Neuropsychologia 44 (2006) 1914–1918

NEUROPSYCHOLOGIA

www.elsevier.com/locate/neuropsychologia

The time course of spatial memory processing in the two hemispheres

Albert Postma [a,*], Rafaële J.C. Huntjens [b], Mariska Meuwissen [a], Bruno Laeng [c]

[a] *Psychological Laboratory, Helmholtz Institute, Utrecht University, The Netherlands*
[b] *Department of Clinical Psychology, Utrecht University, The Netherlands*
[c] *Department of Psychology, University of Tromsø, Norway*

Received 8 April 2005; received in revised form 1 February 2006; accepted 3 February 2006
Available online 13 March 2006

Abstract

Previous studies have shown that memories for positions are often distorted in systematic ways, indicating the influence of categorical positions codes which can bias responses in object-relocation tasks towards stored spatial prototypes. In the present study, we examined the time course of these categorical influences. Subjects had to relocate the position of a tachistoscopically presented dot within a circle, which could appear in either the left visual field (i.e. initially to the right hemisphere) or the right visual field (i.e. initially to the left hemisphere). Three retention intervals between presentation and relocation were used: 500, 2000 and 5000 ms. Performance was most accurate with left visual field/ right hemisphere presentation. Systematic distortions were found for angular errors (dot relocations regressed towards the 45° with a quadrant) as well as for radial errors (dots were replaced in the direction of the circle's circumference, and this more so when the dot was further away from the circumference). Importantly, these categorical biases became stronger with retention interval and initial left hemispheric processing. These results suggest that categorical spatial coding might be the default manner in which spatial information is remembered over time. Finally, the left hemisphere may play an important role for such a categorical spatial coding.
© 2006 Elsevier Ltd. All rights reserved.

Keywords: Spatial memory; Hemispheric differences; Retention intervals

1. Introduction

Remembering the locations of objects in space has been claimed to encompass at least two distinct spatial codes (Huttenlocher, Hedges, Corrigan, & Crawford, 2004; Huttenlocher, Hedges, & Duncan, 1991; Laeng, Peters, & McCabe, 1998; Lansdale, 1998). First, there is a fine-grained code providing exact knowledge about the objects' positions. Second, a categorical spatial code represents the general spatial category in which an object falls. Spatial memory performance typically reflects the combined influences of the two codes. Evidence for the categorical codes follows from the fact that distortions in spatial memory are not simply random (which would indicate a unitary, but imperfect fine-grained coding mechanism) but show systematic distortions in the direction of what can be argued to be categorical prototypes. In a "classic" task that has been used in many studies thus far, and it was also employed in the present study, subjects have to reconstruct the location of a single dot in a circle. The relevant spatial categories are formed by the circle's (invisible) quadrants. Prototypical category values attract the reconstructed location towards the centre of the quadrant (angular bias) in which it was originally presented and towards the circle's perimeter (radial bias).

Interestingly, the foregoing dual code distinction can easily be linked to the distinction between coordinate and categorical coding of spatial relations in perception made by Kosslyn and others (Jager & Postma, 2003; Kosslyn, 1987; Kosslyn, Chabris, Marsolek, & Koenig, 1992; Laeng & Peters, 1995). Coordinate spatial relations capture precise, metric information needed amongst others to guide spatiomotor actions. In turn, categorical spatial relations provide abstract, invariant information about visual constellations, allowing a degree of constancy to perspective changes. One important further implication of Kosslyns' idea was that coordinate spatial processing would engage more right hemisphere processing, whereas categorical processing would depend more on left hemispheric resources. Laeng

* Corresponding author at: Psychological Laboratory, Utrecht University, Heidelberglaan 2, NL-3584 CS Utrecht, The Netherlands. Tel.: +31 30 2533657; fax: +31 30 2534511.
E-mail address: a.postma@fss.uu.nl (A. Postma).

0028-3932/$ – see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.neuropsychologia.2006.02.001

et al. (1998) applied this lateralization hypothesis successfully to the domain of spatial memory. In a visual half field study, they showed that systematic biases in positional reconstruction from memory – supposedly reflecting categorical coding – were stronger with lateralized stimuli presentations to the left hemisphere.

Assuming that indeed two spatial memory codes in combination determine how well we are able to reconstruct the locations of previous events, an important question concerns the time course of these coding mechanisms. Moreover, if we further assume that different neural circuitries are involved as well, it clearly would be of interest to explore the temporal characteristics of spatial processing within each hemisphere. Werner and Diedrichsen (2002) recently looked at the presence of categorical distortions in spatial memory on the very short time scale, i.e. within a few 100 ms after presentation. They observed that categorical distortions already occurred with retention intervals as brief as 50 ms. One possible interpretation of these findings is that, already during the perceptual phase, categorical and coordinate spatial mechanisms run in parallel and they automatically influence spatial memory.

