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Supplemental information

Symbiotic electroneural and musculoskeletal framework to encode proprioception via neurostimulation: ProprioStim

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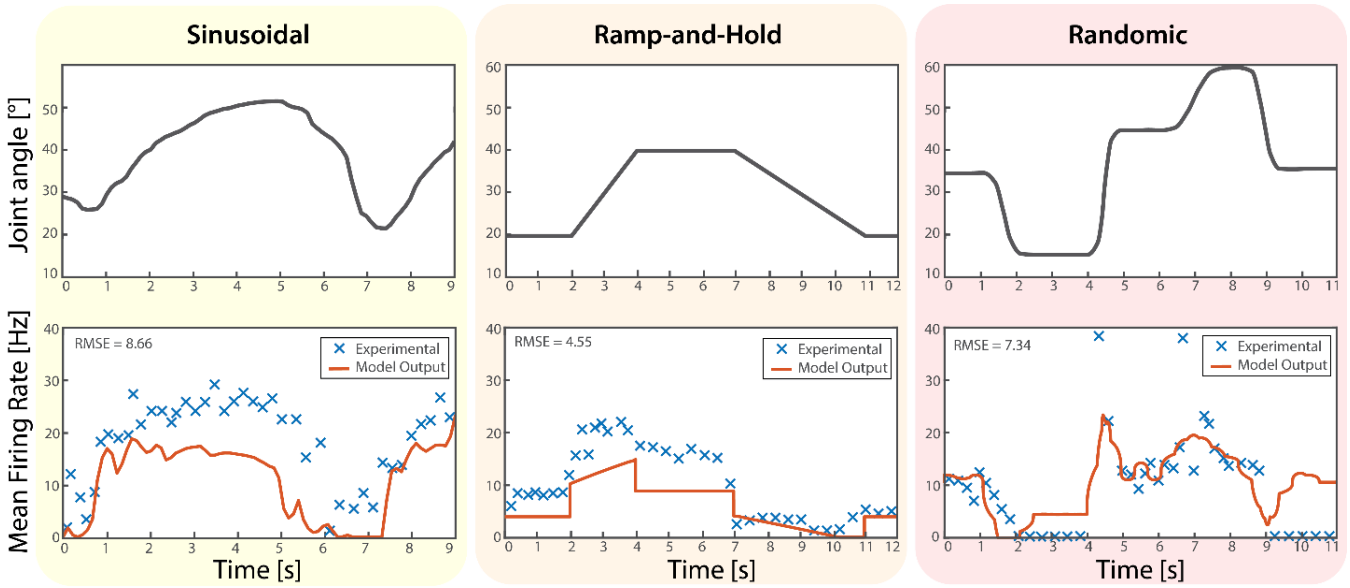

Figure S1. Validation results on a single trial per trial type of the modified Prochazka Ia muscle spindle transducer model, related to Figure 3A. Top row presents the metacarpal-phalangeal joint trajectory; on the bottom row comparison between experimental microneurography and predicted Ia mean firing rate. Three types of trials are shown: on the left, active sinusoidal movement of the joint; in the center, guided ramp-and-hold movement; on the right, free joint movement.

