

Visual Area (PPA) Correlates With Auditory, Spatial Cues Given by an Audio Drama's Narrator

Is The PPA a Visual Area?

BOLD responses to incidental spatial cues in naturalistic stimulation

Christian O. Häusler^{1,2,3} and Michael Hanke^{1,3}

1. Institute of Neuroscience and Medicine, Brain & Behaviour (INM-7), Research Centre Jülich, Jülich, Germany,
2. Psychoinformatics Lab, Department of Psychology, University of Magdeburg, Magdeburg, Germany,
3. Institute of Systems Neuroscience, Medical Faculty, Heinrich Heine University, Düsseldorf, Germany



OTTO VON GUERICKE
UNIVERSITÄT
MAGDEBURG

HEINRICH HEINE
UNIVERSITÄT DÜSSELDORF
SYSTEMS NEUROSCIENCE

Introduction

Parahippocampal Place Area (PPA)

- increased BOLD responses to passively viewed pictures of landscapes & rooms¹
- responses to auditory stimuli unclear²

exploratory re-use of "studyforrest" dataset

- natural stimulation via an audio drama & movie
- model-driven analysis (general linear model)

questions

- PPA's behavior during complex, more ecologically valid, taskless stimuli?
- an auditory stimulus for individual localization of a "visual" area, e.g. in visually impaired subjects?

Methods

stimuli: visual localizer (block-design)³;
audio drama⁴, movie⁵ (3543 volumes each)

annotation: speech of the audio drama's narrator;
movie cuts

fMRI data: taken from [StudyForrest.org](https://www.studyforrest.org/); N=14

statistical analysis: standard 3 level GLM for group averages using FSL

primary contrasts of interest:

a) dedicated visual localizer

- landscapes, houses > bodies, faces, objects, scrambled

b) audio drama

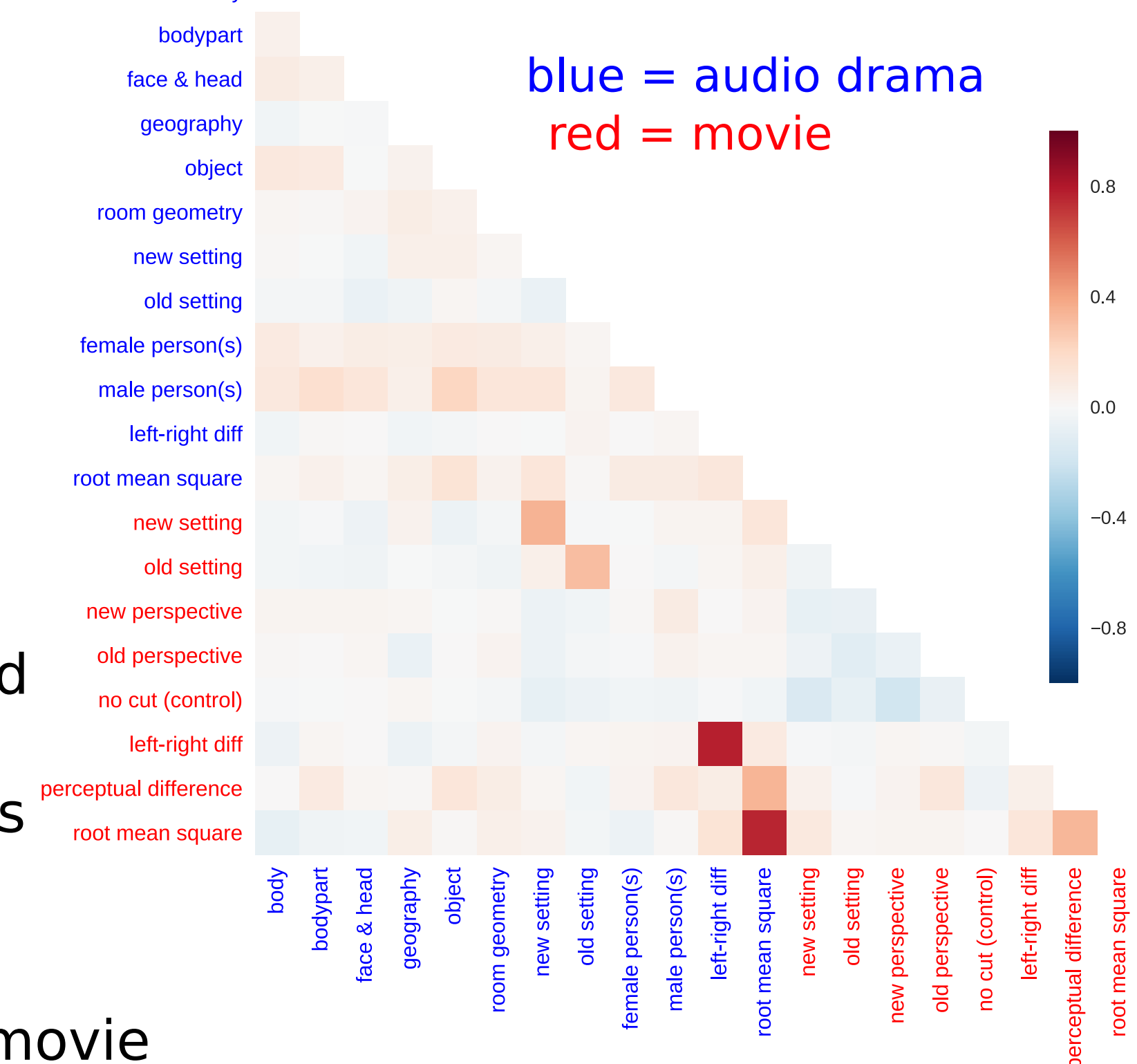
- geography, room geography > bodies, objects, persons

