
Relevant Websites
http://www.biology.uc.edu/~audiospeech/wh-3lab.html
Dr. Lawrence D. Rosenbaum, University of California, Riverside, CA.
http://infantlab.ucf.edu/~infant-development-lab.html
Dr. Lorraine E. Barwick, Florida International University, Miami, FL.
http://infantcenter.ucf.edu/~infant-development-research-center.html
Director Lorraine Barwick, Co-director, Robert Lickliter, Florida International University, Miami, FL.
http://infantsstudied.psy.uq.edu.au ~ Infant Lab. Dr. George H. Hollich, Psychology, University of Western Australia, Perth, WA, Australia.
http://www.psychology.ucf.edu ~ Infant Studies Center. Dr. Janet F. Walker, Department of Psychology, University of British Columbia, Vancouver, BC.
http://www.media.mit.edu ~ Robot word learner. Dr. Deb Roy, MIT, Cambridge MA.

Language Acquisition Theories
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Glossary
Canalization — Canalization in genetics is a measure of the ability of a genotype to produce the same phenotype regardless of variability in the environment. More broadly, canalization refers to the developmental path of least resistance, the path typically followed by a species.

Corpus — A large collection of spontaneously produced utterances.

Ergative languages — An ergative language is one in which the subject of an intransitive verb (e.g., “Elmo runs home”) is treated in grammatical terms (word order, morphological marking) similarly to the patient of a transitive verb (e.g., “Bert runs in Elmo hits Bert”) and differently from the agent of a transitive verb (e.g., “Elmo runs home”). Ergative languages contrast with nominative languages such as English; in English, both the subject of the intransitive verb (“Elmo runs home”) and the agent of a transitive verb (“Elmo hits Bert”) are placed before the verb, whereas the patient of a transitive verb is placed after the verb (“Elmo hits Bert”).

Morpheme — A meaning-bearing linguistic form that cannot be divided into smaller meaning-bearing forms, for example, “unbearable” is composed of three morphemes, un, bear, and able.

Morphology — The study of how morphemes are combined into stems and words.

Motherese/parentese — The kind of speech that mothers (and others) produce when talking to infants and young children. It is characterized by higher pitches, a wider range of pitches, longer pauses, and shorter phrases than speech addressed to adults (also referred to as child-directed speech or infant-directed speech).

Null-subject languages — Some languages allow pronouns to be omitted from a sentence when the

Introduction
The simplest technique to study the process of language learning is to do nothing more than watch and listen as children talk. In the earliest studies, researcher parents made diaries of their own child's utterances (e.g., Stern...
Language Acquisition Theories

Theoritical Accounts of Language Learning

Behaviorism

Consistent with the psychological theories of that era, prior to the late 1930s, the child was considered just another behavior, one that can be acquired by the general laws of behavior. Take, for example, associative learning, a general learning process in which a new response becomes associated with another stimulus. Association seems to be a natural way to explain how children learn the words of their language, but it is not so simple. Quine's famous theoretical puzzle highlights this problem: Imagine that you are a stranger in a foreign country with no experience of the local language. You say 'garoupa' while pointing at a rabbit running in the distance. You try to associate the new response 'garoupa' with a particular stimulus, but which stimulus should you choose? The example of the rabbit? Its call? Its running? The grammar itself?

The possibilities are limitless and associative learning solves only a small piece of the problem. In addition to association, imitation, and reinforcement were also proposed as mechanisms by which children learn the grammatical 'habits' that comprise language. However, even the most cursory look at how children learn language reveals that neither of these mechanisms is sufficient to bring about language learning.

Children learn the language to which they are exposed and, in this broad sense, learn language by imitation. But do children model the sentences they produce after the same sentences they hear? Sometimes they do. Sometimes they are not imitators. Moreover, the children who are imitators do not learn language any more quickly than the nonimitators. Even the children who randomly choose do not copy everything they hear — they are selective, imitating only the parts of the sentences that they are able to process at that moment. Thus, imitation is guided as much by the child as by the sentences the child hears.

