1 The growth of language

1.1 Introduction

The acquisition of our first language is a silent feat. Most probably, we have no recollection of it at all. In many respects, the feat is essentially accomplished by the time children are three years old. Yet it is "doubtless the greatest intellectual feat any of us is ever required to perform" (Bloomfield 1933, 29; cf. Gleitman et al. 1988). The purpose of this book is to (a) introduce the scope and nature of this "intellectual feat," and (b) highlight results from the last several decades from intensive scientific study of the mystery of its accomplishment.[1] In doing so, we will (c) attempt to articulate essential theoretical issues which concern the "explanation" of this mystery. Throughout, we will (d) develop the foundation for a theory of first language acquisition. This theory is fundamentally "rationalist," acknowledging the innateness of a powerful Language Faculty in the human species but integrating the role of constrained experience in the "growth of language" in order to explain language development. We will see that language acquisition is an inherently intellectual feat in that children do complex theory construction. The growth of language is mediated in the human species by complex symbolic computation.

Nothing is more specifically "human" than the knowledge of language. We have no firm means of scientifically determining how or when language originated in the human species. However, we witness this feat continually – in ourselves and in every child born.[2]

1.2 A logical-developmental perspective

The research for review here bears on an ultimate mystery: *the nature of development, specifically development of the mind.* Since development entails

[1] Intensive scientific study of language acquisition (empirical and theoretical) developed with the appearance of work by Roger Brown (e.g., 1973b) at Harvard, and Noam Chomsky (e.g., 1965) at MIT; Chomsky's famous critique of Skinner's (1957) book in 1959 confronted the problem of language acquisition directly. Lashley's "The Problem of Serial Order in Behavior" (1951) implicated language in cognitive science (Bruce 1994).

[2] Although "human beings were anatomically ready to speak more than 150,000 years ago . . . clear evidence that they were doing so does not appear for 100,000 years afterward" (Holden 1988, 1455; see also Lieberman 1992).

the creation of what is entirely new, it involves a compelling area of scientific inquiry. Knowledge of language, in turn, represents one of the most challenging areas of human development. This is not only because of the formal complexity and infinity of language knowledge, but also because we know that the acquisition of language cannot be derived by simple inductive theories of learning (in which we merely copy or imitate properties of our environment). This implies internal control of language acquisition.

Development of language reveals biological programming, suggesting "genetic control." Except under the most extreme conditions, one cannot help but acquire a language. A regular course of acquisition is generally followed, one not determined by changes in the environment, nor by "goal directed practice" or immediate "need" (Lenneberg 1966, 220; 1967). Given only minimal input, neither deafness nor blindness nor both combined need prevent it.[3] The lack of vocal production in the oral medium need not prevent it.[4] The lack of a good model need not prevent it.[5] Neither severe cognitive deficits nor severe intersocial and communicative deficits need prevent it.[6] Neither amoebae nor plants acquire it. Not even chimps or bonobos acquire it as humans do, although many species do have other marvelous means of communication.[7] In many ways, there appears to be a developmental program for language acquisition in the human species, which specifies sequence and timing of general developmental events as well as certain precise aspects of the "program."

Yet the "language program" cannot be completely innate. Children are not born pre-programmed to learn a *specific* language – any of the world's approximately 7,000 languages are equally acquirable,[8] but children not exposed to a language do not learn that language. This seemingly puzzling developmental issue provides the foundation for our investigation of first language acquisition.

Study of language acquisition today is characterized by distinct, and in some ways contradictory, approaches. At one extreme is "developmental" research, in which the course of acquisition over time is described empirically. At another extreme is a "logical" approach, in which the problem of language acquisition is analyzed formally, often independent of empirical observations of child language.

