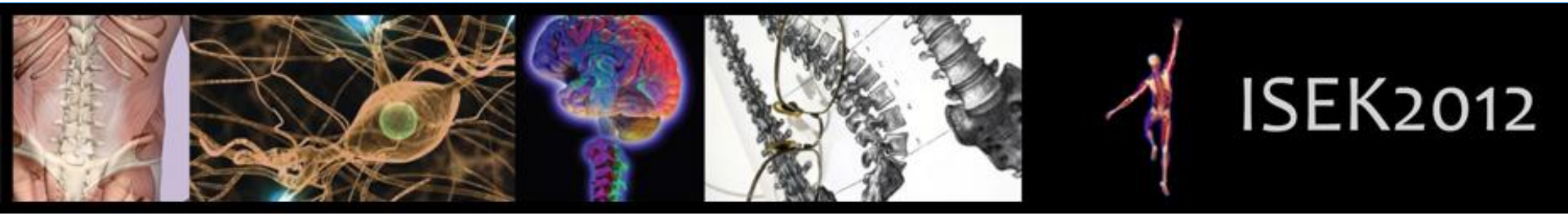

SIMPLIFICATION OF EMG DRIVEN BIOFEEDBACK OF SUB-MAXIMAL MULTI-JOINT LEG EXTENSIONS

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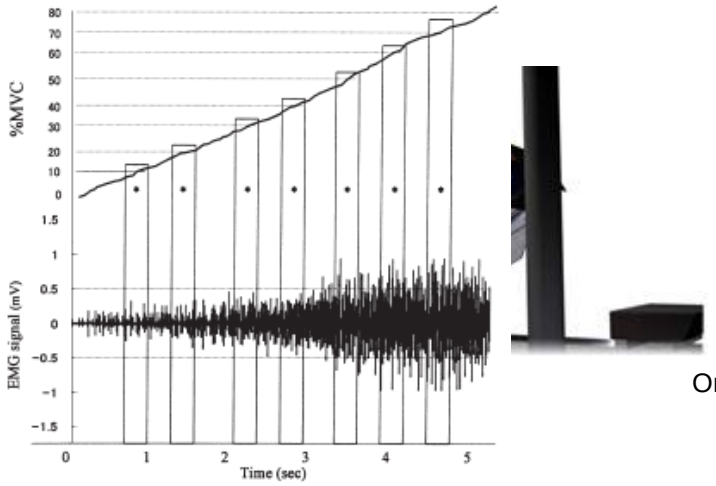
Standardization of submaximal voluntary muscle actions

For investigation of in vivo

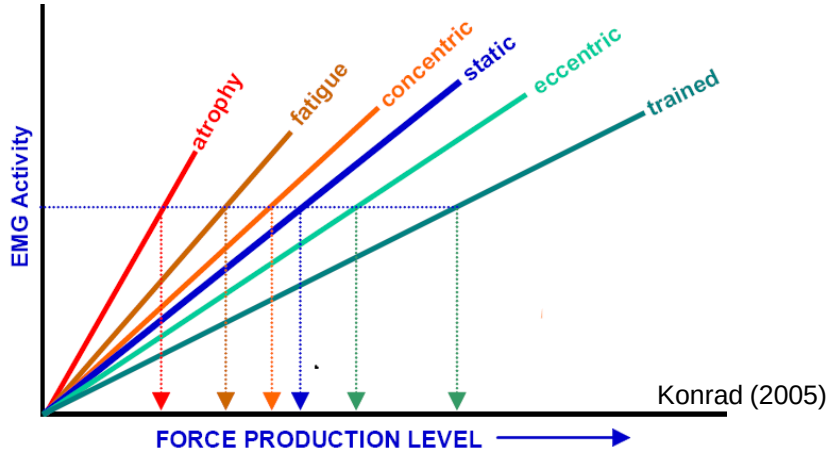
- Muscle-/ Neuromechanics
- Human strength-curves
- Contraction history effects

standardized

- Kinematics
- Intensity
  - Muscle activity
  - Muscle force, torque
  - ➢ Biofeedback
- EMG-Force Relation
  - Not necessarily linear
  - Influenced by several factors



Onishi, H. et al (2000)



Konrad (2005)

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Standardization of multi-joint movements

- Standardization of muscular activity for the investigation of sub-maximal multi-joint movements is crucial due to **motor redundancy** which offers an **infinite number of task-solving solutions**.

