### Orientation and Navigation

**定位和导航**

To South Americans, robins are birds that fly north every spring. To North Americans, the robins simply vacation in the south each winter. Furthermore, they fly to very specific places in South America and will often come back to the same trees in North American yards the following spring. The question is not why they would leave the cold of winter so much as how they find their way around. The question perplexed people for years, until, in the 1950s, a German scientist named Gustave Kramer provided some answers and. in the process, raised new questions.

在南美，知更鸟每年春天都会飞往北方。而在北美，知更鸟每个冬天又都会往南飞。而且，他们会飞往几个固定的位于南美的地方，然后在第二年春年又会回到在北美原来的那些树上。问题是他们为什么会在寒冷的冬天离开，然后又是怎样找到迁徙的路径的。这个问题困扰了人们很久，直到 1950 年，一个叫做 Gustave Kramer 的德国科学家回答了这个问题。但同时，又提出新的问题。

Kramer initiated important new kinds of research regarding how animals orient and navigate. Orientation is simply facing in the right direction; navigation involves finding ones way from point A to point B.

Kramer 提出了新的重要的关于动物如何定位和航行的研究。定位就是面朝正确的方向，航行包括了找到从 A 点到 B 点的路径。

Early in his research, Kramer found that caged migratory birds became very restless at about the time they would normally have begun migration in the wild. Furthermore, he noticed that as they fluttered around in the cage, they often launched themselves in the direction of their normal migratory route. He then set up experiments with caged starlings and found that their orientation was. in fact, in the proper migratory direction except when the sky was overcast, at which times there was no clear direction to their restless movements. Kramer surmised, therefore, that they were orienting according to the position of the Sun. To test this idea, he blocked their view of the Sun and used mirrors to change its apparent position. He found that under these circumstances, the birds oriented with respect to the new "Sun." They seemed to be using the Sun as a compass to determine direction. At the time, this idea seemed preposterous. How could a bird navigate by the Sun when some of us lose our way with road maps? Obviously, more testing was in order.

在这些研究的早期，Kramer 发现被关在笼子里有迁徙习惯的鸟在他们往常在野

外应该开始迁徙的时候变得好动。而且，他注意到，当这些鸟在笼子里躁动不安时，他们通常将自己推向通常的迁徙路径的方向。他于是将星椋鸟关在笼子里做实验，然后发现了他们的方向。事实上，他们有在适当的迁徙方向，除了天空布满云彩德时候，因为这个时候往往使得他们的骚动不安的活动没有了清楚地方向指向。因此，Kramer 猜测道，他们时通过太阳的方位来确定方向的。为了验证这个猜想，他蒙住他们的眼睛并且用镜子改变太阳的自然方位。他发现，在这种环境下，这些鸟按照新的太阳来定位。似乎他们把太阳作为一个罗盘来决定他们的方向。在那个时候，这种猜想看上去是荒谬的，当我们中的一些在有地图的情况下都会走失他们又怎么能够用太阳进行导航呢？显而易见的，接下来会有更多的实验。

So, in another set of experiments, Kramer put identical food boxes around the cage, with food in only one of the boxes. The boxes were stationary, and the one containing food was always at the same point of the compass. However, its position with respect to the surroundings could be changed by revolving either the inner cage containing the birds or the outer walls, which served as the background. As long as the birds could see the Sun, no matter how their surroundings were altered, they went directly to the correct food box. Whether the box appeared in front of the right wall or the left wall, they showed no signs of confusion. On overcast days, however, the birds were disoriented and had trouble locating their food box.

所以，在另外一组试验中，Kramer 在鸟笼周围放置了相同的餐盒，但是只有一

个餐盒中有食物。这些餐盒是静止的，装有食物的那个餐盒始终在罗盘的同一个地点。但是，这个点会由于周围的环境而发生相对改变，那就是既可以通过旋转装有鸟的内部笼子或者旋转作为背景的外墙。只要这些鸟可以看见太阳，无论他们身处的环境如何变化，他们都为径直找到那个正确的餐盒。无论这些盒子是在左墙还是右墙前方，他们都没有表现出迷惑的样子。但是，在阴天，他们就不能定位并且有困难发现盛有食物的餐盒。

In experimenting with artificial suns, Kramer made another interesting discovery. If the artificial Sun remained stationary, the birds would shift their direction with respect to it at a rate of about 15 degrees per hour, the Sun's rate of movement across the sky. Apparently, the birds were assuming that the "Sun" they saw was moving at that rate. When the real Sun was visible, however, the birds maintained a constant direction as it moved across the sky. In other words, they were able to compensate for the Sun's movement. This meant that some sort of biological clock was operating-and a very precise clock at that.

在关于人造太阳的试验中，Kramer 又有一些有意思的发现。如果人工太阳保持

静止，这些鸟会每小时以 15°的速度去改变他们的方向，这个速度正是太阳在天空中运动的速度。显然，这些鸟认为他们所看见的“太阳”是按照这个速度移动的。但是，当看见真正的太阳时，这些鸟保持了连贯的方向，正如太阳在天空中移动一样。也就是说，他们可以适应太阳的运动。这就意味着，有一种非常精准的生物钟在起着作用。

What about birds that migrate at night? Perhaps they navigate by the night sky. To test the idea, caged night-migrating birds were placed on the floor of a planetarium during their migratory period. A planetarium is essentially a theater with a dome-like ceiling onto which a night sky can be projected for any night of the year. When the planetarium sky matched the sky outside, the birds fluttered in the direction of their normal migration. But when the dome was rotated, the birds changed their direction to match the artificial sky. The results clearly indicated that the birds were orienting according to the stars.

那些在夜晚迁徙的鸟又是怎样的呢？也许他们通过夜晚的天空来航行。为了验证

这个猜想。这些在夜晚迁徙的鸟被关进笼子里，并在他们的迁徙期放置在一个天

文馆里。这个天文馆是一个具有穹顶状的天花板的剧场，并且这些天花板可以放

映出一年中任何夜晚的样子。当天文馆的屋顶与外面的天空相吻合时，这些鸟就

会朝着往常迁徙的方向振翅。但是当这个圆屋顶旋转的时候，这些鸟改变方向以

适应这个人造天空。这就清楚地表明这些鸟是通过星星来进行方向定位的。

There is accumulating evidence indicating that birds navigate by using a wide variety of environmental cues. Other areas under investigation include magnetism, landmarks, coastlines, sonar, and even smells. The studies are complicated by the fact that the data are sometimes contradictory and the mechanisms apparently change from time to time. Furthermore, one sensory ability may back up another.

这些不断积累的证据表明鸟是通过非常多的外界环境信息来引导他们的航行。包括磁场、里程碑、海岸性、声波甚至气味也同样被作为实验对象进行观察。由于这些数据常常是相反的并且磁场经常随着时间的改变而改变的事实，使得这些研究非常的复杂。此外，一种知觉能力可能会支持另一种。