

theoretical in character and two may be thought of as practical applications of present-day thinking.

18.1.3 The two theoretical streams to be considered are this author's interpretation of Chomsky's particular brand of **Cartesian rationalism** and Piaget's approach to human psychology under the guise of his particular variety of **intellectual constructivism**. These theoretical approaches have been juxtaposed (**Piatelli-Palmarini** 1980) in a way that suggests the probable directions of present-day inquiry for some time to come. Also, since Chomsky in particular has been influenced by Peirce to a considerable extent (Chomsky 1975, 1979, 1980),¹ and since his remarks about the freedom of language use from stimulus control are coincident with Einstein's claim for the logical independence of conceptualizations and sense-impressions, without too much difficulty Chomsky's thinking may be viewed as a rational extension of classic pragmatism. Piaget's thinking, on the other hand, is seen more as a sounding board for contrast, though his approach too has been immeasurably more rational than that of the behaviorists.

18.1.4 The two practical streams, on the other hand, both deeply influenced by Chomsky's ideas about **generative grammar**, merge into one. Stephen Krashen has been primarily concerned with understanding **non-primary** language acquisition, and Frank Smith with explaining literacy, but their thinking comes together so smoothly that it might be argued that any differences are negligible. The particular ideas from each of them which are to be examined briefly are Krashen's **input hypothesis** and Smith's approach to reading and writing.

18.1.5 Relating the foregoing streams of thought, then, to ideas distilled from Peirce and Einstein (ideas elaborated to some extent primarily by Dewey and Piaget), the intent here is to offer a sketch of **rational pragmatism**, as close as possible to Peirce's thinking under the heading **pragmatism**.

18.1.6 We have already met Piaget (in Chapter 16) so there is somewhat less work to do in developing his line of thought than in the

¹In his conversations with **Mitsou Ronat**, Chomsky said at one point, "The philosopher to whom I feel closest and whom I'm almost paraphrasing is Charles Sanders Peirce . . . Peirce argued that to account for the growth of knowledge, one must assume that 'man's mind has a natural adaptation to imagining correct theories of some kinds', some principle of 'abduction' . . ." (1979, p. 71).

case of Chomsky, Krashen, and Smith. Chomsky's thinking is foundational to the latter two, so it will require the greater amount of space. (No claim here is made for completeness. The intent is to provide merely a rough outline suitable for establishing certain connections.)

18.2

PIAGET AND CHOMSKY

18.2.1 As Dewey and Einstein implied, and as Peirce explicitly stated in his writings (Peirce 1908, p. 325) much of human intellectual capacity must be innate. Chomsky augments and develops that theme tracing it back to **Descartes** and the rationalists of the seventeenth century. Piaget on the other hand minimizes the importance of "a priori or innate cognitive structures in man" (1980, p. 23) and stresses the idea that intelligence develops in stages, beginning with and progressing forward through "successive actions performed on objects" (p. 23).

18.2.2 For this reason, Piaget calls his theory **genetic epistemology**.² He sees the progressive fitting of intellectual structures (**groupings**) to the facts of experience as an active process of **equilibration** where more and more complex cognitive structures are constantly built up from less complex ones. These structures begin with **sensory-motor** activities of **assimilation** (adjusting the objects and facts of experience to fit into developing **cognitive schema**--structures and groupings) and **accommodation** (adjusting the cognitive schema to fit the facts) until the learner arrives at **formal operations**--logical processes which among other things are characterized by their complete **reversibility**.

18.2.3 Mathematical operations such as adding 2 to 7 to get 9 and then subtracting 2 to get back to 7, or multiplying x times 3 to get $3x$ and

²The meaning of this term was identical in Piaget's use apparently to that by James (1907c, see 10.20 above) when he spoke of a **genetic** theory of truth, and by Dewey (1916) where he wrote "One of the points which gave much offense in the essays [his own dated 1903; reissued later as *Essays in Experimental Logic*] was the reference to **genetic** method--to a natural history of knowledge (p. 66)" and on the next page explained "To set **genesis** in opposition to analysis is merely to overlook the fact that the sciences of existence have found that considerations of **genesis** afford their most effective methods of analysis" (p. 67). Therefore, it does not seem impossible that this term might have come to Piaget through some influence of these pragmatists in particular--though he may not have consciously realized the origin of the term. Piaget (1971) does cite Dewey in the book, *Genetic Epistemology* and James in a number of places (e.g. Piaget 1947a, pp. 96-97).

then dividing by 3 to obtain x again, and the like, illustrate the logical meaning of reversibility. Physical actions, or **concrete operations** as Piaget calls them, are merely precursors to full-fledged **formal operations** since they are not completely reversible. We cannot unlight a fire, and though we may leave a room and return to it, this cannot be done without a lapse of time, and some carpet wear. That is, events in space-time are only partially reversible, while purely logical relations are completely so (setting aside the psycho-physiological events that accompany those operations).

18.2.4 Of course, Peirce, James, and Dewey (not to mention Russell and Einstein) took more or less explicit notice of the fact that logical operations as much as concrete operations require time and space when actually carried out and that in this sense they are not completely reversible any more than physical events or other actions are. Apart from this caveat, Piaget's intellectual constructivism has much in common with the pragmatism of James and Dewey, though Dewey, at least, did not reject the claim of Kant that experience requires prior (innate) knowledge. Dewey admitted that abstract conceptual possibilities (categories) must pre-exist their investment with experiential meaning.

18.2.5 Peirce, on the other hand, was less committed to a materialistic outlook than James, or even Dewey. He himself accepted the major part of Kant's rationalism and Galileo's "il lume naturale"--the inner light which guides our understanding and the development of knowledge of the world. Peirce argued that scientific progress as we know it would have been impossible except for a pretuning of human intellect to the physical universe. He wrote:

There is a reason, an interpretation, a logic, in the course of scientific advance, and this indisputably proves to him who has perceptions of rational or significant relations that man's mind must have been attuned to the truth of things in order to discover what he has discovered (1908, p. 325).

18.2.6 In this same connection Peirce quoted Galileo who said "of two hypotheses the *simpler* is to be preferred" (p. 255). At first, Peirce thought Galileo should have said "logically simpler". Later he came to believe that it is exactly

the simpler hypothesis in the sense of the more facile and natural, the one that instinct suggests, that must be preferred; for the reason that, unless man have a natural bent in accordance with nature's, he has no chance of understanding nature at all. . . . I do not mean that logical simplicity has no value at all, but only that its value is badly

secondary to that of simplicity in the other sense (1908, pp. 325-326).

18.2.7 Because of this one point, Peirce's **pragmatism** differed substantially from the pragmatism of James, though less so from that of Dewey. Interestingly Einstein agreed with Peirce (and Kant) when he commented that the "comprehensibility" of the world of experience is "a miracle" (1.1.7). While both might have agreed in part with Piaget's insistence on pushing **constructivism** as far as it might go, they would have been compelled to assert that it would have to be assisted by an innate system of logical possibilities that pre-exist the possibility of any experience or any construction to which it might lead. This latter suggestion is one that has been developed lately by Chomsky.

18.2.8 As a rationalist of a more radical sort than Piaget, Chomsky has taken a dim view of constructivism. Whereas Piaget is an extreme "rationalist" if compared against the American behaviorists such as J. B. Watson or B. F. Skinner, he is a materialistic rationalist if compared against Chomsky and his collaborators. Chomsky's rationalism is **ideal** in character--scarcely needing either the physical world or social interaction. Some believe that he has gone too far in his **idealism**, but his argument requires a hearing.

18.2.9 Chomsky contends (much in the manner of Peirce and Einstein) that human language never comes fully under the control of behavioral "stimuli" of any sort. It is in Chomsky's words, not only innovative and potentially infinite in scope, but also free from the control of detectable stimuli, either external or internal. It is because of this freedom from stimulus control that language can serve as an instrument of thought and self-expression . . . (1972, p. 12).

Chomsky's statement is a close paraphrase of Einstein where he says: the concepts which arise in our thought and in our linguistic expressions are all--when viewed logically--the free creations of thought which cannot inductively be gained from sense-experiences (3.11).

An important difference from Chomsky is that Peirce and Einstein accepted the dualism of mind and body as unresolvable and necessary. Chomsky (1988, p. 145) rejects the need for the term "body" (or even "other minds") and hence is a more radical rationalist than either of them. Chomsky is an idealist.

