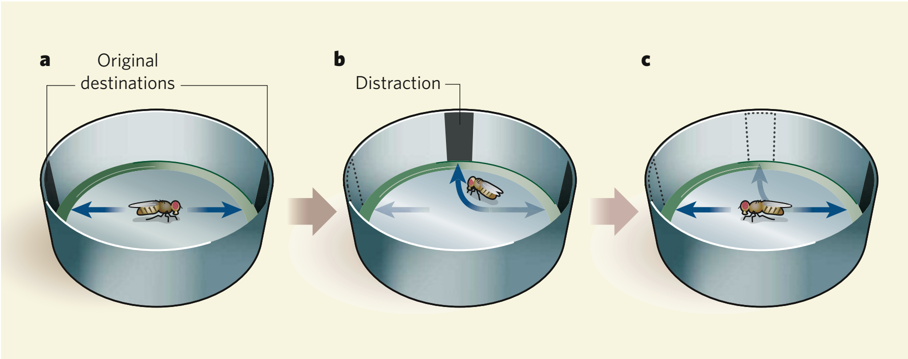

Figure 1 | Undeterred by the detour. a, A fly will walk back and forth between two opposing black stripes in a circular arena even if, midway, the target stripe disappears. Neuser *et al.*[1] find that if (**b**) a fly is distracted midway by a new black stripe to its side, the insect still remembers the position of the original stripe, and (**c**) when the distracter stripe subsequently disappears, resumes walking along its original course. The authors find that this behaviour depends on ring neurons of the ellipsoid body in the fly brain.

fly turned and headed towards the distracter, the investigators made that stripe disappear too. In most cases, the fly then turned back and reassumed its initial target orientation, suggesting that it still remembered the location of the original stripe (Fig. 1c). The distracted flies' memory of the location of the original stripe lasted at least four seconds and might last longer, as the authors did not explore the maximum time for which the original direction was remembered.

What is this interesting type of memory that might be used for navigation? Performance in the detour paradigm seems to be innate and hard-wired. Flies have a natural tendency to move towards arena landmarks[2]: they remember the position of a stripe without being trained to remember it or to associate it with a reward or punishment; and several practice laps in the detour paradigm fail to improve the flies' accuracy in reorienting themselves towards the original target after they are distracted. Neuser *et al.*[1] describe this memory type broadly as 'spatial orientation memory'. But do the flies remember the location of the original stripe by forming a neural representation of this external spatial cue, or by remembering their own movements towards the distracter relative to their original orientation?

Perhaps both. There is extensive evidence[4] that specific types of neuron guide horizontal navigation in vertebrates. One well-studied type of neuron is the head-direction cell. These neurons are present in many brain areas, and become active only when an animal's head points in a specific direction, irrespective of the animal's location or its behaviour at the time. Initially, the optimal firing properties of these neurons can be guided by external landmarks, but they are maintained when the landmarks are no longer visible. Neuser and colleagues' detour paradigm for *Drosophila* might tap into a memory that is partly mediated by neurons akin to the head-direction cells of vertebrates: that is, the memory forms as a result of association between directional neurons' activity and either a neural representation of the original visual target or cues derived from the animal's own movement.

Different types of memory are often stored in specific brain areas[5]. To localize the regions of the fly brain that are crucial for performance in the detour paradigm, the authors tested several lines of mutant flies that have structural defects in the central complex — an area of the brain involved in coordinating movement in insects[6]. Mutants with defects in a part of the central complex called the ellipsoid body performed poorly in the detour paradigm, suggesting that this brain structure is necessary for the task. The researchers verified the requirement for the ellipsoid body by genetically silencing subsets of its neurons in flies and then testing their performance. This revealed that ring neurons within the ellipsoid body are specifically required for performance in the detour test. As these neurons release the inhibitory neurotransmitter GABA (γ-aminobutyric acid), they are thought to inhibit downstream neurons.

Do the *Drosophila* ring neurons participate in spatial orientation memory by monitoring direction — like the head-direction neurons of vertebrates — or by forming a neural representation of the original visual target? Again, perhaps both, but there are also other possibilities. For instance, ring neurons might not be part of the neural system that forms the memory, but might instead have some ancillary role in the circuitry required for task performance. Interestingly, the mushroom body — a part of the fly brain necessary for certain tasks such as forming memories about odours and retrieving learned associations about visual cues independently of the context[5,7–9] — is not necessary for performance in the detour test.

Having discovered that ring neurons mediate spatial orientation memory, Neuser *et al.* embarked on identifying molecular signalling pathways that are involved in the detour task. The signalling molecule cyclic AMP was a logical candidate, because it is essential for olfactory learning in fruitflies[5]. The authors tested *dunce*, a cAMP-pathway mutant, in the detour task and found that, surprisingly, these

NATURE

50 & 100 YEARS AGO

50 YEARS AGO

'Whistlers' are being heard consistently at Scott Base, the New Zealand International Geophysical Year Antarctic Station, McMurdo Sound. From the time observations commenced on April 15 until the time of writing considerable activity has been observed, including 'bonks', 'tweeks', short and long 'whistlers', whistler trains, and periods of strong 'sferics'. No dawn chorus has yet been observed... It is believed that this is the first time that whistlers have been heard in such a high geomagnetic latitude. The whistlers appear to have dispersion characteristics similar to those heard in lower geomagnetic latitudes. However, the characteristics cannot be truly determined until tape recordings of them are sent to New Zealand for spectrographic analysis, at the end of the Antarctic winter.

From *Nature* 28 June 1958.

100 YEARS AGO

"The rings of Saturn" — In a note published as Bulletin No. 32 of the Lowell Observatory, Prof. Lowell develops rather more fully the idea that the appendages B and C of Saturn are not flat rings, but tores. He arrives at this conclusion, by two independent methods, from a discussion of the phenomena observed at Arizona during November and December last. In the first place, a black core was observed running medially through the length of the shadowy band which then encircled the planet. This core...is presumed to be the black shadow of the plane ring A bordered by the particles of the rings B and C scattered above and below the plane of A. That is to say, the rings B and C differ from A in being tores and not flat rings... The assumed heaping up of the particles, as indicated by the agglomerations [seen at many observatories], is in accordance with gravitational laws. Furthermore, it is shown from the observational results that the inevitable disintegration of the rings is in the process of taking place.

From *Nature* 25 June 1908.