3  A case of language acquisition

1  Both sides now

This chapter provides a domain-specific illustration of the theoretical framework presented in chapter 2. Although the 1975 debate was mainly about the (non) existence of language as an ontogenetic novel structure, language was not itself the explicit subject of the debate. It was only because of the dominance of Chomsky and Fodor that the debate turned into a debate on language. The 1975 debate, as was presented in chapter 2, turned out to be a discussion about the pros of Chomsky's position and the cons of Piaget's position. In this chapter, Chomsky's nativistic language acquisition theory and Piaget's constructivistic theory are explicitly evaluated with respect to their claims about the ontogenetic emergence of language skills. The language 'facts' from the classical debate will be presented again, this time explicitly. I focus on both the pros and cons of Chomsky's, and Piaget's position.

2  Introducing the domain of language acquisition; vertical versus horizontal explanations

The theories of both Chomsky and Piaget are specific instances of two classes of theories: (1) 'inside-out' theories, in which intrinsic instructions are held responsible for the acquisition process, and (2) 'cognition-first' theories (Rosenberg, 1993), in which general cognition is believed to be both central and essential to the process of language acquisition. In 'cognition-first' theories, cognition is an indispensable precondition for language acquisition, 'intellectual development is possible without language, but language acquisition is bound to the elaboration of cognitive structures in general' (Sinclair, 1975, p. 255).

Inside-out theorists - also called nativistic or preformistic - presuppose the existence of a mental organ which developed during evolution. This organ controls the process of language acquisition, and preforms the use of language, just as the jaws and teeth preform the process of chewing (Chomsky, 1980a). According to this view, the ontogeny of language reflects the unfolding of some pre-existing structure. Consequently, language acquisition does not imply the development of a novel structure: there simply is no development involved in language acquisition. The disagreement between the two classes of theories is especially clear in their concepts of novelty. While inside-out theories deny the existence of ontogenetic novelty, 'cognition-first' theories assert that language skills are the novel products - cognitive structures - of a real developmental process (the process of language acquisition). Notwithstanding the fact that the process may be similar among children, language structure is taken to be non-existent until the developmental process takes off. As a consequence,
language develops from the outside in. 'Cognition-first' theories form a set within the class of 'outside-in' theories (Golinkoff & Hirsh-Pasek, 1990). In 'cognition-first' theories, the only entity that is assumed to be inherent is the mechanism which is believed to construct cognitive structures.

'Cognition-first' theories are horizontal theories in that they state that the assumed (co)determining structures - cognition and language - are at the same level of description (aggregation). Chomsky's theory is a prototypical instance of a vertical theory, in which biological structures are supposed to determine cognitive or psychological structures (the innateness hypothesis). In Piaget's words (1980, p. 25), the problem is 'to choose between two hypotheses: authentic constructions with stepwise disclosures to new possibilities, or successive actualization of a set of possibilities existing from the beginning'. Piaget chooses the first hypothesis; language is constructed ontogenetically and adapted, whenever required by environmental demands, by an endogenous mechanism.

There are two points of disagreement between Piaget's and Chomsky's approaches. The first point was presented in detail in chapter 2. Briefly, according to Piaget, cognitive structures are novel (new), that is they develop out of the blue during ontogeny, notwithstanding the fact that they are universal and predictable. In contrast, Chomsky depicts development as the pervasion of existing schemes by experience, 'we can know so much because in a sense we already knew it, though the data of sense were necessary to evoke and elicit this knowledge' (Chomsky, 1975, p. 7). Chomsky rejects novelty on the ontogenetical level of abstraction. Cognitive schemes and structures originate during evolution. They do not first come into being in ontogeny. Ontogenetical novelty does not exist. Consequently, the debate between horizontal ('outside-in') and vertical ('constructivist') theories can be characterized as the novelty controversy. Vertical theorists (nativists) locate novelty exclusively on the evolutionary time scale, horizontal theorists (constructivists) locate novelty in both ontogeny and evolution.

The second point of disagreement deals directly with the position of language with respect to other cognitive domains. Piaget states that language and other cognitive domains originate from similar roots, while Chomsky insists on the modularity of language (and other cognitive domains). Let us now pick up our goal and try to evaluate which position is right and which is wrong, and for what reasons.

3 Pro Chomsky

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As a spider's web emerges from the spider, rather than being specified in a pre-existing blueprint of that web, cognitive structures emerge from the mental activities of children. These activities can be delineated by the Piagetian construction mechanism of subsequent adaptation through accommodation and assimilation.

Novelty does not designate the unique or peculiar. Neither does it signify that which did not exist previously. Novelty is an ontological predicate, denoting the time scale on which cognition is assumed to originate (see chapter 1).
In 1957, the appearance of Chomsky's *Syntactic structures* signifies a revolution in linguistics. Chomsky forcefully opposes the positivistic Bloomfieldians and, so doing, implicitly opposes the anti-mentalistic behaviorists. In his review of Skinner's *Verbal behavior* in 1959, Chomsky directly attacks behaviorism for the first time. Behaviorists are extremely outside-in oriented. According to them, language behavior is completely determined by experience, being just like any other kind of behavior 'the result of a continuous shaping process' (Skinner, 1957, p. 91). Babbling is continuously shaped into talking as parents reward some of the sounds in the autonomous babbling of the child and punish others. Even with respect to its structure - syntax - language is completely determined by the process of (operant) conditioning (in contrast to that of Chomsky, behaviorism is a horizontal theory).

By showing that the structure of language cannot be derived from the child's incomplete experience with language use that is mostly incorrect, Chomsky (1957, 1965, 1980a) discredited the behaviorists' beliefs about language acquisition. Chomsky (1980a, p. 35) stated that 'Within a given speech-community, children with varying experience acquire comparable grammars, vastly underdetermined by the available evidence'.

