

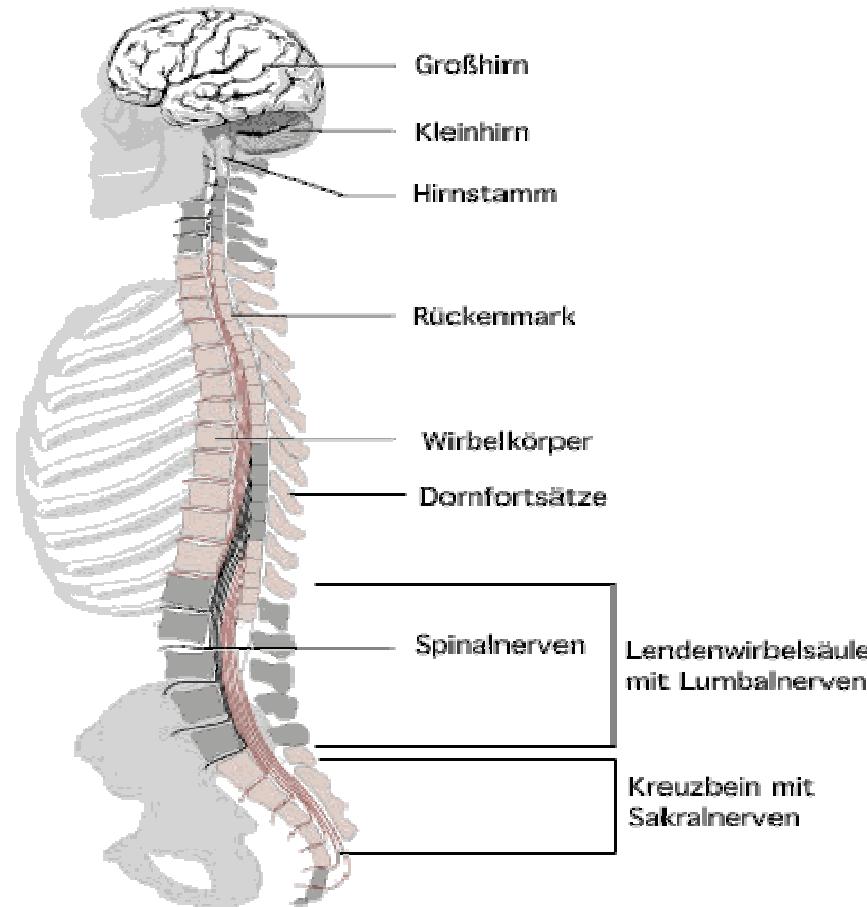
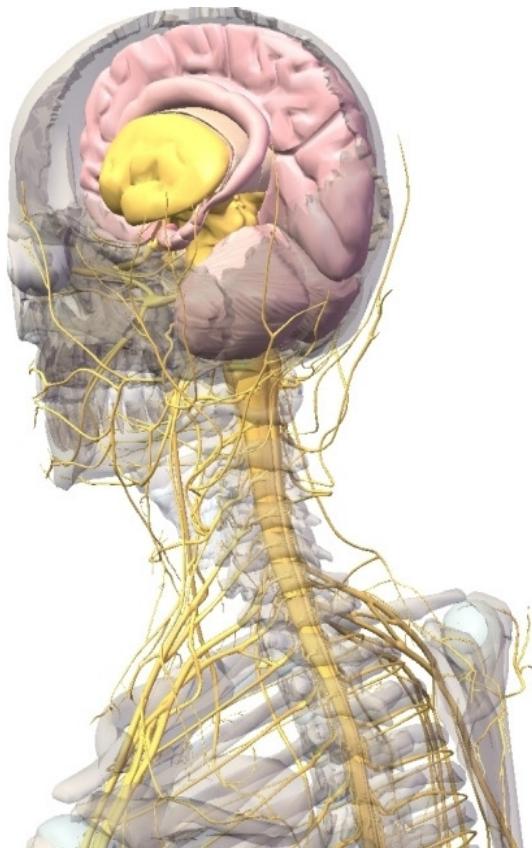


Ermüdbarkeit und Regeneration der Feinmotorik

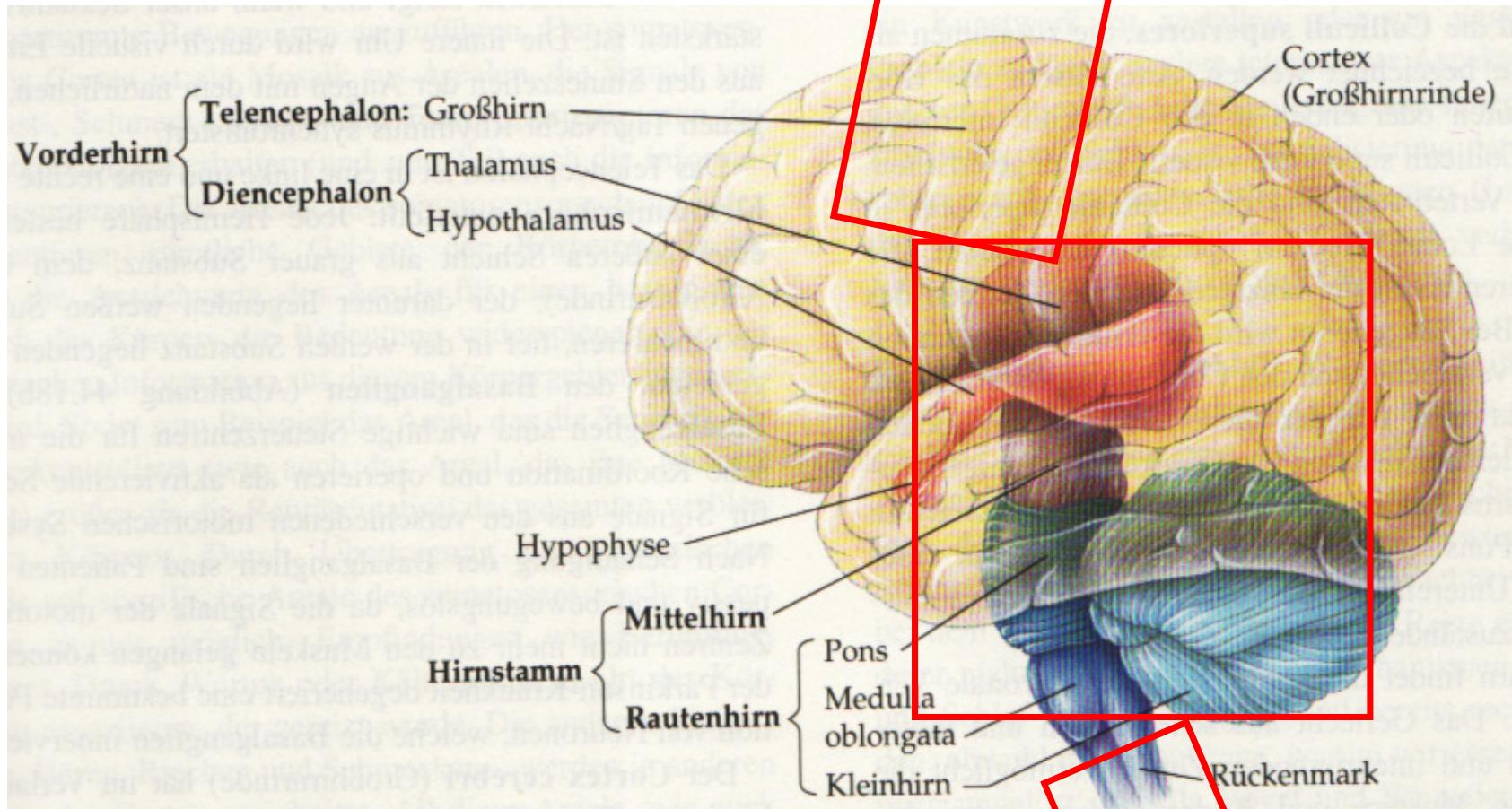
DR. BENEDIKT LAUBER, MAGGLINGEN, 25.10.2017

- Überblick Nervensystem
- Ermüdung
- Einfluss auf von Ermüdung auf die Leistung
- Trainierbarkeit der Feinmotorik

Ermüdbarkeit und Regeneration der Feinmotorik - *Einleitung*



Ermüdbarkeit und Regeneration der Feinmotorik - *Einleitung*



Ermüdbarkeit und Regeneration der Feinmotorik - *Einleitung*

„Drei Klassen von Bewegungen“ (vereinfacht)



1. Willkürbewegungen



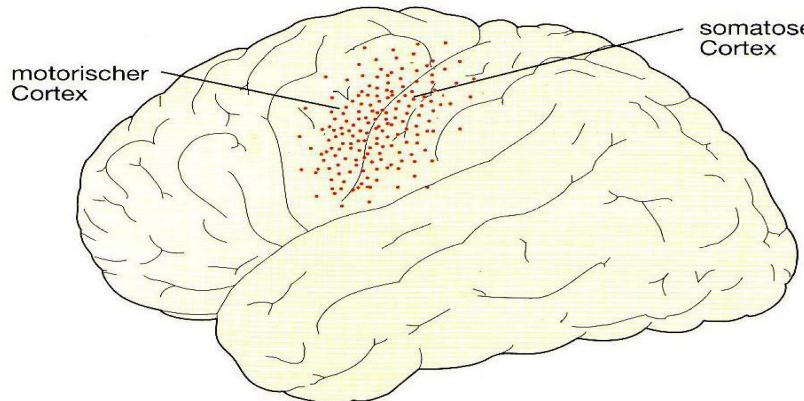
2. Zyklische Bewegungen



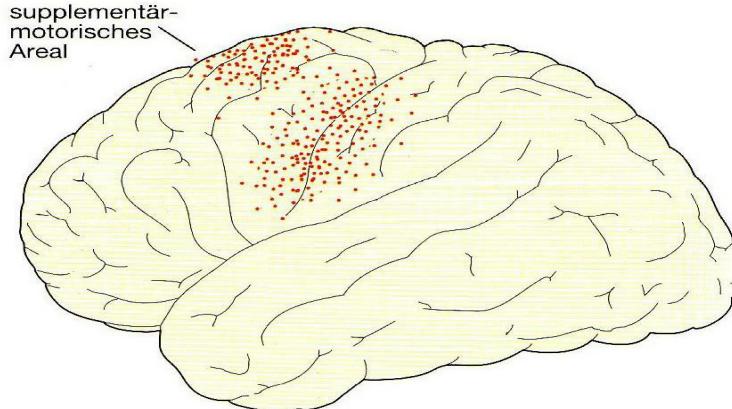
3. Reflektorische Bewegungen

Ermüdbarkeit und Regeneration der Feinmotorik - *Einleitung*

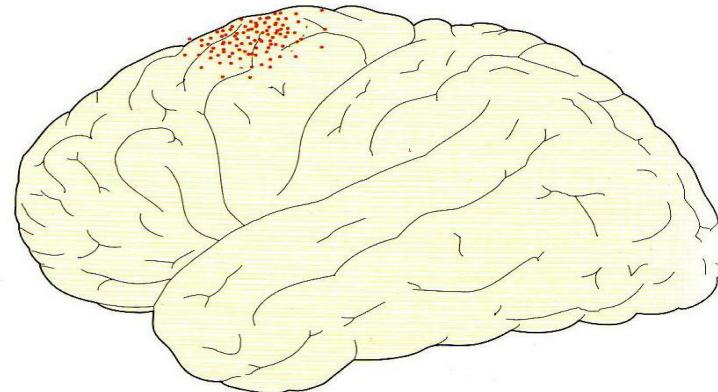
A einfache Fingerbeugung (ausgeführt)



B komplexere Bewegungsfolge der Finger (ausgeführt)

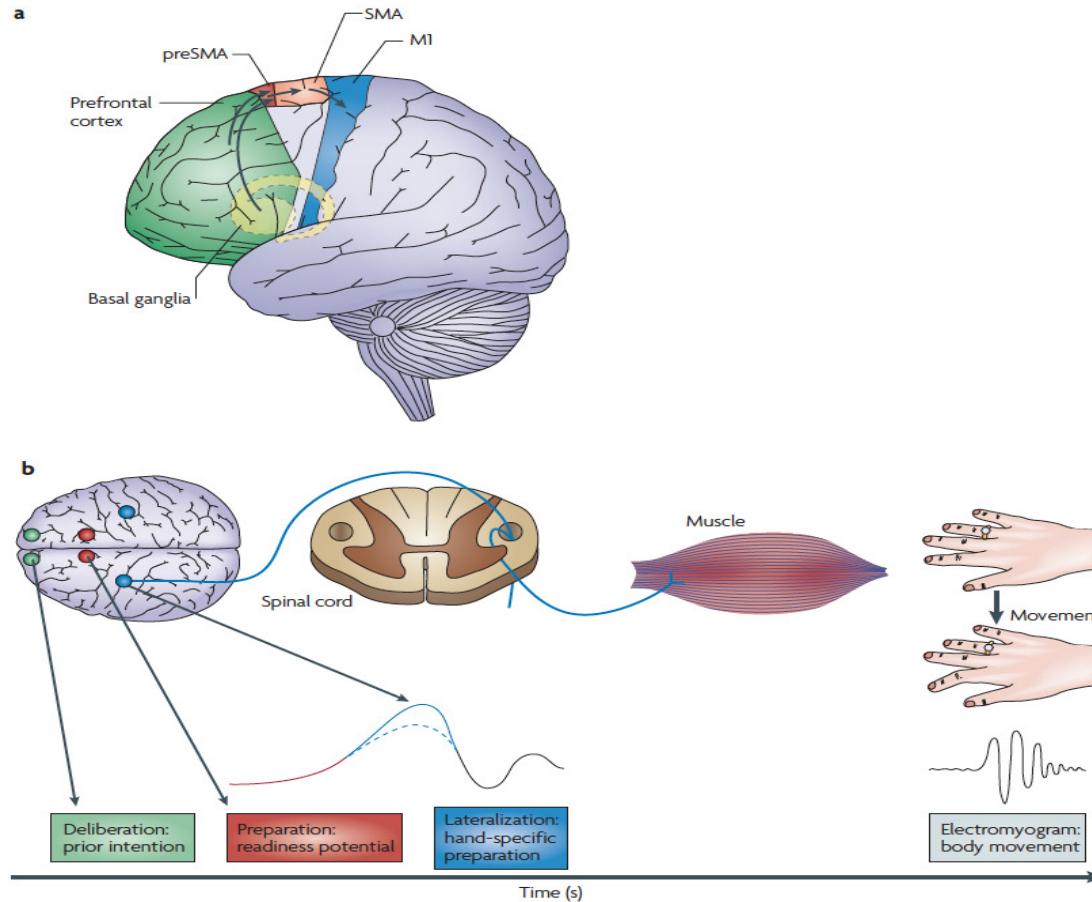


C komplexere Bewegungsfolge der Finger (vorgestellt)



