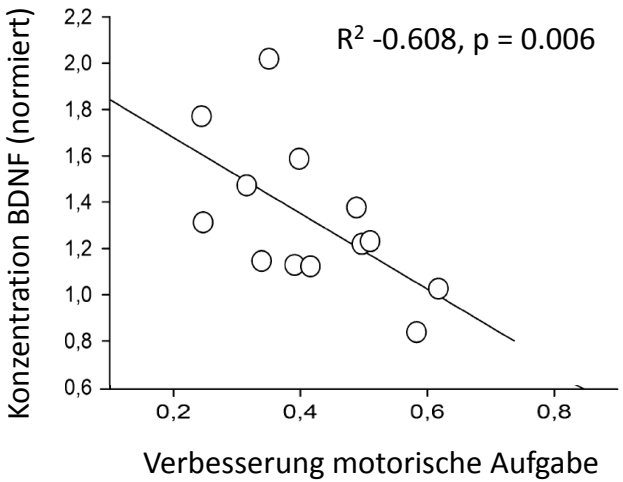
Fatigue et régénération de la motricité fine – *conclusion*

Brain-Derived Neurotrophic Factor (BDNF)

1h



7 jours



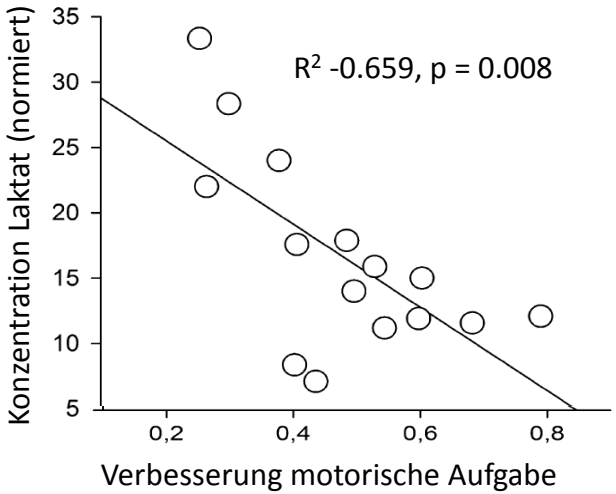
Skriver et al. 2014

Corrélation entre la concentration de BDNF et la consolidation de la mémoire à court et à long terme

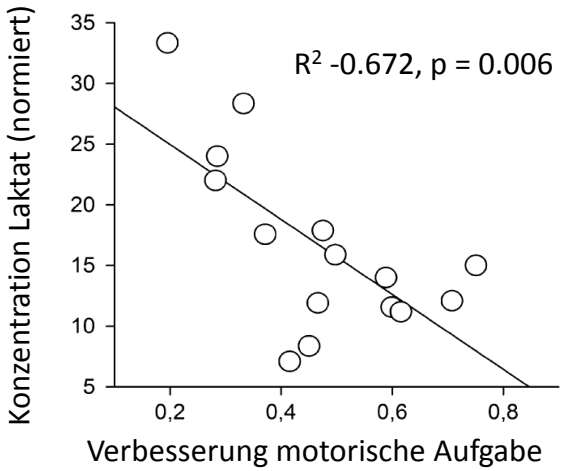
Fatigue et régénération de la motricité fine – *conclusion*

