

Supplementary material

Given the large number of figures proposed to further illustrate the article, please use the table of content to navigate to the set of figures of interest. More similar set of figures are available upon request.

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SET OF FIGURES 1: TARGETS REACHED FOR SUBJECT 1

This set of figures represents the reconstructed movements of the end effector in the virtual environment. The spheres correspond to all the possible targets, the yellow one corresponds to the starting target and the red one corresponds to the target to reach. The thin blue lines are the end effector movement of each repetition and the medium black line to the mean of those movements. From this set of figures for subject 1, we can already see a variation in the movement performed within a single subject. Targets of interest in the figures in order from left to right and top to bottom: 1, 3, 5, 7, 10, 13.

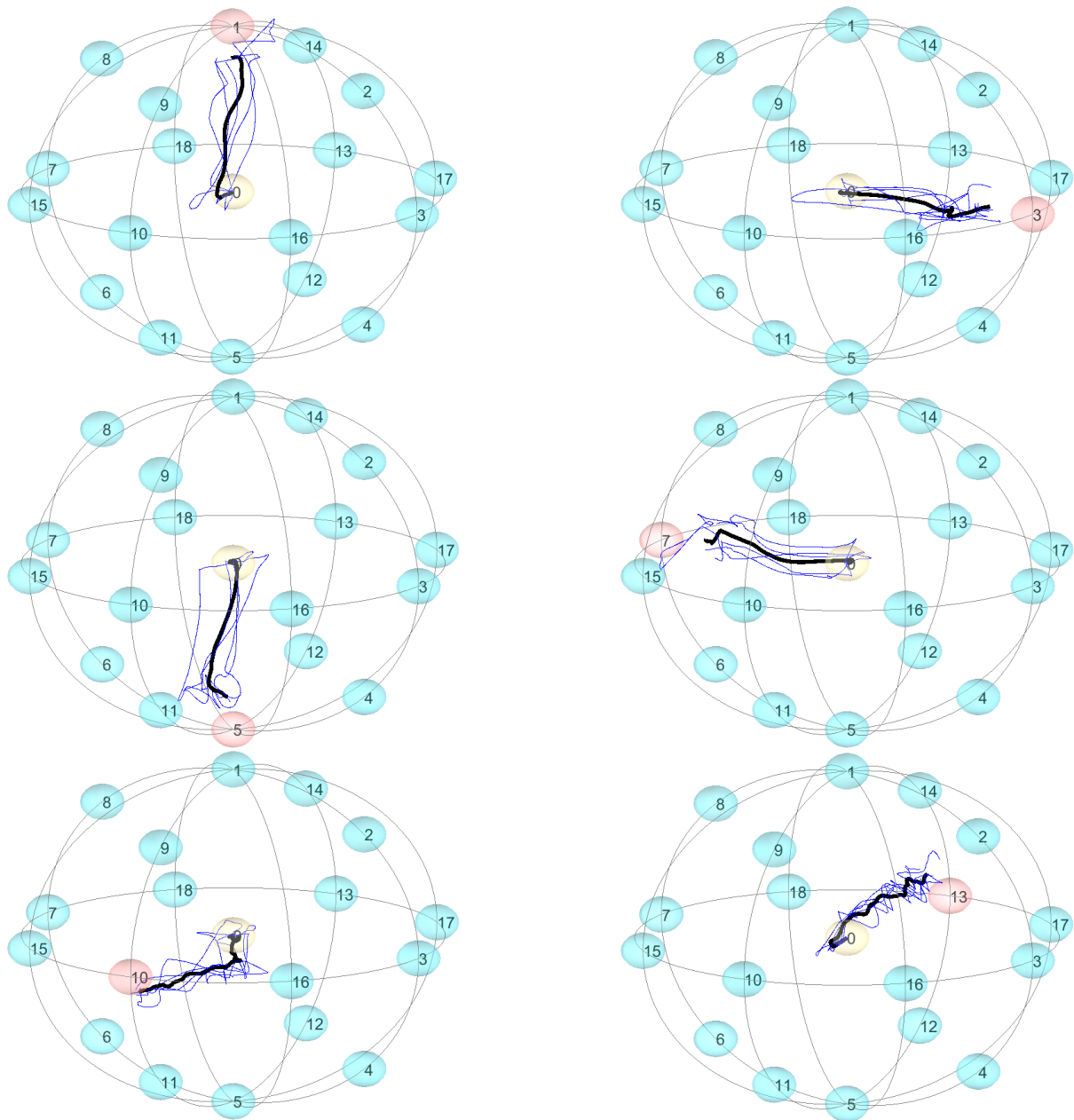


Figure 1: Targets to reach in the 3D virtual space. The yellow sphere corresponds to the starting position, the red one, to the target to reach. The thin blue lines, correspond to the kinematics of the end effector over the repetitions. 5 repetitions were recorded for this particular subject and the black line correspond to the mean movement over these repetitions.

SET OF FIGURES 2: ACTIVATIONS OBTAINED FROM ACTIVATION DYNAMICS FOR RECORDED MUSCLES

On this set of figures, the activations obtained directly from the activation dynamics for each of the recorded muscles are displayed. The EMG from recorded muscle, rectified, aligned, and normalized is fed to the activation dynamics to obtain its corresponding activation. Throughout all the signal evaluations, those signals are considered our ground truth.

This set of figures is divided into subparts, for each subject, and for each subject, each of the 6 targets is represented as well. The fine lines correspond to the activations obtained from activation dynamics for each specific repetition and the medium blue line corresponds to their mean, showing us the general activation pattern for the reaching task.

Subject 1

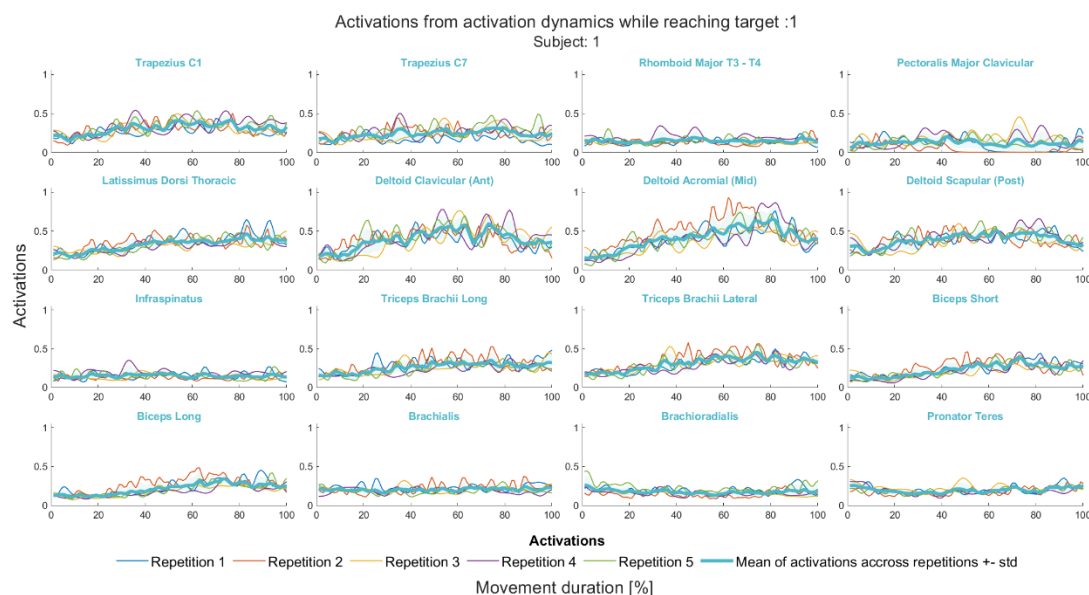


Figure 2: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 1, while reaching target 1 (upward).

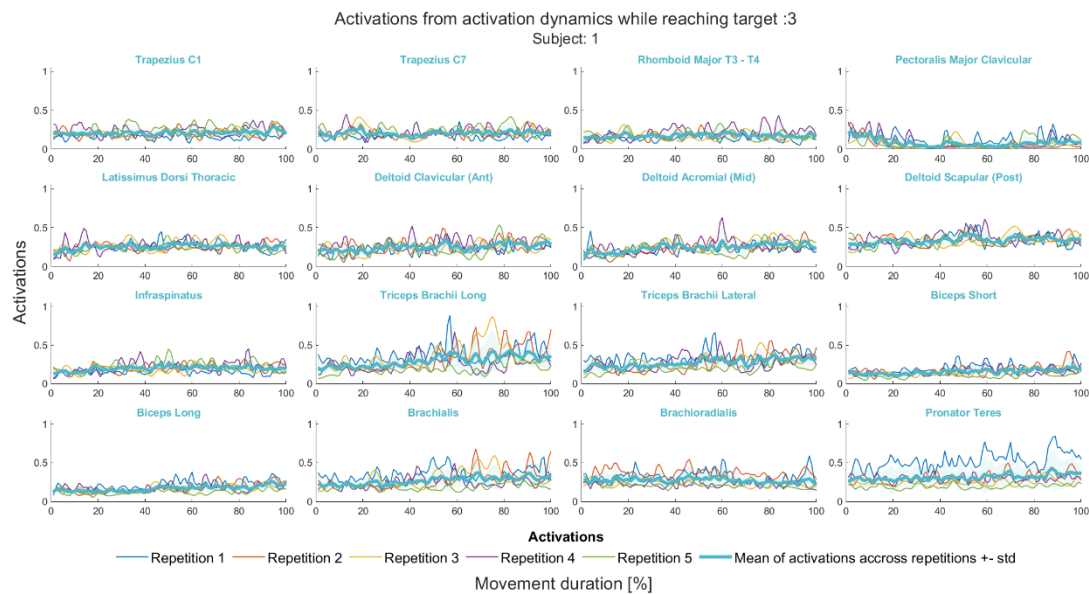


Figure 3: Activations obtained directly form the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 1, while reaching target 3 (to the right).

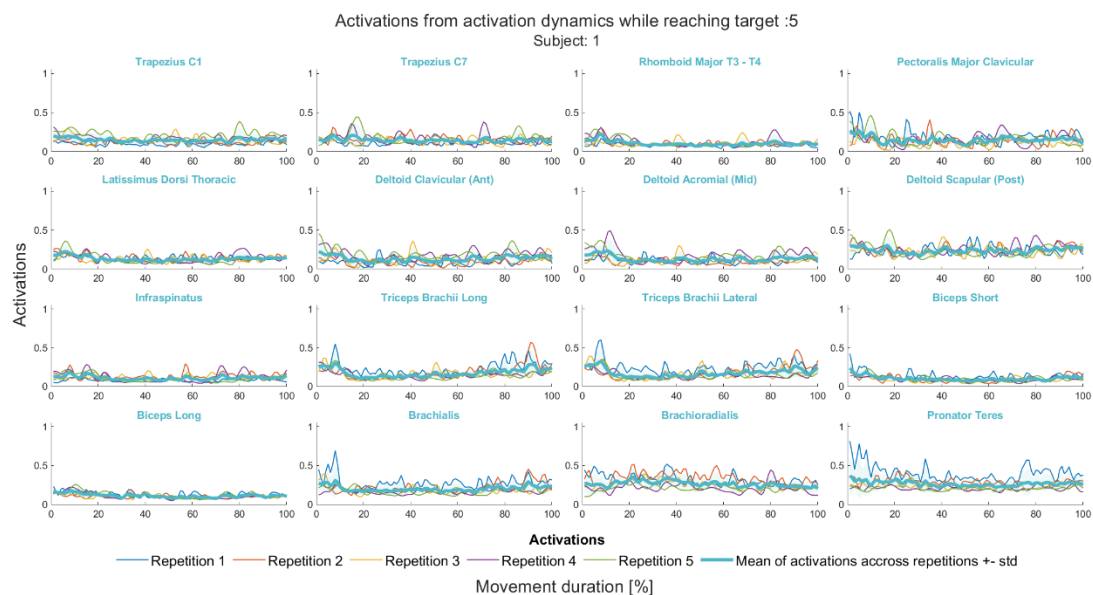


Figure 4: Activations obtained directly form the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 1, while reaching target 5 (downwards).

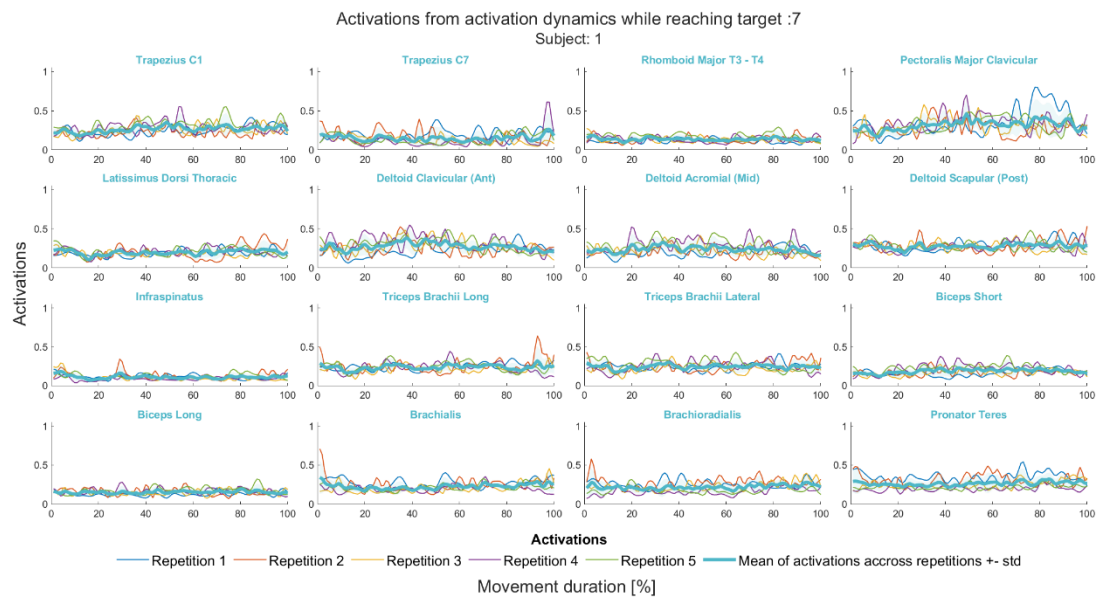


Figure 5: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 1, while reaching target 7 (to the left).

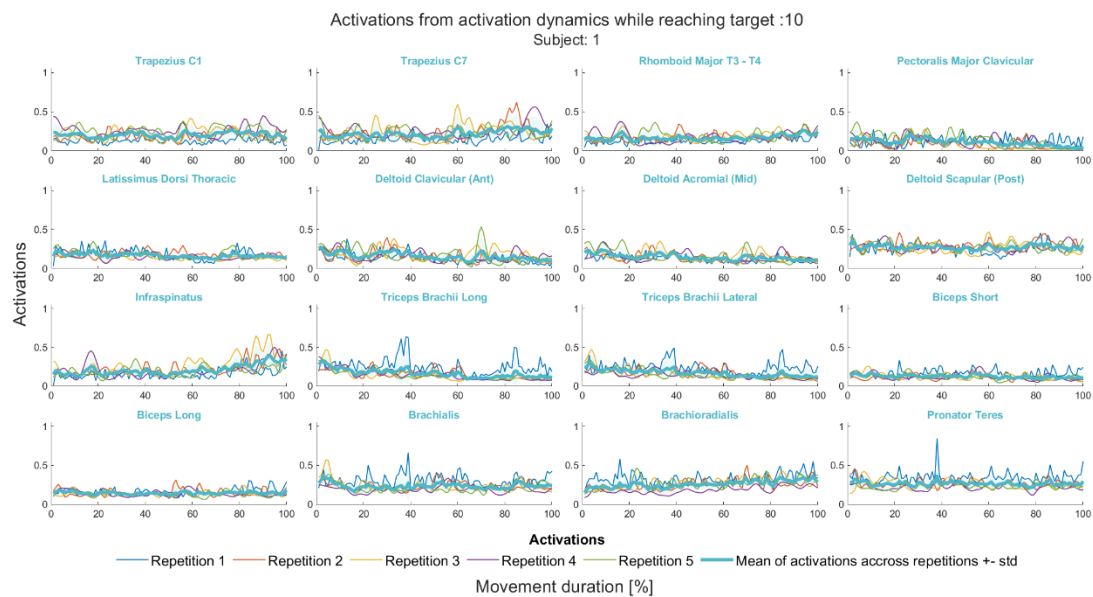


Figure 6: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 1, while reaching target 10 (towards the subject).

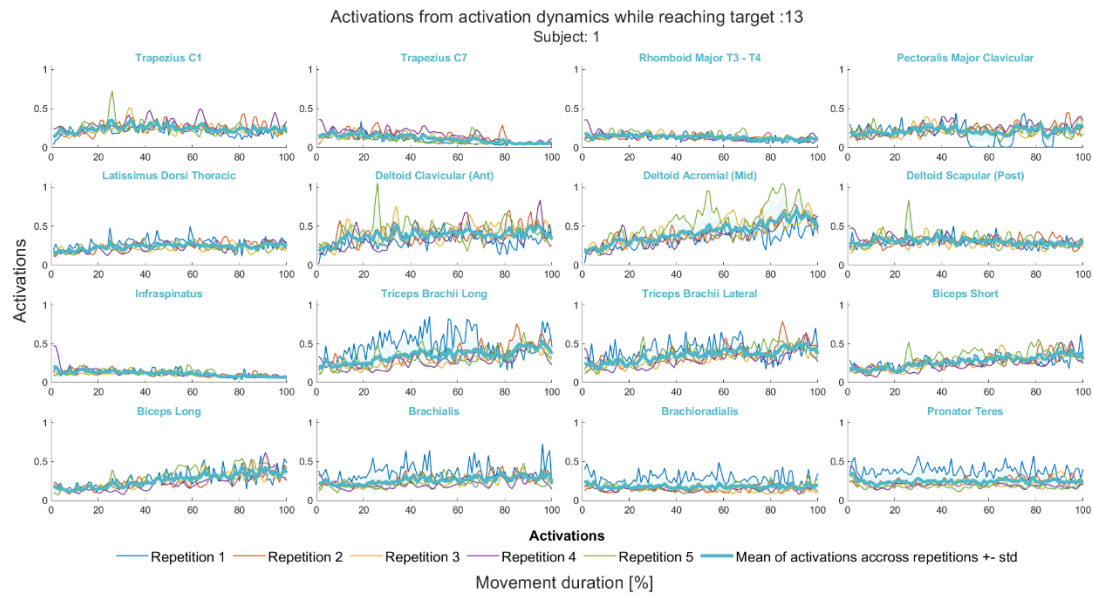


Figure 7: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 1, while reaching target 13 (forward).

Subject 2

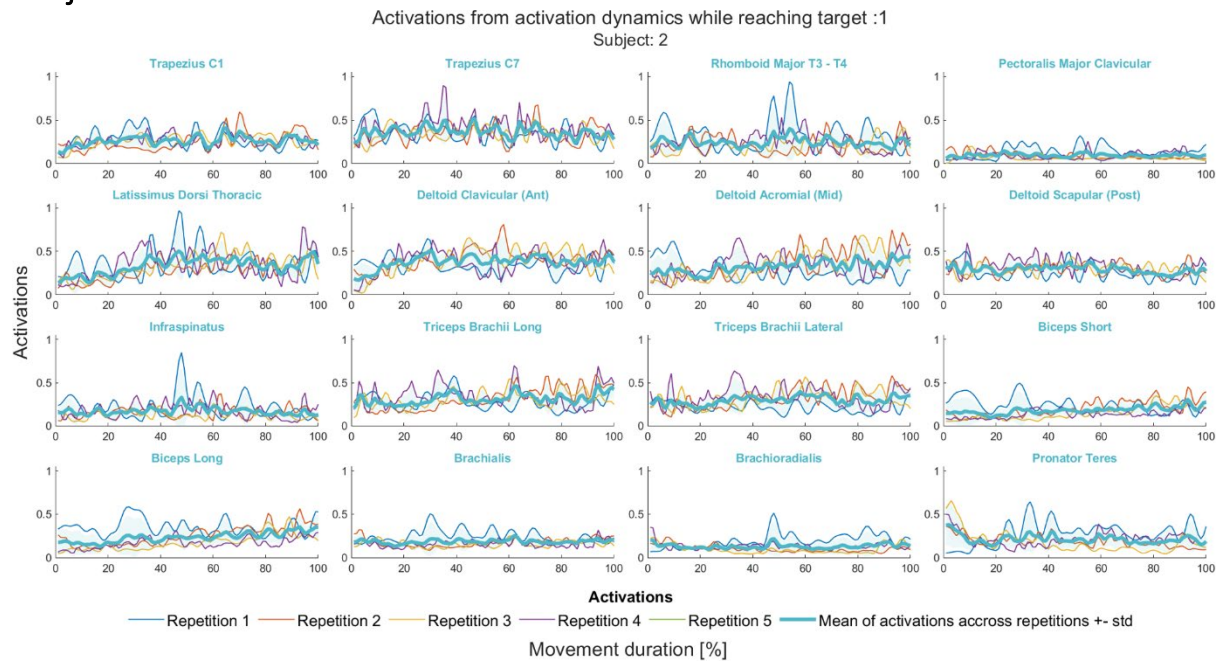


Figure 8: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 2, while reaching target 1 (upward).

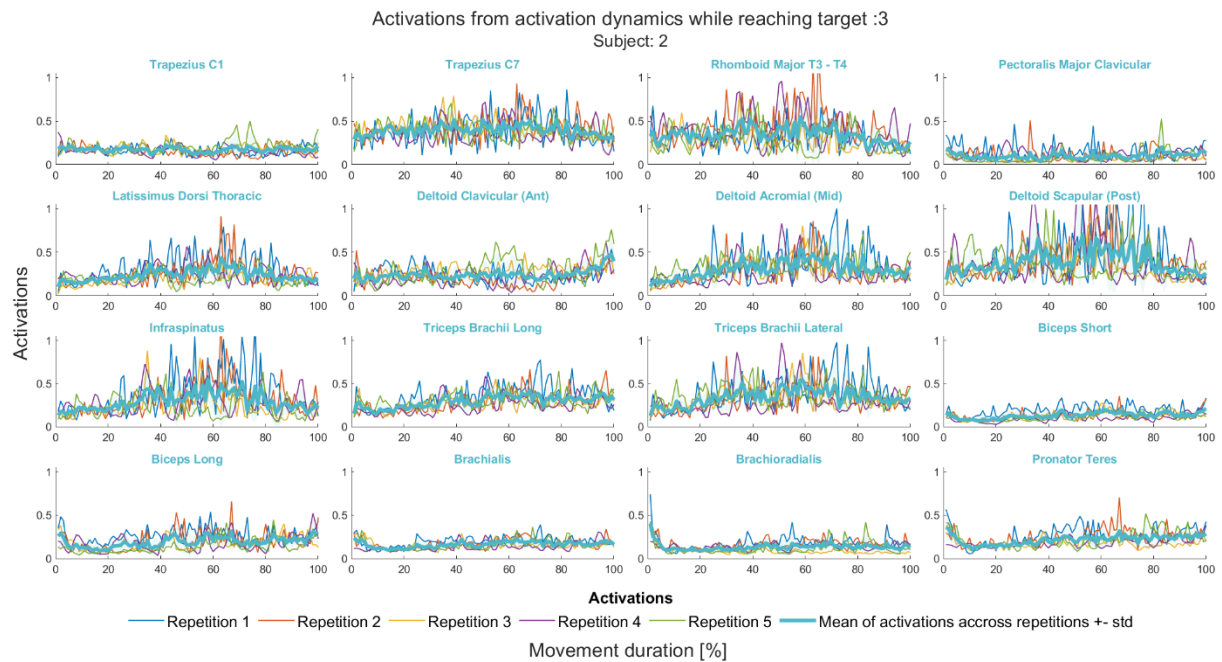


Figure 9: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 2, while reaching target 3 (to the right).

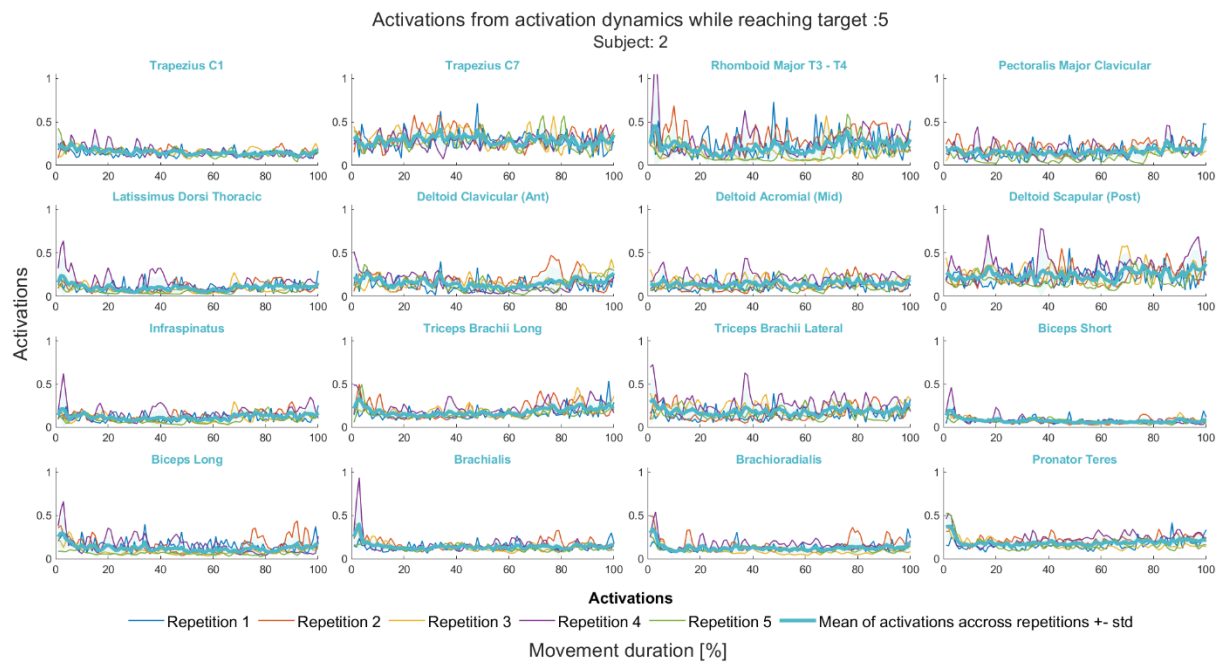


Figure 10: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 2, while reaching target 5 (downward).

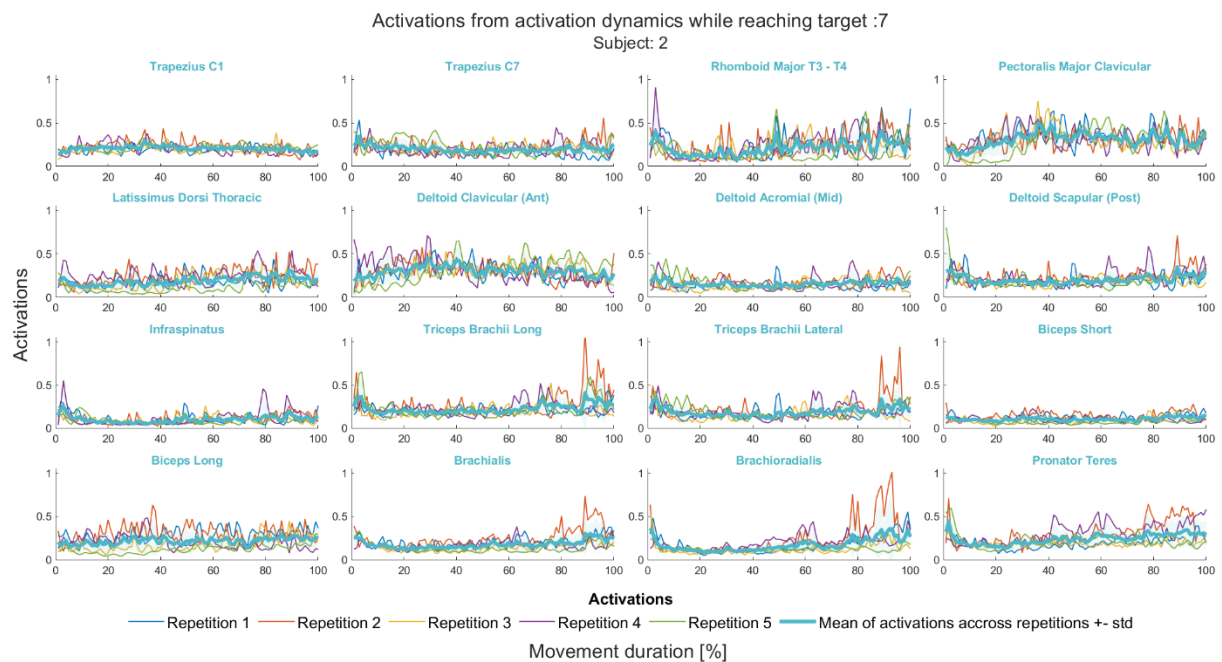


Figure 11: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 2, while reaching target 7 (to the left).

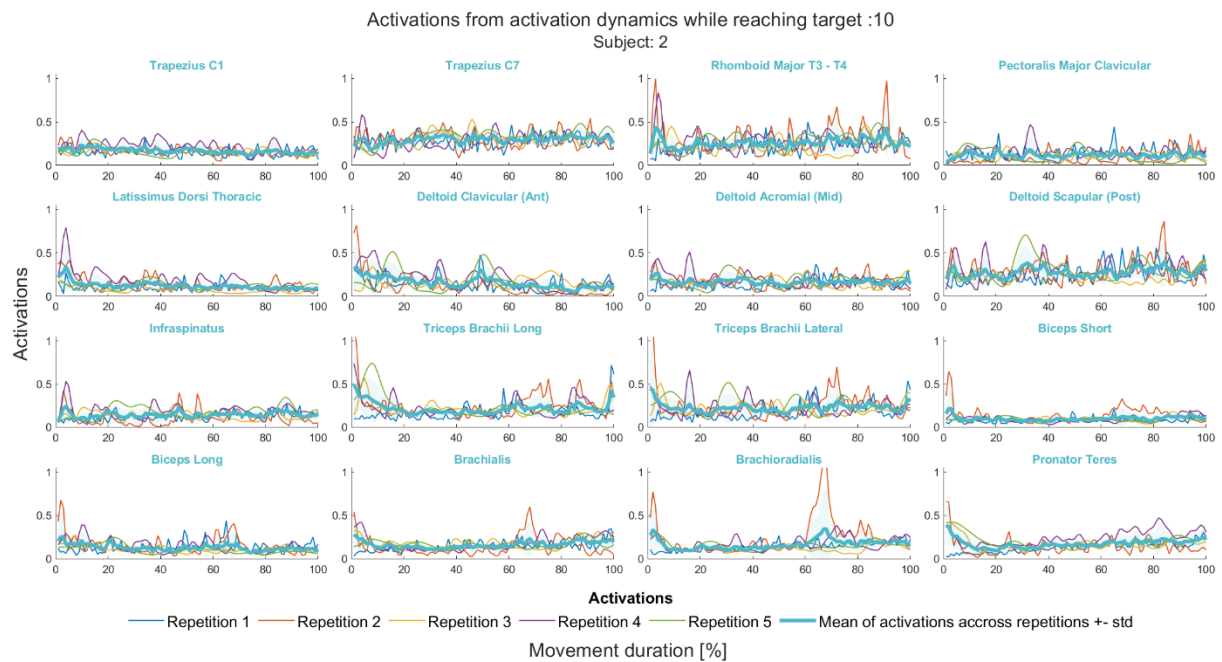


Figure 12: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 2, while reaching target 10 (backward).

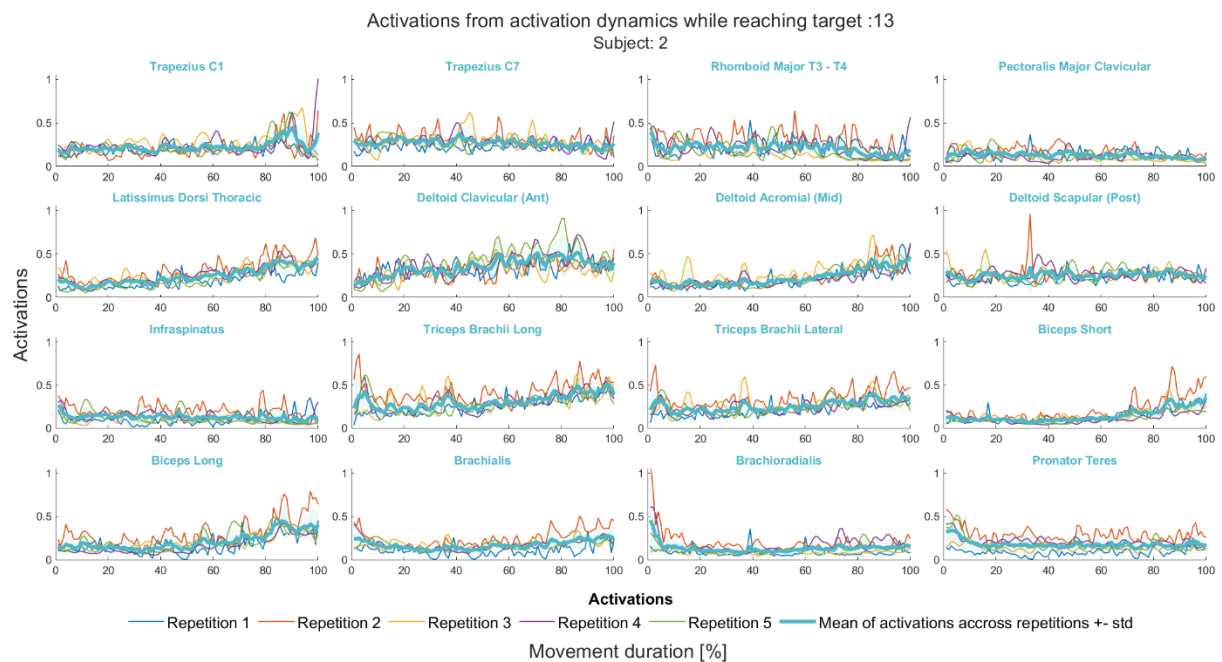


Figure 13: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 2, while reaching target 13 (forward).

Subject 3

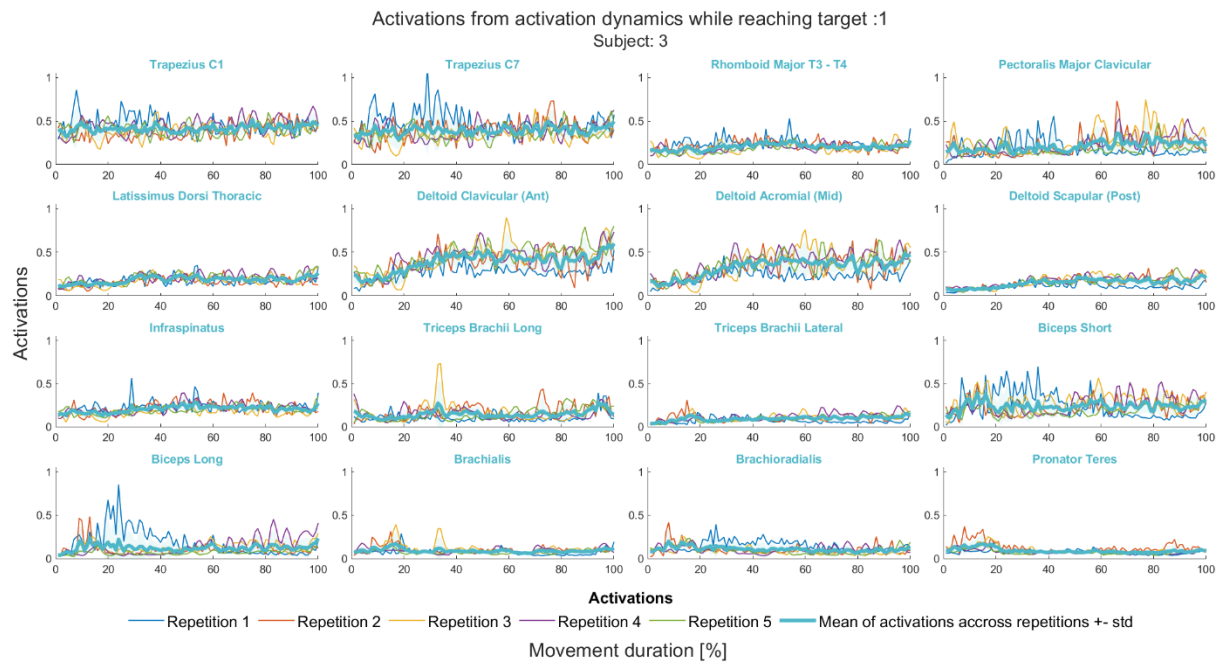


Figure 14: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 3, while reaching target 1 (upward).

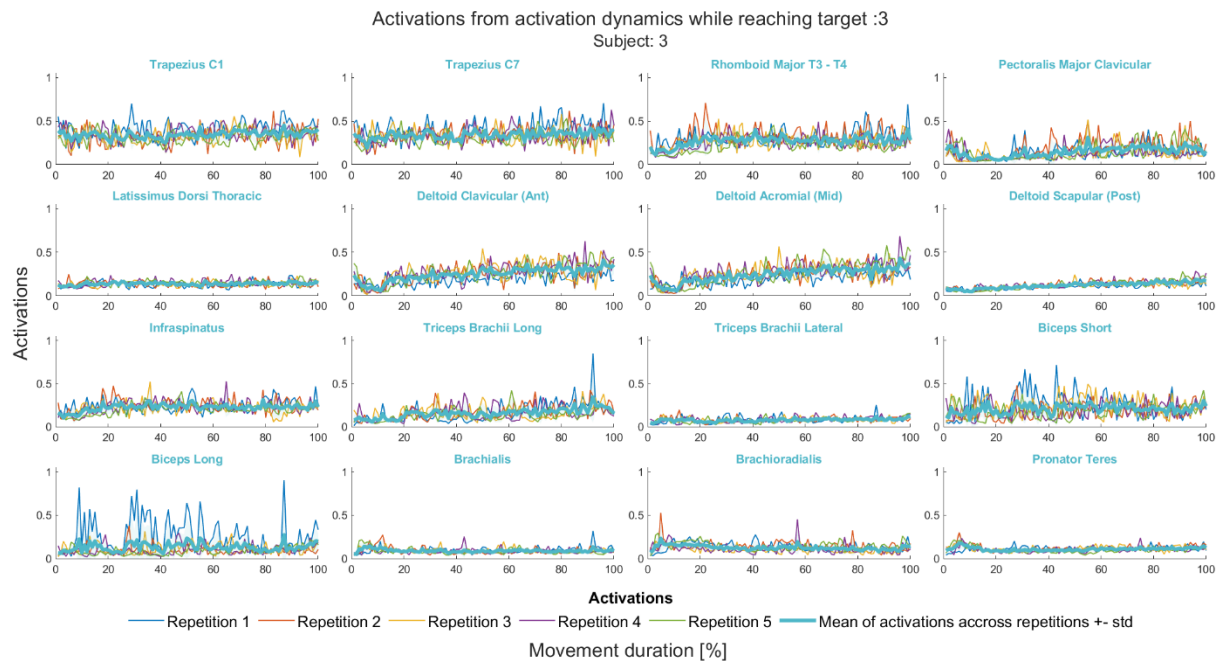


Figure 15: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 3, while reaching target 3 (right).

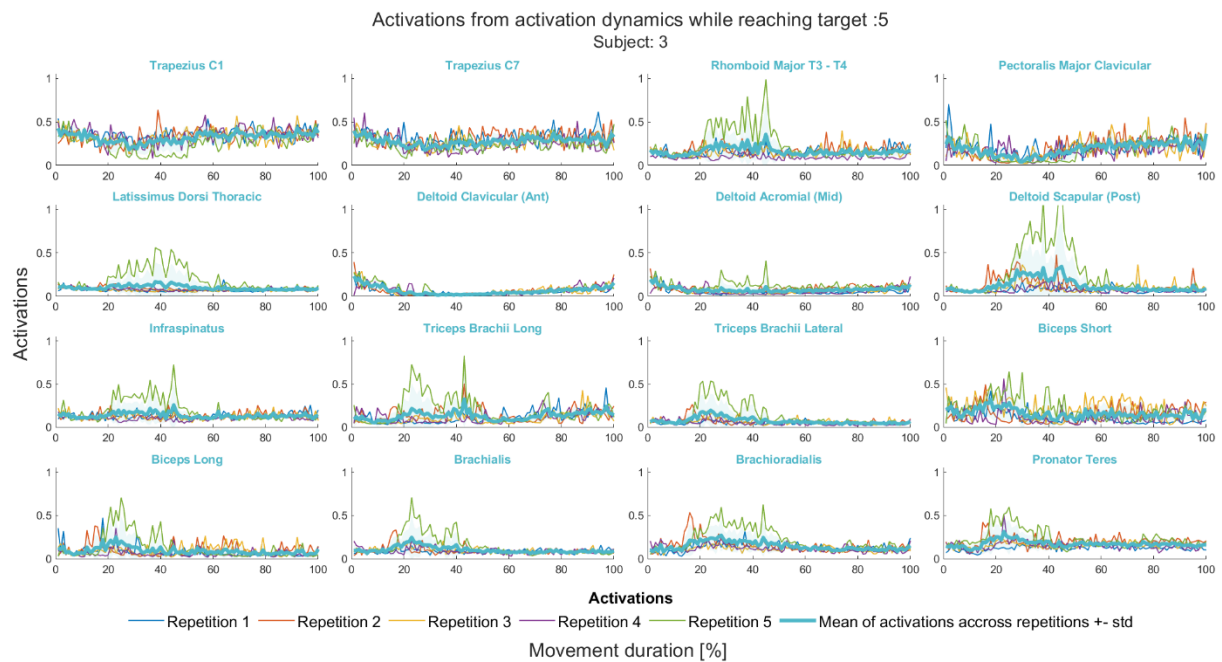


Figure 16: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 3, while reaching target 5 (downward).

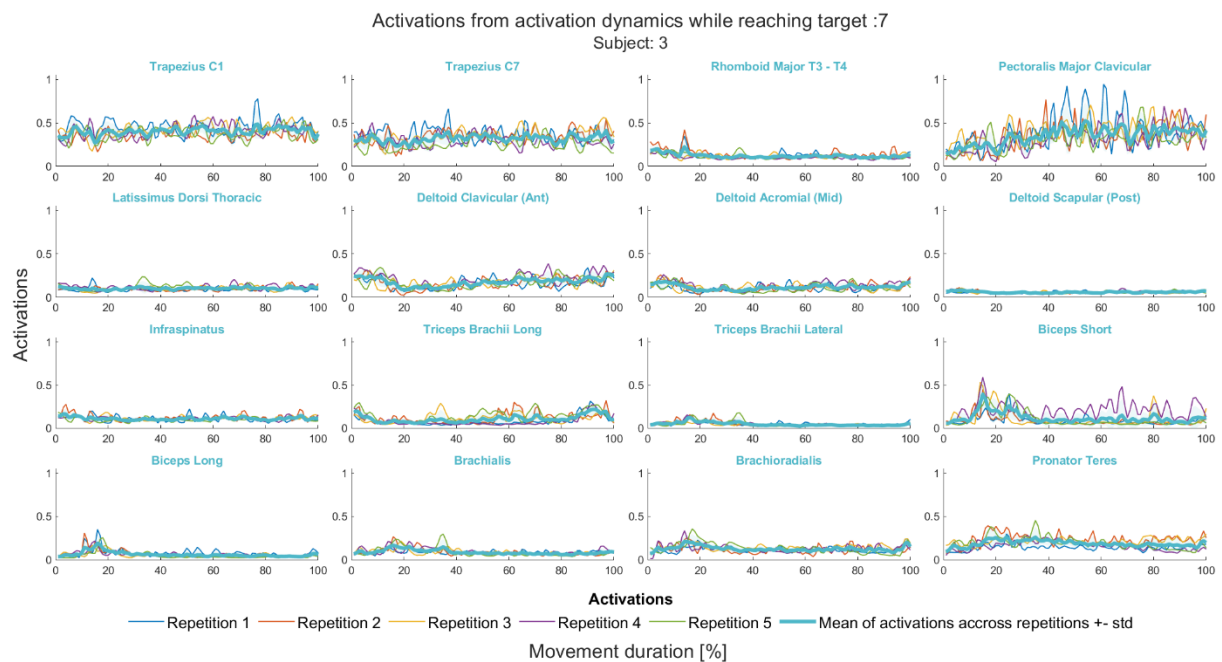


Figure 17: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 3, while reaching target 7 (left).