18.2.10 However, saying that language is "free from stimulus control" is not the same as saying that it is unconstrained altogether. Chomsky

goes on to point out that

Cartesian discussion of the limits of mechanical explanation . . . took note of a third property of the normal use of language, namely, its **coherence** and its **"appropriateness to the situation"**--which of course is an entirely different matter from control by external stimuli (p. 12).

While some have maintained that "appropriateness" is precisely what is meant by "control by external stimuli", this argument cannot be maintained if the logical independence of signs and what they may be used to represent is admitted--and this must be admitted according to classic pragmatism (especially, see Einstein's several remarks on this, 1.2.3, 1.7.1, 3.9, 3.11, and 3.12)

18.2.11 Another point of agreement between Chomsky, Peirce, and Einstein concerns what can be said about how appropriateness is achieved. Einstein wrote in 1936 that

nothing can be said concerning the manner in which the concepts are to be made and connected, and how we are to coordinate them to the experiences (1.1.9).

Compare Chomsky in 1972:

Honesty forces us to admit that we are as far today as Descartes was three centuries ago from understanding just what enables a human to speak in a way that is innovative, free from stimulus control, and also appropriate and coherent. This is a serious problem that the psychologist and biologist must ultimately face and that cannot be talked out of existence by invoking "habit" or "conditioning" or "natural selection". . . . Neither physics nor biology nor psychology gives us any clue as to how to deal with these matters (pp. 12-13).

18.2.12 To appreciate why Chomsky's argument, like Einstein's before him, is likely to remain uncontradicted into the indefinite future, it is necessary to appreciate something of the scope of the language problem that the theoretician faces. An important part of the argument may be developed roughly as follows.

18.2.13 **George Miller** [1920-present], former Harvard psychologist and collaborator of Chomsky, estimated (1964) that the number of words that can form an appropriate continuation at any given point in a text of English is on the average about ten. Call this number "Miller's average". To make it larger would only strengthen the conclusion toward which we are moving and it must be admitted that Miller's average is excessively conservative, i.e., much too low.

18.2.14 With that in mind, suppose we set an arbitrary limit on the length of a text. If this is done, we may estimate the number of possible texts of that length by employing Miller's average. If there were, for example, a length limit of two words, there would be ten words that might fit in the first word position and ten in the second which would yield one hundred possible texts of length two ($10 \text{ times } 10 = 10^2 = 100$). If texts of up to three words were allowed, there would be about one thousand possible texts of that length ($10 \text{ times } 10 \text{ times } 10 = 10^3 = 1000$), and so on. That is, the number of possible texts can be estimated by raising Miller's average to the power of the number of words in the text.

18.2.15 But clearly there is no necessary upper bound which must be chosen. And, as was noted already, the number of words that can form an appropriate continuation sometimes is much greater than 10. For instance, when numbers are included within a text, the number of possible continuations may skyrocket all the way to infinity, as in the sentence, "___ is a number." But to admit this only strengthens the argument under consideration. Therefore, let Miller's average stand, and to form a clearer idea of the scope of the language creativity problem, suppose we take the length of a novel as a reasonable bench-mark for estimating the number of possible texts in a given language. That is, suppose we estimate the number of possible texts of novel-length. It is not unusual for a novel to reach a length of about 200 pages with say about 250 words per page or a total length of 50,000 words. Now by using Miller's average the number of possible texts of 50,000 words would be 10^{50000} (ten raised to the fifty-thousandth power)--any one of which would be comprehensible to any normal native speaker of the language in question.

18.2.16 To appreciate the scope of the capacity just described, it is necessary to get an idea of just how large a number we are speaking of and then to realize that it is much too low an estimate since the number of possible texts cannot be limited to novel-length. Furthermore, it is important to bear in mind that only a human being can understand something as complex as a novel. No other artificial or biological intelligence that we know anything about can even come close to handling such a complex network of relations as are found in any coherent novel.

