**Appendix 7: Apparent versus true HT axial rotation**

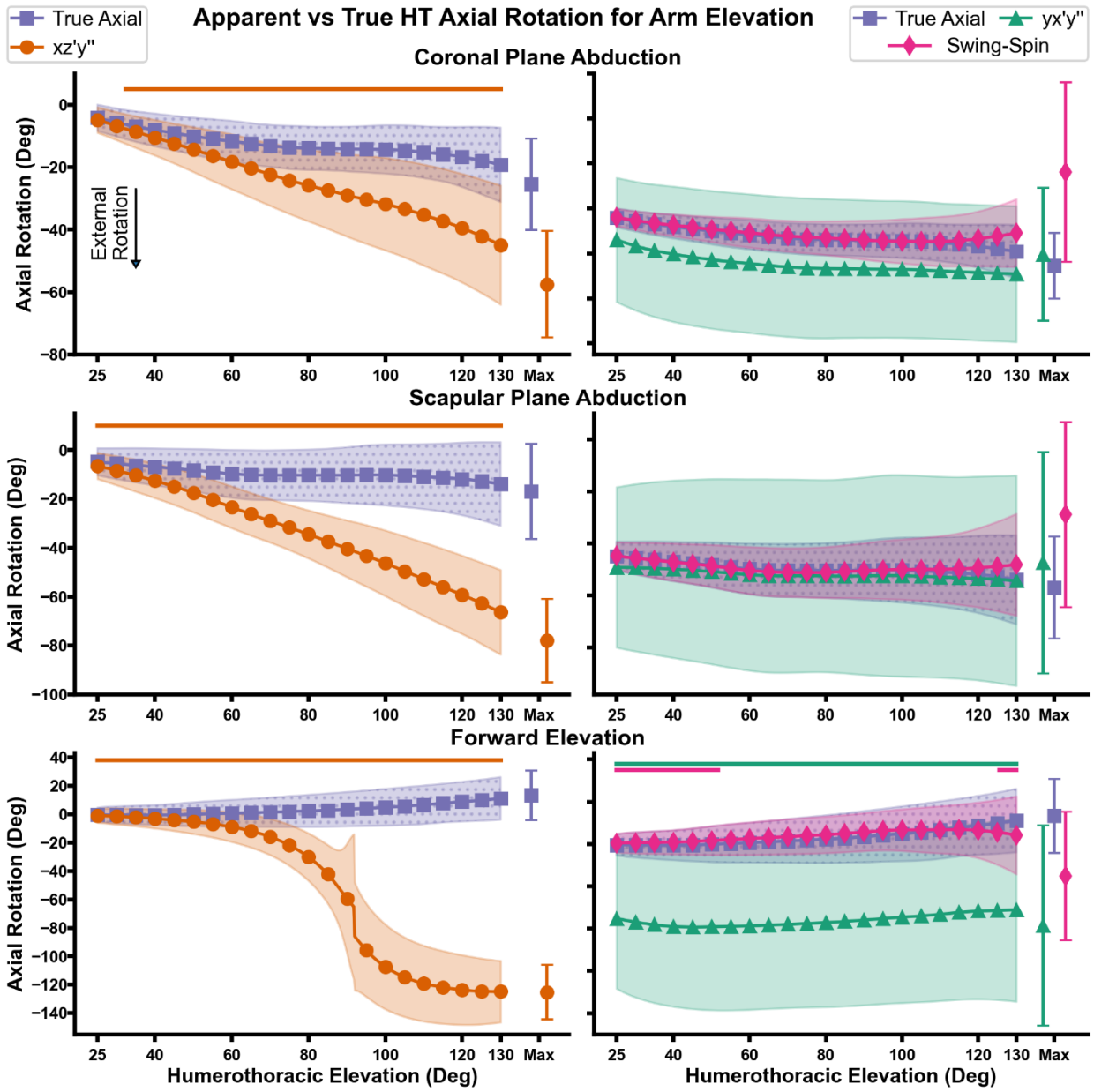


**Fig. A7a**: Comparison of xz'y'' (left), yx'y'' (right), and swing-spin (right) apparent HT axial rotation versus true HT axial rotation for CA (top), SA (middle), and FE (bottom). The singular data point indicates axial rotation at maximum HT elevation (differs by subject). The errors bars around the singular data point and the shaded regions indicate ±1 standard deviation. The solid lines (orange for xz'y'', green for yx'y'', and magenta for swing-spin) at the top of each plot indicate regions where a SPM1D non-parametric paired t-test found significant differences between apparent and true axial rotation.

Although xz'y'' is not typically utilized for HT trajectories, it is presented for completeness, and it nears a singularity during FE at 90° of HT elevation. The yx'y'' decomposition undergoes large changes in axial rotation from 0-25° of HT elevation as evidenced in the right-column and explained in Appendix 5. It also demonstrates large inter-subject variability for axial rotation, reducing the ability to distinguish between experimental groups. The swing-spin decomposition closely tracks true axial rotation up to 130° of HT elevation, but beyond that, sharply deviates due to a large increase in the spherical area between the trajectories.

