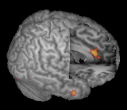

Semantic context and visual feature effects on verbal self-monitoring measured with Arterial Spin Labelling

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BACKGROUND

In object naming tasks, the semantic context in which items are presented influences naming latencies. When items are blocked within object category (homogeneous context), naming takes longer when compared with items blocked between category (heterogeneous context).[1]

Investigating the neuroanatomical correlates of this effect may inform us about the cognitive mechanisms responsible for this difference in behavioural performance.

Potential mechanisms include either inhibition or excitation of lexico-semantic representations, or incremental learning of associations between semantic features and names.[1]

The effect is also hypothesised to increase demands on verbal self-monitoring during speech production. However, the visual similarity of within category items may also influence naming latencies.

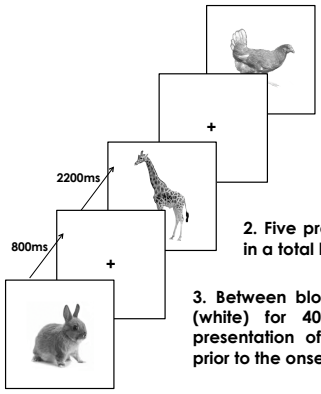
These different mechanisms provide competing anatomical hypotheses:

ANATOMICAL HYPOTHESES

1. Excitation or inhibition of lexico-semantic representations should respectively increase or reduce rCBF in the left middle temporal gyrus.[2]
2. Conversely, an effect of incremental learning via associative encoding should be observed in the medial temporal lobe (hippocampus).[3]
3. Verbal self-monitoring is thought to involve the left middle-posterior superior temporal cortex.[2]
4. Visual feature similarity has been reported to modulate signal in the anterior medial temporal lobe (in particular perirhinal cortex[4]).

METHOD

- 18 subjects were scanned using perfusion fMRI on a Bruker Medspec 4T system equipped with a TEM head coil, and 8 people participated in a behavioural experiment identical to the fMRI paradigm.
- Subjects overtly named objects presented in either homogeneous or heterogeneous blocks. Responses were recorded.
- There were 50 stimuli in total, taken equally from 5 object categories: animals, fruits, vegetables, clothing & vehicles. 50% of stimuli were visually similar, 50% were visually dissimilar, based on published feature norms.[5]
- The context and visual feature manipulations resulted in 4 conditions:
  1. Homogeneous (i.e. within category) blocks comprising 25 visually similar objects (HomV+)
  2. Homogeneous blocks comprising 25 visually dissimilar objects (HomV-)
  3. Heterogeneous (i.e. between category) blocks comprised of the 25 visually similar objects from condition 1 (HetV+)
  4. Heterogeneous blocks, comprised of the 25 visually dissimilar objects from condition 2 (HetV-)



1. A stimulus was presented on the screen for 800ms then replaced immediately by a centrally positioned black fixation cross for 2200 ms.

2. Five presentations per block resulted in a total block time of 15 seconds.

3. Between blocks, the screen was blank (white) for 4000 ms, followed by the presentation of a fixation cross 1000 ms prior to the onset of the next block.

4. There were 80 blocks in total, counter-balanced within and between subjects.

PREPROCESSING

The perfusion time series was obtained through pairwise subtraction of temporally adjacent tagged and non-tagged perfusion images.[6] Preprocessing involved realignment using INRIalign[7], co-registration to each subject's T1, normalisation to the MNI template, and smoothing at 10mm FWHM in SPM5.

DATA ANALYSIS

Each trial type was modelled independently at the first level. Contrast images for each condition relative to baseline were then fed into a second level 2x2 ANOVA modelling context (Hom vs Het) and visual similarity (V+ vs V-).

REGIONS OF INTEREST

A priori defined ROIs were constructed based on probabilistic atlases for left superior temporal gyrus (STG), left middle temporal gyrus (MTG), bilateral hippocampus and bilateral perirhinal cortex.[8,9] Results are reported at p<.05 corrected across the whole brain and in the ROIs.

BEHAVIOURAL RESULTS

The behavioural study analysis revealed a significant effect of context, with naming in the homogeneous context taking on average 69ms longer. There was no effect for visual features and no interaction.

PERFUSION RESULTS

– CONTEXT EFFECT IN LEFT STG

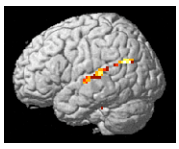
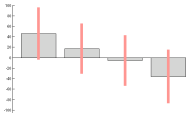


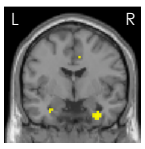
Figure shows perfusion signal in left superior temporal cortex for naming in homogeneous relative to heterogeneous blocks. Increased signal rendered on the MNI surface template (render at p<.001 unc.).

Plot shows the mean centred effect size at the peak voxel [-66,-30,12].



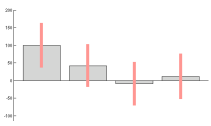
PERFUSION RESULTS

– CONTEXT EFFECT IN HIPPOCAMPUS



Increased perfusion signal in the hippocampus ROI for homogeneous relative to heterogeneous blocks. Signal rendered on an averaged T1 coronal section of the standardised brain (render at p<.001 unc.).

Plot shows the mean centred effect size at the peak voxel [33,-6,-33].



PERFUSION RESULTS

- INTERACTION WITH VISUAL FEATURES

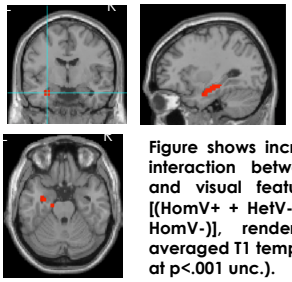


Figure shows increase for the interaction between context and visual feature similarity [(HomV+ + HetV-) > (HetV+ + HomV-)], rendered on an averaged T1 template (render at p<.001 unc.).

Peak in perirhinal cortex ROI marked with crosshairs at [-30,-6,-24] on coronal slice.

SUMMARY & CONCLUSIONS

- Blocking items according to semantic category resulted in increased naming latencies, consistent with previous literature. [1]
- This semantic context effect was associated with significantly increased perfusion signal in the left middle to posterior superior temporal gyrus – a region associated with verbal self-monitoring. [2]
- No perfusion changes were observed in the left middle temporal gyrus ROI. This is not consistent with proposals that the semantic blocking effect occurs via inhibition or excitation of lexico-semantic representations.
- Instead, we report increased signal bilaterally in the hippocampal ROIs, suggesting that the functional mechanism underlying the blocking effect is incremental learning of associations between semantic features & names.[1]
- Although naming latencies were not modulated by the number of shared visual features within a block, there was an interaction with the context in which items were presented at the anatomical level, manifesting as perfusion increases in the anterior MTL including our ROI in left perirhinal cortex.

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