### 3.1 Language is underdetermined by learning and experience

Underdetermination (see also chapter 2) means that the application of general learning and association mechanisms to the surface features of the language input (the stream of sounds), irrespective of their complexity, would produce an unapproachably large number of grammars. Children within a particular language community do in fact converge on one language, which they master without much effort in a very short period of time and largely independently of the specific input. So, the underdetermination argument, also called the poverty of the stimulus argument, holds that it is logically impossible to deduce grammar on the basis of general derivation principles. An adequate theory of language acquisition must provide a basis for 'developing a hypothesis about initial structure that is sufficiently rich to account for acquisition of language, yet not so rich as to be inconsistent with the known diversity of language (Chomsky 1965, p. 58; see also 1980a, p. 49)'. Chomsky takes the initial state of a child's linguistic knowledge to consist of a structure of knowledge - the Universal Grammar - that exists prior to the onset of language acquisition (1986).

As we have seen in chapter 2, empirical research has revealed that specific categories of errors are never observed, even though they are to be expected if the process of acquisition depends (solely) on learning principles. From this, Chomsky concludes that language acquisition can not be dependent on general learning mechanisms, since these always depend on hypothesis generation at one stage and hypothesis confirmation at a later stage (see Fodor, 1981, see also chapter 2).

Chomsky's way out of this dilemma is to assume that every child possesses an inborn
language acquisition device (LAD). The LAD consists of a system of 'principles and parameters', Chomsky, 1981, 1986), which forms the underpinning of all actual, and all possible languages. The complete system is called the Universal Grammar (UG). UG defines the initial state of every child's linguistic knowledge. It determines the process of language acquisition in every language. Rules that are specific to each language are derived from the UG principles. These principles can be conceived of as constraints on the hypothesis space of all possible languages, which rule out some conceivable constructions and thus explain why children never make particular kinds of errors during ontogeny.

3.2 Principles and parameters

Let us consider the projection rule as an example of a UG principle. In order to express its intrinsic meaning, for instance, the verb kiss requires both a subject (for instance a teddy bear) that does the kissing, and an object (an elephant) towards which the action is addressed. The minimal syntactic structure that can express this semantic relationship consists of the verb (kissing) and the two nouns, a subject that does the kissing and an object which serves as the recipient of the action: the teddy bear kisses the elephant. In this way, the semantic features (constraints) of the lexical item project onto the syntactic structure of the sentence. The two arguments, the teddy bear and the elephant (called Θ-roles), must be traceable to their original position (doing the action and receiving the action) in all derivatives (sentences that can express the action of the teddy bear kissing the elephant). In addition to principles, the UG also consists of parameters. According to Chomsky (1981), there are some 'complexes of properties typical of particular types of languages; such collections of properties should be explained in terms of the choice of parameters in one or another subsystem' (p. 6). Parameters are like switches, in that each parameter can be set to one of two pre-specified values (on or off). Changes in `a single parameter may have complex effects, with proliferating consequences in various parts of the grammar' (p. 6). The parameters are tuned by experience with a specific language. That is, the linguistic input determines which value will be selected for each parameter. An example of parametric variation is the parameter that determines the order of words. In English, the order of the words in simple sentences is subject-verb-object (SVO). In contrast, Dutch is a so called SOV language. The position in the relative clause of both the derived verb, and the parts of finite verbs follows directly from the selection of either of the two values (SVO for English, SOV for Dutch). An example:

a Jan gooit zijn olifant weg 
b dat Jan zijn olifant weggooit

a¹ Jan throws his elephant away 
b¹ that Jan throws his elephant away
Exposure to Dutch leads the child to set the word order parameter to SOV, exposure to English sets the parameter to SVO. To summarize, the innate LAD determines the process in which experience is mapped onto language structure. The LAD is an answer to the underdetermination argument. It is an essential part of a hypothesis about language acquisition in which language is appropriately determined. An integral component of the LAD is a system of linguistic principles and parameters - the UG - a universal structure which is claimed to establish every actual and every possible language. Thus conceived, every language is a particular manifestation of the UG. Different configurations of parameters match with different languages, making every language a case of one and the same essential elements.

Chomsky showed how language is underdetermined by learning and experience. Since language does come into being, it must be appropriately determined by a set of entities or a process (in order to explain its emergence, which is an empirical fact). Chomsky calls the condition on which the acquisition of language depends (which I would like to call the condition of appropriate determination) the innateness hypothesis: `The "innateness hypothesis", then, can be formulated as follows: Linguistic theory, in the form of the UG, is an innate property of the human mind. In principle, we should be able to account for it in terms of human biology' (1975, p. 34). The innate structures that determine language acquisition originate on the evolutionary time scale, and should be studied in 'human biology' (Chomsky, 1975, 1980a; Lenneberg, 1967; Katz, 1966). The innate knowledge that is assumed to exist prior to the process of language acquisition is incorporated in three interacting but independent biological structures, called modules: a grammatical module that computes the relationship between form and meaning, a conceptual module that contains knowledge of the world and a pragmatic module that contains, for example, rules with respect to role taking in conversation (Chomsky, 1980b; Rosenberg, 1993). Neuropsychological research has provided evidence for the modularity assumption, for instance, observations of brain-damaged adults in whom left-hemispheric damage is associated with impaired grammatical competence, while conceptual and communicational competence appears to be intact (associated with the still intact right hemisphere (Marshall, 1990, Yamada, 1990; in paragraph 6 we discuss this subject more extensively). According to Chomsky, 'the "faculté de langage" is only one of the faculties of the mind' (1965, p. 56); there are also faculties for problem solving, concept formation 3 and social behavior concerning 'the place and role of people in a social world, the nature and conditions of work, the structure of human action, will and choice, and so on' (Chomsky, 1975, p. 35, see also Chomsky 1965, 1980a).

