

Reduced integration and differentiation of the imitation network in autism:

A multimodal fMRI and DWI study

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Supplementary Online Material

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sMethods. White matter tract reliability and anatomical validity.

As stated in the main document (Methods), to ensure inclusion of underlying white matter voxels, tractography seeds were nudged towards the local grey-white matter boundary (see Figure S1). No seed was nudged more than 10 mm on any of the 3 axes, with an average Euclidean distance of 10mm (range = 6 – 15mm).

ROIs used for tractography were relatively small and not commonly examined in tractography studies. We were therefore careful to establish both anatomical validity of potential TOIs and reliability of tractography-based identification before considering tracts for further analysis. Tracts were considered “reliable” if at least 93% of participants (i.e., all but two participants) from each group had at least 0.01% of initiated streamlines reaching the target ROI. Not all potential TOIs met this conservative criterion, as seen in the tract identification rates shown in Table S2 below. Overall, tract identification rates did not differ between the groups ($p = 0.31$ and $p = 0.64$ for A to B and B to A tracts, respectively).

Anatomic validity of the identified tracts was verified through comparison to available axonal tract-tracing studies in non-human primates (anterograde tract tracing using radiolabeled isotopes).¹ First, seed ROIs were mapped to homologous regions in the primate atlas, with reference to other human and non-human primate cytoarchitectonic atlases.^{2,3} Second, ROI pairs were evaluated to determine if there was tract-tracing evidence of direct connections between ROIs in either direction (i.e. from either seed to the other seed). For example, results from Case 5 in Schmahmann and Pandya¹ show that radiolabeled isotopes injected in the area of SI / IPS label axons projecting to IFG. If such evidence was found, the pathways reported in the primate atlas were then compared to those identified in our human tractography to verify similarity of the routes taken. In the previous example, the route was through a portion of SLF referred to as SLF III, paralleling results from our diffusion tractography, which found a clear route through the SLF. All identified routes matched well to the gold-standard of axonal tract-tracing.

FA and MD are summative measures that describe the directionality of water diffusion on a scale from zero (random diffusion) to one (unidirectional diffusion), and average water diffusion within a given voxel, respectively. Typical white matter development is marked by gradual increases in FA and decreases in MD, indicating increased organization of fiber tracts and decreased extra-axonal space.⁴

References:

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3. Kötter R, Wanke E. (2005): Mapping brains without coordinates. *Philos Trans R Soc Lond B Biol Sci*. 360(1456): 751-766.
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Table S1. Imitation regions exhibiting significant ($p < 0.01$) group differences (ASD vs. TD) in FC