c) movie

- new settings > old perspectives

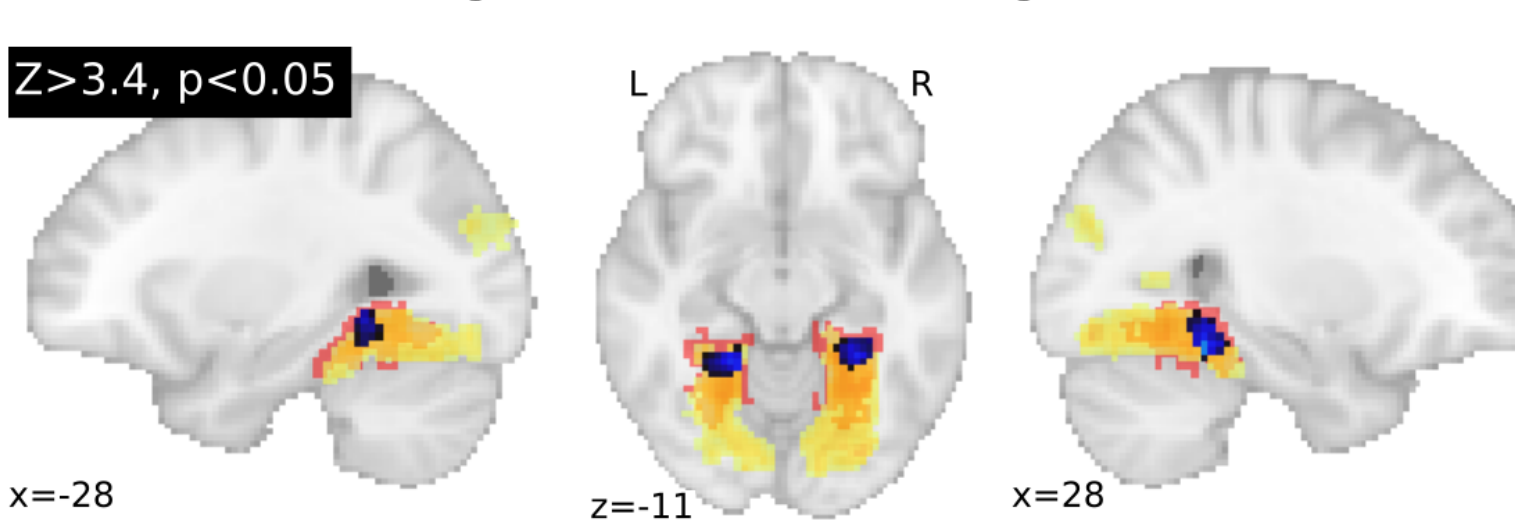
+ negative controls & cross-modal controls for audio & movie