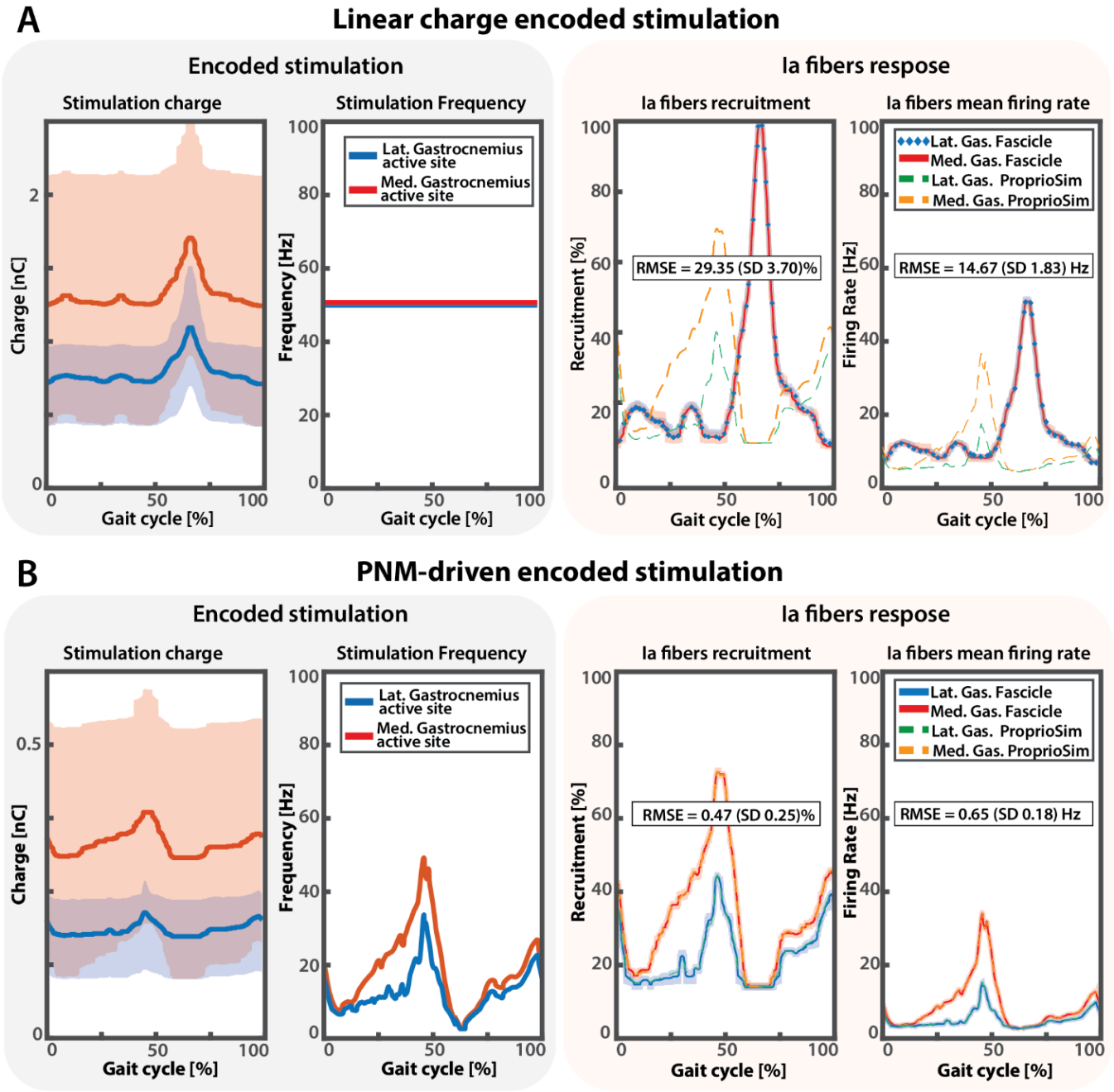

Figure S2. Results of Proprio-Neural Model (PNM)-driven encoding stimulation in-silico simulations for each modeled electrode placement most selective active sites, related to Figure 6. The figure illustrates mean and IQR of each identified potential gastrocnemius fascicle combination and each primary fiber population dispositions. **(A)** Same encoding strategy illustrated in Fig. 6B. On the left, mean time-varying charge and frequency encoding parameters are presented. On the right, Ia fiber stimulation derived recruitments and mean firing rate are displayed and confronted with the PNM estimated natural activity. **(B)** Same encoding strategy illustrated in Fig. 6C. On the right, mean time-varying charge and frequency encoding parameters are presented in the central block. On the right, Ia fiber stimulation derived recruitments and mean firing rate are displayed and confronted with the PNM estimated natural activity.

