

TNO_ROM_EMG investigation

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Muscles:

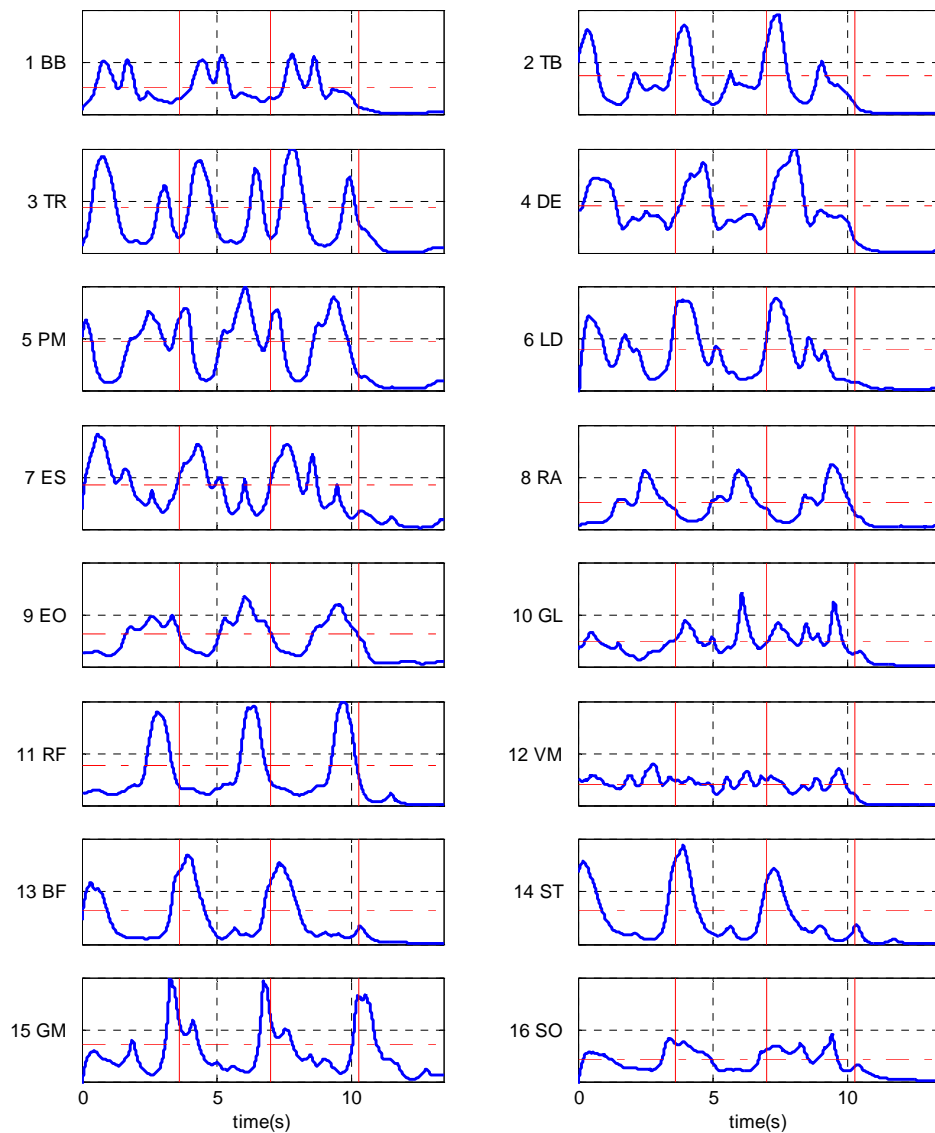
chan	region	top-bottom	abbr
electrode are placed right side unilaterally			
1	arm	biceps brachii	BB
2		triceps brachii (long head)	TB
3	shoulder region	trapezius (descendens)	TR
4		deltoideus (posterior)	DE
5		pectoralis major	PM
6	trunk	latissimus dorsi	LD
7		erector spinae (L1)	ES
8		rectus abdominis	RA
9		external oblique	EO
10	hip	gluteus max	GL
11	upper leg	rectus femoris	RF
12		vastus medialis	VM
13		biceps femoris	BF
14	lower leg	semitendinosus	ST
15		gastrocnemius medialis	GM
16		soleus	SO

Protocol of the exercises:

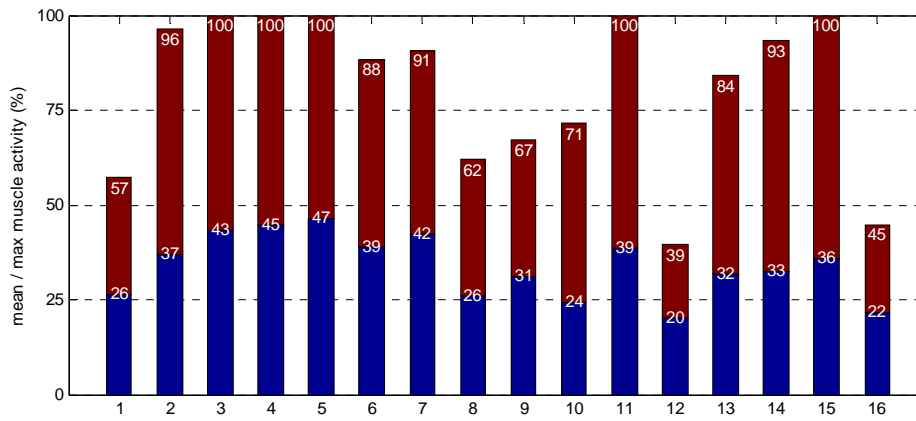
	body	movement	intensity	reps
			(%)	
1	upper	rowing	90	3
2		rowing	50	3
3		rowing	20	5
4	lower	stepping	90	4
5		stepping	50	5
6		stepping	20	5

- Intensity is indicated in percent of maximum voluntary contraction (%-MVC)

