

# Dysregulated Local Oscillatory Connectivity of the Visual System in Autism Spectrum Disorder



## Background

- Autism Spectrum Disorder (ASD) is associated with a distinct pattern of sensory traits, and hypo/hypersensitive reactions to sensory stimuli.
- Recent magnetoencephalography (MEG) autism research has suggested that one candidate mechanism may be disorganised local oscillations, combined with reduced top-down modulation (*Kessler, Seymour & Rippon, 2016*).

## Participants and Paradigm

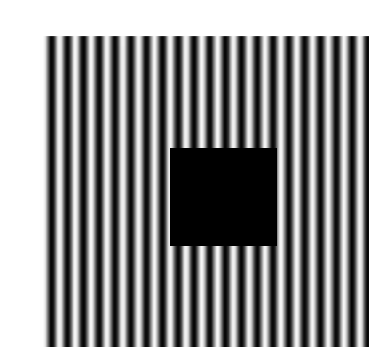
- Participants performed an interactive visual paradigm designed to elicit non phase-locked high-frequency (40-70Hz) gamma oscillations.

- MEG data acquired using 306-channel Neuromag Elekta scanner

	N	Mean Age	Sex	AQ adult	Mean Trial Number	Movement
ASD	17	17.63 (2.00)	5 female	32.65 (6.76)	62.46	>5mm
Control	17	17.43 (1.90)	5 female	11.38 (6.25)	62.33	>5mm



*BASELINE* →



## MEG Analysis

Performed in *Fieldtrip* & customised *MATLAB* scripts. Statistical analyses conducted using cluster-based permutation tests

