Can an Insect Speak? : The Case of the Honeybee Dance Language

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ABSTRACT In this paper I investigate the scientific understanding of the honeybee dance language. I elucidate the implicit and explicit reasons why the honeybees' communication system has been referred to as a 'language', and examine the ways this designation has entangled the themes of animal mind and human–animal continuity. I end with an investigation of a scientific controversy surrounding the honeybee dance language. I argue that this controversy was a battle over assumptions regarding insect capacities, and a willingness or unwillingness to abandon those assumptions in the face of a phenomenon that undermined them.

Keywords animal mind, form of life, honeybee, human–animal continuity, language

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> Bees not only tell their comrades, by means of a peculiar sort of dance, that they have found a feeding place, but they also indicate its direction and distance, thus enabling beginners to fly to it directly. This kind of message is no different in principle from information conveyed by a human being. In the latter case we would certainly regard such behavior as a conscious and intentional act and can hardly imagine how anyone could prove in a court of law that it had taken place unconsciously . . . . Nor is there any proof that bees are unconscious. (Jung, 1973: 94)

The honeybee[1] dance language is considered the most complex symbolic system decoded, to date, in the animal world. According to ethologists Karl von Frisch and Martin Lindauer, 'the language of the bees is on a higher level than the means of communication among birds and mammals with the exception of man' (1996 [1956]: 540). Almost 50 years later, behavioral scientist James Gould affirms that the dance language is 'second only to human language in its ability to communicate information' (2002: 41). The honeybee dance has been called 'one of the seven wonders of animal behavior' and is considered among the greatest discoveries of behavioral science (Gould & Gould, 1995 [1988]: 69). Von Frisch referred to the language of honeybees as 'one of the most remarkable mysteries of their complex social organization' (1950: 75). He was awarded the Nobel Prize in 1973 in large part for this discovery.[2]

Narrating to a layperson how honeybees share information about resources for the hive provokes amazement. There is a counterpart to this

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reaction in the scientific literature: beyond extending and refining knowledge about when the bees dance, how the dance encodes information, what resources are danced about, and the like, there has been a deep perplexity about how to understand it. Inevitably, 'the language of the honeybees' raises abstruse questions that behavioral scientists have often sought to sidestep: whether man is the only species with language; whether 'language' can be defined in a way that allows for the possibility that non-human animals may possess it; the plausibility of the distinction between 'intentional action' and 'non-intentional behavior' to demarcate human and animal life; the validity of regarding invertebrates as 'lower forms of life'; and the nature of cognition and awareness in the animal world. These topics come under the rubrics of human–animal continuity and animal mind.

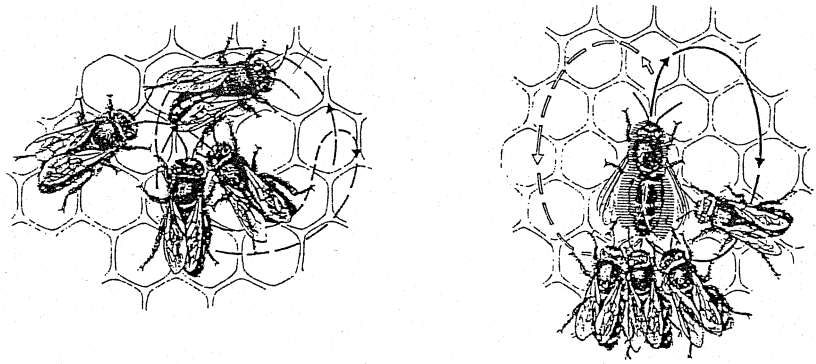
In the present paper, I investigate how human–animal continuity and animal mind have been engaged and implicated in the scientific understanding of the dance language. I do so by focusing on how scientists have described and interpreted the dance as a natural language, and the ways these descriptions and interpretations have been problematized against a background of previous expectations – expectations that did not include an insect with language.

First, I elucidate the standards invoked in the scientific literature to support the sustained reference to the dance as language. I show that the use of the concept 'language' is neither facetious nor merely conventional. On the basis of criteria intuitively and deliberately abstracted, scientists have represented the honeybee dance as a bona fide linguistic system. I discuss how the dance is understood as rule-governed; both structurally stable and contextually flexible; symbolic in representing states of affairs distant in space and time; and performative, whether described as announcement, order, report, and so on, or translated into utterances that announce, order, report, and the like.

I then turn to the deeper questions evoked by the surprising discovery that honeybees use symbols. The employment of the dance as a symbolic code has foregrounded questions about cognition and awareness, and enabled the use of mental concepts (like remembering, interpreting, or understanding) in the scientific literature to describe what the honeybees are doing. The implication of mind has both made the dance language problematic within behavioral science, and contributed to strengthening the case that mental capacities may be more generously distributed than we are inclined, or inculcated, to believe (Wenner & Wells, 1990; Griffin, 2001 [1992]; Gould, 2002).

The plausibility of attributing language to an insect was called into question, and a scientific controversy erupted between the mid-1960s and mid-1970s. I discuss this controversy in the last part of the paper. For most scientists in the honeybee behavioral community the controversy was closed in favor of the efficacy of the dance's symbolism to guide bees to resources. But those who contested the 'dance language' remained adamant in their position. I argue that the controversy was not about the

FIGURE 1
The Round and Waggle Dance



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adequacy of empirical evidence for the dance – which turned out to be 'beyond reasonable doubt' for the majority of scientists involved. It was a battle about received assumptions regarding insect capacities, and a willingness or unwillingness to abandon those assumptions in the face of a phenomenon that profoundly undermined them.

A Description of the Dance

When Karl von Frisch announced that honeybees use a symbolic system to communicate the location of food and other materials his claim was greeted with incredulity.[3] Such a discovery was unanticipated to say the least. What came to be known as the 'honeybee dance language' was soon confirmed by other behavioral scientists (Griffin, 1976 [1950]). After von Frisch's original work, many more facets about the dance have been garnered from observations and experiments. Overall they testify that honeybees use a sophisticated communication system that enables them to share information about the location and nature of resources.

Von Frisch discovered the dance while studying what colors honeybees can perceive. He observed that after placing sugar solution on an experimental table – to see if the bees could be trained to respond to colors – a long time might elapse before they found the food. But after one honeybee found the solution, bees soon began swarming around the feeder.[4] He inferred that some communication was transpiring in the hive that functioned as a means of recruitment. Von Frisch then marked the first bee to find the sugar solution and observed her actions back at the hive. He saw her perform a curious movement that he called the 'round dance': the bee moves in a circle, and once the circle is completed she loops around to describe it in the opposite direction, whence she turns to retrace the same circle, and so on (Figure 1). For convenience, in these first experiments the

sugar solution was placed close to the hive; von Frisch concluded that honeybees perform the round dance for food sources near the hive.

Von Frisch soon identified the 'waggle dance' performed when the resource is at some distance from the hive. The waggle dance resembles a figure eight. The dancer makes a short run on the vertical comb. After completing the 'waggle run', she loops around, comes back and retraces it, then loops around in the opposite direction returning to trace the waggle run again, and so on (Figure 1). She often re-inscribes the exact same run. But as she is also moving about to some extent, the run may be repeated at a slightly displaced spot; in any case, *all* waggle runs of the *same* dance are nearly identical in length and orientation.[5] The 'round' dance gives way to the 'waggle' dance after the bee has completed a circle and begins to circle the other way: at that point, there is a brief lateral vibration that lasts longer and longer as, in experimental situations, the food source is moved farther and farther away from the hive.[6] Von Frisch regarded the two dances as discrete types, but this view has been revised and they are presently considered the same dance (Kirchner et al., 1988; Seeley, 1995: 96).[7] On the impetus of tradition, the distinction between the two dances persists in many textbook accounts.

Dances are overwhelmingly about flower patches. When a honeybee discovers a rich patch, she returns and seeks out her hive-mates in a specific location near the hive entrance called the 'dance floor'. She performs the dance on the vertical comb in the dark hive surrounded by numerous potential recruits. The dancer pauses for antennal contact with her followers, and to transfer some of the nectar she has harvested to them (Dreller & Kirchner, 1993). The communicative nature of the dance is apparent in that dances are never performed without an audience (von Frisch, 1967a; Seeley, 1995; Griffin, 2001 [1992]). While the dance is mostly used to indicate the location of flowers, it is also used for pollen, water when the hive is overheating, waxy materials when the comb needs repair, and new living quarters when part of the colony must relocate (Griffin, 2001 [1992]: 203–04).

Dances are performed only where there is pressing need in the hive, or for food sources that are especially rich. When sources are abundant, honeybees rely on their sense of smell to locate them. There is an inverse relationship between the intensity of source odors and the use of dances; the stronger the surrounding scents, and thus the scents brought into the hive, the less the dance is needed (and used) to communicate where resources can be found. Recent evidence suggests that dances are executed more frequently during the fall than in the spring – for during the latter season both food sources and presumably odors are more abundant (J. Gould, personal communication). Cognitive ethologist Donald Griffin sums up the significance of searching for odors *and* using information as follows: 'Odors are used to find food sources near the hive or when close to a distant goal, but the symbolic dances are used to reach the general vicinity of distant goals' (2001 [1992]: 203).

Honeybee researchers agree that honeybees use *both* dancing and odors to identify the location of resources (Seeley, 1991; Gould & Gould, 1995 [1988]); which of the two will be relied on more, and how their respective importance is weighted, depend on environmental circumstances and/or hive needs.[8] The importance of odor was also noted by the discoverer of the dance, and underscored by the fact that recruits are assisted by the dancer and other foragers marking the site with a scent organ called the 'Nasonov gland' (von Frisch, 1950: 60–66). 'In doing this', von Frisch surmised, 'they apparently apply to the food source a scent which is very attractive to other bees. It seems to carry the meaning "Come here; this way!"' (1950: 66).

The dance is a code that conveys the direction, distance, and desirability of the flower patch, or other resource, discovered. The straight run of the dance on the perpendicular honeycomb creates an angle with the vertical of gravity that is equal to the angle the bee has flown, with respect to the sun, from the hive to the feeding place (von Frisch, 1967a: 137).[9] The dance is a template – a 'geometrical symbolism', in Griffin's words (2001 [1992]: 195) – that charts the direction that the recruits can fly to the discovered source.