Kandel (2009)

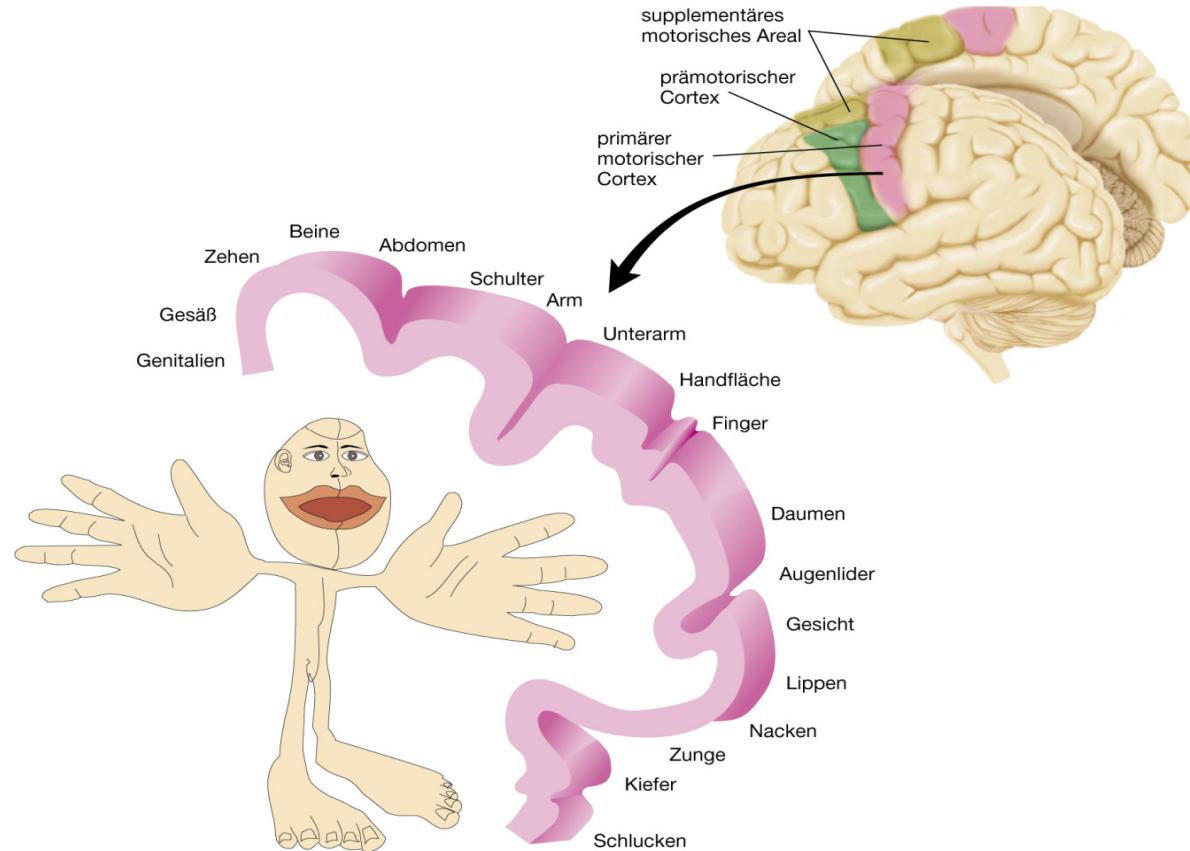
Ermüdbarkeit und Regeneration der Feinmotorik - *Einleitung*



Haggard 2008

Dr. Benedikt Lauber, Magglingen, 25.10.2017

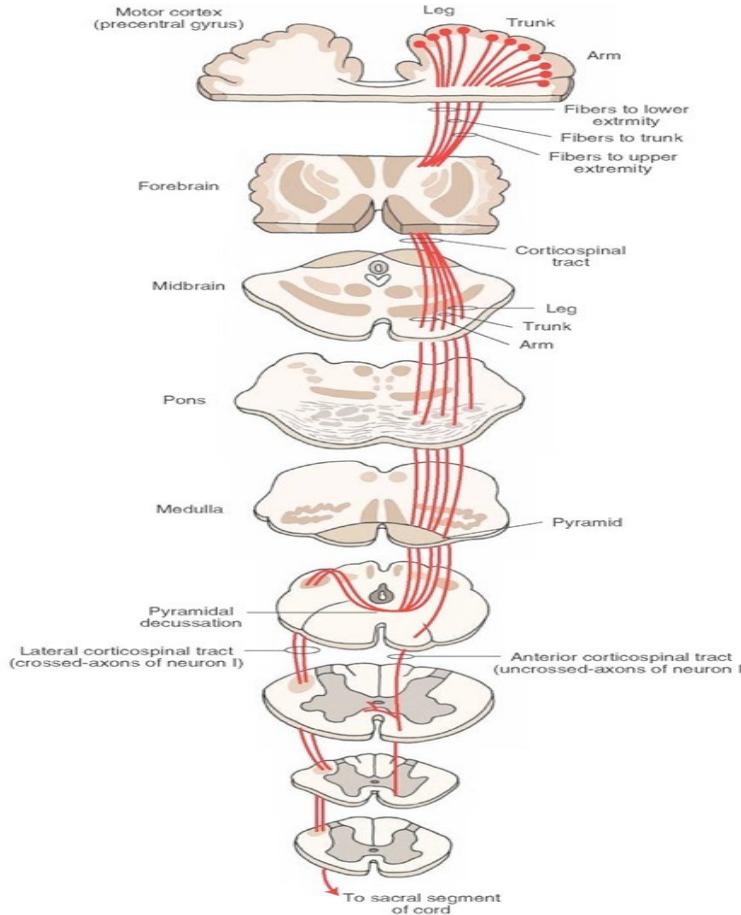
Ermüdbarkeit und Regeneration der Feinmotorik - *Einleitung*



© Pearson Studium 2004

Dr. Benedikt Lauber, Magglingen, 25.10.2017

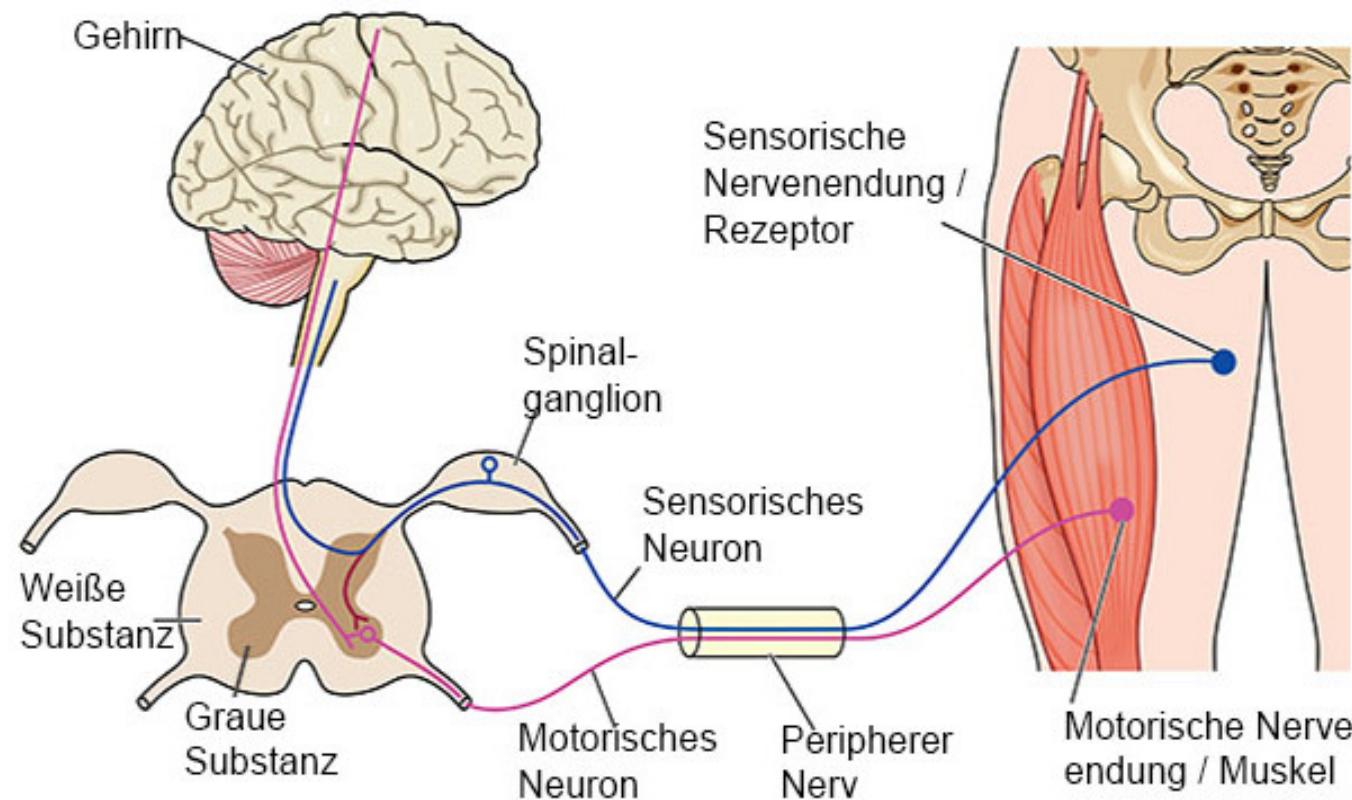
Ermüdbarkeit und Regeneration der Feinmotorik - *Einleitung*



www.what-when-how.com

Dr. Benedikt Lauber, Magglingen, 25.10.2017

Ermüdbarkeit und Regeneration der Feinmotorik - *Einleitung*



Ermüdbarkeit und Regeneration der Feinmotorik - *Ermüdung*



Ermüdbarkeit und Regeneration der Feinmotorik - *Ermüdung*

Fatigue and Exercise



Ermüdbarkeit und Regeneration der Feinmotorik - *Ermüdung*

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**.’ (Lorist *et 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).

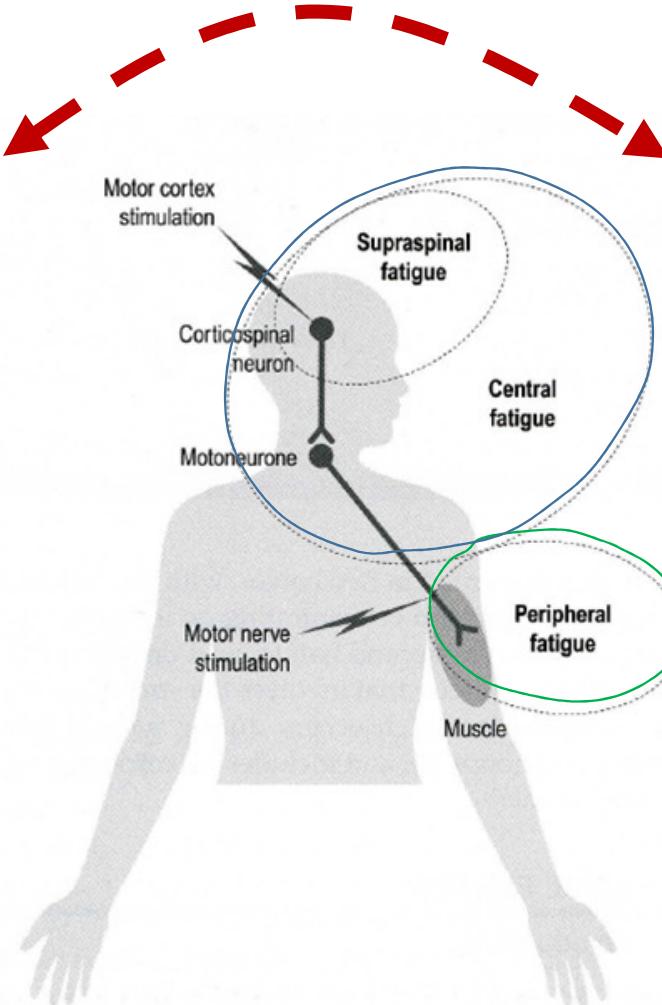
‘The primary purpose of the study was to use functional magnetic resonance imaging (fMRI) to determine the association between feelings of mental fatigue and blood oxygen level dependent (BOLD) brain responses during a **mentally fatiguing cognitive task**.’ (Cook *et al.* 2007).