[3] Herrmann 1998; Keller 1999; Landau and Gleitman 1985; Meier and Newport 1990; Goldin-Meadow 2003.
[4] Kegl, Senghas and Coppola 1999; Lillo-Martin 1999.
[5] Feldman, Goldin-Meadow, and Gleitman 1978; Goldin-Meadow and Feldman 1977; deGraff 1999. Helen Keller, who ultimately accomplished language, was 19 months old when stricken by a fever leaving her blind, deaf and dumb (Hermann 1998).
[6] Smith and Tsimpli 1995 and Blank, Gessner and Esposito 1979, respectively.
[7] Hauser 1997; Hockett 1977; Marler in press; Terrace et al. 1980; Smith 1999.
[8] Grimes (1992) lists 6,703 languages, although she notes the difficulty in distinguishing "language" and "dialect," making it impossible to provide an exact number of existing languages. (See also Crystal 1997, especially pages 286–288.) Michael Krauss (1995), in a paper presented at an AAAS annual meeting (February 1995), estimates that humans probably spoke between 10,000–15,000 languages in prehistoric times; that the number is dropping and that 20–50 percent of the world's languages now are no longer being acquired by children (Gibbons 1995). Ladefoged (1997) estimates that only 3,000 languages will remain in 100 years time. Hale 1994 estimates that only a few hundred languages may be acquired in our great-grandchildren's time.

A related tension exists between developmental paradigms such as Piaget's (1983, 23), wherein the essence of understanding cognitive development lies in studying the "very process of its transformation," i.e., in the study of developmental change *per se* over time, and a paradigm such as Noam Chomsky's in which the most powerful approach to understanding in this area lies in a formal characterization of what he terms the "Initial State" (e.g., 1980).[9]

These approaches must be merged if the essential mystery of human language acquisition is ever to be solved. We will attempt to do so in this book both by providing a description of empirical facts of language development and linking these to important theoretical issues regarding the nature of language and the mind.

1.3 Current research questions

Our developmental survey of language acquisition allows us to address several questions regarding language development which researchers in many laboratories are actively pursuing. What is it about the human mind that makes it possible to acquire language? Which aspects of the language program are biologically programmed? What specifically linguistic knowledge is evident at early periods? What underlies apparent differences between language acquisition in children and adults? Is there a "critical period" for language acquisition that critically distinguishes first and second language acquisition? How does the acquisition of the "end state" of specific language knowledge arise on the basis of biological programming of the Initial State? How do children "project" from the finite data to which they are exposed out to the knowledge of the grammar? Are there *universal* specific stages in the acquisition of sounds and structures of language? What determines the change in children's linguistic knowledge as they develop?

1.4 Language acquisition, linguistic theory and cognitive science

Linguistic theory provides hypotheses regarding a biologically programmed Language Faculty (e.g., Chomsky 1986; 1988a, b; 1999; 2000). In Cognitive Science, "the fundamental design specifications of an information-processing system are called its architecture" (Simon and Kaplan 1989). We may assume that the linguistic theory of the Language Faculty is a theory of the cognitive architecture for language knowledge and acquisition.

If there is a Language Faculty, what is its precise content, and how is it represented in the mind and ultimately in the brain (e.g., Matthews 1991, Pylyshyn

[9] Piattelli-Palmarini (ed.) 1980 reflects this "Piaget–Chomsky" debate; see also Mehler and Dupoux 1994.

1991)?[10] How does this theory contribute to our understanding of language acquisition and development? To what degree is the architecture of the Language Faculty independent of other cognitive components, and to what degree is development of language independent of other aspects of cognitive development? How does the Language Faculty constrain and direct experience? Does the Language Faculty itself develop over time in the individual?

1.4.1 Competing models

We assume "cognition can be understood as computation" (Pylyshyn 1980, 111). Current representations of the Language Faculty of the Cognitive System are defined in terms of a central "computational component," i.e., C_{HL}, Computation for Human Language (Chomsky 1995, 225; Uriagereka 1998).

On the other hand, several other current proposals for cognitive architecture have begun an attempt to account for language acquisition without the assumption of a Language Faculty. These are often referred to as "connectionist" or "neural nets" models. Although these alternative models admit the computational nature of human cognition, many deny its specifically linguistic nature as well as its symbolic and representational nature.[11] They deny the "combinatorial structure in mental representations" (Fodor and Pylyshyn 1988).[12] Can these alternative views be defended in terms of empirical evidence?

