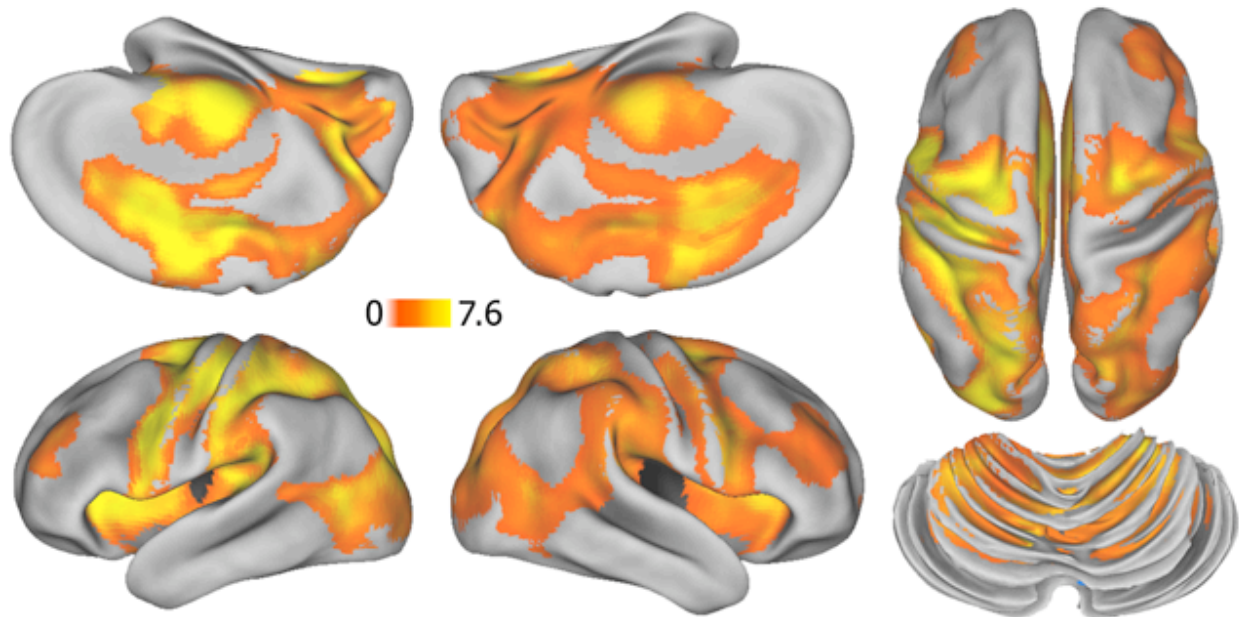
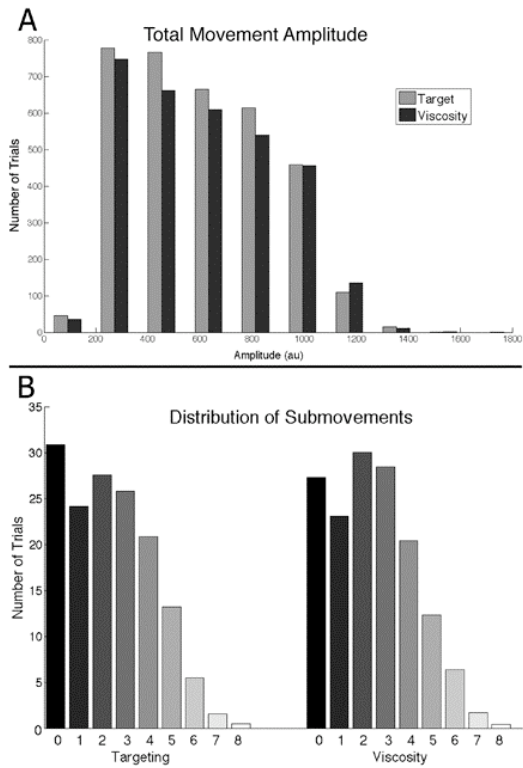


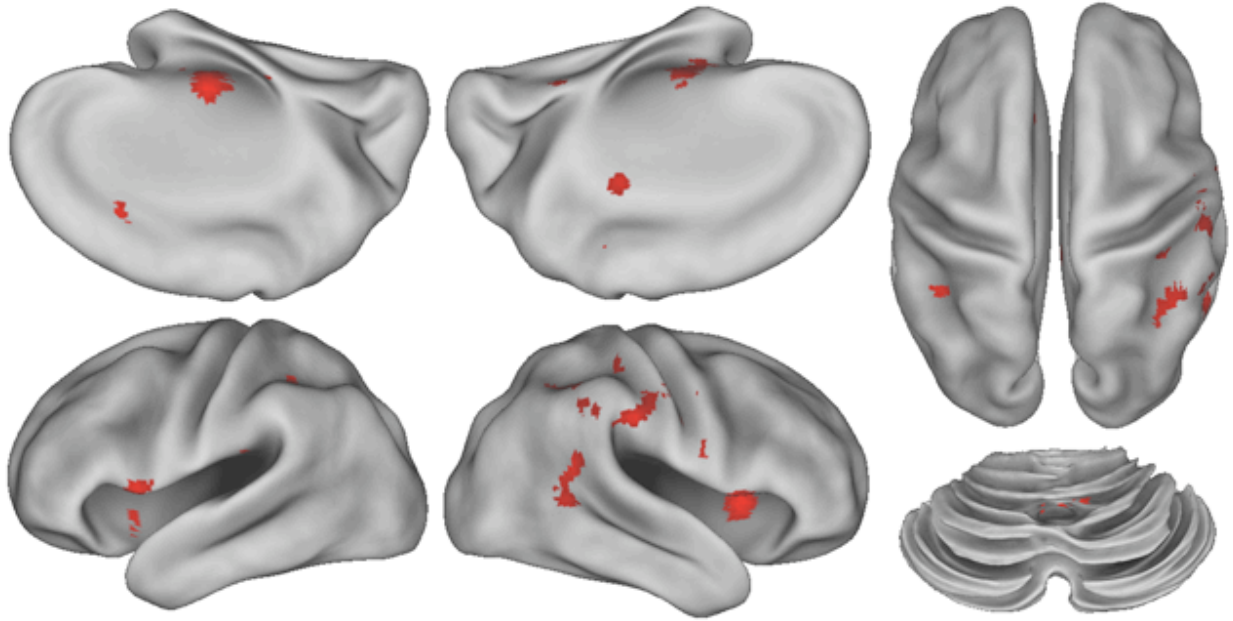
Supplemental Materials.



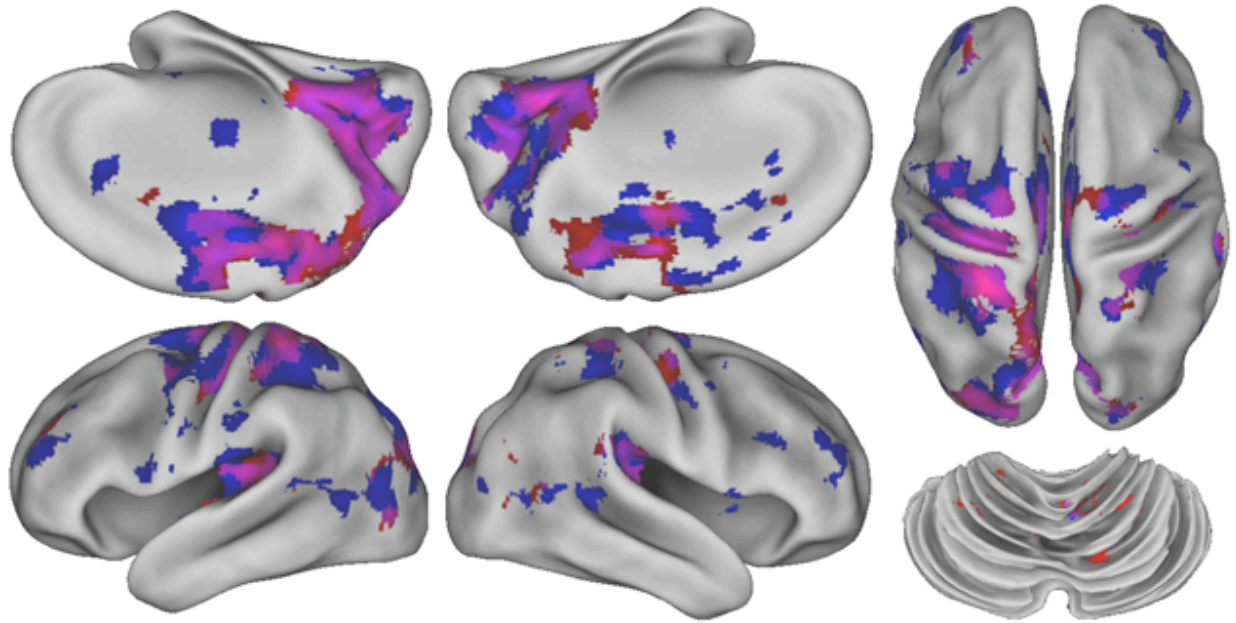
Supplemental Figure 1. Main effect of executing the target capture task, collapsed across type of trial (viscous or target challenge). There is widespread recruitment of premotor, motor and parietal cortex as well as anterior cerebellum. Recruitment is greater in the left motor areas, consistent with the right hand execution. Statistical threshold is $p < 0.05$ FDR corrected for multiple comparisons. This map was used as an inclusive mask for contrasts shown in supplemental figures 3 and 4.