What about the responses of others to children's sentences? Parents might positively reinforce sentences their children produce that are grammatically correct and negatively reinforce sentences that are grammatically incorrect. In this way, the child might be encouraged to produce correct sentences and discouraged from producing incorrect ones. There are two problems with this account. The first is that parents do not typically respond to their children's sentences as a function of the grammatical correctness of those sentences. Parents tend to respond to the content rather than the form of their children's sentences. Second, since parents can correct the child's grammatically incorrect sentences treated differently from their grammatically incorrect sentences, it is still up to the child to determine what makes the correct sentences correct. For example, if the child says a grammatically correct sentence, "I colored the wall blue," and another responds with positive reinforcement (thus ignoring the sentence's troubling content and focusing on the sentence), the child still has to figure out how to generalize from the sentence — she needs to understand the patterns that generate the sentence in order to recognize that one analogous sentence (e.g., "I saw the wall blue") is not grammatically correct while another (e.g., "I pounded the clay flat") is. In other words, there would still be a great deal of inductive work to be done even if children were provided with a set of correct sentences to imitate.

The behaviorist account of language was dealt a devastating blow with the publication in 1959 of Noam Chomsky's review of BF Skinner's Verbal Behavior. Chomsky argued that adult language use cannot be adequately explained in terms of sequences of behaviors or responses. A system of abstract categories underlies each individual's knowledge and use of language, and it is these rules that children acquire when they learn language.

In conclusion, the language acquisition problem requires an entirely different sort of solution.

Naturalist Accounts

The premise of the Chomskyan perspective is that children are learning a linguistic system governed by subtle and abstract principles without explicit instruction and, indeed, with enough information from the input to support induction of these particular principles (as opposed to other principles — Plato's problem or the poverty of the stimulus argument). Chomsky went on to claim that if there is nothing in the input to explain how children learn language, the process must be supported by innate syntactic knowledge and language-specific learning procedures. The theory of Universal Grammar (UG) formulates this a priori knowledge in terms of principles and parameters that determine the set of possible human languages. UG is assumed to be part of the innately ordered knowledge of humans. The principles of UG provide a framework for propositional language, often leaving several (constrained) options open to be decided by the data the child comes into contact with. For example, word order freedom is a parameter of variation. Some languages (English) mandate strictly word order; others (Russian, Japanese) list a small set of admissible orders; still others (Warlpiri, an Australian aboriginal language) allow almost total scrambling of word order within a clause. Input from a given language is needed for learners to set the parameters of that language.

One important aspect of this theory is that sorting a single parameter can create a cluster of superficially unrelated grammatical properties to appear in the language. For example, the null-subject parameter involves a number of properties whether overt subjects are required in all declarative clauses (yes in English, no in Italian), whether explicit elements such as 'it' in 'it seems' or 'there' in 'there are' are exhibited (yes in English, no in Italian), whether free inversion of subjects is allowed in simple declarative clauses (yes in English, no in Italian), etc. The prediction is that the input necessary to set the null-subject parameter results in the simultaneous alignment of all of these properties within a child's grammar. There is, at present, controversy over whether predictions of this sort are supported by the child language data.

Innate knowledge of the principles underlying language is needed to account for how children acquire language. How are children to know what a noun or a subject is in the specific language they are learning? Children obviously need to identify subjects and verbs in their language before they can determine whether the two are strictly ordered in that language, and before the agent can engage whatever innate knowledge they might have about how language is structured. Thus, in addition to innate syntactic knowledge, children also need learning procedures, which may themselves be language-specific.

One example is a set of rules linking syntactic and semantic categories. Under this hypothesis, children are assumed to know innately that agents are likely to be subjects, objects affected by action are likely to be direct objects, etc. All they need is to identify (using context or the agent in a scene), the linking rules allow them to infer that the term used to refer to that agent is the subject of the sentence. Their innate knowledge about how these elements are allowed to be structured can then take over.

Again, controversies exist over whether child language data support these assumptions (e.g., ergative languages do not straightforwardly align with subjects and verbs and yet are easily acquired by young children).

Social/Cognitive Accounts

The nativist position entails essentially two claims: (1) there are some of the principles of organization underlying the language-specific and not shared with other cognitive systems, and (2) procedures that guide the implementation of these principles are themselves innate, that is, centered in the child and not the child's environment. Notice that, while these two claims often go hand-in-hand, they need not. One can imagine that the principles underlying linguistic knowledge might be specific to language and, at the same time, implemented through general, non-language-specific learning mechanisms (although such mechanisms must be more complex than the mechanisms behaviorist account have offered). This position has come to be known as a social or cognitive account of language learning.

For example, by observing others' actions — where they look, how they hold their hands and faces — we can often guess their intentions. Young children could use this information to help them overcome their hypotheses about what a word means. In fact, if a speaker looks at an object while uttering a novel word, a child will assume that the speaker's word refers to that object, even if the child herself is not looking at the object. In other words, children can use general cues to speaker intent to guide their guesses about language.