**Appendix 7: Apparent versus true HT axial rotation**

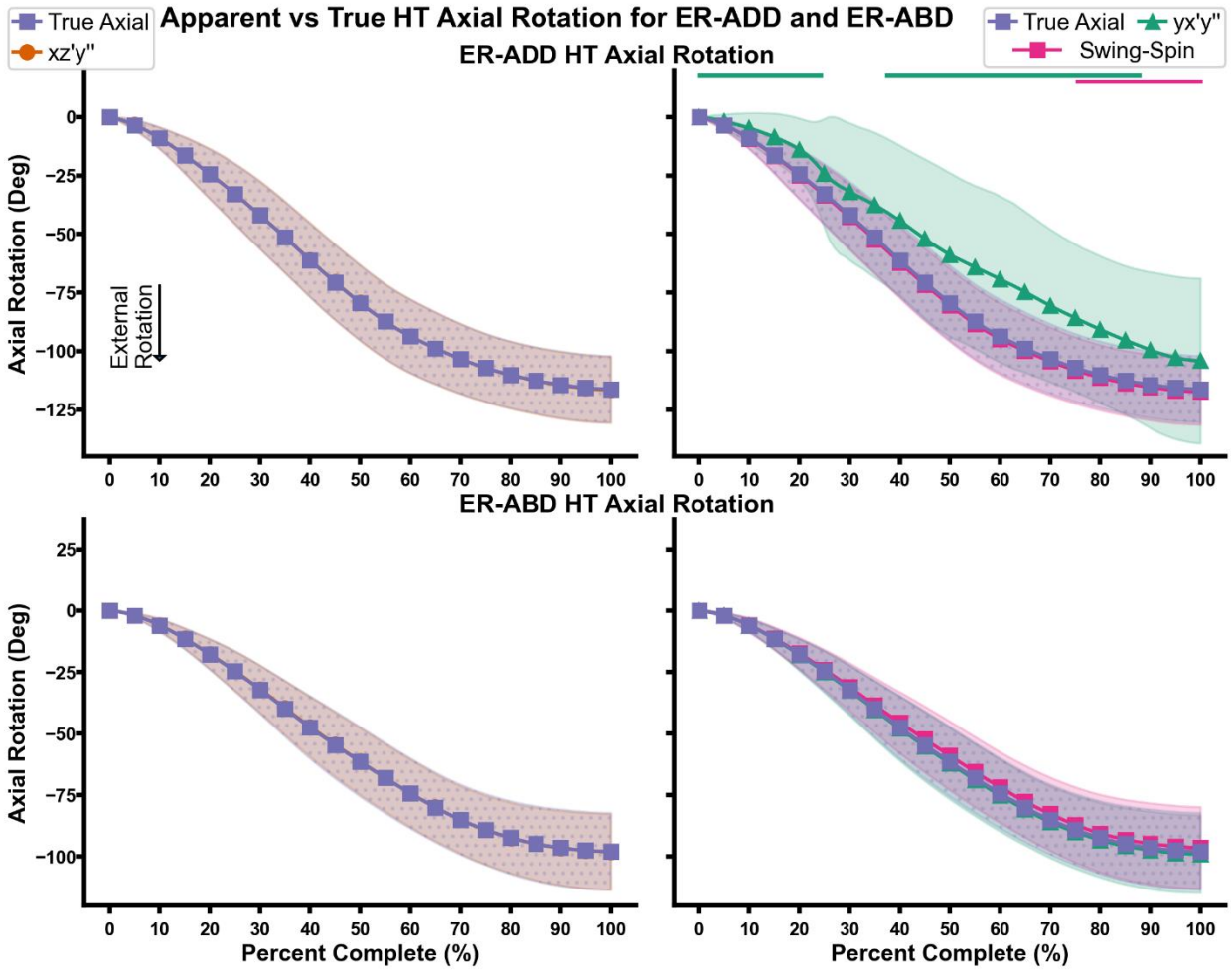


**Fig. A7b:** Comparison of xz'y'' (left), yx'y'' (right), and swing-spin (right) HT apparent axial rotation versus true HT axial rotation for ER-ADD (top) and ER-ABD (bottom). Trials were interpolated at 0.25% increments between the start (0%) of the motion and maximum external rotation (100%). The shaded regions indicate ±1 standard deviation. The solid lines (orange for xz'y'', green for yx'y'', and magenta for swing-spin) at the top of each plot indicate regions where a SPM1D non-parametric paired t-test found significant differences between apparent and true axial rotation.

This figure closely aligns with the complementary GH figure (manuscript Fig. 5), but here the yx'y'' apparent axial rotation significantly differs from true axial rotation (as hypothesized). The swing-spin decomposition tracks true axial rotation more faithfully than the yx'y'' decomposition and is recommended over the yx'y'' decomposition.