From: Enoka&Duchateau 2008

Ermüdbarkeit und Regeneration der Feinmotorik - *Ermüdung*

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

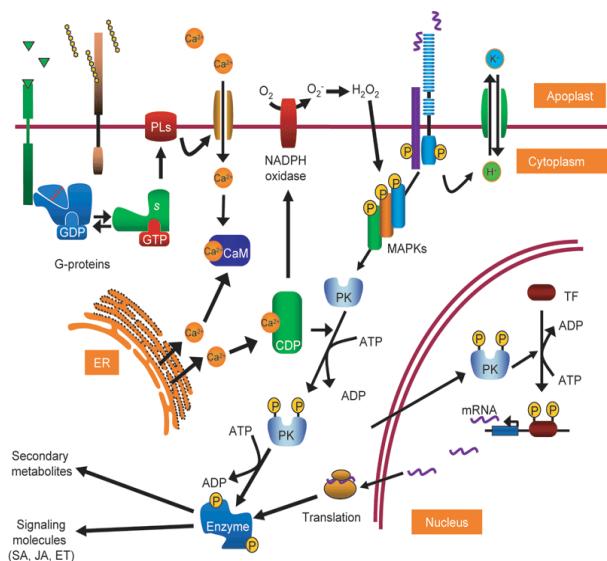
Central
involves events
occurring in the
brain and spinal
cord (Kirkendall 1990)



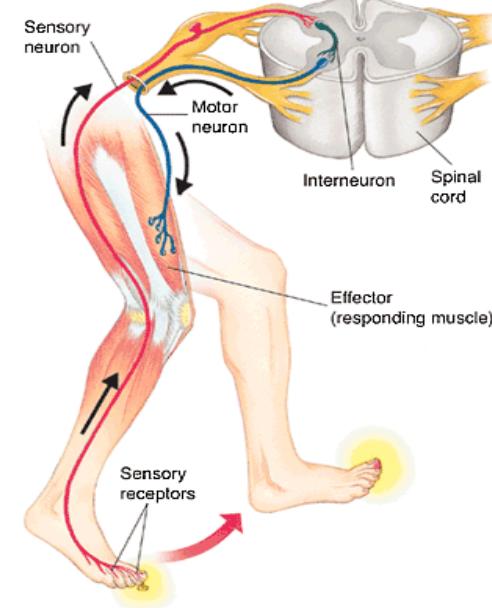
Ermüdbarkeit und Regeneration der Feinmotorik - *Ermüdung*

Fatigue and Exercise

Accumulation of metabolites



Inadequate motor commands



Central Fatigue:

↳ Spinal Fatigue:

↳ Supraspinal Fatigue:

Def:

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

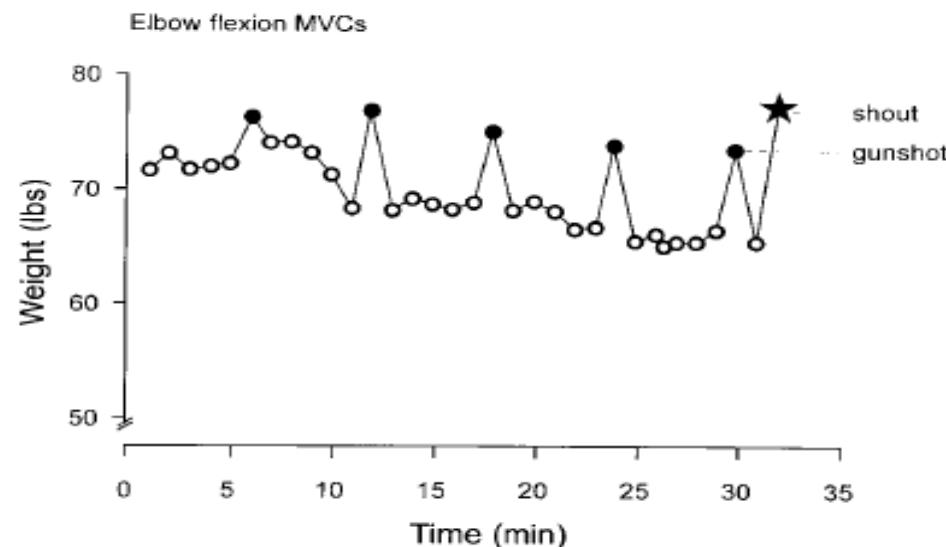
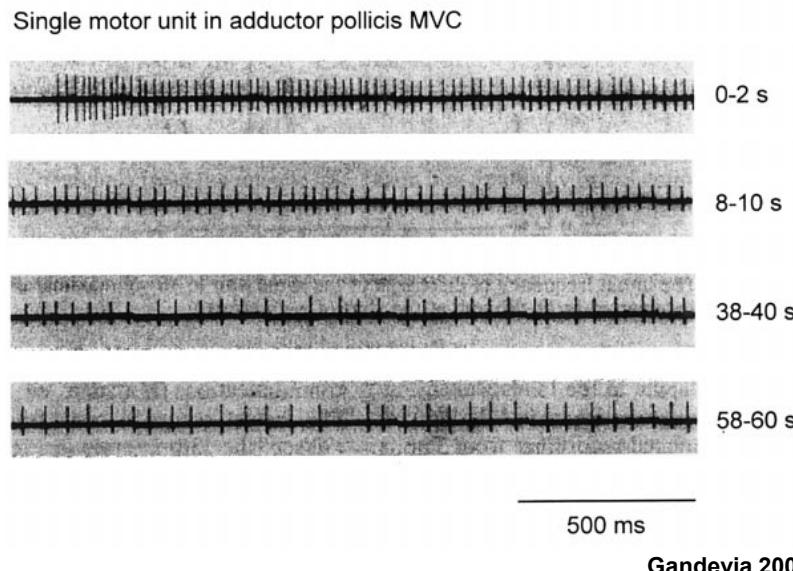


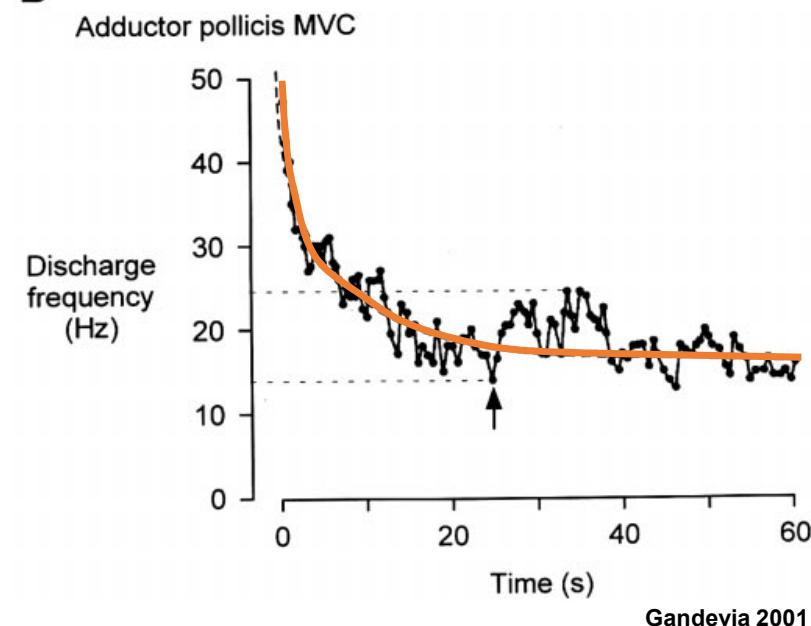
FIG. 2. Classical study of factors affecting maximal voluntary strength. Mean value for brief MVCs of elbow flexors made at 1-min intervals by 10 subjects. Control contractions (open circles), contractions preceded by an unexpected gunshot (solid circles), and a final contraction (star) in which the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