Cluster (<i>Brodman Areas</i>): Subregions		% of cluster vol.	Vol. (μ l)	t-score*	MNI coordinates		
					x	y	z
Seed: Left IFG							
Precuneus (BA 31,7):	L Precuneus	51.7%	3618	4.81	9	-54	37
	L Mid. Cingulate Cortex	21.0%					
	R Precuneus	10.4%					
	R Mid. Cingulate Cortex	9.8%					
	L Post. Cingulate Cortex	6.8%					
L Angular Gyrus (BA 39):	L Angular Gyrus	51.6%	1971	3.93	-49	-72	36
	L Inf. Parietal Lobule	18.9%					
	L Mid. Occipital Gyrus	10.8%					
Frontal Eye Fields (BA 8):	L Mid. Frontal Gyrus	73.8%	1971	4.32	-28	-17	54
	L Sup. Parietal Lobe	26.2%					
Seed: Left SI / IPS							
R SI (BA 3):	R Postcentral Gyrus	55.1%	1107	-4.49	57	-21	-58
	R Precentral Gyrus	43.5%					
Seed: Left Lateral Occipital Cortex (LOC)							
L post. STS (BA 41, 42):	L Sup. Temporal Gyrus	94.1%	1458	-4.31	-55	-31	12
	L SupraMarginal Gyrus	5.3%					
Seed: Right lateral dPMC							
L Pre/cuneus (BA 7):	L Cuneus	65.5%	2700	4.22	-10	-72	33
	L Precuneus	26.5%					
L Sup. Orb. Gyrus (BA 10):	L Mid. Orbital Gyrus	34.2%	1404	4.55	-28	57	-14
	L Sup. Orbital Gyrus	34.1%					
	L Sup. Frontal Gyrus	25.9%					
Seed: Right medial PMC (SMA)							
R medial PMC (BA 24, 6):	R SMA	68.0%	1323	-4.64	12	1	53
	R Mid. Cingulate Cortex	29.7%					
R Fusiform Gyrus (BA 37):	R Fusiform Gyrus	85.1%	1053	-3.96	39	-51	-31
Seed: Right Lateral Occipital Cortex (LOC)							
L post. STS (BA 41, 42):	L Sup. Temporal Gyrus	78.6%	2106	-4.01	-55	-34	15
	L Rolandic Operculum	16.4%					
R medial SMA (med BA 6):	R SMA	45.4%	1647	-4.27	9	-3	72
	L SMA	36.9%					
	L Sup. Frontal Gyrus	9.6%					
R medial SMA (BA 24, 6):	R SMA	83.0%	1323	-4.61	6	13	60
	L SMA	9.5%					
Seed: Right fusiform gyrus (FFA/FBA)							
Frontopolar PFC (BA 10,11):	L Mid. Orbital Gyrus	65.4%	1323	4.39	-7	-57	-7
	R Mid. Orbital Gyrus	25.9%					
Posterior Cingulate (BA 31):	L Mid. Cingulate Cortex	50.4%	1080	4.15	-1	-38	34
	L Post. Cingulate Cortex	19.7%					
	R Mid. Cingulate Cortex	17.5%					
R SMA (med BA 6):	R SMA	85.2%	972	-4.79	15	-3	72
	R Sup. Frontal Gyrus	14.8%					

Note: Seeds not listed (left medial PMC, left lateral dPMC, left pSTS, right IFG, right ant. insula, right SII) did not yield significant between-group clusters. FFA/FBA = fusiform face area / fusiform body area; IFG = inferior frontal gyrus; IPL = inferior parietal lobule; IPS = intraparietal

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sulcus; (d)PMC = (dorsal) premotor cortex; PFC = prefrontal cortex; SI = primary somatosensory cortex; SII = secondary somatosensory cortex; SMA = supplementary motor area; STS = superior temporal sulcus; Inf. = inferior; Mid. = middle; Post. = posterior; Sup. = superior; L: left; R: right. *Positive t -values denote ASD > TD; negative t -values denote ASD < TD. Shaded rows indicate clusters falling within the imitation network; non-shaded rows indicate clusters outside of the imitation network.

Table S2. Tract identification rates, by group

Hemisphere	TOI (ROI pair)		A to B		B to A	
	ROI A	ROI B	ASD (%)	TD (%)	ASD (%)	TD (%)
Left	IFG	lateral dPMC	93%	97%	93%	97%
Left	IFG	medial PMC	96%	97%	96%	97%
Left	IFG	SI / IPS	96%	100%	93%	100%
Left	lateral dPMC	medial PMC	89%	97%	78%	90%
Left	lateral dPMC	SI / IPS	93%	100%	89%	100%
Left	medial PMC	SI / IPS	93%	100%	89%	100%
Right	IFG	lateral dPMC	100%	97%	100%	97%
Right	IFG	medial PMC	100%	97%	96%	97%
Right	IFG	SI / IPL	96%	100%	96%	100%
Right	IFG	FFA / FBA	93%	96%	59%	61%
Right	lateral dPMC	medial PMC	100%	100%	100%	100%
Right	lateral dPMC	SI / IPL	81%	93%	89%	96%
Right	lateral dPMC	FFA / FBA	59%	75%	48%	61%
Right	medial PMC	SI / IPL	85%	93%	85%	96%
Right	medial PMC	FFA / FBA	59%	71%	26%	32%
Right	SI / IPL	FFA / FBA	100%	93%	81%	61%

Note: Percent of subjects meeting tract reliability criterion for each group. Criterion: Greater than 0.01% of streamlines initiated from seed ROI, adjusted for proportion of seed ROI with $FA > 0.2$ [$waytotal / (Vol_{FA > 0.2} * 1000)$], ended at target ROI. Only TOIs for which both groups had success rates $> 93\%$ for both A to B and B to A tracts were considered for further analysis (marked in **bold italics**). Overall, tract identification rates did not differ between the groups ($p = 0.31$ and $p = 0.64$ for A to B and B to A tracts, respectively).

