Can a Dog Learn a Word?

Paul Bloom

When making the point that language learning requires more than just the right environment, psychologists often point out that both a baby and a dog are exposed to language, but only the baby learns to talk. This example may have to change. On page 1682 of this issue, Kaminski *et al*. (*1*) report the impressive abilities of a border collie named Rico, who might well be capable of learning words.

When the experimenters place 10 items in another room, and Rico is asked by his owner to retrieve one, he is usually accurate, and repeated trials suggest that he has a vocabulary of more than 200 words. What is more impressive is that he can learn in just a single trial, akin to the "fast mapping" abilities of young children (*2*–*4*). Kaminski *et al*. tested the collie's fast mapping abilities by placing a new object along with seven familiar ones and having the owner ask Rico to fetch, using a name Rico had never heard before. He usually retrieved the new item, apparently appreciating, as young children do, that new words tend to refer to objects that do not already have names. A month later, Rico showed some retention of the name he had learned. His abilities are comparable to those of children and adults who were tested using similar designs (*3*–*4*).

Dog owners often boast about the communicative and social abilities of their pets, and this study seems to vindicate them. Indeed, Rico's word-learning abilities surpass those of nonhuman primates such as chimpanzees, who have never demonstrated this sort of fast mapping (*5*). As the researchers note, this might be because dogs have been specifically selected for attending to the communicative intentions of people. More generally, this study fits nicely with other research on the social capacities of domestic dogs (*6*), and might signal the emergence of a vibrant area of comparative cognition research. For psychologists, dogs may be the new chimpanzees.

How does Rico's learning compare with that of a child? Kaminski *et al*. point out just two differences: Children have a more diverse vocabulary, including names for specific people, properties, actions, and relations; Rico just knows words for fetchable things, mostly toys and balls. And children can speak; Rico cannot.

But that is not all. Rico is 9 years old and knows about 200 words, whereas a human 9-year-old known tens of thousands of words, and is learning more than 10 new words a day (*2*). Children's word learning is highly robust; they can learn words from overheard speech, even if nobody is trying to teach them (*2*). Rico, in contrast, learns only though a specific fetching game. Children can understand words used in a range of contexts; Rico's understanding is manifested in his fetching behavior. To rephrase a remark made by the psychologist Lila Gleitman (in reference to ape language): If any child learned words the way Rico did, the parents would run screaming to the nearest neurologist.

Perhaps Rico is doing precisely what a child does, just not as well. A 2-year-old human knows more than a 9-year-old dog, after all, and has a better memory, and a better ability to understand the minds of adults. Rico's limitations might reflect differences in degree, not in kind.

A more skeptical alternative is that Rico's abilities have nothing to do with human word learning. For a child, words are symbols that refer to categories and individuals in the external world (*7*). Even one-year-olds appreciate the referential nature of words. When children learn a word such as "sock," they do not interpret it as "bring-the-sock" or "go-to-the-sock," and they do not merely associate it with socks. They appreciate that the word refers to a category, and thereby can be used to request a sock, or point out a sock, or comment on the absence of one.

Does Rico understand reference? It is not clear (see the figure). In the experiments, Rico's abilities are limited to specific routines. All new items are learned in the course of fetching, and Rico's understand-

Different ways to interpret a command. When Rico, a border collie, is requested by his owner to fetch a sock, he might understand her in the same way a child would. That is, Rico might appreciate that the word "sock" refers to a category of objects in the world and that the rest of the command means that he should act in a particular way (fetching) toward a member of that category. Alternatively, he might not understand reference at all and might be limited to associating the word spoken by his owner with a specific behavior such as approaching a sock or fetching a sock.

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ing of these items is tested in this context as well. Also, it is always Rico's owner who is communicating with him. These experiments are carefully designed, and so there is no worry about problems akin to those of Clever Hans (a horse that seemed to have mastered arithmetic but was actually responding to subtle cues by its owner). Yet, if Rico really is learning sound-meaning relations, as Kaminski *et al*. maintain, it should not matter who the speaker is.

Further experiments can help to resolve this issue. Can Rico learn a new word by being shown an object and hearing a person name it? Can he learn a word for something other than a small fetchable object? Can he display knowledge of a word in some way other than fetching? (Kaminski *et al*. note that there is anecdotal evidence that he can—this issue is worth pursing experimentally.) Can Rico follow an instruction *not* to fetch an item, just as one can tell a child not to touch something? Rico's abilities are fascinating, but until we have answers to these sorts of questions, it is too early to give up on the view that babies learn words and dogs do not.