Children do not sound like adults when they begin to speak — clearly, there is something that needs to be done. The question is what kind of work is required? One possibility, favored by some nativists, is that children have in place all of the grammatical categories and syntactic principles they need, they just lack the operating systems.
that will allow these principles to run. The developmental work to be done does not, under this view, involve a changing grammar.

Another view suggests that the child's language changes dramatically during development, transforming from a system based on semantic categories to one based on syntactic categories. This transformation could be determined maturely or guided by innate linking rules. However, the transformation could also result from an inductive leap children make on the basis of the linguistic environment, which we label with the cognitive and/or social skills they bring to the task -- this inductive leap is at the heart of all social or cognitive accounts of language acquisition.

Cognitive underpinnings are obviously necessary but they may not be sufficient for the onset of linguistic skills. For example, the onset of gesture plus speech combinations that convey two elements of a proposition (open plus point at box) precedes the onset of two-word combinations (open box): by several months, suggesting that the cognitive ability to express two semantic elements is not the final stumbling block to two-word combinations. More than likely, it is the inability to extract linguistic patterns from the input that presents the largest problem.

Social and cognitive accounts claim that there is, in the other direction in the linguistic input children hear, particularly in the context of the supportive social environment in which they live, to induce a grammatical system. Ample research indicates that adults alter the speech they direct to children. Speech to children (often called ‘motherese’) is slower, shorter, higher-pitched, more exaggerated in intonation, more grammatically well-formed, and more directed in context to the meanings to which each phrase is addressed to adults. And children pay particular attention to this fine-tuned input, interpreting it in terms of their own biases or operating principles (e.g., paying attention to the sounds of words). However, one problem that arises with postulating motherese as an engine of child language learning is that child-directed speech may not be universal. In many cultures, children participate in communicative interactions as overhearers (rather than as addressees) and the speech they hear is not likely to be simplified in the same ways. Nevertheless, children in these cultures become competent users of language in roughly comparable timeframes. These observations suggest that there may be many developmental routes to the same end -- a reasonable conjecture given the robustness of language.

One very interesting possibility that skims the problem that children do not universally receive simplified input is that the children may do the simplifying themselves. For example, young children's memory limitations may make it more likely to repeat entire strings of words or morphemes. They would, as a result, be doing the analytic work required to abstract linguistic regularities on a smaller dataset (the less is more hypothesis). This filtering may be just what children require to arrive at their linguistic systems. Moreover, a general process that children around the globe presumably bring in equal measure, to the language-learning situation.

**Connectionist Accounts**

Connectionism is a movement in cognitive science whose goal it is to explain human intellectual abilities using artificial neural networks (also known as multilayer neural networks). Connectionist models are simplified models of the brain composed of large numbers of units (the analogs of neurons) and weights that measure the strength of the connections between those units. In a connectionist account, behavior is shaped by selective reinforcement of the network of interconnected units. Under this view, language development is a process of continuously adjusting the relative strengths of the connections in the network until linguistic output resembles linguistic input.

In a sense, connectionism is more of a technique for exploring language learning than an explanatory account. But connectionism does come with some theoretical baggage. For example, most connectionist models are based on the assumption that language (like all other cognitive skills) can be explained without recourse to rules. Connectionism offers a tool for examining the tradeoff between the three components central to all theories of language learning: environment (input to the system), structures the child brings to the learning situation (architectures of the child's pre-existing syntactic and semantic knowledge (learning algorithms)). For example, a great deal of linguistic structure is assumed to be innate on the nativist account. Connectionism provides a way to explore how much structure the child needs to be built in to achieve learning, given a particular set of inputs to the system and a particular set of learning mechanisms. As another example, networks have been successfully trained to apply short strings of sentences only if the memory span of the network for previously processed words begins small and gradually increases (reminiscent of the 'less is more' hypothesis described earlier). In principle, connectionism is agnostic on the question of whether the architecture of the system (the child) or the input to the system (the environment) determines the relative strengths of each connection. However, the empiricist account emphasizes the importance of input. And, of course, the unanswered question is what determines the units that are to be connected in the first place.

**Constrained Learning**

All theoretical accounts agree that human children are prepared to learn language. But what are they prepared with? Do children come to the learning situation with specific hypotheses about how language ought to be structured? Or do they come with general biases to process information in their linguistic systems? More recently, a second position suggests that the strong inclination that children have to structure communication in language-like patterns falls out of their general processing biases coming into contact with natural language environments.