How to handle?

- In single-joint tasks, even with **more than one agonistic muscle**, feedback control is mostly given by one leading muscle that represents the whole muscle group (e.g. v. lateralis vs. m. quadriceps).

- In multi-joint setups it is questionable if one muscle is able to represent what happens during complex motion tasks.

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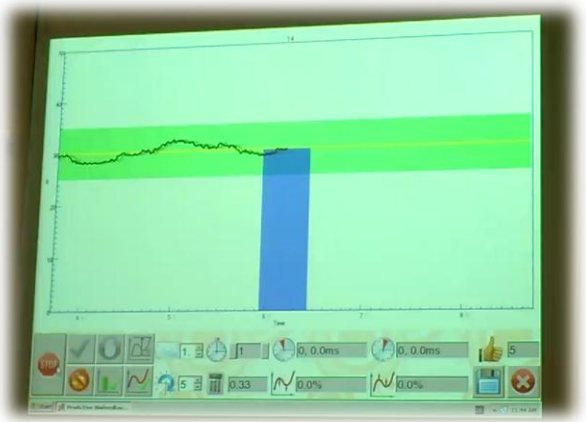
Methods

- N = 10 subjects
- 15 isometric (60° KFA) multi-joint leg extensions at 30% of individual maximum voluntary force (MVC), 30s each
- visual feedback of ground reaction force (GRF)
- EMG-Data of 9 muscles (right leg):

  Vastus lateralis (VL), Vastus medialis (VM), Rectus femoris (RF), Biceps femoris (BF), M. semitendinosus (ST), Mm. Gastrocnemii (GL & GM), M. soleus (SOL), M. tibialis anterior (TA)

Data processing:

- Filter: Butterworth High-/ Lowpass 10/500Hz
- Root-Mean-Square 500ms
- 6 Time segments (2s each)
- Normalized to mean maximum activation in MVC trials
- Means, correlations (Spearman) and statistics (ANOVA, t-test) calculated of trials 4 to 15



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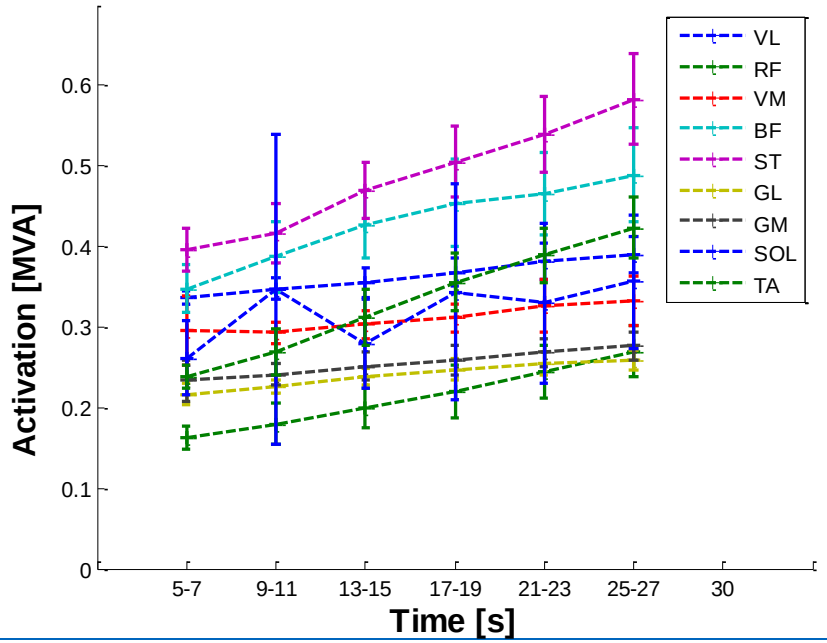
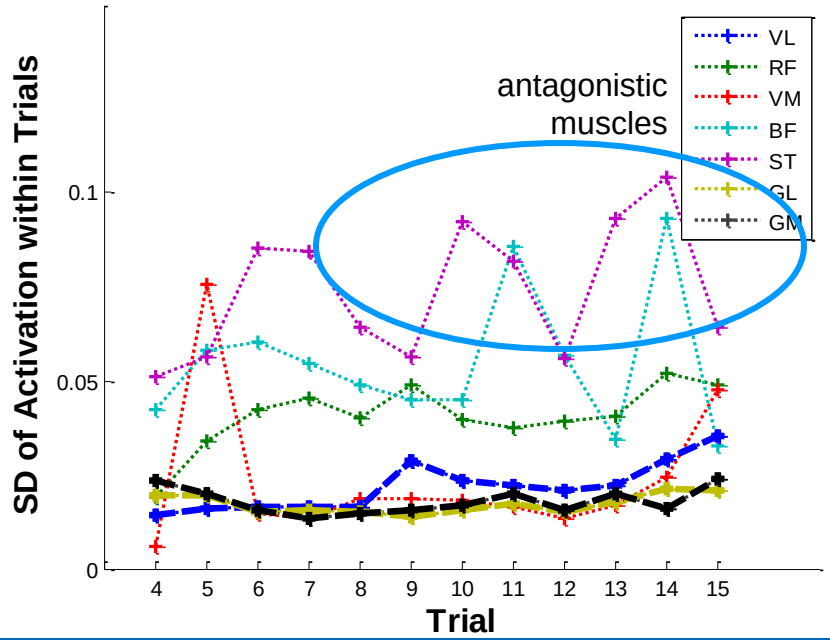
Results I

