Supplementary Material

Manuscript Nelissen et al. 'Action observation circuits in the macaque monkey cortex.'

Supplementary text.

3 Supplementary Figures.

5 Supplementary Videos.

Supplementary text:

Methods

The ROIs consisted of 89 voxels for PF, 70 for PFG, 137 for PG, 84 for Opt, 64 for AIP, 69 for LIPa, 68 for MT/V5, 92 for MTp, 58 for MSTd, 75 for FST, 94 for LST, 50 for STPm, 80 for LB1, 80 for LB2, 86 for UB1 and 81 for UB2.

For STS ROIs, all voxels within the ROI were considered for ROI analysis, since these ROIs were defined on the basis of their responses to visual stimuli (the motion tests of Nelissen et al. (2006) or the action localizer test). Since parietal regions have a more heterogeneous population of visual, somatosensory and motor neurons (Taira et al., 1990; Colby et al., 1993; Duhamel et al., 1998; Andersen et al., 1990; MacKay, 1992; Fogassi et al., 2005; Yokochi et al., 2003; Rozzi et al., 2008), only visually responsive voxels were taken into account for the parietal ROI analysis. Typically the proportion of visual voxels was more restricted in the IPL than in the IPS and in the 3T than in the 1.5T. For

the acting-person runs in the 1.5T, these percentages were: 97, 100, 56, 19, 100 and 100 for PF, PFG, PG, Opt, AIP, LIPa respectively. For the isolated-hand runs in the 1.5T these were: 100, 90, 80, 76, 100, 100; for the acting-person runs in the 3T: 0, 37, 72, 64, 95, 100 and for the isolated-hand in the 3T: 0, 21, 32, 21, 72, 100, respectively.

References

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Supplementary Figure S1.

MR activations for observation of goal-directed and mimicked actions in STS, IPL and IPS. A. Percent MR signal change (baseline: fixation only condition) in the 10 STS ROIs (A) and 6 IPL and IPS ROIs (B) for goal directed and mimicked hand grasping actions. Controls are either translating or static hands. Group data from 2 monkeys (M6, M11). Error bars indicate SEMs across runs. Asterisks indicate significant stronger ($p < 0.05$, corr.) response to action observation compared to respective controls. In LB2 there was a trend for goal-directed action to evoke more response than mimicked condition. This main effect was not significant in the group, but in one animal (M6) it was significant in LB2 ($t=6.57$, $p<0.05$).

Supplementary Figure S2.

MR activations for grasping observation in F5. Percent MR signal change (baseline: fixation-only condition) during the observation of grasping and its scrambled and static controls for acting person (A) and isolated hand action (B) video-clips in three cytoarchitectonic sectors of F5. F5c = F5 convexity, F5p = bank posterior, F5a = F5 bank

anterior. Single subject 3T data (M15) from Experiment 1. Error bars indicate variability over runs. Asterisks indicate a significantly stronger ($p < 0.05$, corrected) response to action observation compared to the respective controls. All contrasts between action observation and the three controls and fixation were significant in all regions ($t>3.71$, $p<0.0006$ or better), except for the contrasts action vs static end (t -4.19) and action vs fixation (t .27) for isolated hand in F5c.

Supplementary Figure S3.

Heterogeneity of voxels within ROI for isolated hand action and translating hand observation. Correlation between functional MRI activations for observing isolated hand actions in MSTd (top left), STPm (top middle), LB2 (top right), PFG (bottom left) and AIP (bottom right). Percent MR signal change values for observation of hand action and translating hands (versus static control) are plotted from all voxels within ROI responding to isolated hand action. The MR signal change was calculated with respect to the static control, rather than the fixation baseline to avoid the possibility that voxels which simply responded to the static control, which is the same for action and translation, would artificially inflate the correlation. Pooled data from 2 monkeys (M6 and M13). The correlations were significant at $p<10^{-4}$ in all five areas. The difference in correlation between PFG and STPm was significant at $p<0.02$. In MSTd the correlation is intermediate ($R^2= 0.46$) and the median response to action observation is shifted towards smaller values. Furthermore, the relationship in MSTd appears non-linear and the activity in MSTd voxels responding strongly to action observation shows hardly any correlation between action observation and translation