The language that the children learn must, at some level, be inferable from the data that are out there. After all, if language is to perform its function, they cannot just rely on the innate knowledge, since it is not the case that the children must have knowledge about the structure of language. Instead, the children must have a general ability to learn the structure of language from the data that are available.

One learning mechanism that has been proposed is known as statistical learning. The assumption underlying this mechanism is that children are sensitive to the patterns in their input, and can perform realistic and complete computations of the co-occurrences among neighboring elements in that input. By performing statistical computations with a corpus, children can pick out the recurring patterns in the data and thus are less likely to be misled by individual counter-examples.

However, children must also face the problem that a corpus can be analyzed in many different ways. How do children know which computations to perform on a given corpus? Perhaps children are only able to perform a limited set of computations. If so, this limitation would effectively narrow down the range of possible patterns that could be extracted from a database. Thus, one way that children may be prepared to learn language is that they come to language learning ready to perform certain types of computations and not others.

To discover which computations young language learning children are able to perform, we can provide them with samples of data constructed to exhibit a pattern that can be discovered using a particular computation. If the children then extract the pattern from the data, we know that they are able to perform this type of computation. For example, suppose we give children 8-month-old infants were exposed to a corpus of nonsense words playing continuously on an audiocube for 2 min. The corpus was arranged so that the transitional probabilities between sounds were 0.73 inside words, but 0.31 across words. The only way the infants could figure out what the words in the corpus were was to (1) pay attention to these transitional probabilities and (2) assume that sequences with high probabilities are likely to be the words and sequences with low probabilities are likely to be the accidental juxtapositions of sounds at word boundaries. The infants not only listened differentially to words vs. non-words, but they were able to discriminate between words and part-words (flat words contained the final syllable of one word and the first two syllables of another word) and were more accurate than the corpus of the infants heard but had different transitional probabilities from the words). The 8-month-olds were not merely noting whether a syllable sequence occurredThey were assigning some kind of weight to the sounds they had heard, and using a mechanism that calculates statistical frequencies from input to do so.

Infants are thus sensitive to the transitional probabilities between sounds and can use this knowledge to segment speech into word-like units. Can this simple mechanism be used as an entry point into higher levels of linguistic structure? If, for example, children can use transitional probabilities between words (or word classes) to segment sentences into phrases, they could then use this phrasal information as a wedge into the syntax of their language. In other words, children may be able to go a long way toward inducing the structure of the language they are learning by applying a simple procedure (tabulating statistical frequencies) to the data that they receive. A related domain-general approach that has been taken to the problem is the Bayesian inference framework, a tool for combining prior knowledge (probabilistic versions of constraints) and observational data (statistical information in the input) in a rational inference process. The theoretical assumptions underlying all of these approaches is that children come to language learning equipped with processing strategies that allow them to induce patterns from the data to which they are exposed. The open question at the moment is how sophisticated do the data-processing strategies have to be in order for children to induce the patterns of their language from the input that they actually receive? Can children get by with the ability to calculate transitional probabilities, building up larger and larger units over developmental time? Or are there units over which children are more, or less, likely to calculate transitional probabilities? For example, children may not be able to calculate statistical probabilities over units that are not immediately adjacent (i.e., dependencies between units that are at a distance from one another). For instance, the "cats on the couch are fluffy, the verb" are 'spelling because it depends on 'cats', the subject of the sentence, which occurs several words earlier). Some of the constraints that children exhibit during language learning may come from the processing mechanisms they bring to the situation.

Two questions are frequently asked about language processing mechanisms: (1) what are the mechanisms that children apply to language learning unique to language, or are they used in other domains as well? and (2) the species-specific question -- are the mechanisms children apply to language learning unique to humans, or are they used by other species as well?
Constrained Invention

When children apply their data-processing mechanisms to linguistic input, the product of their learning is language. But what if a child was not exposed to linguistic input? Would such a child be able to invent a communication system and, if so, would that communication system resemble language? If children are able to invent a communication system that is structured in language-like ways, we must then consider whether the constraints that guide language learning are the same as the constraints that guide language invention.

Language was clearly invented at some point in the past and was then transmitted from generation to generation. Was it a one-time invention, requiring just the right assembly of factors, or is language so central to being human that it can be invented anew by each generation? This is a question that seems impossible to answer today. Children do not typically have the opportunity to invent a language, as they are all exposed from birth (and perhaps even before birth since babies can perceive some sounds that are not part of any community). The only way to address the question is to find children who have not been exposed to a human language.

