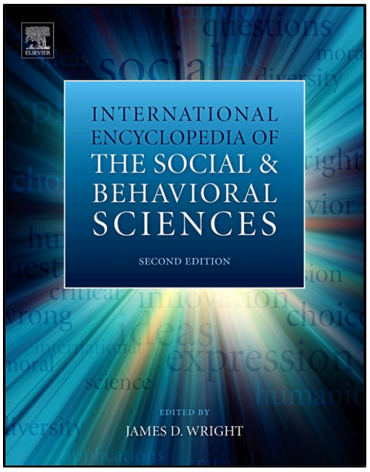

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Language Acquisition

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Abstract

Adults often underestimate the size and scope of the social, cognitive, and motoric challenges that children face when learning language. In fact, language learning is the most complex task that any of us will master, and the fact that we all succeed in learning our native language reflects the extent to which language is shaped to conform to the abilities we all possess.

The ability to learn language is present in almost every human child. Children who are born blind have no problem learning to speak, although they may occasionally be confused about words for colors or locations. Children who are born deaf readily acquire a rich system of signs, as long as they are exposed to native sign language speakers. Even a child, like Helen Keller, who has lost both hearing and sight, can still acquire language through symbols expressed in touch and motion. Children with neurological disorders, such as brain lesions or hydrocephalus, often acquire complete control over spoken language, despite some early delay (MacWhinney et al., 2000). Children with the most extreme forms of mental retardation are still able to acquire the basic units of human communication. Given this pervasiveness and inevitability of first-language acquisition, we often tend to take the process of language learning for granted. But language is the most complex skill that a human being can master. The fact that nearly all of us succeed in this task indicates how remarkably well the structure of language adapts to our underlying abilities. Language is immensely complex, but its complexity is accessible to all of us because it is uniquely crafted to fit our human nature (Christiansen and Chater, 2008).

We can look at language acquisition from different perspectives. Of these, the three most fully developed are those of the linguist, the psychologist, and the educator. Linguists tend to think of language as having a universal core from which individual languages select out a particular configuration of features, parameters, and settings (Chomsky, 1982). From this perspective, child language is an interesting slice of the universal pie. The shape of this slice is presumably limited by both formal universal constraints and the child's mental abilities or developmental status.

Psychologists (MacWhinney, 1998) look at language learning from a very different perspective. To the psychologist, language acquisition is a window on the operation of the human mind. This window allows us to view the structure and functioning of neural circuits in the brain. It also allows us to understand how these circuits support processes such as reinforcement, generalization, imagination, and thinking. To understand these processes better, psychologists conduct controlled experiments in which children learn new words, sounds, and rules. They may measure these processes using neural imaging techniques, or they may simply study the changes in the language of the child across time.

Educators and parents are typically interested in understanding how to use language learning to promote children's overall social, emotional, and cognitive development. Working within the tradition of sociocultural theory, as articulated by Vygotsky (1934), these researchers examine the ways in which children use words in specific games and interactions with their parents as a way of acquiring the patterns of their culture (Nelson, 1998).

Important and engaging though these adult perspectives may be, the best way to appreciate the dynamics of language development is to assume the perspective of the child. In particular, we need to understand the specific challenges that language learning presents to the child and the ways in which each is overcome. For detailed data on actual interactions between children and their parents, readers are encouraged to browse the many recordings and transcripts to be found at http://childes.talkbank.org.

Early Audition

William James (1890) described the world of the newborn as a "blooming, buzzing confusion." However, on the auditory level, the newborn's world is remarkably well structured. The cochlea and auditory nerve provide extensive preprocessing of signals for pitch and intensity. In the 1970s, researchers discovered that human infants were specifically adapted at birth to perceive contrasts such as that between 'p' and 'b,' as in *pit* and *bit*. However, subsequent research showed that even chinchillas are capable of making this distinction (Werker, 1995). Thus, it appears that much of the basic structure of the auditory world can be attributed to fundamental processes in the mammalian ear.