The goal of the present study was to examine the time spectrum of these effects in more detail. In other words: what happens to categorical spatial memory codes as time passes? To answer this question, we compared performance on the dot in circle memory task for short intervals (500 ms) to intermediate duration intervals (2 s) to relatively 'long' periods (5 s). We may speculate here about three possible outcomes. One could be that categorical biases not only emerge very rapidly (see Werner & Diedrichsen, 2002) but also persist in time. For instance, categorical coding would be useful because it provides a way to infer and maintain the invariants from a continuously changing environment. A second possibility could be that categorical codes decline after some time. One likely pattern could be that systematic errors are replaced by (larger) random errors over time. Finally, the influence of categorical biases could actually become larger over time, because this memory is more resistant to decay than the spatial memory of the actual coordinates. In other words, eventually people may just remember the prototypes and not the specific instances any longer.

2. Methods

2.1. Research participants

Twenty-four students of the Utrecht University participated, 12 males and 12 females. They varied in age from 20 to 26 years, and were all right-handed. All participants had normal or corrected to normal vision, and none suffered any subjective memory or attention complaints.

2.2. Materials and procedure

Subjects were seated 39 cm from a 17 in. computer monitor. Their head was fixed in a chin rest and head clamp. They fixated on a fixation cross in the middle of the screen at eye level. Their task was to click with the computer mouse on the middle of the fixation cross to start an experimental trial. Next, a grey circle with a black circumference of 9 cm diameter appeared against a grey background, with the centre of the circle either 15° to the left or to the right of fixation. The circle contained a black dot of 0.1 cm diameter which was located in one out of 80 possible positions (see Fig. 1). The dot's position varied according to a 4 (quadrant) × 5 (angle within quadrant, 8°, 26.5°, 45°, 63.5° or 82°, respectively) × 4 (radial location within angle, being 0.3, 0.5, 0.7 or 0.9 of the radius from the centre of the circle, respectively) design. The 8° was close to the vertical axis in all quadrants, whereas the 82° was close to the horizontal axis in all quadrants. Notice that the centre of the circle was never marked.

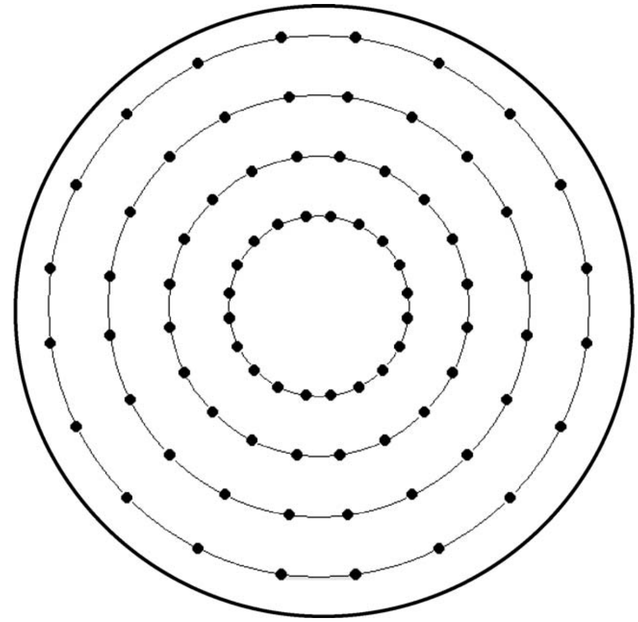

Fig. 1. The 80 possible dot locations within the circle. Notice that circles within the bold perimeter were never really shown.

Dot and circle were presented for 85 ms. After a delay of 500, 2000 or 5000 ms the circle reappeared (always in the same horizontal position as originally presented). Subjects were instructed to relocate the position of the dot as well as they could using the mouse cursor. Subsequently, the next trial started.

A dot appeared only once in one of the 80 possible locations within the circle. Accordingly, there were 80 trials in each visual for each retention interval, making a total number of 480 trials. Order of locations within the circle and of the circle within the left and right visual field was randomised. Subjects performed three blocks, each block corresponding to one of the retention intervals. Order of retention intervals was counterbalanced over subjects.

3. Results

3.1. Angular differences

An analysis of variance was conducted with hemisphere (left, right), retention interval (500, 2000 and 5000 ms) and quadrant angle (8°, 26.5°, 45°, 63.5° or 82°) as independent variables, and angular deviation (i.e. difference between presented angle and relocated angle) as the dependent measure. Notice that with regards to biases towards spatial prototypes, a negative angular deviation would mean an error towards the 45° for angles smaller than 45°, whereas such a bias would be expressed as a positive angular deviation accuracy deviation for angles larger than 45°. Importantly, there was a significant hemisphere main effect ($F[1,23] = 5.80$, $p = .02$). Errors were larger when the dot presentation and relocation took place under initial left

دریافت فوری ← متن کامل مقاله

ISIArticles
مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات