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More on the Ontogeny of Human Logic

Jonas Langer
The Origins of Logic: One to Two Years
Orlando, FL: Academic Press, 1986.
415 pp. ISBN 0-12-436555-8 (alk. paper); 0-12-436556-6 (paperback).
$75.00 (£65.00) hardcover; $36.95 (£32.50) paperback

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In *The Origins of Logic*, Langer seeks the ontogenesis of human logic in the development of the infant's intercourse with the world of objects. The book under review follows *The Origins of Logic: Six to Twelve Months* (Langer, 1980), which laid the developmental foundations on which the present volume rests.

Langer's central assumption is that the development of object manipulation forms an emerging protologic that provides a foundation for the logico-mathematical cognition of middle and late childhood, as well as, implicitly, for the formal logic of adulthood. The final empirical links for his thesis will be presented in a third volume, currently in preparation, which will trace developments from 2 to 5 years of age.

The author's method is to make painstakingly detailed observations of 12 infants at each of four ages interacting spontaneously with preset arrays of objects such as blocks, rings, cars, and Play-Doh. His techniques of observation and data analysis combine Piaget's clinical method with the American penchant for standardization and quantification. It is a cross-sectional study: Different infants are studied at 15 months, 18 months, 21 months, and 24 months. By not giving the infants set tasks or problems to solve, Langer has created conditions in which they can display their internally generated structuring of the situation. At the same time, the arrays of objects have been strategically created to permit the sensitive detection of such protological structures as classes of similar items or two arrays spatially organized in one-to-one correspondence of their elements. Examples are shown in the figures below. To illustrate Langer's theoretical approach to his data, he would see the first figure as showing protological construction of class intension. The second figure could be interpreted in his framework as demonstrating protological understanding of certain aspects of class extension, specifically one-to-one correspondence.

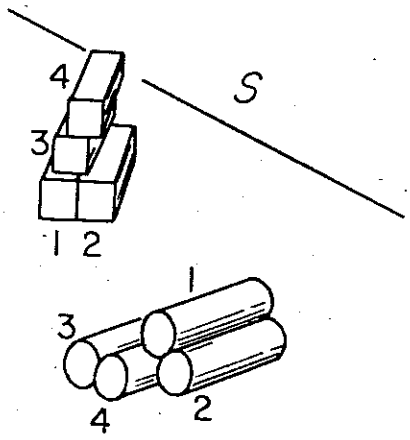

Figure 1. Consistent classification of two sets. (From *The Origins of Logic: One to Two Years*, p. 257, by Jonas Langer, 1986, Orlando, FL: Academic Press. Copyright 1986 by Academic Press. Reprinted by permission.)

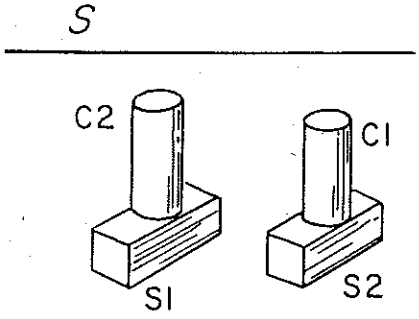

Figure 2. One-to-one correspondence. (From *The Origins of Logic: One to Two Years*, p. 212, by Jonas Langer, 1986, Orlando, FL: Academic Press. Copyright 1986 by Academic Press. Adapted by permission.)

Behind the basic arrays presented to the children is the notion that "part–whole constructions are at the heart of all operational structuring and therefore constitute prime data for studying the development of logicomathematical cognition" (p. 3). Langer distinguishes *logico-mathematical* cognition from *physical* cognition, which involves one object (the means) causing something to happen to another object (the end). Unlike Piaget (1952), Langer is explicit that each type of mature cognition (logico-mathematical and physical) has separate but parallel roots in infancy. Each receives separate treatment, although the emphasis is on protologic.

The figures can also be used to illustrate what Langer terms *second-order* cognition, which involves combining elementary cognitions. In Figure 1, an elementary cognition (specifically, the proto-operation of composition) would have produced but a single class, instead of the two classes shown. In Figure 2, elementary cognition would have produced a single extensive (logical meaning of the term) grouping, that is, one stack instead of the two shown. The results presented in Langer's earlier volume on the period from 6 months to 1 year describe the ontogenesis of elementary cognition. The distinctive development of the second year, the subject of the volume under review, is second-order cognition. Perhaps most startling is Langer's proposal that the origin of representation lies in second-order cognition, the mapping of elementary cognitions onto each other.

