The dance language of honey bees
Described by Karl von Frisch in 1940s to explain the ability of honey bee foragers to recruit nestmates to food

The Basic Facts (not in dispute)
• Forager honey bees, on returning to nest, perform a "dance" which contains information about the distance and direction of food they have found
• Bees in the nest pay attention to the dancers
• At least some of the dance followers end up at the food
Dance communicates flight direction relative to sun in orientation of waggling runs.

...relative to the sun...

...or relative to gravity.

And it also communicates flight distance--in duration of waggling run.
Von Frisch's Dance Language Hypothesis

- The dance followers extract the spatial information from the dance, and use it to get to the general vicinity of the food
- These prospective recruits use odors (learned while following the dancer) to narrow their search
Von Frisch's Evidence for Dance Language Hypothesis

• Observational evidence
  • correlation between the bee’s flight path (direction and distance) and subsequent dance behavior
  • correlation between dance following and recruitment
  • problem: CORRELATION ≠ CAUSATION

• Experimental evidence
  • "fan" and "stepwise" experiments to test whether recruits search preferentially end up near where the dancers are signaling
  • problem: other hypotheses might predict same results--this is example of "weak inference"
Fan and Stepwise Experiments: recruits appear predominately at baits nearest the location foragers are indicating in dances.
Jan 12: Dance -- Odor Search Hypothesis

Wenner's Challenge: The Odor Search Hypothesis

The Hypothesis

- Dance contains spatial information, but the followers do not use it
- Instead, bees get recruited to the food solely through the use of odors learned while following the dance

Wenner's evidence

- Von Frisch's results: all explained by odor search hypothesis (claims Wenner)
- Wenner's direct tests: recruits go to major source of odor, not to location signaled by dancer
Attempts to resolve the controversy -- von Frisch

• Argument from design: a complex trait like the dance MUST have a function (and the one we hypothesize)
  (this is a fallacious argument: to see the flaw, consider the moth spiralling into the flame)
• Experiments showing that recruits search randomly when the dancers are disoriented

Dance on horizontal is scattered when bee can’t see sun...

...and so are recruits
Disoriented dances = Disoriented recruits (2002)

Dance on horizontal is scattered when bee can’t see sun...

...and so are recruits

But, perhaps the procedure that makes the dance disoriented also disrupts the ability of dance followers to stay with the dancer and perceive odors she carries

Sherman & Visscher 2002
Attempts to resolve the controversy -- Gould's "misdirection" experiments, a "strong inference" approach

- Paint out ocelli of dancer, and shine bright light on dance floor

- Ocelli: three single-lens eyes on top of insect head; involved in adjusting sensitivity of compound eyes to light.
Predictions of alternative hypotheses in Gould’s misdirection experiments

Dancer: orients to gravity (ocelli painted)
Recruit: can measure dance relative to light

Recruits should fly here if using odors
And here if using spatial information
Gould found that bees tend to go in direction dancer points

Wenner’s rebuttal: Wind direction could have changed; sample sizes small
Attempts to resolve the controversy -- the “robot” bee

• Mechanical bee signals direction of food

(Michelsen et al. 1992)
Robot Bee results

- Recruits go in direction indicated by "dancer"
- Effect is independent of direction of wind

Wenner’s rebuttal: multiple approaches by recruits may have been counted, hence inflating the effects
Where Do We Stand Now?

- On balance, evidence favors dance language hypothesis: by far the most parsimonious explanation of the data (Wenner still denies this)

- What about the evidence that recruit bees may sometimes use odors in preference to spatial information?
  - Answer--von Frisch himself had argued that odors are important in the recruit process, and had already shown himself that odors can override spatial information.
  - Wenner sees this as weasling.

- Thus, the controversy continues. As a great physicist once remarked, scientific progress occurs one funeral at a time.
Deeper Lessons

• Necessity of persistent and creative experimentation in study of behavior
  • Wenner’s critique served useful function in inspiring additional experimental approaches
  • Good experiments must create situations that discriminate between competing hypotheses (strong inference)
• Our conclusions are always subject to uncertainty (true of any field of science)