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Reticulospinal drive with a flexor bias can be detected as α-band shared neural drive during voluntary tasks in healthy individuals

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There is growing evidence suggesting that synchronized activity between muscles at ~10 Hz (α-band), quantified by coherence analysis, reflects their shared neural drive arising from the reticulospinal pathway. This α-band shared neural drive can be observed, for example, across muscles in response to acoustic startle, which is transmitted via the reticulospinal pathway. Interestingly, muscles involved in pathologic flexion synergy post stroke also show exaggerated α-band shared neural drive. This is consistent with a previous suggestion that inappropriate activation through the reticulospinal pathway is an important for expression of such pathologic synergies.

However, little is known whether or not such drive exists in healthy individuals during voluntary actions. To test this possibility, we measured intermuscular coherence between the muscle pairs driving isometric wrist torque in 4 directions (flexion and extension, and radial and ulnar deviation). As present in flexion synergies post stroke, we expect that flexor muscles receive stronger reticulospinal drive, and therefore stronger α-band shared neural drive, compared to extensors. Conversely, corticospinal drive may play the predominant role in the control of radial/ulnar deviation. Thus, we expect a lack of α-band shared neural drive between muscles during those actions.

We first asked twelve consenting participants to produce constant, isometric wrist flexion or extension torque at 20% MVC, and calculated pair-wise EMG coherence across synergistic wrist flexors and extensors. We found that wrist flexors showed significantly higher α-band coherence compared to the extensors ($p < 0.01$). This was not altered by error augmentation in visual feedback, nor related to force variability during the isometric holds (both of which can alter proprioceptive feedback). Since the relative strength of reticulospinal drive may increase with contraction level, we then asked three of the participants to perform the wrist flexion task at 5% and 30% MVC. In them, coherence in the α-band increased with contraction level ($p < 0.01$). Finally, to confirm the dominance of corticospinal drive in radial-ulnar deviation torques, we asked a subset of participants ($n = 2$) to perform those actions. We found no significant α-band coherence between radial deviators (FCR and ECR) nor ulnar deviators (FCU and ECU).

Our results strongly suggest that intermuscular coherence reflects the differential contribution of corticospinal vs. reticulospinal pathways during voluntary actions by healthy individuals. The impactful corollary to this result is that intermuscular coherence can be used to assess re-organization of cortico- and reticulo-spinal pathways that results in pathologic synergies.