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3 Chamisky speaks of 'a system of beliefs, expectations, and knowledge concerning the nature and behavior of objects, their place in a system of "natural kinds", the organization of these categories, and the properties that determine the categorization of objects and the analysis of events' (1975, p.35).
In chapter 2, I showed that, in accordance with Chomsky, Fodor (1975, 1980, 1981) argues that learning something new can not possibly be based solely on asking and searching. In this section, I will repeat and elaborate in more detail on Fodor's point of view. According to every learning theory, learning is critically based on hypothesis formation and confirmation (generalizing and then testing the generalizations against experience). Hypothesis formation and confirmation imply that one knows already what one is searching for, making learning superfluous. Therefore learning must be based on instruction. In nativism this instruction is assumed to be located within the organism. It is conceived of as genetic instruction, a genetic program or an innate rule system. 'Cognition-first' theories and outside-in theories more generally, on the other hand, assume that instruction takes the form of learning in an environment. According to Fodor, this position is logically invalid. Suppose a child must infer the rule that specifies the declarative-question transformation (see chapter 2). For the process of learning the transformation to begin, the child must have an idea of what has to be learned. This idea, a hypotheses designating a tentative rule, is the input for the process of acquisition (1). The next step is to evaluate whether or not the transformations generated by the tentative rule agree with the format of question sentences found in the language environment (2). If the rule does not generate good question sentences, the hypothesis must be altered, for instance by means of corrections provided by competent speakers. Subsequently, the process of acquisition must be repeated. However, if the transformation rule generates appropriate question sentences, the hypothesis is confirmed and the rule is said to be learned. So the only way to derive a language rule is by selecting a rule from a database in which the rule has been present from the start.

The same argument holds for concept learning. It is not possible to acquire a new concept (say kissing), unless (1) the child is able to formulate a hypothesis about what the concept to be learned might mean. In other words, the meaning of the concept kissing can only be grasped if the child has already generated an input representation of the learning process that, for example, signifies the elephant and the teddy bear touching each other tenderly with their mouth). In the second stage of the learning process (2), the child subsequently evaluates whether this idea corresponds with what actually happens. After confirmation the concept is learned (output). The steps (1) and (2) are circular: the process of learning the output requires the existence of the output at the input phase. It is not possible to generate a hypothesis about concepts that cannot be represented in terms of other concepts, the so called primitive concepts. It is impossible to generate a hypothesis about such concepts without internal structure (like rain, wind, thunder, and lightning together making up the assembled concept thunderstorm), that is without using the concept itself. To grasp the meaning of 'wind' you have to use the concept 'wind' itself (of course you can describe the concept in other words, like for example the irregular displacement of air). Finally, the same paradox also holds for acquiring a new stage in Piagetian theory: a hypothesis about a new
mental structure requires the new structure to be represented within the old structure. Because
the 'cognition-first' view advocates the ongoing enrichment of cognitive structures, every new
structure must be represented in the preceding one. Again, the input for the learning process
requires essential features of the output. From this observation Fodor concludes that there is
no developmental mechanism that is able to explain how children can acquire new rules,
representations and cognitive structures ontogenetically. An adequate theory of development
must be based on principles other than learning and association. Such a theory does not yet
exist, so, according to Fodor, nativism is the best available alternative. Fodor even assumes
that all our primitive concepts are innate.

To summarize, UG is a theory which provides a condition of appropriate
determination, so constituting an answer to the logical question: how can children acquire
language? In other words, both the reason for assuming the existence of a UG, and the form
of the UG are based on the learnability of language, on the possibility of language acquisition.
Language must be learnable and the claim is that UG not only provides an exhaustive
description of the language structure of adult language users, but also yields an adequate
explanation of language acquisition. That is, language can be learned by any child who is
equipped with the principles, rules, and parameters of the UG.

4 Against Chomsky

As a description of the language competence of adults, UG has been generally considered to
be highly successful and accurate (Goodluck, 1991; Rosenberg, 1993; Reyna, 1993). However, as a developmental theory, a theory of acquisition, UG is less satisfactory. I shall
argue that the transformation of UG from a theory of description into a theory of
development involves nothing more than adding the unfalsifiable assumption that the `theory
of UG, is an innate property of the human mind' (Chomsky, 1975, p. 34).

In contrast to 'cognition-first' theories, UG does not describe a mechanism of
development. Instead it proposes a fixed, i.e. unchanging over time, system of rules and
representations. I will briefly repeat the criticism which was stated in chapter 2. UG is a
representational theory. However, although a system of rules and representations may
provide an adequate description of the language behavior of a language user, this does not
guarantee that the system determines behavior, and as such, is innate in the language user. For

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‘Fodor concludes '...there literally isn't such a thing
as the notion of learning a conceptual system richer than
the one that one already has' (Fodor, 1980, p. 149) and
further 'The only intelligible theory of enrichment of
conceptual resources is that it is a function of
maturation, and there simply isn't any theory of how
learning can affect concepts.' (p. 149).

UG is indeed conceived of as a theory of language
acquisition, see for instance Goodluck (1991)
example, the behavior of our dog may be perfectly comprehensible in terms of thoughts, intentions, and plan making which we assign to the animal. However, we can be almost certain that the animal does not use such things to control its behavior. Moreover, we can even comprehend the working of our computer at the intentional level (Dennett, 1978). Although the transformation from a declarative to an interrogative sentence may be comprehensible by assigning the language user the complex structure dependent rule ($H_2$, see chapter 2), there is probably no such rule in our brain at all. From chapter 2 we know that representational theories like UG make the error of assigning the semantics of the observer to the system being observed, just as we all do in our everyday lives. In doing so, the theorists are epistemic agents outside the system, defining the encoding relation that may indeed exist for the agents themselves, but that does not necessarily exist for the system under consideration. In short, the ontological reality of any description can not be proven by the degree of success of a particular description system. In addition, the fact that UG may provide a good structural description of the language system does not prove that UG is a good theory of language acquisition.

Chomsky's argument of the underdetermination of language skills seems completely plausible. However, on closer examination it may turn out to be less feasible than it seems at first sight. In the example of the declarative-question transformation rule, for example, the argument is that a child uses the complex structure dependent rule ($H_2$), including an abstract class (noun phrase), without even trying the simple structure independent rule first ($H_1$). It could be argued that the child's preference for ($H_2$) over ($H_1$) does not necessarily have to be built in. A child is not trying to learn a cluster of syntactic rules. What a child is interested in has something to do with manipulating semantics, meaning and communicating (Piaget stresses this over and over but does not complete the argument in the debate). If a child is trying to learn rules at all, semantic rules would be much more probable candidates than syntactic rules. Structure independent semantic rules simply do not exist (Putnam, 1980; Rosen, 1985). Consequently the child does not try out ($H_1$). Language acquisition takes off with semantics. Abstract structural concepts such as sentence, noun, and verb phrase are much more likely to be the primitives of a process of inferring rules than are physically marked sound-wholes or patterns. The fact that semantics are not easily computable (more precisely sequential or Turing computable, see chapter 2) is a problem of computation that is apparently not shared by children. The `poverty of the stimulus' argument implicitly comes down to the fact that the sonic or audio-spectral input stream does not explain syntactic order. This may ultimately turn out to be a much weaker argument than it seemed at first sight. After all, who would dare to argue that the primitives of music perception should consist of single notes with their individual duration, or that the primitives of speaking or reading are the letters of the alphabet. To conclude, the 'poverty of the stimulus' argument may in fact be less self-evident than that Chomsky took it to be (see also Bruner, 1975; Petrovich & Gewirtz, 1985; Tomassello et al, 1993). Of course it is possible that this objection does not hold and that the poverty of the stimulus argument is still valid. However, concluding from this argument that
language is determined or specified by a genetic control system which 'specifies the phonetic, syntactic, and semantic properties of an infinite class of potential sentences' (Chomsky, 1980a, p. 35), is not warranted. In fact, there are several reasons that make this conclusion almost preposterous.