Signs of Central Fatigue: decline in MN discharge frequency

A

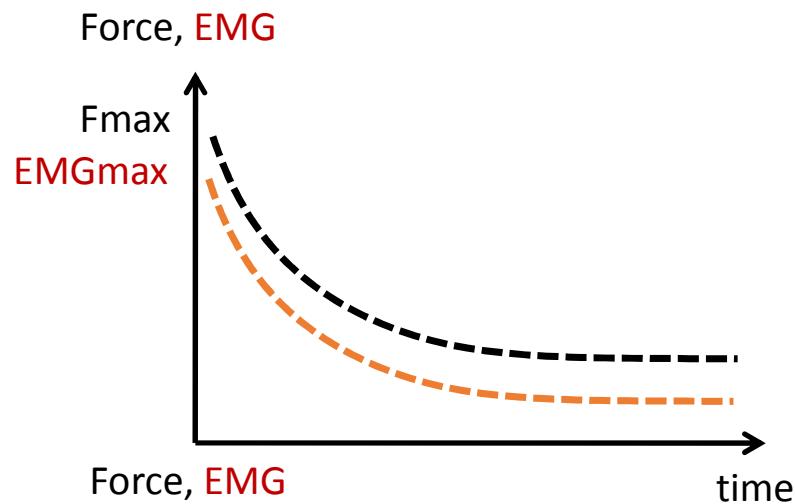


B

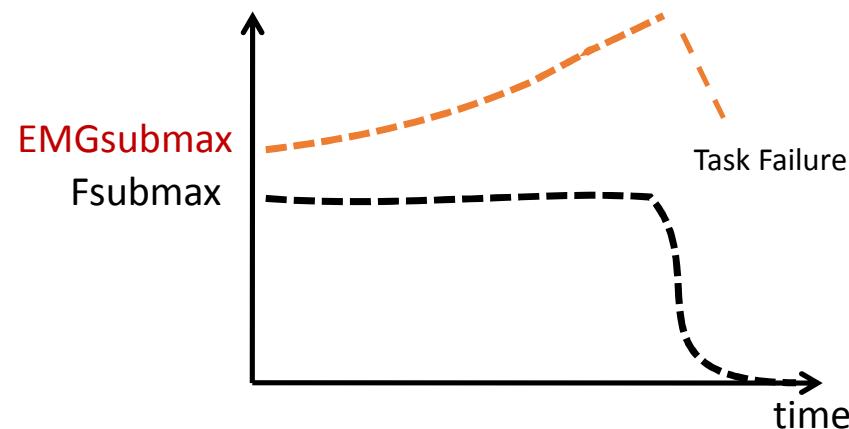


Signs of Central Fatigue

Max. Effort



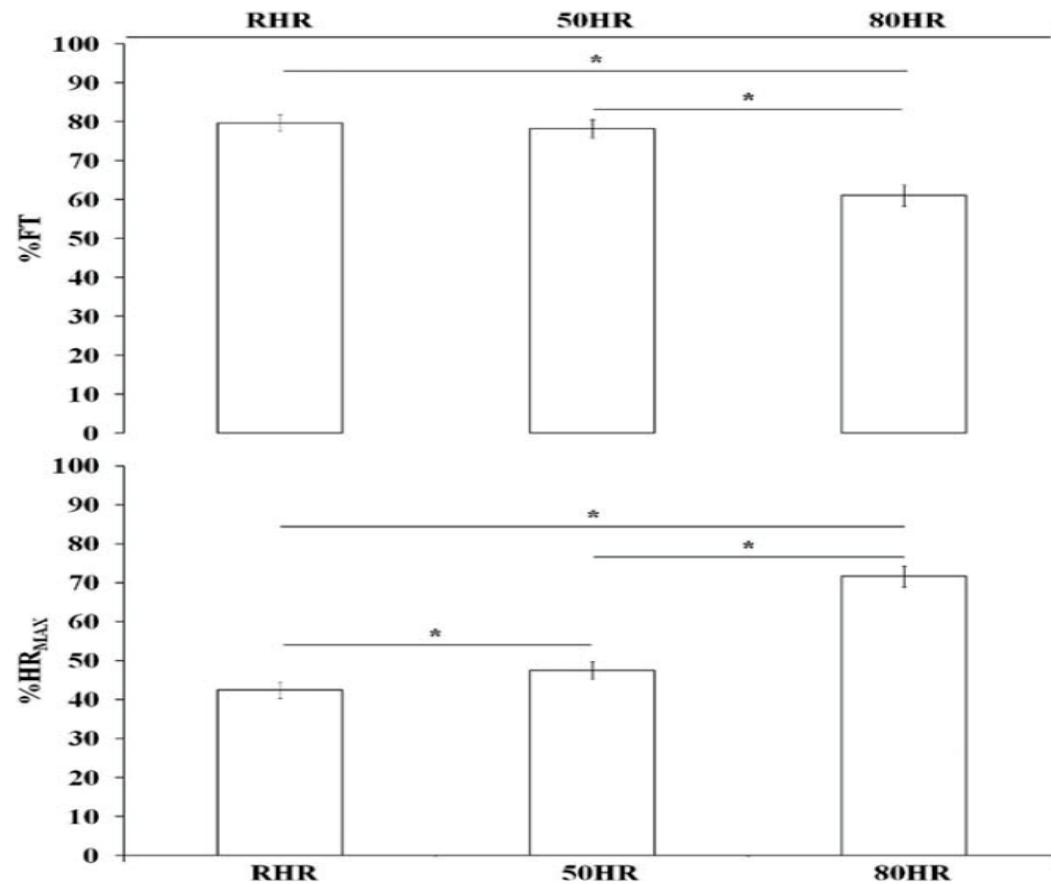
submax. Effort



Ermüdbarkeit und Regeneration der Feinmotorik - *Sportarten*



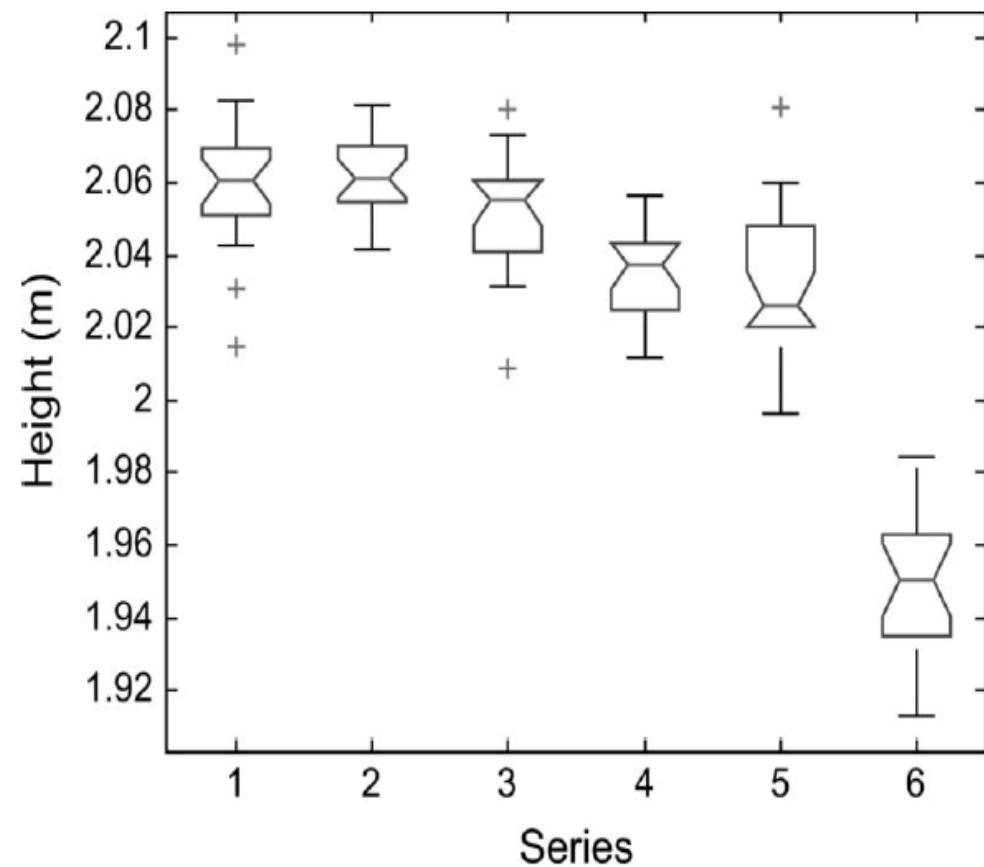
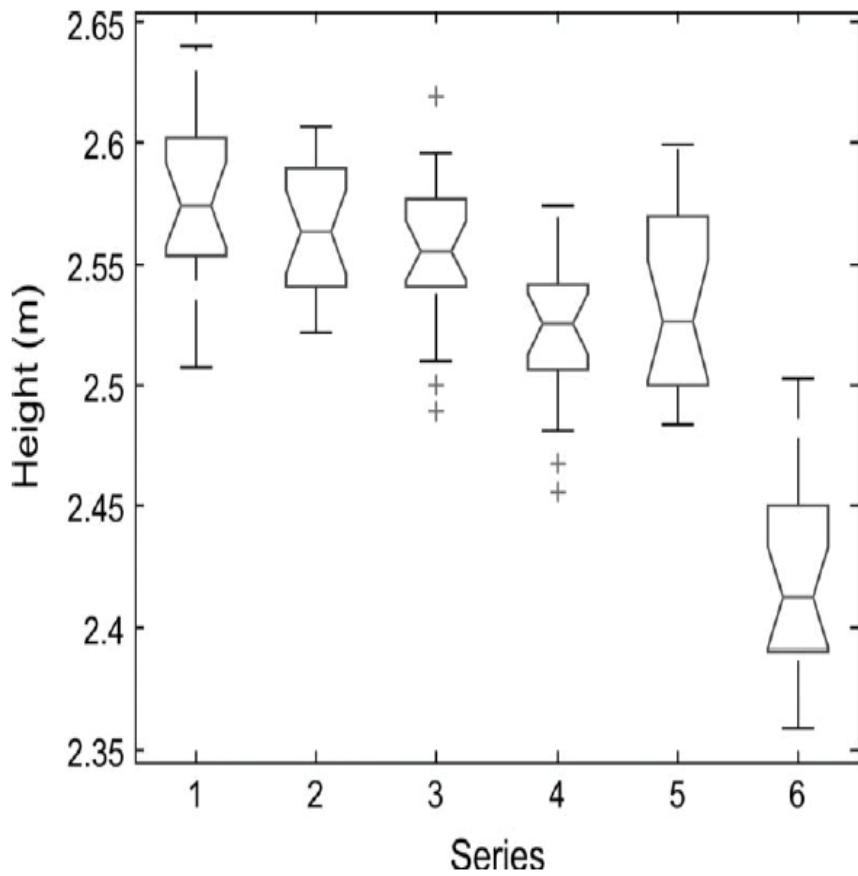
Ermüdbarkeit und Regeneration der Feinmotorik - *Basektball*



Padulo et al. 2014

Dr. Benedikt Lauber, Magglingen, 25.10.2017

Ermüdbarkeit und Regeneration der Feinmotorik - *Basektball*



Erculj et al. 2009

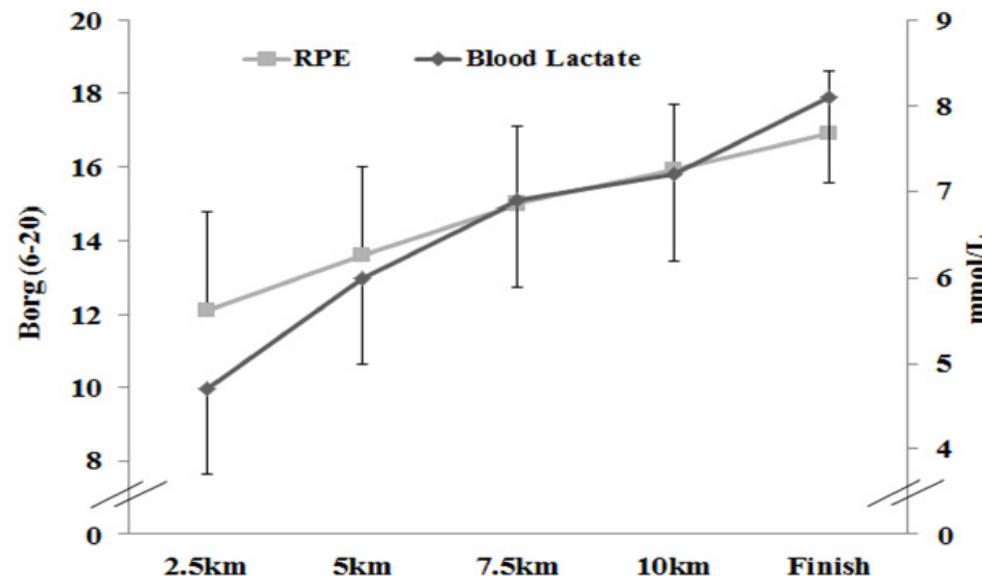


International Journal of Sports Physiology and Performance, 2017, 12, 377-384
<http://dx.doi.org/10.1123/ijspp.2016-0195>
© 2017 Human Kinetics, Inc.

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

Ermüdbarkeit und Regeneration der Feinmotorik - *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

Dr. Benedikt Lauber, Magglingen, 25.10.2017

Ermüdbarkeit und Regeneration der Feinmotorik - *Biathlon*

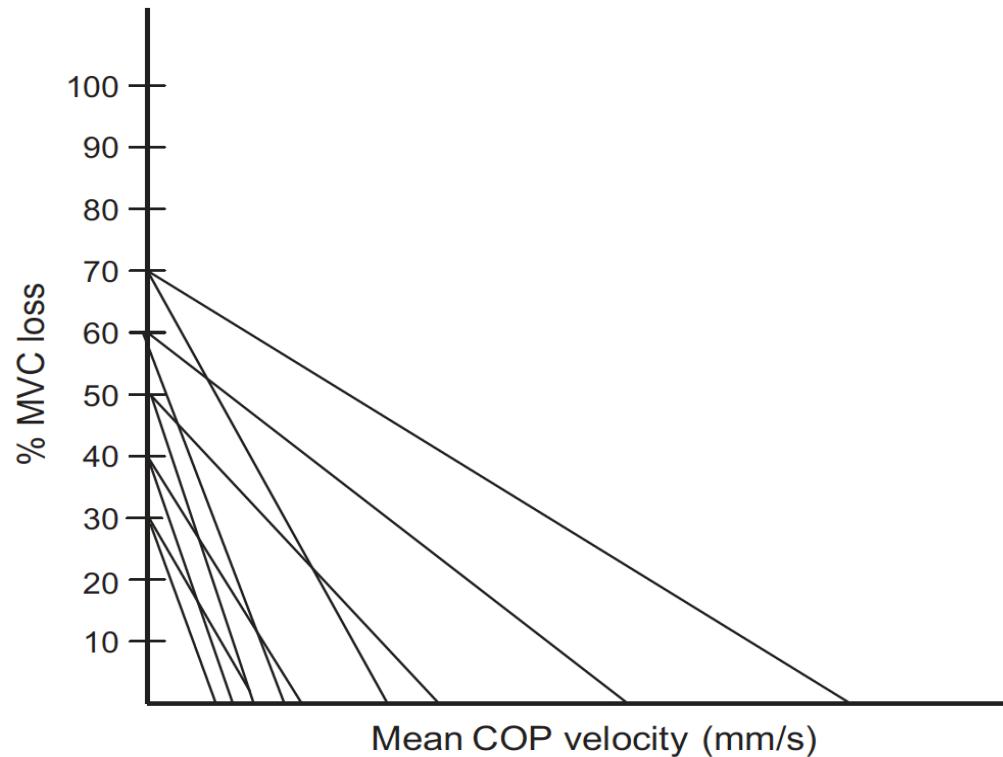
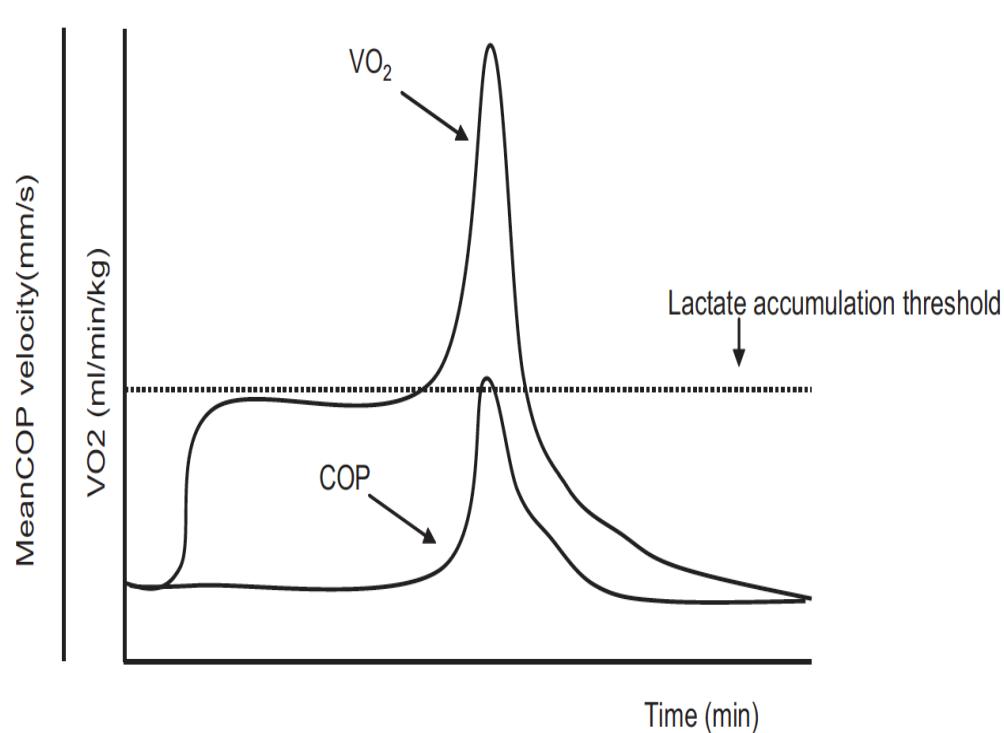


	Descriptive Statistics		LDA		
	High score	Low score	R	P	F
Rest shooting					
trigger coefficient (a.u.)	0.68 ± 0.45	0.84 ± 0.46	.18	.418	0.69
shoulder_mean (N)	18.77 ± 9.34	26.13 ± 23.72	.21	.350	0.92
shoulder_SD (N)	0.08 ± 0.03	0.13 ± 0.08	.43	.060	3.97
rifle_SD_X (mm)	1.32 ± 0.40	1.66 ± 0.37	.41	.069	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

Dr. Benedikt Lauber, Magglingen, 25.10.2017

Ermüdbarkeit und Regeneration der Feinmotorik - *Einleitung*



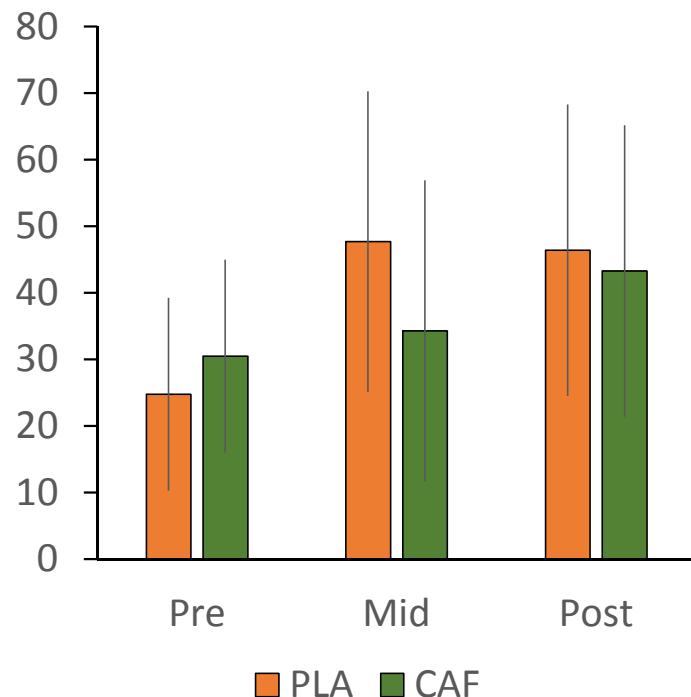
Pillard et al. 2012

Dr. Benedikt Lauber, Magglingen, 25.10.2017

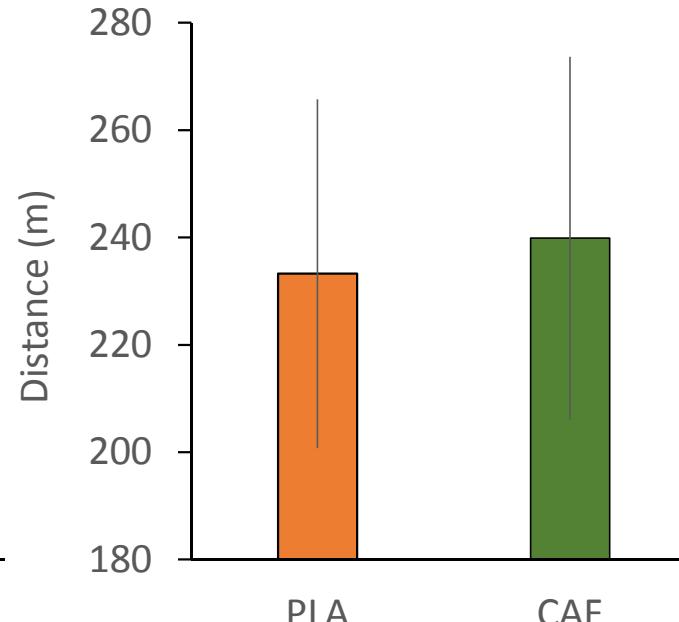
Ermüdbarkeit und Regeneration der Feinmotorik - *Golf*