Supplemental Figure 2. Distribution of movement amplitude (A) and number of submovements (B) as a function of function of task type (viscous and target challenge), aggregated over all subjects. The two tasks are closely matched for both these kinematic variables.



Supplemental Figure 3. Submovement formation in cortex and cerebellum. Areas where the number of submovements during the viscous challenge task correlated with BOLD activity on a trial by trial basis are shown in red. There were no significant areas for the target capture task. Statistical threshold, $p < 0.005$ uncorrected. Peaks within this volume that are significant with FDR correction for multiple test comparisons are highlighted in supplemental table 1.



Supplemental Figure 4. Movement amplitude effects in cortex and cerebellum. Areas where the movement amplitude correlated with BOLD activity on a trial by trial basis for the viscous challenge are shown in red, for the target challenge in blue and their overlap in purple. Statistical threshold, $p < 0.005$ uncorrected. Peaks within this volume that are significant with FDR correction for multiple test comparisons are highlighted in supplemental table 1.

Supplemental Table 1. Brain Correlates of Submovement Formation

Search Vs Contrast	Anatomic Region	x	y	z	t	p	Significant after FDR Correction	
Basal Ganglia								
Submovement (Viscous) > Submovement (Target)	Left Insula	-34	6	-10	5.87	0.001	*	
Submovement (Viscous) > Submovement (Target)	Left Subthalamic Nucleus	-14	-18	-6	4.39	0.001	*	
Submovement (Viscous) > Submovement (Target)	Right Internal Globus Pallidus	20	-10	-8	4.24	0.001	*	
Submovement (Viscous) > Submovement (Target)	Right Putamen/Insula	30	14	0	3.98	0.001	*	
Submovement (Viscous) > Submovement (Target)	Right Ventral Lateral Nucleus Thalamus	12	-12	2	2.85	0.005	*	
Submovement (Viscous) > Submovement (Target)	Right Internal Globus Pallidus	16	-6	2	2.78	0.005	*	
Submovement (Viscous) > Submovement (Target)	Right Putamen/Insula	34	-6	-10	2.76	0.005	*	
Amplitude (Target) > Amplitude (Viscous)	Left WM	-22	-16	16	4.69	0.001		
Amplitude (Target) > Amplitude (Viscous)	Left Medial Dorsal Nucleus Thalamus	-6	-14	12	3.13	0.005		
Amplitude (Target) > Amplitude (Viscous)	Right Medial Dorsal Nucleus Thalamus	6	-12	14	3.17	0.005		
Amplitude (Target) > Amplitude (Viscous)	Right Caudate	14	18	2	3.16	0.005		
Amplitude (Target) > Amplitude (Viscous)	Left Caudate	-20	24	-4	3	0.005		
Submovement (Viscous)	Left Substantia Nigra	-16	-24	-10	5.02	0.001	*	
Submovement (Viscous)	Right Internal Segment Globus Pallidus	22	-8	-2	4.94	0.001	*	
Submovement (Viscous)	Right Caudate/Putamen	20	-10	16	4.58	0.001	*	
Submovement (Viscous)	Left Caudate	-22	-4	26	3.29	0.005	*	
Submovement (Viscous)	Left Insula	-30	4	20	3.29	0.005	*	
Submovement (Viscous)	Right WM	26	-28	16	3.29	0.005	*	
