

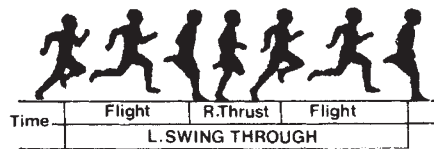
deceleration — this is to be expected as the theory simply assumes the driver instantaneously reaches a particular deceleration while a real driver does not 'slam on the brakes'.

The above argument is not restricted to the control of man-made machines: exactly the same kind of visual information could be used to control landing whether of a bird on a branch or a bee on a flower and there are numerous other skills which require accurate visual monitoring of time-to-contact.

Analysis of the optic flow field may enable us to explain how athletes get the kind of precise visual information they need to control their footing. One task that has been looked at from this viewpoint is the long jump<sup>3</sup>. A long jumper sprints some 40 metres and then leaps off a 20 centimetre wide take-off board. To achieve a successful jump the athlete must leap from as close as possible to the front edge of the board without overstepping it.

Film analysis of jumps made by three international standard athletes shows that the run up can be divided into two phases. In the 'run up' the athletes, although trying to use a stereotyped approach, inevitably build up positional errors as they sprint down the track. Three or four strides from the take-off they average standard errors in footfall position of more than 30 cm. They then 'zero in' and use visual information to adjust the final strides so that they hit the board with a standard error of less than ten cms (at a speed of around 22mph).

How do they visually regulate their final



strides? As shown in the figure a stride is composed of three segments which can be varied independently: the *thrust*, from the start of the stride to the point when the foot leaves the ground, which can be increased by lowering the hips; the *flight* the airborne distance travelled which can be modulated by changing the horizontal impulse (the 'drive') which affects the velocity of the athlete or the vertical impulse (the 'lift') which affects the time for which the athlete is in the air; and the *landing length*, how far ahead the foot touches the ground, which can be increased by stretching the leg forwards.

Analysis of films of the athletes suggests that they zero in on the board by regulating only the flight segment of the stride and that they do so by modulating the 'lift', which changes only the flight time, rather than the drive, which changes the velocity. The problem of striking the board may thus be usefully conceived of as one where the athlete makes a timing judgement rather than a distance judgement: the duration of the remaining strides is programmed just to fill the time remaining to reach the board — the necessary information being given in the time-to contact variable in the optic field.

The apparent simplicity with which some behaviours might be controlled by the optic

flow field has led some researchers (in particular JJ Gibson who provided much of the original inspiration in this area) to suggest that the relation between perception and the optical input to the eye is in some sense 'direct' and is characterised by an 'immediate pick up of information'. Recent controversy (see ref.4 for an attack on Gibson's theory and replies) seems to have been confounded by a lack of any clear agreement on what is meant by 'direct perception'. Some (its critics) hold that it implies the nonsensical idea that perception can take place without anything going on at all in the head. Others say that it merely implies, in contrast to the view held by many who study visual illusions, that perception does not require an animal to make 'hypotheses' about the world from inadequate visual cues.

Whether or not there is any value in the idea of 'direct perception' there is little doubt that a shift in emphasis from the analysis of static visual arrays to a consideration of what an animal actually uses visual information for (as Gibson<sup>5</sup> does in his 'Ecological Optics') is likely to help us to understand how animals see. □

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1. Lee, D.N. *Perception* 5, 437 (1976).
2. Spurr, R.T. *Automobile Engineer* 39, 58 (1969).
3. Lee, D.N. *et al. Athletics Coach* 11, 26 (1977).
4. Ullman, S. *Behav. Brain Sci.* 3, 373 (1980).
5. Gibson, J.J. *The ecological approach to visual perception* (Houghton-Mifflin, 1979).
6. Lee, D.N. *Phil. Trans. R. Soc. B* 290, 169 (1980).



### 100 Years ago

*The Mountain Nestor or Kea (Nestor notabilis).* — Whatever may have formerly been thought to the contrary, there can be now no doubt that animals are continually changing their habits in order to suit themselves to the altered circumstances of their existence. A very familiar instance of this is that of the common swallow, which, in Europe at least, usually builds its nest in chimneys. But a much more striking and less laudable change of habit has of late years taken place in a New Zealand bird, of which we herewith give an illustration. Parrots, though varying much in the details of their diet, are generally considered to be altogether frugivorous. Fruit and seeds, and in certain special cases moss and honey, are, no doubt, their proper food. But since the introduction of the domestic sheep into New Zealand the Mountain Nestor, which was previously content with a modest repast of an entirely vegetable character, has developed a taste for mutton. Many instances have now been recorded of this bird attacking not only sick and dying sheep, but; it is alleged, even those that are strong and healthy, though we should hardly suppose that this parrot exists anywhere in sufficient numbers to be likely to do the flock-masters any serious injury.



From *Nature*, 24, 534 (1881).