### Source Localisation

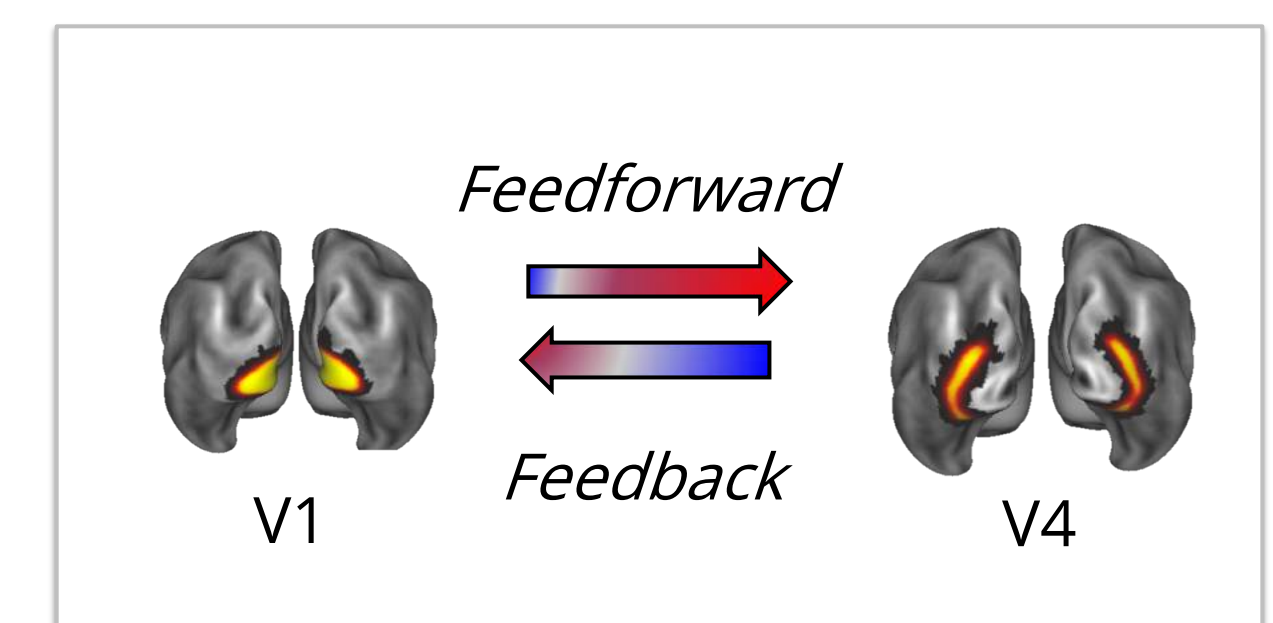
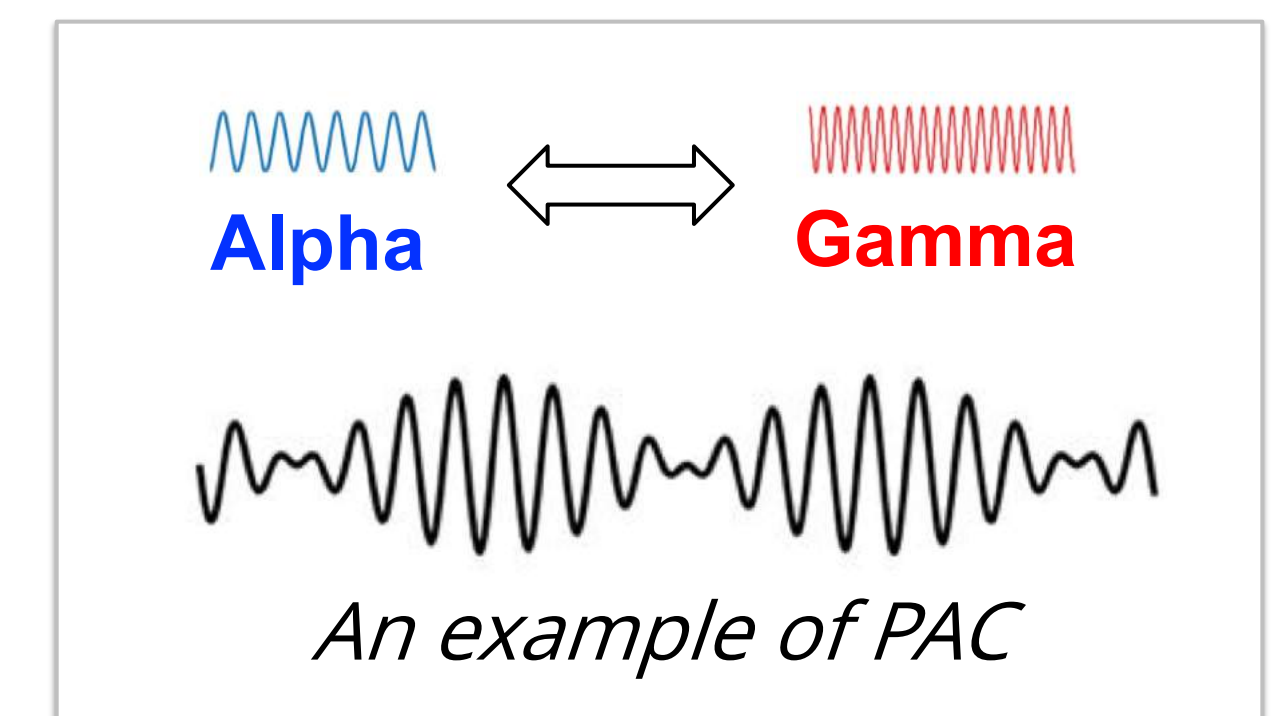
- LCMV Beamformer [0.3s to 1.5s vs. -1.5s to -0.3s ; 40-70Hz]
- Time-courses were extracted from area V1 and V4.

### Phase Amplitude Coupling (PAC) Analysis

- PAC = coupling between amplitude of higher frequency and the phase of lower frequency oscillations (*Ozkurt & Schnitzler, 2011*)