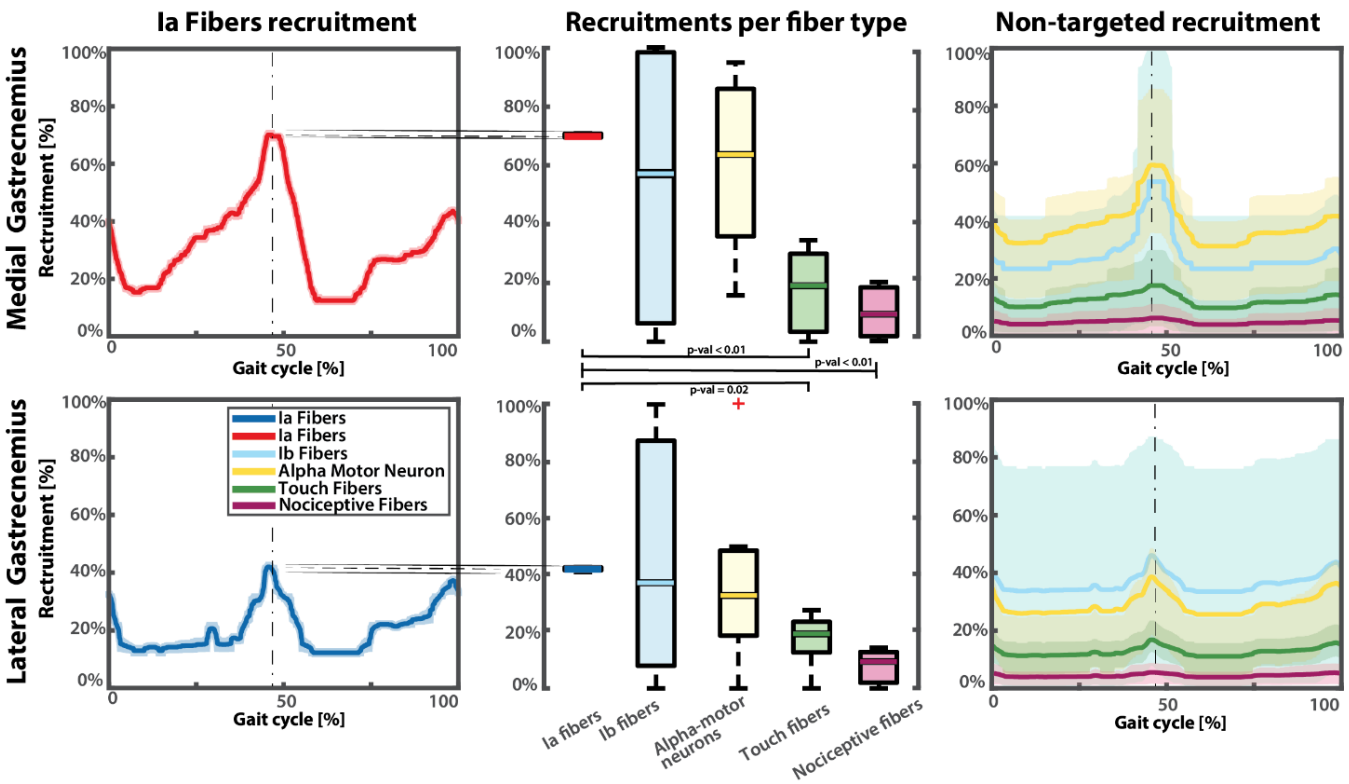

Figure S3. Fiber recruitments on fiber populations during walking cycle with Proprio-Neural Model (PNM) driven encoded stimulation, related to Figure 5. On the left, mean and IQR percentile target recruitments of the Ia afferent fibers from medial (red) and lateral (blue) gastrocnemius fascicles obtained with the PNM-driven stimulation. On the right, non-target recruitments of Ib (light blue), alpha motor neurons (yellow) of the motor fascicles during the same stimulation are displayed; simultaneous recruitment of touch fibers (green) and nociceptive fibers (purple) on the non-motor most selective fascicle are presented. In the center, distribution of all fibers population recruitments at the toe-off (maximum gastrocnemius extension) are compared; significant p-values of the statistical analysis for Ia fibers and the non-targeted populations are shown.