Beyond this basic level of auditory processing, it appears that infants have a remarkable capacity to record and store sequences of auditory events. For example, if a 6-month-old hears a string of nonsense syllables such as *badigudibagadigudigagidu* repeated many times, the parts that are repeated will stand out and affect later listening. In this example, the repeated string is *digudi*. If infants are trained on such strings, the repeated segment will first pop out, and then they will grow tired of this sound and will come to prefer to listen to new sound strings rather than those that have the boring old *digudi* string (Thiessen, 2009). These habituation effects are strongest for stressed syllables and syllables immediately following stressed syllables.

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Recent studies of these effects in auditory memory suggest that we are born with an ability to store and recall the sounds of human language. It is as if the infant has a tape recorder in the auditory cortex that records input sounds, replays them, and accustoms the ear to their patterns.

Babies also demonstrate preferences for the language that resembles the speech of their mothers. Thus, a French infant will prefer to listen to French, whereas a Polish infant will prefer to listen to Polish (Jusczyk, 1997). In addition, babies demonstrate a preference for their own mother's voice, as opposed to that of other women. Together, these abilities and preferences suggest that during the first 8 months, the child is remarkably attentive to language. Although children are not yet learning words, they are acquiring the basic auditory and intonational patterns of their native language. As they sharpen their ability to hear the contrasts of their native language, they begin to lose the ability to hear contrasts not represented in the native language. If the child is growing up in a bilingual world, full perceptual flexibility is maintained. However, if the child is growing up in a monolingual world, flexibility in processing is gradually traded off for quickness and automaticity.

Early Articulation

During the first 3 months, a baby's vocalizations are nothing more than cries and vegetative adaptations. However, around 3 months, at the time of the first social smile, babies begin to make the delightful little sounds that we call 'cooing.' These sounds have no particular linguistic structure, but their well-integrated intonation makes them sure parent pleasers. By 6 months, the baby is producing structured vocalizations, including a larger diversity of nasals, vowel types, and syllables with the canonical consonant–vowel (CV) structure. The basic framework of early babbling seems to be constructed on top of patterns of noisy lip smacking that are present in many primates (MacNeilage, 1998). These vocal gestures include some form of vocal closure followed by a release with vocalic resonance. Essentially, this is the CV syllable in which a consonant is followed by a vowel.

Until the sixth month, deaf infants continue to babble normally. However, by the age of 9 months, deaf infants lose their interest in babbling. This suggests that earlier babbling is sustained largely through proprioceptive and somaesthetic feedback, as babies explore the various ways in which they can play with their mouth. After 6 months, babbling relies increasingly on auditory feedback. During this period, the infant tries to produce specific sounds to match up with specific auditory impressions. It is at this point that deaf children no longer find babbling entertaining, since they cannot obtain auditory feedback. These facts suggest that, from the infant's point of view, babbling is essentially a process of self-entertainment.

In the heyday of behaviorism, researchers analyzed the development of babbling in terms of reinforcement theory (Mowrer, 1960). They thought that process of producing reinforcing sounds like the sounds made by the child's mother would lead a Chinese baby to babble the sounds of Chinese, whereas a Quechua baby would babble the sounds of Quechua. This was the theory of 'babbling drift.' However, closer observation of the babbling of 8-month-olds indicates that virtually no such drift occurs. By 12 months, there is some slight drift in the direction of the native language, as the infant begins to acquire the first words. Proponents of universal phonology have sometimes suggested that all children engage in babbling all the sounds of all the world's languages. Here, again, the claim seems to be overstated. Although it is certainly true that some English-learning infants will produce Bantu clicks and Quechua implosives, not all children produce all of these sounds.

