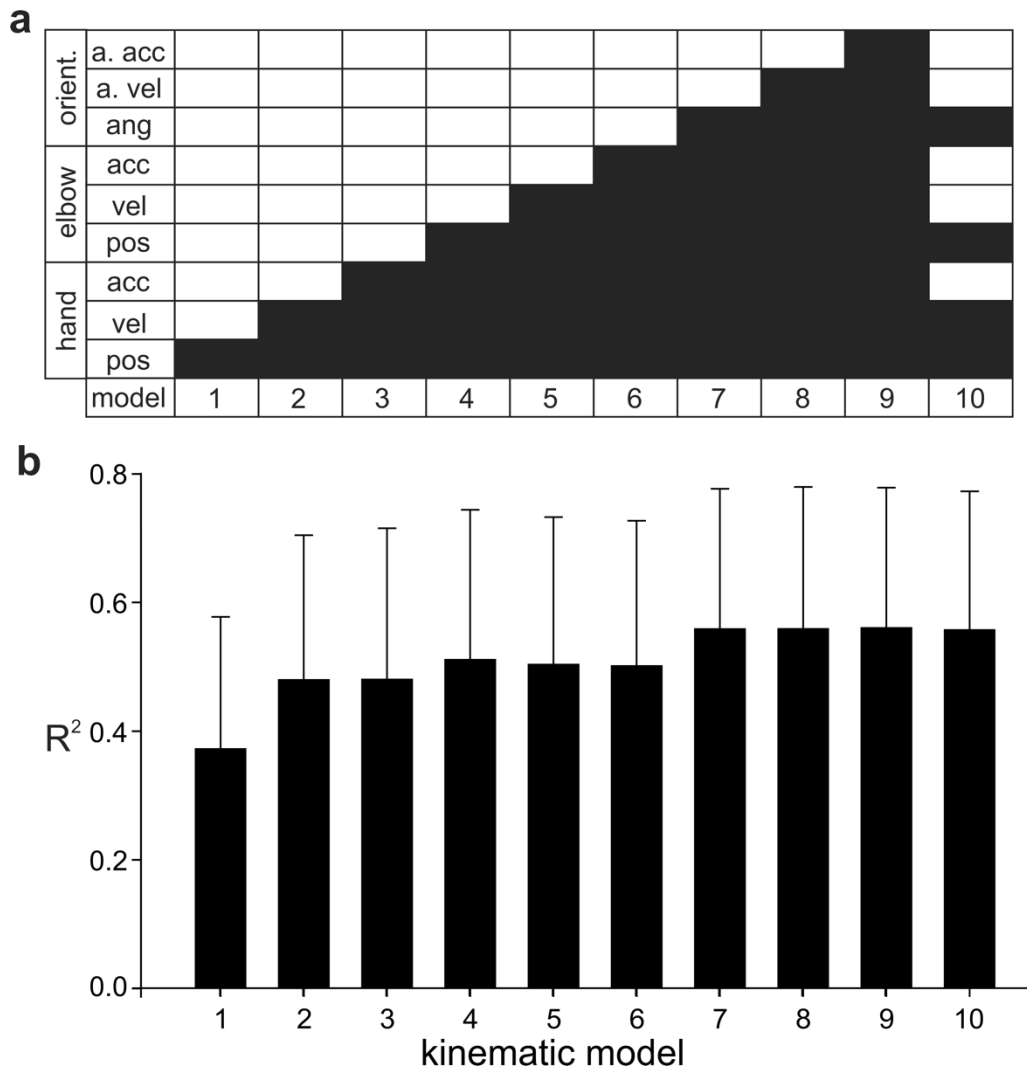


Supplemental Materials

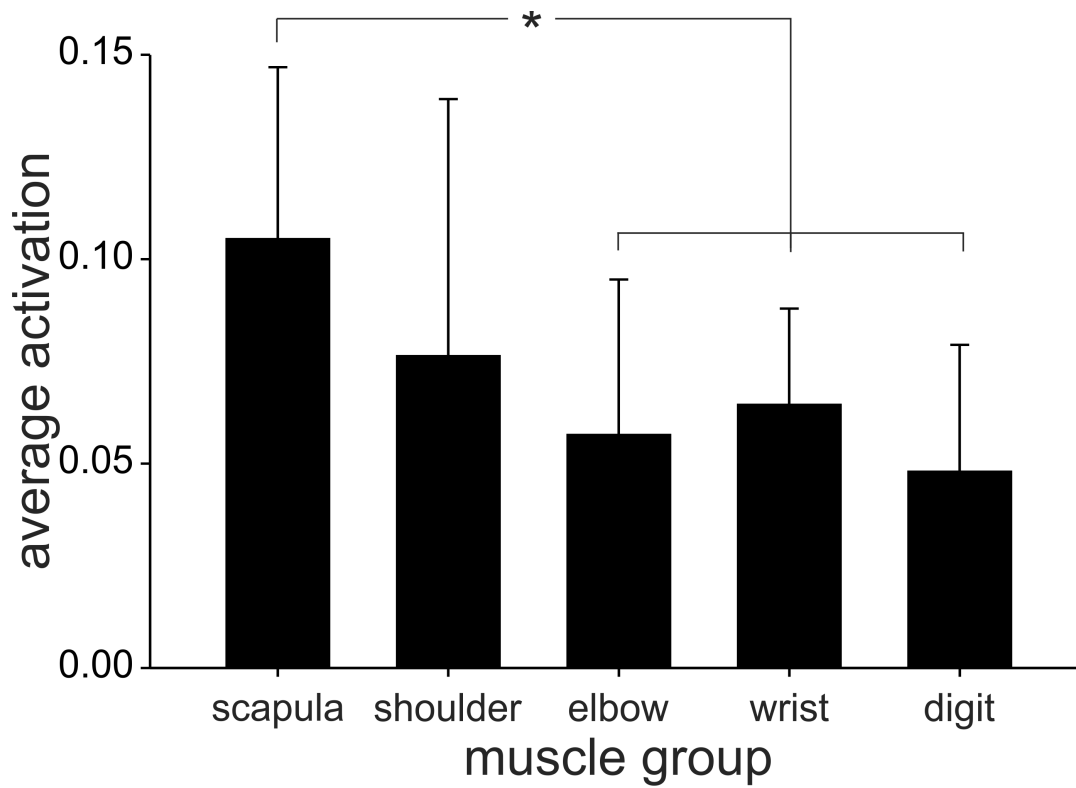
Table 1. Implanted muscles, acronyms, functions. These muscles were selected because they were considered as the main muscles controlling arm movements. Other muscles, such as teres minor, pectoralis minor, coracobrachialis, dorsoepitrochlearis, and levator scapulae were not implanted because of their relatively small sizes and presumed ancillary roles.

Muscle Group*	Muscle	Acronym	Main Functions
extrinsic digit	extensor digitorum communis	edc	extend digits 2 – 5 and wrist
extrinsic digit	flexor digitorum profundus	fdp	flex digits 1 – 5 and wrist
extrinsic digit	flexor digitorum superficialis	fps	flex digits 2 – 5 and wrist
wrist	supinator	sup	supinate forearm
wrist	extensor carpi radialis	ecr	extend and radially deviate wrist
wrist	extensor carpi ulnaris	ecu	extend and ulnarly deviate wrist
wrist	pronator	pro	pronate forearm
wrist	flexor carpi radialis	fcr	flex wrist
wrist	palmaris longus	pl	flex wrist
wrist	flexor carpi ulnaris	fcu	flex and ulnarly deviate wrist
elbow	lateral triceps	latr	extend elbow
elbow	long head of triceps	lotr	extend elbow and shoulder
elbow	medial triceps	mtr	extend elbow
elbow	brachioradialis	brd	flex elbow
elbow	brachialis	bra	flex elbow
elbow	medial (short) head of biceps	mbi	flex elbow, supinate forearm
elbow	lateral (long) head of biceps	lbi	flex elbow, supinate forearm
shoulder	pectoralis major	pma	adduct and internally rotate shoulder
shoulder	anterior deltoid	adel	flex shoulder
shoulder	middle deltoid	mdel	abduct shoulder
shoulder	posterior deltoid	pdel	extend shoulder
shoulder	teres major	tmaj	adduct and internally rotate shoulder
shoulder	latissimus dorsi	lats	extend, adduct, and internally rotate shoulder
scapular	serratus anterior	sant	protract scapula
scapular	infraspinatus	isp	externally rotate shoulder, abduct scapula, shoulder stabilizer
scapular	supraspinatus	ssp	abduct and stabilize shoulder
scapular	upper trapezius	utr	elevate scapula
scapular	subscapularis	ssc	internally rotate, adduct, and stabilize shoulder
scapular	rhomboids	rho	retract and elevate scapula

