higher discharge rates of the recruited motor units. Further analysis should investigate if the higher activation of VM relative to the VL in CKC versus OKC is related to differences in motor unit behavior.

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3 NMF/MC

Stretching-induced crossover effect: partitioning the mechanisms by an EMG, MMG and force combined approach

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Aim: After an acute bout of passive stretching (PS), the performance of the stretched muscle (SM) is depressed [1]. Often this occurs also in the contralateral muscle (CM), which is not involved in the PS manoeuvre [2]. This phenomenon is called crossover effect. Mechanisms underpinning PS-induced crossover effect are still unclear. The use of an electromyographic (EMG), mechanomyographic (MMG), and force (F) combined approach may help to shed more light on this phenomenon [3].

Methods: Twenty-one participants (age: 22 ± 3 years; stature: 1.75 ± 0.08 m; body mass: 73 ± 9 kg, mean ± SD) underwent a single-leg PS-bout (5 elogantions of 45 s) of the knee extensor muscles (KE). Before and after, the maximum voluntary contraction (MVC), the percentage of muscle activation, detected by the interpolated twitch technique (VA $_{\%}$), and the range of motion (ROM) of the KE of both legs were measured. During contraction, EMG, MMG and F were recorded from the vastus lateralis, medialis and rectus femoris muscle of SM and CM. The total electromechanical delay ($Delay_{TOT}$) and its components (Δt EMG-MMG, electrochemical component; Δt MMG-F, mechanical component) were calculated off-line for each muscle.

Results: After PS, MVC and VA % decreased in both legs (−15 and −10% SM, −8 and −7% CM; P from 0.01 to <0.001). The ROM increased (+14% SM, +6% CM; $P = 0.02$ and 0.04). Independently from the muscle, $Delay_{TOT}$ (+20% SM, +12% CM; $P = 0.007$ and 0.01) and Δt EMG-MMG lengthened in both legs (+24% SM, +12% CM; $P = 0.002$ and 0.009), whereas Δt MMG-F lengthened only in SM (+28%, $P < 0.001$).

Conclusions: The present findings suggest that PS-induced crossover effect seems to be due to alterations in the chain of electrochemical events linked to the excitation–contraction coupling (longer Δt EMG-MMG) likely provoked by a decrease in the central motor command (reduced MVC and $VA_{\%}$).

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4 NMF/MC

Effects of marathon fatigue on the discharge rates of individual motor units in older adults

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Aim: Age-related changes in motor unit properties are essential to understand muscle behavior after exercise in older adults. In this study, we compared the changes in motor unit discharge rates during steady isometric contractions before and after a half-marathon in elderly individuals.

Methods: During the event Run4Science, we recorded high-density surface electromyography (HD-sEMG, 128 channels) on the tibialis anterior muscle (TA) in eight old subjects. Subjects executed a 40 s static dorsiflexion at 25% MVC. The test was performed in two consecutive days, the first under non-fatigue conditions before half-marathon (BM) and the second immediately after half-marathon (AM). Using a novel decomposition technique for HD-sEMG recordings (Negro et al. 2016), we compared the changes in the discharge properties of the TA motor units before and after the half marathon. We calculated the global average discharge rate value (GADR) of all MUs in the two conditions. Only MU pulse trains with a silhouette measure > 0.9 were used in the study.

Results: We extracted the individual contribution of 486 unmatched MUs (∼ 30 per contraction). The GADR were 13.43 ± 1.46 (pps) and 14.89 ± 1.67(pps) for the BM and AM conditions respectively. Paired T-test analysis showed a significant difference between conditions ($P < 0.05$).

Conclusion: The results showed that the discharge rates of the identified MUs increase after the half-marathon. Future work will focus on the tracking of the same MU in the two conditions (Martinez-Valdes 2017) in order to increase the sensitivity of the estimation.

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5 NMF/MC

Motor output relative error during static linear maximal torque ramp: influence of the age

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Aim: To evaluate if the torque output relative error during linearly varying static contractions can be influenced by possible changes in

motor unit properties and activation/deactivation strategies (MUAS and MUDS) due to the ageing process.
Methods: Eleven young (Y, 23.90 ± 3.72 years) and eleven old (O, 69.63 ± 4.34 years) subjects were recruited for the study. After the measurement of first dorsal interosseous (FDI) maximal voluntary contraction (MVC) during static abduction, the subject performed one triangular isometric contraction (0-100-0%). The rate of the up-going (UGR) and down-going ramp (DGR) was 13.3% MVC/s. The requested output tension (% MVC target) was provided on a pc screen together with the force from the subject for the necessary visual feedback. The global relative errors (E %) were calculated, for the whole triangle and for the up going and down-going phases separately, according to the formula E % = absolute value of (exerted—requested target force)/requested target force*100. The filtered force signal (bandwidth: 0–20 Hz) was also analyzed using the Spike Shape Analysis (SSA) technique. Statistical significance of the calculated parameters between Y and O was set at $p < 0.05$.
Results: As reported in the table the calculated E % were always greater in old subjects. The SSA reported lower number of longer spikes, with similar absolute amplitude, in O with respect to Y subjects. When the spike amplitude is scaled to the individual MVC the spikes of O subjects are greater than in Y.