1) Upper body “rowing” at 90%-MVC

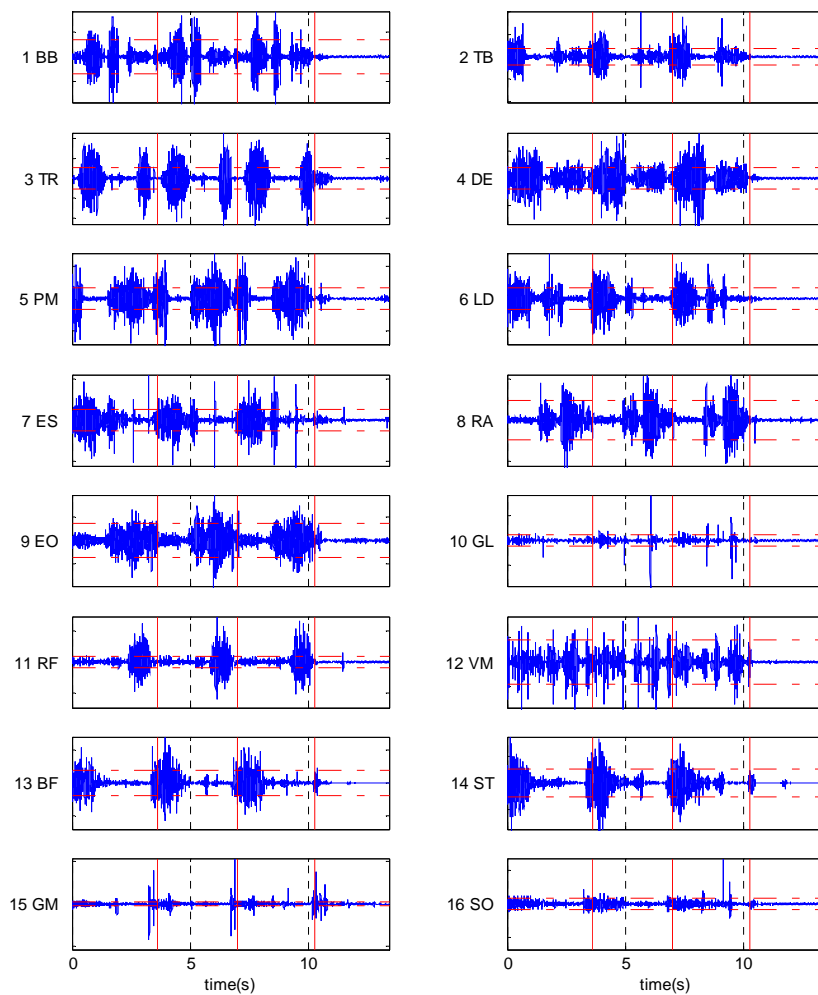


- EMG-activity in respect to MVC (the range [0-100%] is given by the box limitation)
- red vertical bars indicate the beginning of the stroke (most forward position)
- red horizontal dashed line indicates the mean value over the entire exercise



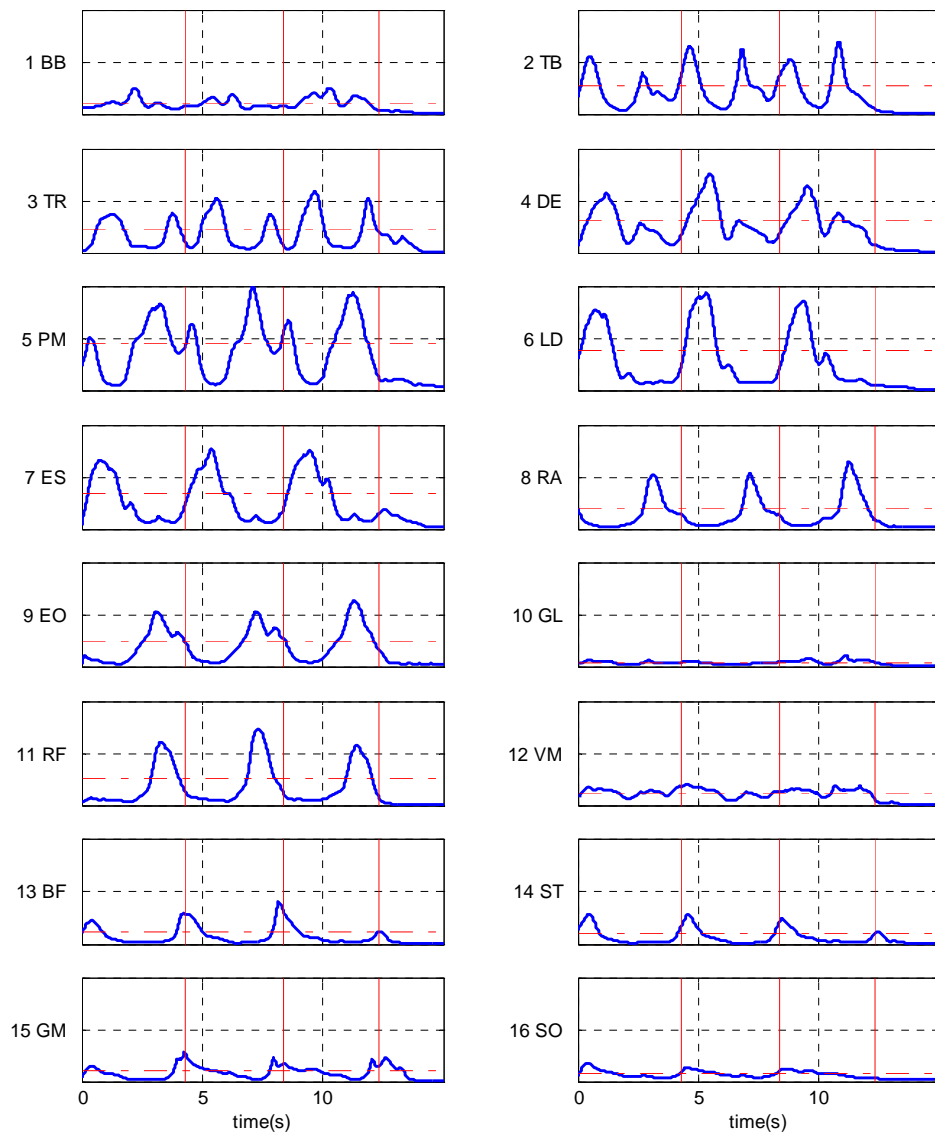
- mean and max activity over the entire exercise
- lower and higher values mean and maximum, respectively

Note, many muscles show 100%-MVC in this exercise, which is partly due to electrode artifact. In the following figure each EMG-signal is scaled to its max to recognize the “raw” EMG-patterns and artifacts. For instance gastrocnemius medialis (15) shows an artifact with very short and steep peaks. Even after filtering the signals (first figure of this exercise) this artifact could not be removed.

