opinions, then combine the opinions into a judgment or belief, and finally hold this belief with a certain degree of confidence. When it comes to making the most of diversity, people fall short at all three stages. First, people do not uniformly seek out additional opinions. When they do, they often do not seek diversity. Instead, they collect opinions from relatively homogenous sources that share a common perspective, either because they seek confirmation or because similar others are more proximate. For example, a doctor may talk to a colleague with the same specialty or training, and an economist may discuss a forecast with someone who shares the same theoretical assumptions. Second, people combine fewer opinions than they should. One reason for this is that many people have incorrect intuitions about averaging, believing that it locks in the accuracy of the average judge in a crowd. Another reason is that people are overconfident in their ability to identify expertise and consequently "chase the expert" by selecting the single opinion they believe to be most accurate. Even with a larger group, people may focus on themselves or on just a few judges and miss out on the wisdom of the rest. In a 2009 article in *Management Science,* Albert Mannes showed that neglecting others comes at a high price in large crowds. Third, as shown by David Budescu and his colleagues, people are more confident when opinions are in agreement as opposed to disagreement. Although agreement is a signal of accuracy, it is also a signal of a shared perspective and shared error. People rarely recognize this latter implication of agreement. In fact, Ilan Yaniv, Shoham Choshen-Hillel, and Maxim Milyavsky have shown that confidence increases even when people understand that others' opinions were cherry-picked to agree with their own initial answer.

To tap into the crowd's wisdom, appreciating the roles of both knowledge and diversity are essential. People value the knowledge of individuals, and they often chase the expert to obtain it. But in doing so they may forsake diversity and risk missing out on the combined knowledge of the collective.

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See also Anchoring; Debiasing; Decision Improvement Technologies; Dissent, Effects on Group Decisions; Group Decision Making

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Word Learning

Language learning raises unique problems of learning and memory. This is widely recognized with respect to syntax learning, but it is also true of word learning. Word learning is the process of developing generalized (i.e., abstracted) mental representations to associate a *word form* (e.g., sequence of speech sounds or hand shapes/movements) with a *meaning* (e.g., category of events or objects that the word refers to) and *conditions of use* (e.g., Where in a sentence does this word typically belong? In what social contexts does one use the word?). The remainder of this section describes some unique features and questions about word learning in comparison to other kinds of learning. The next section describes research findings on children's word learning, including the typical course of vocabulary development, individual differences, typical errors, and ecological and cognitive factors that facilitate word learning. Subsequent sections briefly describe the neurological changes associated with word learning, the relation of word learning to reading, the nature of word learning in multilingual individuals, and word learning in adulthood.

Word learning entails special questions because the corpus of words we learn, our *lexicon,* is a unique set of information. It is dynamic and additive: Consider how the compound word *electronic* *mail*, coined in the 1980s, was quickly reduced to *e-mail*, which has since spawned analogous terms such as *e-commerce*. Adults can rapidly understand such words despite their novelty. This illustrates how we can, throughout life, add new elements (words) to our lexicon. In so doing we establish new, systematic connections (of sound, meaning, syntax, and usage) to other words and other linguistic and conceptual knowledge. Although words are arbitrary in form (e.g., nothing about the sound *dog* is inherently doglike), the lexicon is nonetheless somewhat principled. For example, words are hierarchical in meaning (e.g., *animal* refers to a category that includes all referents of *dog*) and in structure (e.g., an *-ed* verb ending denotes the real or hypothetical completion of an act or state). Also, words are combined in particular ways to express more precise meanings (e.g., *fire truck* and *truck fire* have different meanings). The lexicon is both social and normative (e.g., only our cultural knowledge makes *e-commerce* understandable) *and* internalized (e.g., we use words to facilitate cognitive processes such as explicit memory).

Word learning can be called *symbol learning* because it encompasses not only spoken words but signed words and even pictorial symbols (e.g., brand logos). Several nonhuman species (i.e., apes, parrots, dolphins) can learn small numbers of abstract names and symbols for objects, properties, or actions. There is no evidence that nonhuman animals use the full human range of word meanings (e.g., *not*, *think*, *silly*, *maybe*), word variants (*go*, *gone*, *went*, *had gone*), or word functions (e.g., puns, metaphors, novel compounds such as "climbing wall"). Yet children as young as 2 to 4 years old flexibly adopt such a wide range of forms, meanings, and uses: They can learn words defined by tone variations (e.g., Mandarin; Yoruba), percussive "click" or ingestive noises (Sindhi, Xhosa, Zulu), or gestures (American Sign Language). They learn words that take complex *inflections* (i.e., changes to the forms of a word, such as *run*, *ran*, *running*). Such variations are extensive and complex in languages like Turkish and Hungarian. Children also can integrate word meanings with cultural and conceptual knowledge (e.g., American children know that *Pokémon* refers to fictional characters, toys, playing cards, a game, a TV program, DVDs, and a video game, but *Pokémon Diamond* only refers to the last of these). How do children learn all of this?