Table S3. Regions of functional connectivity within ASD and TD groups.

ASD			TD		
Cluster (<i>Brodmann Areas</i>) Subregions (% of cluster)	t-score	x,y,z	Cluster (<i>Brodmann Areas</i>) Subregions (% of cluster)	t-score	x,y,z
Seed: Left IFG					
L IFG (BA 44) L Inf. Front. Gyrus, p.Tri (20.6%) L Precentral Gyrus (14.5%) L Inf. Front. Gyrus, p.Op (12.3%) L Sup. Temp. Gyrus (10.0%)	28.5	-58,12,14	L IFG (BA 44) L Inf. Front. Gyrus, p.Tri (17.2%) L Insula Lobe (14.9%) L Sup Temp Gyrus (11.6%) L Inf Front. Gyrus, p.Op (11.3%) L SupraMarginal Gyrus (11.1%)	29.2	-61,12,18
R IFG (BA 44) R Inf. Front. Gyrus, p.Op (15.4%) R Postcentral Gyrus (14.6%) R Inf. Front. Gyrus, p.Tri (14.3%) R SupraMarginal Gyrus (12.3%) R Rolandic Operculum (10.4%)	11.6	57,15,21	R IFG (BA 44) R Insula Lobe (21.1%) R Inf. Front. Gyrus, p.Op (19.9%) R SupraMarginal Gyrus (15.4%) R Inf. Front. Gyrus, p.Tri (10.1%)	11.3	60,12,11
L medial PMC / SMA (BA 6) L SMA (63.3%) L Sup. Med. Gyrus (21.1%)	7.3	-1,14,54	L Thalamus L Putamen (63.8%) L Caudate Nucleus (16.1%) L Pallidum (11.2%)	8.4	-25,7,4
Seed: Left lateral dPMC					
L lateral dPMC (BA 6) L Postcentral Gyrus (38.4%) L Precentral Gyrus (22.6%) L Inf. Parietal Lobule (12.9%)	22.9	-34,-15,68	L lateral dPMC (BA 6) L Postcentral Gyrus (28.8%) L Precentral Gyrus (16.2%) L Sup. Temp. Gyrus (12.4%)	15.5	-37,-18,71
R lateral dPMC (BA 6) R Postcentral Gyrus (41.2%) R Precentral Gyrus (21.1%)	12.6	33,-12,65	R lateral dPMC (BA 6) R Postcentral Gyrus (32.5%) R Precentral Gyrus (21.6%)	11.8	60,-17,45
Mid. Cing. Cortex (BA 24) L Mid. Cing. Cortex (38.5%) L SMA (25.1%) R SMA (17.2%) R Mid. Cing. Cortex (16.6%)	8.5	-6,-8,52	Mid. Cing. Cortex (BA 24) L Mid. Cing. Cortex (38.2%) L SMA (25.2%) R Mid. Cing. Cortex (18.3%) R SMA (15.5%)	9.3	3,-11,55
L STG / Insula (BA 41) L Sup. Temp. Gyrus (33.4%) L Rolandic Operculum (28.9%) L Insula Lobe (18.3%)	10.4	-43,-3,7			
Seed: Left medial PMC (SMA)					
L,R medial SMA (BA 6) L SMA (10.6%) R Precentral Gyrus (9.8%) R SMA (9.0%)	28.4	-1,7,60	L,R medial SMA (BA 6) R Mid. Front. Gyrus (8.7%) L SMA (7.1%) L Mid. Front. Gyrus (7.1%)	27.6	-1,10,57
L STG / Insula (BA 22) L Sup. Temp. Gyrus (21%) L Precentral Gyrus (18.0%) L Insula Lobe (16.9%) L Inf. Front. Gyrus, p.Op (9.9%)	12.3	-37,19,5	L,R Cuneus (BA 19) L Lingual Gyrus (20.3%) L Calcarine Gyrus (15.9%) R Lingual Gyrus (11.2%) L Fusiform (10.7%) R Calcarine Gyrus (10.2%)	8.23	9,-70,-18
L,R Cuneus (BA 19) L Lingual Gyrus (18.8%) L Calcarine Gyrus (17.3%)	8.0	-13,-81,22	L Thalamus L Putamen (34.1%) L Thalamus (16.9%)	11.8	12,-9,7

