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Hemispheric Effects of Canonical Views of Category Members with Known Typicality Levels

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Is there a preferred hemispheric canonical view of a concept? We investigated this question in a natural superordinate category membership decision task using a hemifield paradigm. Participants had to decide whether or not an image of an object lateralized in the left (LVF) or right (RVF) visual half-field is a member of a predesignated superordinate category. The objects represented high, medium, or low typicality levels, and each object had six different perspective views (front, front-right, front-left, side, back-left, and back-right). The latency responses revealed a significant interaction of Hemi Field × View × Typicality (there was no hemifield difference in accuracy). The findings confirm the presence of asymmetry in stored concepts in long-term memory and suggest, in addition, a hemispheric canonical view of these concepts, a view strongly related to typicality level. © 2001 Academic Press

Introduction

Previous hemifield experiments have shown that there is AN asymmetry in knowledge systems stored in long-term memory (LTM) (1–3). Are concepts in LTM stored/accessed selectively in each hemisphere as function of specific perspective views? It has been proposed that perceptual processes involved in object recognition rely on central structural representations of objects (4, 5). Recently, Barsalou proposed that the structural representations are multimodal and they underlie conceptual representations as well (6). To determine the hemispheric status of concept structural representation, the LTM knowledge system was probed here in each visual half-field in a category membership decision task using exemplars with different perspective views of the same object. Access to stored structural codes for the individual objects was assumed in either hemisphere based on previous findings (1–3).

The mind in the brain creates order from experience with the aid of organized knowledge systems stored in LTM (2). The same external experiences are available to both hemispheres but each is assumed to use its own specialized knowledge organization and its own strategies to process these experiences. Here we investigated the category organization.

If one considers that a specific object's perspective views are instances of an exemplar, then there should be better and worse views of the object or more and less typical views. The ''degree of canonicalness'' was shown to be correlated with speed of object identification (7). Does this apply to both hemispheres equally or not? In the present study, we apply the concept of canonicalness to object perspectives just as typicality is applied to exemplars of natural categories.

The study of the category knowledge system examines the relationships among single concepts by determining ''mental distances'' among members of a category. Reaction time (RT) paradigms are used to determine the mental proximity (6–8). Verification latencies in natural category membership tasks are considered to reflect the degree of similarity between items and the prototype invoked by the category concept because prototypical concepts have more attributes in common with other members of the category than the members have with each other (9). Here, latencies in membership decisions are extended to ''favored view'' of the exemplar.

Methods

Participants. Thirty right-handed students (16 females, 14 males) from an introductory psychology class or an upper-division cognitive psychology class received partial course credit for volunteering to participate in the experiment.

Apparatus. A Macintosh computer was used to display the stimuli in the left (LVF) and right (RVF) visual half-fields as well as to record the accuracy and reaction time (RT) responses.

Stimuli. Images were created using three-dimensional (3D) construction and rendering software. The objects were rendered in gray scale on a pale blue/green background (to minimize the possible effect of blurring of object borders into the background) in six different views: front (F), front-right (FR), front-left (FL), side (S), back-left (BL), and back-right (BR). The F and S views depicted the objects as they would appear with the center of the object at the viewers eye level. The off-center views (FL, FR, BR, and BL) were rotated 33.75° from center on the vertical axis and 45° from center on the horizontal axis. BR and BL views were rotated as described from the back view while the FR and FL views were rotated from the front view. The described rotations represent the view as seen from an individual viewing the center of the object (from the back or front) at eye level and moving to the left or right 45° and then up 33.75°. Table 1 describes the objects depicted as well as the typicality level for the ''Yes'' responses.

TABLE 1
Names of the Objects Belonging to the Categories in the Category Membership Decision Task

''Yes''		
High	Medium	Low
	Vehicle	
Car	Bicycle	Skates
Ambulance	Airplane	Raft
	Carpenter's tools	
Saw	Ladder	Wheelbarrow
Hammer	Wrench	Axe/hatchet

Procedures and Design

A red focal dot was displayed in the center of the computer screen and participants were instructed to fixate their gaze on the dot. A trial consisted seeing a natural superordinate category name, specifically either Furniture or Carpenters Tools in the center of vision, directly above the focal point, for 555 ms, and then, following a 1200-ms delay, seeing an image (described below) exposed briefly either in the LVF or in the RVF for a duration of 135 ms. The task for the participants was to decide with a key press whether or not the flashed image was a member of the predesignated category.