Distance to the site is communicated by the speed of the dance. In experimental settings, the dance slows down as the sugar solution is moved farther away (Butler, 1954: 205). Distance is possibly also codified in the length of the waggle run, which becomes longer the farther the source is from the hive (Seeley, 1995: 39). According to Griffin, 'the detailed nature of distance communication has been difficult to determine'. Given that both the rate of circling and the length of the waggle run correlate with distance information, 'it is not possible from currently available data to be certain which property ... is actually perceived by other bees and used to determine the distance they will fly' (Griffin, 2001 [1992]: 197–98; see also Michelsen et al., 1989). Further complicating matters is the finding that it is not distance per se the bees indicate, but rather the effort needed to arrive at the dance location; the dance slows down when the site is uphill or the wind is contrary to the required flight route (Lindauer, 1971 [1961]: 88–89).[10]

In addition to direction and distance, the dance communicates the desirability of a resource (Lindauer, 1971 [1961]: 34; Butler, 1954: 203). Researchers have long maintained that desirability is expressed in the dance's 'liveliness' or 'enthusiasm': the richer the source, the livelier the dance. According to Griffin, 'vigor or intensity ... is easily recognized by experienced observers' (2001 [1992]: 198). Martin Lindauer, von Frisch's most well-known student and colleague, observed that desirability is also communicated by dances for living quarters, when part of the colony endeavors to relocate:

> A dance for an inferior dwelling place is performed quite sluggishly. This is, indeed, a subjective characteristic, but so striking that any layman can differentiate a sluggish from a lively dance. Moreover, it can be established that a sluggish dance always has fewer bees as dance followers than

> a lively one, and it is broken up after a few seconds. A lively dance, which has a highly qualified dwelling to announce, can last many minutes, even hours, and it is obvious that thereby many more newcomers become alerted and informed than by a dance of short duration. (1971 [1961]: 48)

Recent studies emphasize dance duration as the sign of desirability. Like Lindauer before him, Seeley observes that the longer the dance lasts the more bees the information reaches, resulting in greater harvesting alacrity (Seeley, 1995: 92). But Seeley also agrees about the subjective impression of 'highly energetic' dances for desirable sources, and close analyses of videotaped dances have identified the precise mechanics of movement that produce the impression of liveliness (Seeley, 1995: 92; Griffin, 2001 [1992]: 198).

In the late 1950s, Adrian Wenner discovered that sounds accompany waggle dances (Wenner, 1962). The sounds are probably perceived by the honeybees as airwave and substrate vibrations (Griffin, 2001 [1992]: 199–201).[11] Both observations, and experiments with mechanical bees, suggest that sounds are crucial, for workers cannot be recruited when dances are silent (Michelsen et al., 1989; Dreller & Kirchner, 1993: 321; Gould & Gould, 1995 [1988]: 112). Researchers suspect that the sounds may convey something about the desirability of the site, but their precise role or meaning remains unknown (Griffin, 2001 [1992]: 201).

Why Call it Language?

The question of language in the animal world is tricky in requiring comparison with human language. The problem is that if the yardstick of human language is too strict then language may be excluded, from the outset, from other species. On the other hand, if the defining features abstracted from human language are too general, there is a danger of attenuating the notion of language, such that all sorts of signals (for example, alarm calls or mating calls) could count as linguistic. So the question becomes whether criteria can be abstracted that are general enough to include other species, yet robust enough to exclude all manner of gestures from becoming 'language'.

Since the early days of its discovery, honeybee communication has been called the 'dance language', more often than not without skeptical qualms. Occasionally, 'language' is scare-quoted to indicate reservations about its verbatim applicability to insect communication. Yet in contrast to the purely figurative usage of 'dance', the concept of 'language' is employed in a more literal vein. Robust affinities between the dance language and human language are expressed in several ways, ranging from intuited similarities to deliberate comparisons. In the next sections, I identify the ways honeybee communication is conceptualized as language in the scientific literature: it is described as rule-governed, simultaneously stable and dynamic, a symbolic system, and a performative idiom.

The Dance as a Stable and Dynamic Rule-Set

The dance is grasped as a rule-governed activity, in that fairly reliable rules can be formulated for how, when, and why dances are performed. I reconstruct the rule-set from knowledge about the structural and pragmatic regularities of the dance shared by the honeybee scientific community and routinely described in behavioral and general biology textbooks.

The rule-set of the dance

- In dancing, follow the standard template that conveys direction, distance, and desirability

  Some individual variability notwithstanding, the code is fairly invariant and precise (± 20–30° for direction) in communicating the coordinates of the resource.
- Dance the most urgently required resource

  The dance is a system for dealing with colony needs. Resource priorities are not preset, but contingent on such needs. For example, if pollen supplies (a protein source) fall beneath a certain minimum in the hive, dances will recruit followers to pollen sources.
- Everything being equal, dance for nectar

  The carbohydrate nectar that honeybees convert into honey is their most important food item. If nothing else is required, dances will ordinarily inform about flower patches.[12]
- Everything being equal, dance for the closest source

  When the same quality food is offered at two different distances, the honeybees visiting the nearer location are more likely to dance (Gould & Gould, 1995 [1988]: 96).
- If the discovered resource is rich and reliable, only then dance about it

  Dances are not executed indiscriminately, but only for rich resources that are best exploited swiftly and by great numbers of bees. Dances may not be used at all, if resources can be located strictly through smell. Only after repeated visits have demonstrated the reliability of a source will a recruit dance for it (Gould & Gould, 1995 [1988]: 95).
- If there is urgent need in the hive, then dance even for resources that are not rich

  'Prudence disappears during times of extreme dearth' (Gould & Gould, 1995 [1988]: 95). The rule to dance only for rich, reliable sources is suspended if there is dire need in the hive. What is called the 'dance threshold' – how rich a source needs to be for the bees to dance about it – is not fixed, but shifts according to colony needs or environmental parameters (Seeley, 1995: 102–07).
- Dance at the designated place in the hive

  There is a specific location in the hive for the performance of dances referred to as the 'dance floor'.

- Never dance alone

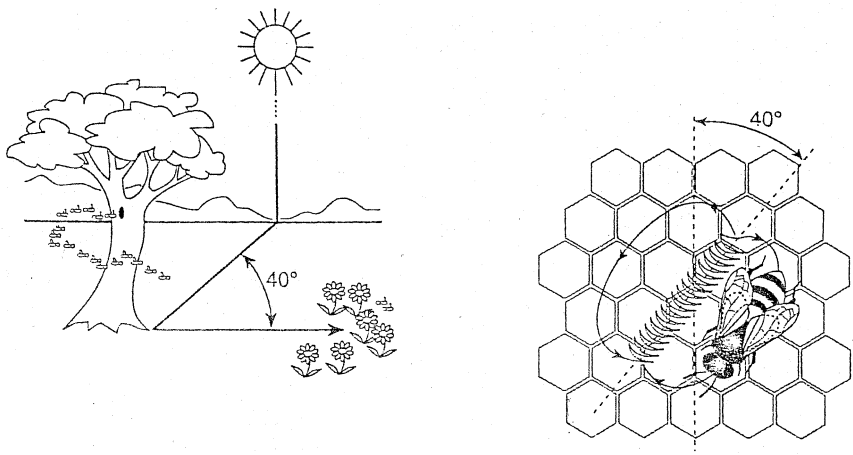
  The dance is not a mechanical reaction upon discovery of a resource. Honeybees dance only within a communicative context, interrupting to engage in physical contact and food exchange with their followers.

That a rule-set for the dance can be extrapolated is integral to its understanding as language. As Ludwig Wittgenstein wrote about attributing language to a newly encountered tribe: there should be 'a regular connexion [sic] between what they say, the sounds they make, and their actions' (1968 [1953]: section 207). If the honeybees are considered as a non-human tribe that evinces communicative behavior, for their communication to count as linguistic it must exhibit regularity in structure and use. But while regularity is a necessary feature, by itself it is insufficient for communication to be robustly comparable with language – a degree of complexity is also required. Both order and complexity have been identified as key dimensions of human language (Bennett, 1976). One aspect of the complexity of the dance rule-set resides in its intricacy: if it consisted in just one or two rules, then reference to it as a 'language' may not have been sustained. The dance also exhibits complexity in its versatile employment, which I discuss later.

Human beings follow grammatical and pragmatic rules of language-use with a high degree of reliability and without deliberation.[13] 'When I obey a rule', wrote Wittgenstein in a widely cited aphorism, 'I do not choose. I obey the rule *blindly*' (1968 [1953]: section 219, emphasis in original). Philosophers G.P. Baker and P.M.S. Hacker argue that this passage was intended to call attention to the primacy of action – not to expose human mindlessness: blind compliance with rules is not 'the blindness of ignorance, but the blindness of certitude. I know *exactly* what to do' (1984: 84, emphasis in original). Observance of rules in human interaction implicates communicative competence – a fairly effortless capacity to follow shared rules – without any reflective knowledge about them required. Thus, the extrapolation of a rule-set for the dance language does not imply that the honeybees are deliberately following rules, only that they can be seen to abide by them and use them competently.

The dance is portrayed as a template that is used by the honeybees in a variety of ways. While its form is structurally invariant, in application the dance is responsive to environmental conditions and hive requirements. The direction, distance, and desirability markers are immutable, but the sources sought and danced about are not rigidly fixed. Like order and complexity, the twin features of *stability* and *dynamism* have been identified as core features of human language; for example, a relatively fixed syntax enables the generation of an indefinite number of new sentences. Stability and dynamism are also evident in the pragmatics of speech. Conversation accommodates an open-ended range of social situations, but also embodies invariant structural features unconstrained by particulars (see Coulter, 1983; Heritage, 1984; Atkinson & Heritage, 1984). In a ground-breaking

FIGURE 2
The Code at a Glance



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paper, ethnomethodologists Harvey Sacks, Emanuel Schegloff, and Gail Jefferson demonstrated that the rules of turn-taking in conversation constitute a 'formal apparatus which itself is context-free, in such ways that it can, in local instances of its operation, be sensitive to and exhibit its sensitivity to various parameters of social reality in a local context' (Sacks et al., 1974: 699–700).