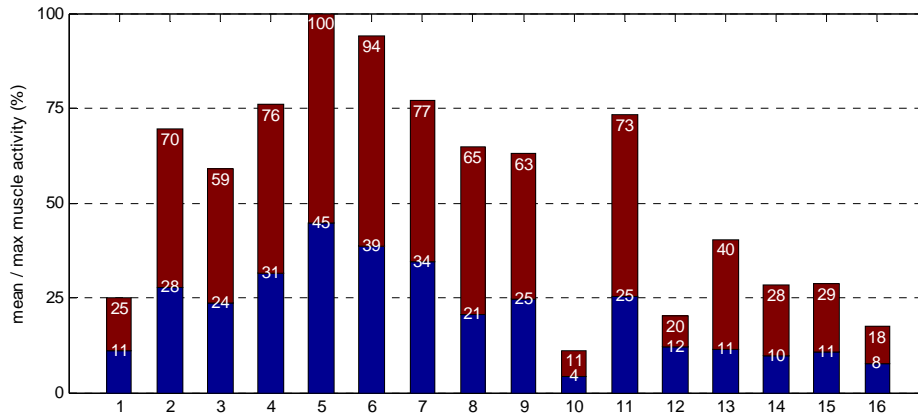


- “raw” EMG-signals, scaled to maximum amplitude
- red vertical bars indicate the beginning of the stroke (most forward position)
- red horizontal dashed lines indicates the MVC

2) Upper body “rowing” at 50%-MVC

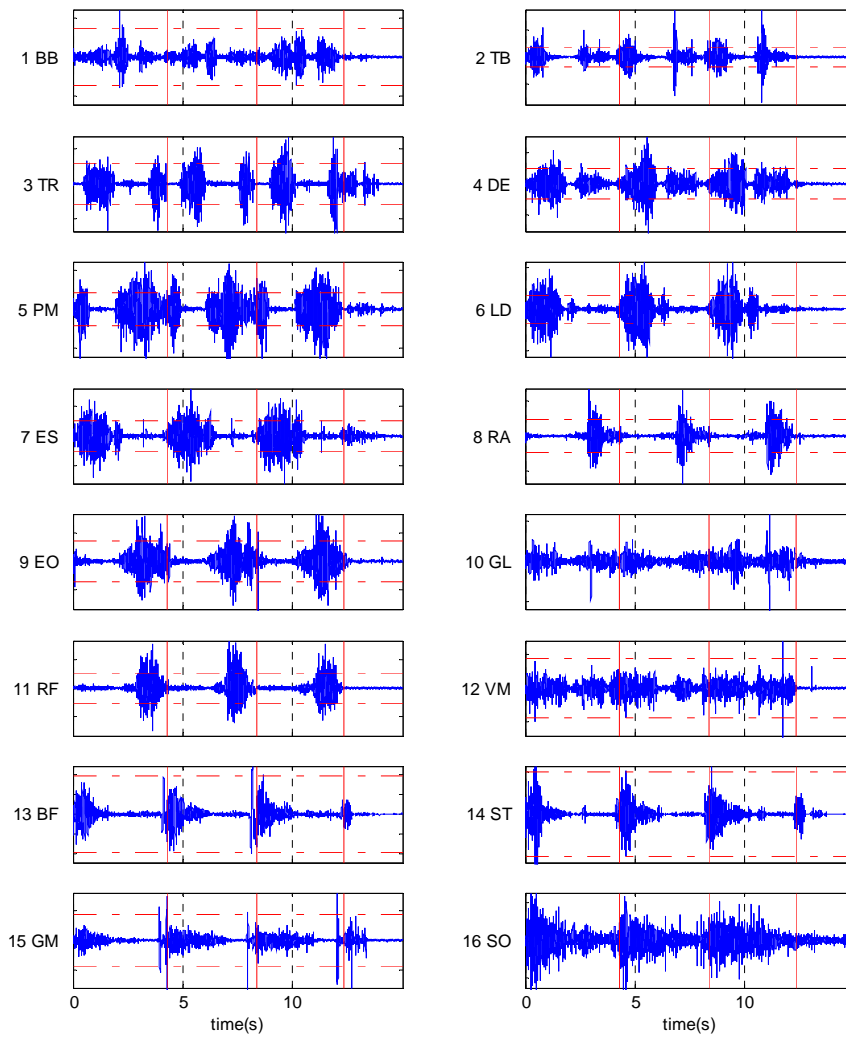


- EMG-activity in respect to MVC (the range [0-100%] is given by the box limitation)
- red vertical bars indicate the beginning of the stroke (most forward position)
- red horizontal dashed line indicates the mean value over the entire exercise



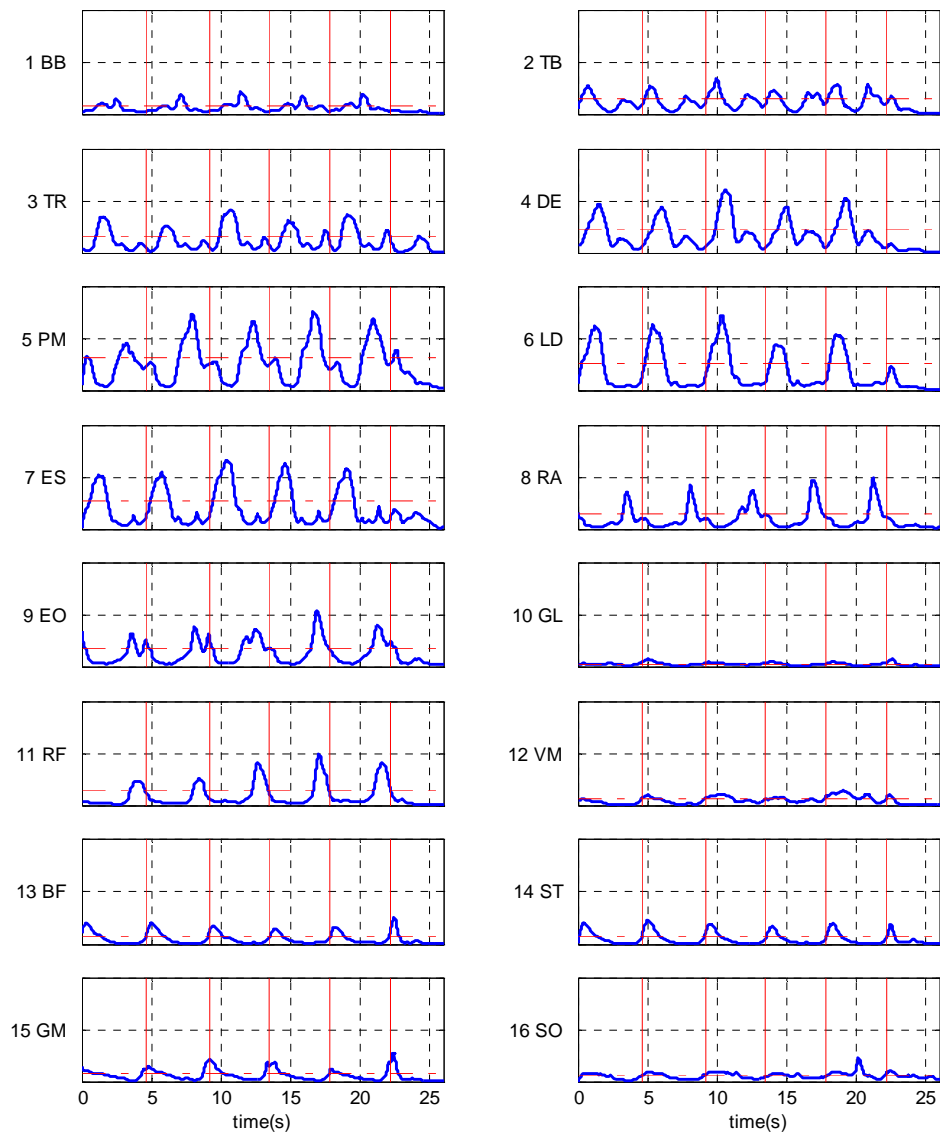
- mean and max activity over the entire exercise
- lower and higher values mean and maximum, respectively

Note, even if 50%-MVC was asked intense end of pushing was produced by pectoralis (5) and intense initiation of pulling were produced by latissimus (6).

