

Supplementary Information

Inclusion and Exclusion Criteria

For physically impaired individuals, inclusion criteria address the minimum length of time since the stroke that led to the impairment. Inclusion criteria may also pertain to meeting dimensional requirements related to interacting with the system hardware (e.g., subject's arm dimensions must be such that they can appropriately don an existing electrode sleeve design). For populations with potential for cognitive impairment (e.g., stroke survivors), inclusion criteria indicating ability to follow 3-step commands and communicate verbally (e.g., at least able to provide yes/no responses with accuracy) apply. Specific Inclusion Criteria include:

1. Males and females ≥ 18 years old
2. Chronic stroke survivors who are at least 180 days post-stroke
3. Ability to provide appropriate consent to partake in the study
4. Ability to follow 3-step commands and deemed by an occupational therapist to have the capacity to complete required upper extremity movements
5. Ability to secure transportation to attend scheduled study sessions
6. Stroke-related hand impairment that interferes with ability to complete activities of daily living and is classified as Stage 1-6 on the hand subscale of the Chedoke McMaster Stroke Assessment

Persons with life-supporting or sustaining equipment or critical non-removeable implanted electronic devices are excluded for safety reasons since it is not known if the experimental systems would interfere with this equipment. Specific exclusion criteria include:

1. Presence of any other clinically significant medical comorbidity for which, in the judgment of the Investigator, participation in the study would pose a safety risk to the subject
2. Currently participating in physical rehabilitation (e.g., occupational or physical therapy) for stroke-related upper limb impairment
3. Co-occurring neurological condition (e.g., Parkinson's disease, Multiple Sclerosis) or other neuromuscular disorder (e.g., Carpal Tunnel Syndrome, neuropathy) that, in the judgment of the Investigator, may influence study results
4. Individuals who are immunosuppressed, have conditions that typically result in becoming immunocompromised, taking chronic steroids, or currently receiving immunosuppressive therapy
5. Individuals having or requiring any of the following: implanted pacemaker, life supporting/sustaining equipment, or critical non-removable implantable electronic devices such as an insulin pump or neurostimulator. An implanted Medtronic LINQ monitor does not meet this criterion (i.e., patients with a LINQ monitor may participate in this study).
6. Persistent pain $\geq 7/10$ in impaired upper extremity, as measured by Numeric Pain Rating Scale (0-10)
7. Individuals whose forearm is determined to be too small or too large to fit the electrode sleeve being investigated.
8. Individuals who are pregnant or plan to get pregnant during the course of the study (self-report).

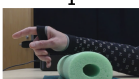
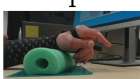
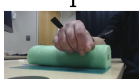
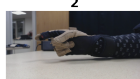
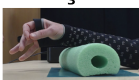
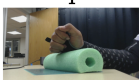
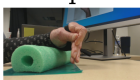
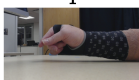
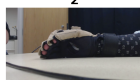
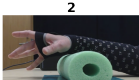
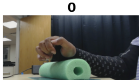
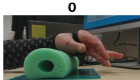
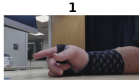
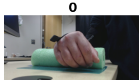
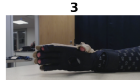
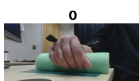
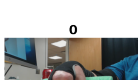
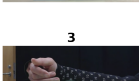
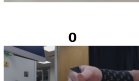
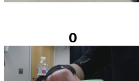
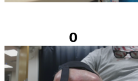
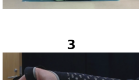
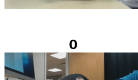
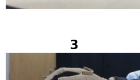
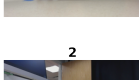
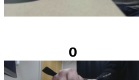
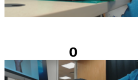
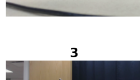
Supplementary Table 1 Motor unit decomposition parameters are from the open-source EMG decomposition package based on Negro et al. 2016. Default values are from the package implementation. Modified values were optimized for the HD-EMG sleeve configuration.

Parameter	Default Value	Used Value	Description
Sampling rate	-	3000 Hz	EMG sampling frequency
Extension factor	16	14	Number of time lags added to each data point for convolutive decomposition
Maximum number of sources	25	Auto (initialized at $n_{channels}/2$)	Maximum number of motor unit sources to identify. Auto setting iteratively updates during batch processing to balance computational efficiency with detection capability
Minimum peaks distance	15 ms	3 ms	Minimum temporal distance between detected motor unit discharges
Contrast function	logcosh	logcosh	Non-linearity used in ICA fixed-point algorithm
Maximum iterations	100	100	Maximum iterations for ICA convergence per source
Convergence tolerance	1×10^{-4}	1×10^{-4}	Tolerance threshold for determining ICA convergence
Silhouette threshold	0.85	0.90	Minimum silhouette score for accepting a source as valid motor unit
Regularization method	truncate	truncate	Method for whitening regularization (truncate or add)
Regularization factor	0.5	0.5	Fraction of eigenvalues considered as noise during whitening
Improvement iteration metric	isi	isi	Metric used during improvement iterations (isi: coefficient of variation of interspike interval)
Firings similarity metric	perc_coincident	perc_coincident	Metric for identifying duplicate sources based on firing coincidence
Maximum similarity	0.3	0.2	Threshold for considering two sources as duplicates (range: 0-1)
Minimum number of peaks	20	20	Minimum number of detected discharges for source to be retained
Batch size	-	36000 samples (12 s)	Size of batches for decomposition of concatenated movement data
Number of sampled batches	-	2	Number of times full dataset is sampled in random order

