# Temporal properties of shape processing across visual areas: fMRI and MEG studies

E. Huberle[1], W. Lutzenberger[2], A. Deubelius[1], H. H. Bülthoff[1], Z. Kourtzi[1]
[1]Max Planck Institute, Tübingen, Germany; [2]University Clinics, Tübingen, Germany.

e-mail: elisabeth.huberle@tuebingen.mpg.de

MAX-PLANCK-GESELLSCHAFT

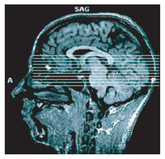
MPI FOR BIOLOGICAL CYBERNETICS

## Introduction

Processing of shape information requires the involvement of different visual areas. Recent studies (Altmann et al., 2003) have shown that global information about shapes is processed in both early ventral (i.e. V1,V2,VP,V4) and higher occipitotemporal visual areas (i.e. Lateral Occipital Complex - LOC). However, the temporal properties of shape processing across visual areas in the human brain are largely unknown. We addressed this question in a combined fMRI and MEG study (Experiment 1) that made use of the high spatial resolution of fMRI and the temporal resolution of MEG. We used an event-related adaptation paradigm in which lower neural responses are observed for two identical than two different consecutively-presented stimuli in each trial (Kourtzi et al., 2001). The stimuli were closed contours that consisted of collinear Gabor elements. We manipulated the interstimulus interval (ISI: 100ms vs. 400ms) between the two consecutively-presented stimuli in each trial. The same subjects participated in the fMRI and MEG study.

The results showed similar adaptation effects in the fMRI and MEG study. That is, we observed adaptation effects for the short and long ISI in the LOC, but only for the short ISI in the early visual areas. Interestingly, differences for the long ISI in the LOC occurred at shorter latencies than for the short ISI in V1. Our findings suggest sustained shape processing in higher visual areas compared to more transient visual processing in early visual areas and a possible role of feedback mechanisms in shape processing. Further studies (Experiment 2) tested the analysis of local vs. global shape features across areas with different temporal processing properties.

## Methods

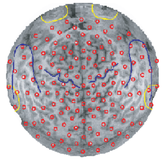



Siemens 1.5T Scanner

Head Coil

11 axial slices

Voxel size: 3.0 x 3.0 x 5.0 mm



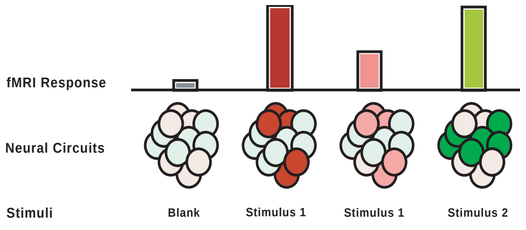
CTF whole-cortex MEG System

151 Channels

3 Localization Coils

Sampling rate: 312,5 HZ

### fMRI Adaptation Paradigm

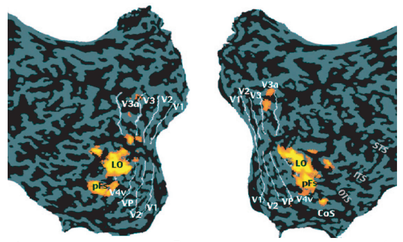



## Experiment 1: fMRI-Study

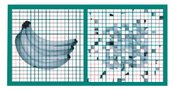
### Question

Are there different temporal properties in the processing of shape information across human visual areas ?

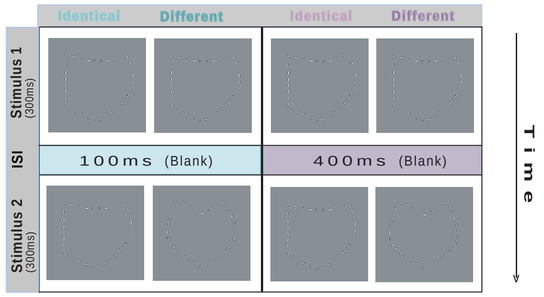
### Regions of Interest: LOC / Retinotopic Areas




Stimuli for Localization of the LOC

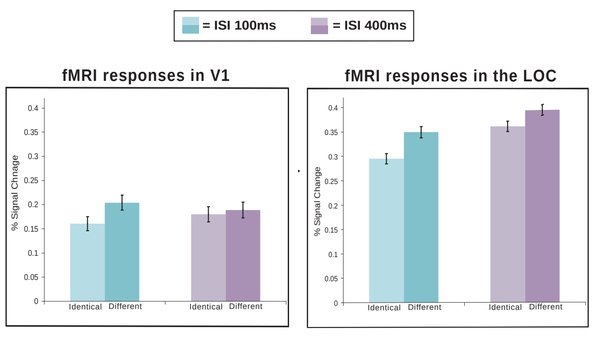



### Stimuli and Conditions




Display Size: 10.9 x 10.9 deg
Average Shape Size: 6.0 x 6.0 deg
Gabor Size: 0.45 deg