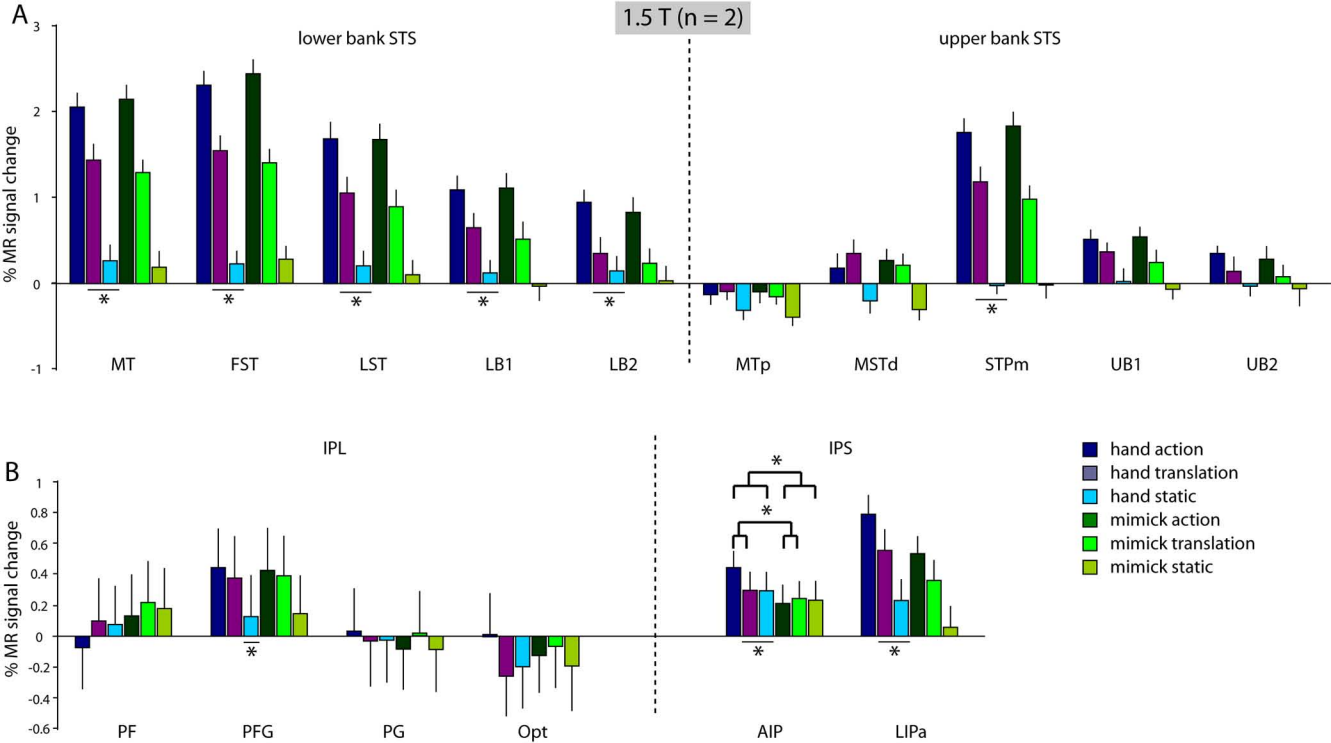
Supplementary Video S1: Isolated hand action.

