A large-scale brain network of species-specific dynamic human body perception

Baichen Li[1], Marta Poyo Solanas[1], Giuseppe Marrazzo[1], Rajani Raman[2], Nick Taubert[3], Martin Giese[3] , Rufin Vogels[2], Beatrice de Gelder[1]

[1] Maastricht University, Maastricht, The Netherlands

[2] KU Leuven, Leuven, Belgium

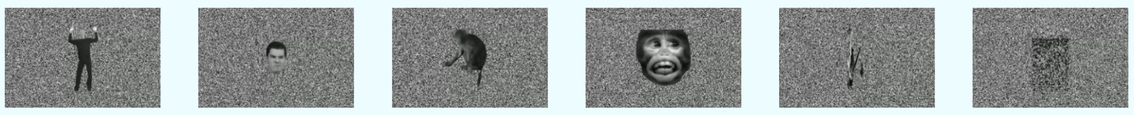
[3] University Clinic Tübingen, Tübingen, Germany

Introduction

The ability to gather information from whole-body postures and movements is a fundamental social skill for many species but the processes involved are not yet well understood. While several body-selective regions have already been identified in both humans[1] and nonhuman primates[2], there is no comprehensive picture of body selective areas, their network organization and their species specificity. This 7T fMRI study investigated the neural correlates of dynamic body perception in human participants viewing naturalistic videos of dynamic monkey and human faces, bodies and objects, including mosaic-scrambled videos for control of low-level features. Our goal was to use data-driven methods to reveal the networks in which body selective brain areas play their roles.

Experiment design

- Human 7T fMRI, in-plane resolution = 1.6 mm.
- Dynamic video stimuli
  - Video length = 1 second
  - Twelve categories including:
    - moving bodies / faces / objects
    - from human / monkey recordings
    - with normal / scramble versions
- Blocked design
  - Six repetitions / category in three scanning runs
  - Ten videos / block; Inter-trial interval = 0.5 seconds
- Button press for fixation shape change



Data analysis

- Contrasts analysis from random-effect GLM
  - Human body (normal - scramble) > Human object (normal - scramble)
  - Human body (normal - scramble) > Monkey body (normal - scramble)
- ICA based large-scale networks
  - 75 components extracted by GIG-ICA algorithm[3]
  - GLM on IC time-courses to detect body modulations
- Condition-dependent network nodes
  - Regress out one condition from the time courses and reconstruct the networks
  - Expect decreased network weights on condition-dependent nodes

Results

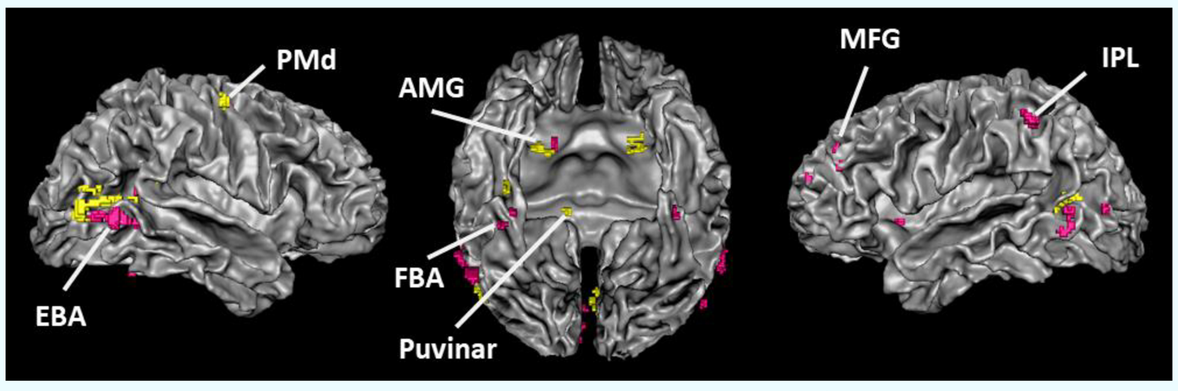


Figure 1. By the contrast of [human body (normal - scramble)] > [human object (normal - scramble)], widely distributed body patches were found (yellow and pink clusters).Further ROI analysis with the contrast of [human body (normal - scramble) > monkey body (normal - scramble)] revealed human specificity around EBA, FBA, pSTS, PMd, frontal gyrus, pulvinar and amygdala (pink clusters).