- No differences in GRF
- Activation increases thoughout time
- Lowest standard deviation (<3% MVA) in VL, GL and GM





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Results II

- High correlations between VL, GL and GM (r > 0.8)

		VL	RF	VM	GL	GM
Spearman-Rho	VL		,699*	,497	**,882****	**,846****
	RF	,699*		,392	,509	,420
	VM	,497**	,392		,591	,559**
	GL	**,882****	,509	,591		**,973****
	GM	**,846****	,420	,559	**,973****	

- Principal component analysis (agonistic muscles, 6 time segments, 12 trials, 10 subjects)

- 3 principal factors
  - **GM**/GL
  - VM
  - **VL**

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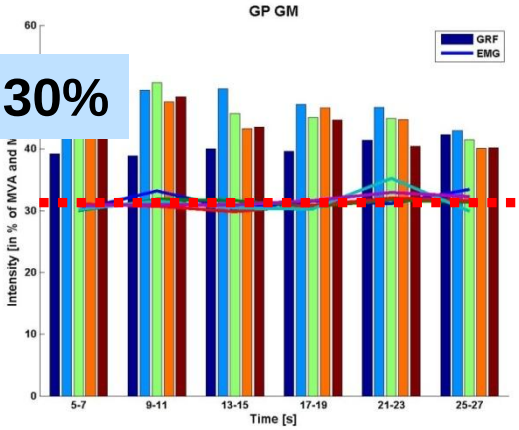
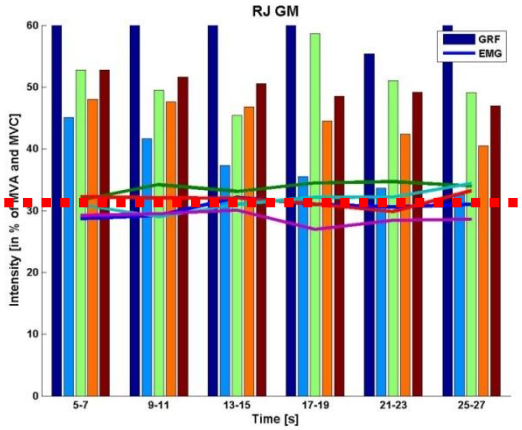
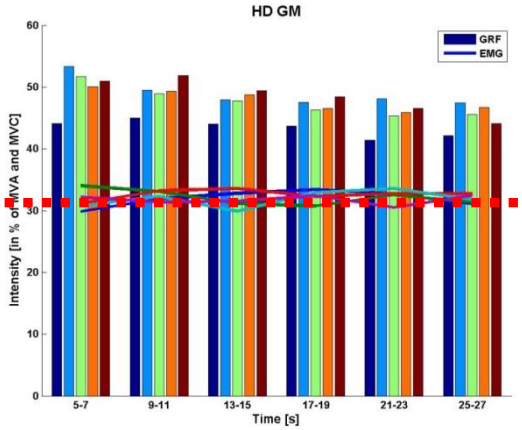
Results III
Re-Test EMG-Feedback; preliminary data