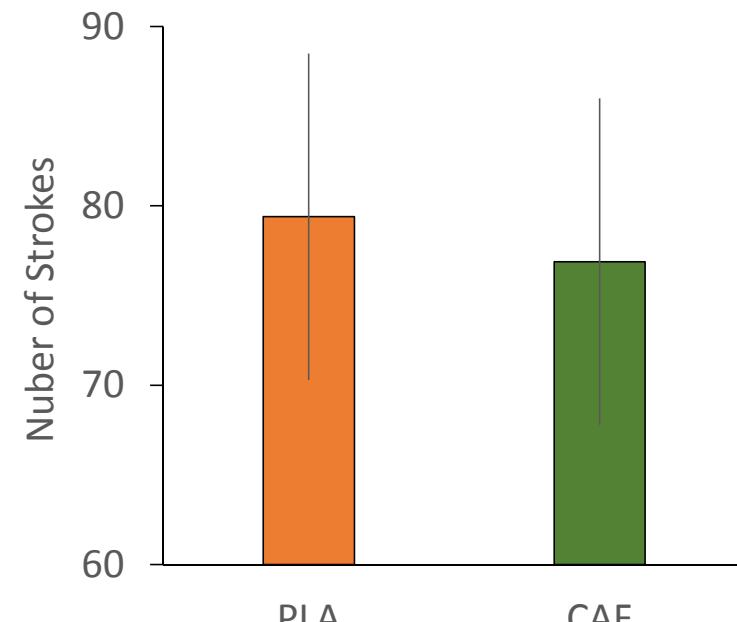
Perceived Fatigue



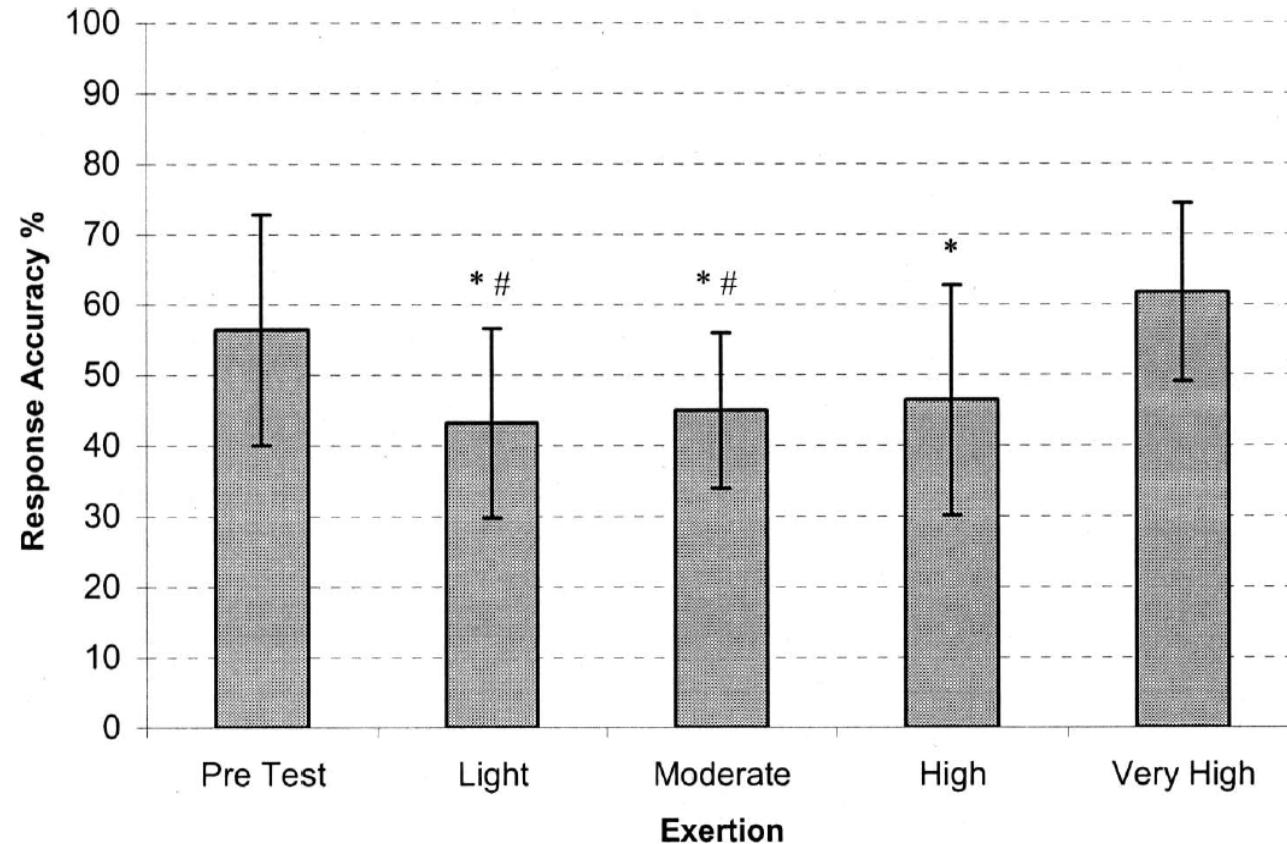
Drive Distance



Strokes



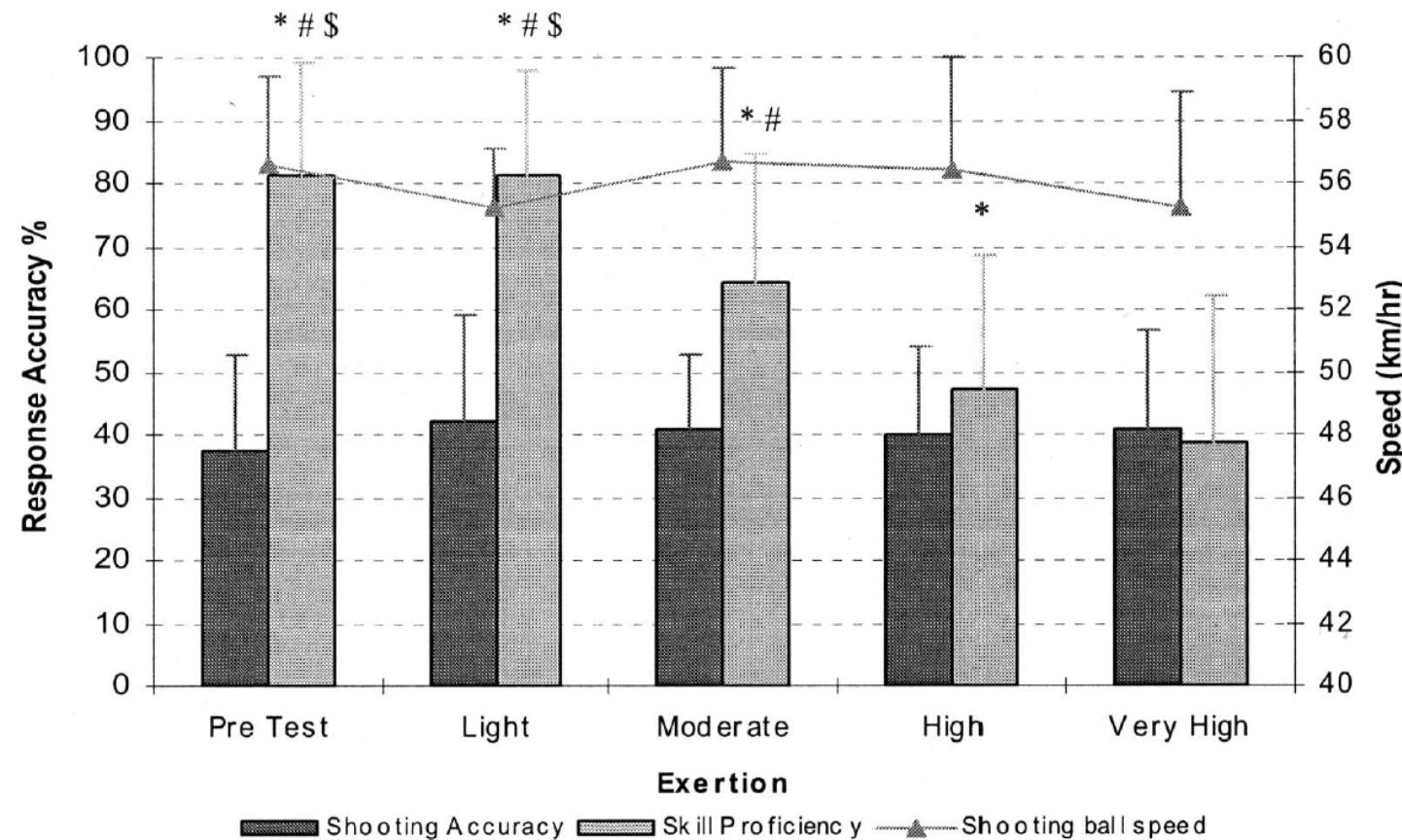
Ermüdbarkeit und Regeneration der Feinmotorik – *Wasserball*



Farrow et al. 2006

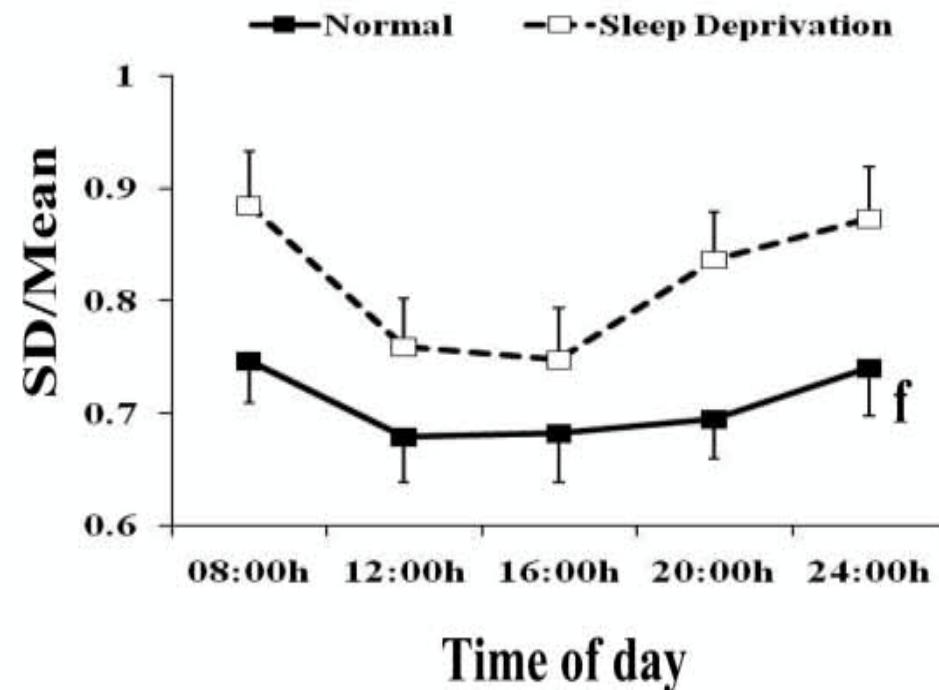
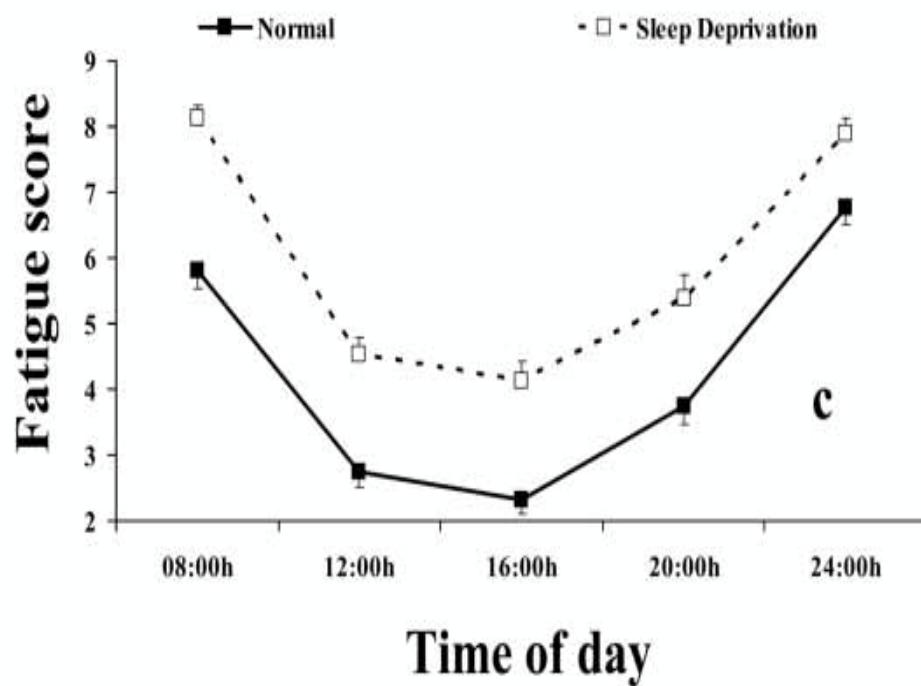
Dr. Benedikt Lauber, Magglingen, 25.10.2017