Behavioral scientists do not explicitly describe the dance as 'context-free' and 'context-sensitive', yet their representations portray it along these lines. Its form is always recognizably the same, but it accommodates different purposes, shifting circumstances, urgent needs, and unprecedented events; while structurally identical every time, it is also contextually flexible. The scientific understanding of the dance can be succinctly encapsulated by paraphrasing Sacks et al. (1974): 'The honeybee dance language is a formal apparatus which itself is context-free, in such ways that it can, in local instances of its operation, be sensitive to and exhibit its sensitivity to various parameters of *social reality* in a *local context*'. The context-free dimension of the dance is rendered, for example, by von Frisch: 'The bees orient the straight portion of the dance at the same angle to the force of gravity as the angle they have flown with respect to the sun during the flight from hive to feeding place' (1950: 77). It can also be delivered pictorially (see Figure 2).

The context-sensitive dimension has emerged in a variety of findings after more than 50 years of research. The empirical findings about the dance can be classified under two headings: responsiveness to local context (as dances track varied and changing environmental parameters) and to

social reality (as dances change according to colony needs and communicative feedback). I summarize certain findings that demonstrate the sensitivity of the dance to factors external and internal to the hive.

Sensitivity of the dance to local context:

- Dances gauge shifts of resource availability
  Dances are effective in monitoring changes in quality and quantity of available resources. Changes in flower patches can occur swiftly, sometimes within hours; pollen peaks last 2–3 days. Dances can track these changes, enabling the colony to keep pace with a dynamic, competitive, and often ephemeral environment (see Gould & Gould, 1995 [1988]: 88; Seeley, 1995: 54ff., 88).[14]
- Dances are gauges of news
  There is another sense in which the dances report news. If two equidistant feeders are made available – one with poor quality food, the other with rich – most dances will, of course, be for the rich source. If the poor station is changed to the *same* quality food as the rich one, bees experiencing the change dance more often than those already accustomed to the rich source. The dances for the respective sites thus gauge the relative change of one resource in comparison to the other rather than reflecting their absolute status. 'Bees are optimists', Gould & Gould note, 'exaggerating positive turns in fortune ...' (1995 [1988]: 96).
- Dances are sensitive to weather
  There is circumstantial flexibility in the execution of dances. If a storm is approaching, bees foraging at distant sites stop dancing about those sites, while bees foraging relatively near the hive continue to do so (Gould & Gould, 1995 [1988]: 96).
- The audience of the dance takes the lay of the land into account
  If a bee trained to feed from an experimental station in a boat, in the middle of the lake, subsequently dances this location, she is apparently unable to recruit bees (Gould & Gould, 1984). (I discuss this experiment in detail later.)

Sensitivity of the dance to social reality:

- Dances are always addressed
  Experiments with empty hives reveal that bees never dance without an audience.
- Dances are sensitive to information received from fellow workers
  Dancers modify their behavior in response to communication about what is required in the hive. A dancer whose resource is not as desirable or necessary as another dancer's will stop dancing for it; dancers 'listen to the "applause" of the unloaders' (Gould & Gould, 1995 [1988]: 99). For example, when the hive is overheating water is required to cool it down. Bees carrying nectar find it difficult to transfer it to worker bees, in contrast to bees carrying water. Water

carriers 'are relieved of their burdens with great greed' (Lindauer, 1971 [1961]: 24). The water is deposited throughout the hive, and fanning by worker bees creates a circulation of air that cools the hive. After the hive has cooled, the collector herself must run about the hive to unload the water she carries. 'This rejecting attitude', concluded Lindauer, 'contains the message "Water needs fulfilled", and the water collecting will thus stop' (Lindauer, 1971 [1961]: 24).[15]

- Dances are used to share, and compare, information

  This applies to the most innovative use of the dance – during swarming when part of the colony must relocate due to overcrowding. This is a first-time situation that no bee has ever experienced, yet the dance is put into operation as an explorative and communicative tool about relocation sites (Griffin, 2001 [1992]: 204). Several 'scouts' travel considerable distances to investigate potential living quarters, and then return and dance, on top of the swarm, the location and quality of the cavities visited. Dancers attend each other's dances. If the cavity learned about is better that the one a scout previously reported, she may switch to dancing for the superior one, or (in most cases) stop dancing about the less desirable site (Seeley & Buhrman, 1999: 29–30). Behavioral scientists have referred to this switch as a 'conversion' (Butler, 1954: 165). By means of a gradual and systematic winnowing procedure – which researchers characterize as the bees' 'reaching consensus' – fewer and fewer cavities are danced for until all dances are about the single best cavity to which the swarm relocates (Lindauer, 1971 [1961]; Seeley & Buhrman, 1999; Griffin, 2001 [1992]).[16]

Keeping in focus how the themes of human–animal continuity and animal mind are foregrounded in the honeybee literature, it is important to note an emergent quality of the dance as a structurally stable and flexibly applied system. The dances are deployed to meet various colony needs; changed to monitor shifting environmental conditions; responsive to communication with hivemates; and switched on the basis of superior information from other dancers. As a whole, these features suggest that the dance is a tool used by the bees, rather than a behavioral pattern rigidly emitted. This implication is acknowledged in the literature. For example, the authors of the textbook *Linguistics* note that honeybees do not dance without an audience, and remark that this 'indicates that the dance is not merely an automatic response conditioned by the return to the hive with a rich supply of food' (Akmajian et al., 1987: 14). In his *Animal Minds*, Griffin devotes a large section to the honeybee dance in which he emphasizes its multi-purpose uses, and the fact that dancing is not executed mechanically (2001 [1992]: 190–211). He highlights the enterprising deployment of the dance system for new quarters, when it is employed in a 'totally unprecedented situation. The same code indicates the location and

quality of something as different from food or water as one can imagine' (2001 [1992]: 205). The enterprising, dynamic application of the dance meets Griffin's conception of 'versatility', which he argues is a plausible criterion of mindful action in the animal world.

Turn-of-the-20th-century naturalist, Maurice Maeterlinck, raised a question after describing the queen's excitement during swarming: 'Does this prodigious emotion issue from her, or is she its victim?' (1901: 79). Paraphrasing Maeterlinck, the same question might be posed about dancing: 'Does this prodigious direction-giving system issue from the bees, or are they its victims?' In other words, do honeybees mean what they say? While this question may not be answerable in scientific or other consensual contexts, the honeybees' versatile and flexible employment of their dance suggests that it is a reasonable question to pose.[17] This alone is intriguing, and, as I discuss shortly, also vexing for some.

I have discussed how the facts about dancing can be reconstructed in terms of a rule-set, which is both context-free (a fixed template) and context-sensitive (responsive to external conditions, internal demands, and communicative feedback). I now turn to more robust standards of the dance-as-language invoked in the scientific literature: its *symbolic* and *performative* dimensions. While the symbolic and performative aspects are inextricably connected, these dimensions merit separate discussion for they are represented in distinct ways. Scientists *explicitly* point out the symbolism of the dance as a linguistic feature of honeybee communication. The performative force of the dance, on the other hand, emerges *implicitly* in casual references to the actions it accomplishes – for example, when it is said to 'announce' or 'report' a discovered resource.

The Dance as Symbolic

The fact that the dance symbolically represents states of affairs in the world is regarded as its most spectacular feature. On this basis alone, the dance has been appraised as linguistic behavior.

Prominent researchers in honeybee behavior and ecology have underscored that the bees use a symbolic system to represent and transmit knowledge about the world. With characteristic eccentricity, J.B.S. Haldane described the dance as 'a propositional function with four variables, translated as follows. "There is a source of food smelling of A, requiring an effort B to reach it, in direction C, of economic value D" ' (1952: 62). Von Frisch and Lindauer maintained that 'the dances of the bees ... transmit the knowledge of significant facts' (1996 [1956]: 540). After summarizing the communicative achievements of the dance, Lindauer noted that 'there is no form of communication in the animal kingdom comparable to the dance of the bees. Through simple symbolic signs, the bees communicate to each other a factual material rich in content when they announce a good food source or suitable dwelling place' (1971 [1961: 59). E.O. Wilson wrote that what distinguishes the waggle dance 'is that it is a truly symbolic message that guides a complex response after the message has been given'

(1971: 262). James and Carol Gould observe that 'the dance communication system is called a language because it satisfies all the intuitive criteria that have been posited for a true language. The dance refers to subjects distant in time and space' (1995 [1988]: 59–60). And Thomas Seeley notes that 'a waggle dance is truly a symbolic message, one which is separated in time and space from both the actions on which it is based and the behaviors it will guide' (1995: 36).

The first compelling indication of the representational nature of the dance was that experimenters could, without prior knowledge, use the information it encoded to find the indicated location. Integral to the discovery of the dance language was *breaking its code*, thereby expanding its circle of shared meaning to include human eavesdroppers. Deciphering the code supported the view that the recruited bees themselves understand and act on the encoded information; it was counter-intuitive to regard its representational nature as an accidental feature.[18] Von Frisch claimed that, using a stop-watch, he could discern 'how far a dancing bee has flown', from which he deduced that 'the bees in the hive can also *understand* the meaning of the dancer's rate of turning and can perceive the distance they must fly to reach the food' (1950: 73–74; emphasis added). According to Lindauer, the dance came to be regarded as a native code after it was deciphered by scientists, who could arrive at the danced location even before the bees. He used this as an argument to dispel skepticism:

> Some people who hear about the dance of the bees for the first time may be skeptical about the possibility of the bees being able to communicate, by means of symbols, such exact information concerning the location of a small spot somewhere in the outdoors. However, there is no better proof for the correctness of the interpretation of the dance of the bees, as it has been given by Professor von Frisch than the experiment just described. The nesting place was completely unknown to us beforehand, for the scouting bees had chosen it themselves. We were able only to observe the dancing bees in the swarm and to decide from their behavior the location of what they had found. We did not follow the swarm as it moved into its new dwelling; we were there at the future nesting place hours before its arrival. (1971 [1961]: 38–39; see also Michener, 1974: 133)

Contemporary behavioral science takes it as a fact that dances inform fairly reliably about the external world. The reliability of the dance's symbolism has led to an intriguing development in behavioral science: the dances are used by scientists as a means of studying where and how honeybees forage. Seeley explains:

> How could we acquire an overview of the colony's foraging operation? The technique of directly tracking a colony's thousands of foragers to their work sites would certainly not succeed. One cannot even track one bee as she flies away from the hive, let alone thousands. So we turn to an indirect, but powerful technique pioneered by one of Karl von Frisch's students: let the bees inform us where they are going by means of their recruitment dances. (1995: 48)

The symbolism of the dance is no longer only a subject matter of scientific inquiry, but has been incorporated into scientific methodology as 'an

indirect but powerful technique' for gleaning information about honeybee foraging patterns. The dance can be regarded as a 'technique' in the Latourian sense as well: a mode of operation that organizes 'data' into a meaningful overview about the state and productivity of the surrounding environs – an overview that *both* honeybees and scientists can understand and utilize (see Latour, 1999: 209–10). The dance is a source of information for the foragers, and has now also become one for the scientists studying their foraging behavior. The bees have thus been incorporated into the scientific process as full-fledged actors, partners in the generation of scientific knowledge, who are not simply *spoken for* by scientists but are granted a reliable, independent voice to *speak to* scientists (c.f. Callon, 1989; Callon & Latour, 1992).