Submovement (Viscous)	Left Insula	-34	-12	14	3.09	0.005	*	
Submovement (Viscous)	Right Caudate/Putamen	14	18	-6	3	0.005	*	
Submovement (Viscous)	Left Internal Segment Globus Pallidus/Hypothalamus	-6	-2	-10	3	0.005	*	
Submovement (Viscous)	Left WM	2	14	18	3	0.005	*	
Submovement (Viscous)	Left WM	-28	-28	2	3	0.005	*	
Submovement (Viscous)	Left Internal Segment Globus Pallidus/Hypothalamus	-2	-2	-12	3	0.005	*	
Submovement (Viscous)	Left Insula	-34	8	-10	4.64	0.001	*	
Amplitude (Viscous)	Right Putamen	30	-14	4	5.43	0.001	*	
Amplitude (Viscous)	Right Caudate/Putamen	16	4	8	4.75	0.001	*	
Amplitude (Viscous)	Left Insula/Putamen	-38	-16	2	4.22	0.001	*	
Amplitude (Viscous)	Left Putamen	-26	-10	6	3.26	0.005		
Amplitude (Target)	Left Caudate	-22	-14	16	4.69	0.001	*	
Amplitude (Target)	Right Putamen/Insula	34	-20	0	4.62	0.001	*	
Amplitude (Target)	Left Putamen/Insula	-36	-8	2	4.34	0.001	*	
Amplitude (Target)	Left Internal Segment Globus Pallidus	-18	0	-14	3.42	0.005	*	
Cortex								
Amplitude (Viscous)	Left Superior Parietal Lobule	BA 7	-26	-42	66	8.43	0.001	*
Amplitude (Viscous)	Left Superior Temporal Gyrus	BA 41	-44	-38	16	5.86	0.001	*
Amplitude (Viscous)	Left Middle Frontal Gyrus	BA 10	-32	50	10	4.5	0.001	*
Amplitude (Viscous)	Right Middle Frontal Gyrus	BA 10	30	52	10	4.36	0.001	*
Amplitude (Viscous)	Right Middle Temporal Gyrus	BA 39	52	-68	16	4.25	0.001	*
Amplitude (Viscous)	Right Cingulate Gyrus	BA 32	12	28	30	3.83	0.001	*
Amplitude (Viscous)	Left Posterior IPS	BA 19	-32	-68	38	3.71	0.005	*
Amplitude (Viscous)	Left Cingulate Gyrus	BA 24	-4	14	36	3.24	0.005	*
Amplitude (Target)	Left Cingulate Sulcus (CMA)	BA 24	-6	-22	46	7.3	0.001	*
Amplitude (Target)	Left Middle Frontal Gyrus	BA 10	-36	52	18	5.07	0.001	*
Amplitude (Target)	Right Inferior Frontal Sulcus	BA 9	42	22	22	4.85	0.001	*
Amplitude (Target)	Left Anterior Cingulate Gyrus	BA 24	-4	30	18	4.27	0.001	*
Amplitude (Target)	Left Middle Frontal Gyrus	BA 9	-32	34	34	4.15	0.001	*
Amplitude (Target)	Right Middle Frontal Gyrus	BA 10	36	48	14	4.03	0.001	*
Amplitude (Target)	Right Medial Segment, Superior Frontal Gyrus	BA 6	8	24	46	3.8	0.001	*
Amplitude (Target)	Right Superior Frontal Gyrus	BA 6	42	6	56	3.61	0.005	*
Amplitude (Target)	Right Superior Frontal Gyrus	BA 8	24	38	32	3.46	0.005	*
Amplitude (Target)	Left Inferior Parietal Lobule	BA 40	-60	-24	36	3.36	0.005	*
Amplitude (Target)	Right Inferior Precentral Gyrus (PMv)	BA 6	50	-2	28	3.2	0.005	*
Amplitude (Target)	Right Cingulate Gyrus	BA 32	8	32	38	3.11	0.005	*
Amplitude (Target)	Left Middle Frontal Gyrus	BA 9	-30	26	24	3.08	0.005	*
Submovement (Viscous)	Right Superior Parietal Lobule	BA 5	22	-38	54	4.27	0.001	*
Submovement (Viscous)	Left Cingulate Gyrus	BA 31	-8	-34	34	4.14	0.001	*
Submovement (Viscous)	Left Parieto-Occipital Fissure	BA 30	-6	-60	14	4	0.001	*
Submovement (Viscous)	Right Inferior Parietal Lobule	BA 40	62	-26	36	3.94	0.001	*
