



The effect of manipulation features on lexical semantic processing: An eyetracking study on normal and brain-damaged populations

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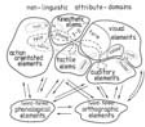
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Goal of Research

- To investigate:
 - whether manipulation features are an *intrinsic* part of the lexical-semantic representation of objects and
 - whether there is a link between the *physical* manipulation of objects and their *lexical-semantic* representation.

Background

- A current theory of distributed semantic representation claims (Allport, 1985):



The semantic representation of concrete objects reflects the extent to which the sensorimotor systems are involved during initial acquisition and further elaboration.

- Consistent with this, neuroimaging studies have found increased neural activations in sensory-motor areas during the retrieval or recognition of manipulable objects such as tools and utensils (e.g., Martin et al., 1996):



(Modified from Martin & Chao, 2001)

Yet, there is no direct *behavioral* evidence showing sensitivity to manipulation features.

- Studies on apraxia, a specific deficit of object-related movements, showed that apraxic patients are impaired at making an explicit judgment on object manipulation features, suggesting a relationship between physical object-related movements and knowledge about them (e.g., Buxbaum et al, 2000).

However, these results are from an *explicit* task where participants were *explicitly* asked to access manipulation knowledge. Thus, it is not clear whether this knowledge is also accessed *without conscious effort*, reflecting its status as an *intrinsic* part of the lexical-semantic representation of objects.

Questions

- Would participants show the effect of manipulation features in an implicit task where they are not required to access those features specifically?
- Would apraxic patients show a deficit in the lexical-semantic processing of manipulation features in an implicit task as well?

Experiment 1

Method

- 30 participants were presented with four pictures on a 3 x 3 array and asked to touch the target picture matching the concurrent auditory input.
- Two conditions:
 - Experimental Condition (Fig. 1a):
Target, manipulation-related competitor and 2 unrelated **distractors**
 - Visual Control Condition (Fig. 1b):
In order to assure that the results are not due to the visual similarity among manipulation-similar objects.

Target, visual control and 2 unrelated **distractors**

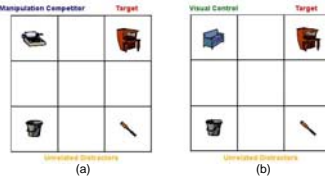


Figure 1. Example display of each condition

- 10 experimental trials, 10 visual controls, 40 fillers
- Eye movements and screen touches recorded using EyeLink I and an Elo Entuitive touch screen monitor

Predictions

- Manipulation-related competitors** will draw more looks than unrelated **distractors** or **visual controls**.

Results

- Manipulation-related competitors** were fixated significantly more often than unrelated **distractors** ($p = .017$) (Fig. 2a) or **visual controls** ($p = .04$) (Fig. 2a & 2b).

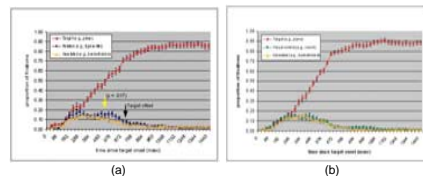


Figure 2. Proportion of fixations on each picture type in each condition

- Given the average target duration of 701 ms and the average eye movement launching time of 180 ms, the manipulation-related effect, which started around 500 ms, emerged around 300 ms after target onset.

Experiment 2

Method

- 5 apraxic patients and 5 brain-damaged controls
- Both patient groups had lesions involving the left frontoparietal area.
- Neuropsychological and language tests:
 - Aphasia: Boston Diagnostic Aphasia Examination (BDAE), Western Aphasia Battery (WAB)
 - Apraxia: Florida Apraxia Battery (FAB)
- Materials and Procedure as in Experiment 1 except:
 - 4 new trials were added to each condition for apraxics.
 - General Semantic Condition (e.g., target: pants, competitor: shirt) was added for apraxics in order to assure that the results are not due to general semantic deficits.

Predictions

- Apraxic patients will show a deficit in fixating on the manipulation-related items in comparison with their brain-damaged controls.

Results

- Although both patient groups showed an effect of manipulation similarity, the manipulation-related effect occurred far later in the apraxic group than in the control group (1060 ms vs. 830 ms) (Fig. 3a & 3b).
- In addition, unlike the young normal participants in Exp. 1, both patient groups showed an effect of visual similarity (Fig. 4a & 4b).

Experimental Condition:

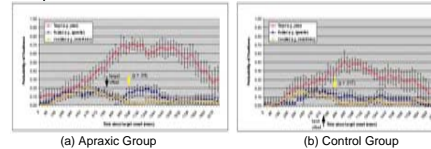


Figure 3. Proportion of fixations on each picture type in Experimental Condition

Given the average target duration and the average eye movement launching time, for the control group the effect emerged before the target offset (around 650 ms), while for the apraxic group it emerged 100 ms after the target offset (around 880 ms).

Visual Control Condition:

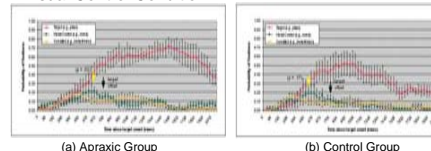
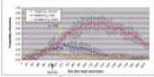


Figure 4. Proportion of fixations on each picture type in Visual Control Condition

- General Semantic Condition: The apraxics showed an effect before the target offset (around 460 ms).
- Thus, apraxics have a specific deficit of accessing manipulation features, which was manifested by a delayed time course. These results are consistent with Buxbaum et al.'s findings.



Summary & Discussion

- For normal participants, manipulation-related competitors drew more fixations than visual controls and unrelated distractors, suggesting that:
 - manipulation features are accessed in an implicit task
 - object concepts sharing manipulation features are interconnected in the lexical-semantic network.
- The effect of manipulation similarity emerged in both patient groups. Yet, the time course of manipulation feature activation was delayed in the apraxic group.
- Following Buxbaum et al.'s findings, the results suggest that apraxia is not simply a perceptuomotor deficit of movements, but results in a concomitant impairment in representing manipulation features and accessing them for cognitive processing. These findings are consistent with the view that perceptual and motor processes share resources and/or mechanisms with cognitive processes (e.g., Barsalou, 1999).
- The visual similarity effect in the brain-damaged population occurred earlier than the manipulation-related effect, suggesting different sources of these effects (perceptual vs. semantic).

References

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