### Granger Causality Analysis

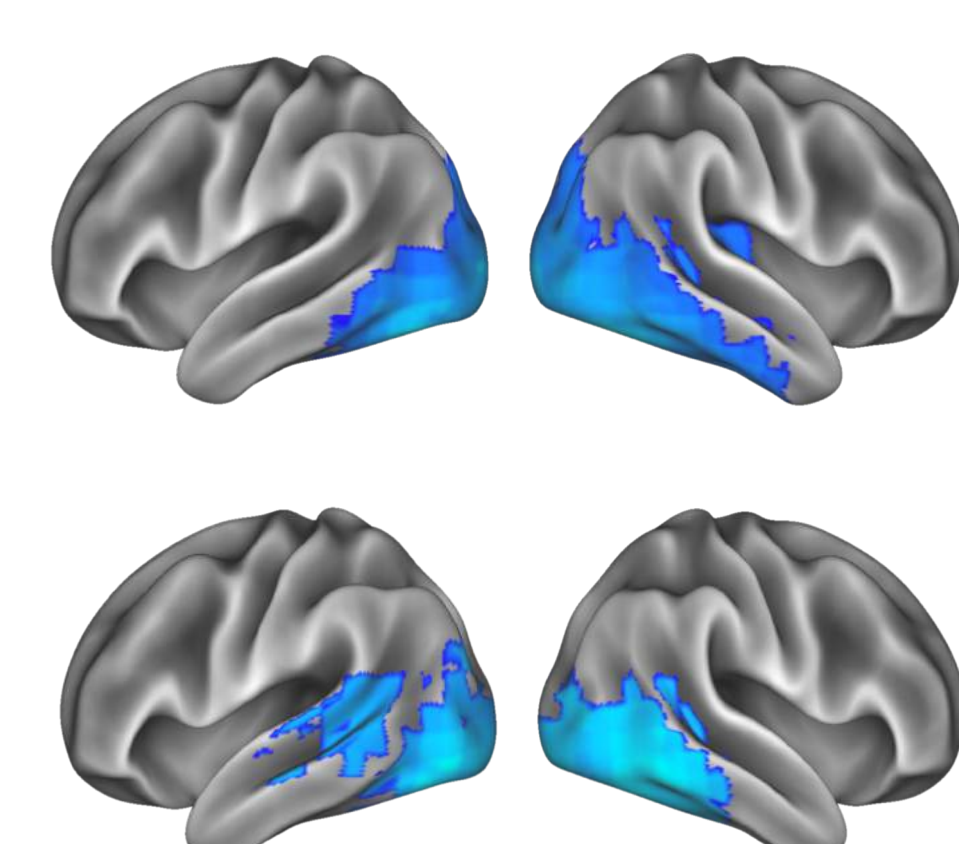
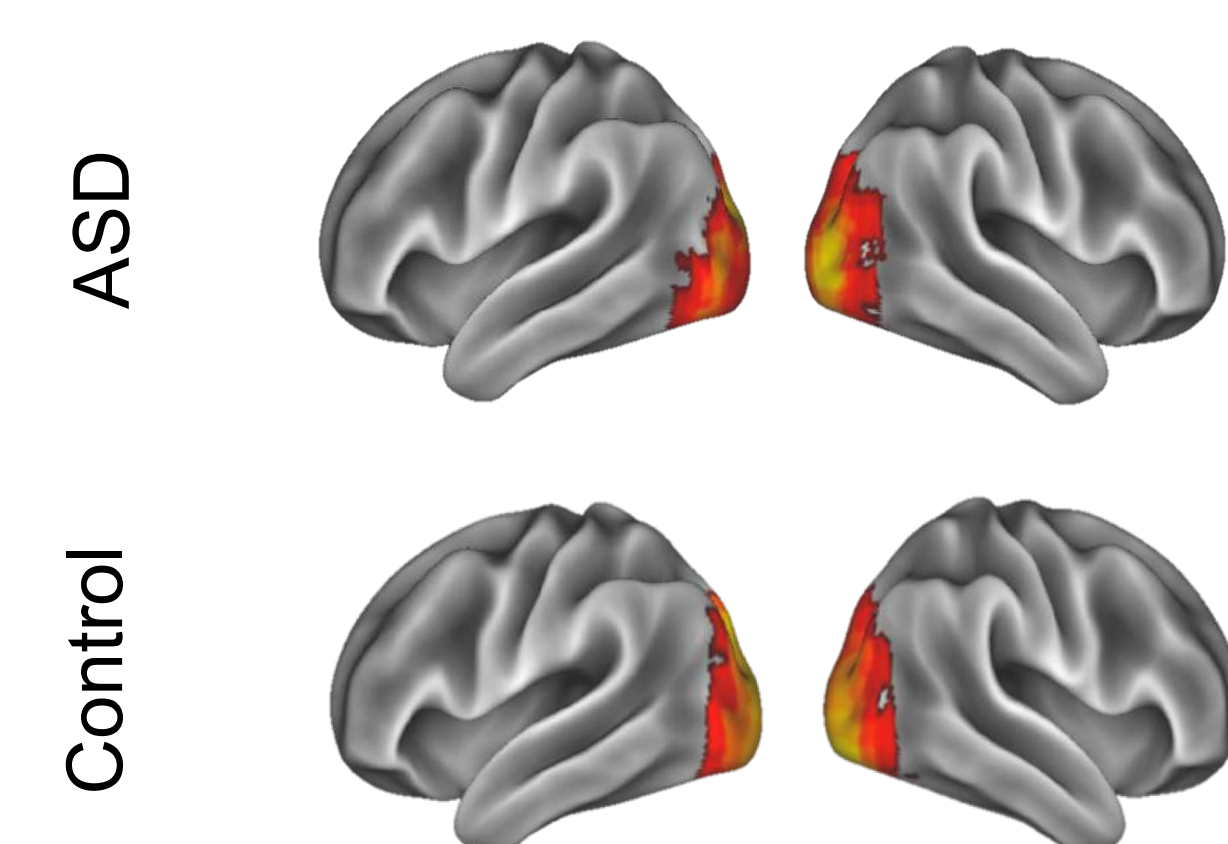
- Non-parametric spectrally-resolved granger causality (1-140Hz) computed between V1 and V4.
- Directed Asymmetry Index (DAI) = ratio between feedforward and feedback (*Bastos et al., 2015*)