L Cuneus (15.7%)			L Caudate Nucleus (12.6%)		
R Calcarine Gyrus (14.1%)			L Pallidum (10.9%)		
R Lingual Gyrus (9.8%)					
L Thalamus	9.0	-22,13,-2	R Thalamus	11.1	24,0,1
L Putamen (34.3%)			R Putamen (38.7%)		
L Thalamus (16.5%)			R Pallidum (23.9%)		
L Caudate Nucleus (12.7%)			R Caudate Nucleus (17.4%)		
L PFC (BA 9,10)	9.0	-28,42,29	R IPL (BA 40)	7.8	57,-33,54
L Mid. Front. Gyrus (90.1%)			R Inf. Parietal Lobule (46.2%)		
L Inf. Front. Gyrus, p.Tri (9.1%)			R SupraMarginal Gyrus (44.4%)		
R PFC (BA 9,10)	8.3	33,42,29			
R Mid. Front. Gyrus (89.3%)					
R Inf. Front. Gyrus, p.Tri (9.0%)					
Seed: Left SI / IPS					
R IPL / IPS (BA 40)	13.4	45,-33,45	L IPL / IPS (BA 40)	24.2	-40,-42,51
R Postcentral Gyrus (32.7%)			L Postcentral Gyrus (27.0%)		
R Sup. Parietal Lobule (17.3%)			L Inf. Parietal Lobule (20.0%)		
R. Precentral Gyrus (12.6%)			L Precentral Gyrus (15.3%)		
			L Sup Parietal Lobule (14.9%)		
L IPL / IPS (BA 40)	25.7	-40,-42,51	R IPL / IPS (BA 40)	15.1	39,-43,64
L Inf. Parietal Lobule (24.4%)			R Postcentral Gyrus (36.3%)		
L Sup Parietal Lobule (21.6%)			R Precentral Gyrus (17.2%)		
L Postcentral Gyrus (20.7%)			R Sup Parietal Lobule (14.3%)		
L Lat. Occ. Cortex (BA 37)	8.6	-52,-70,-14			
L Inf. Occ. Gyrus (35.7%)					
L Inf. Temp. Gyrus (26.3%)					
L Fusiform Gyrus (12.3%)					
L Mid. Temp. Gyrus (10.1%)					
R Lat. Occ. Cortex (BA 37)	8.2	48,-61,-17			
R Inf. Temp. Gyrus (73.0%)					
R Mid. Temp. Gyrus (10.3%)					
Seed: Left STS					
L STS (BA 22)	23.6	-52,-52,8	L STS (BA 22)	26.3	-52,-52,8
L Mid. Temp. Gyrus (41.7%)			L Mid. Temp. Gyrus (37.4%)		
L Sup. Temp. Gyrus (19.1%)			L Sup. Temp. Gyrus (19.4%)		
L Inf. Frontal Gyrus, p.Tri (10.4%)			L Inf. Front. Gyrus, p.Tri (10.3%)		
R STS (BA 22)	11.8	60,-49,4	R STS (BA 22)	13.2	51,-46,5
R Sup. Temp. Gyrus (36.9%)			R Mid. Temp. Gyrus (30.1%)		
R Mid. Temp. Gyrus (35.3%)			R Sup. Temp. Gyrus (28.5%)		
			R Inf. Front. Gyrus, p.Tri (10.1%)		
Seed: Left Lateral Occipital Cortex (V5)					
L Lat. Occ. Cortex (BA 19)	26.1	-52,-74,0	L Lat. Occ. Cortex (BA 19)	30.4	-52,-74,3
L Mid. Occ. Gyrus (9.0%)			L Mid. Temp Gyrus (10.1%)		
L Mid. Temp. Gyrus (8.1%)			L Mid. Occ. Gyrus (8.9%)		
L Fusiform Gyrus (6.4%)			L Fusiform Gyrus (8.0%)		

