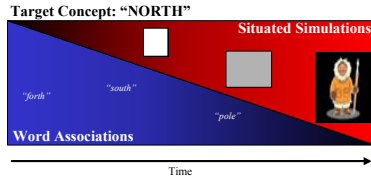


BACKGROUND

**Hypothesis**

Processing the word for a concept (e.g., "NORTH") typically activates two types of information:

- Word associations**
  - An initial burst of associated words, primarily their linguistic forms, with minimal activation of meaning.
- Situated simulations**
  - The word for a concept also activates a multi-modal simulation of a concept instance, not represented in isolation, but situated in a real-world context.



**Previous Evidence**

**Evidence for word associations in conceptual processing**

- Glaser (1992) concluded that words activate superficial word forms initially, and that people often rely on them in conceptual tasks, when conditions permit.
- Solomon and Barsalou (in press) found that participants use a fast word-based strategy in the property verification task when task conditions permit. When task conditions block this strategy, participants utilize slower perceptual simulations instead.
- Kan et al. (2003) replicated Solomon and Barsalou (in press) in fMRI.

**Evidence for situated simulations in conceptual processing**

- Behavioral evidence indicates that people run multi-modal simulations to perform higher cognitive tasks, such as conceptual processing and language comprehension. Variables such as occlusion, size, shape, orientation, direction, and perspective affect these processes (for reviews, see Barsalou, 2003; Barsalou et al., 2003a,b).
- Neural evidence similarly implicates modality-specific processing in conceptual tasks (for reviews, see Barsalou, 2003; Martin, 2001).

**The Current Study**

**Property generation (PropGen) task:** Participants silently generated the "properties typically true of a concept" for each of 30 concepts, for 15 sec each, in a blocked design.

**Word association (WA) task:** Participants silently generated word associates to each of 24 concepts, for 5 sec each.

**Situation generation (SIT) task:** Participants silently imagined a situation in which each of 6 concepts could occur, for 15 sec each.

*Note: The word association and situation generation tasks were performed in a scan session scheduled one week after the session when the property generation task was performed.*

**Specific Predictions**

- Common activation between property generation and word association.**
- Common activation between property generation and situation generation.**
- Word association tends to precede situation generation.** Each 15 sec property generation trial was divided in half to create the **EARLY property generation period** and the **LATE property generation period** (7.5 sec each). Word association areas should primarily be active during the early period, whereas situation generation areas should primarily be active during the late period.
- A concept's "word associativeness" correlates only with word association activation.**

RESEARCH DESIGN

**Image Acquired in a 3T Siemens Trio Scanner**

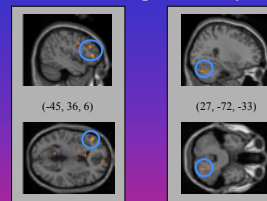
- 10 right-handed subjects
- In Session 1, data collected in 5 runs, each lasting 4 min 45 sec
  - In Session 2, data collected in 1 run, lasting 7 min 40 sec
- In Session 1, 114 T2\*-weighted gradient echo recalled MR scans depicting BOLD contrast
  - In Session 2, 184 T2\*-weighted gradient echo recalled MR scans
- In both Sessions 1 and 2:
  - 28 contiguous 4 mm thick slices in the axial plane
  - Imaging protocol employed a TE = 35 ms, TR = 2500 ms, flip angle = 90°
  - Voxel size = 3 X 3 X 4

**Image Analyses**

- Realignment, normalization, and spatial smoothing (using an 8 mm isotropic Gaussian kernel) conducted in SPM99.
- Individual subjects' data were modeled using a general linear model with a boxcar function convolved with a hemodynamic response function.
- Random effects analyses performed on the subjects' contrast images. All activations shown here are significant at  $p < 0.005$  (uncorrected) unless otherwise noted.

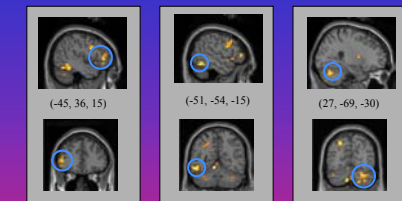
**Prediction 1**

PropGen Early – PropGen Late



Among other regions, BA 45 (Broca's area) is more active early in PropGen (above), while precuneus, right middle temporal and middle frontal gyri are more active later in PropGen (below).

Word Association – Situation Generation



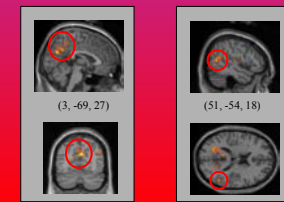
Activity in left BA 45, left inferior temporal, and right cerebellum is associated with word association, while situation generation is associated with precuneus and right middle temporal gyrus activity.

**Prediction 2**

PropGen Late - PropGen Early



Situation Generation – Word Association

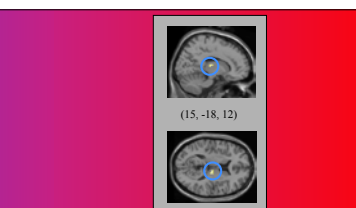
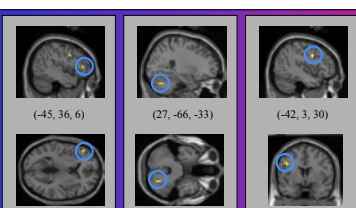


**Prediction 3**

PropGen Early – PropGen Late Mask

PropGen Late – PropGen Early Mask

WA - SIT



SIT – WA



Word association areas in left BA 45, right cerebellum, and left precentral gyrus are active early in PropGen, while only one word association region, in the thalamus, is active later. In contrast, no situation areas were active early in PropGen, but the precuneus, right middle temporal and right middle frontal gyri were all active later in PropGen.

**Prediction 4**

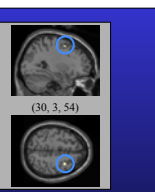
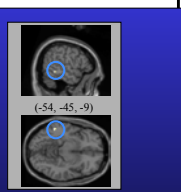
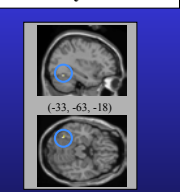
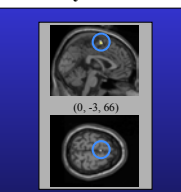
PG Early "+" Mask

PG Early "-" Mask

PG Late "+" Mask

PG Late "-" Mask

WA – SIT



SIT – WA



Activity in several brain regions was correlated with word associativeness. As predicted, some of these regions fell in word association areas, including midline supplementary motor area, left fusiform, inferior temporal, and right middle frontal gyrus. Importantly, no situation areas were located in regions whose activity correlated with word associativeness.

CONCLUSIONS

- Property generation includes word association.** Many areas active in both tasks are commonly observed in imaging studies of language processing.
- Property generation includes situation generation.** Areas active in both tasks are frequently observed in imaging studies of episodic retrieval and the "rest-circuit".
- Word association precedes situation generation.** Word association areas were primarily active early in property generation, whereas situation generation areas were primarily active later.
- A concept's "word associativeness" correlates only with word association activation.** As a concept's "word associativeness" increased, greater activation in word association areas—but not in situation generation areas—occurred.

IMPLICATIONS

**Theoretical:** Conceptual processing typically includes two types of processing: word association and situated simulation.

**Methodological:** When measuring conceptual processing, be aware that conceptual tasks can activate either or both types of information. If deeper conceptual knowledge is of interest, ensure that the task cannot be performed using only word associations. Many previous tasks in the literature may have primarily tapped this process.

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