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Reference directions and reference objects in spatial memory of a briefly viewed layout

Weimin Mou [a,b,*], Chengli Xiao [a], Timothy P. McNamara [c]

[a] *State Key Laboratory of Brain and Cognitive Science, Institute of Psychology, Chinese Academy of Sciences, 10A Datun Road, Beijing 100101, China*
[b] *Department of Psychology, University of Alberta, Canada*
[c] *Department of Psychology, Vanderbilt University, USA*

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Abstract

Two experiments investigated participants' spatial memory of a briefly viewed layout. Participants saw an array of five objects on a table and, after a short delay, indicated whether the target object indicated by the experimenter had been moved. Experiment 1 showed that change detection was more accurate when non-target objects were stationary than when non-target objects were moved. This context effect was observed when participants were tested both at the original learning perspective and at a novel perspective. In Experiment 2, the arrays of five objects were presented on a rectangular table and two of the non-target objects were aligned with the longer axis of the table. Change detection was more accurate when the target object was presented with the two objects that were aligned with the longer axis of the table during learning than when the target object was presented with the two objects that were not aligned with the longer axis of the table during learning. These results indicated that the spatial memory of a briefly viewed layout has interobject spatial relations represented and utilizes an allocentric reference direction.

Keywords: Spatial memory; Scene recognition; Spatial frames of reference

* Corresponding author. Address: Institute of Psychology, Chinese Academy of Sciences, 10A Datun Road, Beijing 100101, China.
E-mail address: mouw@psych.ac.cn (W. Mou).

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1. Introduction

When specifying a location in daily communication, people usually use a spatial reference direction and a reference location. For example, a statement such as, "the car is in front of me," uses an egocentric reference direction (front) and egocentric reference object (the speaker's body). By way of contrast, the statement, "the car is east of the house," uses an allocentric reference direction (geographic east) and an allocentric reference object (the house). Hence, both the spatial reference direction and the reference object can be either allocentric or egocentric.

In the past decade, one major goal of research on spatial memory has been to understand the reference systems that are used in memory to represent locations of objects in the environment; in particular, to determine the extent to which spatial memory is egocentric or allocentric. Two different criteria have been used in determining whether spatial memory is egocentric or allocentric. One criterion is the nature of the reference direction. If the reference direction is determined by the egocentric axis (body axis) of the observer, then spatial memory is classified as egocentric. Alternatively if the reference direction is determined by a direction independent of the observer, then spatial memory is allocentric. A second criterion is the nature of the reference object. If the reference object is the observer, such that self-to-object spatial relations are represented, then spatial memory is egocentric. Alternatively if the reference object is another object or set of objects, such that interobject spatial relations are represented, then spatial memory is allocentric. It is crucial to distinguish the reference direction from the reference object because memory may use a mixture of egocentric and allocentric reference systems (e.g., the car is east of me). Hence instead of asking whether spatial memory is egocentric or allocentric, we should ask two more specific questions: first whether spatial memory depends on reference directions and, if so, whether the reference directions are egocentric or allocentric; second whether self-to-object or object-to-object or both kinds of spatial relations are represented in memory.

Research in the past decade has shown clearly that long-term spatial memory utilizes reference directions. A large body of evidence has shown that long-term spatial memory is orientation dependent (e.g., Mou, McNamara, Valiquette, & Rump, 2004; Roskos-Ewoldsen, McNamara, Shelton, & Carr, 1998; Shelton & McNamara, 1997; Shelton & McNamara, 2001; Valiquette, McNamara, & Smith, 2003; for a review see McNamara, 2003). For example, Shelton and McNamara (1997) had participants learn the locations of several objects on the floor of a room from two orthogonal viewpoints. After memorizing the locations of the objects, participants moved to a different room and made judgments of relative directions ("Imagine you are standing at X, facing Y, please point to Z") using spatial memory. The results showed that judgments of relative direction were better at the imagined headings parallel to the learning views than at novel imagined headings. It is assumed that spatial relations consistent with the spatial reference direction used in memory can be retrieved more efficiently than spatial relations