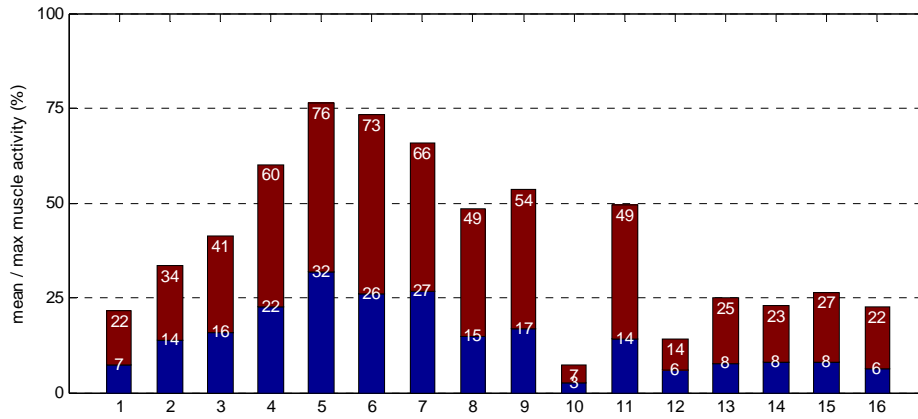


- “raw” EMG-signals, scaled to maximum amplitude
- red vertical bars indicate the beginning of the stroke (most forward position)
- red horizontal dashed lines indicates the MVC

3) Upper body “rowing” at 20%-MVC

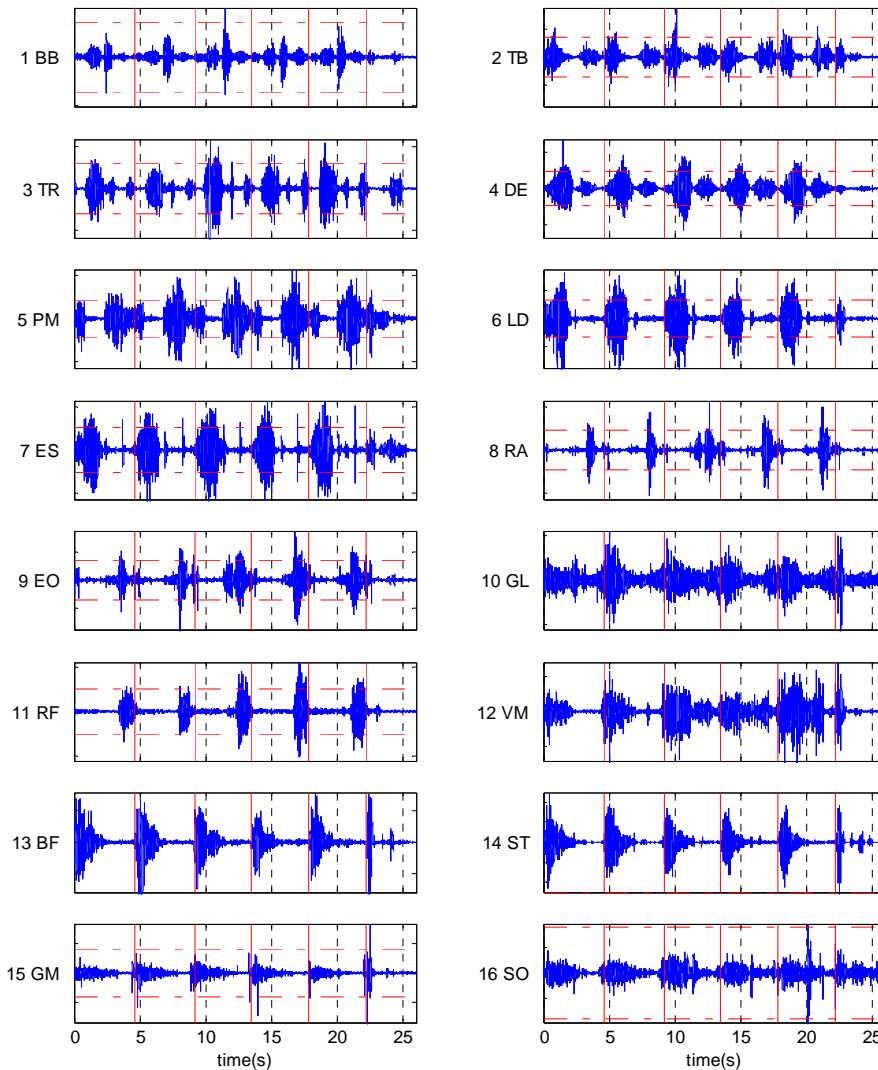


- EMG-activity in respect to MVC (the range [0-100%] is given by the box limitation)
- red vertical bars indicate the beginning of the stroke (most forward position)
- red horizontal dashed line indicates the mean value over the entire exercise



