Information until a relational match is found. Then, perhaps, a symbolic variant of the ABSURDIST algorithm could be applied. There is a tantalizing but surely not absurd future for conceptual webs.

References

Letters

Human spatial representation derived from a honeybee compass

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Wang and Spelke [1] reviewed different navigation strategies of animals and their underlying spatial representations and concluded that humans, like insects, apply predominantly egocentric ‘primitive navigational systems’, such as path integration, beaconing and viewpoint-dependent recognition of landmarks. Despite their arguing in favour of common spatial representations between humans and non-human animals, Wang and Spelke concluded that the uniqueness of humans resides in their capacity to overcome such primitive navigational systems to construct ‘true geocentric maps of the environment’ [1]. We believe that this reasoning assumes a simplistic view of animal navigation in general, and of insect navigation in particular. We focus on insect navigation, because Wang and Spelke’s arguments were based in part on it, and because it may not be purely egocentric and primitive.

The traditional method for studying insect navigation is to train a bee or an ant along a route, and then release it at a novel site and assess the influence of specific information (e.g. sky compass information or landmarks) on its subsequent steering course. Under such conditions, insects use path integration and visual landmarks en route and between their goals [2]. Much richer navigation strategies have been found in honeybees using different training procedures [3]. Furthermore, the use of new techniques such as harmonic radar allows recording for the first time of complete flight paths of bees in their natural environment [4].

In experiments of Menzel et al. [3], bees foraged at a feeder that was regularly rotated around the hive, within its close vicinity. Thus they could not establish a route memory, but were guided by a spatial memory acquired by latent learning during their exploratory flights. Bees trained in this way and released at different novel sites around the hive could return from any location within the distance of their orientation flights without reference to a beacon or a landmark constellation [3]. Bees trained to a single location following conventional route training first applied the navigation vector corresponding to the route learned when released, and only later referred to the ‘general landscape memory’. Thus, bees access the general landscape memory only when they do not have a route memory, or have used it but have not yet arrived at the goal [3].

Furthermore, route-trained bees carrying a transponder enabling harmonic radar to locate them were captured and released at a novel site, either when leaving the feeder to return to the hive, or when arriving empty at the feeder [5]. Both groups of bees first flew their usual vector when released at a novel site, but then headed towards the hive after a phase of circling flights. Again, beacon orientation and navigation according to landscape features were excluded. Most importantly, bees sometimes also decided to fly back to the feeder first rather than directly to the hive. These and additional experiments can be explained by assuming that during their orientation flights, bees learned different locations in their surroundings and attached to the landmarks characterizing these locations local vectors pointing towards the hive. Equipped with such a hive-centered map, bees would be able to perform exactly as they did in the earlier study [3]. However, the fact that bees foraging at a distant and constant feeder could decide to fly first back to the feeder rather than directly to the hive [5] indicates a form of spatial memory in which some geometrical relationships between defined points in space are preserved, in agreement with Tolman’s seminal paper [6].

Wang and Spelke suggest that human navigation must interpreted in the light of egocentric and dynamically updated spatial representations that are common to non-human animals. We agree with this conclusion. But we also think that ignoring the richness of animal spatial representations constitutes an error. The fact that insects can apply navigational strategies more complex than

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Lasnik's review of the Minimalist program in syntax [1] offers cognitive scientists help in navigating some of the arcana of the current theoretical thinking in transformational generative grammar. One might observe, however, that this journey is more like a taxi ride gone bad than a free tour: it is the driver who decides on the itinerary, and questioning his choice may get you kicked out. Meanwhile, the meter in the cab of the generative theory of grammar is running, and has been since the publication of Chomsky's *Syntactic Structures* in 1957. The fare that it ran up is none the less daunting for the detours made in his *Aspects of Theory of Syntax* (1965), *Government and Binding* (1981), and now *The Minimalist Program* (1995). Paraphrasing Winston Churchill, it seems that never in the field of cognitive science was so much owed by so many of us to so few (the generative linguists).

For most of us in the cognitive sciences this situation will appear quite benign (that is, if we don’t hold a grudge for having been taken for a longer than necessary ride), if we realize that it is the generative linguists who should by rights be paying this bill. The reason for that is simple and is well-known in the philosophy of science: putting forward a theory is like taking out a loan, which must be repayed by gleaning an empirical basis for it; theories that fail to do so (or their successors that might have bought their debts) are declared bankrupt. In the sciences of the mind, this maxim translates into the need to demonstrate the psychological (behavioral), and, eventually, the neuro-biological, reality of the theoretical constructs. Many examples of this process can be found in the study of human vision, where, as in language, direct observation of the underlying mechanisms is difficult; for instance, the concept of multiple parallel spatial-frequency channels, introduced in the late 1960s, was completely vindicated by purely behavioral means over the following decade (see, for example, [2]).

In linguistics, the nature of the requisite evidence is well described by Townsend and Bever: ‘What do we test today if we want to explore the behavioral implications of syntax? …the psychological basis for the two primary and ever-present operations, merge and move.’ (Ref. [3], p.82). Unfortunately, to our knowledge, no experimental evidence has been offered to date that suggests that merge and move are real (in the same sense that the spatial-frequency channels in human vision are). Generative linguists typically respond to calls for evidence for the reality of their theoretical constructs by claiming that no evidence is needed over and above the theory’s ability to account for patterns of grammaticality judgments elicited from native speakers. This response is unsatisfactory, on two accounts. First, such judgments are inherently unreliable because of their unavoidable meta-cognitive overtones, because grammaticality is better described as a graded quantity, and for a host of other reasons [4]. Second, the outcome of a judgment (or the analysis of an elicited utterance) is invariably brought to bear on some distinction between variants of the current generative theory, never on its foundational assumptions. Of the latter, the reality of merge and move is but one example; the full list includes assumptions about language being a ‘computationally perfect’ system, the copy theory of traces, the existence of Logical Form (LF) structures, and ‘innate general principles of economy’. Unfortunately, these foundational issues have not been subjected to psychological investigations, in part because it is not clear how to turn the assumptions into testable hypotheses.

Lasnik is optimistic that Minimalism, which is “as yet still just an ‘approach’, a conjecture about how human language works (‘perfectly’)” (Ref. [1], p. 436), can be developed into an ‘articulated theory of human linguistic ability.’ Such optimism would seem to require that the foundational issues be thoroughly addressed, but to our

**References**


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