4.1 Static representations

First, I would like to return to one of UG's key notions, representation, which was presented more extensively in chapter 2. Chomsky takes the language organ to contain representational content, holding that cognition can be decomposed into rules and representations (encodings of the outer world). Where the relationship between the encoding and the encoded is known, encoding may provide an accurate foundation for representational content. However, encodings cannot provide new content. Before representational content can be imposed on anything environmental it must have been present in advance within the system in order for the encoding relationship to be defined. So encoding cannot cross from outside to inside the system, nor vice versa. From this, Chomsky and Fodor conclude that all basic syntactic structures and representations must be innate. There is no way in which syntactic structure or basic concepts can be learned or developed. The burden is thus shifted to learning, or developing, rather than to theories of representation. This is a logical problem attendant on the concept of representation (encoding). It cannot be solved any better by evolution (ontogenetic innateness must stem somehow from evolutionary emergence) than by learning or development. In his book Genetic epistemology, Piaget (1970) points out the circularity incurred by making representations dependent on encodings (or instructions) instead of perceiving them as emergent manifestations of stabilized system-environment interactions. If our representations are copies of things in the world, then we must already know the world in order to construct our copies of it. By adopting the innateness-view we run into the problem of infinite regression of causes. Nativism is nothing more than transferring the problem of the acquisition of novel structures from outside the organism to inside the organism or, more precisely, from ontogeny to phylogeny. The question that remains to be answered is, if language is specified in detail by the language organ, what specifies the language organ? The search for specification can go on infinitely: what specifies the specification of the language organ etc. It can be concluded, therefore, that the question of the emergence of language, regardless of the timescale chosen, has not yet been answered. We need a theory of development to show how structures emerge from, or are determined by, other structures or elements. In the innateness-view, the problem of language acquisition is displaced from ontogeny to evolution but no account of the evolutionary emergence of language structure is given. So UG is not a developmental theory, neither at the level of ontogeny nor at the level of evolution. The problem here is again the problem of encoding. Encodings cannot account for their own basic encoding. In chapter 2 we concluded that representations would be
impossible if 'encodinism' were right. Fodor's argument is another example of laying the burden on learning instead of on representation. Fodor's learning paradox shows the impossibility of making a learning mechanism exclusively dependent on inductive extrapolation: a credible theory of development must devise another mechanism (see Tomasello et al, 1993). However, Fodor's conclusion that all rules, representations, and new cognitive stages must be innate cannot be true. It could just as easily be argued that rules and representations are real features not of the developing systems themselves, but rather of the epistemic agents that observe the systems. In fact, it is possible to conceive of Fodor's argument as falsifying the innateness view. It is not plausible to assume that prehistoric people were waiting for the right circumstances to select concepts like computer, and Universal Grammar from their innate database. From this it follows that hypothesis generation and evaluation does not explain learning: Fodor's very own argument can be used to falsify his own conclusion. Many learning theories rely heavily on the view of intra-individual events, consolidation processes, as causes of both stability and change. In this way, one does not gain any insight in enculturation processes. Nativism is not a viable alternative to the learning paradox.

4.2 The degrees of freedom problem and the robot's dilemma

A similar problem occurs in more practical attempts to engineer from a computational frame of mind. The conceptualization of cognitive abilities as stemming from a computational system, i.e. a computer system consisting of rules and representations expressed in algorithms and data matrices, has recently become more widely discredited (Van Gelder, 1992; Smolensky, 1988). Designing a robot from a classical Artificial Intelligence computational conception, that is, from the kind of rules and representations that form UG, has turned out to be difficult if the robot is required to adapt its behavior, even to very slight changes in a severely restricted world (Edelman, 1987). For example, let's consider a robot that is designed to paint cars. Even an infinitesimal change in the angle between the car and the paint arm will indisputably cause dramatic effects. In contrast, both men and animals move in a very adaptive (plastic) fashion through their worlds. Somebody putting a cigarette in his mouth while speaking, for instance, usually remains perfectly understandable, notwithstanding the significant changes that occur in the contraction of the lips, tongue, and facial muscles. All these changes are hardly, if at all, noticed by the listener. However, in making a robot behave adaptively, one should be prepared for every possible change in the environment, or better, in the robot-world interactions. In other words, every conceivable change in the system-world interaction must be encoded in advance. That is, for any conceivable change in the environment there has to be a representation within the system that matches with that change in order to keep the system on track in the changing world. This problem is called the problem of the degrees of freedom: in any computational device the world is met from a central
controlling (rule) system, comparable to a UG, in which the world is somehow represented. This requires that any possible system-environment change (degree of freedom) be represented in advance (see also Bongaardt, 1996). Moreover, a system has to be able to decide immediately whether or not an environmental change has serious consequences for its behavioral possibilities, whether or not it has to anticipate or react. The degrees of freedom problem forms a serious threat to computational devices like UG. It is called the frame problem or the robot's dilemma (Pylyshyn, 1987). It states that it is inconceivable to model in an artificial device the capacity to perceive and react promptly to relevant effects of incidents (see Haselager, 1995). For similar reasons it is not possible to have a robot acquire any natural language. Both knowledge of the world, and different ways of adapting to change have to be put in the system before it becomes operational.