Acknowledgments

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References

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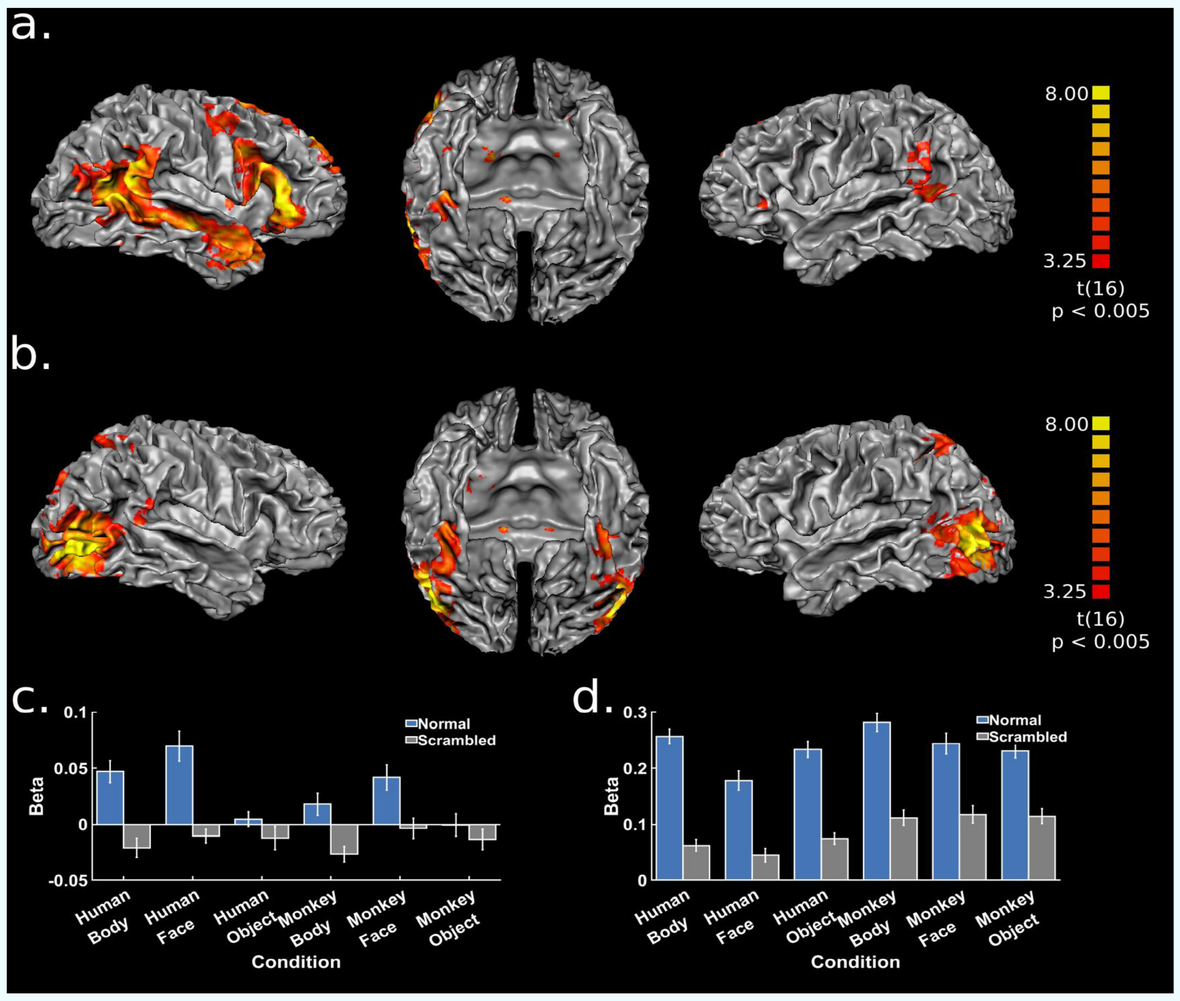

Figure 2. Networks extracted by group-ICA. The individual IC maps were z-transformed and averaged across all runs for each participant. A group t-test against zero was computed using the z-scored maps of each subject. The resulting statistical map was corrected using a cluster-threshold statistical procedure based on Monte-Carlo simulation (initial $p < 0.005$, alpha level = 0.05). (a) & (c). rSTS network and its beta plot. (b) & (d). LOC network and its beta plot.