1.4.2 Cognitive Science and language development

The research for review bears on fundamental issues of cognitive science that must be addressed in all models. How is the cognitive architecture for language knowledge and acquisition related to the biological architecture of the brain? Is the development of language knowledge the result of a simple biological unfolding or "maturation," with gradual change in the fundamental architecture for language knowledge?[13]

Pylyshyn (1986; 1999) proposed that issues of language development may lie generally outside the area of Cognitive Science, and that they may be reducible simply to biologically determined changes in cognitive architecture. We suggest instead that language acquisition is inherently computational and thus as central to Cognitive Science as Cognitive Science is to it. Language acquisition is not reducible to changes in fundamental cognitive architecture for language. One of the major results of our research review will be that, on the contrary, this architecture is "fixed." There is no such thing as a "prelinguistic" child.

[10] "The amount of detail incorporated in an architecture depends on what questions it seeks to answer, as well as how the system under study is actually structured" (Simon and Kaplan 1989, 7).
[11] Elman, et al. 1996 argue against what they term "representational nativism" (367).
[12] Proposals termed "connectionist" vary widely. We return to these issues in chapter 4.
[13] In Cognitive Science, "the components of the architecture represent the underlying physical structures but only abstractly" (Simon and Kaplan 1989, 7).

Results of research reviewed in this book bear on the disciplines central to cognitive science today, from linguistics to neuropsychology. In *linguistics*: how closely does the current theory of "Universal Grammar" (UG) articulate the "Language Faculty"? Although the science of linguistics, a central component of cognitive science, seeks to discover the core principles of all natural languages (which are hypothesized to constitute a Language Faculty), issues remain on how best to obtain empirical evidence for it (e.g., Schutze 1996), and there are issues surrounding the application of Chomsky's theory of UG to actual language acquisition, which takes place in real time.[14]

Children can assist us in this discovery of the degree to which UG articulates the Language Faculty. Our study of children's language acquisition allows us to test, verify and develop linguistic theory, and we can use linguistic theory to guide precise scientific hypotheses about the child mind.

The research results reviewed here also bear on questions in *epistemology*: how is it possible that the human mind comes to know so much, based on limited, diverse and unstructured evidence ("Plato's Problem"), and to what degree is "innateness" necessary to solve this problem; and on questions in *computer science*, the fundamental science of complex knowledge computation; in *psychology*, whose central goal is the characterization of human intelligence, asking if the mind is "modular" in organization, and to what degree the nature of "learning" in this area of knowledge acquisition is inductive or deductive; and in *cognitive development*. Finally, the results will bear on those areas of *biology* and *neuropsychology* that address the relationship between "brain" and "mind."

1.5 The structure of this book

This book will pursue these fundamental issues by providing an introductory survey of existent research results in each basic area of language knowledge and its acquisition. This review will be situated in an introductory investigation of basic theoretical approaches to the study of language acquisition, and of basic research results regarding both the underlying biological matrix for language acquisition and the nature of experience in the human species acquiring language.

It makes little sense to characterize the acquisition of a domain without a reasonably clear concept of what the structure of that domain is, i.e., the goal and outcome of the acquisition process. For that reason, we follow a somewhat unusual mode of presentation in this book. Before discussing what we know of the language acquisition process, we call on modern linguistics to characterize what we know about children's goals. This will allow the reader to evaulate what current language acquisition research tells us about the acquisition process, and where there are gaps in our knowledge.

[14] E.g., Chomsky 1999; Atkinson 1992; Cook 1988; Lust 1999; Wexler 1999, Drozd 2004 on Crain and Thornton 1998 and related commentary.

After introducing basic issues in the area of first language acquisition, biological foundations of language and the role of environmental input in children's acquisition of language, we will consider each of the subsystems of language knowledge which are acquired and which have been researched extensively. Within each specific linguistic subsystem of language knowledge (*phonology*, *syntax*, and *semantics*), we will explicate the problem and issues in terms of "what has to be acquired." Each chapter begins by summarizing what we know about children's goals in that component of language knowledge. This characterizes the "Projection Problem" that they must solve.

Analogous to Lenneberg's classic (1967) description of behavioral developmental milestones in motor and language development (Appendix 1), we will provide a series of appendices that describe early intellectual milestones in the development of each of the basic components of linguistic knowledge. These milestones underlie the development of perception and production of speech sounds, syntax and semantics.

