

Investigating Predictive Processing of Low-Contrast Stimuli using Psychophysics and fMRI

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Predictive processing as a function of the visual system

- The brain uses context to make predictions about the visual environment^{1,2}.
- Predictions are fed down the visual hierarchy and used to process current and upcoming sensory information^{3,4,5}.
- We previously found evidence of feedback signals in V1 in the absence of feedforward visual stimulation^{4,5}.
- There is evidence for amplification and predictive coding accounts of BOLD response to predicted information^{6,7,8}.

Q: How does context influence the processing of degraded visual information?

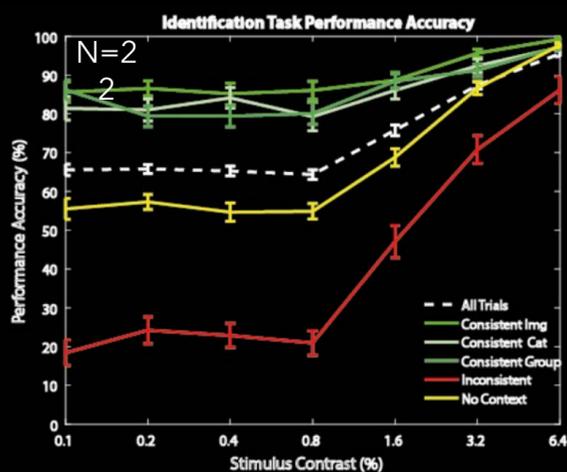
Paradigm

- Partial occlusion paradigm with full-contrast surround and low-contrast target region ('frosted screen occlusion').
- Manipulated consistency between surround and target to investigate how different contextual information (in surround) influences processing of low-contrast target stimulation.
- Task: To identify the low-contrast target region scene.

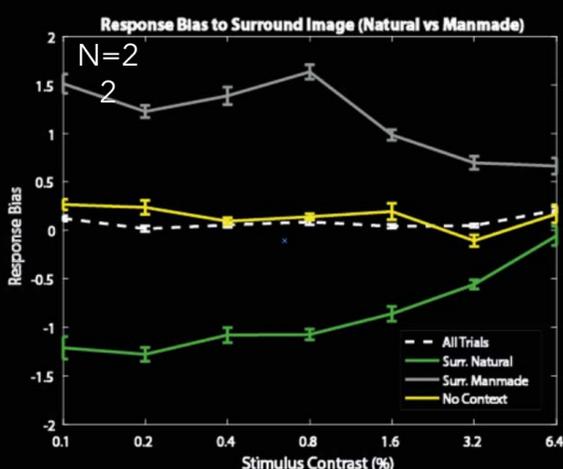


Psychophysics: Context influences the identification of low-contrast information

- Consistency of contextual information in the surround influences the ability to identify the low-contrast scene.
- Compared to having no context, consistent information in the surround improves identification accuracy whereas inconsistent information hinders performance.



Could this consistency effect be explained by a response bias towards the image in the surround?

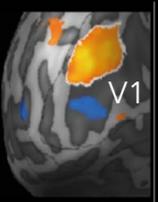


We are looking at response bias towards the image in the surround (criterion of SDT). Results suggest that subjects are more likely to respond that the target image is natural when the surround is natural and manmade when the surround is manmade. i.e. their response is biased toward the surround.

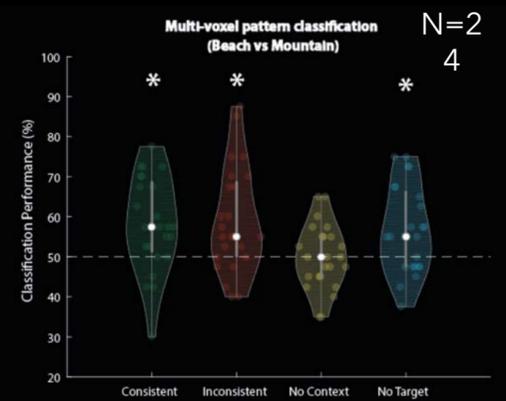
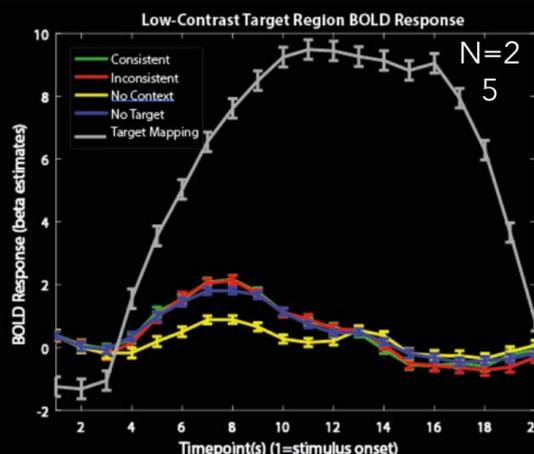
Behaviourally there is little evidence that perception is influenced by top-down influence from the surround - but we show a large response bias.

Do we find neuronal level evidence for an (in-)consistency effect?

fMRI: Feedback signals are present at the neuronal level but their consistency doesn't influence the response



- Same task as psychophysics (except beach vs mountain stimuli).
- One contrast level (subjects' 50% contrast threshold).
- Looked at BOLD response amplitude and MVPA.



- No sig. difference in BOLD response amplitude between consistent and inconsistent conditions.
- Lower BOLD response for no context condition, suggesting presence of feedback signals drives some of the BOLD response in the target region.
- At the target location we are able to decode the context (high-contrast surround).
- The target (low contrast) is too weak to be used by classifier (no context).
- No sig. difference in decodability between consistent and inconsistent conditions (the surround is probably used for decoding in both of these conditions).

Conclusions:

- Psychophysical results suggests consistency of the contextual information influences ability to identify degraded feedforward input.
- However, part of this effect could be driven by a response bias toward the surround.
- fMRI results provide evidence of feedback signals in V1.
- The feedback may contain the high-contrast surround information (cross-classification needed to confirm this).
- There is no distinction between consistent and inconsistent conditions in terms of BOLD amplitude or voxel response pattern.

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