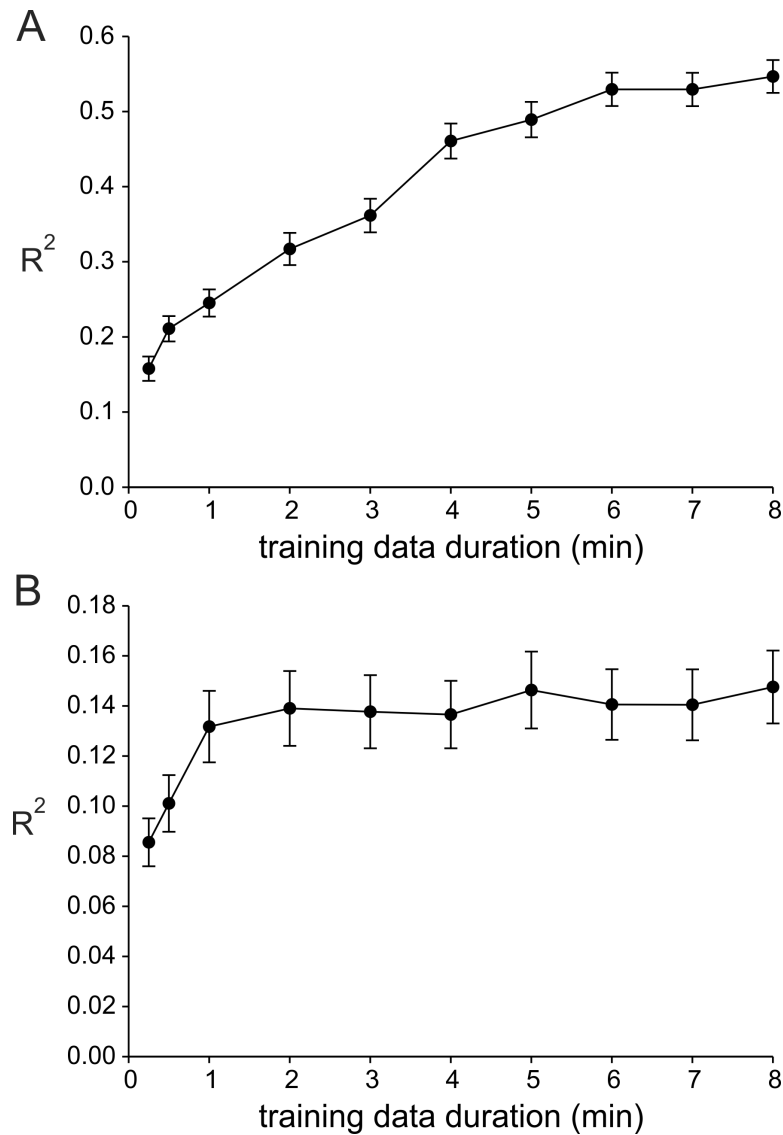
*Designation of muscle groups is somewhat arbitrary as many muscles operate across multiple joints. Scapular muscles are those that have an extensive origin or insertion on the scapula.



Supplemental Figure 1. Effect of including different sets of kinematic parameters in training artificial neural networks on prediction accuracy of activation patterns. **a)** Models 1 – 9 progressively included (filled rectangles) x, y, z positions of the hand; x, y, z velocities of the hand; x, y, z accelerations of the hand; x, y, z positions of the elbow; x, y, z velocities of the elbow; x, y, z accelerations of the elbow; pitch, roll, yaw orientations of the hand; pitch, roll, yaw angular velocities of the hand; pitch, roll, yaw angular accelerations of the hand. **b)** mean (SD) R^2 values across all muscles and test movements in one monkey for each kinematic model based on within-trained ANN. Note that inclusion of accelerations (models 3, 6, 9) provided little noticeable improvement in predictions. Likewise, inclusion of elbow velocity (model 5) or hand angular velocity (model 8) yielded little improvement in accuracy. For model 10, only hand position, hand velocity, elbow position, and hand orientation were included. Predictions based on this simplified model were just as good as that including all parameters.



*Supplemental Figure 2. Mean (SD) actual activation values across all test movements and both monkeys for each muscle group. Scapular muscles were more strongly activated on average than the other muscle groups ($p = 0.014$, 1-way ANOVA, * $p < 0.05$ Holm-Sidak post hoc analysis)*



Supplemental Figure 3. Extent of training data on accuracy of ANN in predicting EMG. Mean (SE) of R^2 values between predicted activation signals and that recorded across all muscles, test movements, and five repeated selections of training data for different durations of training data. Training data did not include test movement data. ANN predictions based on A) training data obtained from the same monkey (within predictions) and B) from a different monkey (across predictions).