So nativists expect human biology to provide an account of the emergence of the biological structure, the language organ, that they assume. They thus suggest that ontogenetic novelty is impossible. Nativists claim that UG is in the genes. However, this calls for plausible scenarios about how it got there in the first place and how it can express itself in the process of language acquisition (De Graaf, 1995). The latter ontogenetic project, seemingly essential for a nativistic theory, has to my knowledge, not yet been undertaken. To establish the innateness-view, one must begin by making the evolutionary emergence of a language organ probable. In fact, however, nativists leave the burden completely to biologists (who do not appear to have any intention of solving the language problem). This leads not only to the already mentioned problem of the infinite regression of causes, but also to the problem that the conceptualization of ontogeny as somehow determined by evolution seems more and more implausible. Contemporary biologists seem increasingly to agree that evolution starts with ontogeny (ontogeny is assumed to furnish the conditions for the developmental mechanism) (Goodwin, 1985; Costall, 1985; Kauffman, 1993; Gottlieb, 1992). In stating that ontogeny is caused by phylogeny, Chomsky's position reveals a form of reductionism that has been widely abandoned in modern developmental biology (more on this in chapter 4). Just like any other cognitive ability, language ability can not conceivably be the outcome of a process of blind and random mutations. Instead it must have been buffered or canalized by processes at the level of ontogeny (Gottlieb, 1991). Language skills are basically functional (Piaget, 1980). Although the language system may not be functional at the structural level, it is functional in that it compresses the degrees of freedom (the search space) of other language users by supplying strict restrictions. This results in an obvious temporal organization or sequencing of speaking, making it possible to communicate.
4.3 The entropic assumption

A third problem can be associated with Chomsky's program. One important nativistic or preformistic assumption that underlies UG is that the output of a behavior producing system can never exceed the sum of the input and the pre-existing rules that process the input (Mohanan, 1992). This *entropic assumption* (De Graaf, 1995; see also chapter 6) states that the complexity of a system can only decrease over time. If entropy holds, then if a system seems to increase in complexity over time, the extra complexity must have been there all the time. That is, it is just becoming manifest in time. From birth, children are supposed to be equipped with knowledge of all possible languages that can be derived from UG. If a language does not express some principle of UG, it is because that particular language lacks the prerequisite form. Mohanan (1992) shows how erroneous conclusions can be derived from this entropic assumption: ‘Suppose the black box contains a concentrated solution of some sort. If we produce a disturbance in the solution, say by cooling, the final state will be a set of highly structured crystals. When extended to crystal formation, the logic for the argument for innately pre-specified principles in LAD would force us to conclude that the black box originally contained crystals (not just the solution) because crystals are part of the final state but not the input' (Mohanan, 1992, p. 650).

Closed systems are perfectly entropic. In contrast, most biological, and psychological systems are (to a large extent) open. In the long evolutionary track from single celled organisms to, for example, mammals, many reorganizations have occurred. These reorganizations have repeatedly resulted in a degree of complexity that has exceeded the sum of input and complexity of the system before the transformation. One example is the emergence of a system of blood vessels to make intercellular communication possible within larger systems of cells. On an even longer timescale, the development from the big bang, via atoms, molecules, crystals, single celled animals finally up to the human mind, displays a persistent increase in complexity of arrangement.

According to the entropic assumption, the UG represents predetermined knowledge (Crain, 1991; Chomsky, 1986). UG is a theory of the initial state of the language organ, `prior to any linguistic experience' (Chomsky, 1986, p. 4). So what students of language acquisition take to be innate is something synonymous to unlearned (Oyama, 1990), that stands in sharp contrast to knowledge that is determined by learning. With the entropic assumption leading nativists to postulate a language organ to help explain why ‘different learners converge on similar mental representations on the basis of dissimilar environments' (Crain, 1991, p. 597), innatism assumes implicitly that the structure of the language organ is just a larger expression

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6 Innateness and learning do not stand in a perfectly symmetrical relation to each other. They relate to different biological levels of aggregation. Learning relates to cognition and action, while innateness relates to genes and proteins within nuclei of cells, which of course do not process or regulate speech input and output.
of the genetic code. This assumption also leads to the previously mentioned infinite regression of causes. In embryology there was a very similar preformatist view that stated that the DNA in the egg contains a blueprint of the human body. This view, however, has been rejected in modern embryology (Gottlieb, 1991; see chapter 4 and 6). The structure of an organ such as the brain is not a simple instantiation of a genetic code, but rather the result of a great number of dynamic processes, like cell growth, migration, synaptic generation and degeneration, and so on. Many environmental effects other than learning alter developmental trajectories. These include the physical, chemical and electrical intercellular environment of genes to which learning is unrelated, but without which the genes cannot survive (Gottlieb, 1992).

To summarize our criticism, three fundamental objections to Chomsky's nativism have been identified: the first addressed the ontological reality of the concept of representation, the second identified the so called 'degrees of freedom' problem, and the third addressed the entropic assumptions underlying nativism. It can be concluded that, although Chomsky's theory is perhaps a vigorous theory at the descriptive level, there are a lot of essential things which UG cannot explain. In fact UG is not a developmental theory at all. Consequently, its claims with respect to the development of language are inadequate.

5 Piaget's theorizing

In summarizing Piaget's theorizing, I shall first explicate Piaget's general theorizing about development and ontogeny and, second, focus on his ideas about language acquisition, although he spent much more time on the first focus of inquiry.

5.1 General theorizing about development

Whereas Chomsky's theory is a theory of assumed constituents, Piaget's theory is a theory of organization. Water and ice have the same content or composition, but their different forms cannot be explained by stating that one form appears above zero centigrade and the other below. According to Piaget, explanation of form always requires a theory of process or organization (Goodwin, 1990) rather than a statement of constituents, (even when this is accompanied by a list of the conditions that must be obtained during the generation of specific forms out of the constituents - entities or structures).

