Biology of communication

First squeaks of speech?

John C. Marshall

THE two hemispheres of the human brain are (roughly) symmetrical at the level of gross anatomy, yet their functional capacities are quite distinct; many domains of visuo-spatial cognition have their neuronal substrate in the right hemisphere, whereas the left is specialized for core aspects of language and speech processing[1]. Although these latter capacities are species-specific properties of humankind, we might nonetheless expect to find, in other animals, some of the underlying biological mechanisms upon which the evolution of language was built[2]. In a study reported on page 249 of this issue[3], G. Ehret, of the University of Konstanz, shows that the perception of communicative calls is lateralized to the left hemisphere in a comparatively lowly species — the house mouse.

A mouse pup that strays too far from the litter will emit ultrasonic calls within a narrow frequency range, and these sounds provoke the experienced mother to retrieve the pup to the nest. The mother is innately pre-wired to attend to ultrasounds, which are categorically centred on the frequency of 50 kHz, but must learn the significance of these 'distress' calls from interaction with her pups.

In Ehret's first experiment, the maternal motivation of primiparous lactating house mice was raised by removing pups from the litter and distributing them along a running board which extended to the right and left of a central nest. After the mother had retrieved the pups and replaced them in the nest, two loudspeakers, each located at a different end of the running board, were switched on. One emitted 50-kHz and the other 20-kHz tone bursts. When tested binaurally, the lactating mice would leave the nest and reliably approach the 50-kHz ultrasound source in preference to the 20-kHz source. This preference persisted when the mothers' left ears were plugged to attenuate the signals by 40 dB, but each sound source was approached equally often when only the right ear was plugged.

Because, as in man, the auditory system of the mouse has primarily contralateral neuronal pathways from ears to cerebral hemispheres, the result demonstrates that the left hemisphere is specialized for some aspect of the complex task that the mice are here engaged upon. But which aspect? Perhaps the right hemisphere can 'hear' both 50- and 20-kHz tones but not discriminate between them. Perhaps it can so discriminate, but not link the discrimination to the respective sources of the tones. Perhaps the right hemisphere can succeed in both these steps, but does not 'know' that 50 kHz signifies distress (and thus does not 'care' which loudspeaker it goes to investigate).

Ehret's solution to this puzzle is extremely neat. In a second experiment, virgin females without experience of pups were placed in the same apparatus. For a reward of drinking water, they were trained to discriminate between 50- and 20-kHz tone bursts and to approach the source of the former tone in order to receive their reward. After conditioning to criterion with binaural presentation of the two simultaneous tone bursts, these animals were then likewise tested with either the left or the right ear plugged. The conditioned response to the 50-kHz tone persisted irrespective of which ear was attenuated.

When listening with either the left or the right ear, the mice can thus discriminate between the tones, locate the source of the preferred tone and respond appropriately by approaching that source. The cerebral hemispheres of the female house mouse seem equally adept in sound perception *per se*. It is only in the first experiment, where one of the sounds has an intrinsic biological significance (and that significance is known to the mouse) that the left hemisphere so dramatically outperforms the right. Furthermore, the 50-kHz distress call plays a crucial communicative role in the interaction of the mouse mother with her young. Ehret accordingly speculates that an underlying lateral specialization for the auditory perception of communicative signals (between conspecifics) might be "a possible basis of the left-hemisphere advantage for speech sound recognition in man".

The evolutionary story must, however, be a good deal more complicated than this account suggests. In the human brain, it seems that the right hemisphere is specialized for the perception of affective aspects of communication, in both the visual and auditory modalities. Thus the recognition and interpretation of facial gesture[4], and of the emotive significance of prosodic information in speech[5], are more severely impaired by right than by left hemisphere damage. The perception of speech in terms of phonetic and phonemic categories is admittedly a strictly left-hemisphere function[6], and one which is furthermore present in very young infants (as indexed by a right-ear advantage for the perception of speech sounds[7]). Yet there is good evidence that the right hemisphere can process speech in a non-phonological mode and may have semantic access to the meaning of auditorily presented words[8]. The linguistic specialization of the left hemisphere in man clearly extends well beyond the auditory domain; the mechanisms responsible for the expression and comprehension of gestural languages (such as American Sign Language) are as firmly committed to left-sided cortical areas as is any aspect of auditory communication[9].

Nonetheless, Ehret has provided an important demonstration of a left-hemisphere advantage in an animal whose rank in the evolutionary scale might have led one to expect a functionally symmetrical brain. But why nature should choose an asymmetrical location for critical biological functions remains as mysterious as ever. The customary account which is given for lateralized control of human speech (or complex song production in canaries and chaffinches) — that it would be very difficult to ensure the requisite synchrony of timing in the operation of centres that were duplicated in two hemispheres — seems not to apply to the perception of 50-kHz tone bursts. □

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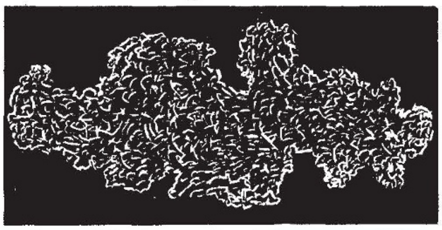
100 years ago

A MOST extraordinary snowstorm occurred here today (January 7). In fifty years' experience I have seen nothing like it. It would be impossible to realize the gigantic size of the snowflakes without seeing them. I can only compare them to a fall of oranges, though the diameter of an orange would be small in com-



parison with thousands of these snowflakes. Snow had been falling with a slight thaw from 10 a.m., the snowflakes being small. Suddenly, at 12h 12m p.m. they became 2½ inches in length; at 12h 14m they had increased to 2¾ inches. At 12h 16m the flakes had increased in size to 3½ inches (and several measured were 4 inches across). Several flakes were sketched before they began to melt, and one of the sketches is sent as an illustration.

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