The Dance as Performative

The referential dependability of the recruitment dance is fully black-boxed in its instrumental use, whereby 'reading' dances is a means for 'determining where a colony's foragers are gathering food' (Seeley, 1995: 49). The dance as a symbolic template, trustworthy indicator of foraging activity, and expedient tracker of contingencies are taken as givens in this methodological prescription. Integrating the dance's informational content into a scientific database, without demurral or skepticism, is a mark of how real its representational nature is considered. And it is not simply the dance's referential quality that is considered indisputable, but also that what it represents is acted upon by the bees. The dance is seen as followed through by action that matches its message; in an irreducible way, observers understand it as prompting action on the part of attending bees. To paraphrase ordinary language philosopher J.L. Austin, behavioral scientists take it that honeybees 'do things with dancing'.

In his classic work *How to Do Things With Words*, Austin analysed 'performative force' as the interface between language and action, whereby 'the issuing of the utterance is the performing of an action' (1975 [1962]: 6). Familiar examples of actions accomplished linguistically are commanding, warning, announcing, advising, apologizing, threatening, promising, and the like. With his analysis of performatives, Austin made a landmark contribution to the study of language. He himself characterized his contribution as questioning the ingrained assumption about language that to say something is 'always and simply to *state* something' (1975 [1962]: 12, emphasis in original).

The most spontaneous and ubiquitous form of depicting the dance is in terms of the actions it accomplishes: the dance is described as an invitation, a summons, a recall to action, or a recruitment; it is said to announce, report, or guide. For example, von Frisch wrote that the dance is an 'invitation which not only recalls the former collecting group to action but also recruits new members to strengthen the working party' (1967a: 4). Relying on the performative idiom again elsewhere, he maintained that

the dancer 'announced its discovery at home' and that 'it is clear that the dance inside the hive reports the existence of food' (1950: 69, 72). He also described the dancer as 'guiding' recruits to flowers (1950: 83). Lindauer also used performatives, referring to the dance as a 'recruiting system' and 'soliciting'; he maintained that the dancer 'announces her discovery', and described followers as 'obeying summons' (1971 [1961]: 33, 23). Throughout his work *Wisdom of the Hive*, Seeley employs the performative description 'recruitment dance'. Performative concepts express the inference that there is a meaningful semantic link, and continuity of action, between the executed dance and the subsequent harvest at the danced location.

While scientists do not explicitly call the dance an Austinian performative, they routinely deploy a vocabulary of announcing, reporting, summoning, recruiting, soliciting, inviting, commanding, and guiding. In one guise or another, this vocabulary essentially conveys that the dance *tells* where resources are to be found. Its performative force can thus be nested under the conceptual auspices of 'telling'. The oblique reference to telling, interred in the performative mode, surfaces openly when scientists *translate* the dance's message. Translations are imaginative iterations, or 'renderings', of the dance message in the form of human statements. While used as metaphorical turns-of-phrase, they are also realistically functional in conveying the meaning of the dance.

Von Frisch had a predilection for quoting what the bees say with dancing: 'The message brought by a bee as she performed the round dance seemed to be a very simple one, one that carried the meaning "Fly out and seek in the neighborhood of the hive!"' (1950: 57).[19] Noting that dances are performed for rich sources, he wrote that 'they also carry the basic meaning "There is plenty of food and sweetness"' (1950: 65). He described the bees' marking the location with their Nasonov glands as saying 'Come here; this way!' (1950: 66). Foragers attending a 'round' dance, according to Lindauer, 'receive the message: "Fly out from the hive; right in the neighborhood is food to be fetched"' (1971 [1961]: 33).

The device of rendering the dance in a human voice is profoundly paradoxical. On the one hand, translations of the dance are not literal – if only because its message is compatible with a variety of performative utterances: as announcing or reporting; ordering, beseeching, or recruiting; describing, guiding, or direction-giving. The meaning of the dance as a performative utterance cannot be univocally pinpointed in human words. This indeterminacy of translations of animal signs, more generally, has prompted their regard as a mere contrivance; such translations have been dismissed as nothing but a 'dramatic idiom' (see Bennett, 1987: 200). On the other hand, however tongue-in-cheek translations of the dance may be, they are also dead serious in two ways. First, translations function as *realistic* vehicles for clarifying the meaning and function of the dance. Second, translations simply make explicit performatives that are *already* ubiquitous in the honeybee literature. Austin clarifies performatives as

utterances that can be rendered as 'a verb in the first person singular present indicative active' (1975 [1962]: 67). The direct parallel with the dance is its translatability into Austin's grammatical form. This translatability underscores – indeed in a dramatic fashion – its intuitive understanding as a performative.

The paradox is that while translations cannot convey literal meaning, at the same time they present the meaning of the dance starkly and concisely. Rendering the dance as speech divulges its simultaneous proximity to and distance from our linguistic form of life: by revealing its sense through translation, its indefiniteness of sense in the medium of human language is simultaneously exposed. Any performative renders the baseline of the dance as doing something – pointing to a state of affairs in the world and eliciting action. Yet the dance cannot be rendered isomorphically to human language, so its meaning remains irredeemably unsettled: opaqueness lingers in the wake of its conversion into words. This feeling of imprecision, however, is less about the intrinsic nature of the dance, and far more about our partiality to the belief that meaning is only crystal clear in *words*. Maurice Merleau-Ponty challenged the bias (or pride) of logocentrism when he stated: 'We have the feeling that our language expresses totally. But it is not because it expresses totally that it is ours; it is because it is ours that we believe it expresses totally' (1982 [1964]: 89–90).

Austin noted a class of 'primary' or 'primitive' performatives that have neither explicit nor precise meaning; for example, 'Shut the door' can be an order or an entreaty. Now in human interaction whether 'Shut the door' is one or the other is, more often than not, obvious without the utterance having to be overtly prefaced with 'I order you' or 'I beg you'. As Austin elucidated:

> There are a great many devices that can be used for making clear, even at the primitive level, what act it is we are performing when we say something – the tone of voice, cadence, gesture – and above all we can rely upon the nature of the circumstances, the context in which the utterance is issued. (1966 [1961]: 231)

In everyday life, performatives are mostly what Austin called 'primary' or 'primitive'. Against a background of relations, context, expression, or affect implicit meanings become actively present, visibly engaged, and realistically consequential. Language entrains an indefinite range of addenda, implications, and effects, which can be deliberate, unintentional, or a little of both. Social theorist Harold Garfinkel referred to the tacit facets of linguistic interaction as 'unspoken but understood et cetera clause[s]', or 'glossing practices' (1989 [1967]: 73ff.; Garfinkel & Sacks, 1970: 342).[20] The sensibility to language as a *living* phenomenon that always marshals the resources that wordlessly expand its perfunctory semblance is a central reason that ordinary-language philosophers, phenomenologists, ethnomethodologists, and others have insisted on attention to a 'phenomenology

of speech', 'alongside an objective science of language' (Merleau-Ponty, 1969: 216).

Philosophers J.L. Austin and John Searle have shown that performative action is not simply a matter of the action of one person automatically following the utterance of another. For an utterance to have the intended effect certain preconditions must be fulfilled: the performative should have a point; an audience for it should be present; and it must be properly acknowledged. These prerequisites are in place with the performance of the dance. It certainly has a point – tracking resources and keeping the hive properly stocked; dances are not performed without an audience; and attending honeybees acknowledge dances as active participants and by visiting the indicated locations. If these conditions were not operative – if dancing occurred in the absence of other bees, or if its message were only randomly heeded – its potential regard as linguistic behavior would be much attenuated; it would seem better described as a reflex response, rather than a communicative act.

The success of performatives also hinges on a background of common meanings, knowledge, and expectations; performatives are powerful linguistic conventions only against the backdrop of an intersubjective way of life. Society is thus implicated in the strong sense of a covenant of shared understandings. For example, if *orders* are to be followed certain rank relations must be presupposed; *announcements* make sense if they bear news; *promises* are made for actions that are not expected to transpire as a matter of course; a *report* is given about an actual state of affairs; *advice* offered usually presumes that the advisor has more knowledge and/or experience than the advisee. So besides the basic prerequisites, a variety of conditions uniquely adequate to different performatives – and ranging from nebulously assumed to crisply defined – must be secure for their felicitous accomplishment (see Austin, 1966 [1961]: 123–52; Searle, 1965: 147). Such groundwork elements constitute the 'et cetera clause' of speech acts.

Performatives, then, are exquisite shorthand of intersubjective transparency. The rendering of the dance as a performative has profound consequences along those lines. The moment the dance is seen as announcement, report, or recruitment, it can no longer be witnessed as spasmodic movement: it becomes a potential sign of honeybee intersubjectivity. A shared world of meaning and knowledge – what Wittgenstein famously called a 'form of life' – is insinuated in the background of the dance as performative action.

An ingenious scientific experiment speaks to this dimension of a shared background for the success of a performative. Ethologist James Gould rigged a set-up where a honeybee danced for a rich source of food 'purported' to be found in the middle of a lake. After placing food in a boat at the danced location he observed that no recruits arrived. Thinking that maybe the bees were reluctant to fly over water, he controlled the experiment by placing food all the way across the lake on the opposite shore. When this location was danced in the hive, the bees flew across the lake to

get to the food. The authors do not interpret these results, but suggest that they are unexplainable in mechanistic terms (Gould & Gould, 1984: 281).