According to Langer, routines involving objects are produced when an infant combines individual action types (first-order cognitions). As these routines take on the qualities of arbitrariness, substitutability, conventionalization, syntactic regularity, and detachment, he sees them as turning into representation and, ultimately, language. For example, the stacks in Figure 2 were called "boats" by the child who constructed them. To Langer, this involves substituting unrealistic objects for realistic ones and two combined objects for a single one. Langer sees language as a relatively late form of representation, and many of his examples of representation are nonlinguistic, as when a child brushes the top of a block as if it were a doll's head.

This proposal concerning the origins of representation is difficult to evaluate. The heart of representation (e.g., as in de Saussure's writings) is that one thing, called a *signifier*, stands for another, called a *signified*. Granted that, in the examples above, a block signifies a doll's head, a stack of blocks signifies a boat. However, the act of signifying per se seems discontinuous with the physical manipulations that created the stack of blocks or made a brushing motion. Yet it is at precisely this point that Langer's view would seem to demand continuity: continuity between the process of signifying and the process of manipulating objects in complex ways. He has not convinced this reader that such continuity exists.

More convincing than the continuity of representation with complex object manipulations is the continuity of logico-mathematical thought. Let us take Piaget's much studied concept of number conservation, an ability to recognize the equivalence between two equal arrays of objects, no matter what the form of the array (e.g., that five buttons bunched together is the same quantity as five buttons spread out in a long row). Piaget views one-to-one correspondence as the conceptual heart of number conservation. Langer presents a number of sensorimotor precursors: (a) in the second half of the first year, infants will make substitutions in a set of objects, maintaining invariance of number; (b) in the second year, they will create two equal sets over time rather than in space, for example, by using an object to produce two sets of four taps on the table top; (c) toward the end of the second year, infants spontaneously create spatial one-to-one correspondences such as the one in Figure 2. These developments constitute a striking sensorimotor foundation for the ability to represent one-to-one correspondence in a verbally presented number conservation problem.

The author has taken on the difficult problem of trying to illuminate the sensorimotor foundations of a more abstract stage of cognitive development. In terms of the logic of scientific proof, how is it possible, while studying children younger than 2 years of age, to prove a connection with later stages of cognitive development? Langer is not the first to have this problem. Piaget's concept of vertical decalage—the idea that developments at one major stage are repeated in a more abstract form at at a later stage—is similar (albeit grosser than Langer's), and it has the same logical difficulty. Essentially it seems that there are three kinds of evidence that can be presented (although none is, in itself, logically conclusive): (a) evidence that one stage precedes another in development, (b) evidence of systematic (as opposed to haphazard) development at the earlier stage, and (c) evidence that an earlier concept is necessary to a later one. Langer presents evidence of the first two types. However, the third type of evidence, probably the most telling from a causal point of view, is lacking: There is no analysis of how the action transformations described in this book are intrinsic, even logically necessary, to later cognitive achievements.

Langer often seems to finesse the issue of causal relations between developments in infancy and later cognitive development by using the terminology of mature logic and mature language to refer to infant actions. The use of terms such as *negation, correlation, inversion, addition, syntax*, and *semantics* to refer to various sorts of object manipulations does not guarantee that the phenomena being described are causally related to the phenomena of mature cognition to which these words are more commonly (and correctly) applied. It would have been helpful (as well as more accurate) if the term *proto-* (meaning primitive, earliest form of) had been more consistently used to separate the action-oriented forms of cognition from their later, abstract forms.

Despite the problem with using terminology from one level of abstraction to refer to cognitive phenomena at quite another level, Langer takes great care to distinguish, rather than to conflate, different cognitive functions; for example, *conception* is carefully differentiated from *language* and *representation*. (One wonders where perception, the basis for so much modern knowledge of infant concepts, fits into this picture.) Langer quite explicitly does not reject the currently fashionable idea of a mind populated with separate cognitive modules (e.g., a language module; Fodor, 1983). Nevertheless, he does present an interesting picture of how certain earlier developing sensorimotor modules could serve as input to later developing cognitive modules, an issue that has thus far been quite ignored in the excitement over the possibility of autonomous cognitive systems.

One flaw in the book is that there is a lack of discussion of closely related work: Sinclair and colleagues' research on sensorimotor logic, Bruner's research on the role of routines in language development, and Bates and colleagues' research on sensorimotor precursors to language, to give a few examples. Although Langer refers to some of these authors, he does not indicate how their theories and findings relate to his own. As so often happens, the failure to acknowledge the contributions of others gives the impression that psychology is not a cumulative science.

Langer's heavy use of logical terminology and a difficult writing style make this book hard reading; it will not be usable in classes, except for the most advanced and specialized graduate seminars. On the other side of the coin, Langer's extraordinary accomplishment is that he accumulates an overwhelming mass of documentation on how infants interact with objects, perceptively analyzes this rich material, and, most important, places it in a coherent theoretical framework. As a consequence, this is a book that must hereafter serve as a point of reference for anyone investigating the conceptual development of infants.

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