Lactate

1h



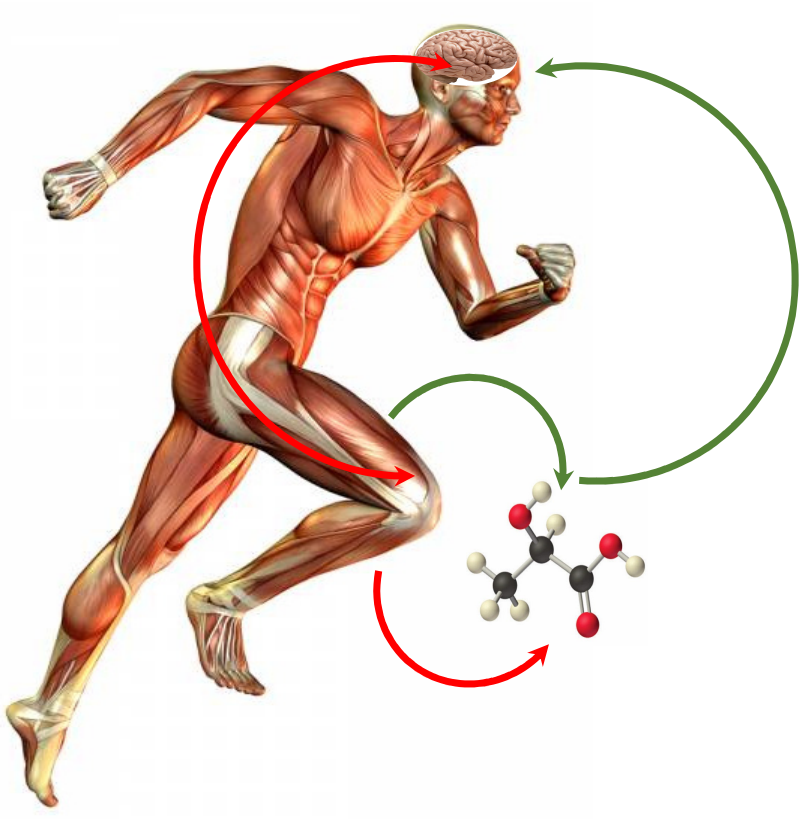
7 jours



Skriver et al. 2014

Corrélation entre la concentration de lactate et la consolidation de la mémoire à court et à long terme

Fatigue et régénération de la motricité fine – *conclusion*



BDNF est ...

- à toutes les étapes de la formation de la mémoire, par ex. La potentialisation à long terme (LTP) (Korte et al., 1995, Vaynman et al., 2003, Bekinschtein et al., 2008, Gómez-Pinilla et Feng, 2012)
- Augmente lors de HIIT par rapport à la charge continue (Afzalpour et al 2015)

Le lactate régule de nombreuses fonctions cérébrales telles que...

- Survie des neurones (Fünfschilling et al 2012, Lee et al 2012)
- Myélinisation des axones (Rinholm et al., 2011)
- Le métabolisme cérébral pendant l'exercice physique (Van Hall et al 2009, Boumezbeur et al 2010)
- Joue un rôle avec une distribution accrue des facteurs de croissance neuronaux tels que le BDNF (Coco et al., 2013)

Das Bewegte Gehirn - *Fazit*

Timing

✓ **HIIT après l'apprentissage moteur favorise la consolidation (et empêche les interférences)**

Intensité

✓ **La forte intensité favorise la consolidation**

Type de charge

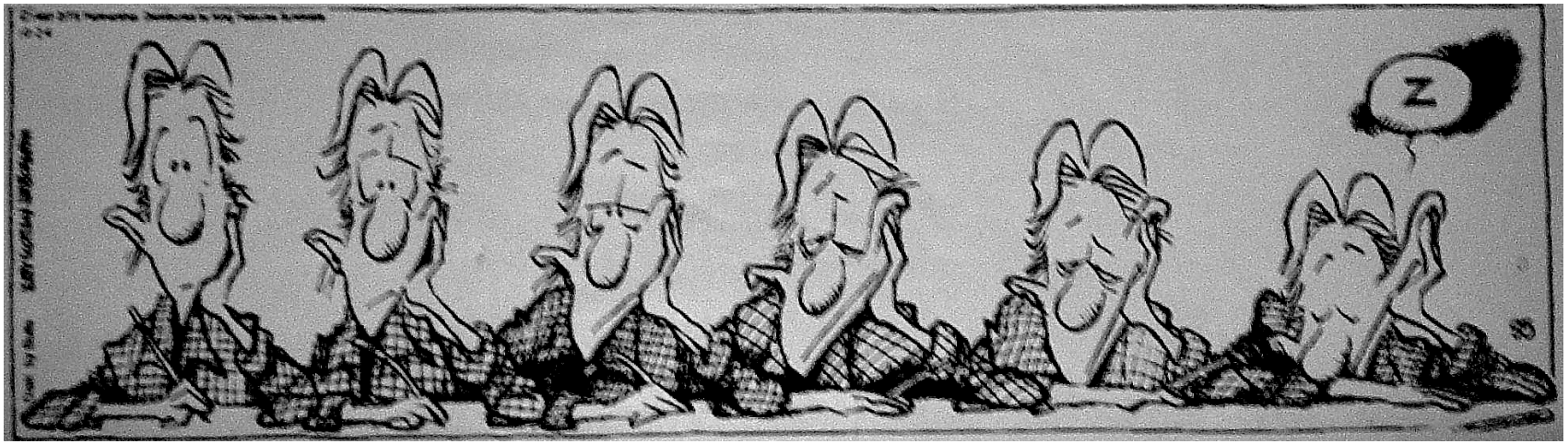
✓ **Le type de charge affecte la consolidation**

Excitabilité neuronale

✓ **Une forte excitabilité est associée à la consolidation**

BDNF & Lactate

✓ **Important pour la consolidation**

Influence sur l'entraînement, la préparation à la compétition, la réhabilitation

Merci
pour votre attention