How Children Learn Words

Vocabulary Development in Childhood

The course of word learning in young children is somewhat predictable. The first 50 to 75 words are acquired slowly, typically by 18 to 24 months of age. These words include proper names (*Mama*), nouns (*bottle*), a few verbs (*give*), descriptive terms (*down, more*), and social routine words (*bye*). Words like *nothing* or *think* are absent. The largest subset of early words is nouns, though it has been argued that this is not true of all languages.

Although first words are acquired slowly, even infants recognize a few words: Their own name sounds familiar by 4 months and by 10 to 12 months they tend to look selectively at an object when they hear its name ("truck!"). Many infants say a few words around 12 months (infants who are learning signed languages gesture their first words around 9 months). Then around 18 to 24 months, toddlers start learning words faster. In Indo-European languages (e.g., English, Italian, Dutch), infants start learning nouns faster, until their total *receptive vocabulary* (i.e., the words they understand) includes 150 to 200 items. Subsequently, the proportion of new verbs and adjectives increases relatively faster. This suggests that children learn nouns until they can and must express more diverse and specific relations between nouns (e.g., "The man petted the dog," vs. "The man fed the dog"). This requires verbs. Fittingly, toddlers start producing two- and three-word sentences around 18 to 24 months. These protosentences are *telegraphic*: They lack articles, prepositions, and inflections. Only after children understand 200 to 400 words (2½–3 years) do they add many such *function morphemes* to their sentences.

From 3 to 5 years of age, vocabulary grows substantially. Although total vocabulary size becomes harder to measure, English-speaking first graders might know an average of 3,000 *root words* (i.e., uninflected terms such as *house*, *run*), and many more inflected or compound words (e.g., *running*, *houseboat*). These large gains have spurred folk beliefs that children are uncannily precocious word learners. However, this claim lacks specificity or verification, and adults in controlled tests learn new words faster than preschoolers. Thus, acceleration in word learning around 18 to 24 months and large vocabulary gains from 2 to 5 years do not prove that word learning is a specialized childhood learning ability.

Individual Differences in Children's Vocabulary

Throughout childhood there is great variability in individual vocabulary size. According to parental report data, average English-learning 24-month-olds use about 300 words. However, children in the lowest 10% use only about 50, and those in the highest 10% use about 500: a 10-fold difference. Adults have similar large differences in vocabulary. At the lower extremes, virtually all children with cognitive or language disorders have some sort of restricted vocabulary.

Among children with language impairment but no other cognitive deficits, a common problem is that the auditory system (i.e., brain network that processes sound information) is slow to process the sound information in speech. This will inevitably impair word learning because, for example, it is harder to separate individual words in continuous speech. It now seems that this problem leads to later problems in decoding words while reading.

The Setting for Children's Word Learning

How do children learn words, and what factors influence children's success in word learning? As to "how," the simplest answer could be that children hear words while attending to the referent and form an association between the two. However, this explanation is inadequate. There are so many possible associations that a more specific theory of learning processes is necessary. A traditional associationist account holds that learning requires words and referents to be paired (a) close in time and (b) frequently. Both assumptions are only partly supported. First, in some situations, toddlers associate a novel word with something they saw a few minutes ago, not the last thing they saw. Second, frequency of input does not precisely predict learning. Preschool children sometimes sensibly guess a word's meaning from hearing it only one to two times. Even infants, after hearing a new word only a few times, might remember something of that word's sound for days. However, such *fast mapping* has been documented in simple, unambiguous experimental contexts, where adults use *ostension* (i.e., naming while showing the child a referent). Ostension is used by parents in specific situations, like picture-book reading. It is unknown how much fast mapping happens in common, everyday situations. Even in moderately complex experimental tasks, young children require many repetitions to learn a word. A correlation has been found between how much parents speak to infants (i.e., variety of words *and* total words) and the infants' vocabularies several years later. Thus, although repetition is not all determining, it usually promotes learning.

Children learn words even when adults are not providing ostensive naming or speaking to them at all. In many cultures, adults speak to infants infrequently or not at all. Perhaps surprisingly, there is no evidence that those infants learn language slower or have smaller lexicons than infants who are spoken to. Thus, the correlation between amount of speech to infants and later vocabulary does not rely on *direct* speech to infants. Infants must learn a lot by overhearing other people talking. Experiments show that toddlers may learn words as effectively from overhearing as from direct ostension.