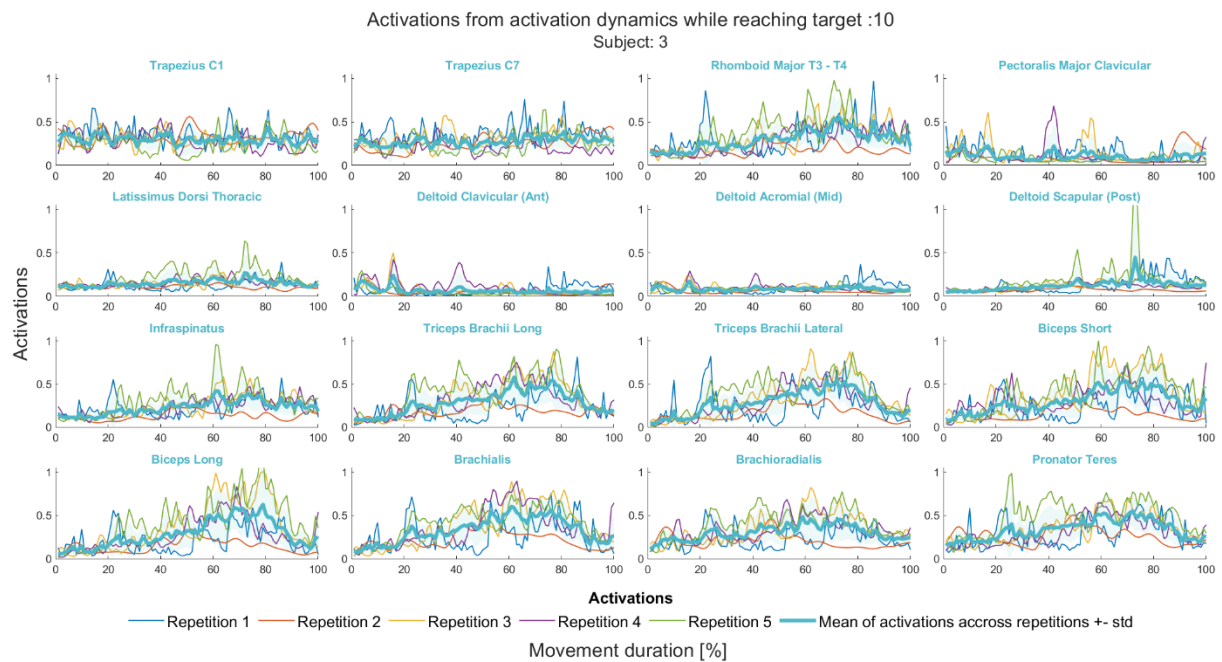


Figure 18: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 3, while reaching target 10 (backward).

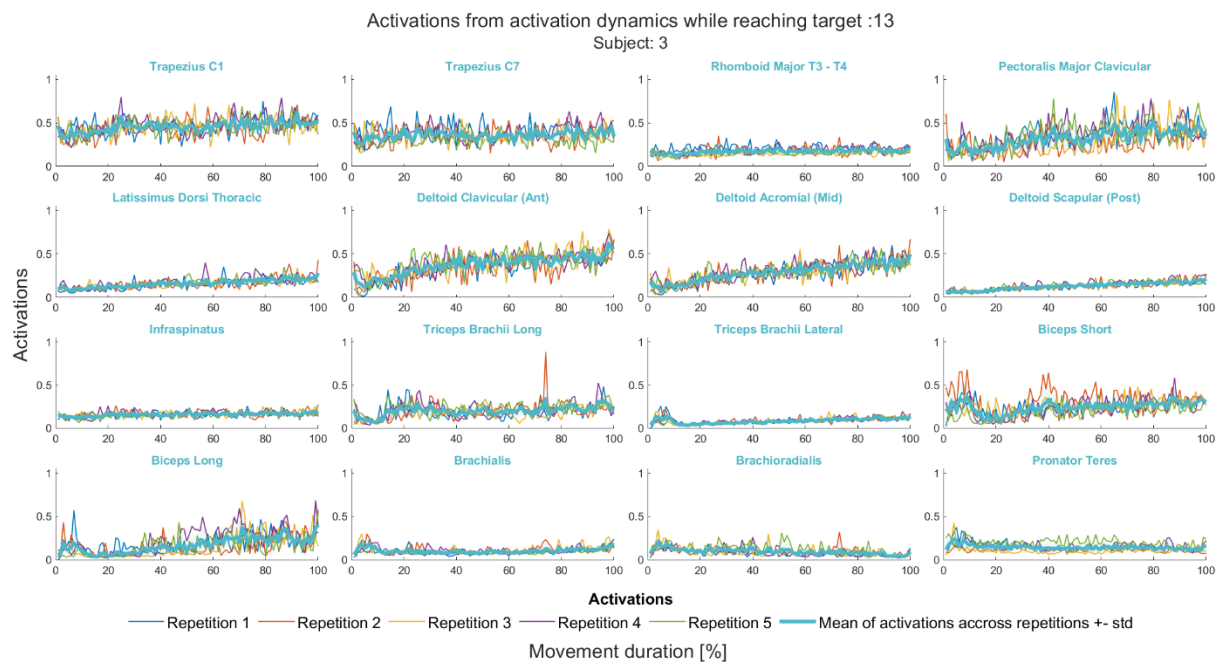


Figure 19: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 3, while reaching target 13 (frontward).

Subject 5

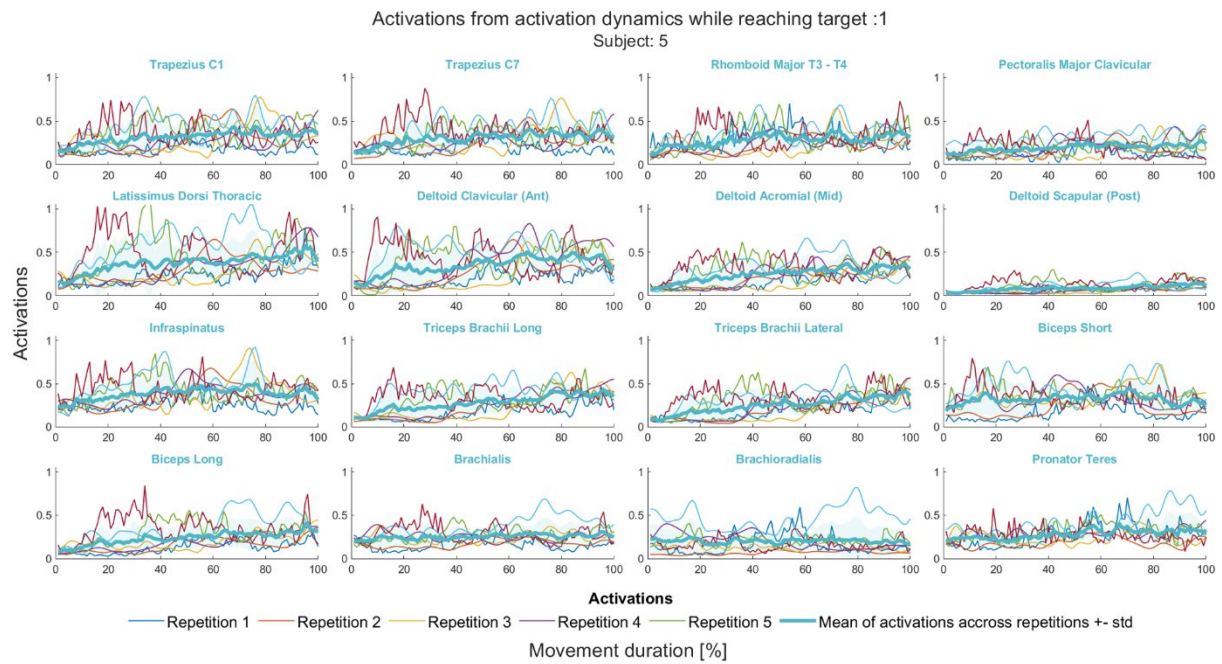


Figure 20: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 5, while reaching target 1 (upward).

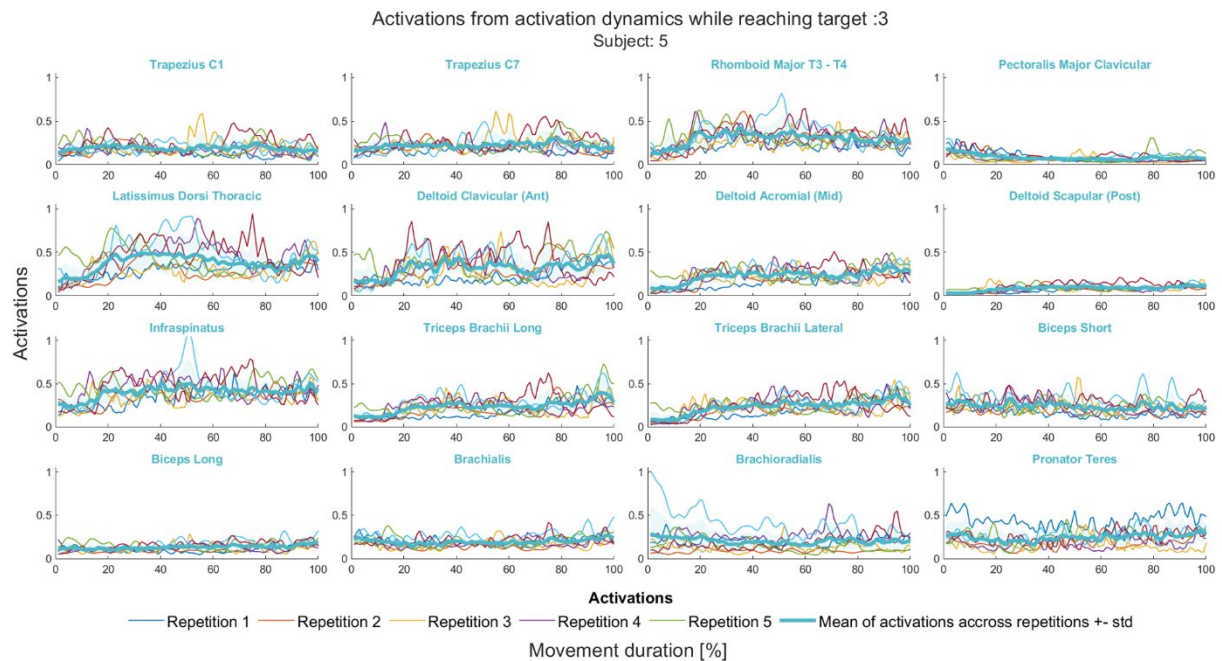


Figure 21: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 5, while reaching target 3 (right).

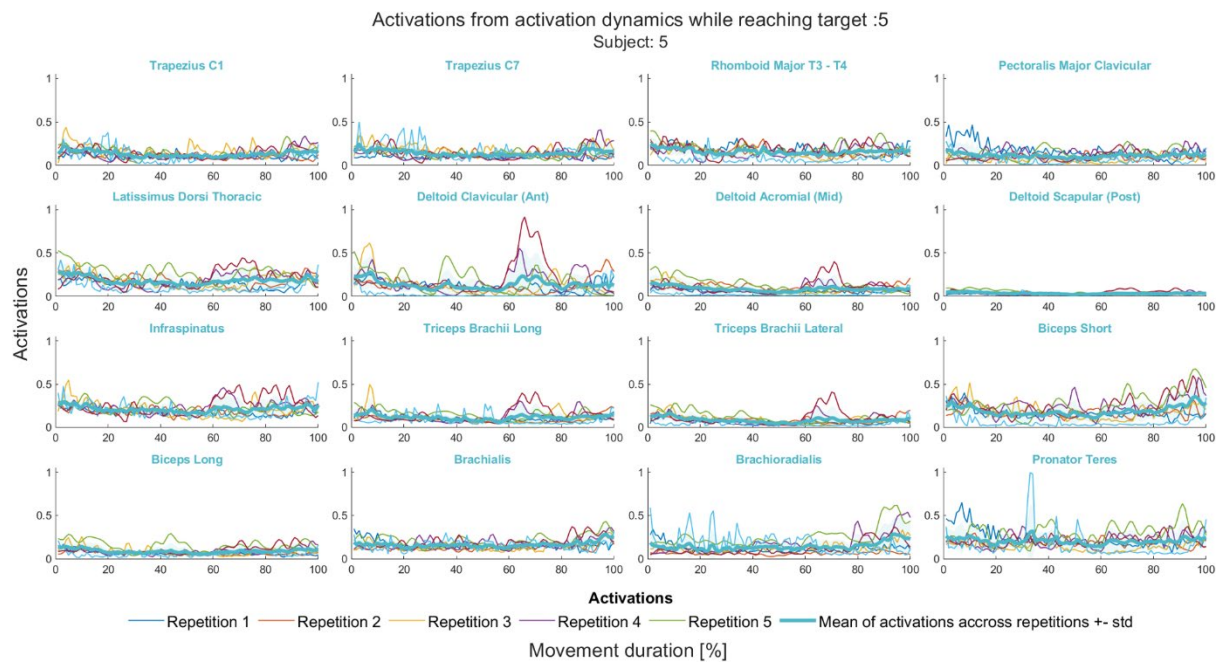


Figure 22: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 5, while reaching target 5 (downward).

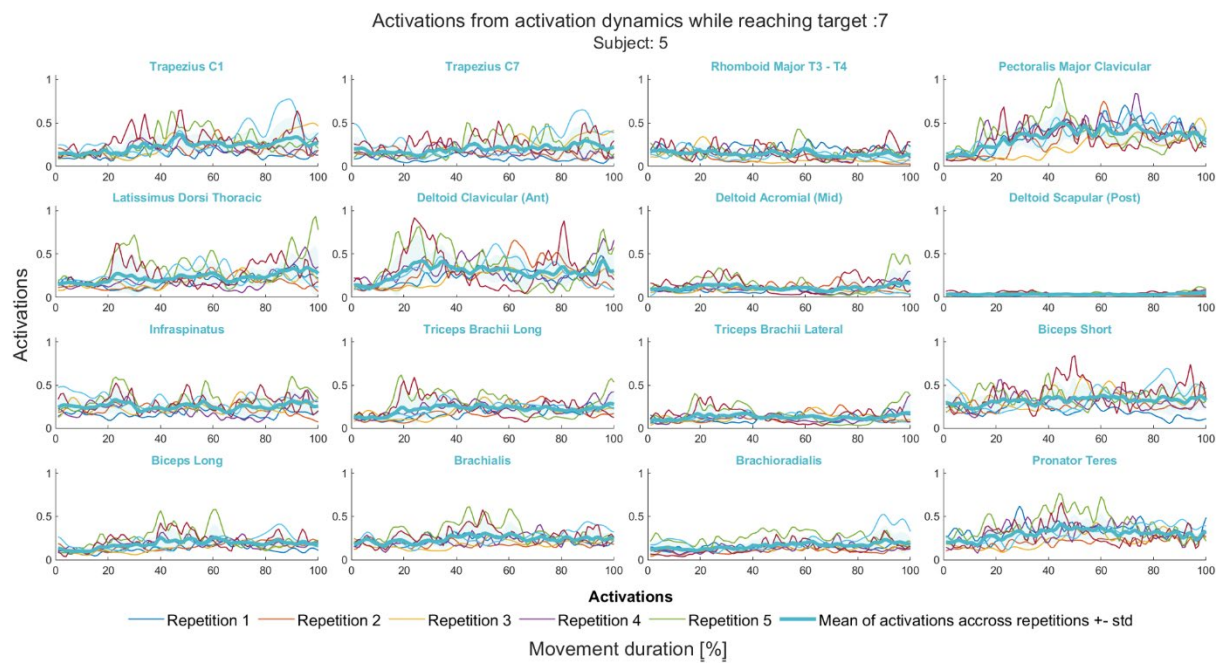


Figure 23: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 5, while reaching target 7 (left).

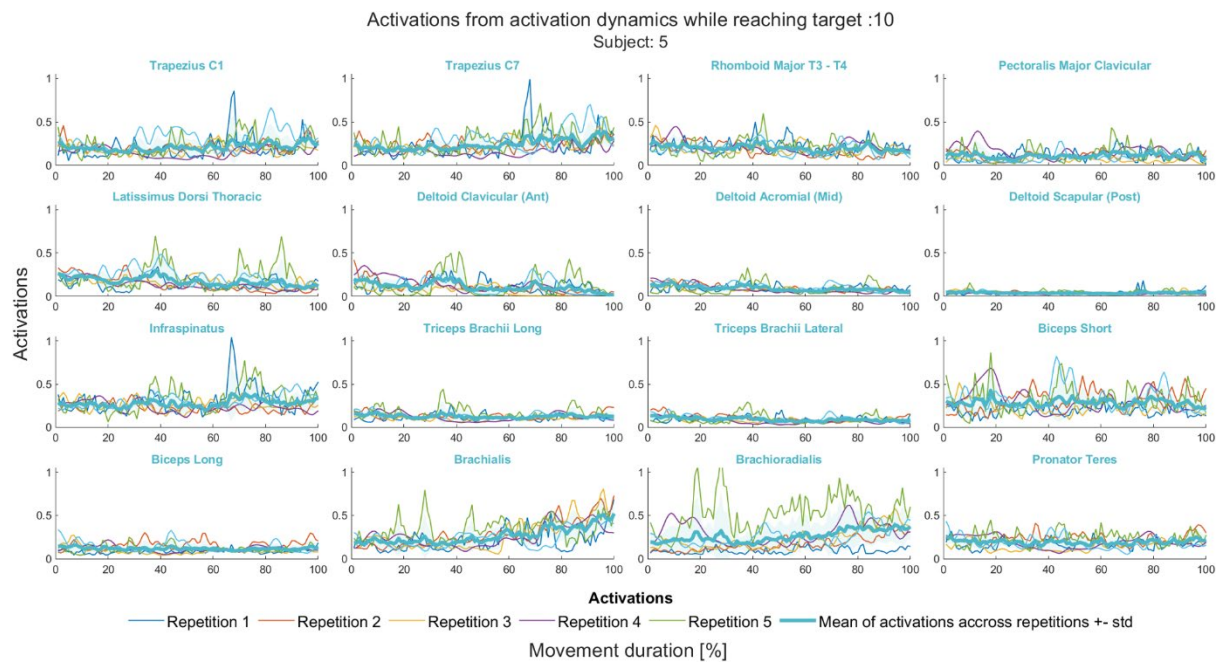


Figure 24: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 5, while reaching target 10 (backward).

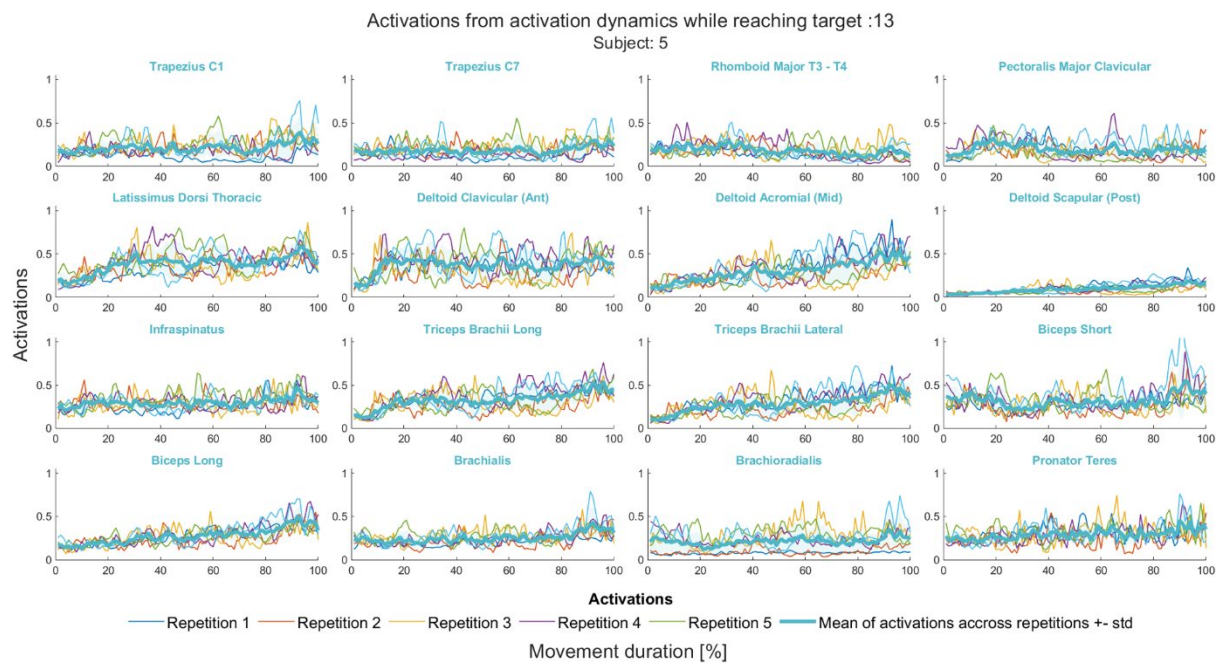


Figure 25: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 5, while reaching target 13 (forward).

Subject 8

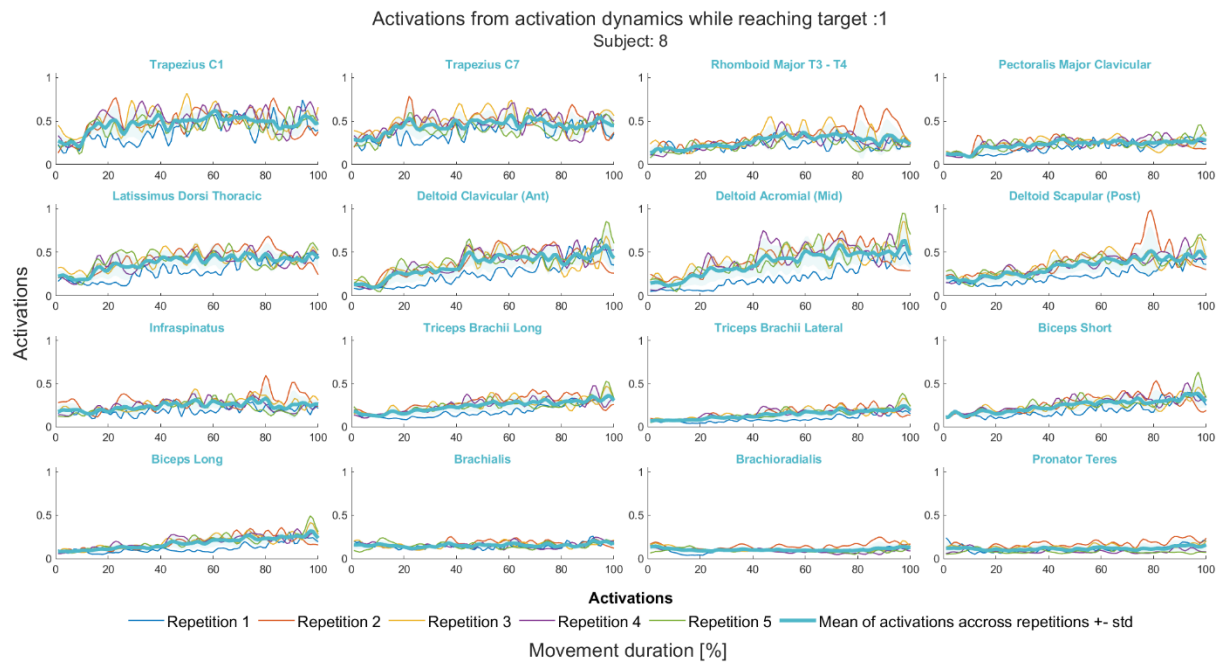


Figure 26: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 8 while reaching target 1 (upward).

