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## Preface

Discussions of visual space perception usually take one of two forms—the obligatory recitation of “cues” found in undergraduate textbooks or the detailed description of specific topics found in handbooks. The former are relatively superficial and the latter so specific that neither provides students or scholars with a coherent overview. This book attempts to strike a balance between the two extremes. It presents a survey of the scientific study of visual space perception at a level that is, I hope, accessible to the undergraduate student while containing enough detail to be a source of basic knowledge for the scholar.

There is an important role for such a book. The renewed interest in the study of vision has attracted scholars from such diverse fields as artificial intelligence, engineering, mathematics, physics, neuroscience, and linguistics so that a single primer could provide a basis for additional study for scholars whose advanced training is in other fields. Furthermore, the development of virtual imaging devices and the popularization of stereoscopic effects in movies and posters has increased the interest level of beginning students. Both groups require more depth than is available in undergraduate texts and more breadth, in a manageable size, than is available in handbooks.

There are, of course, pitfalls in attempting to attain this goal. Topics must be selected that will present a representative overview and, within topics, specific theoretical positions and experimental findings must be selected to represent alternative conceptual positions and clearly established empirical findings. In some cases, these selections are clear but, in others, a judicious decision must be made.

There is no simple way to make such decisions. In general, they were guided by three questions: Does the phenomenon represent a basic process of the visual system? Are the data supporting the phenomenon or theory well established? Should students (undergraduates and scholars alike) know

about this phenomenon in order to understand visual space perception? These questions are not easily answered because an observation that represents a basic process for one theoretical viewpoint may be an artifact for another. Therefore, in many cases, experimental observations are described in a theoretical context. Nevertheless, the topics discussed and the experiments described in this book represent one view of the basics of the field—the information that must be digested before one can begin to study visual space perception seriously.

There are two additional limitations that must be acknowledged. First, topics normally described as aspects of the study of sensation (e.g., color vision, masking) are not included. Second, brain anatomy and physiology are not described or discussed in detail. A few studies are mentioned to support the evidence but, in general, the data included come from psychophysical (behavioral) experiments.

The book has been greatly improved by the editorial comments of Robert P. O'Shea and an anonymous reviewer. Their hard work improved the accuracy, breadth, and clarity of the book and I thank them for it. However, I take full responsibility for any remaining errors.

The study of the aspect of consciousness we call visual space perception has provided me with countless hours of pleasure. If this book introduces others to the wonder and joy of seriously studying this remarkable achievement of our brains, I would feel it has been a worthwhile endeavor.

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## Visual Space Perception



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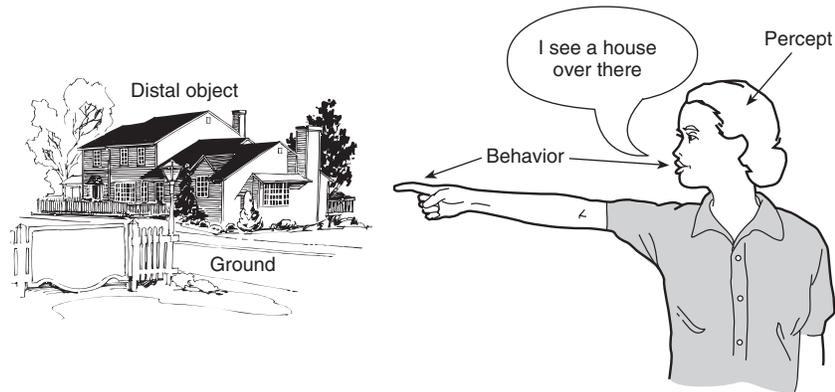
## The Problem of Visual Space Perception

The study of visual space perception begins with the assumptions that the physical world exists and that its existence is independent of the observer. The consequences of these assumptions are illustrated in figure 1.1. It shows a person looking at a scene containing the sky and the ground, as well as specific objects such as a house and a tree. It is not possible to observe the viewer's perception of this scene. Nevertheless, the viewer can describe the perception using two types of observable responses: verbal responses and motor responses. A verbal description of perception occurs when the viewer says, "I see a house over there." A motor response occurs when the viewer points at the house. Overt (observable) behaviors such as these are used to make inferences about the existence and properties of the viewer's perception, or the experience of seeing the house at a particular position in space.

### The Physical World and the Perceptual World

The physical world exists outside the observer. The *perceptual* or *visual world* is experienced by the observer. It is produced by activity in the eye-brain system when patterned light stimulates the eyes of an observer. The perceptual world consists of the ground and the sky, as well as objects (including people) that are in view at a given moment. The perceptual world is normally *externalized*, i.e., it is usually experienced as "out there." (Visual sensations can be experienced internally by striking the eyeball or by stimulating the brain with electrical current. They sometimes occur in dreams or hallucinations.)

The perceptual world is experienced as a world containing objects that move about in a three-dimensional (3D) space. Most observers are aware of the volume of space as a quality of their experience. They are frequently less aware of the fact that their experience is taking place over time, although



**Figure 1.1**

A person looking at a house and a tree on the ground, with the sky beyond. The viewer's perception of the scene cannot be observed by another person. However, the verbal and motor responses can be observed. This viewer reports seeing the house at a particular place (verbal response) and points toward the house (motor response).

the passage of time can easily be noticed when pointed out. Thus, the perceived world is a four-dimensional world—3D space plus time.

The perceived world of the ground and sky is the space within which we as observers exist. We move about in this space and interact with objects in it. This space has attributes such as depth, distance, location, direction, and motion, all of which can vary. Objects in this space have qualitative, intensive, and spatial attributes such as size (extension), shape, constancy (stability and rigidity), motion or movement, direction, and position (distance). Thus, perceived space is a four-dimensional world of objects with attributes—a perceived 3D world filled with objects, some of whose attributes change over time.

### Geometrical Relationships

Both the physical world and the perceptual world have structure. The structure of these worlds and the relationships between the structures can be described by geometry.

#### *Physical Space*

In the study of visual space perception, it is generally assumed that physical space can be described by Euclidean geometry. In this space, an object can