Ermüdbarkeit und Regeneration der Feinmotorik – *Wasserball*



Farrow et al. 2006

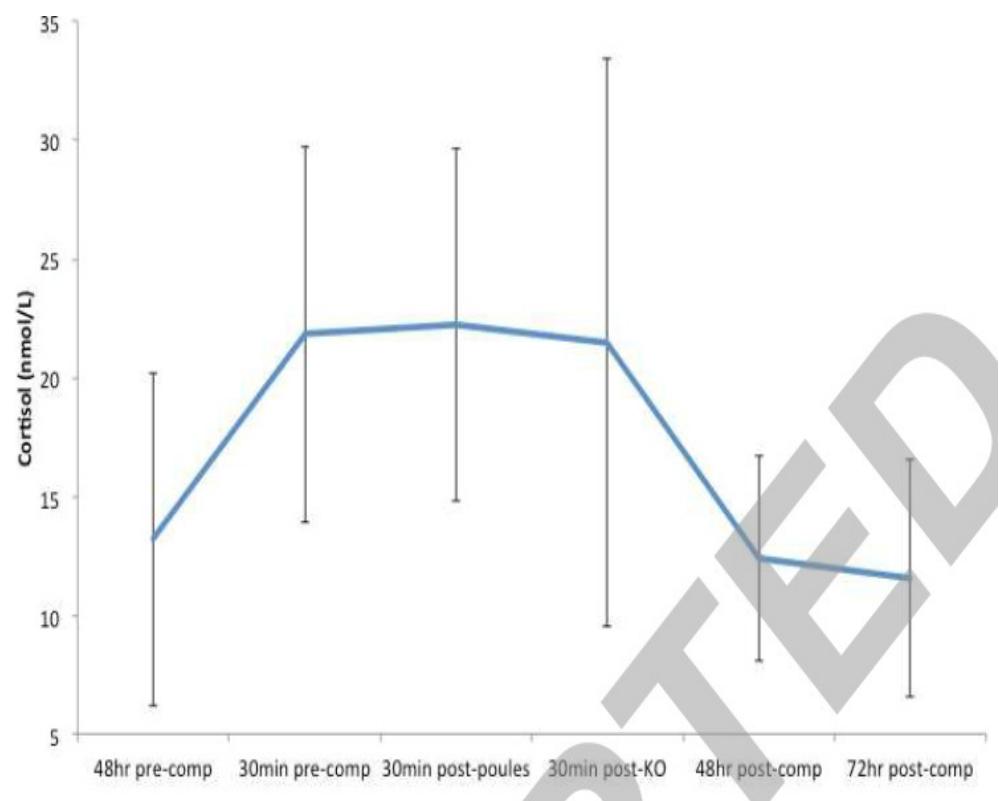
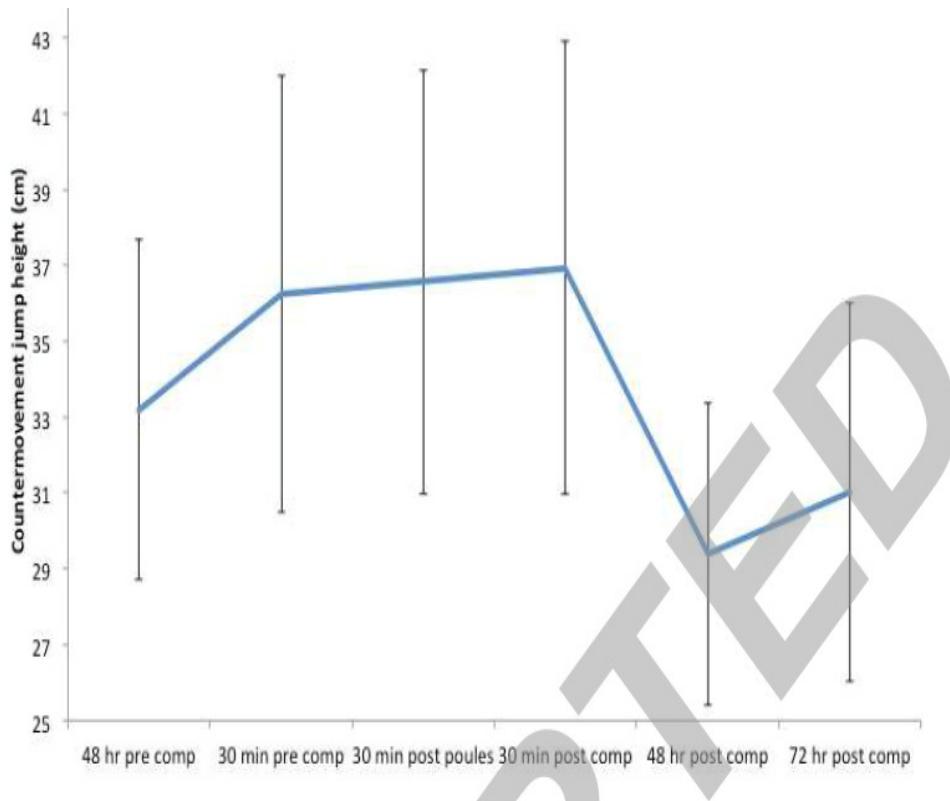
Dr. Benedikt Lauber, Magglingen, 25.10.2017



Edwards et al. 2006

Dr. Benedikt Lauber, Magglingen, 25.10.2017

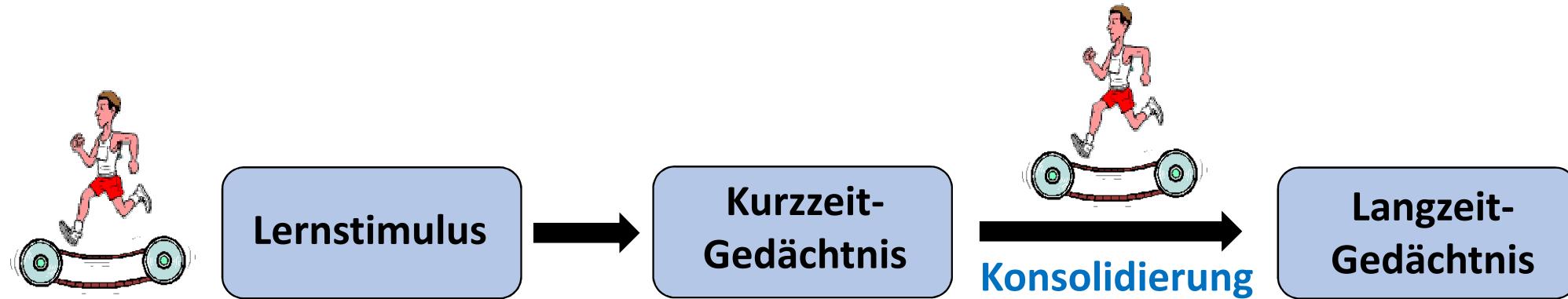
Ermüdbarkeit und Regeneration der Feinmotorik - *Fechten*



Tuner et al. 2017

Ermüdbarkeit und Regeneration der Feinmotorik - *Lernen*

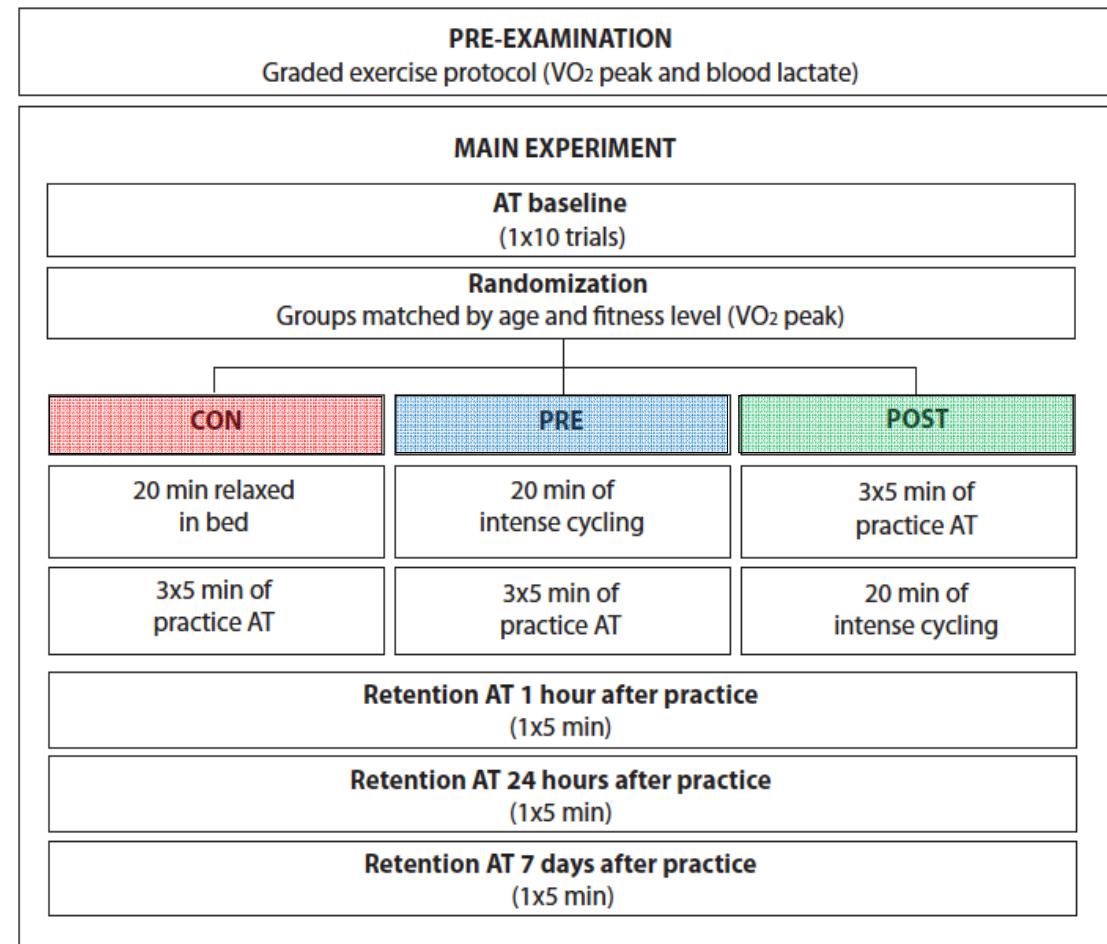
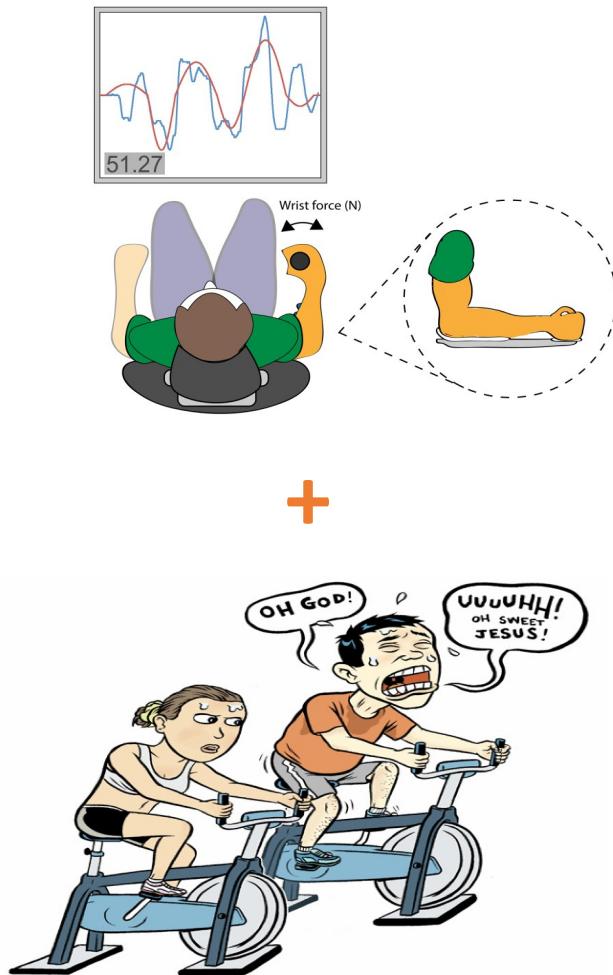
- Timing
- Intensität
- Art der Belastung