We will concentrate on discovering the origins, or foundations, of language knowledge as we pursue the role of the Initial State in language acquisition. Our emphasis will include cross-linguistic evidence from the acquisition of languages other than English (where research is available). This is in order to more closely approximate a discovery of the universal aspects of the "Language Faculty" and of language acquisition, and thus to begin to factor out which components are under biological control.

1.6 Toward a more comprehensive theory of language acquisition

Although we will survey existing empirical research, in the end we will also sketch directions for a new approach to a more comprehensive theory of language acquisition, that is, one which seeks to link theoretical explanation with investigation of the real time development of language, and one which considers all aspects of language development, i.e., not only syntax, but phonology and semantics as well. We will continually assess hypotheses regarding a biologically programmed "Language Faculty" and its contribution to language development in conjunction with description of real time development of children's language in each of the subsystems of language knowledge.

The research results we review in each area of language knowledge provide support for biological programming in the human species of formal properties of a Language Faculty, termed "Universal Grammar" (UG), and they provide evidence for the fundamental cognitive architecture of language as continuous between child and adult. This architecture reflects universal formal properties of language. This is a "Strong Continuity Hypothesis" (SCH) of UG. With regard to "mechanisms" of language development, we will conclude that neither a simple "maturational" theory of language acquisition nor a non-linguistic non-formal

approach is explanatory or empirically motivated (cf. Lust 1999). Current models of language acquisition, which do not admit the role of symbolic computation and of linguistic constraints on child language acquisition are insufficient.

Recent research shows that infants have a marvelous capacity for analyzing language input from birth. However, children's relation to input is always mediated by their grammatical knowledge. Their relation to input data is selective and constructive, and consequently indirect. We relate this paradigm to a proposal for "innately guided learning" (Gould and Marler 1987; Jusczyk and Bertoncini 1988; Marler 1991) which recognizes the dichotomy between "innateness" and "learning" but suggests that these are not mutually exclusive.

Unless somehow cruelly impaired, children everywhere, whether faced with Tulu in South India, Sinhala in Sri Lanka, !Xóõ in the Kalahari desert, or English in Manhattan or London, are endowed with a biologically programmed universal formal architecture for language. Because of this biological programming and a refined, almost indomitable "instinct to learn" (Marler 1991; Pinker 1994) and create, they construct vastly complex, infinitely creative and systematic symbolic theories of their own specific languages.

The intent of this book is to introduce fundamental questions and provide a theoretical and empirical framework within which more in-depth studies of the field can be subsequently conducted. Although we now better understand many properties of the foundations for first language acquisition than ever before, its essential mystery remains.

1.7 Supplementary readings

This book may be used in conjunction with a collection of classic readings in the field of language acquisition, Lust and Foley 2003, or with collections like Bloom 1996.

It may be used in conjunction with a general introduction to linguistics, e.g., Weisler and Milekic 2000; Aitchison, 2003b, Akmajian, Demers, Farmer and Harnish 2001; or Fromkin and Rodman 1998, Fromkin (ed.) 2000. *Language Files* (Jannedy, Poletto and Weldon 1994) provides a useful companion resource, as does Crystal's *Encyclopedic Dictionary of Language and Languages* (1992) and *The Cambridge Encyclopedia of Language* (1997). Smith (1989) provides a general introduction to the study of language. Frazier 1999; Gardner 1985; Karmiloff-Smith 1992; Fodor 1983; and Hauser, Chomsky and Fitch 2002 provide introductions to "modularity" in human cognition.

Other general introductions to the field of language acquisition include Aitchison 1998; Pinker 1994; Jackendoff 1994; Gleitman and Gleitman 1991; Cattell 2000; Barrett 1999; Foster-Cohen 1999; and Mehler and Dupoux 1994. Elman et al. 1996 present an opposing view to the one we present here. The CHILDES (Child Language Data Exchange System) website provides on-line databases for both

research publications in specific areas of language acquisition as well as for child language researchers (http://childes.psy.cmu.edu). A recent film series, "The Human Language Series" (Searchinger) provides a compelling introduction to the field.

For more general introduction to cognitive science and its relation to language acquisition see *The MIT Encyclopedia of the Cognitive Sciences* (Wilson and Keil, eds., 1999). Fodor and Pylyshyn 1988; Pylyshyn 1980; Smolensky 1991; Chomsky 1968/1972; Osherson (ed.) 1995; and Gleitman and Liberman (eds.) 1995 provide more advanced related material.