Seed: Right IFG					
R IFG (BA 44)	29.6	57,15,14	R IFG (BA 44)	24.7	60,15,11
R Mid. Front. Gyrus (14.4%)			R Mid. Front. Gyrus (10.6%)		
R SupraMarginal Gyrus (10.8%)			R SupraMarginal Gyrus (10.0%)		
L IFG (BA 44)	11.2	-34,22,2	L IFG (BA 44)	12.5	-37,0,4
L Inf. Parietal Lobule (15.4%)			L Sup. Temp. Gyrus (17.8%)		
L Inf. Frontal Gyrus, p.Tri (13.1%)			L Insula Lobe (13.1%)		
L Sup. Temp. Gyrus (12.3%)			L Inf. Front. Gyrus, p.Tri (10.9%)		
L Insula Lobe (10.2%)					
R Thalamus	10.7	21,3,4	L,R Precuneus (BA 31)	-9.8	6,-53,24
R Putamen (38.3%)			L Precuneus (42.3%)		
R Caudate Nucleus (15.1%)			R Precuneus (18.0%)		
R Pallidum (13.8%)			L Post. Cing. Cortex (15.4%)		
L Thalamus	8.2	-25,7,-10			
L Putamen (59.1%)					
L Caudate Nucleus (15.3%)					
L Pallidum (10.8%)					
Seed: Right lateral dPMC					
R lateral dPMC (BA 6)	30.0	42,4,60	R Fusiform Gyrus (BA 10)	10.1	30,-85,-18
R Mid. Front. Gyrus (36.9%)			R Fusiform Gyrus (12.2%)		
R Inf. Front. Gyrus, p.Tri (14.8%)			R Mid. Temp Gyrus (11.3%)		
R Inf. Front Gyrus, p.Op (11.8%)			R Precuneus (10.1%)		
L,R Precuneus (BA 7)	9.4	-7,-88,38	R lateral dPMC (BA 6)	24.3	42,1,59
R Precuneus (22.3%)			R Mid. Front. Gyrus (26.4%)		
L Cuneus (13.4%)			R Inf. Front. Gyrus, p.Tri (14.3%)		
L Precuneus (12.6%)			R Inf. Front. Gyrus, p.Op (13.2%)		
R Cuneus (9.8%)			R Precentral Gyrus (10.4%)		
R IPL (BA 40)	9.2	57,-52,8	L Fusiform Gyrus (BA 10)	9.1	-34,-57,-28
R Inf. Parietal Lobule (21.2%)			L Fusiform Gyrus (42.3%)		
R Mid. Temp. Gyrus (20.9%)			L Lingual Gyrus (17.8%)		
R SupraMarginal Gyrus (15%)					
R Mid. Occ. Gyrus (11.6%)					
R Sup. Temp. Gyrus (10%)					
Medial PMC / SMA (BA 6)	9.5	3,16,63	R Thalamus	11.4	12,-33,-5
R SMA (28.3%)			R Thalamus (24.6%)		
L SMA (21.3%)			R Pallidum (16.3%)		
L Sup Med. Gyrus (19.0%)			R Putamen (15.4%)		
R Sup. Med. Gyrus (13.0%)			R Caudate (9.9%)		
L Orbital Gyrus (BA 10,11)	8.1	-25,62,4	L lateral dPMC (BA 6)	7.1	-31,-11,55
L Mid. Front. Gyrus (36.1%)			L Precentral Gyrus (64.6%)		
L Inf. Front. Gyrus, p.Tri (27.2%)			L Postcentral Gyrus (12.4%)		
L Mid. Orb. Gyrus (16.4%)			L Inf. Front. Gyrus, p.Op (10.2%)		
L lateral dPMC (BA 6)	9.0	-40,-9,62			
L Precentral Gyrus (49.9%)					
L Mid. Front. Gyrus (38.0%)					
L Postcentral Gyrus (11.1%)					
Seed: Right medial PMC (SMA)					
L,R PMC / SMA (BA 6)	23.7	15,6,73	L,R PMC / SMA (BA 6)	16.3	12,6,73
L SMA (17.3%)			R SMA (20.2%)		
R SMA (16.5%)			L SMA (15.8%)		
R Mid. Cing. Cortex (12.3%)			R Precentral Gyrus (13.8%)		
L Mid Cing. Cortex (11.1%)			L Mid. Cing. Cortex (11.1%)		