## Results (1) - Power

### Gamma (40-70Hz) Power

### Alpha (8-13Hz) Power

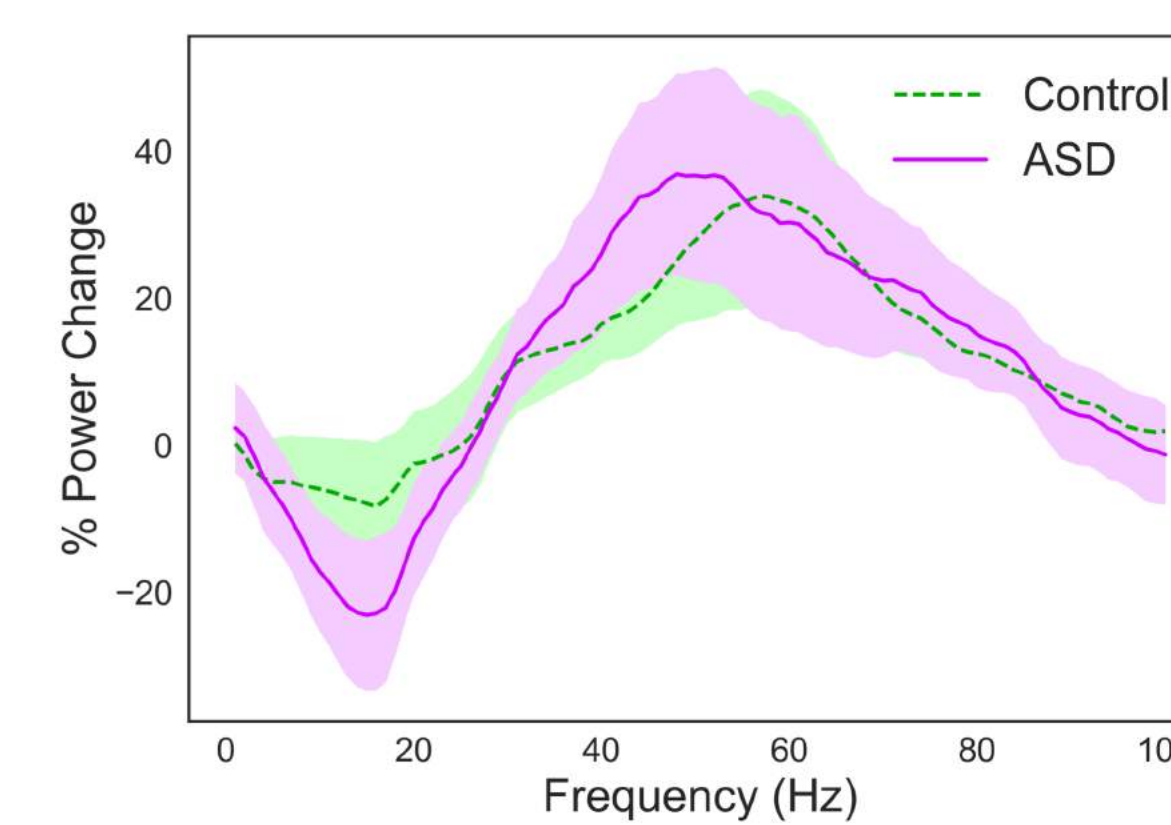
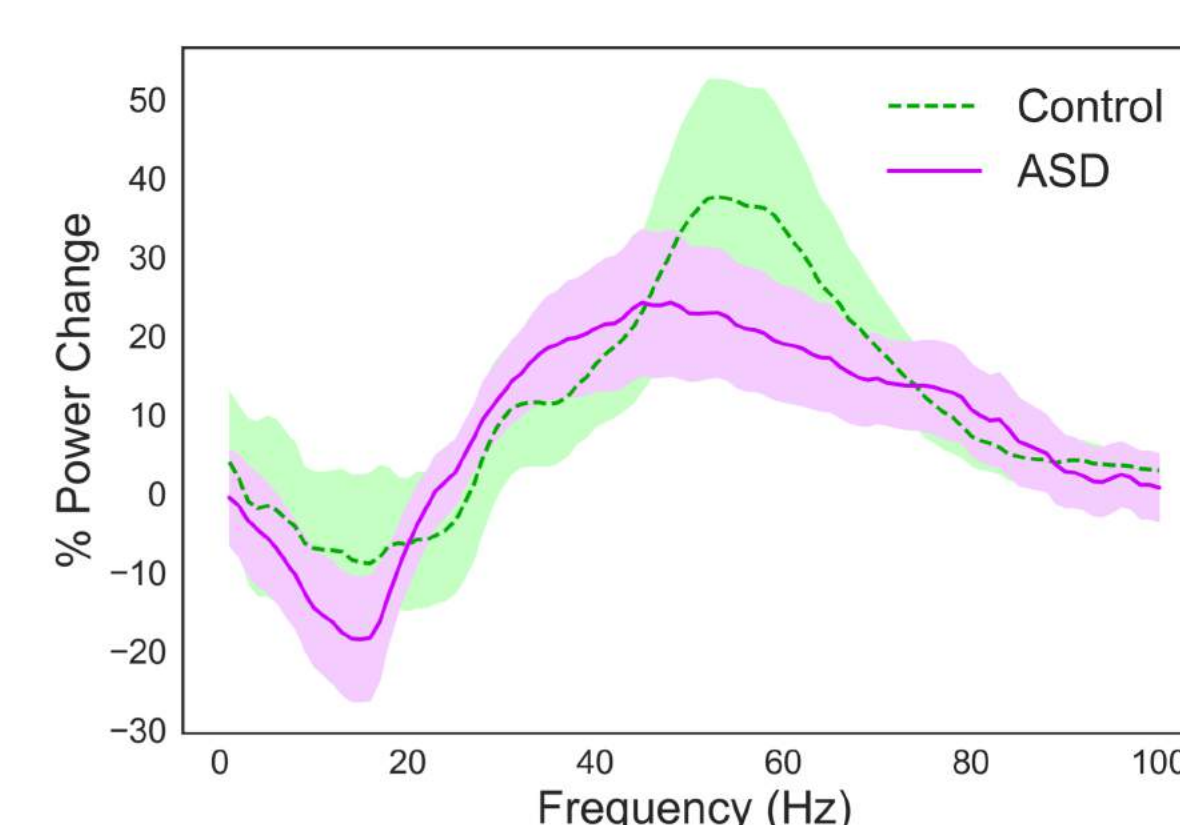