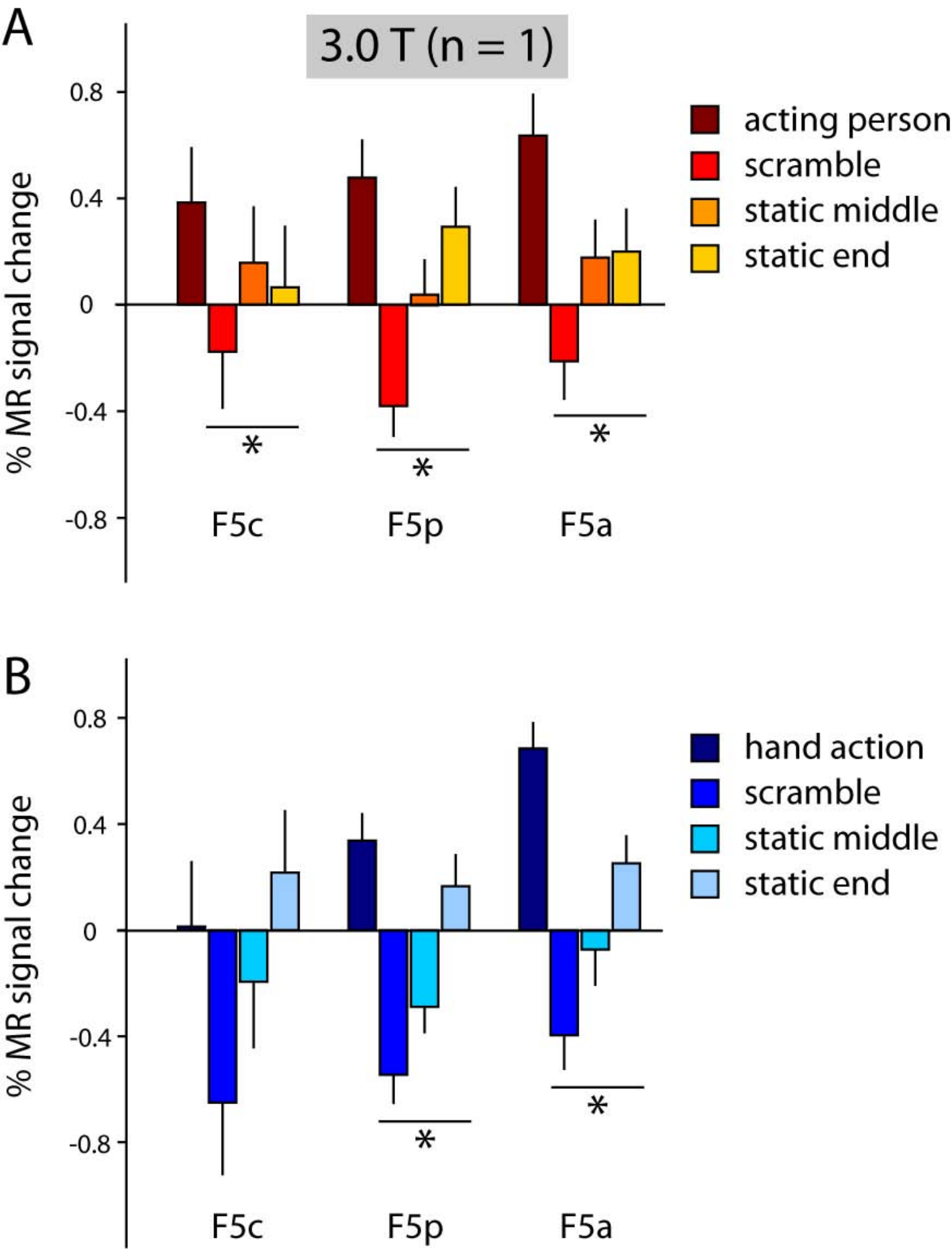
Supplementary Video S2: Acting person.