L Ant. Cing. Cortex (9.4%) R Insula / IFG (BA 44, 22)	12.9	51,13,4	R Mid. Cing. Cortex (10.8%) R Insula / IFG (BA 44, 22)	11.5	51,12,-6
R Insula Lobe (38.4%) R Inf. Front. Gyrus, p.Op (19.0%)			R Insula Lobe (27.4%) R Putamen (15.5%) R Inf. Front. Gyrus, p.Op (14.4%)		
L Insula / IFG (BA 44, 22)	10.4	-40,10,1	L Insula / IFG (BA 44, 22)	10.3	-37,10,1
L Insula Lobe (42.4%) L Rolandic Operculum (12.3%) L Temp. Pole (12.0%)			L Insula Lobe (24.6%) L Putamen (21.2%)		
L IPL (BA 40)	10.0	-61,-41,31	R IPL (BA 40)	8.0	66,-22,25
L SupraMarginal Gyrus (53.8%) L Sup. Temp. Gyrus (15.3%)			R SupraMarginal Gyrus (57.4%) R Sup. Temp. Gyrus (22.8%) R Mid. Temp. Gyrus (15.9%)		
R IPL (BA 40)	8.3	66,-32,38	L,R Precuneus (BA 7)	-8.5	-1,-66,39
R SupraMarginal Gyrus (81.8%) R Sup. Temp. Gyrus (16.0%)			L Precuneus (45.1%) L Post. Cing. Cortex (16.9%) R Precuneus (14.2%)		
R lateral dPMC (BA 6)	7.7	51,2,43			
R Precentral Gyrus (78.0%) R Mid. Front. Gyrus (17.5%)					
Seed: Right anterior insula					
R Insula (BA 13)	24.8	39,3,4	R Insula (BA 13)	27.8	45,4,1
R Postcentral Gyrus (10.4%) R Precentral Gyrus (9.2%) R SupraMarginal Gyrus (8.9%)			R Postcentral Gyrus (7.2%) R Precentral Gyrus (6.8%) L SupraMarginal Gyrus (5.9%)		
L Insula (BA 13)	15.2	-37,16,1	L,R Calcarine Gyrus (BA 17)	7.8	-10,-71,3
L Sup. Temp. Gyrus (15.0%) L Insula Lobe (11.9%) L Inf. Parietal Lobule (10.7%) L Postcentral Gyrus (10.1%)			L Calcarine Gyrus (45.7%) R Calcarine Gyrus (34.3%) L Lingual Gyrus (15.6%)		
L,R Calcarine Gyrus (BA 17)	8.8	15,-83,6	L Lat. Occ. Cortex (BA 37)	8.2	-46,-68,3
L Calcarine Gyrus (16.2%) R Calcarine Gyrus (14.1%) L Lingual Gyrus (11.7%) R Lingual Gyrus (11.3%) L Cuneus (11.0%)			L Mid. Temp. Gyrus (31.6%) L Inf. Temp. Gyrus (21.6%) L. Fusiform Gyrus (17.2%) L Mid. Occ. Gyrus (14.4%) L Inf. Occ. Gyrus (12.5%)		
R IFG / DLPFC (BA 46)	9.8	45,43,9			
R Mid. Front. Gyrus (75.2%) R Inf. Front. Gyrus, p.Tri (19.8%)					
Seed: Right SI / IPL					
R IPL / IPS (BA 40)	28.6	54,-39,54	R IFG (BA 10)	14.2	45,43,9
R Inf. Parietal Lobule (23.3%) R Postcentral Gyrus (22.0%) R SupraMarginal Gyrus (21%) R Sup. Parietal Lobule (17.6%)			R Mid. Front. Gyrus (32.1%) R Inf. Front. Gyrus, p.Op (13.9%) R Mid. Orb. Gyrus (11.1%)		
L IPL / IPS (BA 40)	10.9	-49,-48,47	R IPL / IPS (BA 40)	33.2	54,-39,57
L Inf. Parietal Lobule (52.6%) L SupraMarginal Gyrus (15.9%) L Sup. Parietal Lobule (11.8%)			R Inf. Parietal Lobule (22.9%) R SupraMarginal Gyrus (20.4%) R Postcent. Gyrus (18.9%) R Sup. Parietal Lobule (17.6%)		
R IFG (BA 10)	11.1	45,43,22	L IPL / IPS (BA 40)	12.3	-43,-51,47
R Mid. Front. Gyrus (57.8%)			L Inf. Parietal Lobule (62.0%)		