This experiment is intriguing for, at face value, it ought to count as a case that invalidates the informative and enjoining efficacy of the dance. And yet it creates exactly the *opposite* impression: it bolsters the regard of the dance as linguistic behavior, for in resonance with language-use, it intimates an interpretive and interactive context in the reception of the message, rather than a deterministic link between the provided coordinates and subsequent visit to the location. The experiment insinuates that the bees are not automatically caused to visit a location, but act more in line with interpreting the dance's message. In short, if the dance *causes* the foraging that ensues, then the bees *fail* to arrive at the boat site; but if the dance is *meaningful* for the bees, then their failure to arrive at the boat site is a *success*.

What blocks the interpretation of this result as a failure of the dance's efficacy is the perception of the dance as a performative act. The unstated, but open to view, understanding is that dancing about food in the middle of a lake misfires, because the appropriate existential conditions to follow up the dance's message do not hold. A 'report' about a resource is liable to comparison against a familiar landscape; if the report fails to be credible in the face of such a comparison, then it is simply disregarded. The existential prerequisites for the success of the particular speech act are not in place. For the Goulds there is something astonishing about the bees ignoring dances about food in the middle of a lake. Given the implications of this finding, such a response is not surprising: within the reasonable bounds of its interpretation is the potential imputation of *disbelief* to the attending bees. Yet amazement is not simply corollary to the possibility of honeybee mind. It is also an apropos response to the possibility of a form of life comparable with human existence, a form of life that may share certain 'et cetera clauses' with us. The suspicion of some level of commensurability surfaces, even as it is too awkward to acknowledge.

Pushing the application of Austin's analysis, it might be argued that, given the range of performatives it is compatible with, the dance may be regarded as what Austin variously called an 'implicit', 'primary', or 'primitive' performative.[21] The dance as a communicative act regarding the location and quality of a commodity has the observable *upshot* of the attending bees visiting the danced location. Following Shirley Strum and Bruno Latour, the honeybees may be regarded as living in a 'performative society' in which they are not passive pawns of a fixed social structure, but by means of their dancing are 'actively negotiating and renegotiating what their society is and what it will be' (1987: 789).[22]

At the same time, neither its informative content per se, nor its phenomenology, can reveal to a human perspective whether the force of the dance is an order, or an entreaty, or, for that matter, something that no human word exactly translates. If honeybees do speak, it is also the case

that we do not fully understand them: the et cetera clauses of their dancing are, for the most part, an obscure affair.

Symbolism-cum-Performance: The Dance as a Complete Act

For purposes of clarity I have considered the symbolic and performative dimensions separately. In conveying the meaning of the dance, however, behavioral scientists do not separate its symbolic content from its performative nature. Fused as one, the symbolic and performative facets constitute the dance as a *complete act*, for by describing a state of affairs in the world the dance prompts recruits to harvest it. The single concept in the literature that expresses the full scope of the dance as both symbol and action is its recurrent description as a 'message': a message has informative content and implicates that it will, or should, be followed through.

Symbol and action are roped together in compact statements that deliver the gist of the dance. For example, von Frisch, after noting that bees attending the dance 'clean themselves, load up with honey, hasten to the hive entrance, and fly to the feeding place', summed its meaning thus: 'The dance was the sign that *there is* something *to be fetched*' (1967a: 29, emphasis added). 'There is' corresponds to the symbolic representation of a resource, while 'to be fetched' corresponds to the performative function of harvesting it. Regarding how the collection of water for cooling the hive is instigated and stopped, Lindauer maintained that 'it is really a *mutual communication* whereby the begging bee gives both distinct *information* about the social demands and a strict *order* to continue or to cease collecting water' (1971 [1961]: 30; emphasis in original). Seeley's wording that in dancing the bees 'share knowledge' and 'share information' also bundles together its symbolic and performative nature (1995: 85, 88).

Symbolism and performance are inseparable in lived language. Philosophers who focus on language-use have regularly made this point. Baker and Hacker, for example, write that 'what gives signs their life, what makes them symbols, is the role we give them, the use we make of them, in our daily linguistic transactions' (1984: 134). In his analysis of linguistic behavior, Jonathan Bennett (1976) contends that central uses of language are to inform and to enjoin. While admitting these are not its sole operations, he submits that a language could be imagined to be used for no other purpose than to inform and enjoin; therefore, he reasons, these must be essential constituents. Behavioral scientists conceptualize the dance along these lines – thus offering not an imagined but an actual system that fulfills Bennett's functions of language: it informs about a rich resource and enjoins foragers to go to it.

In the configuration of the dance as informative and enjoining, the events of the scout's discovery, her dancing about it, and the recruits' subsequent harvest become meaningfully and seamlessly connected in the cognitive–perceptual standpoint of the observer. J.B.S. Haldane captured

this diachronic facet in describing dances as 'at once histories and prophesies' (1952: 73). The dance extends temporally and spatially beyond the moment and place of its performance, assembling the dancer's past detection of the resource, her present reenactment of its location, and the future concerted harvest.

As the honeybees' informing–enjoining tool, the dance both arranges and reveals their world as one of spatial expansion and temporal extension. The colony emerges as nested in a familiar abode known and supervised, presupposed and retraced, with every exploration and exploitation. The hive's surroundings take on the primordial status of a dwelling-place. The understanding of the dance as a complete act thus ushers a phenomenological panorama of a meaningful, *designed* world (cf. Crist, 1996). This is not overtly articulated in the scientific literature, but surfaces as the background against which the facts about the dance hang together. As I discuss shortly, the temporal–spatial continuum encapsulated in the understanding of the dance as both symbolic and performative was obliterated in an alternative account, which aimed to reconfigure what honeybees do, not as concerted and meaningful action, but as movements orchestrated within, and by, a field of stimuli.

Upsetting Order: The Bees as an 'Evolutionary Freak'

By now, scientists' use of the concept 'language' in the honeybee literature is also sustained by conventional force – on the impetus of repetition stemming from long-term usage within a research tradition. But the conventional aspect of the label is only one side of the coin. The realist side of the term 'dance language' emerges from its non-trivial affinities with features of human language. I have argued that both general standards (rule-governed, complex, flexible) and robust ones (symbolic, performative) can be discerned that apply to human and honeybee natural languages rendering them non-isomorphically cognate. The reiteration of the label 'honeybee language' is therefore not simply conventional: it is used with vague but literal intent.

This almost-serious idea of an insect with language has had an unsettling effect in behavioral science. For example, the application of dancing on the swarm as a means of comparing potential nesting sites advertised by dancers, and of arriving at an agreement about the best one, has provoked the amazement of scientists. Butler exclaimed:

> Surely these are some of the most astonishing things that have yet been discovered in the whole realm of bee behavior? How can bees which, one supposes, possess no powers of reasoning, reach what amounts to an agreement on one of several possible nesting sites? (1954: 166)

Behavioral ecologist John Krebs also expressed perplexity about honeybee language:

> The chimp and bee examples are always quoted as evidence for the complexity of animal language: chimps one can understand, but bees

> seem to be an anomaly. Either they are an evolutionary freak, or we are awaiting for more scientists of von Frisch's genius. (1977: 792)

Butler's astonishment at the use of the dance for achieving consensus, and Krebs' demurral to regard bees as linguistic beings, seem connected to the implication of mind. It is reasonable to admit chimpanzees have mental capacities given their evolutionary proximity to humans; about bees, however, 'one supposes they possess no powers of reasoning'. Strum and Latour also discern complexity in primate life – actively structured through social skills, negotiations, alliances, and rivalries – but regard eusocial insects at a primitive level wherein 'the actors' own bodies are irreversibly moulded [via genotype]' (1987: 795).[23] The intellectual and lay urge to classify invertebrates as 'primitive' organisms, whose pre-wired machinery somehow does all the acting, is culturally ingrained and deeply habitual. Thus, in his classic paper 'What Is It Like To Be A Bat?' Thomas Nagel announced that 'I have chosen bats instead of wasps ... because if one travels too far down the phylogenetic tree, people gradually shed their faith that there is experience there at all' (1981 [1974]: 393).[24]

The reticence to admit honeybees in the community of language-users, that Krebs and others like linguists Emile Benveniste (1952) and Bennett (1987) have voiced, stems from the mindfulness that language-use implies. Indeed, concepts of memory, attention, recognition, understanding, interpretation, agreement, decision-making, and knowledge, as well as questions about cognition and awareness, have surfaced regularly in the honeybee literature. Early researchers Von Frisch and Lindauer used mental language generously throughout their writings on honeybee communication. Contemporary behavioral scientist Gould raises the question – without giving a definitive response – of whether honeybees have cognitive 'abilities beyond the basics of instinct and conditioning' (2002: 41). Griffin, whose recent work centers on the question of animal conscious awareness, argues that on the grounds of comparable human behavior, it is not unreasonable to conclude that honeybees may be 'consciously thinking and feeling something approximating the information they are communicating' (2001 [1992]: 210).

Mind and language are internally connected, for as Hayden White offered, language can be regarded as an '*instrument of mediation* between consciousness and the world that consciousness inhabits' (1976: 29; emphasis in original). The second definition of language in the Oxford Dictionary reads 'words and the methods of combining them for the expression of thought'. According to the influential social psychologist George Herbert Mead – who was convinced that only man has language – language is the sine qua non of mind (Mead, 1962 [1934]). So while baseline descriptions of the dance, and a diversity of facts associated with it, can be configured to fulfill certain intuitive and formal *standards* of linguistic behavior, a demurral to recognize the dance as a bona fide language may stem from the *entailments* this recognition would involve –

namely, that the dance may then be a tool that 'mediates consciousness', or 'expresses thought'.

Before looking at a controversy within biology in which these issues surfaced explicitly, I propose a conceptual framework to clarify why what the bees do appears disconcerting. This framework can be extracted from a point made by John Searle in his analysis of speech acts:

> For an instance of linguistic communication ... [to be] a message, one of the things that is involved [is] taking the noise or mark ... as having been produced by *a being with certain intentions*. [It] cannot just [be] regarded as a *natural phenomenon*, like a stone, a waterfall, or a tree. (1965: 137; emphasis added)

Searle proposed a typology to segregate 'noise-like' or 'mark-producing' phenomena into intentional and non-intentional sorts. But what the honeybees do baffles this standard typology. Is their recruitment dance to be understood as produced by beings with intentions, or as a natural non-intentional phenomenon? In the scientific literature, the dance is often described as a 'message'. If its understanding as a message is taken seriously, then applying Searle's syllogism the 'noise or mark' of the dance must be produced by 'beings with intentions'. Such an inference, even if obliquely intuited, is dismaying, for there is no consensual mold – scientific or common-sensical – to sustain the proposition that honeybees are beings with intentions. The present-day geography of 'beings with intentions' does not include (in any widely shared sense) insects and other 'lower forms of life'. At the same time, what is known about the dance resists its facile registration as a non-intentional phenomenon. The dance defies the typology recited by Searle. This is indeed a reason that its description *stops* people: there is no ready-made typification to contain symbol-using insects.