Theories of development aim at explaining the origin (emergence) of form, which implies constructing theories in terms of organization. In the case of Chomsky's theory, however, the focus is on content, for instance, specific syntactic or semantic structures. Nothing is said about processes specific of change. With the form-content problem in the water-ice example, understanding, in a generative sense, of the behavior of liquids had to wait for a theory of dynamic space-time order that characterizes the liquid state of matter.
(Goodwin, 1990). Similarly, no matter how much we learn about grammar, syntactic structures, or assumed mental organs, the process of language acquisition will not be understood until we have an exact description of the type of dynamic organization that characterizes the process, and leads to the newer (i.e. closer to the final form) states (Piaget, 1980).

Piaget sought to explain development by formulating a theory about the organization behind the entities and structures to be studied. He dealt directly with the process of knowledge acquisition. He proposed a general mechanism, called construction, through which richer structures emerge out of poorer ones through equilibration. Equilibration refers to `a process which leads from a state of near equilibrium to a qualitatively different state at equilibrium by way of multiple disequilibria and re-equilibrations' (Piaget, 1985, p. 3). He stressed the importance of a theory of organization in the explanation of ontogeny, and the impossibility of explaining cognitive structures in terms of their (assumed) constituents. In terms of the earlier water-and-ice example, the different forms that H$_2$O can assume are not explicable solely in terms of its constituents. Piaget calls his theory constructivistic. He was accused of empiricism by Chomsky because he paid much more attention than Chomsky did to the role which is played in development by external factors which have their effect on the ontogenetical level and thus run counter to a broad range of biological (evolutionary) claims.

Piaget stressed that novelty cannot be solely addressed at the evolutionary level, that in fact ontogeny must be central in evolution (see chapter 6 for an extensive discussion of this view). A steadily increasing number of contemporary biologists is similarly questioning traditional evolutionary theory, suggesting that Darwinism can only be saved by giving ontogeny a central place in evolution theory (Depew & Weber, 1995; Gottlieb, 1992). In contrast to nativistic theories, constructivistic theories postulate a developmental mechanism to account for the ontogenetic emergence of cognition (although current ideas as to the nature of this mechanism may turn out to be wrong).

While the concept of construction is used in both Piagetian theory and linguistic theory its meaning is distinctly different in the two theories. In linguistics, it is taken to be a logical mechanism. The child constructs principles and rules of the grammar within the boundaries of UG in order to account for the (adult) input (Chomsky & Halle, 1968). More recently, interest has shifted away from construction towards the concept of selection (Chomsky, 1981, 1986; Piattelli-Palmarini, 1989, 1994). Nevertheless, in psycho-linguistics construction and selection theories share almost all important assumptions and characteristics. In selection theories, the rules and principles of every possible language are innately available, and the child selects the appropriate values for the parameters of the innate system on the basis of the input data. In constructivistic theories only the universal grammar exists in advance, while the actual rules that generate language production are constructed out of the existing components, structures, and forms within UG. In both nativistic (vertical) theories, the child is born with an explicit language organ. The difference concerns the procedure by which the innate language specific knowledge is assumed to be mapped onto the actual
language of the society in which the child is raised.

Constructivism, as advocated by Piaget, offers a rather different and more fundamental concept of construction. Constructivism in the Piagetian sense means structure formation in an open (dynamical) system, in which the child adapts to the input data (accommodation) and in which the input data are adapted by the child to already developed, or existing structures (assimilation). An essential concept in Piagetian theory is autoregulation, which refers to a kind of functioning that forms elementary mental structures, which are then used as they are, or after modification, as building blocks in new regulations in an iterative prospective (re)construction process (Piaget, 1971). Construction in the Piagetian sense refers to a horizontal process, as new or more mature structures are not contained in earlier, more primitive structures. The task is then to account for language acquisition in terms of a horizontal constructivistic theory. Piaget's theory is called constructionism because, in the process of autoregulation, new elementary structures are constructed. These new structures provide the input (the building blocks) for the next steps in, or the continuation of, the very same process, leading to a continuing, iterative process of constructing adaptive system-environment ensembles. Structures emerging later in development are qualitatively different from structures emerging earlier. Piaget's constructivism is essentially based on an endogenous mechanism. Construction is superior to instruction. New knowledge is better acquired through the constructions of the self-organizing mechanism than through instruction: ‘Remember also that each time one prematurely teaches a child something he could have discovered for himself, that child is kept from inventing it and consequently from understanding it completely’ (Piaget, 1983, p. 175).

Piaget stressed the neg-entropic features of organisms, which are open systems. Recently there has been an enormous increase in interest in the question how complexity can increase over time, the subject of order from chaos (Prigogine & Stengers, 1984; Mohanan, 1991; Geyer, 1994). It is impossible to derive the degree of organization in a linear way from the input and the state of the system (rules, representations etc.) in systems whose complexity is increasing. The theory about order from chaos has therefore been called the theory of non-linear systems or the theory of dynamical systems. In such non-linear systems, the interactions between elements of the input and elements of the system lead to a newly ordered configuration of all elements (self-organization)

5.2 Piaget's theorizing about preformation and universality

According to Piaget (1976), language does not develop independently of non-linguistic