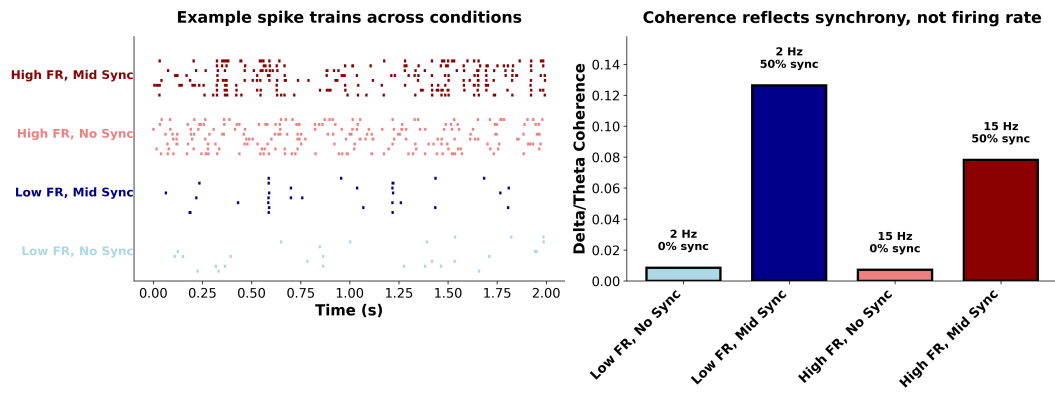
Supplementary Table 2 Subject inclusion across analyses. All subjects were included in firing rate, motor unit module, and global coherence analyses. For muscle-specific coherence analyses, subjects with fewer than four motor units in the relevant muscle group were excluded.

Able-Bodied	AB1	AB2	AB3	AB4	AB5	AB6	AB7
Firing Rate	✓	✓	✓	✓	✓	✓	✓
Motor Unit Modules	✓	✓	✓	✓	✓	✓	✓
Global Coherence	✓	✓	✓	✓	✓	✓	✓
Intra-Flexor Coherence	✓	✓	✓	✓	✓	✓	✓
Intra-Extensor Coherence	✓	✓	✓	✓	✓	✓	✓
Inter-Flexor-Extensor Coherence	✓	✓	✓	✓	✓	✓	✓

Stroke	S1	S2	S3	S4	S5	S6	S7
Firing Rate	✓	✓	✓	✓	✓	✓	✓
Motor Unit Modules	✓	✓	✓	✓	✓	✓	✓
Global Coherence	✓	✓	✓	✓	✓	✓	✓
Intra-Flexor Coherence	✓	✓	✓	—	✓	✓	✓
Intra-Extensor Coherence	✓	✓	✓	✓	✓	—	✓
Inter-Flexor-Extensor Coherence	✓	✓	✓	—	✓	—	✓

	Sub. 1 UEFM-HS: 6 MAS Fingers: 1 MAS Wrist: 1	Sub. 2 UEFM-HS: 2 MAS Fingers: 1 MAS Wrist: 1	Sub. 3 UEFM-HS: 6 MAS Fingers: 1 MAS Wrist: 1	Sub. 4 UEFM-HS: 4 MAS Fingers: 1 MAS Wrist: 0	Sub. 5 UEFM-HS: 0 MAS Fingers: 4 MAS Wrist: 3	Sub. 6 UEFM-HS: 0 MAS Fingers: 4 MAS Wrist: 4	Sub. 7 UEFM-HS: 7 MAS Fingers: 0 MAS Wrist: 0
Hand Open 	2 	0 	1 	2 	1 	0 	3 
Hand Close 	3 	1 	2 	2 	1 	0 	3 
Key Pinch 	3 	1 	2 	2 	1 	0 	3 
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Supplementary Figure 1 Observed movement score for individuals with stroke. The full 12-movement dataset cues and screenshots of participant attempts. The observed movement score is above each subject's movement attempt.



Supplementary Figure 2 Computational demonstration that coherence reflects neural synchronization rather than firing rate. To test whether low firing rates artificially inflate coherence values, we generated synthetic motor unit spike trains with controlled firing rates (2 Hz and 15 Hz) and synchronization levels (independent: 0% synchrony vs synchronized: 50% synchrony). Left: Example spike trains showing clear visual differences in temporal coordination across conditions. Right: Delta/theta band (0-8 Hz) coherence values demonstrating that synchronization level, not firing rate, determines coherence magnitude. When firing rate is held constant at 2 Hz, coherence remains very low (0.009) with independent firing but increases substantially (0.126, a 14.8-fold increase) with synchronized firing. High firing rate (15 Hz) conditions show similar patterns: low coherence with independent firing (0.007) and elevated coherence with synchronized firing (0.078). Critically, comparing conditions with the same synchronization level but different firing rates (2 Hz vs 15 Hz, both with 50% synchrony) yields similar coherence values (0.126 vs 0.078), despite a 7.5-fold difference in firing rate. Furthermore, permutation testing by randomly shuffling spike times while preserving firing rate (destroying temporal relationships) caused coherence to drop by 81.1% (from 0.041 to 0.008). These results establish that coherence is determined by the temporal coordination of motor unit activity, not by firing rate magnitude.