The Progress of Word Learning: Errors

Children's knowledge of a word does not simply fit into one of two binary states, learned or unlearned. Children, like adults, can know a little about a word (e.g., "It sounds familiar . . . maybe it's a kind of food . . .") or a lot (e.g., can recognize, define, and use it correctly), or anything in between. However, children show a lag from *comprehension* to *production.* That is, they typically understand a word before they will say it. This is partly because of slow development of the fine motor skills for speech production. Nonetheless, children do speak, and this can reveal what they know or do not know about a word's meaning. Children's characteristic errors include *overextending* words (e.g., calling any medium-sized mammal "kitty"). These errors sometimes reflect real confusion about a word's meaning (e.g., *kitty* = any cute, fuzzy pet) and sometimes reflect pragmatic accommodations to their small vocabulary. If your only animal words are *kitty*, *horsey*, and *birdy*, your best option for labeling a rabbit or squirrel is "kitty."

How do children correct errors like these? Occasionally children seek information (e.g., "What dat?"), but children often do not seem to realize they are making errors. However, parents sometimes correct children's overt errors of meaning or word choice. They also use less direct strategies, like expanding and elaborating on their toddlers' telegraphic statements. A 20-month-old might point to a pond and say "duck!" The parent might then expand, "Yes, the duck is swimming, isn't it?" This expansion might teach the child not only about *swimming* but also confirm the correct usage of *duck* and implicate a semantic relation between *duck* and *swim* (i.e., ducks are a sort of thing that swims). Or if the parent elaborates, "Yes, ducks are pretty birds!" this provides semantic information about the class-inclusion relation between the categories *duck* and *bird*. Regarding the individual differences noted above, parents who speak more to their infants (who will later have larger vocabularies) also tend to elaborate. Parents' expansions might therefore provide important input to toddlers about word forms, meanings, and uses.

Children's Readiness to Interpret Words

Young children are not "equal opportunity" learners, assigning any plausible meaning to a new word. Children have certain biases. Some are based on perceptual processes. In general, objects that are novel, bright, and prominent will be associated with a novel word. Also, infants tend to associate a new word with an object if the object is moved in rhythm and synchrony with repetitions of the word. Finally, children tend to map novel words for objects onto whole objects, as opposed to specific parts, colors, or textures. However, more specific information about the word can cause children to override their bias and associate the word with another property.

Other biases in interpreting words seem to reflect human conceptual knowledge and ignorance. For example, children seem to assume that words refer to categories of objects, events, or properties, rather than to individuals. A child hearing "lemur" will associate it with a category of similar animals. Although some of toddlers' first words may be narrowly context specific, this seems to be the exception rather than the rule. Even by their first birthdays, infants tend to generalize new words to classes of similar referents. Also, children, like adults, tend to generalize words for objects at a *basic level* of abstraction; that is, an intermediate-breadth category (e.g., car) rather than a very specific one (Mazda 626) or a very general one (vehicle). More specifically, once toddlers know 50 to 100 words they begin to assume that novel object words generalize to categories of same-shape objects. However, this is a *learned* bias, and it is contingent on other properties (e.g., is the object an animal or artifact?). Thus, conceptual biases are not freestanding: They rest on other experiences and learned patterns. For this reason, it is no surprise that children's language constrains the specific concepts that they learn and name. Cross-linguistic studies confirm that meaning biases are affected by language experience. For example, English and Korean prepositions denote different spatial relations: English *in* and *on* do not have exact analogs in Korean. Korean 1-year-olds are sensitive to spatial relations denoted by different Korean words, but English-learning 1-year-olds do not discriminate those relations. Thus, toddlers' lexicons influence their sensitivity to specific meanings and patterns in the world.

Children also have social biases that affect how they learn meaning. By 18 months of age, toddlers monitor where adults are looking, so that when the adult says a novel word, the toddler associates it with whatever referent the adult was looking at. This prevents the infants from spuriously associating words with whatever *they* are attending to, if the toddler and adults are attending to different things.

Other biases for inferring word meanings are ambiguous. One claim is that children believe that each nameable category only has one label—a *mutual exclusivity* bias. For example, if the child sees a horse and a tapir, they will assume that an unfamiliar word (*tapir*) refers to the unfamiliar animal. However, evidence does not support that this is children's true bias. They do preferentially associate a novel word with a novel rather than familiar referent, but there are many possible explanations for this. This exemplifies a general pattern: Although children have many biases for interpreting new words, it is not clear which, if any, of these biases are specific to word learning per se.

Words on the Brain

To understand word learning requires understanding how sound patterns of words are processed by the brain and represented by brain networks so that subsequent brain states (caused by, e.g., the sound of the word) will reactivate that word representation. Activation of lexical knowledge involves widely distributed networks in the cortex, but in most healthy adults it persistently (not exclusively) involves left frontal and temporal cortical areas. However, this anatomical specialization is the result of development: Infants show wider distributed and more bilateral activation during word processing. Activation becomes more focused in left temporal and parietal regions from 14 to 20 months, showing that neuroanatomical specialization starts early. Intriguingly, infants who understand at least 150 words show a more focused electrophysiological response to familiar words as early as 200 to 400 milliseconds (ms) after the word begins.