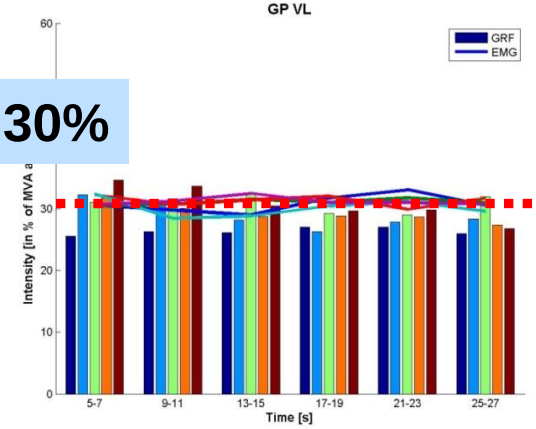
GM 30%

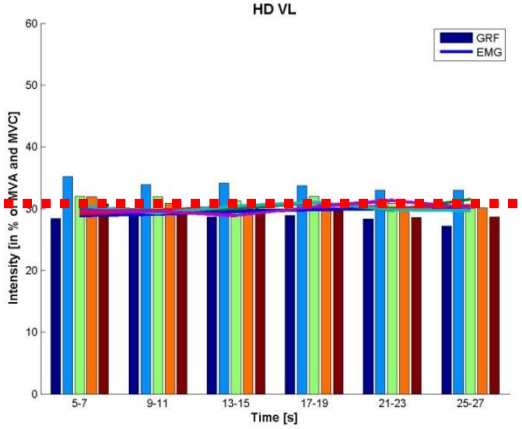


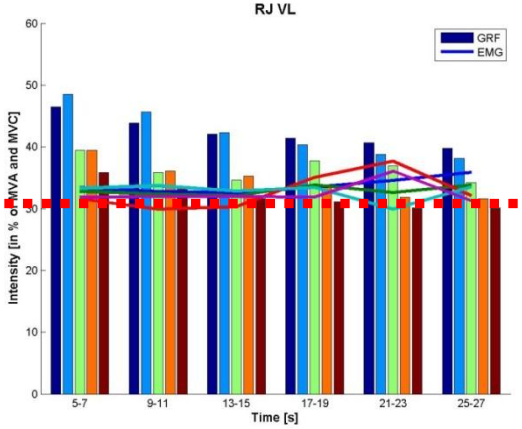




VL 30%







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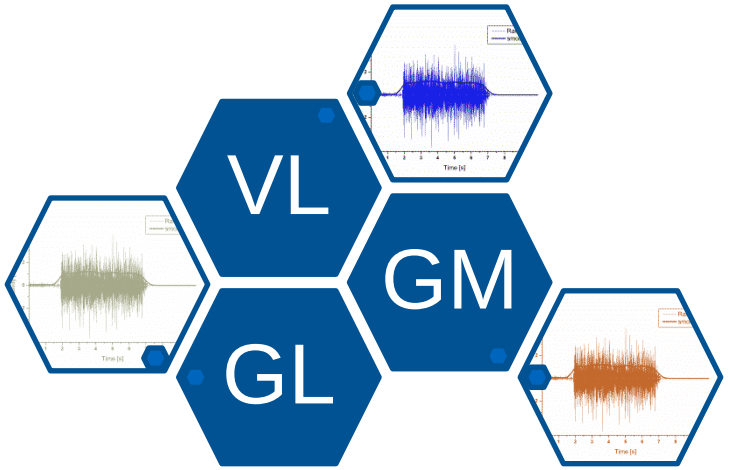
Conclusions

- Despite motor redundancy of the lower extremity our first results indicate that submaximal leg extensions can possibly be standardized by biofeedback of a single muscle.
- VL as well as GL or GM seem to be a good solution.
- Because of high correlations one of them might be representative for the rest.
- Control of GM activity leads to a higher proportion of GRF and variance.



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Thanks.

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