Perceiving and naming actions and objects

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The existence of patients in whom focal brain damage is combined with selective impairments of grammatical categories has led to the suggestion that there are distinct cortical areas for processing verbs and nouns

Lesion data has implied a link between left frontal areas and verb processing, whereas noun processing seems to depend on the integrity of left temporal areas
Nouns and verbs are distinguished in the brain on the basis of their semantic properties, nouns typically referring to objects and verbs to actions.

In the present fMRI experiment, healthy subjects were asked to silently name actions and objects that were presented as simple line drawings. We used two sets of pictures, one depicting actions performed on/with objects and the other displaying only the objects. Subjects named both actions and objects from the action images, and objects from the object images. Actions were not named from pictures with isolated objects, as this task would require the subject to make inferences about the actions, a process not required in object naming. This design addresses the following questions:
(i) Do action and object naming activate different cortical regions when the stimulus is identical?
(ii) How does the content of the image (with/without action) modulate the brain correlates of object naming?
The task was to silently name actions or objects from simple line drawings. Two sets of images were used, each with 100 scenes. Action images illustrated a simple event (e.g. to write with a pen) whereas object-only images consisted of objects from the same images when the action had been dissolved into arbitrary lines in the background, in order to keep the visual complexity of the image unchanged.

The corresponding object and action words were mostly of medium to high frequency in the Finnish language.

The verb and noun corresponding to one image always had different word stems.
The experiment consisted of three conditions: (i) action naming from action images (Act), (ii) object naming from action images (ObjAct), (iii) object naming from object-only images (Obj).

Task periods (30 s) and rest periods (21 s) alternated in a block design. There were two sessions, each lasting about 13 min.

In order to avoid movement artifacts the participants were instructed to name the actions or objects silently. Subjects were asked to keep their eyes straight ahead during the rest condition and not to move during the experiment.

**Results:** A similar network of cortical areas was activated in all three conditions, including bilateral occipitotemporal and parietal regions, and left frontal cortex.
The occipitotemporal cortex and the fusiform gyrus were activated bilaterally in all conditions. When actions or objects were named from action images (Act and ObjAct) the activation additionally encompassed the left posterior middle temporal cortex. Activation was seen in the left inferior frontal gyrus in all tasks. In both action and object naming from action images (Act and ObjAct) the activation centered in the operculum of the inferior frontal gyrus and extended superiorly to include the precentral gyrus and anteriorly to BA 47. The frontal activation was less pronounced when objects were named from object-only images (Obj), mainly encompassing the inferior frontal region.
Naming objects from the images with action context compared to naming the same objects from object-only images (ObjActNObj, Fig. 3B) resulted in significantly stronger activation in a large mostly left-lateralized network, including the precentral gyrus (BA 6/9), the inferior frontal gyrus (pars opercularis and triangularis), the inferior and superior parietal lobules (BA 7/40), and the posterior middle temporal gyrus. Naming actions compared to naming objects from object-only images (ActNObj, Fig. 3C) revealed enhanced activation in the left supramarginal gyrus (parieto-temporal junction; BA 40), left and right posterior middle temporal cortex, left precentral gyrus and superior medial frontal gyrus.

Our results indicate that action and object naming engage a common cortical network, but that the provided input (action pictures, object-only pictures) and the requested output (verb, noun) influence the level of activation in a subset of areas within that network.

The stronger activation in naming objects from pictures with action context, relative both to naming actions from the same images and to naming objects from object-only pictures, suggests involvement of additional task-specific processes.
We found no regions specific to nouns as a grammatical category. Our results agree with a recent study showing that when naming events either as verbs or nouns from identical images, no differences were found between verbs or nouns as grammatical categories.

Our results converge with previous evidence showing that retrieval of verbs and nouns in the healthy human brain using identical stimuli in a picture naming task engages a similar distributed cortical network, as measured with BOLD fMRI. Importantly, however, the content of the image (action vs. object only) had a pronounced effect on the activation in parts of that network that have previously been implicated in processing of action knowledge. Furthermore, object naming in the context of action revealed additional activations, both in comparison to verb retrieval from the same set of images, and in comparison to noun retrieval from images not depicting action, suggesting that attention may be more directed towards motor-based properties of objects when they are presented not as single entities but as part of images that also depict the relevant action.