Chapter 49

On Cognitive Structures and Their Development: A Reply to Piaget

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In his interesting remarks on the psychogenesis of knowledge and its epistemological significance, Jean Piaget formulates three general points of view as to how knowledge is acquired: empiricism, "preformation" ("innatism"), and his own "constructivism." He correctly characterizes my views as, in his terms, a variety of "innatism." Specifically, investigation of human language has led me to believe that a genetically determined language faculty, one component of the human mind, specifies a certain class of "humanly accessible grammars." The child acquires one of the grammars (actually, a system of such grammars, but I will abstract to the simplest, ideal case) on the basis of the limited evidence available to him. Within a given speech-community, children with varying experience acquire comparable grammars, vastly underdetermined by the available evidence. We may think of a grammar, represented somehow in the mind, as a system that specifies the phonetic, syntactic, and semantic properties of an infinite class of potential sentences. The child knows the language so determined by the grammar he has acquired. This grammar is a representation of his "intrinsic competence." In acquiring language, the child also develops "performance systems" for putting this knowledge to use (for example, production and perception strategies). So little is known about the general properties of performance systems that one can only speculate as to the basis for their development. My guess would be that, as in the case of grammars, a fixed, genetically determined system of some sort narrowly constrains the forms that they can assume. I would also speculate that other cognitive structures developed by humans might profitably be analyzed along similar lines.

Against this conception Piaget offers two basic arguments: (1) the mutations, specific to humans, that might have given rise to the postulated innate structures are "biologically inexplicable"; (2) what can be explained on the assumption of fixed innate structures can be explained as well as "the 'necessary' result of constructions of sensorimotor intelligence."

Neither argument seems to me compelling. As for the first, I agree only in part. The evolutionary development is, no doubt, "biologically unexplained." However, I know of no reason to believe the stronger contention that it is "biologically inexplicable." Exactly the same can be said with regard to the physical organs of the body. Their evolutionary development is "biologically unexplained," in exactly the same sense. We can, *post hoc*, offer an account as to how this development might have taken place, but we cannot provide a theory to select the actual line of development, rejecting others that appear to be no less consistent with the principles that have been advanced concerning the evolution of organisms. Although it is quite true that we have no idea how or why random mutations have endowed humans with the specific capacity to learn a human language, it is also true that we have no better idea how or why random mutations have led to the development of the particular structures of the mammalian eye or the cerebral cortex. We do not therefore conclude that the basic nature of these structures in the mature individual is determined through interaction with the environment (though such interaction is no doubt required to set genetically determined processes into motion and of course influences the character of the mature organs). Little is known concerning evolutionary development, but from ignorance, it is impossible to draw any conclusions. In particular, it is rash to conclude either (A) that known physical laws do not suffice in principle to account for the development of particular structures, or (B) that physical laws, known or unknown, do not suffice in principle. Either (A) or (B) would seem to be entailed by the contention that evolutionary development is literally "inexplicable" on biological grounds. But there seems to be no present justification for taking (B) seriously, and (A), though conceivably true, is mere speculation. In any event, the crucial point in the present connection is that cognitive structures and physical organs seem to be comparable, as far as the possibility of "biological explanation" is concerned.

The second argument seems to me a more important one. However, I see no basis for Piaget's conclusion. There are, to my knowledge, no substantive proposals involving "constructions of sensorimotor intelligence" that offer any hope of accounting for the phenomena of language that demand explanation. Nor is there any initial plausibility to the suggestion, as far as I can see. I might add that although some have argued that the assumption of a genetically determined language faculty is "begging the question," this contention is certainly unwarranted. The assumption is no more "question-begging" in the case of mental structures than is the analogous assumption in the case of growth of physical organs. Substantive proposals regarding the character of this language faculty are refutable if false, confirmable if true. Particular hypotheses have repeatedly been challenged and modified in the light of later research, and I have no doubt that this will continue to be the case.

It is a curiosity of our intellectual history that cognitive structures developed by the mind are generally regarded and studied very differently from physical structures developed by the body. There is no reason why a neutral scientist, unencumbered by traditional doctrine, should adopt this view. Rather, he would, or should, approach cognitive structures such as human language more or less as he would investigate an organ such as the eye or heart, seeking to determine: (1) its character in a particular individual; (2) its general properties, invariant across the species apart from gross defect; (3) its place in a system of such structures; (4) the course of its development in the individual; (5) the genetically determined basis for this development; (6) the factors that gave rise to this mental organ in the course of evolution. The expectation that constructions of sensorimotor intelligence determine the character of a mental organ such as language seems to me hardly more plausible than a proposal that the fundamental properties of the eye or the visual cortex or the heart develop on this basis. Furthermore, when we turn to specific properties of this mental organ, we find little justification for any such belief, so far as I can see.

I will not attempt a detailed argument here, but will merely sketch the kind of reasoning that leads me to the conclusions just expressed.

Suppose that we set ourselves the task of studying the cognitive growth of a person in a natural environment. We may begin by attempting to delimit certain cognitive domains, each governed by an integrated system of principles of some sort. It is, surely, a legitimate move to take language to be one such domain, though its exact boundaries and relations to other domains remain to be determined. In just the same way, we might proceed to study the nature and development of some organ of the body. Under this quite legitimate assumption, we observe that a person proceeds from a genetically determined initial state S_0 through a sequence of states S_1, S_2, ..., finally reaching a "steady state" S_s which then seems to change only marginally (say, by the addition of new vocabulary). The steady state is attained at a relatively fixed age, apparently by puberty or somewhat earlier. Investigating this steady state, we can construct a hypothesis as to the grammar internally represented. We could try to do the same at intermediate stages, thus gaining further insight into the growth of language.