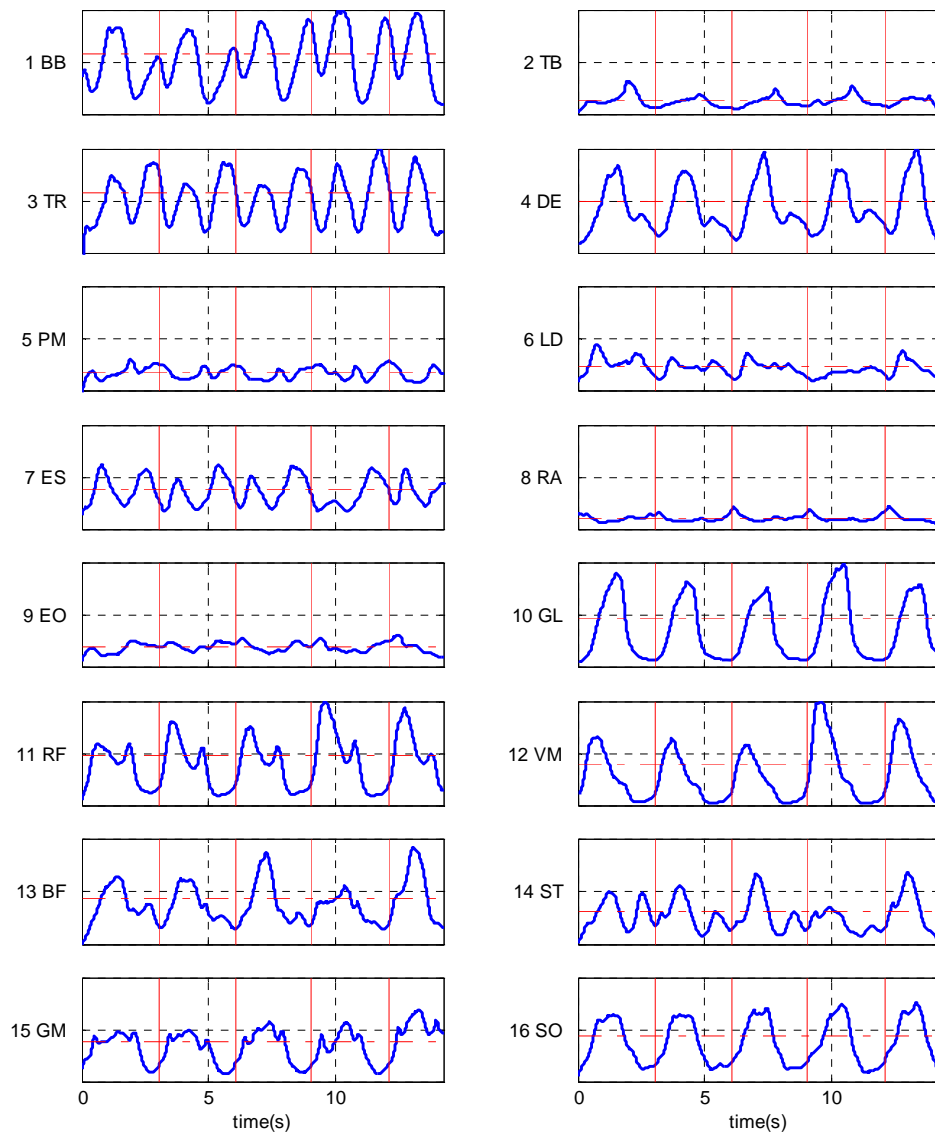
- mean and max activity over the entire exercise
- lower and higher values mean and maximum, respectively

Note, strongest muscle activities during this exercise are produced by pectoralis (5) whereas, gluteus (10) shows very low activities.

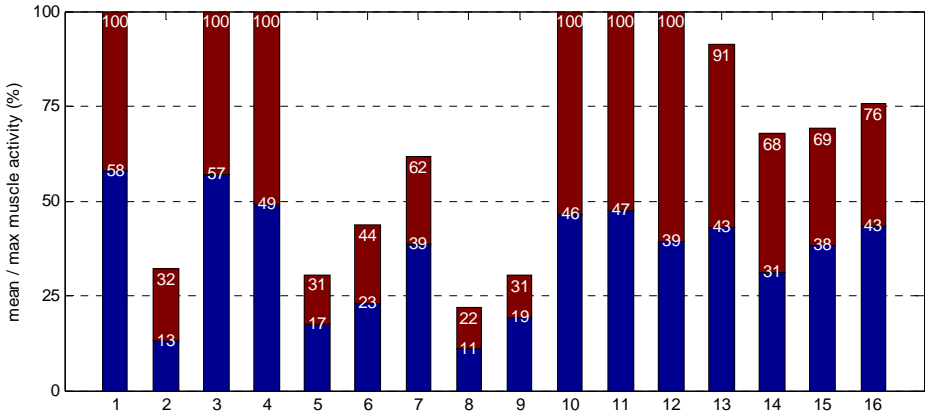


- “raw” EMG-signals, scaled to maximum amplitude
- red vertical bars indicate the beginning of the stroke (most forward position)
- red horizontal dashed lines indicates the MVC

4) Lower body “stepping” at 90%-MVC

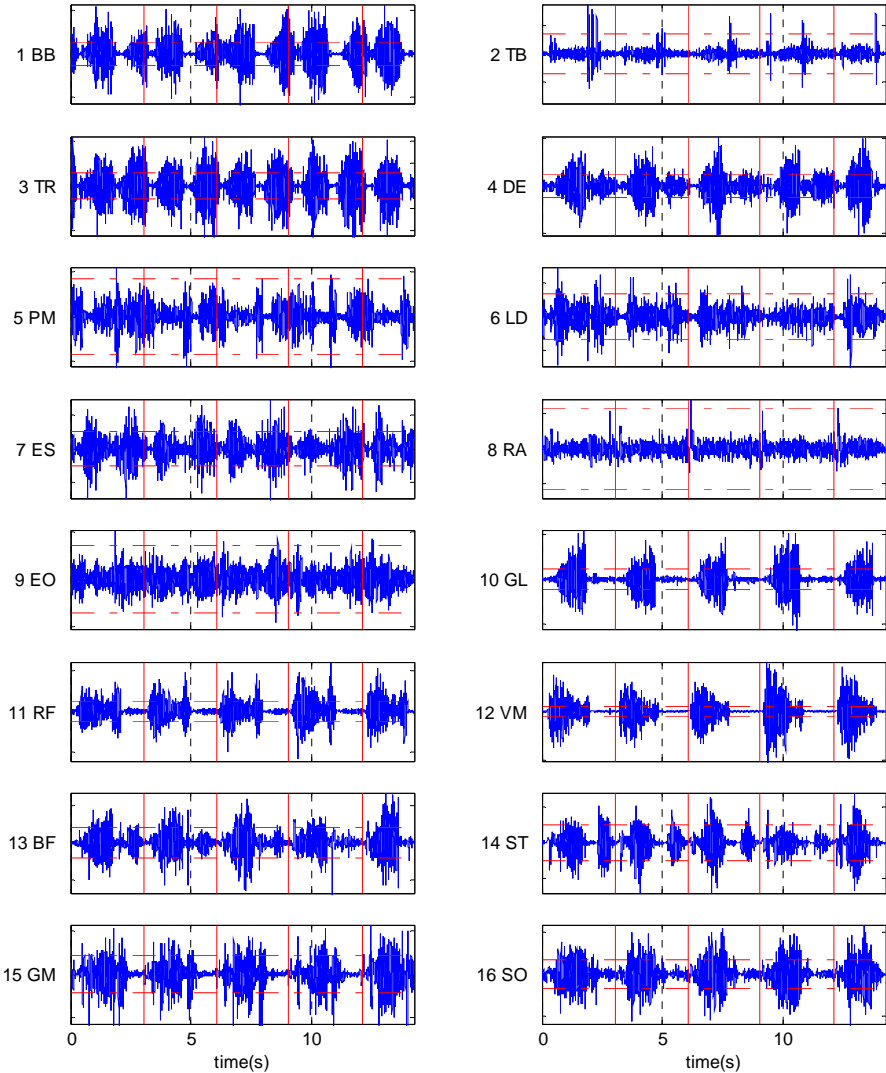


- EMG-activity in respect to MVC (the range [0-100%] is given by the box limitation)
- red vertical bars indicate the beginning of the push (left food up)
- red horizontal dashed line indicates the mean value over the entire exercise



