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## Correspondences

# A new mode of information transfer in foraging bumblebees?

**Ellouise Leadbeater and Lars Chittka**

Pollinating insects have provided one of the most enlightening systems for understanding how natural selection shapes animal foraging behavior, but their movements from one plant species to another are not thoroughly understood. Bumblebees forage in highly unpredictable habitats where the flower choices of conspecifics may provide exploitable up-to-date information about current reward levels. Nonetheless, interactions between foragers in the field have been largely viewed in an antagonistic context, where scent marks left by foragers on flowers act as a deterrent to other bees [1]. Here we show, conversely, that foraging conspecifics can not only increase the attractiveness of an inflorescence, but also entice bees to switch from a familiar species to sample a new flower type.

We examined the behavior of 17 'observer' and 'demonstrator' bees from three *Bombus terrestris* colonies in a flight arena (Figure 1). Individual observer bees chose between a yellow and a blue flower species, each represented by four artificial inflorescences (see Supplemental experimental procedures in the supplemental data available with this article online), all providing equally high amounts of 2 M sucrose solution *ad libitum.*

At the start of a trial, a demonstrator bee was allowed to forage upon one inflorescence, randomly chosen to be either yellow or blue and placed at a random location. Once the demonstrator had settled we introduced the seven alternative 'unoccupied' alternatives into the arena. The naïve observer bee was then released and allowed to choose one inflorescence to forage upon.

In this first trial, when observers were entirely unfamiliar with both species, bees strongly preferred the occupied inflorescence (Figure 2A; binomial test $p < 0.01$) over the seven unoccupied options. As demonstrators had not chosen the inflorescence that they foraged upon themselves, or

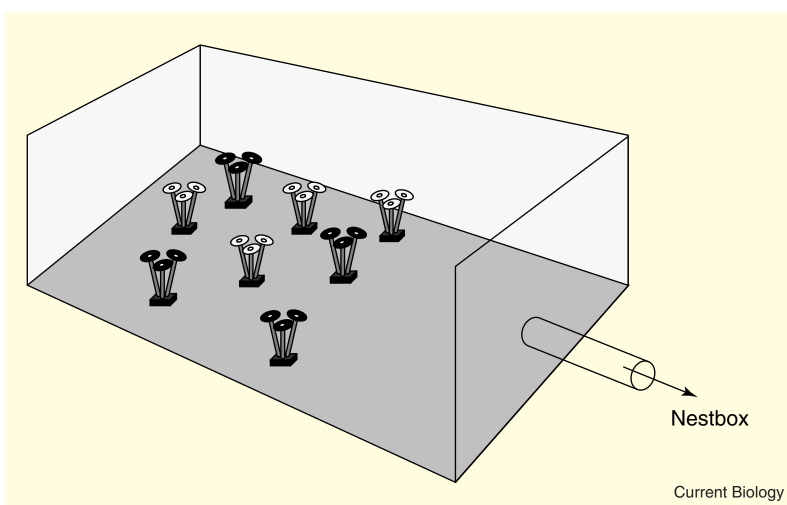


Figure 1. Choice array.

Eight equally and highly rewarding inflorescences, each containing three flowers, were presented to the observer bee in a 105 x 70 x 30 cm flight arena connected to the nestbox.

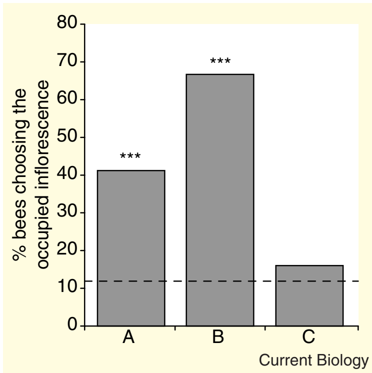


Figure 2. Preferences for the occupied inflorescence.

The dashed line indicates chance expectations, asterisks indicate $p < 0.01$. (A) In the first trial, when both species (blue and yellow) were unfamiliar to the bee, individuals chose the occupied flower more often than would be expected by chance. (B) On subsequent visits, if individuals probed an inflorescence of a different species — for example, if a bee that had initially chosen a blue inflorescence later probed a yellow — bees again strongly preferred the occupied inflorescence. (C) However, when individuals revisited a species that they had already tried at least once, preferences were close to chance levels.

landed upon the alternatives, this effect could not reflect a common preference for certain locations within the arena or repellent scent marks on unoccupied flowers.

We repeated this 12 times for every observer/demonstrator pair. In each trial, the demonstrator foraged upon a different inflorescence, which in half the trials would be of the yellow type and half the blue, in random order. New inflorescences at different positions were used in each case. 65% of observers continued to visit only inflorescences of the species (blue or yellow) which they had chosen in the first trial throughout. Others, however, sampled an inflorescence of the alternative species at least once. When this occurred, bees again strongly preferred the occupied inflorescence (Figure 2B; binomial test $p < 0.01$). This attraction to the occupied inflorescence when sampling *new* species contrasts strongly with trials when bees chose to visit species which they had already tried, where preferences were very close to chance levels (Figure 2C). Moreover, bees *never* switched from their initially chosen species to probe an unfamiliar flower type unless the demonstrator bee was also on the untried species (binomial test, $p = 0.03$). Hence, bees that initially preferred yellow would never probe a blue inflorescence unless a demonstrator was also on blue, and vice versa.

Attraction to valuable resources through the presence of conspecifics, termed local or stimulus enhancement, could reflect a tendency for individuals to approach cues associated with others [2], or occur because the presence of a conspecific draws an individual's attention to a certain stimulus [3]. But here we found that bees were only influenced by others when sampling *unfamiliar* flowers, so this behavior is unlikely to be solely an adaptively neutral byproduct of such processes. Instead, bees that detect foraging conspecifics on an untested inflorescence might be able to avoid the costly investment inherent to individual exploration, making use of an efficient shortcut to current feeding bonanzas. As reward levels are highly variable within plant species and over time [4], information about the currently most rewarding plant species requires extensive individual sampling efforts because unlike honeybees, bumblebees do not recruit nestmates to foraging locations [5]. However, it is well established that bumblebees learn about reward levels in different plant species, and will ultimately tend to visit highly rewarding plant species more heavily than poorly rewarding ones [6]. The distribution of foraging bees across inflorescences may hence in itself provide a tip-off as to current reward levels.

What cues do bees use to identify occupied flowers? Bumblebees scent-mark flowers with tarsal gland secretions, but such marks usually repel, rather than attract, other bees from recently visited and therefore potentially empty flowers [1]. Hence the attraction of bees scouting for suitable foraging alternatives to conspecifics is likely to have a visual component, but more research is needed to tease apart the pertinent visual (color, pattern and motion) components and olfactory cues.

Social transmission of information is a powerful process which can lead to the spread of behavior patterns throughout a group [7]. Our findings suggest that in bumblebees, a classic model for optimal foraging, cues associated presence of conspecifics may be a significant but as yet ignored factor in determining pollinator movements between plants.

## Supplemental data

Supplemental data including experimental procedures are available at http://www.current-biology.com/cgi/content/full/15/12/R447/DC1/

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