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7 In the Gestalt psychological phenomenon of the whole being more than the sum of parts, we can witness a psychological case of non-linear interactions between elements leading to a new configuration. The whole cannot be derived or reduced to the working of its constituting parts. The fact that the trot precedes the gallop does not imply a causal/chronological relationship; they are just two possible manifestations (configurations) of the
cognitive domains, in particular of the domain of symbolic functioning or thought. The roots of both thought and speech are found in the products of other psychological domains, like perception, senso-motor functioning, emotion, and motivation. Because of this presumed interdependence, language acquisition is assumed to be constrained at every developmental stage by prior non-linguistic achievements, and language acquisition must be studied within the total organization of cognitive development. Piaget classifies four stages through which the development of every child proceeds. Although they are universal, these stages are not preformed. Universality follows from laws and accidental, i.e. a-specific (not instructive), 'constraints' or restrictions. Universality is not determined by a pre-existing blueprint, which indicates that it is in fact an 'epiphenomenon', an emergent property. For example, when water is allowed to flow indefinitely into a number of cups, every cup will ultimately overflow. Let us assume first that due to some a-specific restrictions like the size of the hands, and mouths of the cup-users, the capacities of the cups do not differ too much and, second, that the volume of water flowing in per second does not vary from cup to cup due to some other a-specific restrictions. The moment at which the cups overflow will be quite predictable, universal. As we have seen, Chomsky also proposed the notion of restrictions, that is principles and parameters that restrict the hypothesis space of all potential syntactic structures. However, while Piaget's restrictions are emergent epiphenomena, Chomsky's restrictions are instructive and specific. In the water example, according to Chomsky the overflow would be preprogrammed by a rule: at time \( t_s \), do action 'overflow', requiring a representation of the process of overflowing within a blueprint. According to Piaget, characteristic schemes (a scheme is a strategy to organize perception, thought, and action) are formed at every stage, leading to an increase in the degree of structure of perception, thought, and action. In locating the position of a child with respect to his environment, Piaget identifies two processes: assimilation and accommodation. Assimilation can be defined as 'the integration of new objects or new situations and events into previous schemes' (Piaget, 1980, p. 164). For example, by assimilating them within the scheme of grasping, some nearby, small objects are transformed into things to grasp. Accommodation generates a mechanism of active endogenous (organismic) selection, focussed on increasing adjustment, which imposes a new, and wider, range of dynamic adaptation (see Piaget, 1980, p. 165). For example, the more intricate scheme of visually guided grasping is an accommodation which emerges in response to the repeated coincidental occurence of interactions between the scheme of seeing and the scheme of grasping. So, while in assimilation the interpretation of reality changes (reality is met from a particular structure or perspective), in accommodation the structures themselves change, become adapted to reality. To account for both accommodation, and assimilation, Piaget (1976) suggests a biological mechanism, called equilibration or autoregulation. The origin of every mental structure is the result of the process of equilibration (Piaget, 1971); in contrast to Chomsky, Piaget rejects the idea of innate structures: 'knowledge does not result from a mere recording of observations without a structuring activity on the movement system (like waves and particles).
part of the subject. Nor do any a priori or innate cognitive structures exist in man; the functioning of intelligence alone is hereditary and creates structures only through an organization of successive actions performed on objects' (Piaget, 1980, p. 23).

5.3 Piaget's theorizing about language acquisition

Some perceptual discriminations, for instance the figure-ground discrimination, must be assumed to be innate (Piaget, 1971). In the senso-motor stage, two elementary schemes are constructed from a undifferentiated stream of internal and external stimuli: 1. subject (world inside) and object (world outside), and 2. stable objects in the ever changing world of stimuli. The complete scheme of objects extends the immediately perceptible, requiring the perception of object constancy despite changes in time and space, and thus enabling the child 'to evoke persons or objects in their absence' (Piaget & Inhelder, 1969, p. 3). Language behavior first becomes possible when a child has developed the ability to think independently of objects and persons, that is, to evoke them in thought even in their absence. In the pre-operational stage (2-7 years of age), the child subsequently learns to use symbols, tools and instruments (means to an end) and language (signs for things). The roots of both language and the ability to use instruments are thus found in one single achievement, namely in the symbolic function, made possible by prior senso-motor developments. During the next phase, the stage of concrete-operations (7-11 years of age), the child develops the ability to employ logical operations, like reversing, grouping (classifying), and sequencing. Classes and categories are also of great importance in the formation of semantic and syntactic categories (Inhelder & Piaget, 1964). According to Piaget (1980), one general cognitive mechanism is responsible for the emergence of hierarchical structures in a wide range of mental domains, from language to constructive play. In all of these domains, a child begins with the separate elements before learning to combine them, and thus to construct more complex hierarchical structures. During this stage, before building a complete garage, a child learns to construct the separate constituent parts. He first builds a petrol tank, then he works on a car-wash place, and subsequently on the showroom, before he combines the parts into one total construction (the garage). The same general sequencing ability is displayed in the construction of complex, hierarchical language structures, such as, passive and embedded sentences. In a relative clause, for example, the argument is interrupted, and later continued: 'The elephant, *which I had when I was still a baby*, is still mine'. Temporal abilities are also demanded in the production of passive sentences ('The elephant was held by me') and the detachment of the temporal sequence of a sentence or relative clause from the factual order ('The baby plays with the elephant whenever put in the playpen by his mother'). In the stage of formal operations (11 years of age and older), a child reaches the highest level of mental development, which is displayed in the ability to carry out mental experiments, and to test hypotheses (see for example Sinclair, 1975). Developments in this stage do not affect language acquisition.
6 Against Piaget

It is important to note that Piaget's language acquisition theory is both less specific and less refined than Chomsky's UG. In fact, it is nothing more than a couple of general notions about language acquisition. Piaget's 'cognition-first' conception conflicts with Chomsky's 'innateness-view' in two ways. First, Piaget rejects the notion of preformation. Second, Piaget does not assume the idea of domain specificity with respect to cognition (that is, he does not acknowledge the modularity thesis). In this second area of disagreement, Piaget is at least partly wrong, as will be shown. According to Piaget, senso-motor development forms the roots of the development of symbolic functions, which in their turn, form the roots of language acquisition. An essential precondition for language learning is the development of the ability to 'evoke persons or objects in their absence' (Piaget & Inhelder, 1969, p. 3); other cognitive achievements are taken to constrain language learning at every step of the acquisition process. In neuro-psychological investigation one may search for dissociations between language skills and skills in other cognitive domains. The expected relationship is often found: mental retardation usually causes a delayed development with respect to both language, and general cognition (e.g. Wing, 1975; Graham & Graham, 1971). However, there is some contra evidence.

Marshall (1990) showed dissociations between syntactic and conceptual knowledge. He concluded that 'many aphasic patients with grossly abnormal grammatical abilities show little generalized conceptual loss' (p. vii). Furthermore, for example, relatively intact syntactic-, or intellectual abilities are sometimes observed in patients suffering from closed head injuries, and Alzheimer dementia (Cherkow & Bub, 1990, they speak of 'semantic memory loss'). In these cases, isolated dissociations between knowledge of concepts and their context, and the signification of concepts are observed. However, because the dissociations occur after the phase of acquisition, the cases cited thus far do not prove that the 'cognition-first' approach is wrong. It is still possible that the causality between cognition and language is fundamental but not mutual. It may be true that cognition is a prerequisite for language to develop, and that development results in the formation of isolated systems that may decline rather independently of each other; the resulting systems may be located in different brain areas, which can be damaged in isolation, resulting in partial deficiencies.