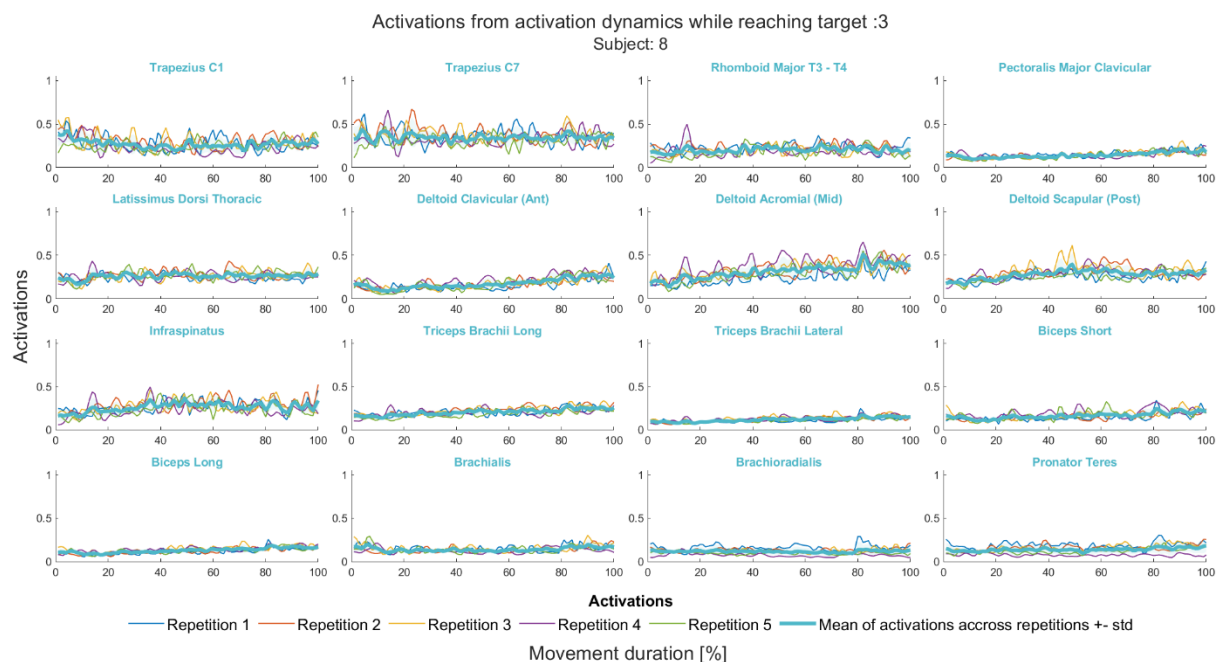


Figure 27: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 5 while reaching target 3 (right).

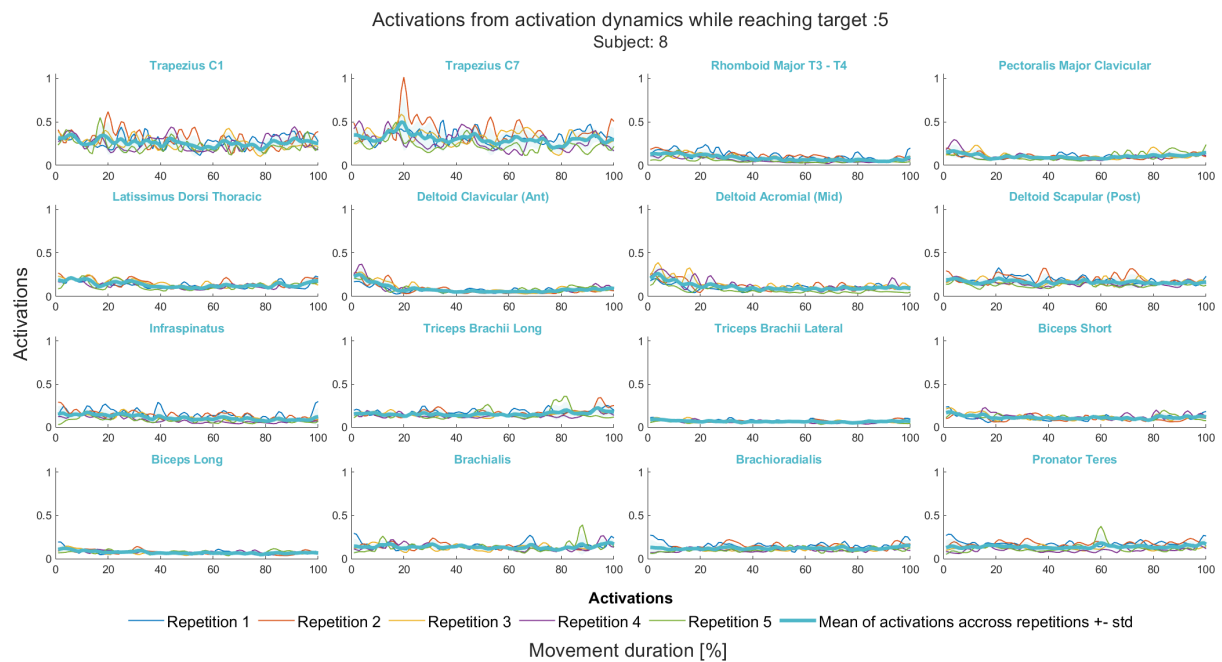


Figure 28: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 8 while reaching target 5 (downward).

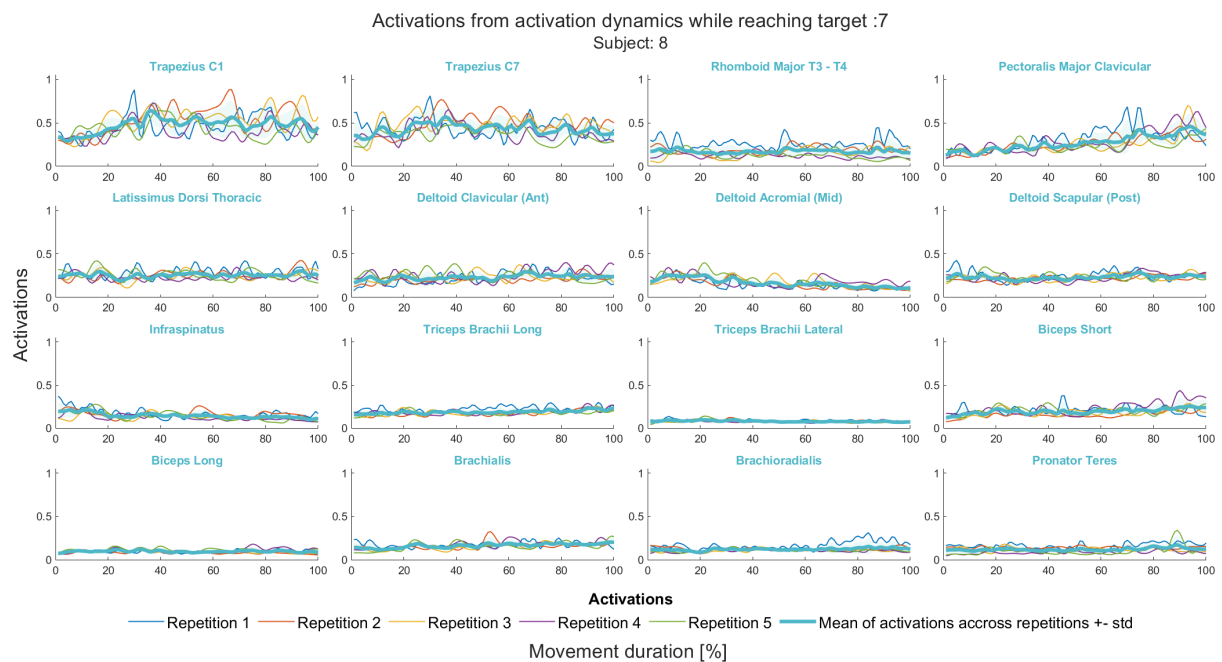


Figure 29: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 8 while reaching target 7 (left).

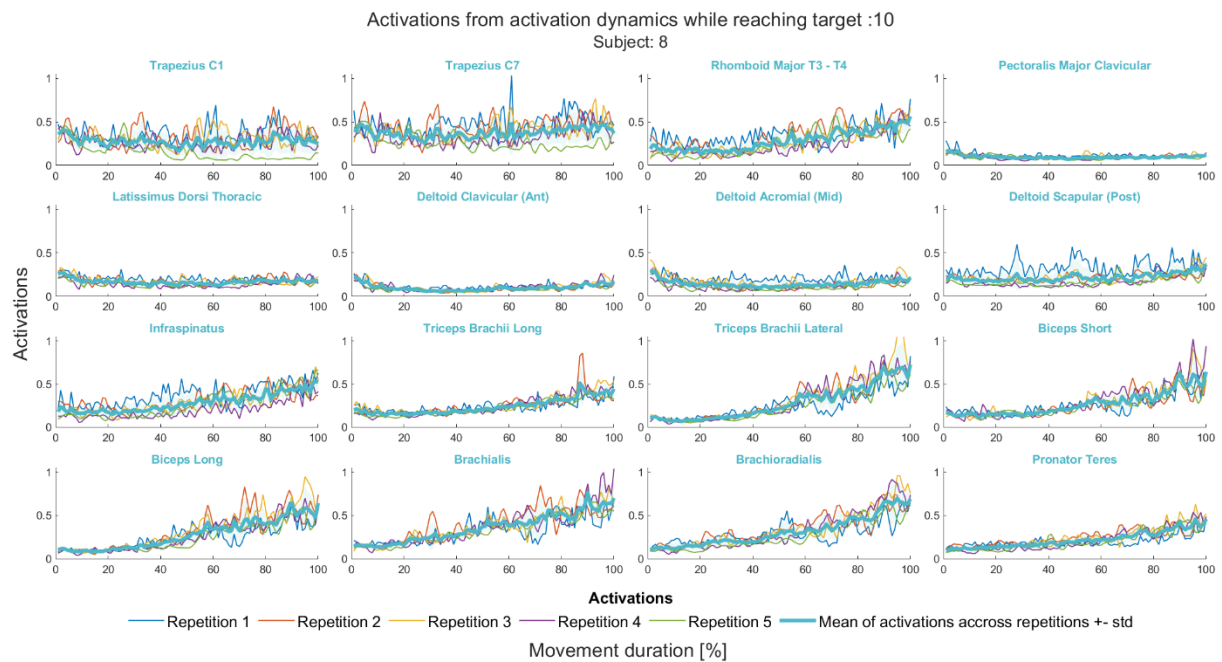


Figure 30: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 8 while reaching target 10 (backward).

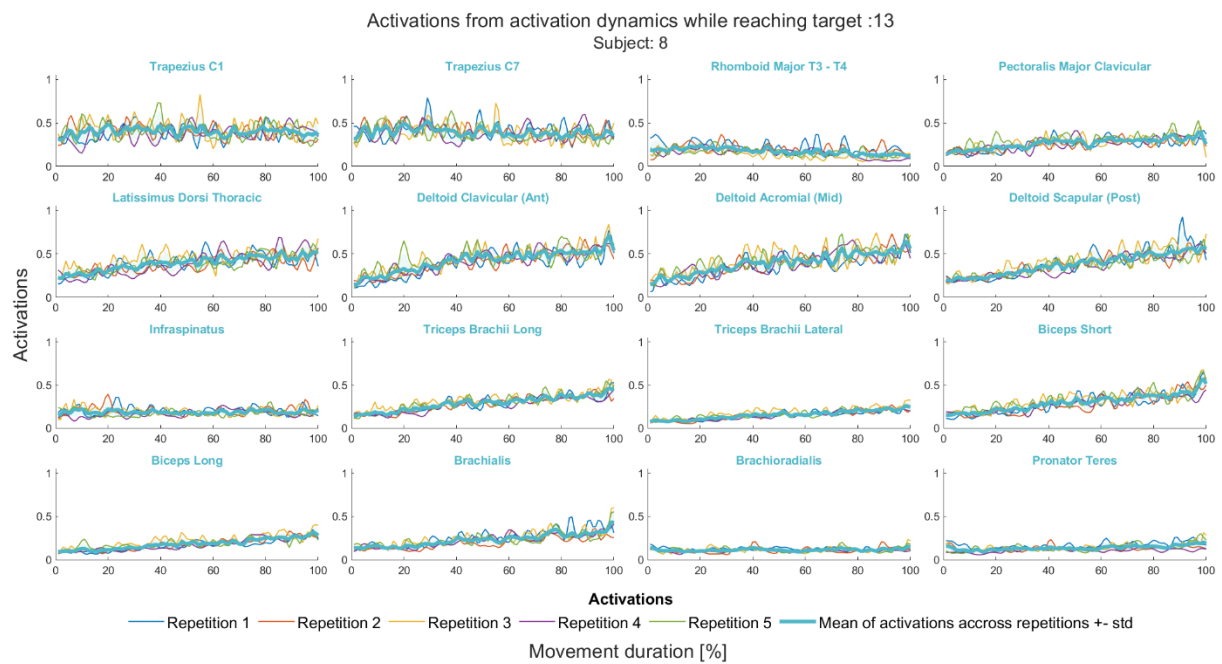


Figure 31: Activations obtained directly from the activation dynamics for each of the recorded muscles, the thick cyan line corresponds to the mean of the activation across the repetitions (coloured thin lines). The signals are the ones obtained for the subject 8 while reaching target 5 (frontward).

SET OF FIGURES 3: MEANS OF ACTIVATION ACROSS THE REPETITIONS PER SUBJECTS AND PER TARGET:

The next presented set of figures corresponds to the means across the repetitions of the activations estimated per subjects and targets reached. Some of them are less smooth than others this is mainly because although their spanning has been reduced to a percentage of movement, their initial duration was not the same which explain the differences in shapes of those figures. One can see that there is also a lot of variability between subjects while performing the same movement, when the comparisons is done between the different targets per subjects.

Subject 1

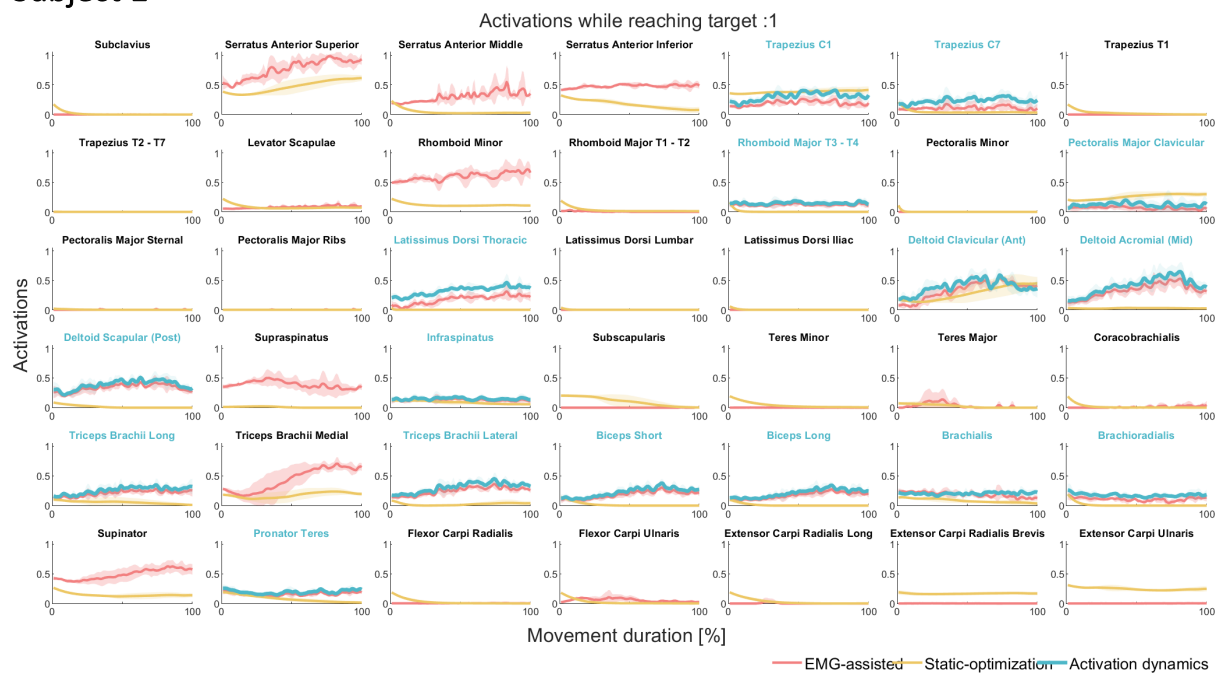


Figure 32: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 1 while reaching target 1 (upward)

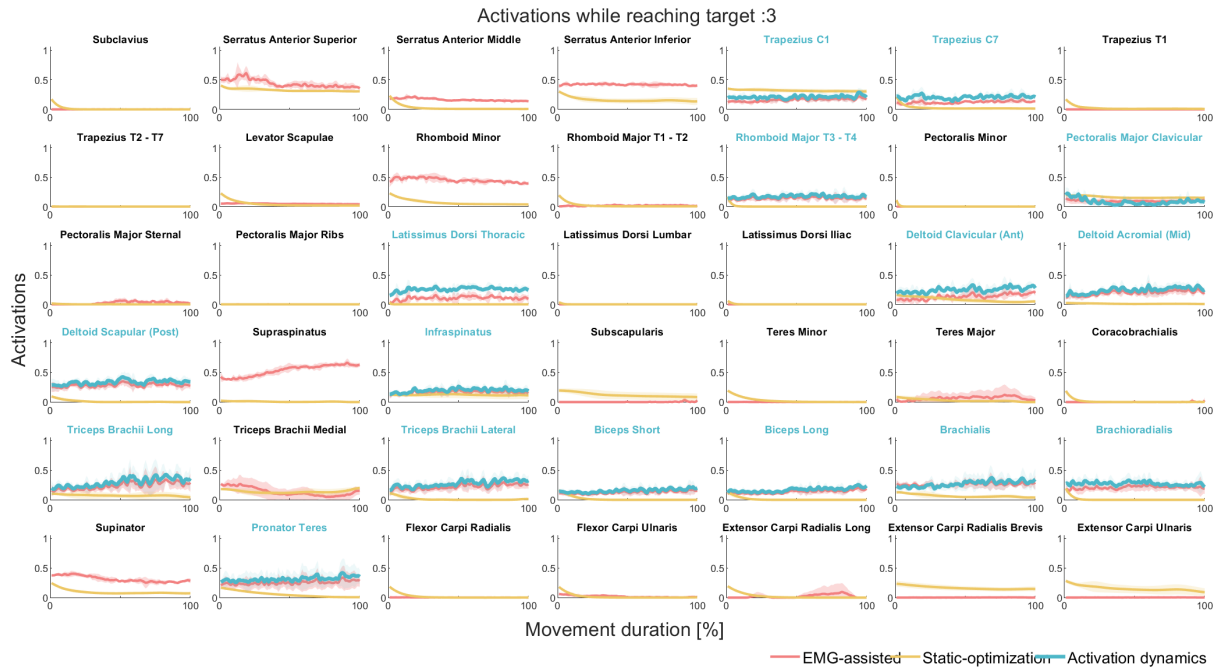


Figure 33: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 1 while reaching target 3 (right)

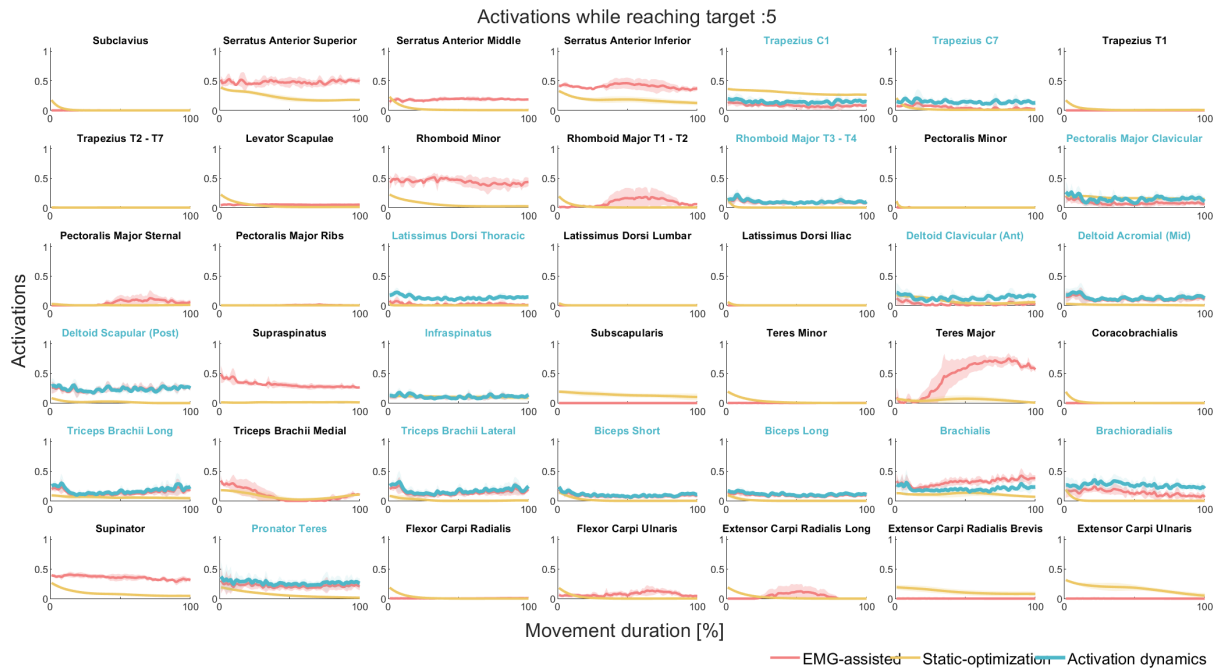


Figure 34: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 1 while reaching target 5 (downward)