In principle, it is possible to obtain as complete a record as we like of the experience available to the person who has achieved this steady state. We make no such attempt in practice, of course, but we can nevertheless focus on particular aspects of this experience relevant to specific hypotheses as to the nature of S_s and S_0. Assuming a sufficient record E of relevant experience, we can then proceed to construct a second-order hypothesis as to the character of S_0. This hypothesis must meet certain empirical conditions: It cannot be so specific as to rule out attested steady states, across languages; it must suffice to account for the transition from S_0 to S_s, given E, for any (normal) person. We may think of this hypothesis as a hypothesis with regard to a function mapping E into S_s. For any choice of E sufficient to give rise to knowledge of some human language L, this function must assign an appropriate S_s in which the grammar of L is represented. We might refer to this function as "the learning theory for humans in the domain language"—call it LT(H,L). Abstracting away from individual differences, we may take S_0—which specifies LT(H,L)—to be a genetically determined species character. Refinements are possible, as we consider stages of development more carefully.

More generally, for any species O and cognitive domain D that have been tentatively identified and delimited, we may, correspondingly, investigate LT(O,D), the "learning theory" for the organism O in the domain D, a property of the genetically determined initial state. Suppose, for example, that we are investigating the ability of humans to recognize and identify human faces. Assuming "face-recognition" to constitute a legitimate cognitive domain F, we may try to specify LT(H,F), the genetically determined principles that give rise to a steady state (apparently some time after language is neurally fixed, and perhaps represented in homologous regions of the right hemisphere, as some recent work suggests). Similarly, other cognitive domains can be studied in humans and other organisms. We would hardly expect to find interesting properties common to LT(O,D) for arbitrary O,D; that is, we would hardly expect to discover that there exists something that might be called "general learning theory." As far as I know, the prospects for such a theory are no brighter than for a "growth theory," intermediate in level between cellular biology and the study of particular organs, and concerned with the principles that govern the growth of arbitrary organs for arbitrary organisms.

Again, we may refine the investigation, considering intermediate states as well.

Returning to the case of language, to discover the properties of S_0 we will naturally focus attention on properties of later states (in particular, S_s) that are not determined by E, that is, elements of language that are known but for which there appears to be no relevant evidence. Consider a few examples.

The Structure-Dependent Property of Linguistic Rules

Consider the process of formation of simple yes-or-no questions in English. We have such declarative-question pairs as (1):

(1) The man is here—Is the man here?
The man will leave.—Will the man leave?

Consider the following two hypotheses put forth to account for this infinite class of pairs:

H_1: process the declarative from beginning to end (left to right), word by word, until reaching the first occurrence of the words *is, will,* etc.; transpose this occurrence to the beginning (left), forming the associated interrogative.

H_2: same as H_1, but select the first occurrence of *is, will,* etc., following the first noun phrase of the declarative.

Let us refer to H_1 as a "structure-independent rule" and H_2 as a "structure-dependent rule." Thus, H_1 requires analysis of the declarative into just a sequence of words, whereas H_2 requires an analysis into successive words and also abstract phrases such as "noun phrase." The phrases are "abstract" in that their boundaries and labeling are not in general physically marked in any way; rather, they are mental constructions.

A scientist observing English speakers, given such data as (1), would naturally select hypothesis H_1 over the far more complex hypothesis H_2, which postulates abstract mental processing of a nontrivial sort beyond H_1. Similarly, given such data as (1) it is reasonable to assume that an "unstructured" child would assume that H_1 is valid. In fact, as we know, it is not, and H_2 is (more nearly) correct. Thus consider the data of (2):

(2) The man who is here is tall.—Is the man who is here tall?
The man who is tall will leave.—Will the man who is tall leave?

These data are predicted by H_2 and refute H_1, which would predict rather the interrogatives (3):

(3) Is the man who here is tall?
Is the man who tall will leave?

Now the question that arises is this: how does a child know that H_2 is correct (nearly), while H_1 is false? It is surely not the case that he first hits on H_1 (as a neutral scientist would) and then is forced to reject it on the basis of data such as (2). No child is taught the relevant facts. Children make many errors in language learning, but none such as (3), prior to appropriate training or evidence. A person might go through much or all of his life without ever having been exposed to relevant evidence, but he will nevertheless unerringly employ H_2, never H_1, on the first relevant occasion (assuming that he can handle the structures at all). We cannot, it seems, explain the preference for H_2 on grounds of communicative efficiency or the like. Nor do there appear to be relevant analogies of other than the most superficial and uninformative sort in other cognitive domains. If humans were differently designed, they would acquire a grammar that incorporates H_1, and would be none the worse for that. In fact, it would be difficult to know, by mere passive observation of a person's total linguistic performance, whether he was using H_1 or H_2.

Such observations suggest that it is a property of S_0—that is, of LT(H,L)—that rules (or rules of some specific category, identifiable on quite general grounds by some genetically determined mechanism) are structure-dependent. The child need not consider H_1; it is ruled out by properties of his initial mental state, S_0. Although this example is very simple, almost trivial, it illustrates the general problem that arises when we attend to the specific properties of attained cognitive states.