Knowledge about the dance language, then, upsets order: conceptually, the dance defies the taxonomy of behavior into intentional versus intrinsically meaningless; empirically, the dance challenges expectations based on the phylogenetic distance between bees and man, and may be seen, in Krebs' wording, as an 'evolutionary freak'. The disruption of order leads to two kinds of responses. One response involves a readiness to amend previous conceptions in order to accommodate a new phenomenon. The other response reaffirms received views, seeking to refute the existence of the 'new phenomenon'. In the section that follows, I examine the latter type of response to the honeybee 'language' – deliberately scare-quoted.

Rejecting the Dance Language 'Hypothesis'

In the mid-1960s behavioral scientists Adrian Wenner, Patrick Wells, and their associates attacked what they recast as the 'dance language *hypothesis*'. They contested that honeybees navigate on the basis of information encoded in the dances they attend, claiming instead that it was *scientists* who deciphered the dance and used the information to find the locations.

For Wenner, the fact that the dance contains information did not mean the attending bees use that information (1971: 7, 37). Rather, he maintained that '*successful* recruited bees had acted *as if* they had used the distance and direction information we scientists had chosen to measure' (1971: 52, emphasis in original). Gould, a pivotal scientist in the controversy that ensued, described Wenner's view of the representational features of the dance as 'a fortuitous collection of orientational artifacts with no actual role in recruitment' (Gould & Gould, 1995 [1988]: 73).

Wenner conceded that the bees 'arrived predominantly at or near the site indicated in the dance maneuver', but claimed that 'we cannot say for certain ... that these bees arrived at the site indicated *because* they were able to interpret and use quantitative information provided by successful foragers' (1971: 47; emphasis in original). He argued that instead of using the symbolism of the dance, the recruits rely solely on odors; he called this view 'the olfactory hypothesis'. Wenner claimed that reliance on odor cues to detect resources was a simpler and more sensible hypothesis about insect behavior than the idea of a 'honeybee language':

> I feel that the language hypothesis is no longer a useful paradigm. It is better to say that experienced bees depend upon a conditioned response for re-recruitment to familiar food sources and that inexperienced bees rely upon an odor source as they search for that supply of food to which they have been recruited. (1971: 90)

He proposed this explanation at a time when the symbolic function of the dance had been established in the scientific community as fact.

The alternative hypothesis was a challenge to the dominant view. The subsequent controversy unfolded in a series of articles in *Science* in the late 1960s and early 1970s, with von Frisch himself responding to his critics.[25] The olfactory view inspired a series of new experiments to probe the efficacy of the dance as a symbolic system (see Gould & Gould, 1995[1988]: 83ff.). The supporters of the olfactory hypothesis repeated certain of von Frisch's original experiments that had demonstrated the honeybees' use of the dance code: recruits congregated in greater numbers at the feeding site at which the dancer had been trained, and ignored, or showed up in fewer numbers at, other feeding sites placed in the field. The olfactory team did not replicate the experiments per se, but added what they termed 'controls' – odors and an additional control hive – to the experimental set-up. Foragers from the control hive were trained to forage at all stations. Now each location had both potent odor and more foraging bees. Under the experimental conditions created by the olfactory team, the bees from the 'observation hive' showed no preference for the location specified by the dance.[26] According to Gould, the disparity between von Frisch's results and Wenner's results reflected their use of different training techniques with the bees (1975: 689).

The challengers of the 'language hypothesis' maintained that their experiments showed that recruited bees followed odor cues – adhering to the dancer and the food she parcels out – rather than using information

symbolically delivered. Von Frisch responded that 'odor controls' voided the experiments from actually testing the dance, for when odors in the hive become strong honeybees switch to using only smell to forage. Von Frisch's point was that adding what the olfactory team called 'controls' created conditions that eliminated the need for dancing; their experiments did not disprove the dance language – but preempted its performance by making it superfluous.[27] About the olfactory experiments, Von Frisch wryly commented: 'It is a pity they tried to investigate the importance of dancing with bees that never or seldom danced at all' (quoted in Gould & Gould, 1995 [1988]: 76).

The fact that the 'olfactory hypothesis' offered an explanation more in line with the chemical nature of insect communication was intriguing to scientists (see for example, Wilson, 1971: 266–67). The olfactory proponents themselves, defended their explanation as being in agreement with Occam's 'razor', or the 'law of parsimony'.[28] Their challenge called for an experiment that would disentangle the use of the dance's symbolism from reliance on odor, thereby demonstrating or disproving the coordinate-giving efficacy of the dance. Clinching proof of the dance would be offered if 'the dances of the foragers were altered in such a way that recruits would proceed to a location to which the dancing foragers had never been' (Gould & Gould, 1995 [1988]: 79). This was achieved when Gould performed 'misdirection experiments' in which he succeeded in getting a dancer 'to lie' about the location she had visited (1975; Gould & Gould, 1995 [1988]: 79–83).[29] By manipulating a peculiarity of the bees' visual system, the placement of the comb, and artificial lighting, Gould got the dancer to point to a location that she had never visited. If the recruits were following odor (of the resource and/or locale) they would go to the location the dancer actually returned from – not the one indicated by her dance. If the recruits were following the information encoded in the dance, they would fly to the danced location – even though the dancer had never been there. The recruited bees visited the location symbolically indicated by the dance, despite the fact that the dancer did not carry the odor of the location.[30]This experiment was regarded as confirming the dance's representational function *for* the honeybees, and closing the controversy.

Any remaining doubt was dispelled by the construction of a mechanical bee that can lead – apparently not very reliably, but reliably enough to demonstrate that bees garner information from the dance – recruits to designated sites to which the 'honeybee' has never been (see Michelsen et al., 1989, 1991, 1992; Gould & Gould, 1995 [1988]: 83; J. Gould, personal communication). The use of the informative content of the dance by honeybees is so well established today that, as noted, researchers employ it to investigate their foraging patterns (Seeley, 1995). But the honeybee behavioral community, in part due to the challenge the olfactory team presented, recognizes that honeybees use both odor and the dance language to find sources. Indeed, when resources are plentiful and odors profuse, the honeybees do not (need to) use the dance.

Despite the olfactory team being credited as contributing a finer understanding of honeybee communication (Gould & Gould, 1995 [1988]: 83), Wenner and Wells never abandoned their strict olfactory position and resolute opposition to the dance language. In 1990, they coauthored *Anatomy of a Controversy: The Question of a 'Language' among Bees*, in which they draw on philosophy and sociology of science both to analyze the controversy and to promote their view – as, at least, an equally credible paradigm.[31] They argue that it has not been indisputable evidence from nature that closed the debate in favor of the dance language, but rather 'deep-seated social control' (1990: 209). Social factors such as the reward system within science, peer-group pressure, perceived scientific authority, and 'New Age' thinking in the culture at large are invoked throughout (see Wenner & Wells, 1990: 209, 186, 68, chapter 11).[32] Not surprisingly, concepts from science studies literature are used to make these arguments.[33] In ascribing extra-scientific underpinnings, their aim was to place the 'dance language paradigm' on wobbly grounds. Wenner and Wells sought to undermine its epistemic status by maintaining that non-rational factors underpinned its acceptance, rather than rationally adjudicated empirical evidence.

Extra-scientific factors do figure eminently in the debate – the most evident among them brought to the forefront by the challengers themselves.[34] In particular, issues of human–animal comparison and animal mind were key sticking points for the olfactory proponents.[35] Integral to the promotion of the olfactory perspective was its avowal as more fitting to insect behavior than an explanation of foraging recruitment via symbol-use. For the olfactory team, ascribing language to bees amounted to the attribution of a sophisticated human ability to an organism with a miniscule brain. According to Wenner and Wells, the dance language 'presumed that honey bees were capable of anthropomorphic human level behavior' (1990: 63, 240). In support of the olfactory view, Ruth Rosin affirmed the 'time-old truth' that 'both the physical and psychical complexities have attained their maximal in man', and differences between man and lower animals 'are not only simply quantitative, but also qualitative' (Rosin, 1980: 461). The olfactory hypothesis thus aimed to correct an ostensible anthropomorphism that projected language on an invertebrate species: both its preset intent and substantive content reaffirmed the proper positions of humans and insects within a hierarchical scala natura where 'speaking bees' are not admissible as real.

The logic of the olfactory framework, as well as the arguments its proponents set forth, was intrinsically tied to the declaration of human–animal – or at least human–insect – discontinuity and to the non-credibility of insect mind. *The elimination of agency* from the honeybee world was part and parcel of the olfactory reasoning, constituting both a motive for seeking an alternative account and one of its central epistemic consequences. By agency, I refer to the regard of animals as wide-awake, active and alert toward others, events, and objects in daily life.[36]

The olfactory view was formulated in the behaviorist idiom of stimulus–response: the stimulus of odor emanating from the dancer triggers the honeybees to fly to the resource. The foraging reaction of experienced bees was described as a 'conditioned response'; first-time recruits were portrayed as triggered to follow the odor emanating from the dancer's body to the food source. This idea alone – that bees react to a stimulus rather than interpret encoded information – re-ranks them in the 'lower-organism' category. But the olfactory view was even more stringent than downgrading an intellectual capacity to a sensory reaction. According to Wenner, the bees *do not conduct a search* using odor as a guide; Rosin underscored this point, remarking on the exclusion of 'any reference to a search for an odor center ... to any search in a *human* sense at all' (1978: 599, emphasis added). Indeed, an attribution of 'searching' might insinuate agency – instead of following directions symbolically encoded, the bees would be actively using smell to locate a resource. But the olfactory proponents averred that the flight to the resource is *determined* by odor cues carried by the wind; honeybees do not *use* odor as a guide, rather the *odor* guides them to the food.