R Mid. Orb. Gyrus (16.7%)			L Sup. Parietal Lobule (13.3%)		
R Inf. Front. Gyrus, p.Tri (15.1%)					
L Lat. Occ. Cortex (BA 37)	8.4	-46,-63,-25	L IFG (BA 44)	9.6	-37,22,-2
L Inf. Temp. Gyrus (37.6%)			L Insula Lobe (26.0%)		
L Inf. Occ. Gyrus (27.1%)			L Precentral Gyrus (24.9%)		
L Fusiform Gyrus (18.9%)			L Inf. Front. Gyrus, p.Op (21.6%)		
R Lat. Occ. Cortex (BA 37)	9.8	54,-57,-21	L,R Precuneus (BA 31)	-9.0	-1,-50,31
R Inf. Temp. Gyrus (66.2%)			L Precuneus (41.0%)		
R Fusiform Gyrus (12.9%)			R Precuneus (20.2%)		
			L Post. Cing. Cortex (15.7%)		
R IFG (BA 44)	11.4	51,12,24	R Lat. Occ. Cortex (BA 37)	8.2	57,-51,-20
R Inf. Front. Gyrus, p.Op (76.0%)			R Inf. Temp. Gyrus (76.2%)		
R Precentral Gyrus (12.8%)			R Mid. Temp. Gyrus (11.3%)		
R lateral dPMC (BA 6)	10.4	3,-2,56	L IFG / DLPFC (BA 46)	8.7	-46,41,3
R Mid. Front. Gyrus (49.3%)			L Inf. Front. Gyrus, p.Tri (58.9%)		
R Sup. Front. Gyrus (24.1%)			L Mid. Front. Gyrus (31.9%)		
R Precentral Gyrus (22.2%)					
L IFG (BA 10)	6.9	-43,40,6	L Lat. Occ. Cortex (BA 37)	8.3	-52,-64,21
L Inf. Front. Gyrus, p.Tri (70.6%)			L Inf. Temp. Gyrus (43.9%)		
L Mid. Front. Gyrus (25.5%)			L Inf. Occ. Gyrus (28.2%)		
			L Fusiform Gyrus (16.9%)		
			Medial PMC / SMA (BA 6)	8.6	6,20,44
			R SMA (31.5%)		
			R Mid. Cing. Cortex (21.4%)		
			L SMA (20.6%)		
			L Sup. Med. Gyrus (10.2%)		
Seed: Right SII / IPL					
R IPL / IPS (BA 40)	28.6	60,-28,22	R IPL / IPS (BA 40)	23.0	63,-25,22
R Sup. Temp. Gyrus (8.8%)			R Insula Lobe (20.3%)		
R Insula Lobe (7.2%)			R Sup. Temp. Gyrus (17%)		
R Postcentral Gyrus (6.8%)			R Rolandic Operculum (15.0%)		
			R SupraMarginal Gyrus (15%)		
			L IPL / IPS (BA 40)	13.6	-64,-31,22
			L Sup. Temp. Gyrus (28.3%)		
			L Insula Lobe (15.2%)		
			L SupraMarginal Gyrus (13%)		
			L Rolandic Operculum (11.1%)		
			L,R Mid. Cing. Gyrus (BA 24)	10.2	3,1,50
			L Mid. Cing. Cortex (19.1%)		
			R Mid. Cing. Cortex (18.0%)		
			R SMA (14.3%)		
			L SMA (9.7%)		
Seed: Right Lateral Occipital Cortex (V5)					
R Lat. Occ. Cortex (BA 19)	24.2	54,-65,4	R Lat. Occ. Cortex (BA 19)	22.7	57,-65,0
R Mid. Temp. Gyrus (30.5%)			R Mid. Temp. Gyrus (24.8%)		
R Fusiform Gyrus (18.3%)			R Fusiform Gyrus (15.5%)		
R Mid. Occ. Gyrus (16.1%)			R Lingual Gyrus (11.0%)		
R Inf. Temp. Gyrus (15.0%)			R Mid. Occ. Gyrus (10.6%)		
L Lat. Occ. Cortex (BA 19)	12.2	-52,-77,3	L Lat. Occ. Cortex (BA 19)	12.0	-52,-77,-0
L Mid Occ. Gyrus (30.6%)			L Mid. Occ. Gyrus (19.7%)		
L Fusiform Gyrus (17.6%)			L Mid. Temp. Gyrus (17.5%)		
L Mid. Temp. Gyrus (13.2%)			L Fusiform Gyrus (15.2%)		