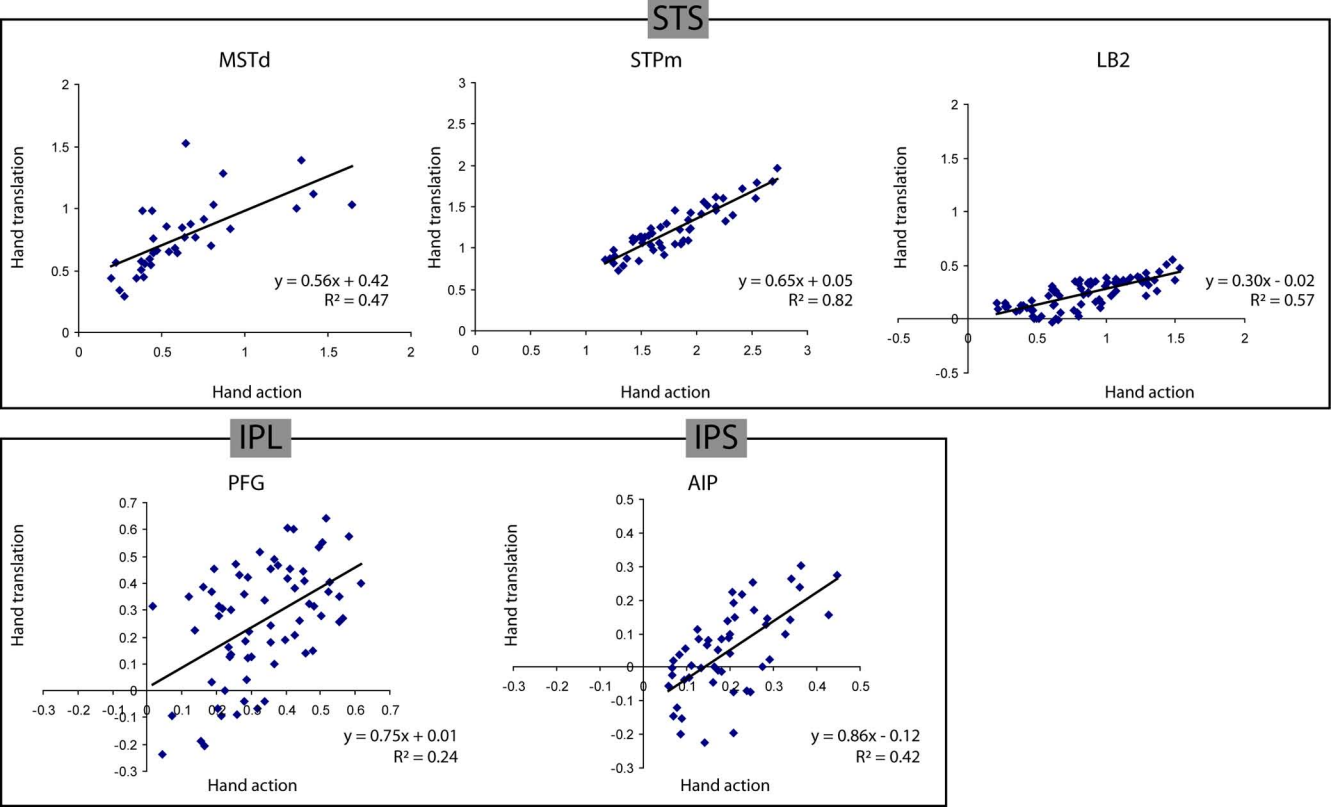
Supplementary Video S3: Fourier-phase scrambled isolated hand action.

Supplementary Video S4: Translating isolated hand.

Supplementary Video S5: Mimicked isolated hand action.


A
1.5 T (n = 2)
lower bank STS
upper bank STS
% MR signal change
3
2
1
0
-1
MT
FST
LST
LB1
LB2
MTp
MSTd
STPm
UB1
UB2
B
IPL
IPS
% MR signal change
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
PF
PFG
PG
Opt
AIP
LIPa
hand action
hand translation
hand static
mimick action
mimick translation
mimick static


A
3.0 T (n = 1)
0.8
0.4
0
-0.4
-0.8
% MR signal change
acting person
scramble
static middle
static end
*
*
*
F5c
F5p
F5a
B
0.8
0.4
0
-0.4
-0.8
% MR signal change
hand action
scramble
static middle
static end
*
*
*
F5c
F5p
F5a


STS
MSTd
Hand translation
Hand action
y = 0.56x + 0.42
R² = 0.47
STPm
Hand translation
Hand action
y = 0.65x + 0.05
R² = 0.82
LB2
Hand translation
Hand action
y = 0.30x - 0.02
R² = 0.57
IPL
PFG
Hand translation
Hand action
y = 0.75x + 0.01
R² = 0.24
IPS
AIP
Hand translation
Hand action
y = 0.86x - 0.12
R² = 0.42