Recalling Searle's terminology, the olfactory perspective redrew the line between a mark produced by 'beings with intentions' versus one occurring as a 'natural phenomenon'. The olfactory hypothesis reconfigured all movements of the honeybees – both the 'dance' and subsequent foraging flight – as unintentional phenomena, thereby reaffirming the divide between intentional action and mindless behavior. More than not locating commodities through interpreting symbolic signs, honeybees were deemed cognitively unequipped even to search for resources by means of smell. Through a representation of their foraging behavior as odor-induced and odor-determined movement, honeybees even lost their *sentience* – the quality of being 'responsive to, or conscious of, sense impressions' (*Webster's Ninth New Collegiate Dictionary*). The olfactory hypothesis was thus far more than an explanation of behavior grounded in mechanism: it accomplished the 'extra-scientific' work of *avoiding mind*.

The elimination of agency was effected through representing honeybee behavior as passive. Stimuli, like invisible, sensory-impacting strings, set the puppet-like bees into motion. The picture of passivity was escalated in portraying their behavior as bootstrapped – from one consecutive but disconnected moment to the next – by odor cues. On the stimulus–response model (S–R), honeybees exist in a perennial moment, propelled by impinging stimuli to move through disjoined pockets of space. The main analytical move of S–R is to 'desequence' action in order to convert it into mere movement. An experiential perspective of the animal on its world is erased – for such a perspective can only be grounded upon the experience of spatial continuity structured by a temporality of 'now', 'before', and 'later' (Crist, 2000). As previously discussed, the symbolic and performative understanding of the dance – signifying that 'there is something to be fetched' – assembles a temporal and spatial continuum, which creates a conceptual environment friendly to ideas like remembering, recognizing,

searching, finding, understanding, and even disbelieving. But the olfactory hypothesis vitiated the explanatory or descriptive power of such concepts, for it replaced an actively *designed* world that animates them with an objectively *distributed* world inhabited by quasi-automata.

The effects of the olfactory and dance-language views differ profoundly both at the level of their respective explanans and at the phenomenological level of the worlds they conjure to house the creatures they describe. The olfactory hypothesis extinguished agency via a behavioral model that constructs bees as utterly passive. The avoidance of mind, and affirmation of a hiatus between insect and human worlds, was not only intrinsic to the logic of S–R, but an openly operative and motivating assumption of the olfactory supporters. In their 1990 work, Wenner and Wells posed a pointed question:

> In brief, the question at issue here is: '*Can one really believe that the small honey bee visiting a flower has language capability?*' The same social situation that permitted the rise of *'New Age' thinking* in the public at large had apparently spilled over into the biological community. (1990: 68; emphasis added)

The implied response is that one cannot *really* believe such a far-fetched proposition as an insect with language. Since there are people in the biological community who apparently hold this unreasonable belief, Wenner and Wells offered a cultural–ideological origin for such irrationality – 'New Age' thinking, presumably implying the embrace of flaky, half-baked, or romantic ideas. The authors do not consider that their own adamant rejection of a 'small' honeybee with language capability has deep-seated historical origins, cultural roots, and ideological overtones.[37]

Earlier in the same work, the existence of the dance language is portrayed as a 'rather trivial question'. Discussing their motives for considering the controversy, Wenner and Wells appear momentarily less intransigent about rejecting the 'possibility of a dance language':

> This opportunity to provide raw materials [for the disciplines of philosophy, sociology, and psychology of science] strikes us as a far more important issue than *the rather trivial question* of a possibility of a 'dance language' among bees. (1990: 10; emphasis added)

The former passage implies that the idea of a bee 'language' is implausible, while the latter allows for its possibility. While at face value the two views appear inconsistent, there is a deeper sense in which there is no incongruity between them – for they share a cardinal anthropocentric credo: the tacit idea of insects as a lower form of life denotes *both* that honeybees cannot have language, and that anyway, the question of whether they do is trivial in comparison to the interest in the human discourses surrounding that question.

Rosin also attacked the dance language on the grounds that it contravenes a clear-cut demarcation between human and insect realms:

> The controversy between [the] ... 'language' hypothesis and ... [the] olfactory hypothesis for the arrival of honey bee recruits at field sources, is

> essentially a controversy between a human-level hypothesis for an insect and an insect-level hypothesis for an insect. Since a hypothesis which claims human-level 'language' for an insect upsets the very foundation of behavior, and biology in general, the burden of proof for the 'language' hypothesis is, and always was, upon supporters of that hypothesis. (1978: 589)

The meanings of a 'human-level hypothesis' and 'insect-level hypothesis' are assumed to be both clear and fixed. The author proceeds to make the burden of proof for a 'human-level hypothesis' an endless task for the proponents of the dance language. In considering various experiments that show the bees' use of the dance code – to the satisfaction of the central researchers in the field – she contends that all lack the 'proper controls'. Rosin's grievances appear as an instantiation of H.M. Collins' idea of 'experimental regress', for the distinct impression is conveyed that no experiment could establish the dance language beyond all doubt, since a flaw might always be discerned in its design (see Rosin, 1978; Collins, 1992 [1985]: 83ff.).

The olfactory view revalidated beliefs that the discovery of the dance language disturbed. It did so in a vociferous manner. Implicitly, the S–R model of the olfactory hypothesis portrayed bees as puppets in a matrix of stimuli that automatically steer them. Explicitly, with a 'let's-get-real' attitude, the olfactory supporters insisted that the existence of an insect with language is less than credible, and a simpler explanation for locating resources should be preferred. A postulate about the plausible distribution of capacities in the animal world was not implicit but openly declared; as the passages cited earlier illustrate, it was used as an *argument* against the language hypothesis. Pitted against the dance language, the olfactory hypothesis was more than a contesting set of claims, or an alternative set of experiments, about honeybee communication. It maximally disjoined insect and human forms of life and avoided animal mind by eliminating agency – the wide-awake and sentient presence that anchors the possibility of mindfulness, and allows questions about cognition to arise or be posed.

The paramount role of what 'one can believe', when it comes to the abilities of animals (and especially insects), was nicely displayed in a quote from Lewis Carroll with which the leading researcher of the olfactory view ended his 1971 work (Wenner, 1971: 102):

> 'I can't believe that!' said Alice.
>
> 'Can't you?' the Queen said in a pitying tone.
>
> 'Try again: draw a long breath, and shut your eyes'.
>
> Alice laughed. 'There's no use trying. One can't believe impossible things'.

Conclusion

I have examined how behavioral scientists, from von Frisch to contemporary researchers, have conceptualized the honeybee dance as a linguistic

system. While no one claims that the dance language comes anywhere near the complexity of human language, the two exhibit non-trivial affinities. Scientists have understood the dance as rule-governed; sensitive to hive exigencies; responsive to environmental conditions and changes; symbolic in representing states of affairs distant in space and time; and performative in that honeybees do things with dancing.

The dance upset deep-seated assumptions, lay and scientific. The honeybee language makes a shambles of what one olfactory-hypothesis proponent called 'our old-fashioned phylogenetic system' (Rosin, 1978: 600).[38] In other words, it disturbed the 'great chain of being' still at large despite the Darwinian revolution: the picture of man (and other 'higher mammals') at the apex and invertebrates in the basement of a hierarchy of ability and value. The discovery of the dance contributed to undermining the idea that language is a distinguishing human possession – an idea that has also been damaged by primate studies.[39] The dance language threw a monkey wrench into the cogs of the pervasive, if often invisible, belief that insects are 'natural automata' (Descartes, 1981 [1646–49]: 244). Finally, the discovery of the dance intimated the possibility that conscious awareness – associated with a capacity to represent landscapes, products, needs, and sentiments symbolically – may exist in worlds we have been disinclined to imagine.

I have discussed the debate between the dance language and olfactory view proponents from a particular perspective: I argue that the controversy centered on divisive disagreements about background assumptions. If this controversy speaks to familiar post-Kuhnian ideas like 'incommensurability', 'conversion versus resistance to a new paradigm', or 'seeing duck versus seeing rabbit', then I would argue that it shows this: that if 'one *really does not believe* that a small honeybee has language capability', then apparently no evidence may ever suffice to prove its existence. This seems a reasonable explanation for why a minority of skeptical scientists has renounced evidence that the preponderance of the honeybee research community have found amply persuasive.

The present paper has not been a detached analysis of the scientific understanding of the dance. I accept at face value that scientists have discovered a remarkable fact about the animal world – and by implication, about the human world. A significant contribution of the knowledge about the dance language has been to expand our horizons beyond preconceptions that have served human vainglory while ignoring or demeaning the complexity of the living world. As von Frisch urged:

> consider in their entirety the accomplishments of these small insects . . . . The more deeply one probes here the greater his sense of wonder, and this perhaps may restore to some that reverence for the creative forces of Nature which has unfortunately been lost. (quoted in Morrow, 1998: 56)

So, can an insect speak? And if yes, do we understand it? Wittgenstein maintained that 'if a lion could speak we would not understand him', by

which he implied that we do not share the 'form of lion-life' that would make lion language fully transparent to us (1968 [1953]: 223).[40] Thomas Nagel also might insist that after a century or more of scientific research, we are still largely in the dark about 'what it is like to be a honeybee'. A similar insight was eloquently expressed by the early 20th-century naturalist and honeybee researcher Maurice Maeterlinck. The irony that he wrote these words before the discovery of the dance makes their wisdom all the more poignant:

> Beyond the appreciable facts of their life we know but little of the bees. And the closer our acquaintance becomes, the nearer is our ignorance brought to us of the depths of their real existence. But such ignorance is better than the other kind, which is unconscious and satisfied. (1901: 6)

Notes

I would like to thank James Gould for an enlightening phone interview, four anonymous reviewers of an earlier draft, and Michael Lynch for his editorial and substantive suggestions. Especially, I would like to thank Professor Donald Griffin for careful readings of earlier drafts, detailed suggestions, and sharing of film clips of dancing honeybees. Any inaccuracies in this paper are due solely to my own ignorance of the intricacies of honeybee behavior.