The First Words

The child's ability to produce the first word is based on three earlier developments. The first is the infant's growing ability to record the sounds of words. The second is the development of an ability to control vocal productions that occurs in the late stages of babbling. The third is the general growth of the symbolic function, as represented in play, imitation, and object manipulation. Piaget (1954) characterized the infant's cognitive development in terms of the growth of representation or the 'object concept.' In the first 6 months of life, the child is unable to think about objects that are not physically present. However, as infants learn more about objects, they become able to associate their properties with their own actions and other features of the context. In this way, subtle cues can be used to dredge up fuller representations from memory. For example, a child may see a dog's tail sticking out from behind a chair and realize that the rest of the dog is hiding behind the chair. This understanding of how parts relate to wholes supports the child's first major use of the symbolic function. When playing with toys, the 12-month-old will begin to produce sounds such as room or bambam that represent properties of these toys and actions. Often these phonologically consistent forms (Peters, 1983) appear before the first real words. Because they have no clear conventional status, parents may tend to ignore these first symbolic attempts as nothing more than spurious productions or babbling.

Even before children have produced their first conventional word, they have already acquired an ability to comprehend as many as 10 conventional forms. They learn these forms through frequent associations between actions, objects, and words. Parents often realize that the prelinguistic infant is beginning to understand what they say. However, they are hard pressed to demonstrate this ability convincingly. Researchers deal with this problem by bringing infants into the laboratory, placing them in comfortable high chairs, and asking them to look at pictures, using the technique of visually reinforced preferential looking (Schafer and Plunkett, 1998). A name such as dog is produced across loudspeakers. Pictures of two objects are then displayed. In this case, a dog may be on the screen to the right of the baby and a car may be on the screen to the left. If the child looks at the picture that matches the word, a toy bunny pops up and does an amusing drum roll. This convinces babies that they have chosen correctly and they then do the best they can to look at the correct picture on each trial. Some children get fussy after only a few trials, but others last for 10 trials or more at one sitting and provide reliable evidence that

they have begun to understand a few basic words. Many children show this level of understanding by the tenth month – often 2–3 months before the child has produced a recognizable first word.

Producing the first word is a bit like stepping out on stage. When babbling for their own entertainment, the only constraints that infants face are those arising from their own playfulness and interest. If they want to play around with a particular articulatory pattern or sound, there are no problematic consequences. However, when faced with the task of producing word forms, the child's articulation has to be extremely accurate and within conventional limits. Because the motoric aspects of speech production are so demanding, the requirement to produce conventional forms represents an enormous barrier to the child's learning of language. As a result, the forms of early words often deviate radically from the adult standard. The many simplifications that the 1-year-old introduces to adult phonology are well known to students of phonological development (Vihman and Croft, 2007). Children tend to drop unstressed syllables, producing *hippopotamus* as *poma*. They repeat consonants, producing *water* as *wawa*. And they simplify and reduce consonant clusters, producing tree as pee. These phonological processes echo similar processes found in the historical development and dialectal variation of adult language. What is different in child language is the fact that so many simplifications occur at once, making so many words difficult to recognize.

Early Semantics

Since Plato, scholars have considered the task of figuring out word meaning to be a core intellectual challenge. Quine (1960) illustrated the problem by imagining a scenario in which a hunter is out on safari with a native guide. Suddenly, the guide shouts 'Gavagai!' and the hunter, who does not know the native language, has to quickly infer the meaning of the word. Does it mean 'Shoot now' or 'There's a rhino' or perhaps even 'It got away'? Without some additional cues regarding the likely meaning of the word, how can the hunter figure this out?

The problem facing the toddler is similar to that facing the hunter. Fortunately, the toddler has some good cues to rely on. Foremost among these cues is the parent's use of joint attention and shared eye gaze to establish common reference for objects and actions. If the father says *hippo* while holding a hippopotamus in his hand, the child can use the manual, visual, verbal, and proxemic cues to infer that the word *hippo* refers to the hippopotamus. A similar strategy works for the learning of the names of easily produced actions such as falling, running, or eating. It also works for social activities such as *bath* or *bye-bye*. The normal child probably understands the role of shared eye gaze even before learning the first words. At 3 months, children maintain constant shared eye gaze with their parents. In normal children, this contact maintains and deepens over time. For autistic children, contact is less stable and automatic. As a result, autistic children may be delayed in word learning and the general growth of communication.