In fact, there are children who are unable to take advantage of the language to which they are exposed. These children are congenitally deaf with hearing losses so severe that they cannot acquire the spoken language that surrounds them, even with intensive instruction. Moreover, in deaf populations, parents who do not know a sign language and have not placed their children in a situation where they would be exposed to one. These children lack an accessible model for human language. Do they invent one?

The short answer is yes. The children are able to communicate with the hearing individuals in their world, and use their language to do so. This is hardly surprising since all hearing speakers gesture when they talk. The surprising result is that the deaf children’s gestures do not look like the gestures that their hearing parents produce. The children's gestures have language-like structure; the parents' gestures do not.

The children combine gestures, which are themselves composed of parts (akin to morphemes in conventional signed languages), into sentence-like strings that are structured with grammatical rules for deletion and order. For example, to ask an adult to share a snack, one child pointed at the snack, gestured eat (a quick jab of an open-handed gesture at his mouth), and then pointed at the adult. He typically placed gestures for the object of an action before gestures for the action, and gestures for the agent of an action after.

Importantly, the children's gesture systems are generative—the children concatenate gestures conveying several propositions within the bounds of a single-gesture sentence. For example, one child produced several proportions about snowshoes within a single sentence: that they are used to dig, that they are used when boots are worn, that they are used outside, and kept downstairs. The gesture systems had parts of speech (noun, verb, adjective), were used to make generic statements (as in the snowshoe example), and are used to tell stories about the past, present, future. Furthermore, the children combined these parts of speech with their gestures to talk to themselves and to talk about their own gestures.

In contrast, the children's hearing parents use their gestures at all. The children's gestures are synchronized with speech and are rarely combined with another. The gestures produce a meaningful form of communication with no component parts and no hierarchical structure.

The theoretical interesting finding is not that the deaf children communicate with their gestures, but that their gestures are structured in language-like ways. Indeed, the children's gestures are sufficiently language-like that they have been called home signs. It is important to note that the deaf children could have used mime to communicate—this would be another recent example of a community that was formed, or revived, by As-Sayyid Bedouin. Two of the majority's five were deaf and, with the last three generations, 150 deaf individuals have been born into the community. As-Sayyid Bedouin Sign Language (ASL) was thus born, AVLdiffers from NLS in that it is developing in a socially stable community with children learning the system from their parents. Because ASL is characterized by the language of the children, the signs from each of the three generations are likely to diverge form those of the past and differ systematically, in the system of signs they use. By observing signs from each generation, we can therefore make good guesses as to what a particular linguistic property first entered the language. Moreover, because the individual families in the community are tightly knit, with strong bonds within families but not across them, we can chart changes in the language in relation to the social network of the community. We can determine when properties remained within a single family and when they did not, and thus follow the trajectory that particular linguistic properties took at some point (or spread (or failed to spread) throughout the community. This small and self-contained community consequently offers a unique perspective on some classic questions in historical linguistics.

Because sign languages are processed by eye and hand rather than ears and mouth, we might have expected them to be structured differently from spoken languages. But they are not. Sign languages all over the world are characterized by the same hierarchy of linguistic structures (syntax, morphology, phonology) and thus draw on the same same mechanisms. Moreover, many children exposed to sign language from birth acquire language as naturally as hearing children acquire the spoken language to which they are exposed, achieving major milestones at approximately the same ages.

However, the manual modality makes sign languages unique in one at least one respect. It is easy to use the manual modality to invent nonlinguistic forms that can be immediately understood by naïve signers (e.g., indexical pointing gestures, iconic gestures). Thus, sign languages can be created anew by individuals and groups, and are particularly useful in allowing us to determine whether language-creation is constrained in the same ways that language learning is.

Computational and robotic experiments offer another approach to the question. These studies explore whether communication systems with properties akin to those found in natural human language can emerge in populations of initially language-less agents. These are the results of this work. The first functional approach assumes that linguistic structure arises as a solution to the problem of communication. For example, as a way of limiting search through possible interpretations. The second, structural approach does not rely on communication pressure to motivate change but rather examines the emergence of structure as the system is passed from human to human, and so on. In the case of ASL, the community has found that a composition system with recursion, grammatical categories, and word order is sufficient to result in an initially unstructured sign language that will be used by a new generation of users. These are the results of this work. The third the properties found in the deaf children's home-sign systems, but the home-sign systems are not passed through a series of learners and are instead created by individual children who are the sole users of their systems. Once again,
we find that there is more than one way to arrive at language-like structure. In general, modeling studies, com-
bined with observations of language learning and language invention, can help us appreciate the range of
circumstances under which language-like structure can arise and the mechanisms responsible for that structure.