2 What is acquired?

2.1 What is language?

> In this chapter, we, like children, seek ". . . the discovery of the place of human language in the universe." (Hockett 1977, 163)

It is impossible to study the acquisition of language scientifically unless we address the question, "what is language?," i.e., "what is acquired?" (2.1 and 2.2). We sketch an overview of the linguistic computation children must acquire when they acquire a language, laying down a number of fundamental concepts and terms (2.3). We sketch the basic design of human language knowledge and the basic architecture of the human Language Faculty (2.4). We provide a framework for investigation into the nature of language acquisition. These foundations allow us to form the "essential questions of language acquisition" (2.5).

2.1.1 Attempting to define language

Language is first and foremost *symbolic*. Sounds, words and sentences represent and capture an infinity of possible meanings and intentions. We can produce, understand and think of an infinity of possible statements, questions, commands or exclamations. These may concern the future, the past, what has occurred and what has not, what is possible or impossible. Through language, we can tell the truth or lie, regret or hope. We can deploy an infinity of demands, requests, contradictions, ranging from poetry to propaganda. The next sentence we say or understand is almost certainly going to be one we have never heard or said before, suggesting that this symbolic capacity of language is in a real sense limitless.

This knowledge can be taken to superb heights of beauty and intellectual power, as in the writing of William Shakespeare or of Wallace Stevens, and to heights of charm and fun as in the writings of Dr. Seuss. What is language that it has this marvelous symbolic power?

1. "Look at me now!" said the cat,
"with a cup and a cake
on the top of my hat!
I can hold up two books!
I can hold up the fish!

And a little toy sheep!
And some milk on a dish!" (Seuss, 1957)

We will see that by about three years, children have acquired the foundations for this infinite symbolic power of language and through it can transcend immediate situations. The two-year-old speaking in (2) worked through his series of utterances to convince himself that an abstract painting of a mythical bird did not truly reflect a dangerous monster, and therefore shouldn't deter his walking past and up the dark staircase beyond.

2. a. No it's too bad . . . looking . . .
b. What's that one too bad looking?
c. That's too bad looking . . . .
d. They're 'caring me . . . . .
. . . *pause* . . . . .
e. I'm not 'cared of those things
f. They're only nice birds . . . (CLAL, BGO21097, 2yrs. 10 mos.)[1]

This child still did not include the initial "s" in certain consonant clusters as in the word "scared" (2d–2e), and still did not evidence full English relative clauses in (2b), where the intention was to question "the one that is very bad looking", and he did not have perfect mastery of the lexicon. However, he clearly had the essential knowledge leading to sentence formation, sentence variation by movement of elements (question formation), and several grammatical operations involved in the use of "only", "too" and present progressive verb inflection using "ing" as the verb ending, and he had the competence to map from form to meaning in new ways. What then has the child acquired?

Early in this century, we find the linguist Sapir's definition of natural language:

3. "Language is a purely human and noninstinctive method of communicating ideas, emotions and desires by means of a system of voluntarily produced symbols. These symbols are, in the first instance, auditory and they are produced by so-called organs of speech" (Sapir 1921, 8).

This definition of language is not sufficient for our purposes. It appears to assume, not define, the essence of what language is. In addition, we now know from more recent studies that not only oral (auditory) but sign (visual) languages have similar structural properties and are acquired at similar developmental periods with similar developmental patterns.[2]

About mid-century, the linguist De Saussure, sought to separate "from the whole of speech the part that belongs to language" (1959, 11). De Saussure's image in Figure 2.1 suggests this analysis: As De Saussure reasoned, "psychological" concepts represented in the mind are linked to "linguistic" sounds which are reflected in a physiological process: "the brain transmits an impulse corresponding to the (sound) image to the organs used in producing sounds"; this

[1] CLAL is an abbreviation for Cornell Language Acquisition Lab, the source of the data.
[2] E.g., Jackendoff 1994, chapter 7; Bellugi 1988; Kegl, Senghas and Coppola 1999; Lillo-Martin 1999; Meier 1991; Pettito 1988.