Shared attention reference is not the only cue toddlers use to delineate and pick out the reference of words. They also use the form of utterances to derive the meanings of new words. For example, if toddlers hear 'Here is a zav,' they know that *zav* is a common noun. However, if they hear 'Here is Zav,' then they know that *Zav* is either a proper noun or perhaps the name of a quantity. If they hear 'I want some zav,' they know that *zav* is a quantity and not a proper or common noun. Cues of this type can give a child a rough idea of the meaning of a new word (Tomasello, 2003). Other sentential frames can give an even more precise meaning. If the child hears, 'This is not green, it is chartreuse,' then it is clear that *chartreuse* is a color. If children hear, 'Please don't cover it, just sprinkle it lightly,' then they know that *sprinkle* is a verb of the same general class of cover. The use of cues of this type leads to a fast, but shallow, mapping of new words to new meanings.

As the child's stock of words grows, it becomes harder to keep words apart from each other. To solve this problem, children have to choose between two opposing strategies: overgeneralization and undergeneralization. It is extremely easy to detect overgeneralizations. If the child calls a tiger by the name *kitty*, there is clear evidence for overgeneralization. Undergeneralization is much more difficult to detect. For example, a child may use the word *dog* to refer only to the family dog and not to any other dog. Or a child may use the word *car* to refer only to cars parked outside a certain balcony in the house and not cars in any other context. Such undergeneralizations can only be detected if one takes careful note of the contexts in which a child avoids using a word.

Undergeneralizations are soon corrected, as they hear the relevant word used in a wider variety of contexts. Overgeneralizations can be corrected by supplying the name for the unknown object, such as the word *tiger* in the case of this example. In most cases, children are happy to learn these new names so that they can properly disambiguate things that are obviously so different as cats and tigers (Merriman and Bowman, 1989).

Word Combinations

Throughout the second year, the child struggles with perfecting the sounds and meanings of the first words. For several months, children produce isolated single words. However, eventually they need to go beyond his/her one-word level. They need to associate predicates such as want, more, or go with arguments such as cookie or mommy. The association of predicates to arguments is the first step in syntactic development. As in the other areas of language development, these first steps are taken in a very gradual fashion. Before producing a smooth combination of two words such as *my horsie*, children will often string together a series of single-word utterances that appear to be searching out some syntactic form. For example, a child might say *my, that, that, horsie* with pauses between each word. Later, the pauses will be gone and the child will say *that horsie, my horsie*. This tentative combination of words involves groping on both intonational and semantic levels. On the one hand, children must figure out how to join words together smoothly in production. On the other hand, they also must figure out which words can meaningfully be combined with which others.

As was the case in the learning of single words, this learning is guided by earlier developments in comprehension. We

have to assess children's early syntactic comprehension by controlled experiments in the laboratory. Here, as in the study of word learning, researchers have used the preferential looking paradigm. To the right of the child, there is a TV monitor with a movie of Big Bird tickling Cookie Monster. To the child's left, there is a TV monitor with a movie of Cookie Monster tickling Big Bird. The experimenter produces the sentence 'Big Bird is tickling Cookie Monster.' If children look at the matching TV monitor, they are reinforced and a correct look is scored. Using this technique, researchers have found that 17-month-olds already have a good idea about the correct word order for English sentences. This is about 5–6 months before they begin to use word order systematically in production.

The grammar of the first word combinations is extremely basic (MacWhinney, in press). The child learns that each predicate should appear in a constant position vis-à-vis the arguments it requires. For example, in English, the word more appears before the noun it modifies and the verb run appears after the subject with which it combines. Slot-filler relations can control this basic type of grammatical combination. Each predicate specifies a slot for the argument. For example, *more* has a slot for a following noun. When a noun, such as *milk*, is selected to appear with more, that noun fills the slot opened up by the word *more*. The result is the combination *more milk*. Later, the child can treat this whole unit as an argument to the verb *want* and the result is *want more milk*. Finally, the child can express the second argument of the verb *want* and the result is *I want more milk*. Thus, children build up longer sentences bit by bit, creating a more complex grammar. This type of word-based learning is present even in adults. In languages with strong morphological marking systems, word-based patterns specify the attachment of affixes, rather than just the linear position of words. In fact, most languages of the world make far more use of morphological marking than does English. In this regard, English is a rather exotic language.