Is Language Innate?

Children are likely to come to language learning con-
trasted to process the language data they receive in cer-
certain ways and not in others. The constraints could be
specifically linguistic, but they need not be. Constraints are
assumed to be internal to the child at the moment when
a particular skill is acquired. But are they innate?

Innateness Defined as Genetic Encoding

The problem of innateness has been addressed repeated-
ely and elegantly in other disciplines, especially ethology,
and many definitions of innateness have been proposed. One
of the most common, albeit not the earliest, definitions of
an innate behavior is that it has a genetic base. Some
have claimed evidence for grammar genes — not for a
single gene responsible for all the circuits underlying
grammar but for a set of genes whose effects are relevant
to the development of the circuits underlying parts
of grammar. The dispute is whether the genes are specific
to the grammatical aspects of language.

What might it mean to claim that language has a
genetic base? At one level, the claim is obviously true —
equipped with the human linguistic potential, humans
develop language. But what does this claim buy us if our
interest is in understanding how children learn language?
We could study twins, both fraternal and identical, to
explore the phonological aspects of language learning. However,
in this regard, it is important to note that, in twin studies
conducted to explore the genetic basis of intelligence (i.e.,
IQ), the focus is on differences among individuals relative
to a normative scale. In contrast, claims about the innate-
ness of language are claims about the commonalities
among people, not the genetic differences between people.

In arguing that language is genetically based, there is no
obvious claim that two individuals who are genetically
related have linguistic systems that are more alike than
those of two individuals who are not genetically related.
All humans who are genetically intact have, at large, compara-
ble linguistic systems. It is comparable in the same way that
all human bodies have two arms and two legs. The details of
the arms of any two unrelated indi-viduals (their height,
width, definition, etc.) are likely to differ (and those differ-
cences are not innate or more generally level) but
the basic troncose and structure of the arm is constant
grossly across all genetically intact humans — so too for language.

So why then (assuming we are not geneticists) should
we care about the genetic base of language learning?
Perhaps we should not. Of all the possible constraints on the re-
duction of definitions and criteria that have, over the years and
over the disciplines, been applied to the term innate, one
could argue that the definition that is least central to the
notion’s core is having a genetic base. A useful definition
of innate need not be anchored in genetic mechanisms.

Innateness Defined as Developmental Resilience

An alternative definition of innate behavior is that it is
developmentally resilient: a behavior is developmentally
resilient if its development, if not inevitable, is overde-
minded in the species; that is, it is a behavior likely to be
developed by each member of the species even under
widely varying circumstances. The way we traditionally
explore the boundaries for the development of a behavior
is to manipulate the conditions under which that behav-
ior is typically developed, extending the range until the behav-
ior no longer appears. For obvious ethical reasons, we cannot
rampet with the circumstances under which children learn
language. But we can take advantage of variations in lan-
guage-learning conditions that occur naturally, and thus
explore the boundaries conditions under which language
development is possible.

Resilience in the face of external variation

Language learning is not infinitely resilient. When human
children are raised by animals, they do not develop lan-
guage. And when children are raised by inhumane parents
who mistreat them physically and emotionally, including
depriving them of a model for language, they do not
develop language. But given a reasonable social world,
children seem to be able to develop language under a
wide range of circumstances.

Consider first the effects of the variability in the way adults
speak to children within a culture. Adults in each culture
tend to use a distinct register of speech with their chil-
dren. Language development is variable in that the pace
of language learning, the length of time it takes to learn
language, the amount of input a child receives can be
quite minimal or quite extensive. For example, hearing
children born to deaf parents often get very minimal exposure to speech. But it turns out that they
do not need much, 5–10h a week of exposure hearing
speakers is typically sufficient to allow language learning
to proceed normally. As another example, twins share
their language learning situation with one another, making
the typical adult-twin situation triadic rather than dyadic.
Nonetheless, language learning proceeds along a normal
trajectory, although often with mild delays. A child may
develop language quickly, but almost all intact children
in almost all linguistic environments eventually
develop language.

The resilience of language learning in the face of across-
variations in language usage is even more impressive: Cultu-
res hold different beliefs about the role that parents need
to play to ensure the child’s acquisition of language. Not
surprisingly, then, children around the globe differ in how
much, when, and what type of language they receive —
not to mention the fact that, in each culture, the child
is exposed to a model of a different language. Indeed, many
children receive input from two different languages and
must learn both at the same time. Despite the broad
range of inputs, children in all corners of the earth learn
language and at approximately the same pace.