18.2.17 The number of possible texts of novel-length would be a one followed by 50,000 zeroes--if we squeezed 2500 characters onto each page, it would require 20 full pages to write it down. Compare this number to the number of particles in the entire universe according to modern

physics, something on the order of 10^{80} (Crick, 1981, p. 51). The number of particles in the universe is negligibly small when compared against the number of possible texts.

18.2.18 Or, think in terms of time. If we use 20 billion years as an estimate of the age of the universe, the total number of micro-seconds (thousandths of seconds) that have elapsed since the beginning is about 6.3×10^{20} . If this quantity were stood on end and measured as a height against the number of possible texts of novel-length, the total number of micro-seconds would be an unnoticeable quantity by comparison.

18.2.19 Now, here is the problem: if the physical universe is comparatively so limited in scope, how comes it that in such a short span as may be allowed for biological existence, or for human experience, there should come to be such a powerful capacity as that represented by normal human language use? Setting aside the related problem of language origin for a moment, consider language acquisition: how could language capacity be built up from scratch out of the few and impoverished cases of language use that one has the opportunity to observe over the course of even a long lifetime? Never mind the much shorter period of four or five years during which most of the language acquisition problem is solved by human children. Or, returning to the origin question, how could such language capacity be the product of experience over the limited time allowed to the existence of the physical universe? These are non-trivial psychological and biological questions.

18.2.20 According to Piaget's constructivism, the progress from stage to stage in the intellectual development of a child is based on a series of inductive leaps up the various steps in the stairway of abstraction. The progress made, according to Piaget (and according to the pragmatism of William James), constantly achieves structures or groupings that were impossible and did not exist in the previous stage. That is to say, Piaget sees intellectual development progressing from a simple logic to ever more complex logics.

18.2.21 Chomsky disagrees (for reasons developed also, by Peirce and Dewey). He does not deny the existence of stages in human maturation, nor does he contest the fact that these stages give the appearance of escalating levels of complexity. Rather, he insists that in order for the process of maturation to unfold as it does, the intellectual gains that are observed must have been pre-programmed into the genetic material of the organism. Chomsky contends that the formation of correct hypotheses

requires innate biases: "*you have to have a set of prejudices in advance for induction to take place*" (in Piatelli-Palmarini 1980, p. 259).

18.2.22 For instance, take the acquisition of predicates to be applied to objects, e.g. "green" in relation to the color of emeralds. Chomsky claims that such a predicate, or such predicates in general, cannot be discovered by inductive abstraction (by examining emeralds and any number of other things one after another), but must, in an important sense, be taken for granted in advance. He writes: "*you must in some sense have the whole set of predicates from the beginning*" (p. 261). Otherwise, inference by induction from the specific facts of experience is quite impossible. Or, as Peirce or Dewey might have argued, a particular predicate, "green" (as of emeralds), say, would not have the meaning that it does if it did not stand in just the tensional oppositions that it does stand in with reference to the entire rest of the spectrum of color as revealed to us in experience.

18.2.23 Emerald green is no more discovered by induction than the brightness of the sun is inductively abstracted from the rest of the sky. It is given in the character of the physiological apparatus and the nature of the external world with which that apparatus interacts. The intellect must pre-specify the rich set of visual and other distinctions which the physiological apparatus is capable of representing. We do not "learn" in the traditional sense of the term to appreciate such "concepts" but we possess them and their intrinsic value beforehand or else intellectual growth ("learning") would be impossible. In fact, as Kant, Peirce, and Einstein argued, any sort of experience whatever would be impossible.

18.2.24 Psychologist, Jerry Fodor has set Chomsky's **innateness hypothesis** against the traditional view of "learning". "It is", he asserts, "*never possible to learn a richer logic on the basis of a weaker logic, if what you mean by learning is hypothesis formation and confirmation. Yet I say again that learning must be non-demonstrative inference; there is nothing else for it to be*" (1980, p. 148). In other words, Piaget's constructivism is not an explanation for the progress that he observes from stage to stage--and it matters little what the stages are for this argument since Piaget's account in principle can only be a partial history of what occurs. It is not an explanation of it.

18.2.25 For a theory of how or why the progress between stages occurs, we must look elsewhere. Any theory of "learning" in the traditional sense will be useless as an explanation because, as Fodor says, "there literally isn't such a thing as . . . learning a conceptual system