In the book *Genie: A psychological study of a modern-day 'Wild Child*, Curtiss (1977) reports the case of a girl who was isolated from any normal human contact for years. When found, she was thirteen years old, and still completely unable to communicate through language. When she was placed in a normal environment, she was surprisingly fast in naming things, affairs, and even abstract concepts. She soon displayed conceptual knowledge about the world, expressed in dichotomies like material-immaterial, future-past, body-soul etc. However, the syntactic structure of her utterances remained almost completely random, the words were arranged in any order without any hierarchical organization of syntactical representation. Apparently, Genie's syntactical disabilities did not stem from some conceptual
deficiency. However, it is not possible to conclude from this case that the 'cognition-first' view is wrong. It may be the case that cognition is not the only prerequisite for language. There may be other, more age-related conditions (critical periods) which must be met.

In addition, Curtiss (1988a) reports cases of children suffering serious mental retardation (for example the syndromes of Down and Turner) whose linguistic achievements, particularly as regards grammar, are far superior to their non-linguistic achievements. Yamada (1990) describes a girl named Laura with an IQ score of below 40. In spite of serious deficiencies in the domains of conceptual semantic, non-linguistic cognition, social communication and pragmatics, Laura displayed relatively intact phonologic, morphologic, and syntactic competence. Laura spontaneously produced linguistic structures which, according to Piaget, stem from concrete-operational capabilities, like for instance reversals and relative clauses ('She, does paintings, this really good friend of the kids who I went to school with last year, and really loved.', p. 28). However, on performing the tests that Piaget has designed to measure the cognitive abilities that are assumed to hold to be the pre-requisites of these linguistic structures, Laura failed completely. In many of her grammatically correct sentences, Laura appeared not even to be able to grasp the full meaning of the words and phrases of these sentences: 'Often Laura used words and phrases that fell within the correct semantic category or domain (a location, a date a number, and so on)... but her response was factually incorrect' (p. 49). When asked which month it was, Laura answered: 'This is 1977'. It was 1980. None of the non-linguistic abilities were spared. For example, while able to produce up to 20-word sentences, her short-term memory span did not exceed three items\(^8\), and other non-linguistic, left-hemisphere 'controlled' processes like sequencing, were also very poor. Furthermore, she was completely unable to understand numbers. However, when imitating, Laura automatically corrected syntactically and, to a certain degree, semantically incorrect sentences. She was unable to imitate wrong sentences without correcting (probably due to her limited memory-span). Furthermore, she displayed syntactic creativity. The fact that Laura has a relatively intact linguistic system despite almost completely impaired cognitive capabilities falsifies the 'cognition-first' view: language appears not to be reducable to perceptual, cognitive, and social factors. Many of the prerequisites put forward by 'cognition-first' theories turn out to be insufficient or even unnecessary to explain language acquisition. Although Piaget's general ideas about development may still be valuable, his language theory is wrong: the ability to construct hierarchical, embedded structures at the syntactical level has been shown to be independent of the ability to produce and understand embedded structures at the semantical level.

It was argued that both cognition-first theories and nativism are in serious trouble. The former is ruled out by the available empirical evidence, while the latter overlooks the notion of

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\(^8\)As a matter of fact, sentence length in both the expressive and the receptive language of normal pre-school children also exceeds memory span, suggesting that memory capacity does not play a major role in the development of morphosyntactics.
process, wrongly assuming that the language producing system is a closed system, and thus landing in serious ontological trouble. If we combine the best of both theories, we may describe the emergence of language behavior, for example, as the successive rules of UG, and as changes of organization in an open system. Changes in open systems can be described in terms of the theory of dynamical systems (TDS), first proposed in thermo-dynamics.

To summarize, the ‘cognition-first’ theories have difficulty explaining why, in some forms of pathology, people are perfectly able to exploit the generative nature of morphologic (or syntactic) structure but are completely unable to combine objects into hierarchical structures. Language abilities may be independent of other cognitive abilities. People with serious mental retardation nevertheless show linguistic abilities far beyond their non-linguistic status (cf. Yamada, 1990). However, Greenfield (1991) suggests that the same structures in the brain (Broca's area) serve both object combination and language learning in children under two years of age, but that these progressively differentiate after age two. With respect to Chomsky's theory we have concluded that, although it is perhaps a strong theory at the descriptive level, it is not a developmental theory. With respect to Piaget's theory, our conclusion may be just the other way round: Piaget's theory may provide a few profound recommendations on how to construct a sound developmental theory but, with respect to language acquisition, it is in fact no theory at all.

7 Conclusion: both sides needed

In this chapter I have tried to show that both Piaget and Chomsky were right, but only up to a certain level. They were right in so far as their ideas addressed their own expertise: developmental theorizing in Piaget's case, and a structural description of language (UG) in Chomsky's case. A compromise is possible. If Chomsky's poor ontology (to conceive of language as being preformed in the language organ) is replaced by a Piagetian developmental perspective, the instructive restrictions - rules and parameters - in the hypothesis space as postulated by Chomsky can be conceived of as a-specific restrictions. Subsequently, how such rules and parameters emerge in a self-organizing developmental process can be studied. This is an enormous challenge to developmental psychologists, and some have already welcomed it (e.g. Tucker & Hirsch-Pasek, 1993; Tomasello et al, 1993; Mohanan, 1992).

Unfortunately, while Chomsky's nativistic claims in particular are inconvenient, many developmental psychologists traded in their own identity - development - for nativism. They were seemingly very much impressed by Chomsky's successes (see for instance Carey & Gelman, 1991). Those developmental psychologists make the error Chomsky and Fodor made. However, they should have known better. To Chomsky, nativism was only a strategy, probably intended to create room for mentalism in a strongly anti-mentalistic atmosphere. However, developmental psychologists are destroying the foundations of their own discipline if they embrace ideas in which the developmental dimension is discredited. They may have
become so tired of proposing developmental theories which, in the end, never turn out to be completely credible, that they have finally surrendered and joined the opposition. Perhaps, very much impressed by the bravura of the nativists, thinking if you can't beat them, join them, they are not entirely aware that they are primarily fighting themselves.