Resilience in the face of internal variation

Language learning is also resilient in the face of many
organic variations from the norm, variations that alter the
way children process the input they receive. For
example, intermittent conductive hearing losses from
repeated middle ear infections can cause a child’s intake
of linguistic input to vary over time in amount and pattern.
Despite this variability, spoken language development for
the most part proceeds normally in children with this
type of hearing loss. As a second example, blind children
live in a visual world that is obviously different from the
sighted child’s world, and that offers a different spectrum
of contextual cues to meaning. However, this difference has
little impact on language learning in the blind child.
Organic variation can be much more severe and still
result in relatively intact language learning. For example,
graham learning in the earliest stages can proceed in a
relatively normal manner and at a normal rate even in the
face of substantial or brain injury. As a second exam-
ple, children with Down syndrome have numerous intrin-
sic deficiencies that complicate the process of language
acquisition. Nevertheless, most Down syndrome children
acquire speech and language basic language organization of
the language they are exposed to (the amount of language that is acquired in general proportion
to their cognitive capabilities). Finally, and tellingly, given the social impairments that are at
the core of the syndrome, autistic children who are
to learn language are not impaired in their grammatical
development, either in syntax or in morphology, although
they do have deficits in the communicative, prag-
matic, and functional aspects of their language.

Interestingly, even when children do have trouble learning language, some properties of language (like
grammatical ones) are spared. For example, a basic understanding of the organization that underlies predicts
in the is to instruct in specific language impairment
children who have neither hearing impairment, cognitive
deficit, nor neurological damage yet fail to develop lan-
guage normally. However, these children have difficulty
with morphological knowledge. As another example, children who are not exposed to a spoken language unit
adherence have no trouble matching word order when learning language late in life, but do have difficulties
with morphology. Some properties of language appear to be robust, and some fragile, across a variety of circumstances
and internal states.

There may be no greater testament to the resilience
of language than the fact that children can invent language
in the absence of a model for language. A combination of
internal factors (the fact that the children are profoundly
defective and cannot acquire a spoken language) and external
factors (the fact that the children have not been exposed
to a conventional sign language) together create the unusual
language-learning circumstances in which the deaf chil-
dren described can invent for themselves. Despite their lack of a model for language, these children still communi-
cate in language-like ways.

In sum, language development can proceed in humans
over a wide range of circumstances and environments.
A wide range of organic and environmental factors, the
process of language development may be buffered against a large number of
both organic and environmental variations. No one factor
seems to be ultimately responsible for the course and
outcome of language development in humans, nor is
the surprising result given the complexity and importance of
human language.

Mechanisms that Could Lead to Resilience

Another way of describing the language-learning process
is that the range of possible outcomes is not
narrowed. This narrowing or canalization is often attrib-
uted to genetic causes. However, canalization can also be
catalyzed by the environment and can introduce same from
another species. Exposing a bird to a particular language
at one point early in its development can narrow the
bird’s learning later on; the bird becomes particularly suscep-
tible to responding to that stimulus and not others. Note that, in order for acquisi-
tion to be universal when the environment is playing a
causal role, the relevant aspect of the environment must be relatable to each member of the
species. In a sense, the environment must be consid-
ered as much a part of the species as its genes.

For language, it looks as though there is a basic, resilient
form that human communication naturally gravitates

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toward, and a variety of developmental paths that can be taken, and arrive at that form. In this sense, language development is said to be characterized by equifinality, an embryological term coined to describe a process by which a system reaches the same outcome despite different input conditions. No matter what route you take, you always end up in Rome.

Are there any implications for the mechanisms of development that we can draw once having identified language as a trait characterized by equifinality? Two types of systems seem possible:

1. A system characterized by equifinality can rely on a single developmental mechanism that not only can make effective use of a wide range of inputs (both external and internal) but will not veer off track in response to that variability, that is, a mechanism that is not sensitive to large differences in input. The gross image that comes to mind here is a sausage machine that takes inputs of all sorts and, regardless of the type and quality of that input, creates the same product.

2. A system characterized by equifinality can rely on multiple developmental mechanisms, each activated by different conditions but constrained in some way to lead to the same end product. The analogy here is to several distinct machines, each designed to operate on a particular type of input (e.g., chickens vs. pigs) but constrained to produce the same result. Despite the different processes that characterize the diversifying and reinforcing operations of each machine, the machines result in the same sausage product. At first glance, it may seem improbable that a variety of developmental mechanisms would be constrained to arrive at precisely the same outcome. However, it is relatively easy to imagine that the functions served by the mechanisms (e.g., a function that all of the developmental trajectories would share) might have been sufficient to ensure, given the constraints each of the mechanisms to produce the same product. Communicating via symbols with other humans might be a sufficiently constraining function to result in several mechanisms, each producing a language-like structure.