Submovement (Viscous)	Right Middle Temporal Gyrus	BA 39	44	-50	6	3.9	0.001	*
Submovement (Viscous)	Left Cingulate Gyrus	BA 32	-14	22	34	3.84	0.001	*
Submovement (Viscous)	Left Postcentral Sulcus	BA 7	-22	-30	42	3.81	0.001	*
Submovement (Viscous)	Right Inferior Parietal Lobule	BA 7	30	-62	32	<3.72	0.005	
Submovement (Viscous)	Right Cingulate Gyrus	BA 23	6	-32	32	<3.72	0.005	
Submovement (Viscous)	Right Anterior Cingulate Gyrus	BA 24	16	12	28	<3.72	0.005	
Submovement (Viscous)	Left Parahippocampal Gyrus	BA 35	-18	-32	-10	<3.72	0.005	
Submovement (Viscous)	Left Superior Temporal Gyrus	BA 42	-56	-30	18	<3.72	0.005	
Submovement (Viscous)	Right Precentral Gyrus (PMv)	BA 6	46	-14	32	<3.72	0.005	
Submovement (Viscous)	Left Inferior Parietal Lobule	BA 40	-50	-44	42	<3.72	0.005	
Submovement (Viscous)	Left Inferior Parietal Lobule		-34	-36	32	<3.72	0.005	
Submovement (Viscous)	Right Inferior Precentral Gyrus (PMv)	BA 6	62	2	18	<3.72	0.005	
Submovement (Viscous)	Left Intraparietal Sulcus	BA 40	-40	-46	48	<3.72	0.005	
Submovement (Viscous)	Right Superior Temporal Sulcus	BA 41	44	-32	2	<3.72	0.005	
Submovement (Viscous)	Left Middle Frontal Gyrus	BA 9	-36	28	28	<3.72	0.005	
Submovement (Target)	Right Cingulate Gyrus	BA 23	10	-20	30	3.61	0.005	*
Submovement (Target)	Right Cingulate Gyrus	BA 31	18	-24	40	3.55	0.005	*
Cerebellum								
Submovement (Viscous) > Submovement (Target)	Right Anterior Lobe Cerebellum	Lob III	0	-44	-26	4.17	0.001	*
Submovement (Viscous) > Submovement (Target)	Right Anterior Lobe Cerebellum	Lob V	6	-60	-16	4.04	0.001	*
Submovement (Viscous) > Submovement (Target)	Left Anterior Lobe Cerebellum	Lob V	-6	-62	-22	3.97	0.005	*
Submovement (Viscous) > Submovement (Target)	Left Anterior Lobe Cerebellum	Lob VI	-28	-64	-28	3.88	0.005	*
Amplitude (Viscous) > Amplitude (Target)	Left Anterior Lobe Cerebellum	Lob V	-18	-44	-20	4.19	0.001	*
Amplitude (Viscous) > Amplitude (Target)	Right Anterior Lobe Cerebellum	Lob V	0	-62	-16	4.15	0.001	*
Submovement (Viscous)	Left Anterior Lobe Cerebellum	Lob V	-4	-60	-24	3.87	0.005	*
Submovement (Viscous)	Right Anterior Lobe Cerebellum	Lob V	8	-62	-18	3.51	0.005	*
Submovement (Viscous)	Right Anterior Lobe Cerebellum	Lob III	6	-34	-28	3.4	0.005	*
Amplitude (Viscous)	Left Anterior Lobe Cerebellum	Lob V	-2	-62	-16	5.06	0.001	*
Amplitude (Viscous)	Left Anterior Lobe Cerebellum	Lob V	-18	-44	-20	4.3	0.001	*
Amplitude (Viscous)	Right Anterior Lobe Cerebellum	Lob VI	22	-56	-30	4.34	0.001	*
Amplitude (Viscous)	Left Anterior Lobe Cerebellum	Lob VI	-24	-56	-22	3.76	0.005	*
Amplitude (Viscous)	Right Posterior Lobe Cerebellum	Lob VI	14	-70	-22	3.75	0.005	*
Amplitude (Viscous)	Left Anterior Lobe Cerebellum	Lob VI	-30	-54	-32	3.41	0.005	*
Amplitude (Target)	Right Anterior Lobe Cerebellum	Lob V	8	-58	-12	3.56	0.005	*

BA - Brodmann's area (based on Talairach atlas)
Lob - Lobule (based on atlas of Diedrichsen)