Missing Glue

The child's first sentences are almost all incomplete and ungrammatical. Instead of saying, 'This is Mommy's chair,' the child produces only 'Mommy chair' with the possessive suffix, the demonstrative, and the copula verb all deleted. Just as the first words are full of phonological deletions and simplifications, the first sentences include only the most important words, without any of the glue. In some cases, children simply have not yet learned the missing words and devices. In other cases, they may know the 'glue words' but find it difficult to coordinate the production of so many words in the correct order.

These early omissions provide evidence for two major processes in language development. First, children try to make sure that the most important and substantive parts of the communication are not omitted. Unfortunately, children make this evaluation from their own, egocentric perspective. In an utterance like *Mommy chair*, it is not clear whether the child means 'This is Mommy's chair' or 'Mommy is sitting in the chair,' although the choice between these interpretations may be clear in context (Bloom, 1973). The second factor that shapes early omissions is phrasal frequency. Children tend to preserve frequent word combinations such as *like it* or *want some*. These combinations are often treated as units, producing errors such as 'I like it the ball' or 'I want some a banana.'

Productivity

Productivity can be demonstrated in the laboratory by teaching children names for new objects. For example, we can show a child a picture of a funny-looking creature and call it a *wug*. As we noted before, the positioning of the word *wug* after the article 'a' induces the child to treat the word as a common noun. Children can then move from this fact to infer that the noun *wug* can pluralize as *wugs*, even if they have never heard the word *wugs*.

Three-year-olds also demonstrate some limited productive use of syntactic patterns for new verbs. However, children tend to be conservative and unsure about how to use verbs productively until about age of 5 years. From the child's perspective, these laboratory experiments with strange new toys and new words tend to encourage a conservative approach. As they get older and braver, children start to show productive use of constructions such as the double object, the passive, or the causative (Brooks et al., 1999). For example, an experimenter can introduce a new verb like *griff* in the frame 'Tim griffed the ball to Frank' and the 5-year-old will productively generalize to 'Tim griffed Frank the ball.'

The control of productivity is based on two complementary sets of cues: semantics and co-occurrence. When children hear *a wag,* they correctly infer that *wag* is a count noun. In fact, because they also see a picture of a cute little animal, they infer that *wag* is a common, count, name for an animate creature. These semantic features allow them to generalize their knowledge by producing the form *wugs*. However, we could also view this extension as based on co-occurrence learning. The child learns that words that take the indefinite article also form plurals. On the other hand, words that take the quantifier some do not form plurals. In this way, the child can use both semantic and co-occurrence information to build up knowledge about the parts of speech. This knowledge can then be fed into existing syntactic generalizations to produce new combinations and new forms of newly learned words. The bulk of grammatical acquisition relies on this process.

The Logical Problem of Language Acquisition

The problem with productivity is that it produces overgeneralization. For example, an English-speaking child will soon learn to form the past tense of a new verb by adding one of the variant forms of *-ed*. This knowledge helps the child produce forms such as *jumped* or *wanted*. Unfortunately, it may also lead the child to produce an error such as *goed*. When this occurs, we can say that the child has formulated an overly general grammar. One way of convincing the child to reject the overly general grammar in which goed occurs is to provide the child with negative feedback. This requires the parent to tell the child, 'No, you can't say goed.' The problem here is that children seem to ignore parental feedback regarding the form of language. If the child calls a hamburger a hot dog, the parent can say, 'No, it is a hamburger.' The child will accept this type of semantic correction. But children are notoriously resistant to being corrected for formal grammatical features.