Which of these scenarios characterizes what actually happens when children learn language is an open question. But what is clear is that language-like structures are determined in human children. Many paths lead to the same outcome, and whatever developmental mechanisms we propose to explain language learning (or language innovation) is going to have to be able to account for this equifinality.

Language Not a Unitary Phenomenon

Until now we have been discussing language as though it were a unitary phenomenon, as though it were obvious what the appropriate unit of analysis for language is. However, it is clear that language is not a unitary whole, particularly when it comes to issues of resilience and inconstancies.

Children who are not exposed to a conventional language model create communication systems that contain some, but not all, of the properties found in natural human languages. Thus, the absence of a conventional language model appears to affect some properties of language more than others. Even when linguistic input is present, it is more likely to affect rates of acquisition for certain properties of language than for others. Further, when language is acquired off-time (i.e., in late childhood or adolescence) certain properties of language are likely to be acquired and others are not. Thus, some properties of language are relatively resilient, while others are relatively fragile. Moreover, there is some evidence that the same properties of language (e.g., using the order of words to convey what does not exist) are resilient across many different circumstances of acquisition — acquisition without a conventional language model, with varying input from a language model, and late in development after puberty. Thus, language as a whole need not be said to be innate.

The definition of innate that best fits the language-learning data is developmental resilience. This notion operationalizes innateness by specifying the range of organisms and environments in which language learning can take place. There are limits on the process of language development, children raised without human interaction do not develop language. But the process of language development can proceed in children with a range of limitations and in children raised in environments that vary radically from the typical. What we see in exploring this resilience is that certain aspects of language are central to humans — so central that their development is virtually guaranteed, not necessarily by a particular gene but by a variety of combinations of genetic and environmental factors. In this sense, language is innate.

See also: Bilingualism; Grammar; Imitation and Modeling; Language Development: Overview; Learning; Literacy; Pragmatic Development; Preverbal Development and Speech Perception; Semantic Development; Speech Perception.

Suggested Readings


Language Development: Overview

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Glossary

Grammar — The study of classes of words, their inflections, and their functions and relations in a sentence.
Morphology — The system of word-forming elements in a language.
Phonology — The study of speech sounds.
Semantics — The study of the meaning of words.
Syntax — The way in which words are put together to form phrases, clauses, or sentences.

Introduction

All over the world, children learn to talk on a roughly equivalent timetable. They do so by learning the language or languages of their environment. There is considerable debate over what cognitive, social, or specifically linguistic, factors account for this language learning. This article begins with a brief timetable of development and then focuses in turn on the major aspects of language learning in terms of infancy, learning words, learning morphology, early grammar, later grammar, and the learning of pragmatic and metalinguistic skills. It concludes with some brief reflections on typological development.

The relevant theoretical issues are covered as they arise in each section and are considered again in the last section on learnability and constituency.

During infancy, children develop a wide range of cognitive and social skills together with a developing ability to segment the speechstream into meaningful units. They usually produce their first recognizable words somewhere between 10-18 months of age and their first word combinations between 14-24 months. By age 3 years, children are often able to produce quite long utterances and are beginning to be able to combine more than one clause into coordinate and subordinate constructions (e.g., relative clauses, cleft sentences). Between the ages of 4 to 7 years, there are more advances in children's ability to take the perspective of others, to interpret intonation, and to produce coherent discourse and narrative sequences. These abilities, as well as the ability to reflect on language as an object of knowledge, develop throughout the school years and are much influenced by the extent of literacy or other complex language (for instance, ritual language) to which children are exposed.

Throughout this developmental timetable, there are major individual differences in the ages at which children reach these points and, in addition, in the balance of skills that a particular child may manifest at a particular point in time. There are also individual differences in how children tackle any of these tasks. This is an important point to remember when considering theories that rely for their confirmation on a particular order of development or on a particular relationship among different skills. It is also important to remember that many children (perhaps most) grow up hearing and, to some extent at least, learning more than one language. The evidence to date is that does not have a significant impact on the developmental timetable for language learning in the early years.

Overview of Development

Infancy

Children are born with the ability to discriminate their mother's voice from that of other women and to discriminate speech from non-speech, presumably because of their...