			Medial SMA (BA 6)	8.8	6,-3,72
			R SMA (42.5%)		
			L SMA (20.3%)		
			L lat. dPMC / SMA (BA 6)	6.9	-37,-5,59
			L Postcentral Gyrus (36.9%)		
			L Precentral Gyrus (36.4%)		
			L Sup. Parietal Lobule (19.6%)		
			R IPL / IPS (BA 40)	7.4	27,-58,56
			R Postcentral Gyrus (47.6%)		
			R Sup. Parietal Lobule (25.8%)		
			R Precentral Gyrus (17.9%)		
			R lat. dPMC / SMA (BA 6)	7.8	48,-2,53
			R Precentral Gyrus (70.3%)		
			R Mid. Front. Gyrus (19.3%)		
Seed: Right fusiform gyrus (FFA/FBA)					
R Fusiform Cortex (BA 37,19)	17.6	48,-57,-28	R Fusiform Cortex (BA 37,19)	22.6	45,-54,-31
R Mid. Temp. Gyrus (9.5%)			R Mid. Occ. Gyrus (5.8%)		
R Fusiform Gyrus (9.1%)			R Fusiform Gyrus (5.0%)		
R Postcentral Gyrus (8.3%)			R Mid. Temp. Gyrus (4.3%)		
R Inf Temp. Gyrus (8.1%)					
L Fusiform Cortex (BA 37,19)	13.2	-43,-51,-24			
L Mid. Occ. Gyrus (20.7%)					
L Inf. Parietal Lobule (15.8%)					
L Fusiform Gyrus (15.3%)					
L Sup. Parietal Lobule (10.0%)					
L Inf. Tem. Gyrus (9.8%)					
R IFG (BA 9)	9.7	51,24,25			
R Mid Front. Gyrus (30.0%)					
R Inf. Front. Gyrus, p.Tri (25.0%)					
R Inf. Front. Gyrus, p.Op (19.0%)					
R Precentral Gyrus (13.9%)					
L IFG (BA 9)	8.5	-49,5,33			
L Precentral Gyrus (53.5%)					
L Inf. Front. Gyrus, p.Tri (27.4%)					
L Inf. Front. Gyrus, p.Op (17.0%)					

Note: Imitation seed regions were based on the peak activations determined by the ALE meta-analysis by Caspers *et al.* (2009) of “action imitation” task data.

Figure S1. Examples of seed ROIs nudged for tractography.

This figure demonstrates the outcome of nudging and illustrates that nudged seeds remained within the same functional/anatomical parcel. Original seeds as defined by the ALE coordinates and utilized in fMRI analyses are depicted in yellow; seeds nudged for tractography are marked in red. **A.** Coronal and sagittal views of right mPMC and right lateral dPMC, pre- and post-nudging. **B.** Coronal and sagittal views of right SI / IPL, pre- and post-nudging, overlaid with a binary mask of IPL from the Jülich-Histological Atlas included in FSL.