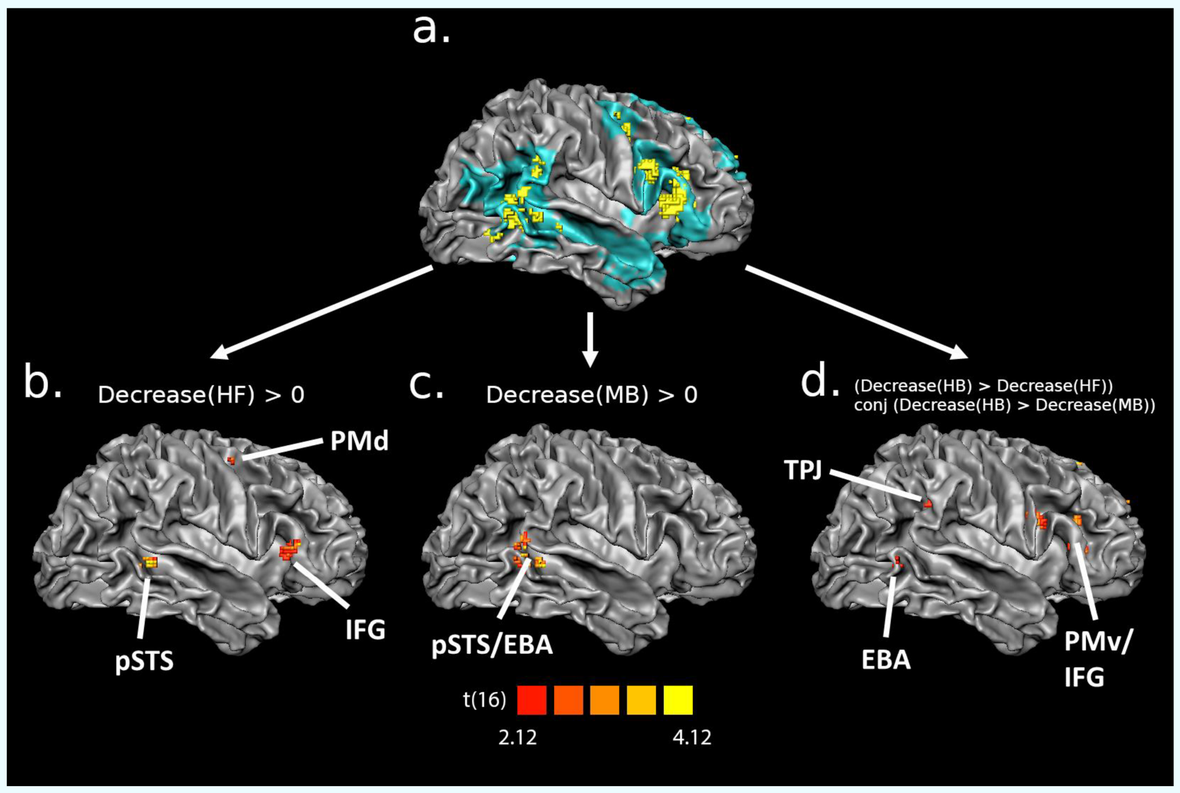

Figure 3. Different dependence properties revealed by the weight decreases when regressing out human body, human face, and monkey body conditions. (a). The rSTS nodes showing human body dependency projected to cortical mesh with blue shadows indicating the network coverage. (b). Node voxels showing human face dependence. (c). Node voxels showing monkey body dependence. (d). Node voxels showing human-specific body dependence. Abbreviations in the contrasts: H: human; M: monkey; B: body; F: Face.

Conclusion

Widely distributed body areas were found in both cortical and subcortical structures, which could be further separated into the LOC network and the rSTS network. The rSTS network showed higher species selectivity, and within this network, significant human body induced node connectivity was found around EBA, STS, TPJ, premotor cortex and IFG. Furthermore, the results indicated that the nodes of TPJ, premotor cortex and IFG may play an important role in human-specific body perception. The discovery of this human specific network allows us to pull together so far isolated findings from studies that either looked at category selectivity, at action perception, and emotion recognition or at embodiment.