correlation of regressors



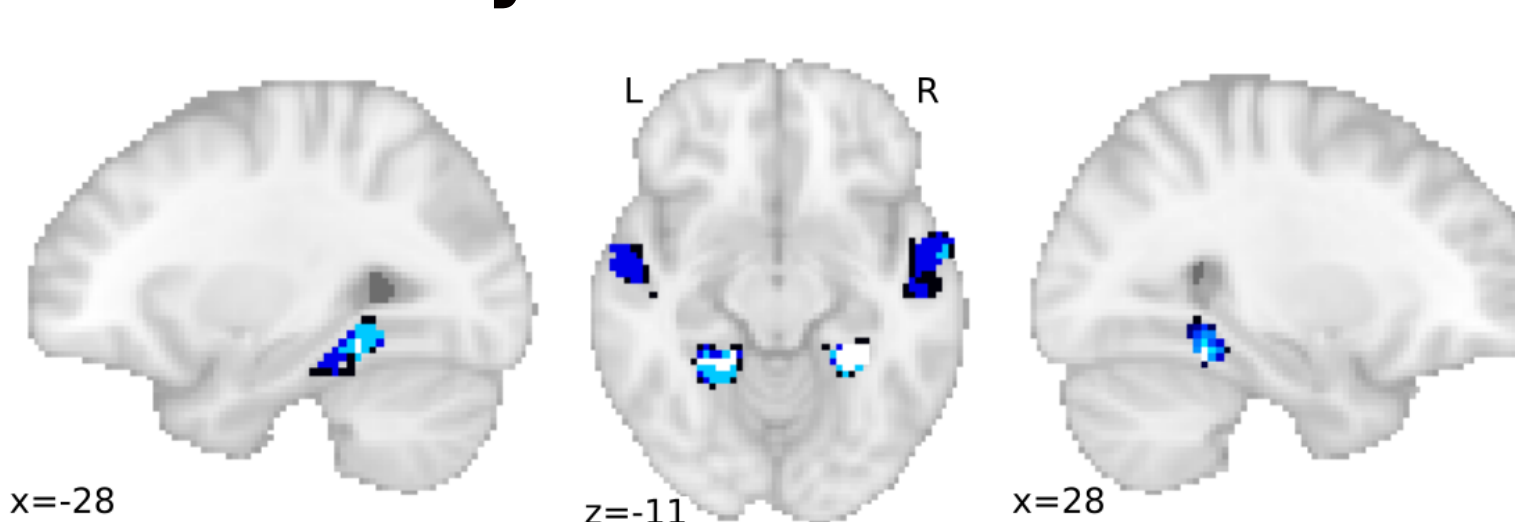
Results

group average



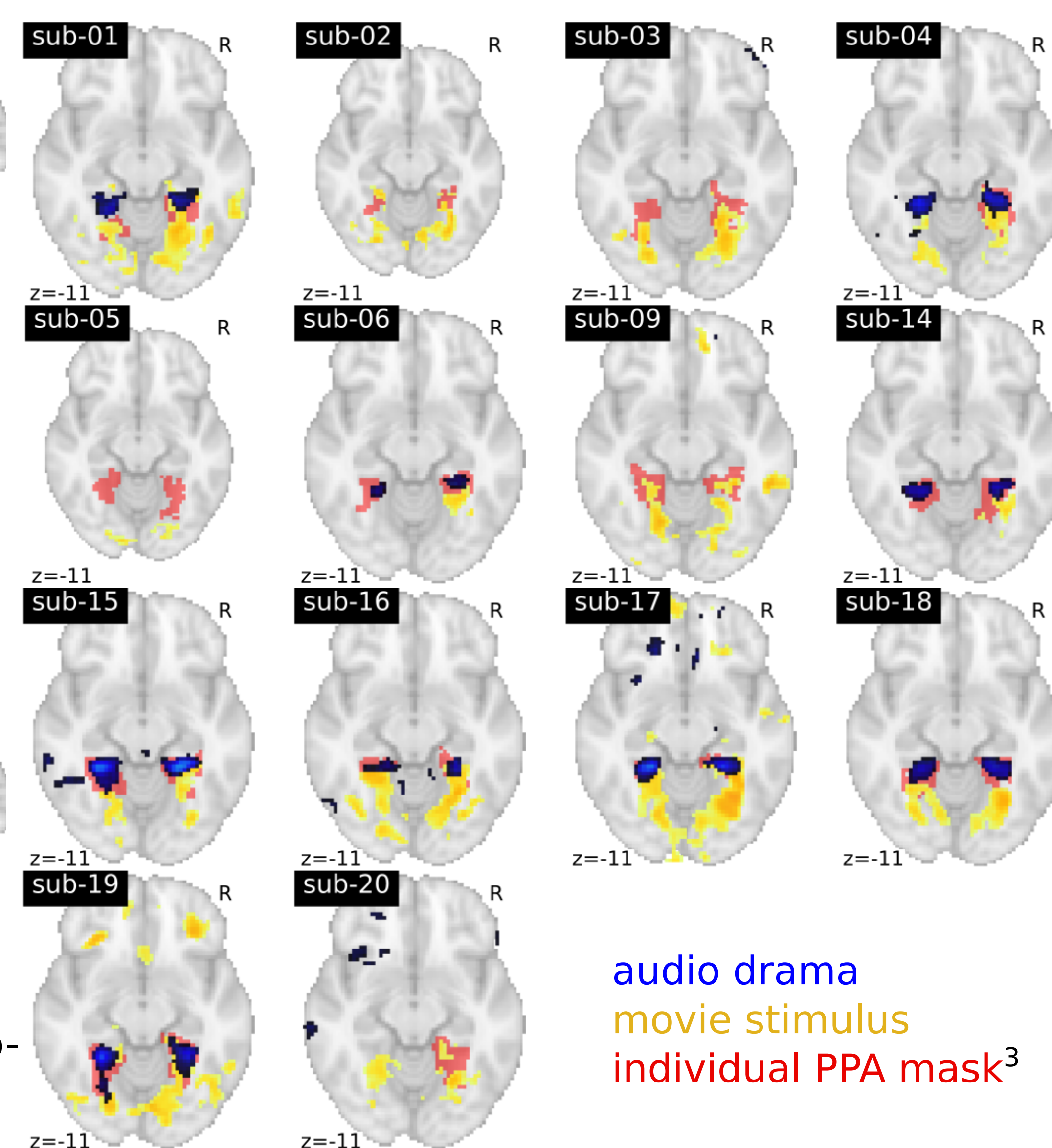
mixed-effects group-level (N=14) contrasts for the **audio** and **movie** stimulus; **overlap of individual PPA masks**³ derived from visual localizer paradigm; coordinates in MNI 152