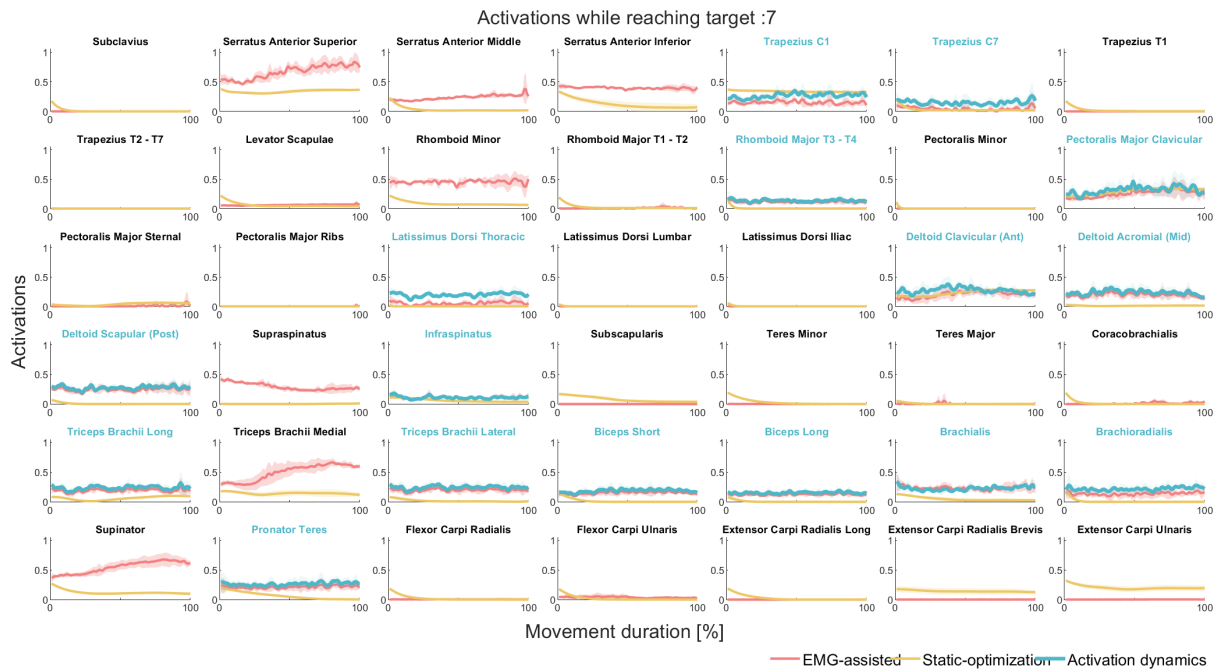


Figure 35: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 1 while reaching target 7 (left)

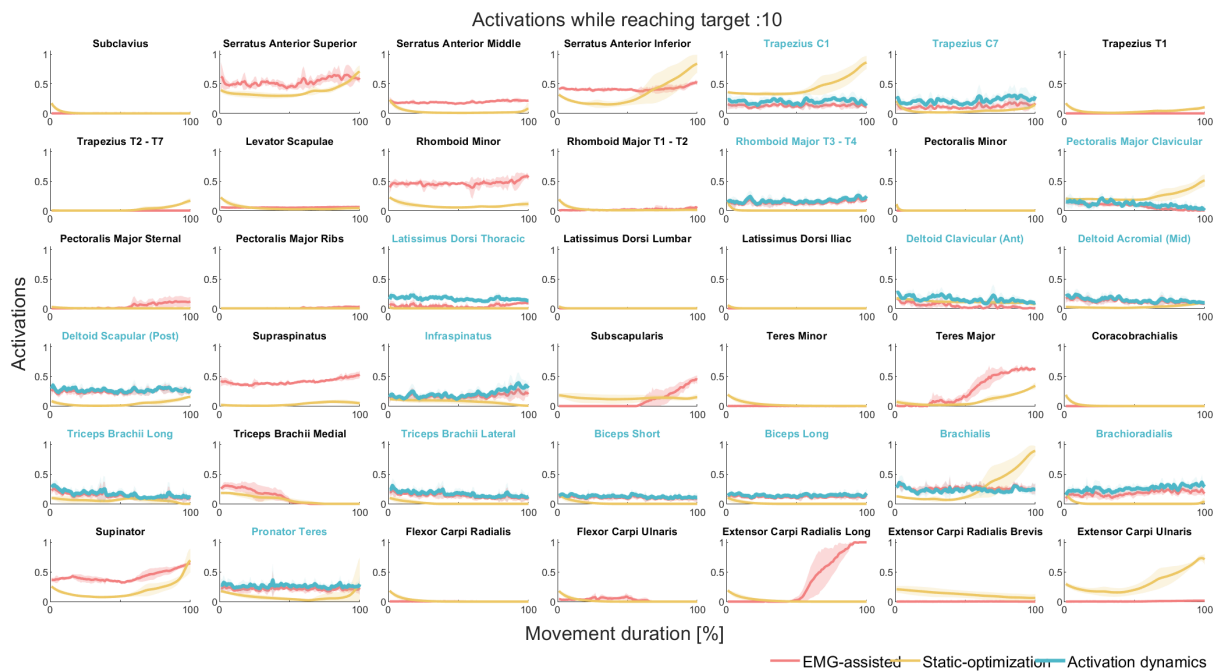


Figure 36: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 1 while reaching target 10 (backward)

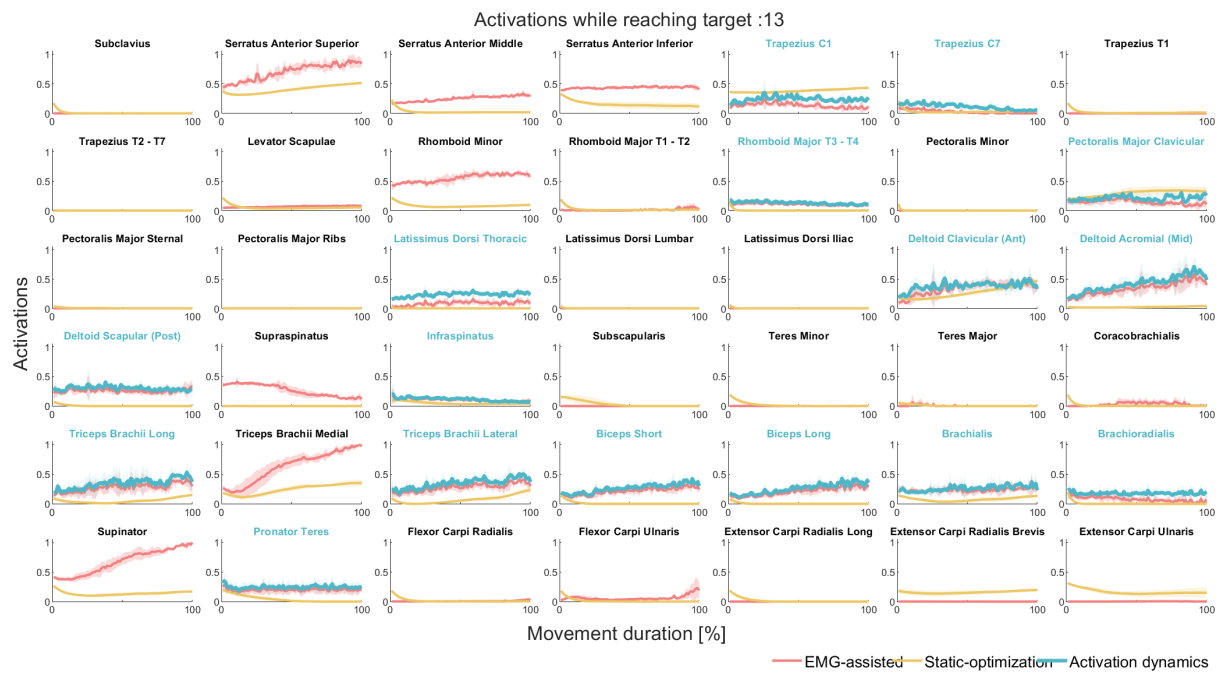


Figure 37: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 1 while reaching target 13 (forward).

Subject 2



Figure 38: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 2 while reaching target 1 (upward).

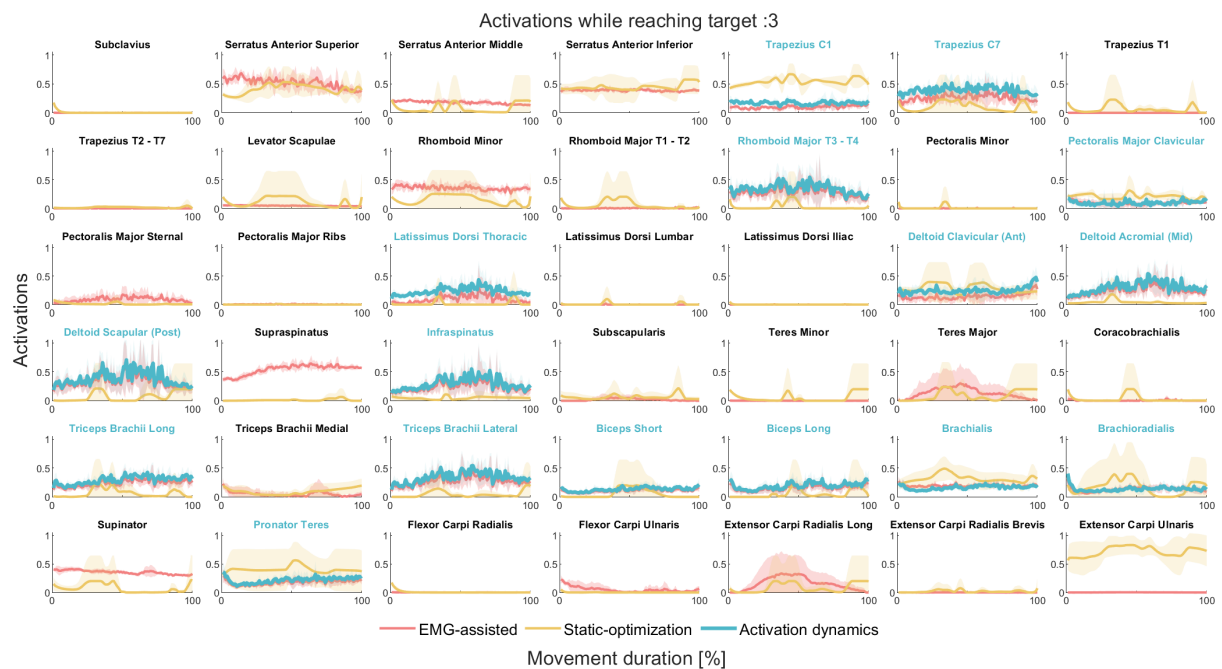


Figure 39: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 2 while reaching target 3 (right).



Figure 40: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 2 while reaching target 5 (downward).

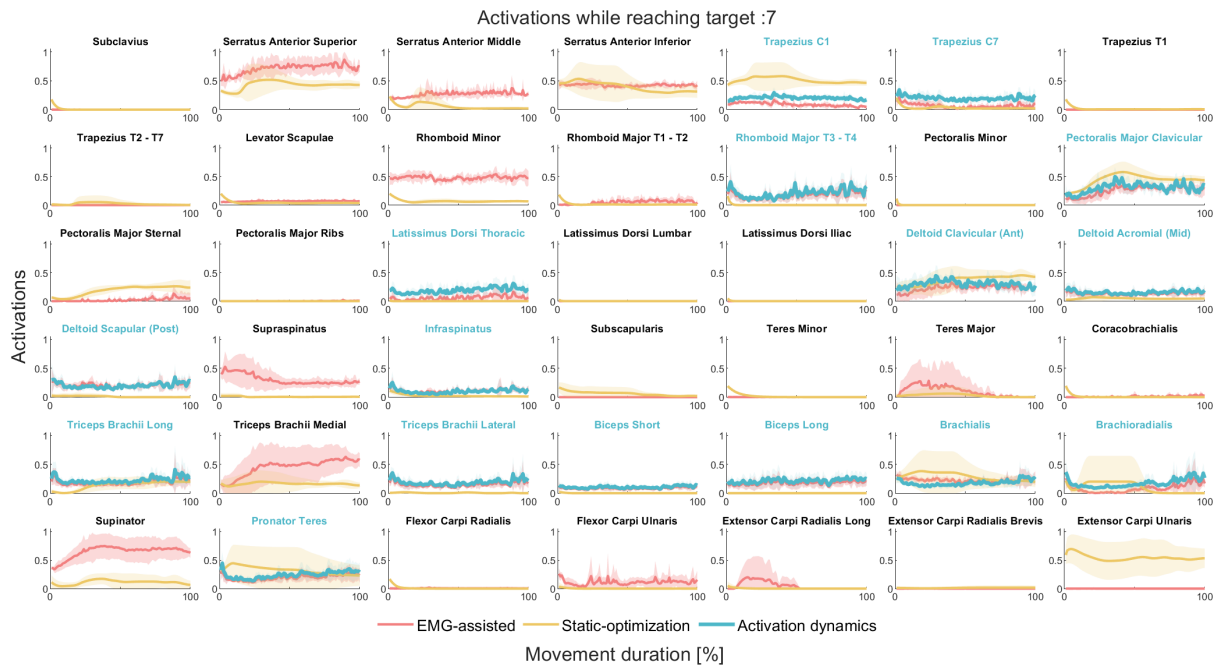


Figure 41: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 2 while reaching target 7 (left).

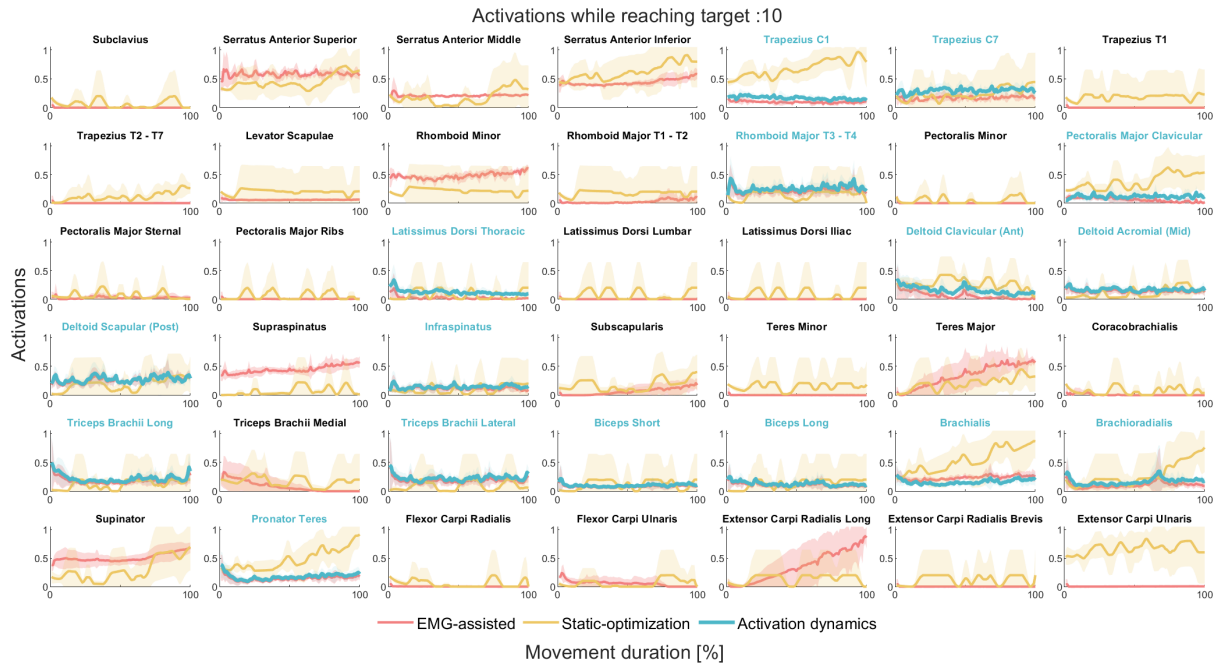


Figure 42: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 2 while reaching target 10 (backward).

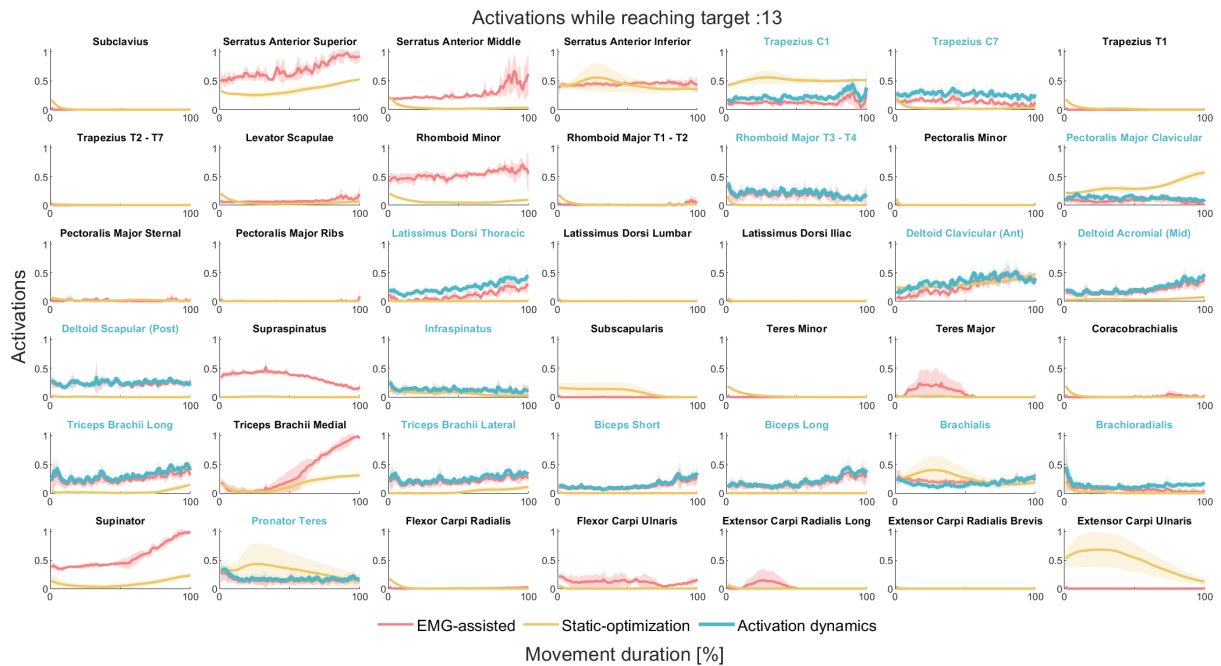


Figure 43: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 2 while reaching target 13 (frontward).

Subject 3

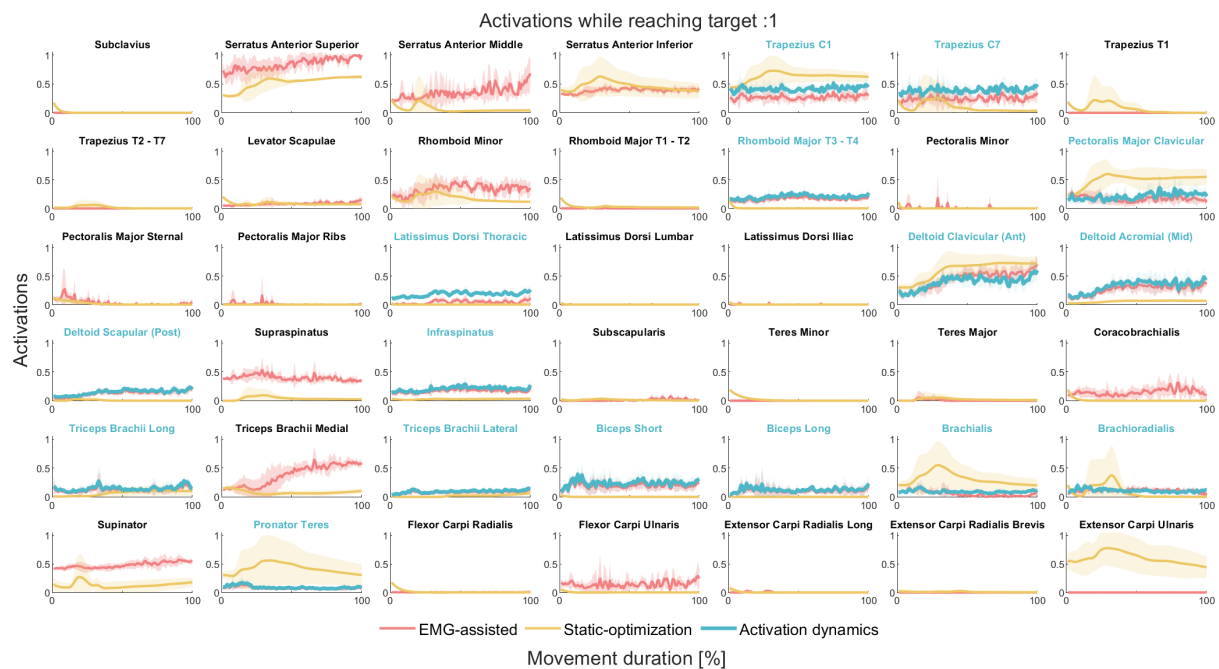


Figure 44: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 3 while reaching target 1 (upward).