### Results (n=11)

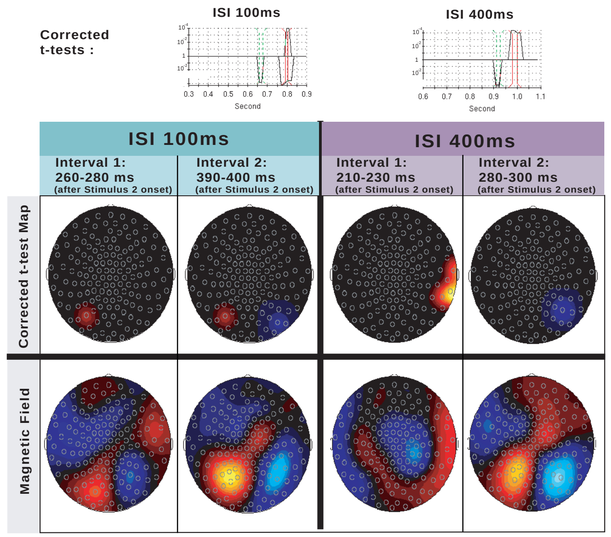



### Summary

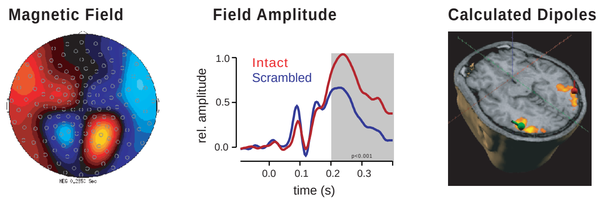
Adaptation effects were observed both for the short ISI (100ms) and the long ISI (400ms) in higher visual areas, but only for the short ISI in early visual areas.

## Experiment 1: MEG-Study

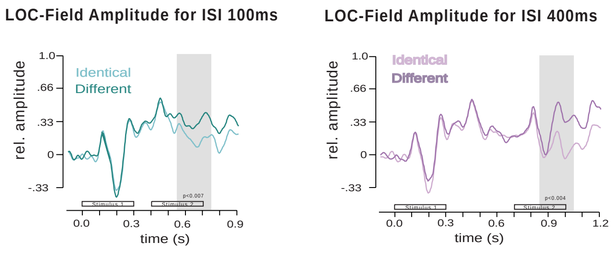
### Results: Identical vs. Different (n=12)




### Field of Interest for the LOC




### Results: Field analysis (n=12)




### Summary

Significantly stronger responses for different than identical shapes were observed in occipital regions for the short ISI and temporal regions for the long ISI.

These adaptation effects occured at later latencies for the short ISI (260-280ms) than the long ISI (210-230ms).

Field of Interest analysis for the LOC showed adaptation effects both in the short and the long ISI.

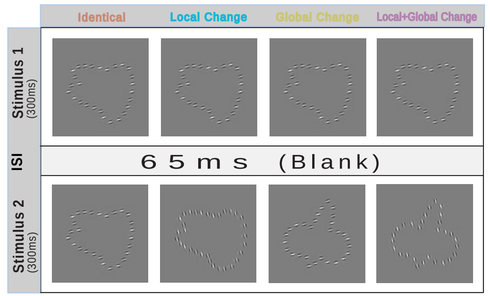
## Experiment 2

### Question

What features of shapes are processed in early and higher visual areas ?

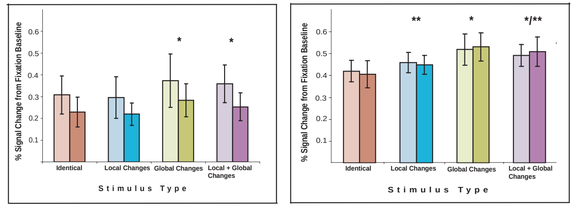
Does task-dependent attention influence the processing of shape information across visual areas ?

### Stimuli and Conditions




Display Size: 10.9 x 10.9 deg
Average Shape Size: 6.0 x 6.0 deg
Gabor Size: 1.06 deg

### Results (n=8)




*: p< 0.05 **: p<0.05

### Summary

Increased fMRI responses for Global Shape Changes were observed both in V1 and the LOC.

Increased fMRI responses for Local Orientation Changes were observed in the LOC, but not in V1.

We found no significant effect of task-dependent attention.

## General Discussion

Neural populations in early and higher visual areas encode global shape and feature information.

Adpatation effects were observed for the short and the long ISI in the LOC, but only for the short ISI in early visual areas. These results suggest a transient manner of shape processing in early visual areas.

The MEG adaptation effects occurred at longer latencies for the short ISI than the long ISI. These results suggest feedback mechanisms on shape processing in early visual areas.

Responses in early and higher visual areas were increased across global shape changes. These findings provide further evidence for the role of feedback mechanisms in shape processing.