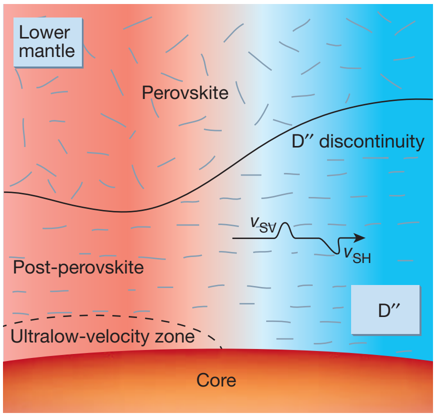

Figure 2 **New model for the mantle's base. The D″ discontinuity is now thought to be due to a transition from the perovskite to a post-perovskite structure in $(Mg,Fe)SiO_3$ about 200–300 km above the base of the mantle. The phase boundary is elevated in locally cooler regions (blue) and depressed in locally hotter regions (red). A tendency for the layers of the post-perovskite phase to align parallel to Earth's core can help to explain the faster propagation of horizontally polarized (v_{SH}) than vertically polarized (v_{SV}) shear waves. Ultralow-velocity zones are thin (5–40-km thick) regions, located directly above the core, where shear-wave velocities are strongly depressed.**

properties and deformation behaviour of perovskite and other lower-mantle minerals. Instead, it was proposed that the anisotropy resulted from aligned inclusions or layering of minerals with dissimilar seismic velocities. The discovery of the post-perovskite phase may provide a simpler explanation.

The proposed transition between perovskite and post-perovskite will not resolve all questions about the D″ region. But it clearly provides a new framework for studying the region and is sure to stimulate further geophysical observations, laboratory experiments and computer calculations. From a mineral-physics viewpoint, studies of texture development in the new phase, as well as constraints on the behaviour of more chemically complex systems, are clearly needed. Also, the elastic anisotropy has only been calculated at 0 K, yet in some cases temperature can drastically change the magnitude and even orientation of anisotropy. The theoretical studies[1,2,5,6] are in remarkably good agreement. But they all used similar techniques involving some degree of approximation, which will also necessitate further examination.

Nevertheless, a new era in the study of Earth's deepest mantle has begun. An explanation for both the D″ discontinuity and the onset of seismic anisotropy in the region may finally be within our grasp. ■

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Language

Children think before they speak

Paul Bloom

A linguistic contrast between English and Korean provides a telling test of different ideas about whether thought precedes the acquisition of language, or whether certain concepts are language-specific.

In his autobiography, written in the fourth century AD, Saint Augustine[1] described how he learned to talk: "By constantly hearing words, as they occurred in various sentences, I collected gradually for what they stood, and having broken in my mouth to these signs, I thereby gave utterance to my will." For Augustine, thought precedes language: language is a tool with which to express one's ideas and to understand the ideas of others. This is the view of many contemporary philosophers and psychologists[2–4], but it is not the only possibility. Many scholars would instead endorse the theory of linguistic relativity, and maintain that learning a language has a profound influence on a child's mental life. If so, then speakers of different languages might think in very different ways[5,6].

On page 453 of this issue, Hespos and Spelke[7] present data, from 5-month-old babies, that support Saint Augustine's view. They concentrate on a much-studied linguistic contrast. Korean, but not English, makes a distinction between 'tight-fitting contact' and 'loose-fitting contact'. For instance, Korean uses different verbs when describing placing a shoe in a large box, where it fits loosely, and when placing the shoe in a small box, where it is a tight fit — even young children who are just beginning to learn Korean honour this distinction when they speak[6]. Hespos and Spelke ask whether this distinction between two sorts of contact is universal, and exists before language-learning (in which case it should be present in babies), or whether it is the result of acquiring Korean (in which case it should be present only in children and adults who have some knowledge of that language).

They address this question by using a standard method in infant cognition. They show babies instances of a given category until they get bored (or habituated) and stop looking, and then see if the babies perk up — look for longer — at an instance from a

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Snug fit: in situations such as this, the Korean language makes a distinction between tight and loose contact.

new category. If so, it means that babies are sensitive to the categorical difference. Using this method, Hespos and Spelke find that 5-month-olds who are raised in an English-speaking community are sensitive to the Korean categories of meaning. If the babies are habituated to tight-fitting events, such as a cylinder placed within a narrow container or a ring-like object placed around a post, they will look for longer when later shown a loose-fitting event, such as a cylinder placed into a wide container (see Figs 1 and 2 of the paper, pages 453 and 454). The converse is also true. If habituated to loose-fitting events, babies will look for longer when shown a tight-fitting event. In this domain at least, the traditional view is right: thought precedes language.

Hespos and Spelke note the analogy here with phonology, in which there are also crosslinguistic differences — certain acoustic contrasts are present in some languages but not others. It is not that children become increasingly sensitive to the distinctions made in the language that they are exposed to. Instead, they start off sensitive to every distinction that human languages make; the process of learning a particular language involves becoming insensitive to those distinctions that are irrelevant, and learning what to ignore.