stability across 7 contrasts



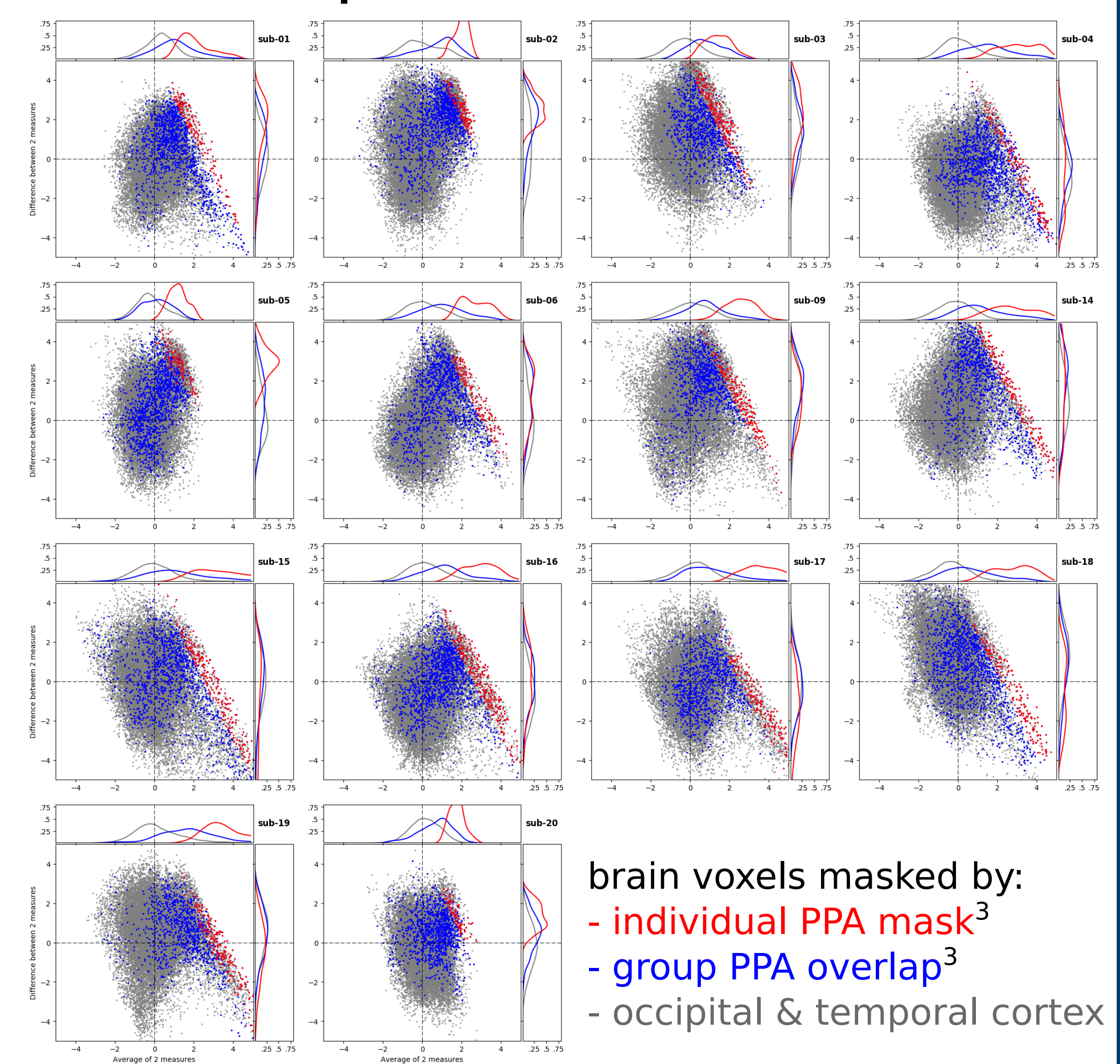
overlap of significant clusters ($Z > 3.4$; $p < 0.05$) across all seven tested audio-contrasts aiming for the PPA but with varying agreement with the spatial layout hypothesis¹;
s. QR-Code for unthresholded z-maps uploaded at neurovault.com