Word Learning and Reading

As children get older, they can *decontextualize* language—see it as separable from the "here and now" (e.g., talk about absent referents, tell stories). Decontextualization of language is maximized in written text, such that we can enjoy the language of "speakers" who are absent, or even deceased.

Learning to read during childhood has a bidirectional relation to word learning: Children with larger vocabularies do better in reading, and children who read a lot learn more words. Throughout school, vocabulary is the best predictor of reading comprehension. During grade school, some nontrivial proportion of vocabulary growth is due to word learning from text. When unfamiliar words arise, we try to use the meaningful content of surrounding text to interpret them. Although a minority of contextually learned words are retained, the consequences are nevertheless substantial: Hypothetically, if a child reads 600,000 words in a summer (e.g., the last three Harry Potter books) and 1% of words are unfamiliar but inferable from context, and if she has only a 5% chance to infer and remember a word from context, her net gain would be 300 words. Thus, reading a lot of grade-level text is important for vocabulary growth. Children at risk for reading failure enter school with a lower level of language skills, read less, and remain below-average readers with smaller vocabularies.

In skilled readers, recognition of written words elicits maximal activation in a specific region in the temporal cortex. Less skilled readers show too widely distributed patterns of activation over many cortical regions, and recent evidence suggests that training these readers' discrimination of sound patterns in words can lead to more focused patterns of brain activation during reading.

Words in Two Languages

Most people in the world are multilingual: Monolingualism is the exception. How do people learn two lexicons, which might overlap in meaning but contain many single-language word forms? One debate is whether two lexicons are initially merged or separate. Although there is great diversity across individuals and situations, toddlers' two languages begin separating very early. Recent brain research suggests that bilinguals show activation of largely but not completely overlapping areas of cerebral cortex for each language.

Word Learning Later in Life

Word learning continues throughout life. There is a general idea that *age of acquisition* matters: Words learned earlier (e.g., as a toddler) are the most strongly represented in neural networks. For example, in *aphasia,* or loss of language due to brain injury, there is usually some degree of *anomia* (i.e., poor production or understanding of words). However, early learned words are more likely to be retained.

Word learning in adulthood can be very robust. Some words learned as a young adult will be retained for decades, even if never heard or used in the interim.

What do we know about the processes of word learning in adults? Like children, adults learn most new words by inferring meaning from context. Adults' rich phonological knowledge helps them efficiently learn new sounds of words. Adult word learning is affected by many general cognitive effects: For example, words at the beginnings or ends of sentences are more likely to be remembered (i.e., primacy and recency effects: the general advantage in remembering items from, respectively, the beginning and end of a list). When learning words over time, *distributed practice* rather than *massed practice* tends to increase retention intervals (i.e., how long words are remembered). Associations of new words are subject to both *proactive* and *retroactive* interference (i.e., confusion caused by prior information or subsequent information, respectively). In all these effects, we see continuity from childhood to adulthood, and substantial overlap of word learning with general processes of learning and memory.

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See also Concepts, Development of; Dyslexia, Developmental; Language Development; Language Development, Overregulation in; Representations, Development of; Speech Perception; Word Recognition, Auditory; Word Recognition, Visual

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Word Recognition, Auditory

Language provides humans with the remarkable capacity to express their thoughts through a physical medium to share with others. To do so, we combine elements, words, whose form has been conventionalized within a particular language community. Thus a critical step in the process of retrieving a talker's message consists of identifying these elements in his or her speech. This entry discusses how our knowledge of the auditory forms that words take may be represented in memory, and how listeners decide, based on the auditory stimulus, which words they heard, out of all possible word combinations the talker may have spoken.

What Does Our Knowledge of Words Look Like?

When we listen to someone talk, words seem to pop out of his or her speech effortlessly. This impression is misleading, however. Words are not neatly segregated from one another in speech as they are in print. How many words the utterance contains, and where they begin and end in the speech stream, are properties that the listener must establish. Moreover, the way spoken words sound varies considerably across contexts—for example, when produced by a man or a woman, in the clear speech used in lecture halls, or in the casual speech characteristic of informal conversation. Our knowledge of the form of words must accommodate this variability. Two approaches to this issue can be contrasted.

First, listeners may represent the form of a word as a compilation of the memory traces that correspond to all past exposure with the word. Each instance retains the acoustic properties resulting from the context in which the word was uttered. Such a representation is sometimes described as a cluster of observations in a multidimensional space. A more compact representation may also be postulated, such as one that represents the central