An Adaptive Combination Approach to Spatial Representation: Using Geometric and Featural Spatial Information

Nora S. Newcombe (newcombe@temple.edu)
Department of Psychology, 1701 N. 13th Street
Philadelphia, PA 19122 USA

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Debate in developmental psychology concerning the origins of knowledge often centers on the question of what capabilities are available at the start of life. While this question is important, it is only one aspect of the issue; understanding the mature cognitive architecture to which the developing child is headed also has crucial implications for the origins debate. This paper will consider the evidence on two contrasting approaches to the origins of spatial knowledge. In a modular view, various sources of spatial information are processed independently in separable cognitive processing units (e.g., Wang & Spelke, 2002). In alternative models, information sources are combined, using mechanisms that weight sources based on their potential usefulness (e.g., Ernst & Banks, 2002; Huttenlocher, Hedges & Duncan, 1991). Modularity is typically associated with nativist views, although this relation is by no means forced by logic (Fodor, 2001). Similarly, the adaptive combination view is often associated with empiricism, because it seems natural to suppose that the weightings in an integrative process are affected by experience, although the process itself could well be innate.

In the spatial domain, one important line of work on modular or integrated cognitive architecture has focused on a remarkable fact about spatial functioning in a wide variety of animal species, namely that they share a powerful sensitivity to geometric properties of enclosing spaces (e.g., the relative length of walls defining enclosures), using such information to reestablish spatial orientation after being disoriented (for a review, see Cheng & Newcombe, 2005). Based on findings that both rats and human children fail to use nongeometric (or featural) information (e.g., colors or markings on surfaces), even when use of featural information would be adaptive because it would disambiguate geometrically congruent locations, it has been suggested that such geometric processing constitutes a specialized cognitive module that is impenetrable to nongeometric information, even when that information has been processed (Gallistel, 1990; Hermer & Spelke, 1996).

The adaptive combination approach to spatial processing and development provides an alternative framework to modular architecture for considering the phenomena in this domain of research. Specifically, in such an approach, a continually changing mix of spatial information sources is utilized, with the exact mix responsive to factors such as the sources' reliability, variability and usefulness, and the certainty with which it has been encoded. Newcombe (in press) has proposed that the existing data on integration of featural and geometric information can be best explained by an adaptive combination approach in which the likelihood of using the two kinds of information varies depending on factors such as uncertainty or history of cue validity. Studies exploring the influence of the salience, certainty, variability, and usefulness of featural and geometric information hold the promise of specifying how geometric and featural information are used and combined in different circumstances, and the developmental mechanisms that underlie behavioral changes in feature use in enclosed geometric spaces as well as in more naturalistic ones.

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