Einfluss von *akuter* körperlicher Belastung

- **Direkter** zeitlicher Zusammenhang

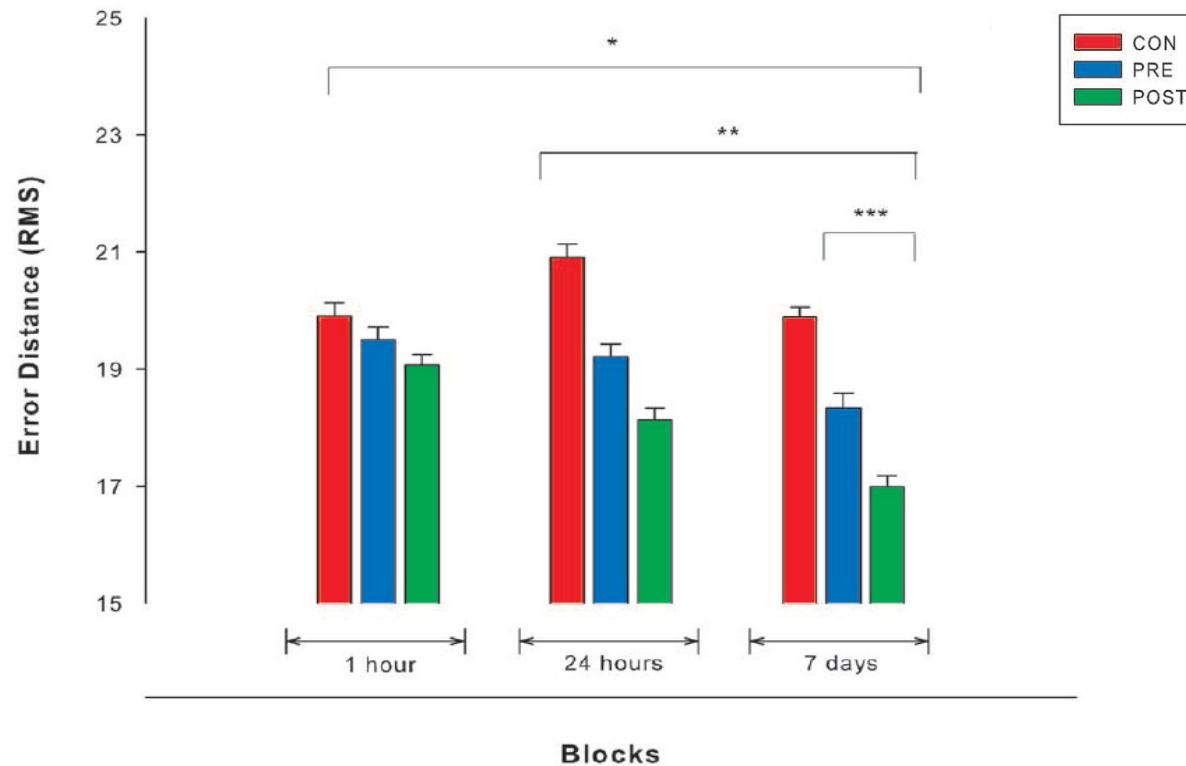
Ermüdbarkeit und Regeneration der Feinmotorik - *Timing*



Roig et al. 2012

Dr. Benedikt Lauber, Magglingen, 25.10.2017

Ermüdbarkeit und Regeneration der Feinmotorik - *Timing*

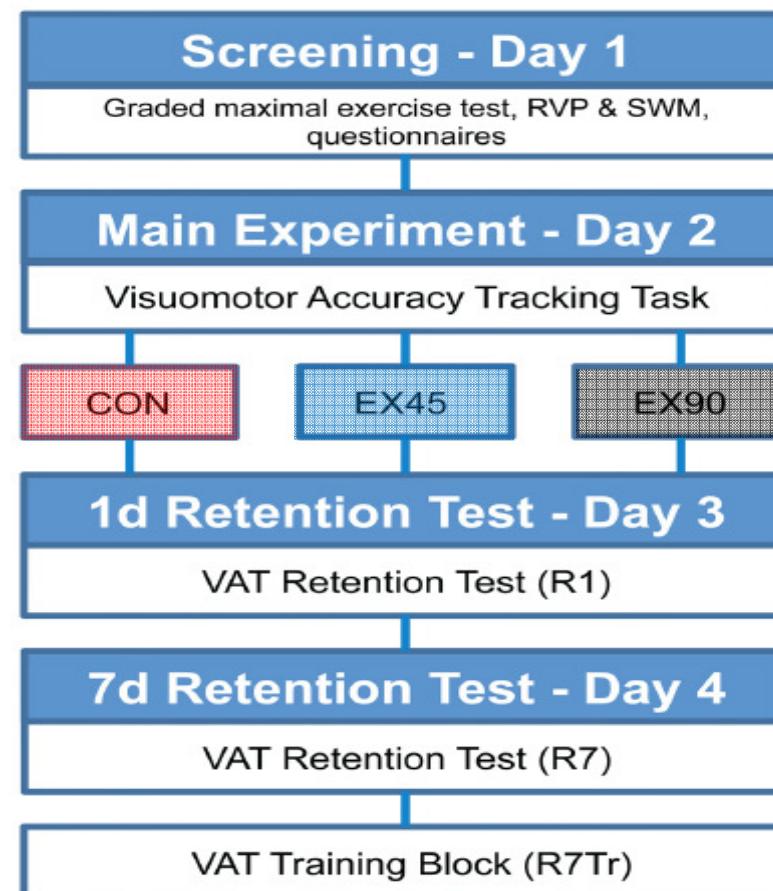


HIIT nach motorischem Lernen begünstigt Konsolidierung

Roig et al. 2012

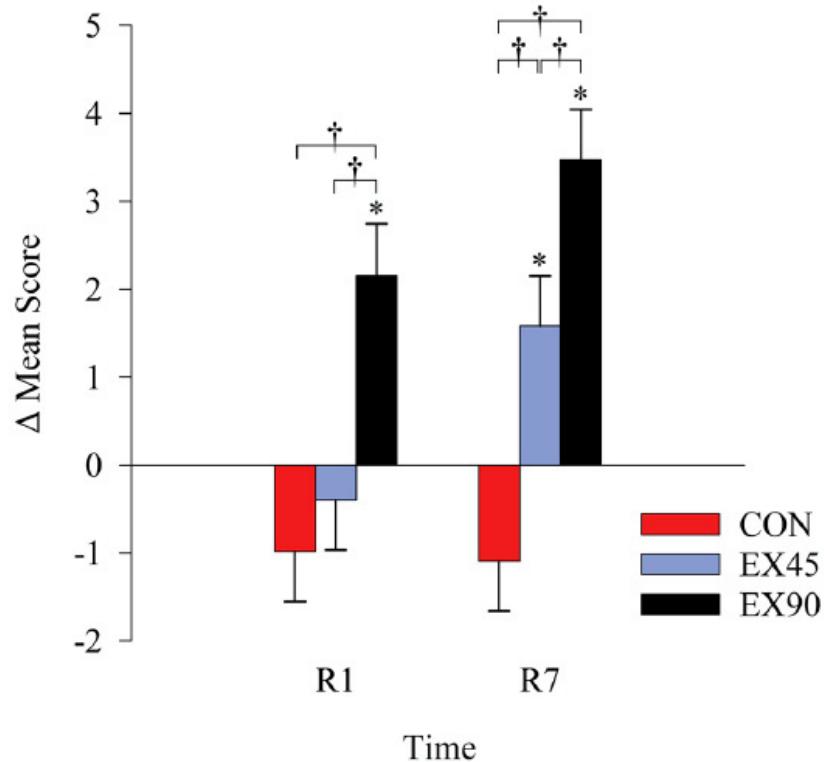
Dr. Benedikt Lauber, Magglingen, 25.10.2017

Ermüdbarkeit und Regeneration der Feinmotorik - *Intensität*



Thomas et al. 2016

Ermüdbarkeit und Regeneration der Feinmotorik - *Intensität*

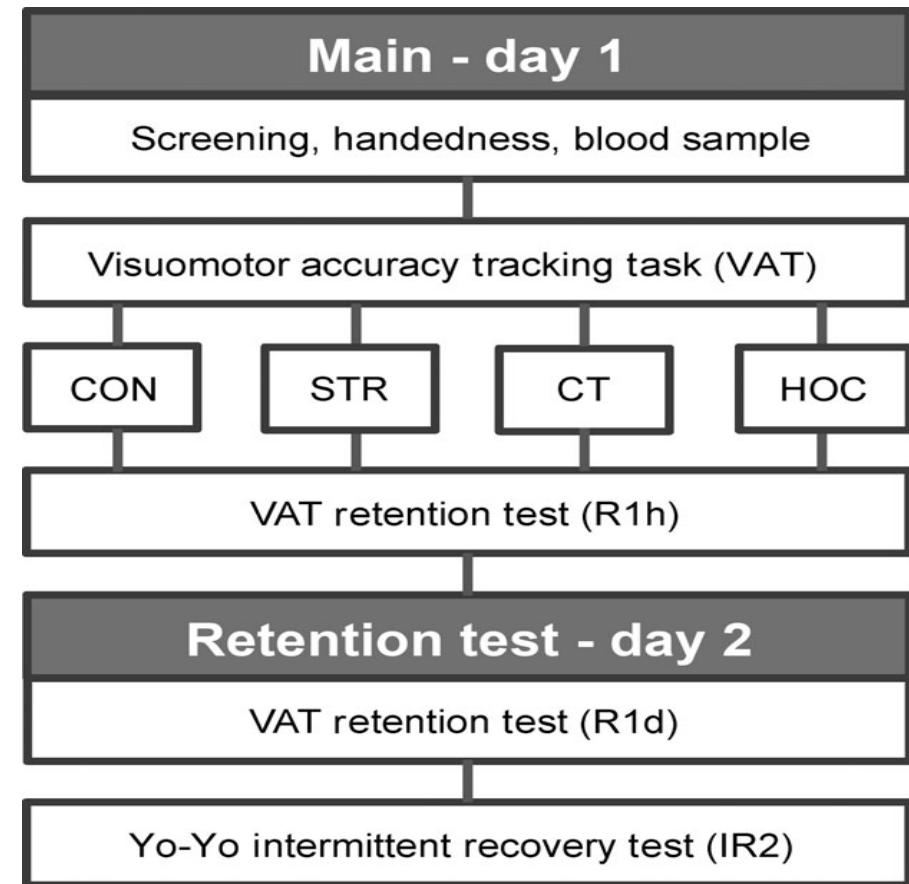
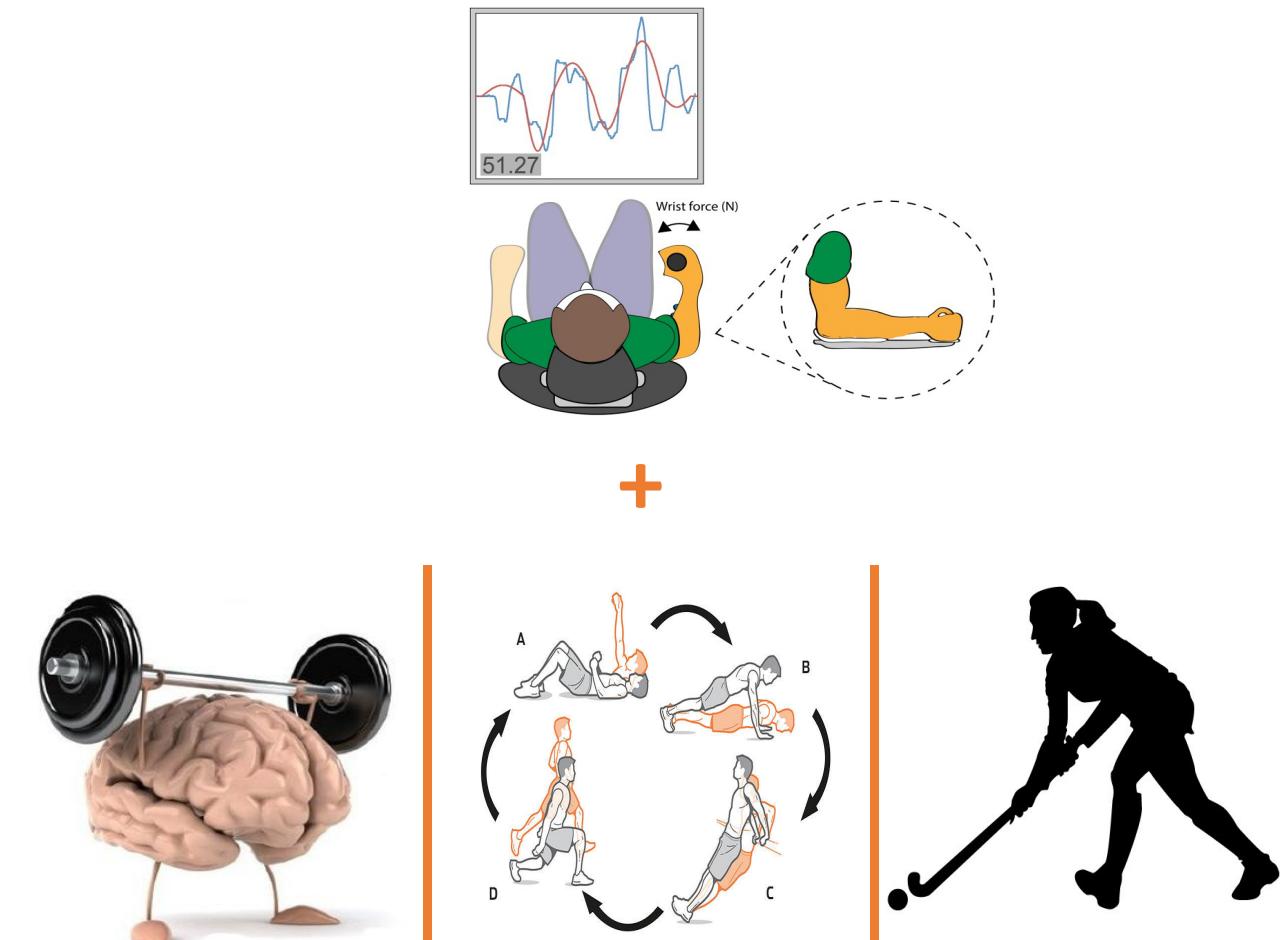