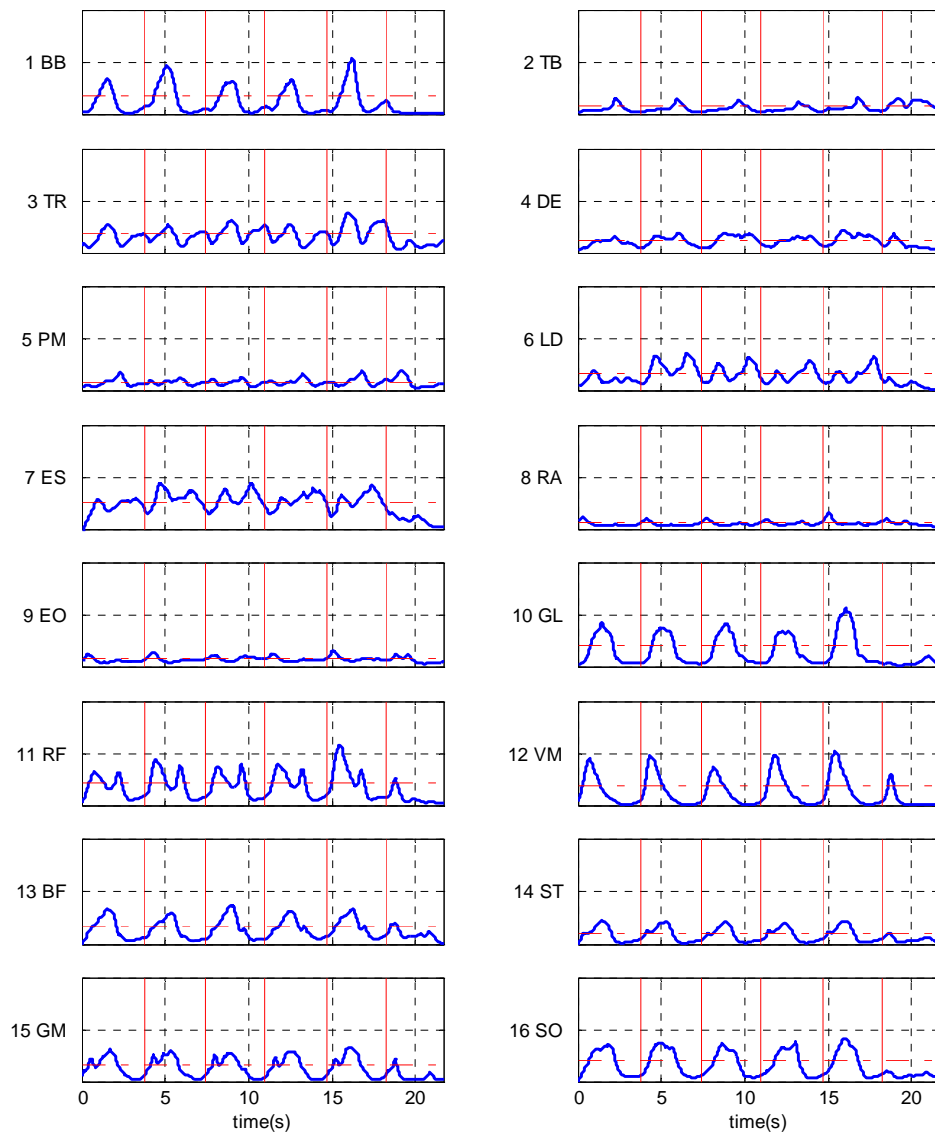
- mean and max activity over the entire exercise
- lower and higher values mean and maximum, respectively

Note, strong arm and shoulder flexor activities (1, 3, 4) pulls the body down to provide pressure against the pedal. Abdominal muscles of the trunk (8, 9) remain almost silent.

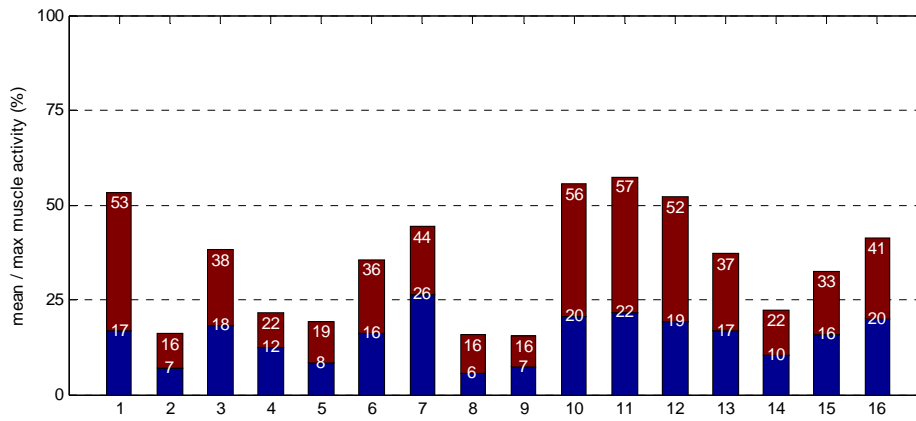


- “raw” EMG-signals, scaled to maximum amplitude
- red vertical bars indicate the beginning of the stroke (most forward position)
- red horizontal dashed lines indicates the MVC