	Time interval of contraction	Young	Old	Young vs Old Statistical Significance
E %	1.25 - 13.75 s (UGR + DGR) % Relative Error [%]	9.52 ± 1.85	16.81 ± 4.95	**
	1.25 - 7.5 s (UGR) % Relative Error [%]	9.98 ± 2.77	16.15 ± 7.06	*
	7.5 - 13.75 s (DGR) % Relative Error [%]	9.06 ± 1.69	17.47 ± 7.93	**
SSA	**1.25 - 13.75 s** (UGR + DGR)			
	Number of spikes [#]	20.27 ± 3.49	13.09 ± 3.38	**
	Relative average spike amplitude [%MVC]	6.81 ± 1.78	11.88 ± 4.36	**
	1.25 - 7.5 s (UGR)			
	Number of spikes [#]	10.27 ± 2.37	7.17 ± 1.83	*
	Relative average spike amplitude [%MVC]	7.94 ± 3.26	12.60 ± 5.25	*
	7.5 - 13.75 s (DGR)			
	Number of spikes [#]	10.00 ± 2.40	5.90 ± 2.16	**
	Relative average spike amplitude [%MVC]	6.10 ± 1.6	12.06 ± 6.71	*

* p<0.05 **p<0.001

Conclusion MUAS and MUDA adopted by Y and O subjects determine a more precise motor output in Y than in O. The key factors may be: a. the larger number of error correction (reflected in the spike number) and b. the larger motor unit size due to the muscle fibers re-innervation process with age (reflecting the larger relative spike amplitude in O compared to Y).

6 NMF/MC
Electromechanical delay components after acute effect of direct inhibitory pressure: new insights from an EMG, MMG and force combined approach

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Aim: Direct inhibitory pressure (DIP) is commonly used to enhance joint range of motion and decrease the perceived level of soreness [1]. A force (F) reduction is often reported after DIP [2]. Factors underpinning F reduction are still under debate, and the intervention of the autogenic inhibitory reflex seems is the most accredited mechanism. The partitioning of the total electromechanical delay ($Delay_{TOT}$) into an electrochemical and mechanical component may help in clarifying possible mechanisms involved in the DIP-induced F reduction [3].
Methods: $Delay_{TOT}$ partitioning was assessed by electromyographic (EMG), mechanomyographic (MMG), and F combined approach during maximum voluntary contraction (MVC) of the plantar flexor (PF) and dorsiflexor muscles (DF) in twenty-four participants (age: 23 ± 2 years; stature: 1.67 ± 0.12 m; body mass: 65 ± 15 kg, mean ± SD). Measurements were performed before and after DIP, which consisted in a constant pressure applied with the thumb at the PF myotendinous junction. Three conditions were tested: DIP lasting 10 s (DIP_{10}); 30 s (DIP_{30}); and without DIP (control, Ctrl). During contraction, EMG, MMG and F were recorded from the medial, lateral gastrocnemius, soleus and tibialis anterior muscles. $Delay_{TOT}$ and its components (Δt EMG-MMG, electrochemical component; Δt MMG-F, mechanical component) were calculated off-line.
Results: MVC of PF decreased significantly by 8 and 10%, in DIP_{10} and DIP_{30}, respectively, compared to Ctrl ($P = 0.002$). MVC of DF increased significantly by 10 and 7% in DIP_{10} and DIP_{30}, respectively, compared to Ctrl ($P = 0.001$). $Delay_{TOT}$ and its components increased significantly in PF in DIP_{10} and DIP_{30}, and decreased in DF only in DIP_{30} ($P = 0.002$).
Conclusions: The present findings suggest that the AIR intervention could explain the changes in F in agonist and antagonist muscles after DIP. The lengthening of Δt MMG-F seems to indicate a concomitant alteration in the myotendinous junction's mechanical properties, altering F transmission to the muscle insertion point.

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7 NMF/MC
Reliable identification of motor unit discharge timings during ballistic contractions of the tibialis anterior muscle

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Aim: The identification of motor unit discharge patters during explosive contractions poses important challenges due to the high degree of time overlapping of motor unit action potentials (MUAPS). In this study, we propose a combination of high-density electromyographic (HDEMG) recordings and an improved optimization algorithm for the reliable extraction of individual discharge patters during ballistic contractions.
Methods: HDEMG signals (128 electrodes) were recorded from the tibialis anterior muscle during ballistic isometric dorsiflexions. Three healthy volunteers (age: 22 ± 3) participated in the experiment. The recorded signals were filtered at 20–500 Hz and convolutive blind source separation (Negro et al. 2016) was applied to estimate individual motor unit pulse trains during the ballistic task. To improve the convergence of the algorithm, three contractions per each subject were concatenated and processed concurrently. Due to the significant superimposition of MUAPS, the decomposed sources exhibited considerable variability in the amplitude of the individual pulses. Consequently, previous reliability indexes based on the silhouette measure showed to be suboptimal. An optimization algorithm based