Hohe Intensität begünstigt Konsolidierung

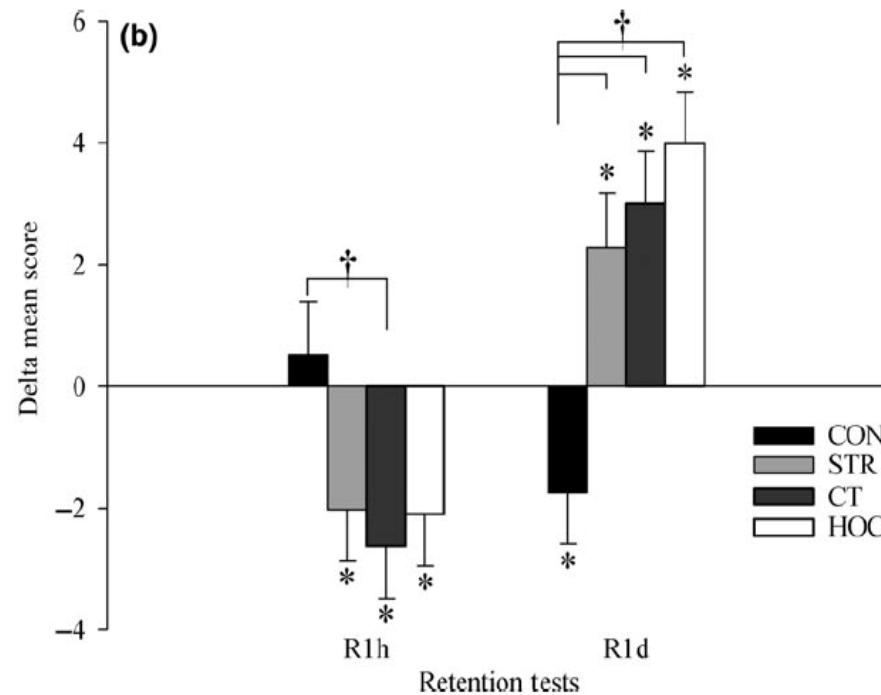
Thomas et al. 2016

Dr. Benedikt Lauber, Magglingen, 25.10.2017

Ermüdbarkeit und Regeneration der Feinmotorik - *Art*



Thomas et al. 2016

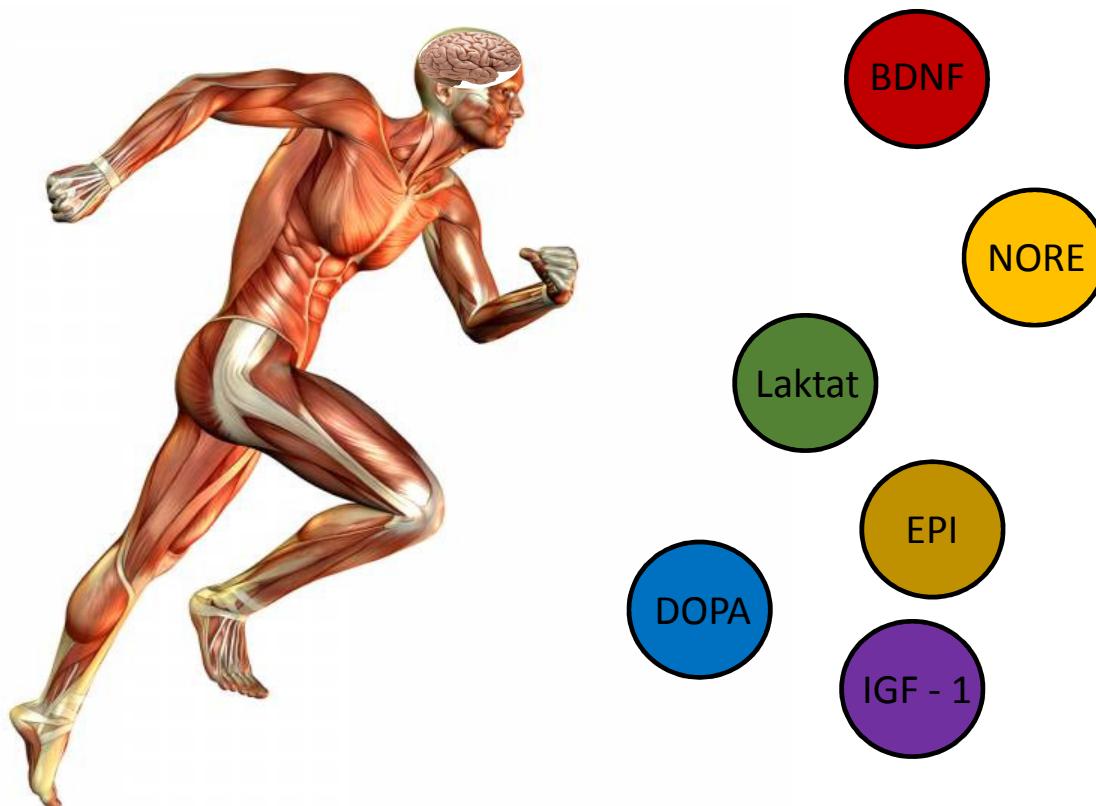


Art der Belastung beeinflusst Konsolidierung

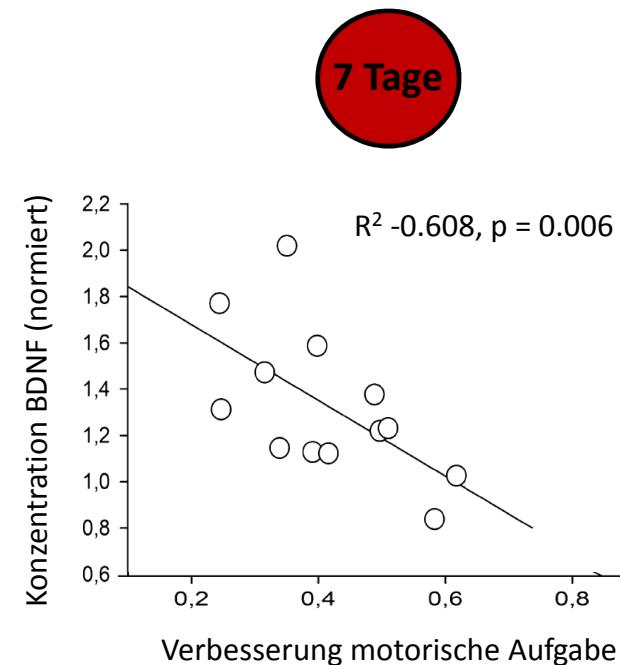
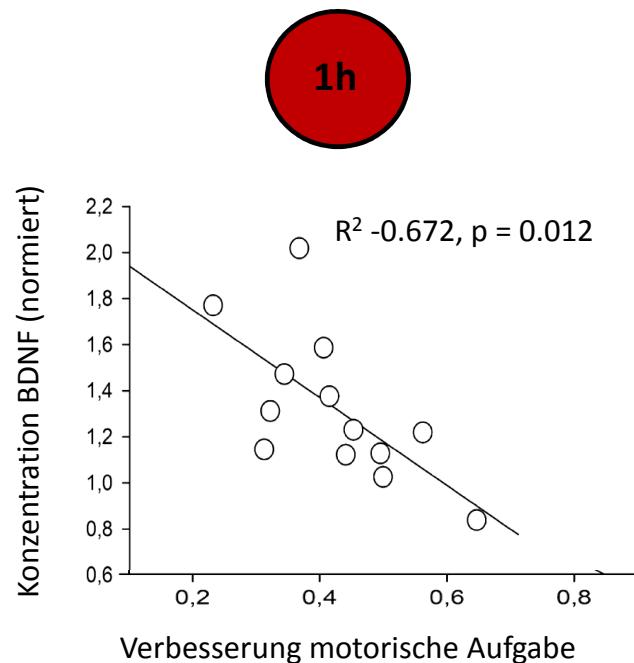
Thomas et al. 2016

Dr. Benedikt Lauber, Magglingen, 25.10.2017

Ermüdbarkeit und Regeneration der Feinmotorik - *Fazit*



Brain-Derived Neurotrophic Factor (BDNF)

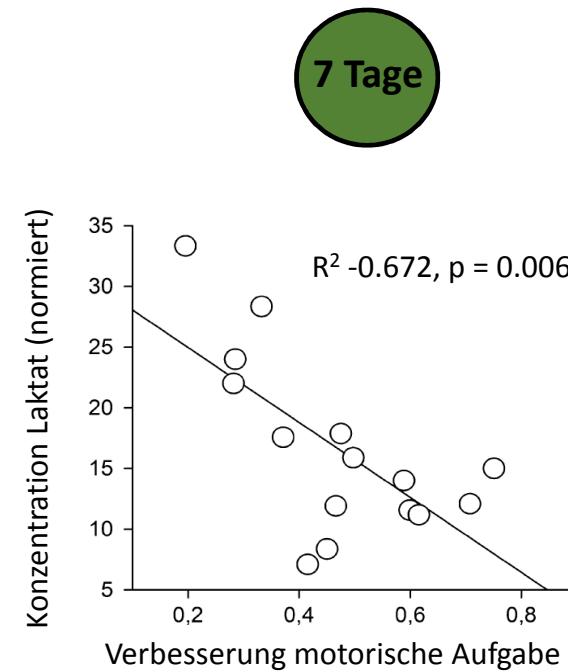
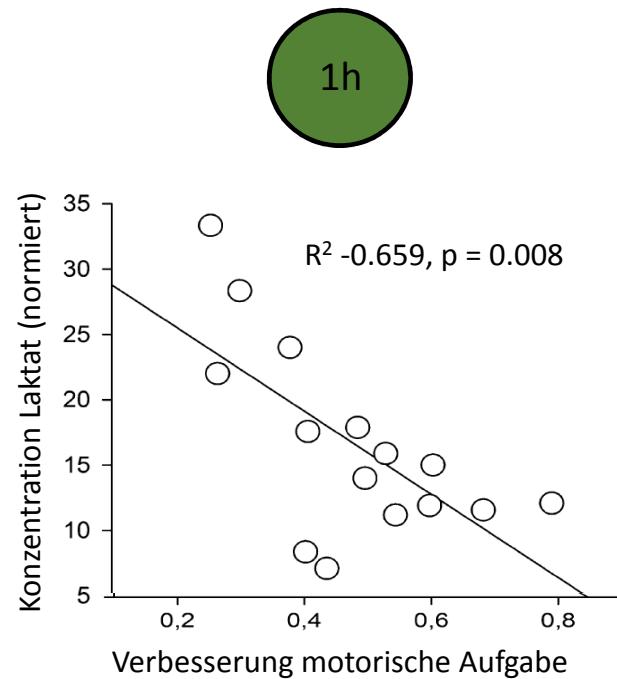


Skriver et al. 2014

Zusammenhang zwischen BDNF Konzentration und Kurz- und Langzeit- Gedächtniskonsolidierung

Ermüdbarkeit und Regeneration der Feinmotorik - *Fazit*

Laktat



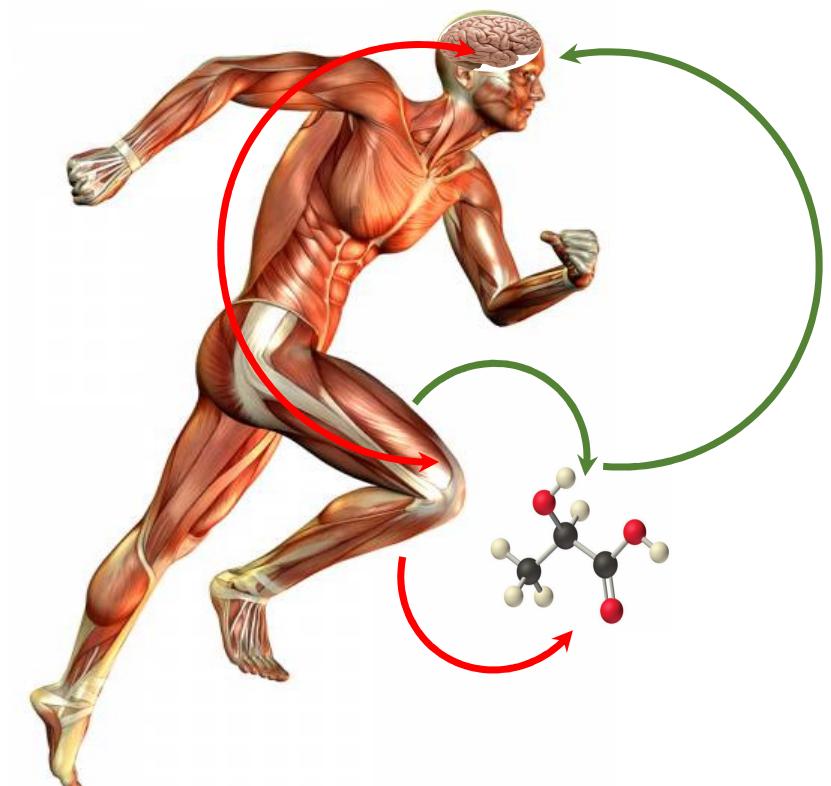
Skriver et al. 2014

Zusammenhang zwischen Laktatkonzentration und Kurz- und Langzeit- Gedächtniskonsolidierung

Ermüdbarkeit und Regeneration der Feinmotorik - *Fazit*

BDNF ist...

- in alle Schritte der Gedächtnisbildung eingebunden, wie z.B. Long Term Potentiation (LTP) (Korte et al. 1995; Vaynman et al. 2003; Bekinschtein et al. 2008; Gómez-Pinilla and Feng, 2012)
- Ist bei HIIT erhöht verglichen mit kontinuierlicher Belastung (Afzalpour et al. 2015)



Laktat reguliert viele Gehirnfunktionen wie...

- Überleben von Neuronen (Fünfschilling et al. 2012; Lee et al. 2012)
 - Axonale Myelinisierung (Rinholm et al. 2011)
- Gehirn-Metabolismus während körperlicher Belastung (van Hall et al. 2009; Boumezbeur et al. 2010)
- Rolle bei vermehrter Ausschüttung von neuronalen Wachstumsfaktoren wie BDNF (Coco et al. 2013)

Das Bewegte Gehirn - *Fazit*

Timing

- ✓ HIIT nach motorischem Lernen begünstigt Konsolidierung (und verhindert Interferenz)

Intensität

- ✓ Hohe Intensität begünstigt Konsolidierung

Art der Belastung

- ✓ Art der Belastung hat Einfluss auf Konsolidierung

Neuronale Erregbarkeit

- ✓ Hohe Erregbarkeit hängt mit Konsolidierung zusammen

BDNF & Laktat

- ✓ Wichtig für Konsolidierung

Einfluss auf Trainingsgestaltung, Wettkampf vorbereitung, Rehabilitation

Danke für die
Aufmerksamkeit