5) Lower body “stepping” at 50%-MVC

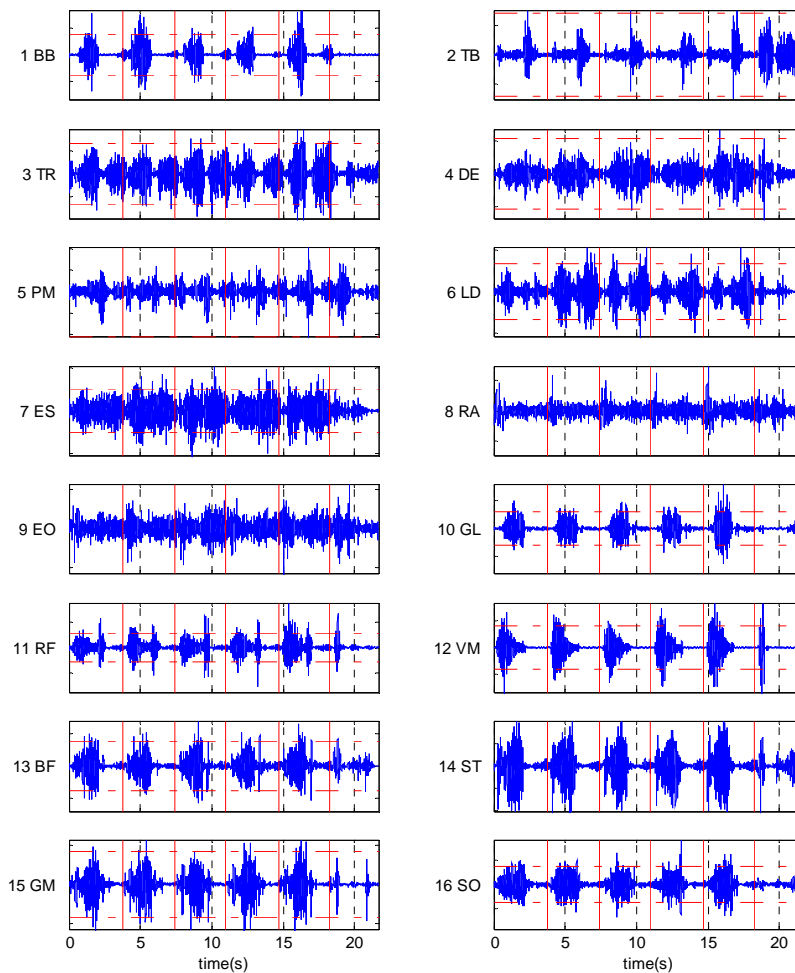


- EMG-activity in respect to MVC (the range [0-100%] is given by the box limitation)
- red vertical bars indicate the beginning of the push (left food up)
- red horizontal dashed line indicates the mean value over the entire exercise



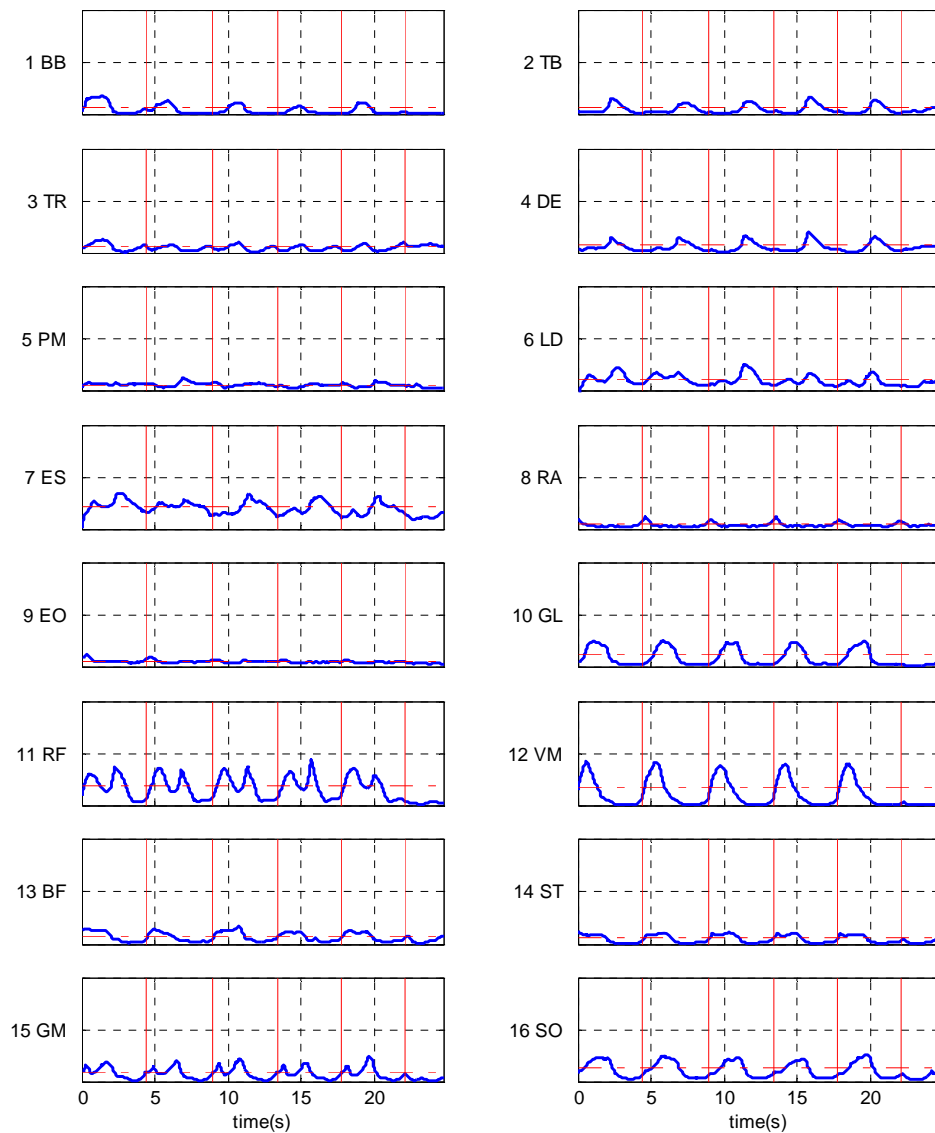
- mean and max activity over the entire exercise
- lower and higher values mean and maximum, respectively

Note, low activities for triceps brachii (2) and abdominal muscles (8, 9).

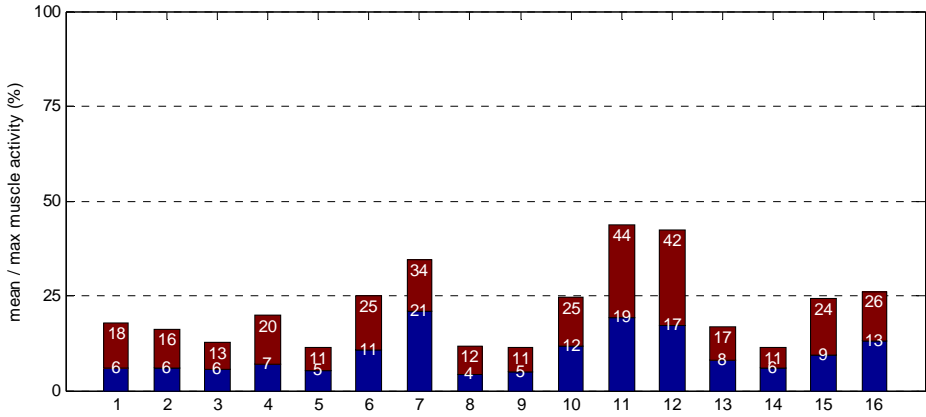


- “raw” EMG-signals, scaled to maximum amplitude
- red vertical bars indicate the beginning of the stroke (most forward position)
- red horizontal dashed lines indicates the MVC