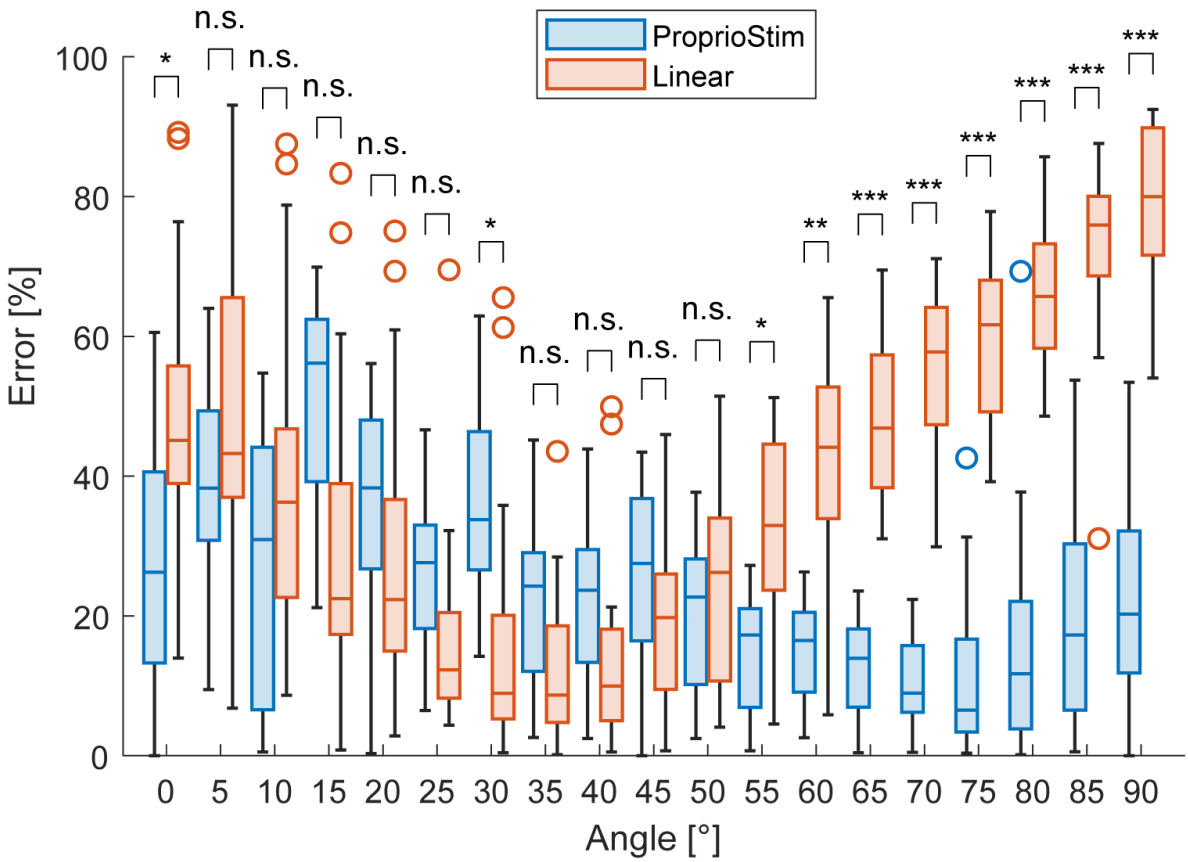

Figure S4. Absolute value of percentual errors made by all subjects during TENS angle matching experiments, grouped by target angle, related to Figure 7. The errors were compared by fitting a repeated measures ANOVA with Tukey's honest significance test for post-hoc multiple comparisons.