The fact that children tend to ignore formal correction has important consequences for language acquisition theory. In the 1960s, work in formal analysis convinced some linguists that the task of learning the grammar of a language was impossible unless negative feedback was provided. Since negative feedback appeared to be unavailable or unused, this meant that language could not be learned without some additional innate constraints. This argument has led to many hundreds of research articles exploring the ways in which children's learning places constraints on the form of grammar. Referring back to Plato's *Republic* and *the Allegory of the Cave*, Chomsky and others have characterized the task of language learning as a logical problem, much as Quine characterized the word learning Gavagai problem.

In fact, children have more resources available to them than Chomsky seems to suggest. Using these resources, the child can recover from overgeneralization without negative feedback. In the case of goed, everyone agrees that recovery is easy. All the child has to do is to realize that there is only one way of producing the past tense of go and that is went. In other words, the irregular form went comes to block production of the overregularized form goed. Here, recovery from overgeneralization is based on the competition between the regular pattern and the irregular form.

Consider another example. Suppose that a child decides that the verb *recommend* patterns like the verb *give*. After all, both verbs involve a beneficiary and an object being transferred. However, only *give* allows a double object construction, as in 'John gave the library the book.' Most people find 'John recommended the library the book' ungrammatical. One solution to this error is to avoid making it in the first place. However, a more general solution is to record the strength of the competing syntactic patterns. The correct way of saying 'John recommended the library the book' is to say 'John recommended the book to the library.' This correct formulation should be strengthened whenever it is heard. As the strength of the frame for the verb recommend grows in comparison to the ungrammatical frame, the use of the competing frame is blocked. This solution assumes that the child realizes that the two frames are in competition. It may be that reaching this realization requires some attention to syntactic form. However, this solution does not require children to pay attention to corrective feedback. Instead, they only need to attend to correct sentences and to make sure that they understand that these are competing ways of saying roughly the same thing.

Emergentist Accounts

In the 1980s, a sharp division existed between accounts of language acquisition that emphasized learning and those that emphasized innate knowledge of universal grammar. At the start of the twenty-first century, there is no longer a clear separation between alternative approaches. Instead, the challenge facing researchers is to formulate a set of mechanisms that is rich enough to account for the details of these emergent processes and that is grounded on the facts of human neurophysiology. To achieve this, many psychologists rely on the formalisms of neural network theory, which is also known as connectionism (Rumelhart and McClelland, 1986). This framework uses large numbers of units and the connections between these units to capture the patterns of language. This weblike architecture of nodes and connections is intended explicitly to resemble the structure of the human brain with neurons, synapses, and weights on synaptic connections. Neural network models have provided good accounts for the acquisition of morphology, phonology, and syntax (MacWhinney, 1999).

A major limitation of many current models is their failure to pay sufficient attention to the child's perspective on learning. In the late 1990s, researchers began to correct this problem. Models that rely on concepts derived from dynamic systems theory (Smith, 1999) and the theory of attention (Merriman, 1999) have proven useful in accounting for word learning by focusing on the ways in which concrete situations provide learners with cues. Newer formal models also relate word learning to children's physical control of their own body and their own perspective as a causal agent (MacWhinney, 2008). These new developments may also allow us to understand how language works to embed children into the fabric of social life (Nelson, 1998).

Conclusion

Language is a unique marker of humanity. It distinguishes the human species from the rest of the creation, and it allows us to share our thoughts and feelings. Language is the most complex skill that any of us will ever master. Despite this complexity, nearly every human child succeeds in learning language. This suggests that language is optimally shaped to mesh with the abilities of the human mind and body. On the one hand, the universals of human language match up with our neurological, cognitive, and physical abilities. At the same time, parents provide rich contextual and emotional support to guide children through the process of language discovery. By studying language learning, we learn more about universals of human language, the shape of social interaction, and the structure of the human mind.

See also: First Language Acquisition, Linguistic Theory of; Language Learning Impairment.

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