Cross-modal object processing in three different anterior temporal regions

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BACKGROUND
- Functional brain imaging of normal subjects, as well as neuropsychological data, have demonstrated the critical role that the anterior temporal lobes play in object processing.
- Here, we investigate whether placing different demands on object discrimination processes in normal subjects differentially engages one or more of these anterior temporal regions.

METHOD EXPT 1: AUDIOVISUAL MATCHING
- 18 subjects were scanned with fMRI using a block design.
- Subjects responded to successively presented auditory and visual stimulus pairs with a match/no-match decision (key press). There were 6 presentations per block: 3 congruent and 3 incongruent, with 24 blocks in total.
- 108 stimuli from 3 object categories (animals, objects, musical instruments) were presented in 4 ways: pictures of objects, written names, environmental sounds, auditory names. This resulted in 2 different crossmodal conditions (written names & sound/visual names).
- To reduce the sensory differences between different types of stimuli, each meaningful stimulus was presented with a simultaneous meaningless stimulus in the opposite modality.

METHOD EXPT 2: TACTILE-VISUAL MATCHING
- 18 subjects were scanned with fMRI using a block design.
- Subjects responded to successively presented tactile and visual stimulus pairs with a match/no-match decision (foot movement). There were 6 presentations per block: 3 congruent and 3 incongruent, with 32 blocks in total.
- There were two types of stimuli: visual silhouette abstract shapes or a silhouette circle, and 2-dimensional wooden block shapes or spheres.
- Tactile stimuli were presented by the experimenters to either the left or the right hand of the subject. Visual stimuli were presented either left or right of a central fixation point. This resulted in four different combinations of cross-modal trials balancing left/right hand and left/right side of screen. A control circle/sphere was presented in the opposite hand/screen side in each trial.

ANALYSIS & CONTRASTS
- Data were pre-processed and analysed with SPM2 using standardised procedures.
- The contrast of interest from each experiment was the difference between activation for congruent versus incongruent trials.
- These two contrasts were combined in a second level ANOVA modelling the effect of congruency in the combined audiovisual (AV) crossmodal conditions and the combined tactile-visual (TV) crossmodal conditions. This ANOVA allowed us to test for the main effect of congruency and its interaction with experiment (AV versus TV).
- A small volume correction was used (sphere 12mm) in a region of interest based on the coordinates of peak atrophy in patients with semantic dementia.

CONCLUSIONS
- We have dissociated three functionally different anterior temporal regions, demonstrating different responses properties to perceptual and semantic inputs:
  1. The left temporal pole is involved in successful integration of input from distributed regions of modality-specific cortex and is engaged when inputs can be successfully combined into a perceptual or semantic 'whole', independent of meaning or the modality of input.
  2. In lateral temporal cortex, the lack of congruency effect during tactile-visual shape matching experiment suggests that this region is primarily concerned with conceptual processing, or not responsive to tactile input.
  3. In medial temporal cortex the contrasting effects suggest a different role in the object processing hierarchy: discrimination of a perceptual whole (higher activation for matching tactile visual inputs) and signalling a mismatch in conceptual inputs (higher for incongruent audiovisual matching).

REFERENCES