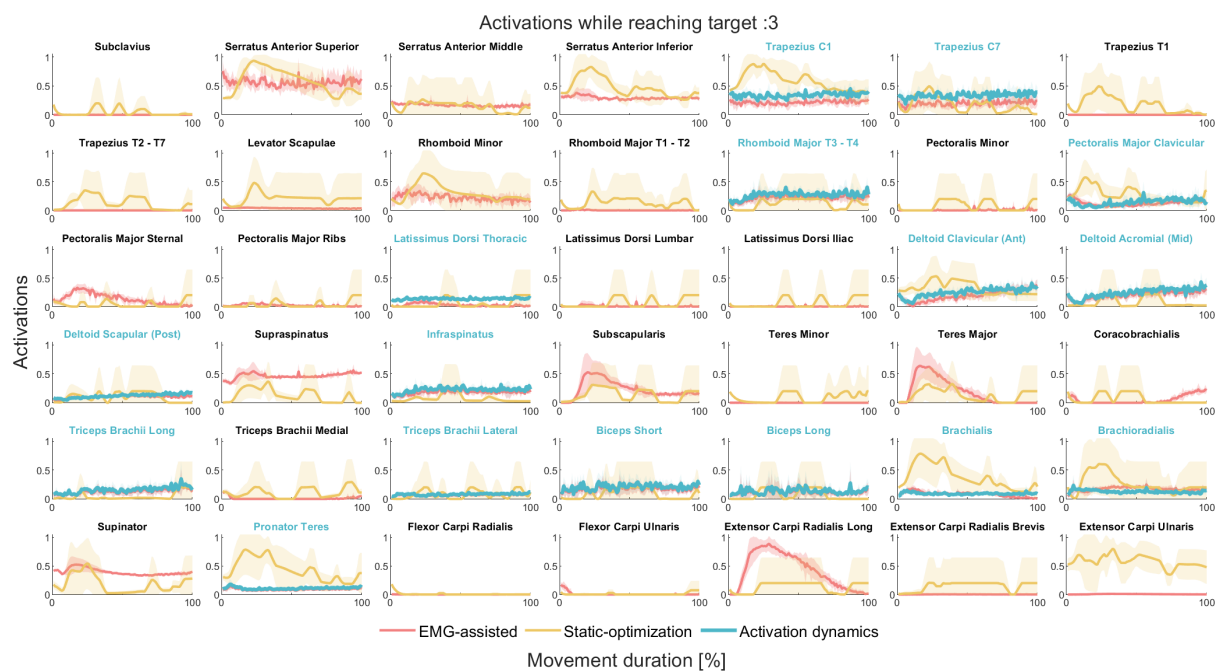


Figure 45: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 3 while reaching target 3 (right).

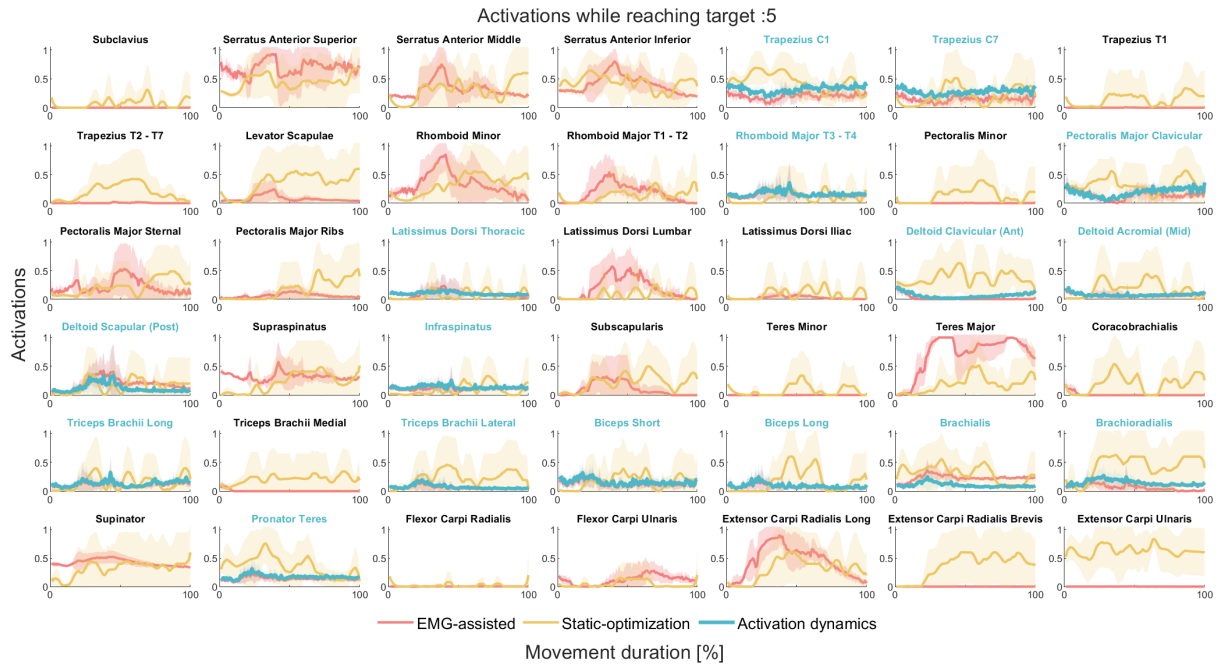


Figure 46: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 3 while reaching target 5 (downward).

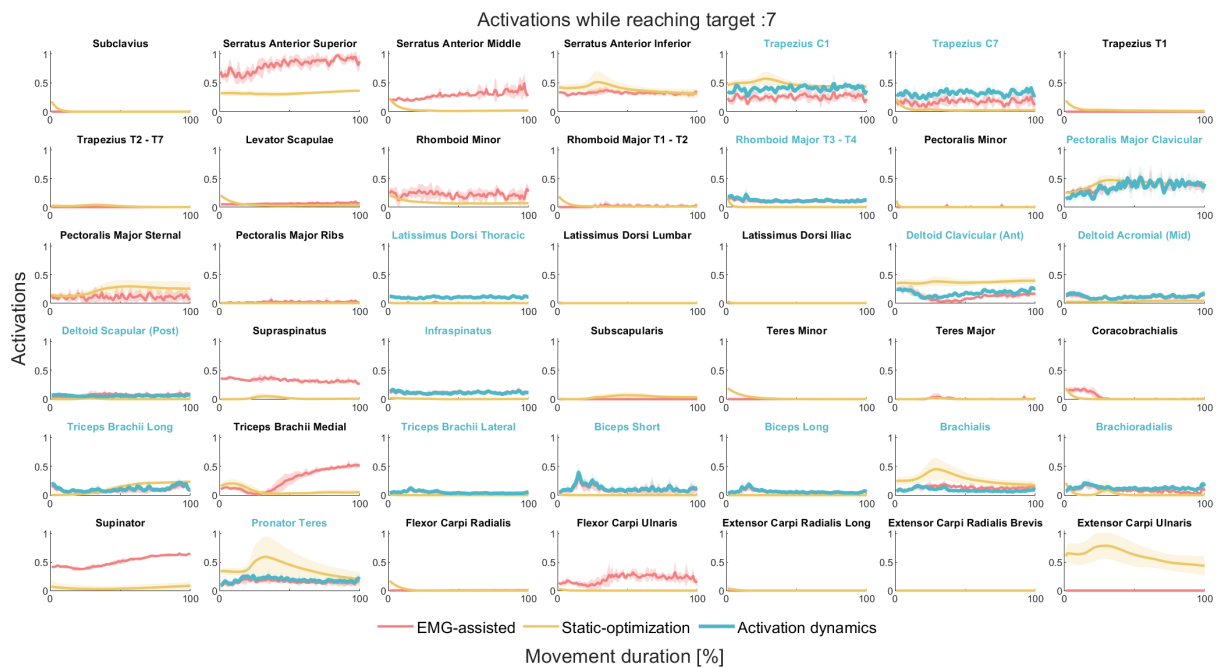


Figure 47: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 3 while reaching target 7 (left).

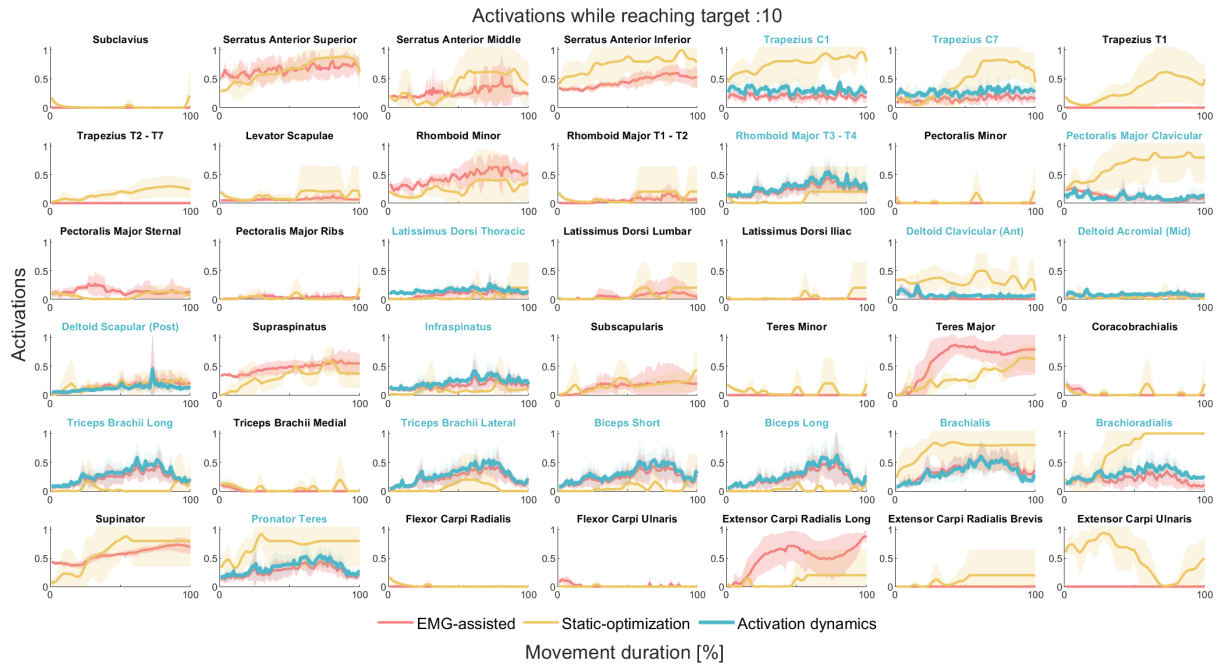


Figure 48: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 3 while reaching target 10 (backward).

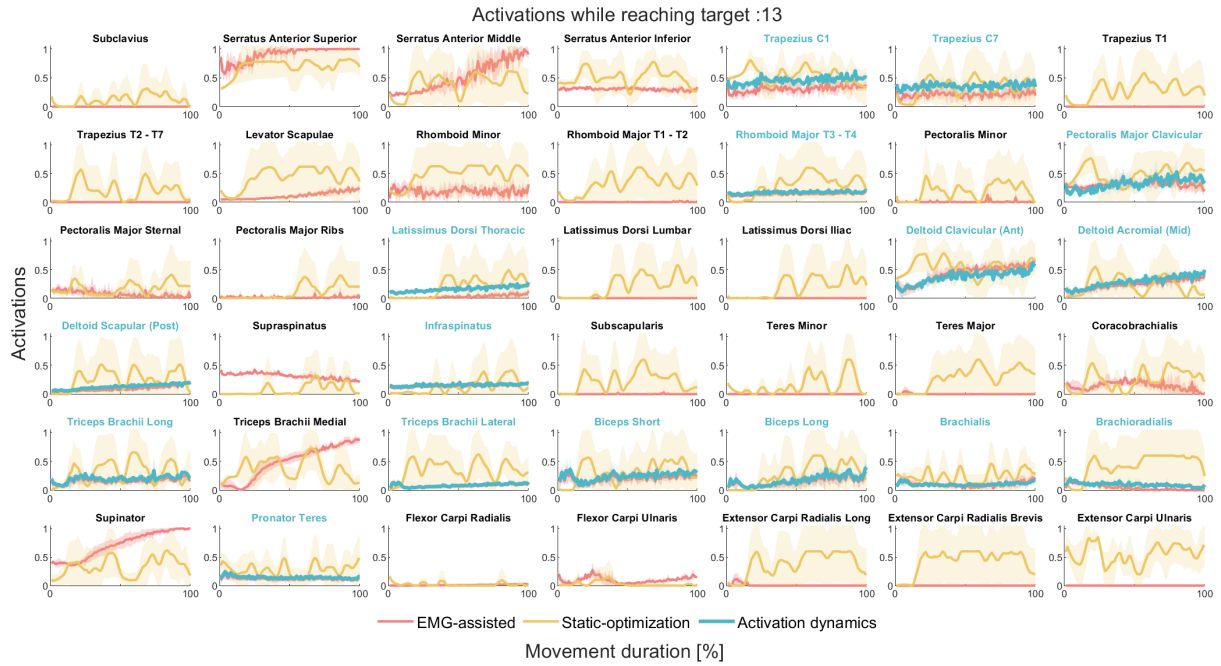


Figure 49: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 3 while reaching target 13 (frontward).

Subject 5

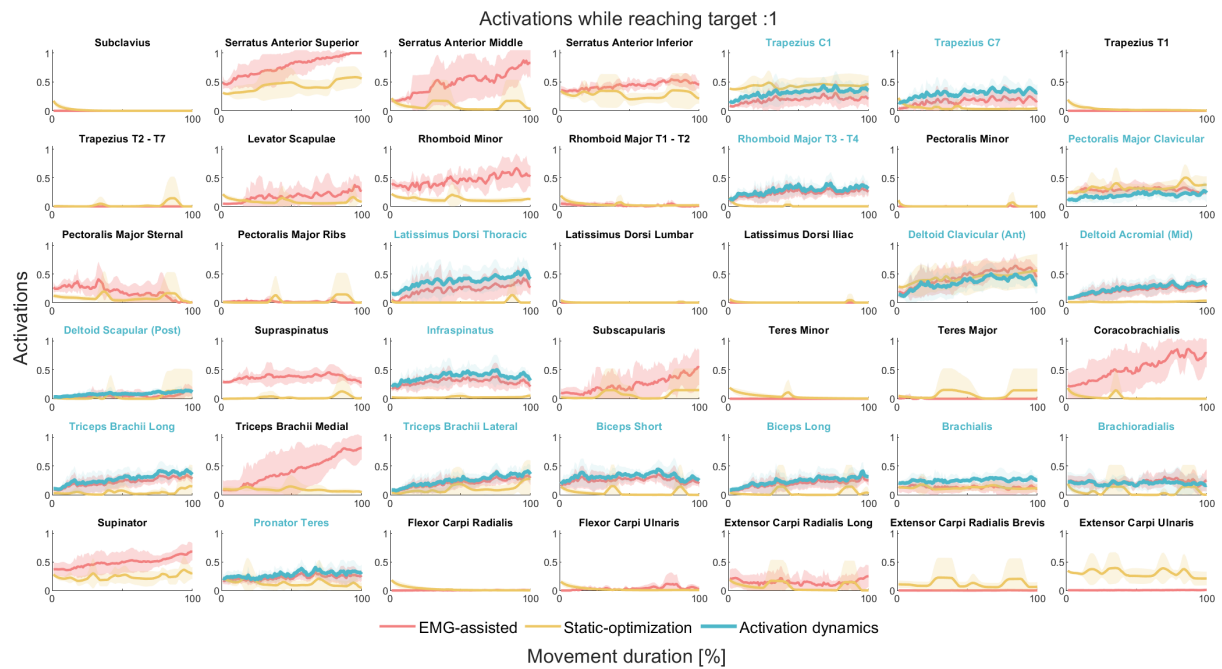


Figure 50: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 5 while reaching target 1 (upward).

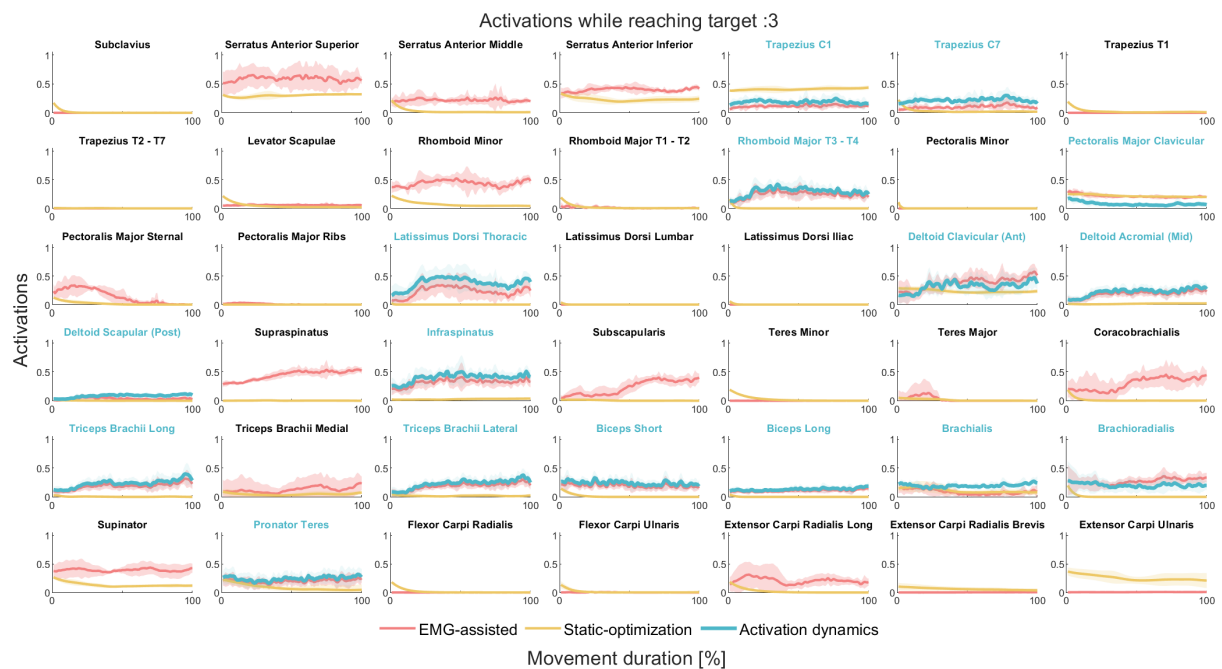


Figure 51: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 5 while reaching target 3 (right).

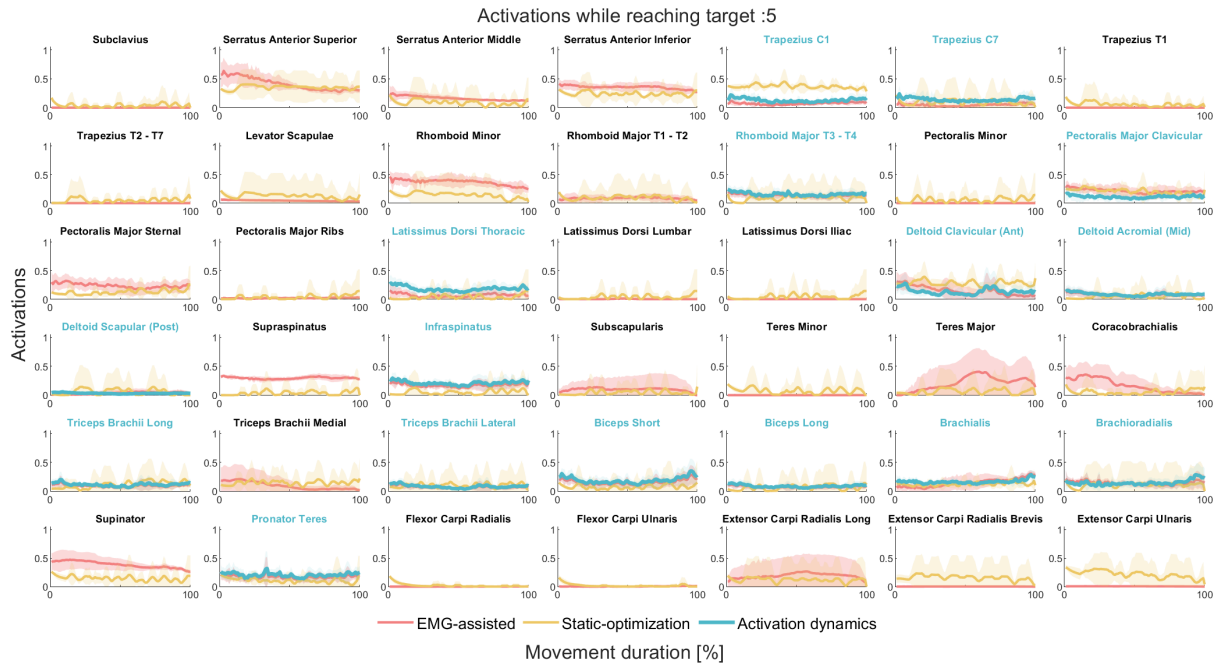


Figure 52: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 5 while reaching target 5 (downward).

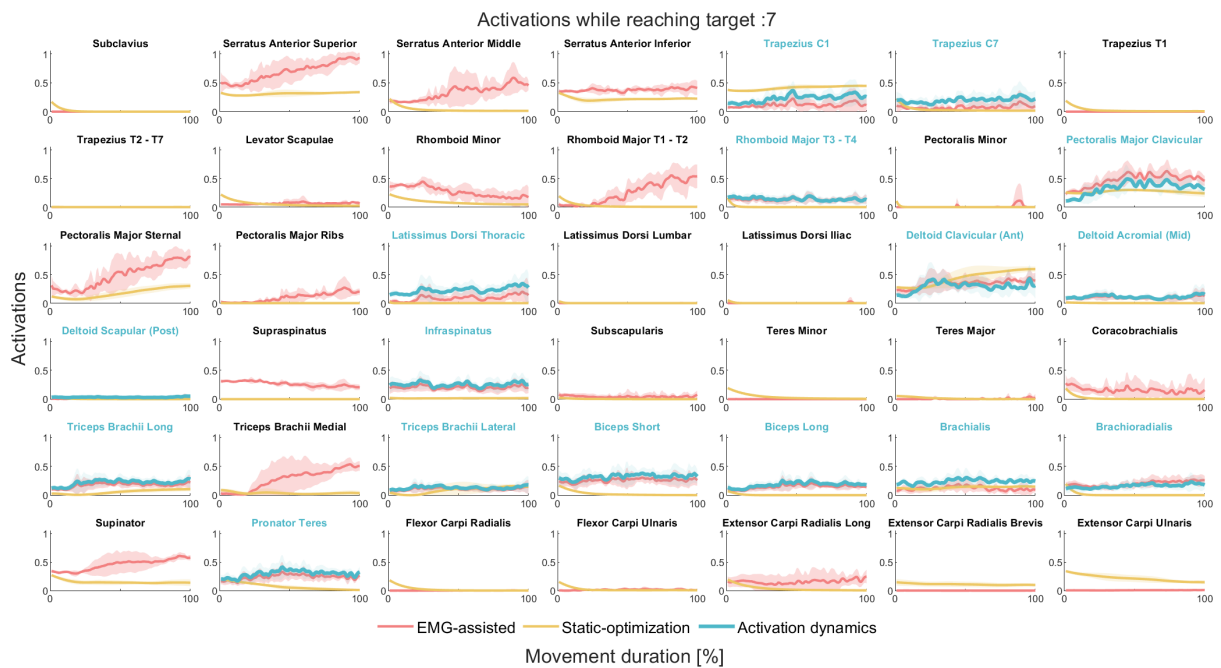


Figure 53: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 5 while reaching target 7 (left).