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MATERIALS SCIENCE

Fundamental Size Limits in Ferroelectricity

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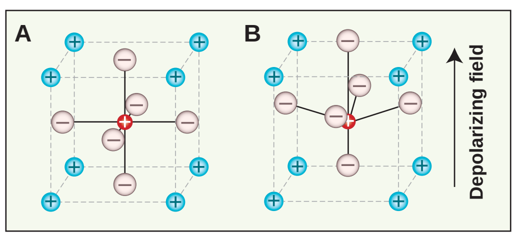
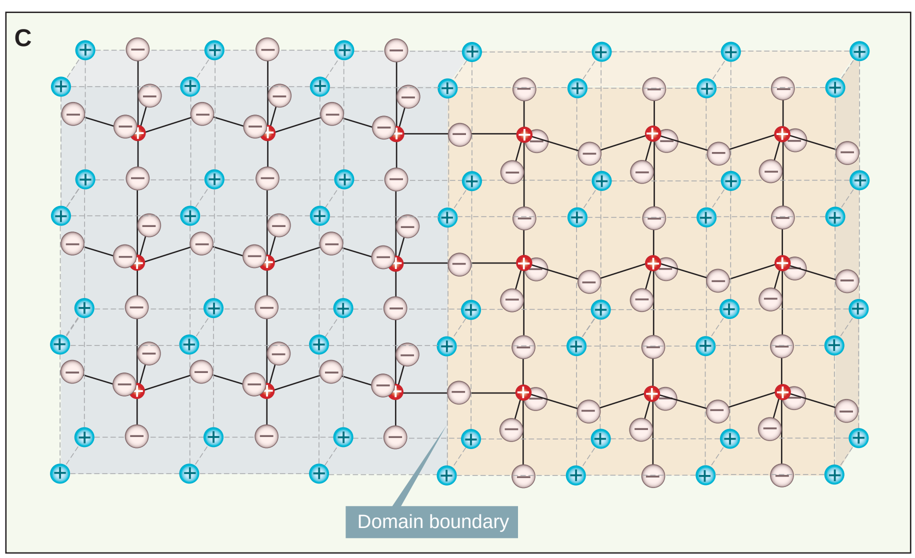
With the continued demand for portability in consumer electronics, it is becoming increasingly important to understand the effects of miniaturization on the properties of the active components in electronic devices. In many cases, however, the basic physics of such size reduction is poorly understood and can be difficult to characterize, because competing effects such as surface properties, strain effects from substrates, and fundamental size quantization complicate the behavior. This is particularly true in the case of ferroelectrics—materials that have a spontaneous electric polarization that can be switched by an applied electric field. Indeed, it has long been believed, on the basis of empirical evidence, that there is a critical size on the order of hundreds of angstroms below which a spontaneous electric polarization cannot be sustained in a material [for reviews of the literature, see (*1*)]. Such behavior would render ferroelectrics useless for applications at sizes below this cutoff, thereby limiting their importance in future technologies. Recent first-principles theoretical work (*2*–*4*), however, has indicated that the critical size is orders of magnitude smaller than previously thought, and this view has been corroborated by some measurements (*5*). On page 1650 of this issue, Fong *et al.* (*6*) provide the first unambiguous experimental evidence that these theoretical predictions and recent experimental indications are indeed correct by confirming that ferroelectricity persists down to vanishingly small sizes.

Ferroelectrics find three main technological niches based on three related physical characteristics. First, as a result of their spontaneous electric polarization, they can be used as binary data storage media in which opposite directions of polarization represent the 1 or 0 data bits. In addition, because the electric polarization is coupled to the structure of the material, ferroelectrics can convert mechanical energy to electrical energy and vice versa. This leads to their widespread use in transducer applications such as piezoelectric actuators and sonar detectors. Finally, they have very large dielectric permittivities leading to applications in capacitors. In all cases, it is crucial to understand the size dependence of the ferroelectric behavior as ever smaller devices are produced.

Consider why the existence of a critical size might be expected intuitively. Most technologically important ferroelectrics are perovskite-structure oxides (see the figure, pan-





Persistent polarization. (**A**) Schematic of the ideal cubic perovskite structure. A small cation (red) sits at the center of an octahedron of oxygen anions (white) with large cations at the corners of the unit cell. (**B**) In the distorted ferroelectric structure, the cation cage displaces (in this case down) relative to the anion cage, creating an electric polarization and a consequent depolarizing field. (**C**). In the samples of Fong *et al.* (*6*), domains of oppositely oriented polarization form, so that the net depolarizing field is zero. The figure shows a schematic of two domains, separated by a domain boundary across which the polarization changes orientation by 180°.

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