Is fusiform activation to animals driven by the stimulus or process?

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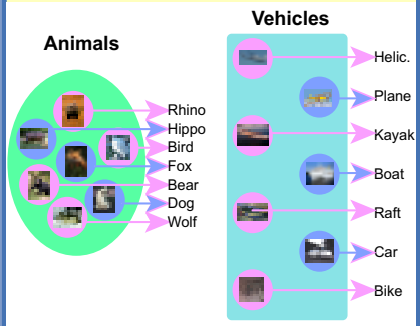
Introduction

There is growing evidence from functional imaging studies that distinct regions in the fusiform gyri are differentially sensitive to object category. Pictures of animals tend to increase activation in lateral posterior fusiform areas relative to tools, and the reverse contrast results in medial fusiform activations (Chao et al., 1999). Such results are often taken to reveal something about the kind of information stored by different brain regions. For instance, the lateral fusiform may show more robust activation for animals than tools because it codes domain-specific representations (Caramazza & Shelton, 1998); or because it codes visual features typical of animals but not tools (e.g. Martin and Chao, 2001).

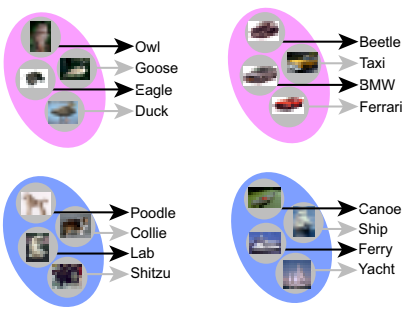
An alternative hypothesis

Another possibility is that such apparent domain effects arise from processing demands that are jointly determined by representational structure and the particular task being performed. For instance, at an intermed-iate or "basic" level of classification, dif-ferent animals tend to have more visual and semantic attributes in common than do different artifacts. Hence, animals may be more difficult to discriminate on visual or semantic grounds, at this level of specificity.



1. At an intermediate or "basic" level of classification, animals may be more difficult to discriminate than artifacts.

However at a more specific level of classification, such "structural" differences between domains are attenuated. A subordinate concept such as BMW has many neighbours with similar visual and conceptual properties (i.e. other kinds of car), just as do subordinate concepts in the domain of animals (e.g. different kinds of bird).

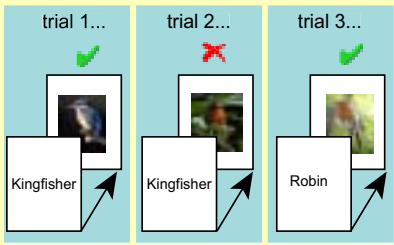


2. At more specific levels, artifacts are as difficult to discriminate from one another as animals.

The experiment

In the current experiment, we asked participants to categorise colour photographs of different birds, dogs, cars, and boats, at three different levels of specificity. If animal-related activity in the lateral fusiform results from the kind of information encoded there, domain effects should be observed in all three conditions. If such activity arises from processing demands exerted by domains with different degrees of similarity structure, domain effects should interact strongly with level of specificity.

Procedure

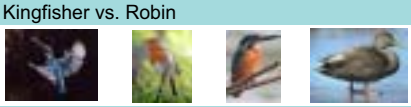


For each trial in an experimental block, participants viewed a printed word followed by a colour photo-graph, and indicated by button-press whether the object in the photo matched the word. For baseline trials, participants viewed scrambled pictures and pressed a button. 9 experimental and 3 baseline trials were administered to 12 participants in total.

