The waggling dance of honeybees conveys navigational information about where food is to be found. But it seems that the information is valuable only in certain circumstances.

Almost 60 years ago, Karl von Frisch discovered that worker honeybees, after returning home from rich sources of nectar or pollen, can encode the direction and distance of food sources into body movements that he called dances (Fig. 1). Von Frisch argued that spatial information in the dance, together with odours carried by the dancer, could be used by nest-mates to find the food. The discovery of this so-called dance language provoked intensive research and no small amount of controversy. It remains a lively area of research, the latest contribution coming from Sherman and Visscher on page 920 of this issue.

A matter that has never been satisfactorily resolved concerns the precise way in which spatial information in the dance increases the ability of the colony to accumulate food from the environment. Although dancing is correlated with a build-up of forager recruits at a food source, it is not absolutely necessary for recruitment to occur, especially when the food is close and odour cues are strong. Even when spatial information is present, it is sometimes ignored in favour of odour cues by recruits searching for food.

Such observations are hardly evidence that the dance does not communicate spatial information, as some sceptics claim, but they do raise the question of why that information is sometimes used for recruitment and sometimes not. Sherman and Visscher address this question, and in doing so provide insight into the adaptive function, or survival value, of the dance language. They have studied colonies of the European bee, Apis mellifera, in southern California, to see what influence the danced information has on a colony's success. They find that there is an effect, but that it depends on the season.

One standard strategy for assessing the adaptive function of a trait is to prevent or alter its expression, and then to see how the manipulation affects the animal's success in the environment. In their application of this strategy, Sherman and Visscher deprived bee dancers of precise directional information, and observed how this affected the recruitment of foragers and the rate of accumulation of food by colonies.

The directional information encoded in the dance is the angle that the bee has flown relative to the Sun's azimuth to reach the food. In the dance, the bee repeatedly runs in a straight line over the comb while vigorously wagging her body. The flight direction is encoded in the orientation of these waggling runs relative to stimuli present in the nest. If the dancer can see the Sun or another bright light source, she simply aligns herself to match her view of the light with her view of the Sun during the flight. If a light source is not visible but the bee's dancing on a vertical surface (as is normal in the darkness of the nest), then she can align her body to gravity to match the angle flown relative to the Sun.

If one deprives the dancers of both gravity and a directional light cue, by rotating the comb to the horizontal and then keeping it in darkness or diffuse light, the dances are typically disoriented.

Sherman and Visscher carried out two experiments to assess the consequences of depriving dancers of directional information in this way. First, they compared the rate of forager recruitment to an artificial flower when dances were oriented or disoriented, using paired colonies and a reciprocal design to control for temporal and colony-level differences. As in earlier experiments, recruitment rates were far lower when dances lacked directional information. That some recruits found the food when dances were disoriented can be attributed to the use of odours.

This experiment adds to the sizeable body of evidence that spatial information in the dance helps recruits to find food. But does this communication system make any difference to the ability of a colony's foraging force to amass resources? The second experiment addressed this question by comparing the rate of gain of mass (presumably, mostly nectar)
Relic of the dawn of time

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Elements heavier than helium are synthesized in stars. But could there be stars, created soon after the Big Bang, that contain almost no heavy elements? The discovery of such a star gives new clues to this early time.

For half a century, astronomers have known that the elements of the periodic table are produced in stars\(^1\). The chemical enrichment of the Galaxy has proceeded from an early state with very low amounts of ‘metals’ (elements heavier than helium) to the present epoch, in which metals make up some 2–3% of the visible mass of the Milky Way\(^2\). This realization led to the quest for some 2–3% of the visible mass of the Milky Way. This quest led to the discovery of halo stars, which contain very little heavy elements.

Stars that contain very small amounts of heavy elements are rare in the Galaxy. Among the brightest 10,000 stars in the sky, only a handful contain really low amounts of metals. These metal-poor stars belong to the Galactic halo, that faint sphere of old stars and globular clusters in which the Galactic disk is embedded (Fig. 1). Theorists believe that these stars are eccentric, taking the stars through the Galactic disk at relatively high velocity. Searches for metal-poor stars have been carried out in two ways: by identifying high-velocity stars that are confirmed as halo objects by the details of their orbit; and by finding stars whose radiation bears the spectral signatures of very low metal abundances. Extensive searches for stars of low metal abundance have been made, but two decades have found many halo stars with metallicities less than 1/100 of that of the Sun, but none with convincingly less than 1/10,000 of the solar metallicity\(^3\).

The apparent absence of any stars in the Galaxy today with such low metallicities has been interpreted as evidence that such stars never formed\(^4\). The process of star formation from gas with low metal content is thought to be different from star formation in today’s Universe. With no metals to radiate away the heat generated by the contraction of the gas cloud, star formation is less efficient. Moreover, theory indicates that in metal-poor gas, the formation of high-mass, not low-mass, stars is favoured. Evidence for this is seen in excesses of the so-called ‘alpha’ elements — oxygen, magnesium and silicon — in metal-poor stars, elements produced primarily during the evolution of massive stars. These early, massive stars would have evolved quickly, leaving the metals they produced and dispersed to the interstellar medium through supernovae explosions as the only evidence that they ever existed. No longer-lived, lower-mass siblings would remain to the present day.

But the barrier at 1/10,000 of the solar metal abundance now seems to have been breached. A new spectroscopic survey of the southern sky, reaching fainter stars than earlier surveys and covering ten times as large a volume of sky, identified the star HE0107 + 5240 as possibly being extremely metal-poor. Spectroscopic follow-up observations by Christlieb et al.\(^5\) at the European Southern Observatory’s Very Large Telescope have confirmed the low metallicity, now measured as 1/200,000 of the solar metal abundance — a fraction 20 times less than in the previously known, most metal-poor stars. Even the strongest spectral lines of metals are barely visible in its spectrum.

The discovery of HE0107 + 5240, at a distance of half the diameter of the Galaxy from the Sun and with a mass only 1/10,000th of the Sun, shows that low-mass, metal-poor stars could and did form in the early Galaxy, despite theoretical indications to the contrary. The chemical composition of HE0107 + 5240 may provide a clue to the mystery of its formation. Although extremely deficient in metals, the star displays a striking excess of the light elements carbon and nitrogen. There is 10,000 times more carbon and 200 times more nitrogen relative to iron. These huge excesses of carbon and nitrogen may have been deposited on the star by a more massive companion star that has since evolved and disappeared.

In fact, a large proportion of stars with metal deficiencies 1/10,000 that of the Sun show excesses of carbon and/or nitrogen, and some are known to be binaries\(^6\). Perhaps most, if not all, of the extremely metal-poor stars in the Galaxy today originated as part of a binary pair, a by-product of the formation of a massive star. Alternatively,