Phonology and meaning differ in certain important ways, however. Another striking fact about phonological development is that the early sensitivity disappears. If the child's language does not exploit a distinction, then the child loses the ability to notice it. This is one reason why it is so difficult to learn a second language. But, as Hespos and Spelke point out, even an adult English-speaker who has never heard Korean can tell the difference between a tight fit and a loose fit. This difference between phonology and meaning makes sense. Phonology is for communicating; once a language is learned, nothing is lost by jettisoning those phonological contrasts that are irrelevant. But meaningful contrasts such as loose fit and tight fit are for making sense of the world. This is nicely demonstrated by the finding that 5-month-olds can use their sensitivity in a non-linguistic context, when predicting the motions of objects.

In addition, although all phonological distinctions made by language may be innate, this cannot be true for all distinctions of meaning. Babies might understand the contrast between tight fit and loose fit, and between support and containment, but they are unlikely to comprehend the contrasting meanings of the verbs 'leering' and 'glaring', or the nouns 'accountant' and 'lawyer'. This must be learned.

What is the nature of this learning? One compromise view is that there is a universal core of meaningful distinctions that all humans share, but other distinctions of meaning that people make are shaped by the forces of language; this is consistent with the theory of linguistic relativity. But it is also possible that the strong Augustinian view is correct: language learning might really be the act of learning to express ideas that already exist, either because they are unlearned (as is likely to be true of the domain studied by Hespos and Spelke) or because they have been learned though experience with the physical and social world.

The question of how language and thought are related is one of the deepest in psychology, and there are many variants of the claim of linguistic relativity that this current research does not address[8–10]. But the capacities of 5-month-olds do pose a serious challenge for certain strong versions of the view that language precedes thought, and show that, in some domains at least, children think before they speak. ■

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Palaeontology

Echinoderm roots

Andrew B. Smith

A bold claim about the origins of the echinoderms is based on newly discovered fossils from China. But many pieces are still missing from this part of the fragmented puzzle of life's evolutionary history.

Few marine animals are so immediately recognizable as echinoderms. The five-fold symmetry of a starfish or sea urchin is striking (Fig. 1), and this pentaradiate form sets them apart from their bilaterally symmetrical relatives. The echinoderm skeleton is equally distinctive, being made of calcite plates with a microstructure that resembles a very holey Swiss cheese. Finally there is their bizarre asymmetrical transformation from larva to adult, which involves loss of the right-hand set of paired larval body chambers. But echinoderms have not always possessed these features, and unravelling their early history remains highly controversial.

On page 422 of this issue Shu *et al.*[1] describe a new group of small fossils from the Lower Cambrian of Chengjiang, China. The fossils are some 520 million years old: Shu *et al.* call them vetulocystids, and interpret them as the most primitive echinoderms yet known. If correct, this links the echinoderms to an enigmatic group, the vetulicolians, remains of which are found in the same deposits of early Cambrian age.

Fossils can be made sense of only by comparison with living organisms, where the biological function of structures that become preserved can be directly observed. This is relatively easy when the fossil is rather close in structure to its extant relatives. But fossils such as the vetulocystids, whose affinity with living groups is not immediately apparent, pose a major difficulty. In the past they would have simply been hived off into their own higher taxonomic group, thereby avoiding the problem. Nowadays, palaeontologists take the harder path and strive to place such fossils into their appropriate branch in the tree of life, interpreting characters they display in the most plausible (or least implausible) way.

The vetulocystids are a fascinating but frustrating group — fascinating, because of what they may tell us about the morphology of echinoderms before they had evolved such distinctive morphology, and frustrating because of the difficulty of interpreting even their basic anatomical organization. In this they are not alone. Another group of primitive and entirely extinct echinoderms, the homalozoans, have been the source of debate amongst palaeontologists for years.

A. B. SMITH

Figure 1 **Sea-urchin symmetry: an example of the unique pentaradiate form of echinoderms.**

Echinoderms belong to the branch of the animal kingdom known as the deuterostomes, a group that also includes ourselves. This is a very diverse assemblage of organisms, the other members being the vertebrates (fishes and tetrapods), urochordates (tunicates and sea squirts) and hemichordates (pterobranchs and acorn worms) (Fig. 2, overleaf). Molecular data strongly support this grouping, placing vertebrates and urochordates together and echinoderms and hemichordates as a second pairing[2]. But in terms of morphology echinoderms have always stood apart because of their aberrant symmetry and lack of structures known as gill slits. Gill slits are present in hemichordates, urochordates and the more primitive vertebrates, and are openings that pierce the wall of the digestive system just behind the mouth. They appear to have evolved for venting excess water drawn into the gut during feeding and are unique to deuterostomes.

Homalozoans are important fossils because they help bridge the gap between radiate echinoderms and other