t-value  
0 5.3

t-value  
0 -6.6

### V1 Power

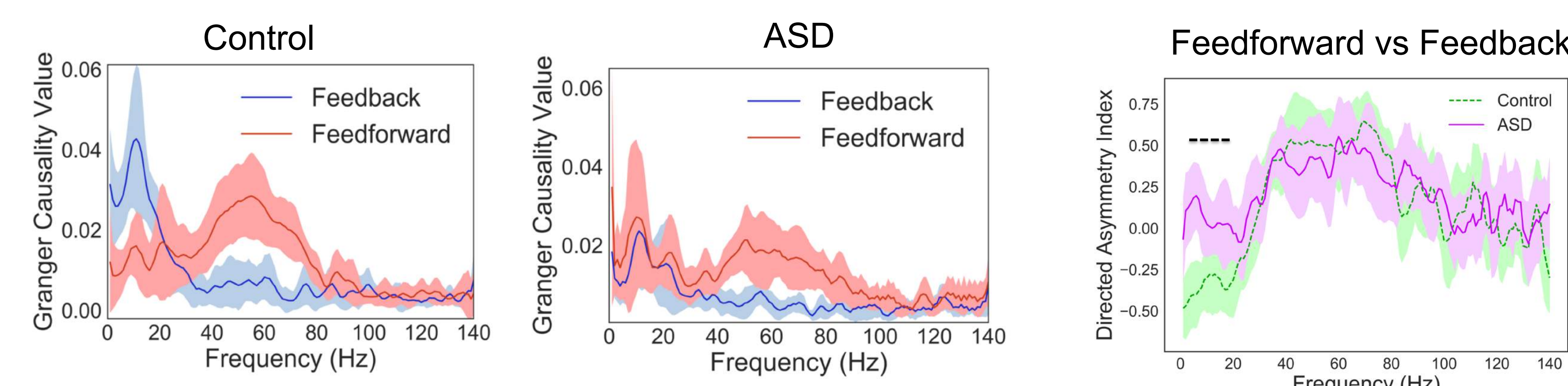
### V4 Power



No statistical differences between **alpha** or **gamma** power in source-space between groups

## Results (2) - Connectivity

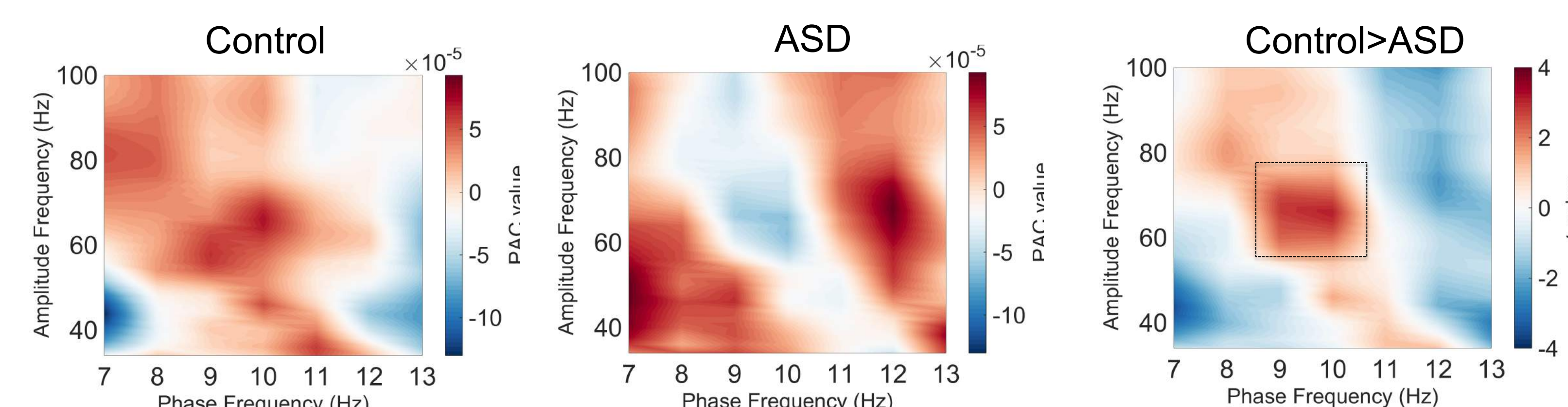
### V1-V4 Feedforward/Feedback Connectivity



ASD group = typical feedforward **gamma-band**...

But reduced feedback connectivity, especially in the **alpha-band**

### V1 Alpha-Gamma Phase Amplitude Coupling (PAC)



Higher PAC frequencies for ASD group

Dysregulated oscillatory activity and an excitation-inhibition imbalance?

## Conclusions

- This work suggests that the complex interplay of **alpha** and **gamma** oscillations within the human visual system are dysregulated in autism.
- The ASD group showed typical patterns of oscillatory power and feedforward connectivity, but **dysregulated oscillatory coupling between frequency bands (PAC)** and **reduced feedback alpha-band connectivity**.
- Local V1 PAC and V1→V4 feedback connectivity are not linked in the ASD group, suggesting that the visual system is locally **segregated** in autism.
- These findings have implications for emerging neurocognitive theories of atypical sensory processing in autism.



## Acknowledgments

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