Categories were presented in blocks with all of the Carpenters Tools' images presented first, followed by all of the Vehicle category images. Within each category, two images were displayed for each typicality level; low, medium, and high. Half of the images displayed within each of the category blocks depicted objects belonging to the displayed category, i.e., ''Yes'' responses (Table 1). The other half of the images displayed in the category-block depicted images not belonging to the category such that the correct subject response was ''No.'' The ''No'' images consisted of animals and miscellaneous objects as listed below and were displayed in random order (animals: pig, dolphin, lion, horse, dog, deer; miscellaneous: whistle, telephone, suitcase, chess piece, camera, bell). Within each of the categories, typicality level and views were randomized along with the visual half-field in which the object was displayed, with the exception that objects were presented in a given visual field no more than three times in succession. There was a total of 144 trials (4 categories × 2 ''Yes'' and 2 ''No'' × 6 objects per category × 6 views per object). Within each sex, half of the participants used their right index finger and half used the left index finger to indicate their response.

Results

The accuracy rate to both ''Yes'' and ''No'' responses was high in both visual half-fields. The RTs to correct ''Yes'' responses were analyzed with a repeated-measures ANOVA with within-subjects factors of Visual Field (LVF, RVF), Typicality (low, medium, high), and View (front, front-right, front-left, side, back-left, and back-right). The ANOVA revealed a significant main effect for Visual Field ($F(1, 29) = 4.58$, $p < .04$) reflecting the fact that the mean RT was shorter in the RVF than in the LVF. A significant main effect also emerged for Typicality ($F(2, 58) = 22.72$, $p < .0000001$), reflecting a gradient of mean RT from fast responses to high typicality, followed by medium typicality, followed by slow responses to low typicality items. There was no main effect for View.

The interaction of Visual Field × Typicality was significant ($F(2, 58) = 6.73$, $p < .002$), as was the interaction of Visual Field × View ($F(5, 145) = 3.59$, $p < .004$). The nature of these interactions can be seen clearly in Figs. 1 and 2. The three-way interaction of Visual Field × Typicality × View was significant ($F(10, 290) = 2.82$, $p < .002$). This can be see in Figs. 1 and 2.

In view of the significant interactions with Visual Field, analyses for simple effects were applied to the RT data. The analyses revealed a faster RT to low typicality items regardless of view in the RVF compared to the LVF ($F = 13.19$, $p < .006$). There was no significant difference between LVF and RVF for high typicality items. Moreover, in the RVF the gradient of RTs to items as function of their typicality level was shallow (no significant difference between high versus low typicality) whereas in the LVF, there was a steep gradient between high and low typicality ($F = 49.4$, $p < .0001$). This can be seen in Fig. 1.

The analyses also revealed a significant difference between the two visual half-fields in two views, the side ($F = 12.02$, $p < .0007$) and the back-right view ($F = 4.33$, $p < .039$).

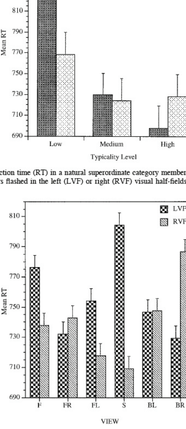

FIG. 1. Mean reaction time (RT) in a natural superordinate category membership decision task, with images of exemplars flashed in the left (LVF) or right (RVF) visual half-fields.

Discussion

The fact that we obtained significant statistical interactions between Visual Field and View suggests that each hemisphere could perform the task but the processing

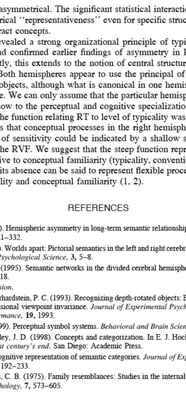

FIG. 2. Perspective views of exemplars of natural categories. Mean reaction time (RT) to exemplars as function of their perspective views. F, front; FR, front-right; FL, front-left; S, side; BL, back-left; BR, back-right.

was selectively asymmetrical. The significant statistical interactions support the notion of asymmetrical ''representativeness'' even for specific structural codes not just for generic abstract concepts.

The results revealed a strong organizational principle of typicality in the hemispheric LTM and confirmed earlier findings of asymmetry in knowledge systems (1–3). Importantly, this extends to the notion of central structural ''favored view'' representation. Both hemispheres appear to use the principal of favored view with regard to some objects, although what is canonical in one hemisphere is not in the other hemisphere. We can only assume that the particular hemispheric favored view is related somehow to the perceptual and cognitive specialization on that side.

The slope of the function relating RT to level of typicality was steeper in the LVF and this suggests that conceptual processes in the right hemisphere are sensitive to typicality. Lack of sensitivity could be indicated by a shallow slope, such as what we obtained in the RVF. We suggest that the steep function represents mechanisms which are sensitive to conceptual familiarity (typicality, conventionality, ''commonness'') whereas its absence can be said to represent flexible processes, i.e., those not bound by typicality and conceptual familiarity (1, 2).

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