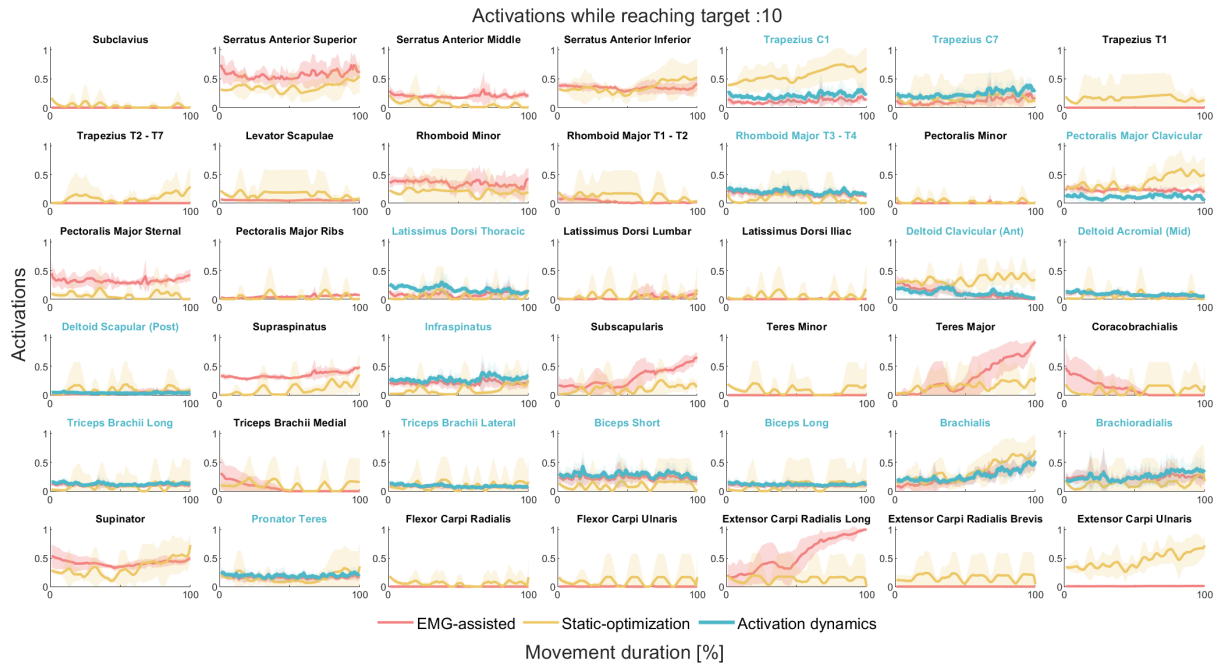


Figure 54: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 5 while reaching target 10 (backward).

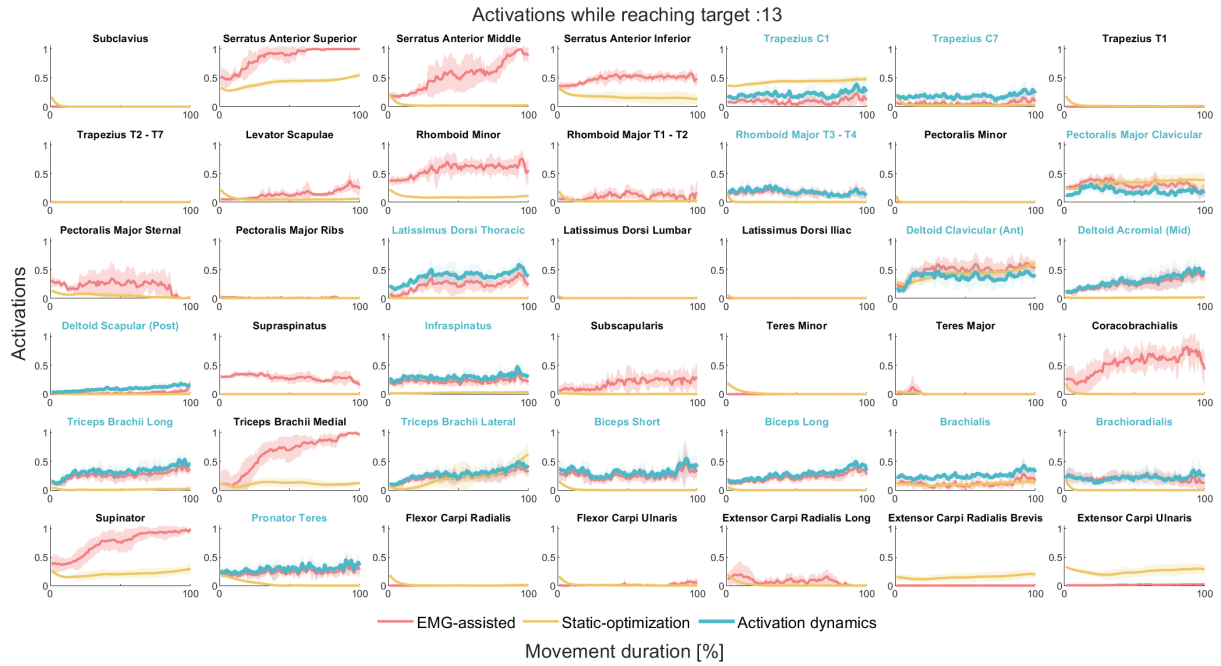


Figure 55: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 5 while reaching target 13 (forward).

Subject 8

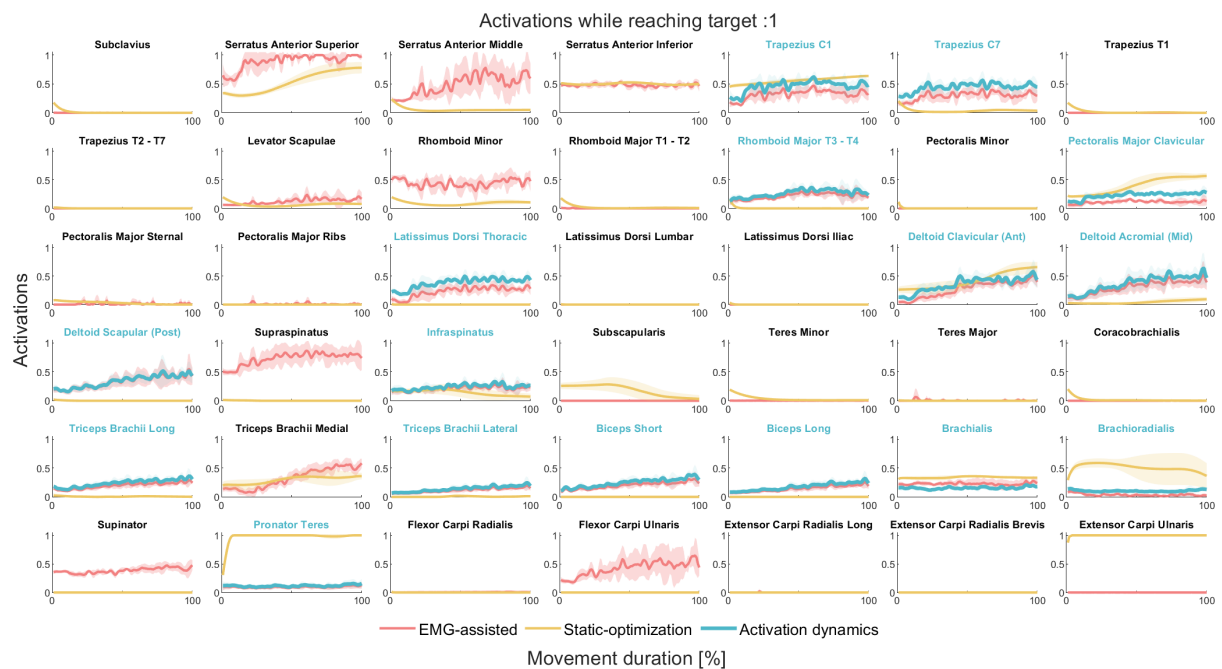


Figure 56: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 8 while reaching target 1 (upward).

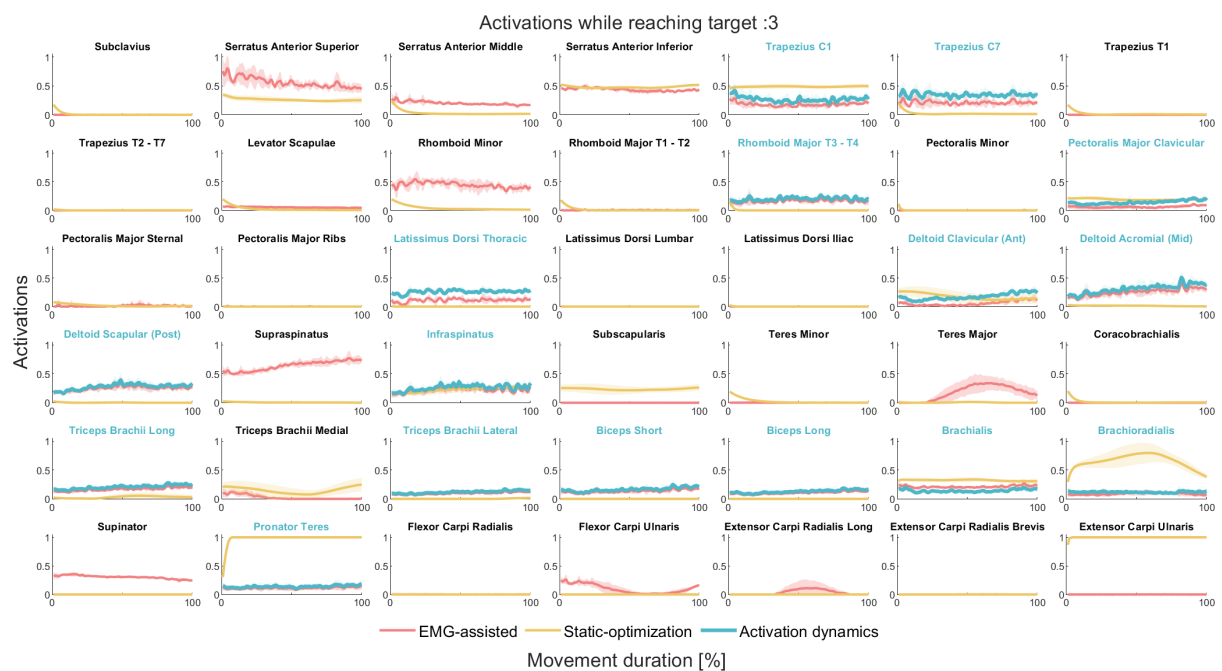


Figure 57: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 8 while reaching target 3 (right).

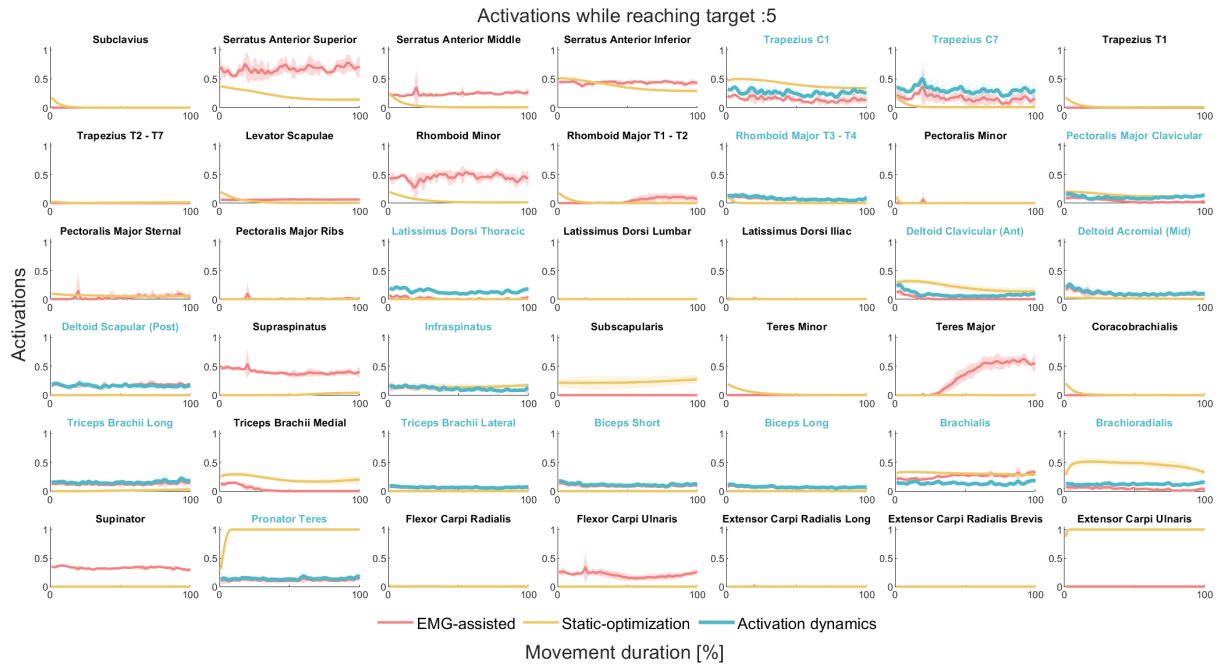


Figure 58: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 8 while reaching target 5 (downward).

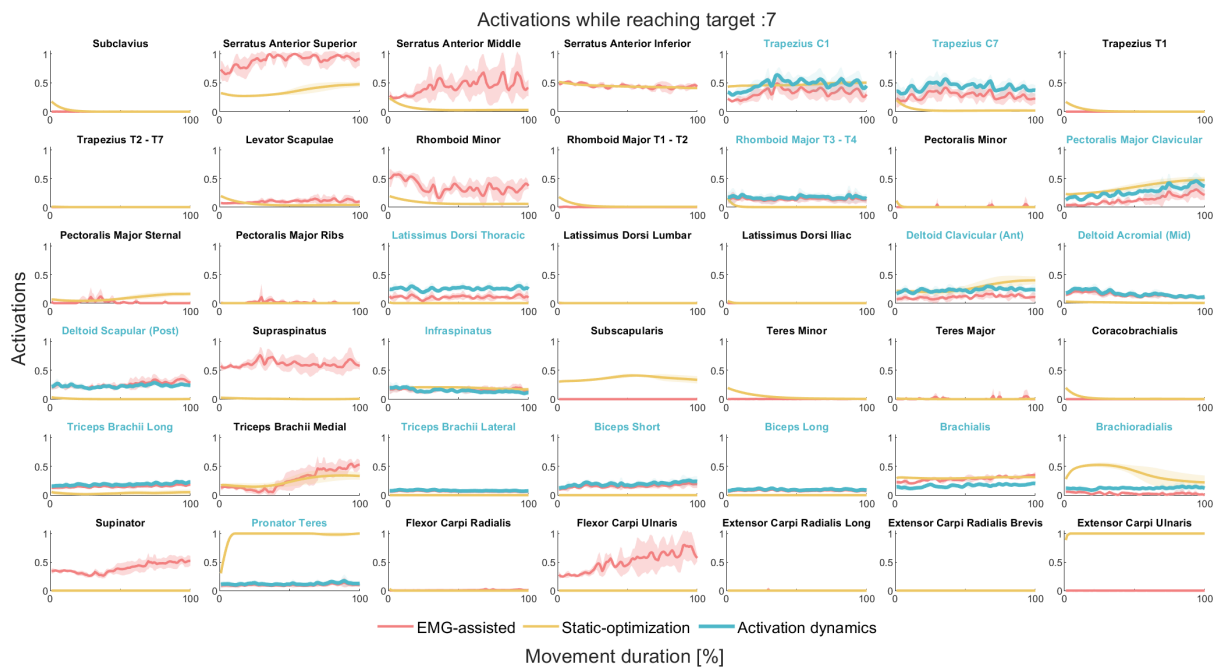


Figure 59: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 8 while reaching target 7 (left).

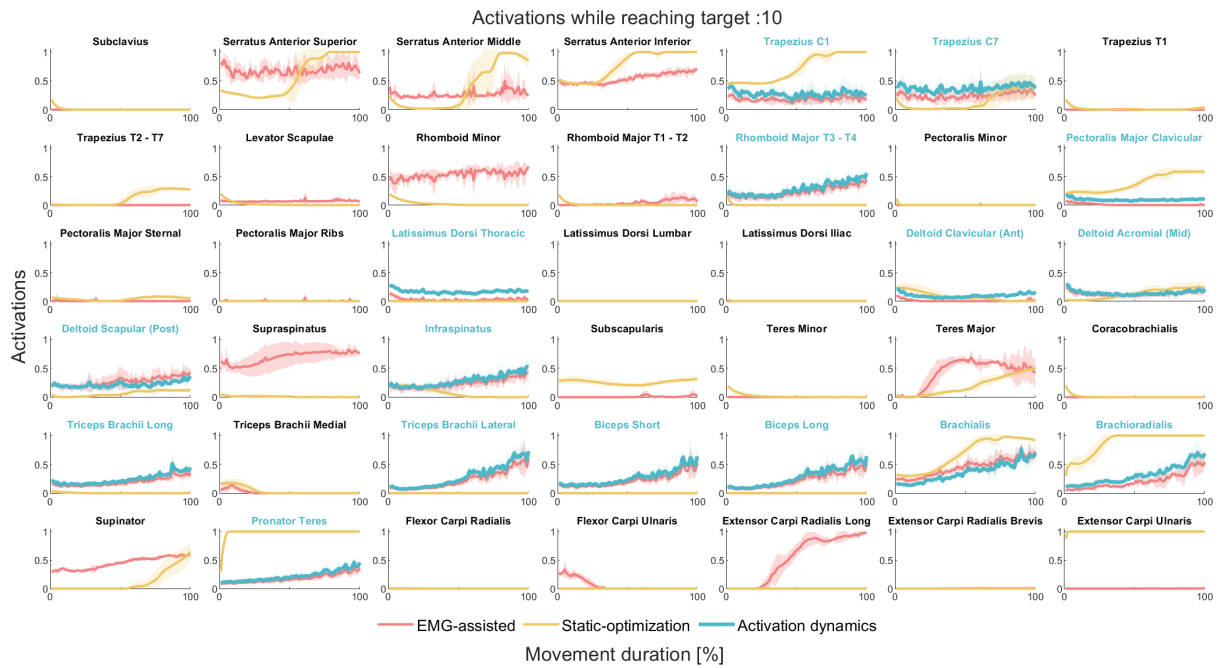


Figure 60: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 8 while reaching target 10 (backward).

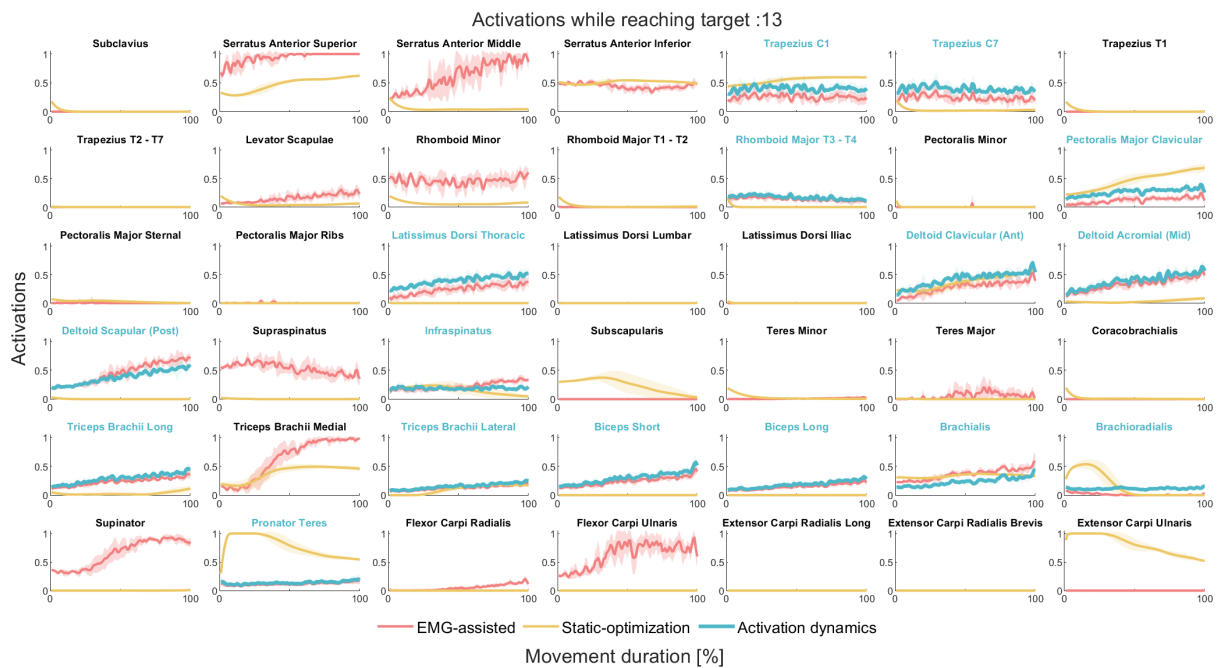


Figure 61: Means of the estimated activations and their standard deviations (shaded areas) for the 42 muscles modeled from the 3 methods, from the physiological static-optimization (in yellow), the EMG-assisted (in red) and directly from the activation dynamics for recorded muscles (in cyan). The signals are obtained for the subject 8 while reaching target 13 (forward).

SET OF FIGURES 4: LEVELS OF ACTIVATIONS FOR ALL SUBJECTS WHILE REACHING THE DIFFERENT TARGETS

The next presented set of figures corresponds to the levels of activations across repetitions for all subjects and targets reached for the recorded muscles. Compared values are from the activations directly obtained via activation dynamics (in blue), the EMG-assisted method (red) and the static-optimization one (yellow).