individual results



2nd level fixed-effects analyses across runs; significant clusters at $Z > 2.3$; $p < 0.05$; coordinates in MNI 152

Bland-Altman plots: visual localizer - audio drama



plots for two spatially corresponding z-values of voxels of the audio drama contrast & the visual localizer contrast; x-axis: average of voxels; y-axis: difference of voxels

brain voxels masked by:
- individual PPA mask³
- group PPA overlap³
- occipital & temporal cortex

Discussion

1. PPA shows increased activation during non-visual, complex auditory stimulation that provides incidental spatial information.
2. only minor temporal correlation of regressors of the audio drama & movie that were not designed for experimental research.
3. but still, alternative contrasts show significant clusters in auditory cortices.

4. inter-individual differences: for two subjects, an alternative audio-contrast shows bilaterally significant clusters whereas the primary contrast shows no significant clusters.
5. audio drama shows bilaterally increased activation in subject 4 in which the visual localizer shows an unilateral cluster.
6. nevertheless, a complex auditory stimulus might allow individual localization of a functionally defined brain region.

7. results of other studies suggest⁷ the PPA does not exclusively process the "spatial layout" but "contextual associations".
8. an audio drama might be suitable as ecologically more valid "localizer" for a variety of brain functions.

References: 1. Epstein & Kanwisher (1998). A cortical representation of the local visual environment.
2. Aziz-Zadeh (2008). Modulation of the FFA and PPA by language related to faces and places.
3. Sengupta et al. (2016). A studyforrest extension, retinotopic mapping and localization of higher visual areas. [StudyForrest.org](https://www.studyforrest.org/)
4. Hanke et al. (2014). A high-resolution 7-Tesla fMRI dataset from complex natural stimulation with an audio movie. [StudyForrest.org](https://www.studyforrest.org/)
5. Hanke et al. (2016). A studyforrest extension, simultaneous and eye gaze recordings during prolonged natural stimulation. [StudyForrest.org](https://www.studyforrest.org/)
6. Häusler & Hanke (2016). An annotation of cuts, depicted locations, and temporal progression in the motion picture "Forrest Gump". [StudyForrest.org](https://www.studyforrest.org/)
7. Aminoff, Kveraga, Bar (2013). The role of the parahippocampal cortex in cognition.



[studyforrest.org](https://www.studyforrest.org)
fz-juelich.de/inm/inm-7
psychoinformatics.de



Acknowledgments: This study was supported by a graduate stipend from the German federal state of Saxony-Anhalt