6) Lower body “stepping” at 20%-MVC

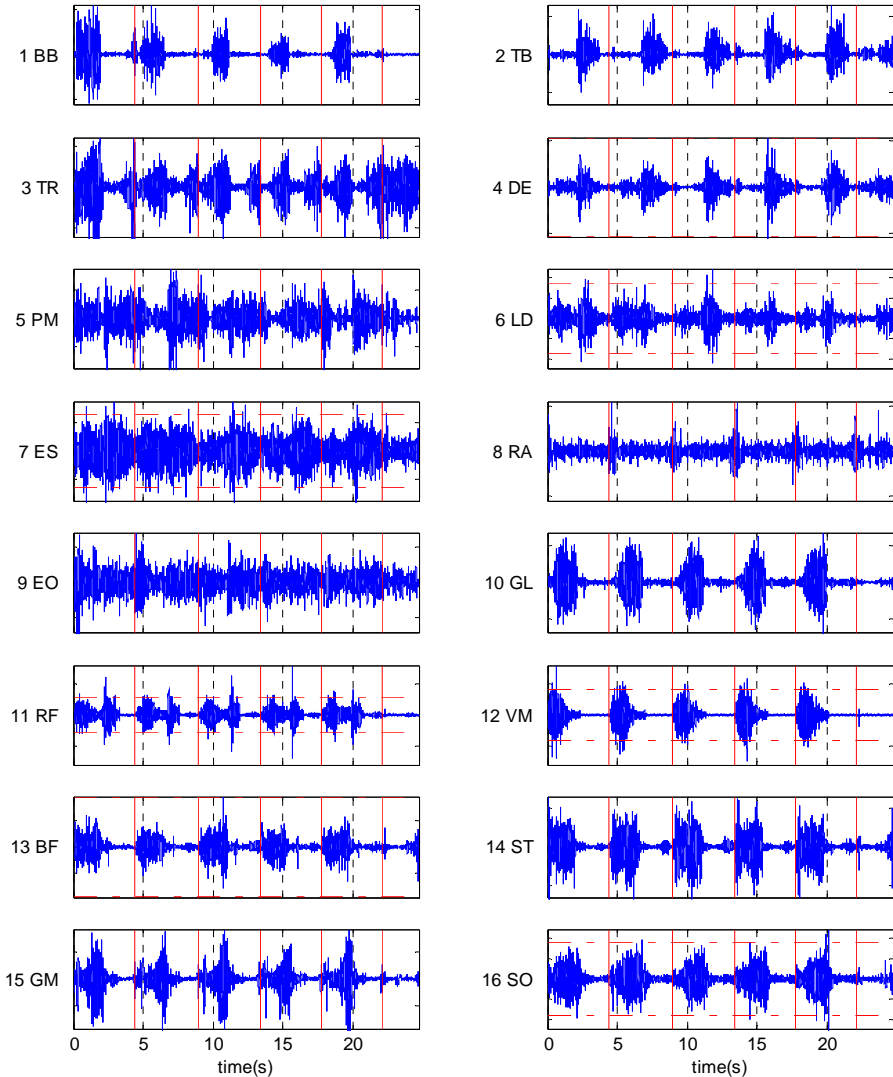


- EMG-activity in respect to MVC (the range [0-100%] is given by the box limitation)
- red vertical bars indicate the beginning of the push (left food up)
- red horizontal dashed line indicates the mean value over the entire exercise



- mean and max activity over the entire exercise
- lower and higher values mean and maximum, respectively

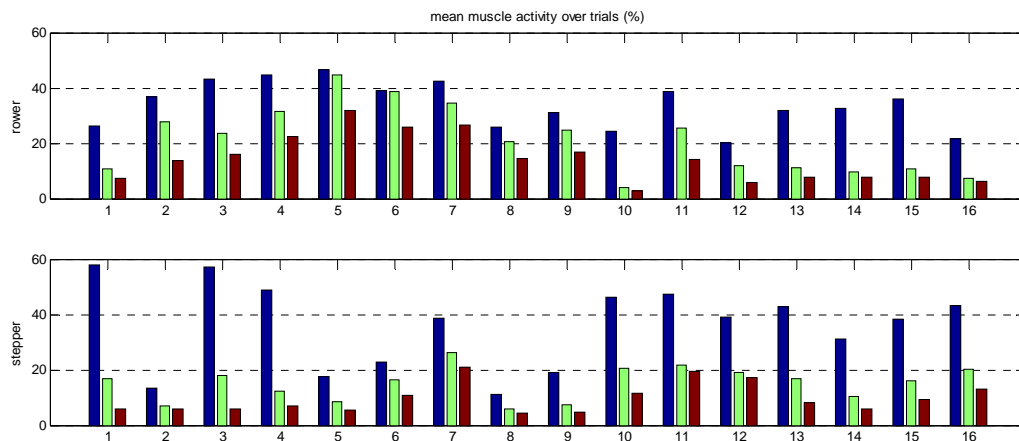
Note, very low activities for triceps brachii (3) and abdominal muscles (8, 9), whereas middle activities for the quadriceps muscle (11, 12).



- “raw” EMG-signals, scaled to maximum amplitude
- red vertical bars indicate the beginning of the stroke (most forward position)
- red horizontal dashed lines indicates the MVC

Overview of all exercises

	body	movement	intensity	reps
			(%)	
1	upper	rowing	90	3
2		rowing	50	3
3		rowing	20	5
4	lower	stepping	90	4
5		stepping	50	5
6		stepping	20	5



- 3 bars show 3 intensities (90%, 50% and 20%-MVC, left - right)

Final conclusions

- Highest muscle activities are reached with ROM. This is possible since ROM works in dynamic contractions, whereas the MVCs were done during isometric contractions
- “rowing”:
 - o As expected the upper body (1-5) and the trunk muscles (6-9) are especially active and thus trained during this exercise
 - o A strong drop of gluteus (10) from 90% to 20/50%-MVC, which is also the case for hamstrings (13, 14) and triceps suare (15, 16) muscles. Thus muscles of the lower body are especially active in high intensities.
- “stepping”:
 - o As expected the lower body (10-16) is especially trained.
 - o For high intensities (90%-MVC) all muscles pulling the body down (1, 3, 4) are strongly active during almost the entire exercise cycle. Whereas at lower contraction intensities (20, 50%-MVC) a strong drop in muscle activities was performed. This is probably due because this movements could be done in using the body weight instead of muscle force.