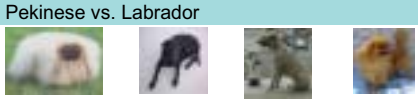
Stimuli and experimental details

Specific condition

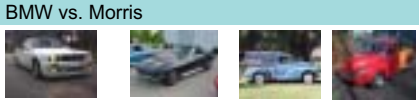
Kingfisher vs. Robin



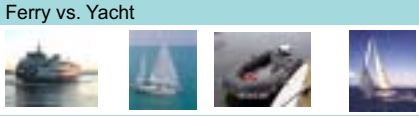
Pekinese vs. Labrador



BMW vs. Morris

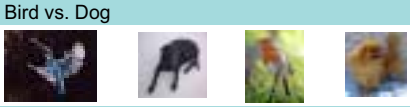


Ferry vs. Yacht

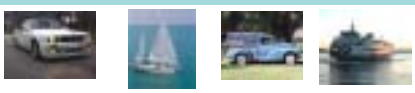


Basic level condition

Bird vs. Dog

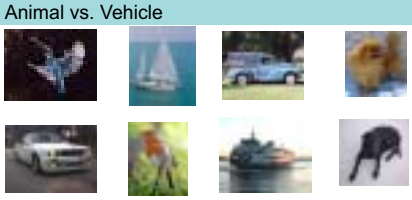


Car vs. Boat



General condition

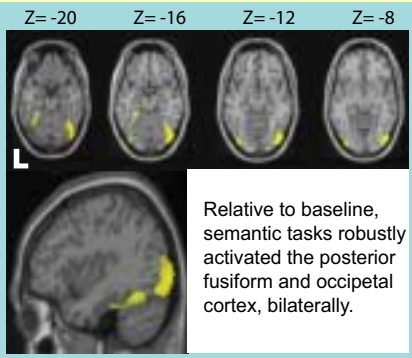
Animal vs. Vehicle



- Two different category names were used within each experimental block.
- Category labels were either general names (e.g. animal/vehicle), basic names (e.g. dog/bird), or specific names (e.g. labrador/pekinese).
- Collapsing across blocks in each condition, exactly the same set of 48 photographs was viewed in all 3 conditions, half animals and half vehicles.
- Each participant was scanned once per block with PET.
- Data were analysed using standard procedures in SPM99.
- Statistical analyses focused on effects of domain (animal vs. vehicle) and the interaction of domain with task condition (General/Basic/Specific).

Results

All semantic tasks - baseline

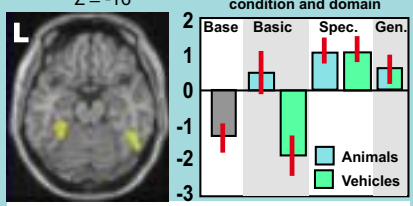


Relative to baseline, semantic tasks robustly activated the posterior fusiform and occipetal cortex, bilaterally.

Main effect: Animals > Vehicles

Animals activated the lateral fusiform cortex more robustly than vehicles overall, consis-tent with past studies (Martin & Chao,2001)...

Interaction with task condition



...but this effect interacted with task condition. In the basic-level condition, the lateral fusiform was more activated for animals than for vehicles. In the specific condition, it was strongly and equivalently activated for both kinds of objects. We cannot tease apart domain effects in the general condition, because participants viewed both animals and vehicles within a single block. However, the lateral fusiform was strongly activated in this condition as well.

Conclusions

The experiment revealed robust activation in the posterior and lateral aspects of the fusiform gyrus, in a category verification task involving animals and vehicles. When participants categorised objects at the basic level, this activation appeared to be specific to animals. When categorising the same objects at a more specific level, the region responded strongly to both animals and vehicles, and no domain effect was observed. Thus domain-specificity in the lateral fusiform may not indicate that this region responds selectively to animals, or to visual attributes typical of animals. Instead, apparent domain-specific activation may arise from the processing demands of the task, coupled with the similarity structure of the representations coded in this region of cortex (Humphreys, Riddoch & Price, 1997). When the tasks requires participants to discriminate amongst items with similar visual or semantic representations, the fusiform is likely to be activated.

References

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Chao, L., Haxby, J. & Martin, A. (1999). Attribute-based neural substrates in temporal cortex for perceiving and knowing about objects. *Nat-Neurosci*., 2(10), 913-9.

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