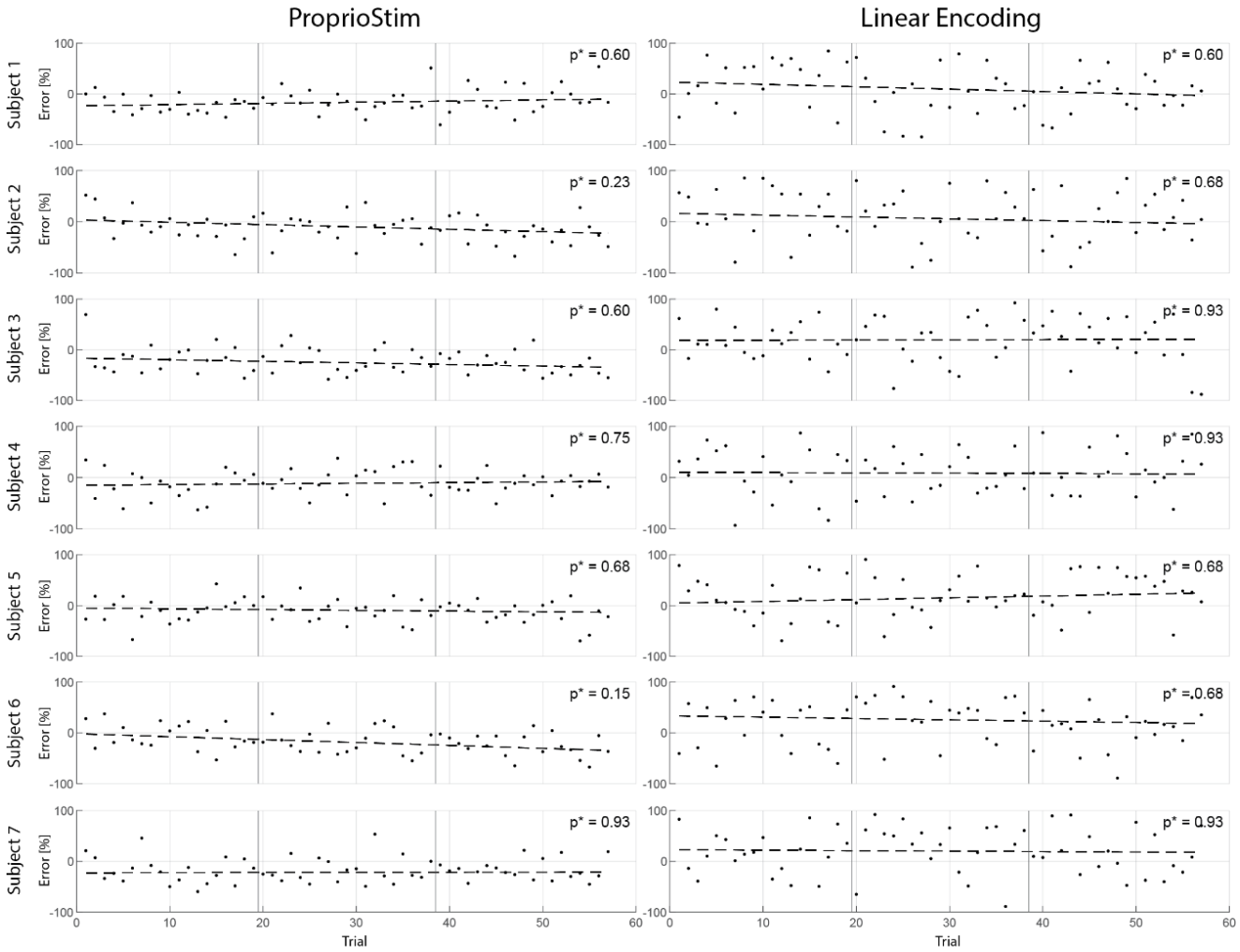

Figure S5. The trend of errors in time reported for each subject for ProprioStim and linear encoding conditions, related to Figure 7. We performed a Mann-Kendall test with the Bonferroni-Hochberg correction for multiple testing, which did not reject the hypothesis of no monotone trends of the errors in time for any subject and condition. The p-value of the Mann-Kendall test adjusted with Bonferroni-Hochberg correction (p*) is reported. The Sen's slope is reported as dashed line. The three consecutive sessions are divided by vertical lines. No statistically significant habituation was detected for any subject or condition.

Table S1. Participant details, related to STAR Methods.

Age	23	23	27	23	24	25	23
Sex	F	M	F	F	F	M	F
Gender	F	M	F	F	F	M	F