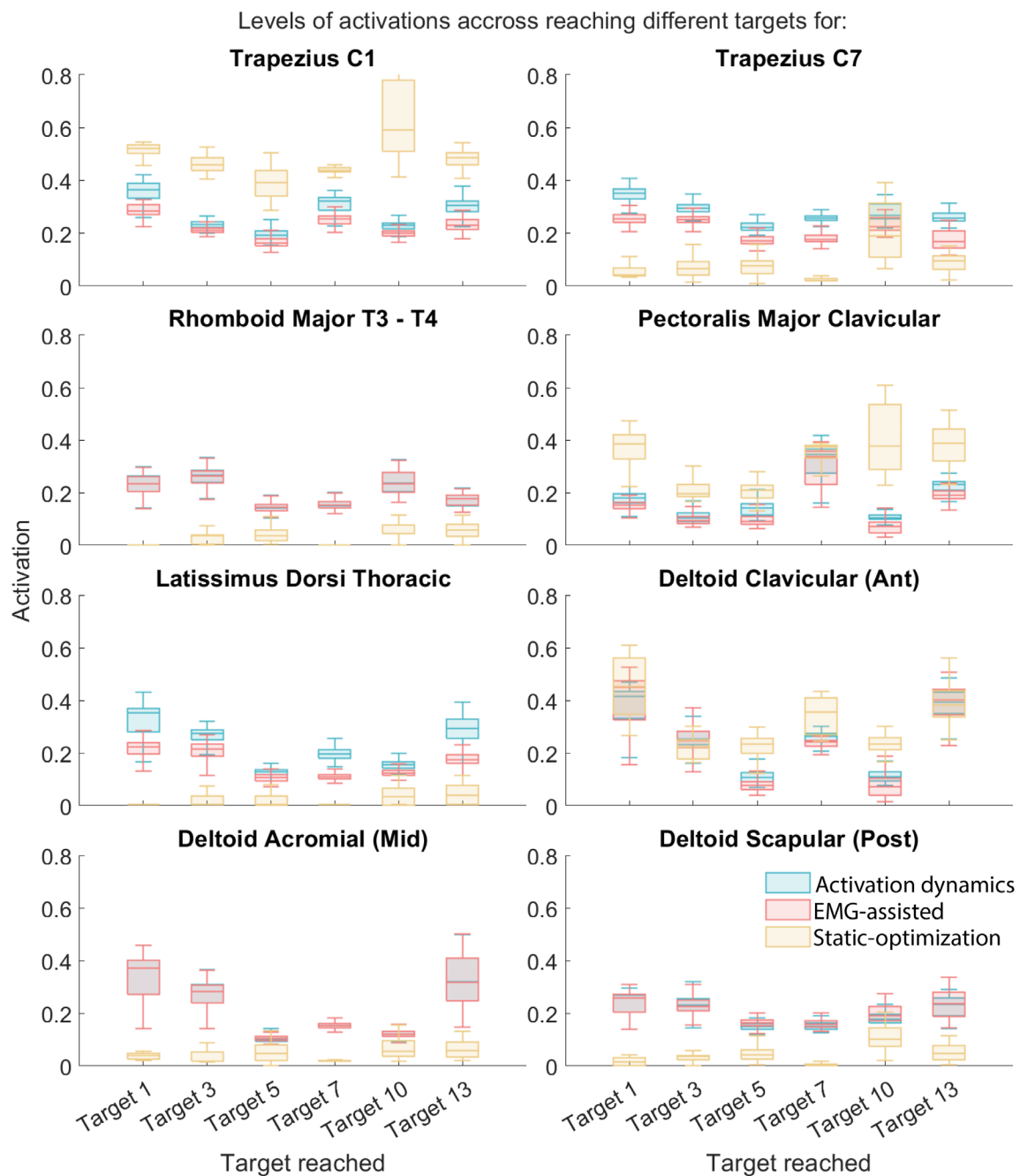


Figure 62: Levels of activations across repetitions for all subjects and targets reached for the recorded muscles. Compared values are from the activations directly obtained via activation dynamics (in blue), the EMG-assisted method (red) and the static-optimization one (yellow)

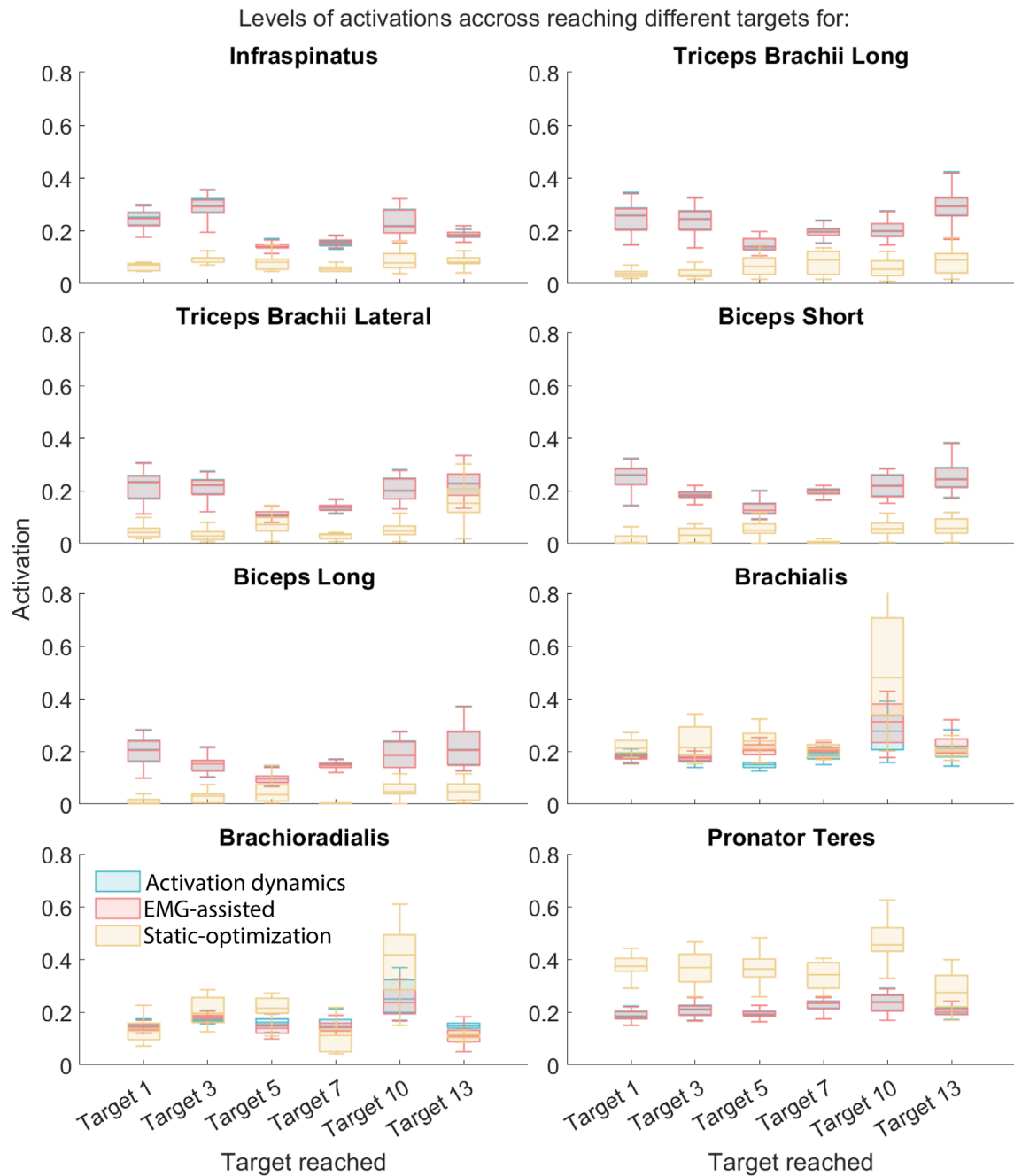


Figure 63: Levels of activations across repetitions for all subjects and targets reached for the recorded muscles. Compared values are from the activations directly obtained via activation dynamics (in blue), the EMG-assisted method (red) and the static-optimization one (yellow)

SET OF FIGURES 5: MOMENT OF JOINT PERS TARGETS

On this next figure, the estimated torques at each joint from the estimated muscle activations and their corresponding force produced are compared to the ones from the equations of movement considered as the ground truth (in blue). Yellow values correspond to the moment obtained with the static-optimization and the red ones to the EMG-assisted one. The plotted values correspond to the means per subject and repetitions.

Each line correspond to the movements performed while reaching a specific target (described on the sphere of targets in the right). Each column corresponds to a joint angle.

When computing the RMSE as a percentage of their maximum measured joint moment from the equations of movement for each of the targets, these were kept low with a mean of $3.39\% \pm 2.13$ for the EMG-assisted and $2.33\% \pm 1.5$ for the static-optimization.

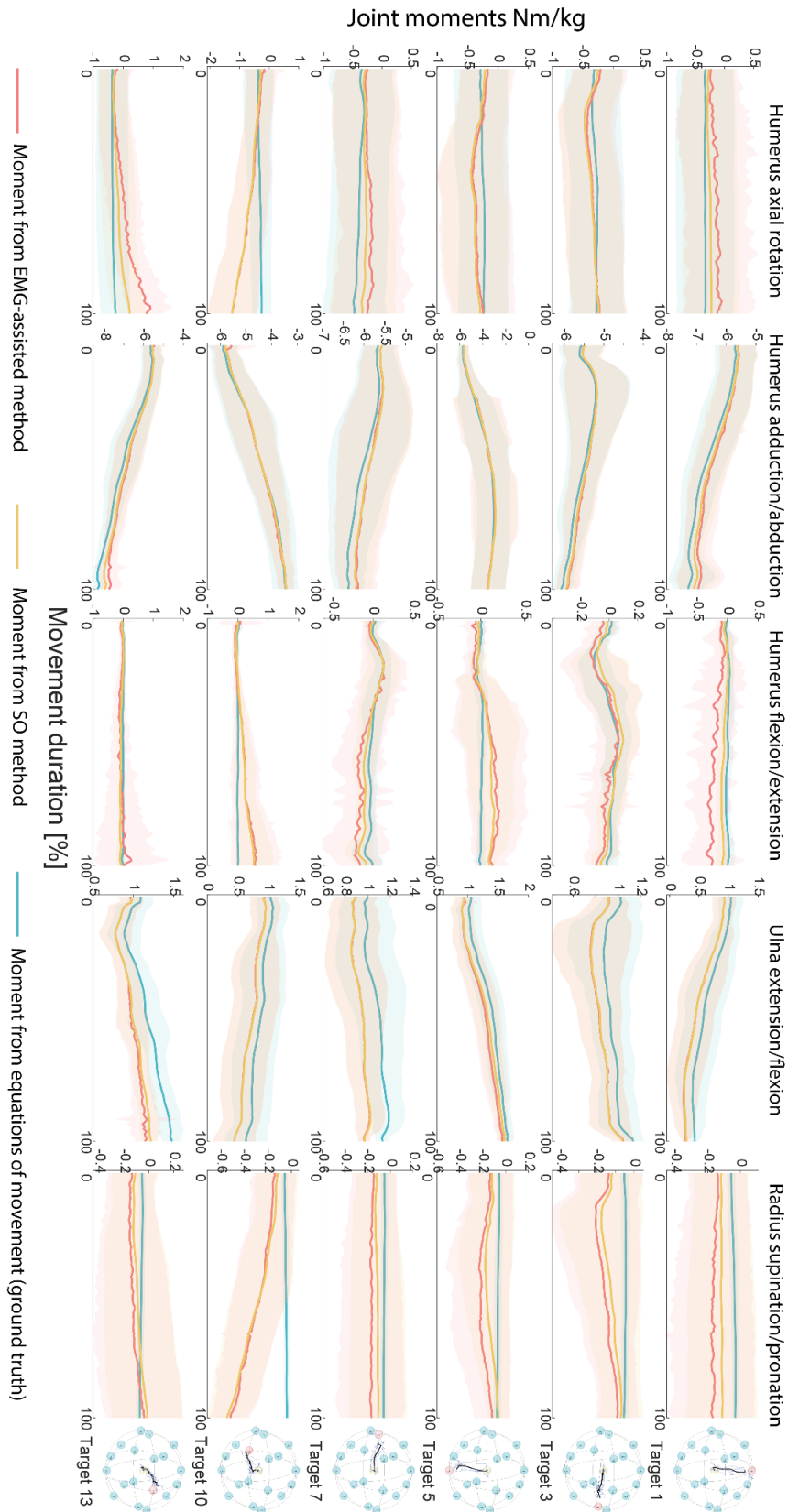
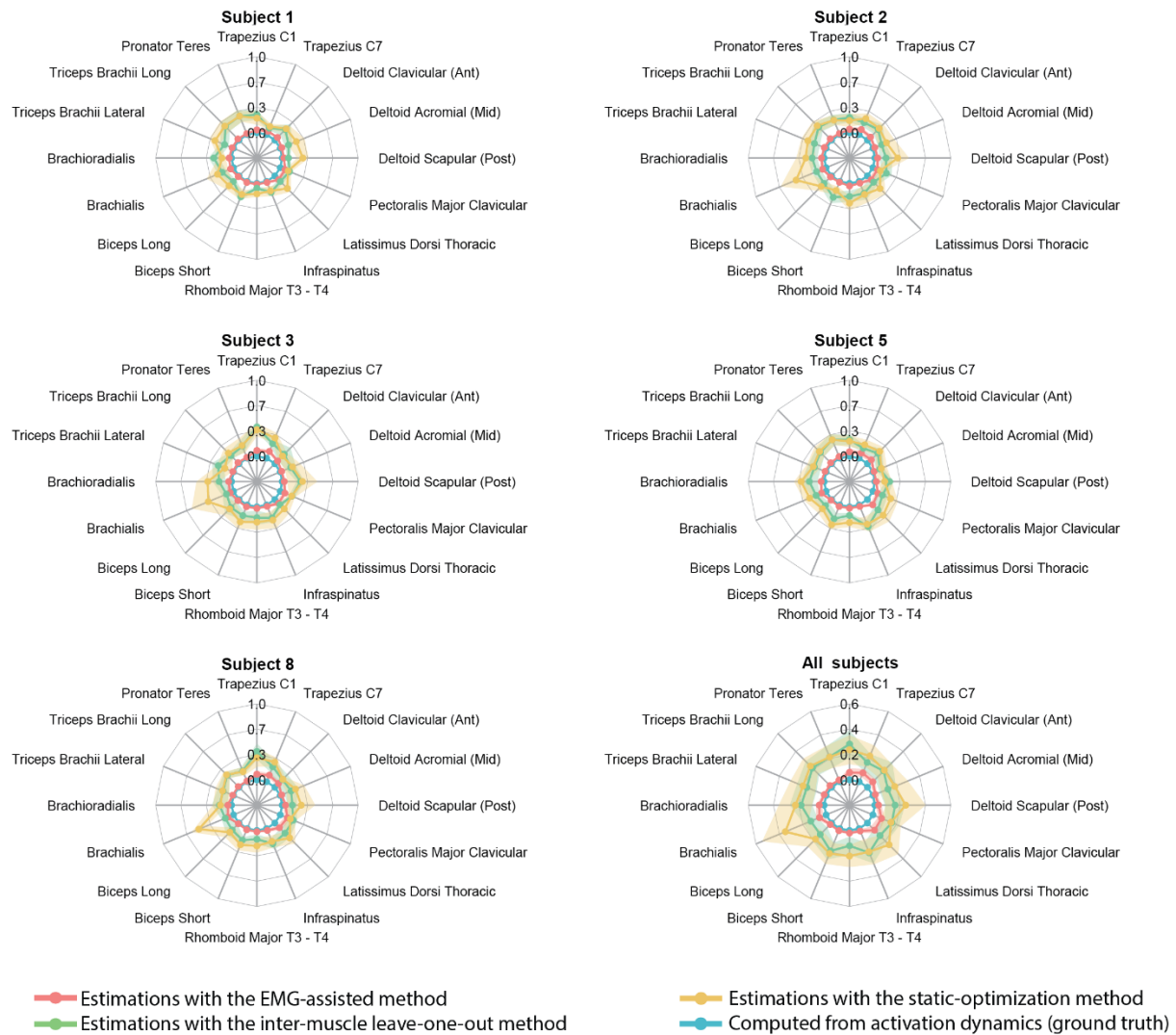


Figure 64: Means per subject and repetitions of the estimated torques at each joint from the estimated muscle activations. From the estimated activations, the corresponding computed forces lead to a joint moment, which is then compared between methods. The ground truth (in blue), correspond to the ones from the equations of movement. Yellow values correspond to the moment obtained with the static-optimization and the red ones to the EMG-assisted one. Shaded area represent the standard deviation.

SET OF FIGURES 6: LEAVE-ONE-OUT CROSSVALIDATION

In this set of figures, the leave-one-out cross validation is shown. Here for each muscle recorded, the root mean square error (RMSE) from its activation from activation dynamics (ground truth) and its estimated values from the static-optimization (in yellow), the EMG-assisted method (in red) and the leave-one out method (in green) are displayed.

The leave-one-out method corresponds to the EMG-assisted one, with that specific muscle taken out from the recorded dataset. Therefore, it shows if we can observe an improvement in the estimation of the non-recorded muscles when using EMG-assisted method compared to the static-optimization. The results shows the RMSE for each subject during all repetitions and all targets reached, with the last one representing the mean across the subjects, with a different axis to show in details the differences.



	Subject 1	Subject 2	Subject 3	Subject 5	Subject 8	All subjects
Mean RMSE EMG-Assisted	0.02 ± 0.00	0.02 ± 0.01	0.03 ± 0.00	0.03 ± 0.01	0.03 ± 0.01	0.03 ± 0.01
Mean RMSE static-optimization	0.19 ± 0.04	0.23 ± 0.07	0.23 ± 0.05	0.21 ± 0.05	0.22 ± 0.03	0.22 ± 0.08
Mean RMSE leave-one-out	0.15 ± 0.03	0.17 ± 0.04	0.18 ± 0.04	0.17 ± 0.05	0.17 ± 0.03	0.17 ± 0.02

Figure 65: Spider plots for the different subjects representing root mean squared error from the estimated muscles' activations and the ones from activation dynamics (in blue) for recorded muscles. The EMG-assisted (in red) and the physiological static-optimization (in yellow) are compared to the activations from the inter-muscle leave-one-out method (in green) which corresponds to an EMG-assisted method excluding the specific recorded muscle. On the bottom, a table shows the means of the root mean squared errors between the estimated activations and the ones from the activation dynamics.

HILL-TYPE MODEL, NORMALIZED FUNCTIONS

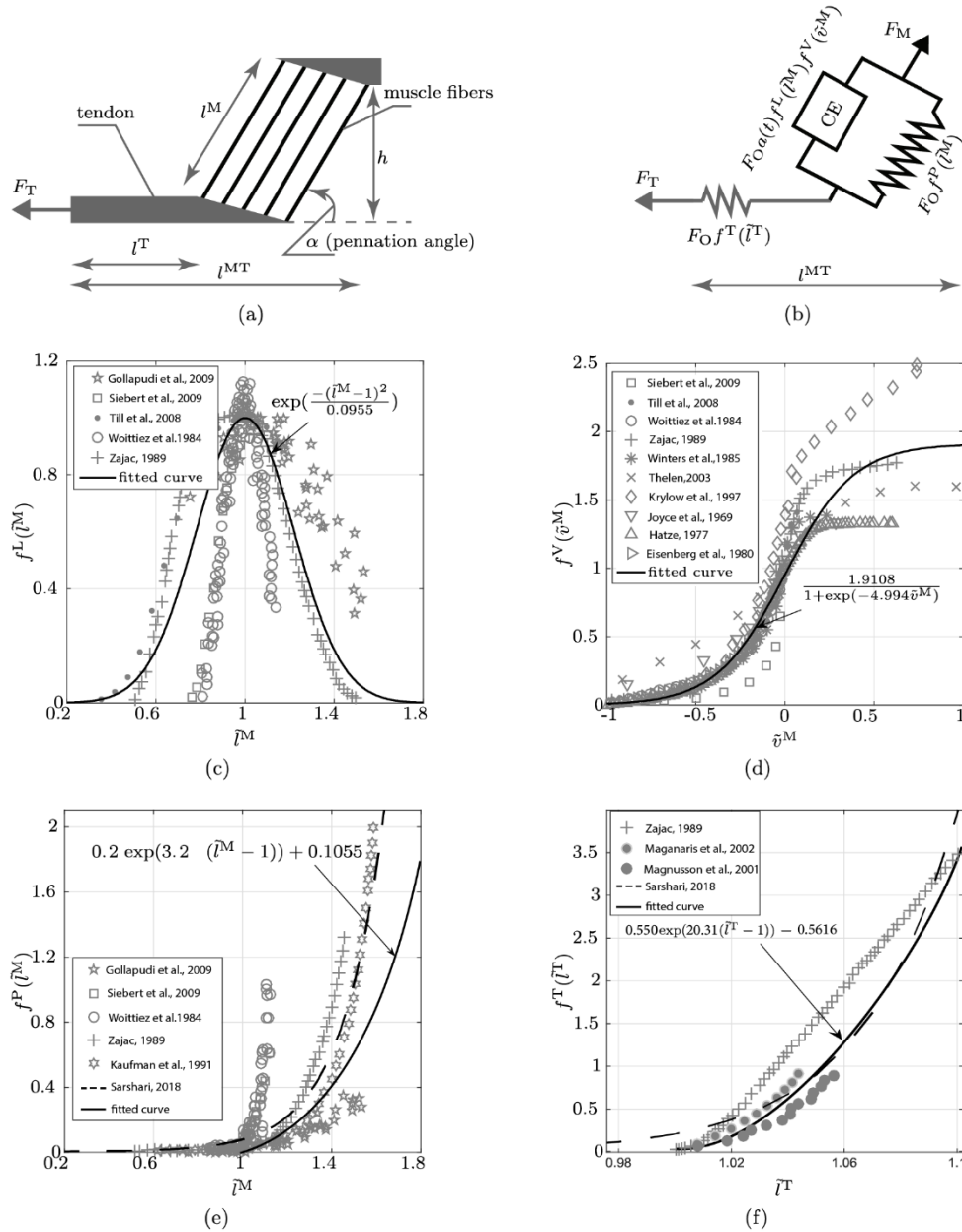


Figure 66: The Hill type model used: (a) Physiological representation of the modeled elements in the Hill type model. The fiber lengths are approximated by a set of straight parallel muscle fibers with equal lengths l^M deviated with a pennation angle α , from the axis of force production (in the direction of the muscle tendon). (b) The corresponding mechanical representation, including the contractile element (CE), the parallel passive elastic element (PEE) and the tendon, the serial elastic element (SEE). The force produced by the muscle F_M is the resultant of the force generated by the contractile element ($F_O \alpha(t) f_L(\tilde{l}^M) f_V(\tilde{v}^M)$) and PEE ($F_O f_P(\tilde{l}^M)$) for a rigid tendon model.

The normalized functions f_P , f_L , and f_V and were obtained previously [1] with a curve fitting of published experimental data. In this present work, the curves fitted of f_P were adapted to better reflect the curves behaviours and avoid numerical errors. Modified from [1] with the author's consent.<