1. I use the spelling 'honeybee' (one word) throughout. Some scientists, however, prefer the two-word spelling 'honey bee'; I preserve that spelling in quotations of researchers who use it.
2. Von Frisch shared the Nobel Prize with Konrad Lorenz and Nikolaas Tinbergen for their contribution to the study of animal behavior (Burkhardt, 1981).
3. The discovery of the dance was announced in 1923, though more enduring descriptions of the form and uses of the round and waggle dance were published by von Frisch in 1946. The language of the bees became more widely known in the English-speaking world after 1950 with the publication of his *Bees: Their Vision, Chemical Senses, and Language,* introduced by Donald Griffin. For short accounts of the history of the discovery see Butler (1954: 201ff.), Gould & Gould (1995 [1988]: 55ff.), and Griffin (2001 [1992]).
4. Earlier naturalists had suspected, but never confirmed, that honeybees might have a way of communicating the location of resources, without leading their hive-mates to the site. See Lubbock (1892: 274ff.), Maeterlinck (1901: 168) and Gould & Gould (1995 [1988]: 55).
5. Studies of the accuracy of direction information suggest that the alternate waggle runs vary more in angle the closer the food source; conversely, the further away the source, the lesser the angle of difference between the waggle runs of a single dance. Researchers have suggested that the small variation in angle might correspond to the typical size of a flower patch (Griffin, 2001 [1992]: 197). After all, rarely are dancers directing the hive-mates to a point location.
6. From his early observations in the 1920s, von Frisch concluded that honeybees do the 'round' dance to communicate about nectar sources and the 'waggle' dance for pollen. With more precise experiments in the 1940s he was able to correct this earlier misinterpretation (Griffin, 2001 [1992]: 191–92).
7. In the round dance, the 'waggle run' is represented at its minimal measure of a single point. Ethologist Colin Butler discerned the identity of the round and waggle dances 40 years ago. Describing the round dance, he wrote that 'the performer turns round in circles on the same spot first in one direction and then in the other; in fact she traces out a figure-of-eight with its two loops more or less closely superimposed upon one another' (1954: 202).

8. The significance of this will become apparent when I discuss the 'dance-language controversy'. Those who rejected the dance-language maintained that honeybees only use odor to locate resources.
9. When the resource is in the same direction as the sun, the waggle run is directed upward, against gravity, whereas the downward waggle run signals that the source is away from the sun.
10. As Colin Butler explained, 'it appears, therefore, that the time or energy that has to be expended in order to reach the feeding place forms the basis of the honeybee's estimation of distance' (1954: 205). If the honeybees can be forced to walk – by connecting a tube from the hive to the food source – they will switch from (what are conventionally differentiated as) the round to the waggle dance only a few meters from the hive. Again, what is conveyed is effort required to arrive at the source, rather than its absolute distance (Gould & Gould, 1995 [1988]: 62).
11. Not all honeybee species employ sound in the dance, leading researchers to view sound as 'a later evolutionary arrival' (Gould & Gould, 1995 [1988]: 110).
12. Bees show aesthetic preferences, choosing real flowers over artificial feeders, and artificial feeders shaped like flowers over open dishes (Gould & Gould, 1995 [1988]: 94–95).
13. A subfield of ethnomethodology called 'conversation analysis' has empirically uncovered and codified a variety of fairly invariant and complex conversational rules – that people follow expectably, but about which they remain happily unaware. See Atkinson & Heritage (1984) for an excellent, classic collection of conversation analysis studies. See also Boden & Zimmerman (1991).
14. Lindauer also pointed out why tracking resources is crucial: 'Newly discovered sources of crops can be exploited as quickly as possible, before the blossoms close their calyces and before competing bee populations take away the newly found nectar' (1971 [1961]: 32).
15. Another aspect of the influence of communicative feedback on the dancer is less well understood. It involves what have been called 'stop signals' produced by attending bees that cause the dancer to stop dancing. The function of these signals is speculated to slow down recruitment when resources being brought to the hive cannot be processed effectively (Griffin, 2001 [1992]: 201).
16. In a remarkable passage in his celebrated *The Life of the Bee*, Maurice Maeterlinck practically describes how the swarm arrives at a decision about a particular location. His description, preceding the discovery of the dance, is remarkably prescient. He writes that upon swarming scouts 'sallied forth in all directions in search of a lodging'. And he goes on 'they return one by one, and render account of their mission'. He then proceeds to state what in contemporary behavioral science researchers describe as the bees' arriving at a consensus: 'We may regard it as probable ... that most careful attention is given to the reports of the various scouts. One of them, it may be, dwells on the advantage of some hollow tree it has seen; another is in favour of a crevice in a ruinous wall, of a cavity in a grotto, or an abandoned burrow. The assembly often will pause and deliberate until the following morning. Then at last the choice is made, and approved by all' (1901: 127–28). Interestingly, Maeterlinck's assessment, which might have been branded as blatant 'anthropomorphism' (in the sense of an imaginative projection of human capacities), turned out, from the point of contemporary knowledge, to be exactly on the mark.
17. For example, Griffin submits: 'Although we can only speculate about what, if anything, the dancing bees and their sisters who follow the dances on swarms are thinking, their vigorous communication suggests that they are thinking of a suitable cavity' (2001 [1992]: 210).
18. Although experiments with lady bugs have revealed a fortuitous correspondence between directional movement with respect to the sun transferred to directional movement with respect to gravity, serving no apparent function (Gould & Gould, 1995 [1988]: 70–71).

19. Experimenting with the placement of feeding stations at four different directions relative to the hive, von Frisch found that after attending round dances bees soon appear at all four locations. On the basis of this experiment, he inferred that the round dance is used in the case of food sources nearby the hive, and it does not direct the bees to a *specific* location.
20. The analogy that comes to mind in reading Garfinkel's presentation of the background knowledge brought into action in everyday talk is that what we actually say to one another constitutes the tip of the iceberg. In transcribing a conversation between husband and wife, for example, Garfinkel shows that the 'et cetera clause' accompanying each turn (and set next to it by the analyst) is two to three times longer than the turn's utterance itself (see 1989 [1967]: 38–39).
21. Of course this analogy is simply an analytic mechanism to reveal the level of opacity of the dance to human language and not in any sense a proposal of what the dance is in its own terms. A performative can only be implicit against the notion, or counter-example, of its being explicit; it can only be primitive against the background of its being precise.
22. It may be noted, however, that there is a predilection to err on the side of exaggerating levels of intentionality and shrewdness of actors among primates (including human). Social theorist Harvey Sacks observed that when we examine how we engage in such routine perceptual actions as seeing 'that's a married couple and that's a black guy', and routine judgments about 'what an afternoon with your boyfriend or girlfriend consists of', 'you can begin to appreciate that there is some immensely powerful kind of mechanism operating in handling your perceptions and thoughts, other than the known and immensely powerful things like the chemistry of vision, etc.' (1992 [1970]: 219).
23. Here the authors forget their own insight, earlier in the paper, that 'the socio-biological solution [of finding stable properties in genotypes] le[aves] moot the question of the proximate means by which society could be achieved' (Strum & Latour, 1987: 788). Gesturing in the direction of social insect genetics also leaves moot the question of the extraordinary, proximate coordination required to create and run their societies.
24. In a conservation biology context, Stephen Kellert and E.O. Wilson have argued that dismissive and/or derogatory ideas about invertebrates reveal more about the human attitudes and perceptions than about the organisms themselves. Negative perceptions do a profound disservice to the vital ecological roles of invertebrates (Wilson, 1987; Kellert, 1993).
25. See Johnson (1967), Wenner (1967, 1971), Wenner et al. (1969), von Frisch (1967b) and Wenner & Johnson (1967).
26. In addition, the olfactory supporters maintained that no adequate attention was paid to wind direction and speed in early experiments. See Wenner et al. (1991) for a report on more recent olfactory experiments, with control odors and foraging bees, making similar claims.
27. Von Frisch also cited two of his telling experiments in response to critics. In one case, when the dark vertical hive is turned horizontally, bees continue to dance but the dances 'become disoriented and indicate neither a certain distance nor direction' (1967b: 1073); recruited bees show no predilection for a specific site. When the hive is set vertical again, recruits immediately orient toward where the dance is pointing (1967b: 1073). The other case involved detour experiments where the dancer indicated the 'beeline' direction over a mountain ridge or high building, despite that she did not discover the source by flying over it; recruits however did fly over it, indicating they were following no cue other than the directions from the dance (1967b: 1073). As Gould put it, in flying over an obstacle (in one case a 12-storey building), von Frisch deduced that the bees 'must have "known" where to go' (1975: 685).
28. See Wenner (1971:100–01) and Wenner & Wells (1990: 246).
29. The use of the idea of the bee 'lying' about where she'd been implicitly borrows from the overall performative ('telling') dimension of the understanding of the dance. At the same time it is a facetious usage, for 'lying' implies providing misinformation deliberately.

30. Interestingly, Gould & Gould note the following: 'When the experiments were repeated using the training methods of Wenner and Wells, this pattern disappeared. Apparently when there is a highly fragrant food source ... dancing declines as recruits search successfully using only odor cues' (1995 [1988]: 82).
31. Similarly in 1991, Wenner et al. averred that 'the two ... competing hypotheses ... may both be considered to be supported by any given set of experimental results; however neither should have become a "ruling theory" '(1991: 779).
32. Biologist Thomas Seeley's review of this work for *Nature* was scathing (1991). He charges the authors for presenting a 'straw man' version of the dance language view, as ascribing no role to odors – when von Frisch himself recognized their importance. Seeley concludes that 'virtually all the evidence that Wenner and Wells muster to refute the dance-language hypothesis is consistent with von Frisch's view of the dance language'. He goes on to note that 'many other serious errors of scholarship further erode the credibility of this book's analysis of the dance-language controversy'.
33. In particular, a panoply of Kuhnian notions of paradigm, anomalies, normal and revolutionary science, scientific community, and others is deployed to keep a controversy that is pragmatically closed, conceptually open.
34. Questions of character, reputation, and authority have been part of the controversy, but did not play the decisive role that Wenner, and others, sought to assign them in closing the controversy (see Veldink, 1989). Rather, behavioral scientists are satisfied that experimental evidence has sufficiently disentangled odor and dance cues to prove that honeybees, themselves, can use the dance's symbolically encoded information to locate resources.
35. 'Discovering' or 'proving' the existence of a language in a non-human species does not hinge only on evidence. One first of all has to be able to 'believe' that such a capability can be possible (Wenner & Wells, 1990: 67). Commentators who favor Wenner and Wells' skepticism raise congruent questions: 'The question to ask is whether the brain of a bee is capable of processing of such abstract information' (Kak, 1991: 364).
36. I do not use 'agency' in the actor network theory (ANT) sense of 'actant'. In acknowledging the substantive participation of 'non-humans' in the creation of scientific knowledge, ANT endeavors to epistemologically navigate between the Scylla of sociological reductionism and Charybdis of naive realism (Latour, 1994). But the notion of 'actant' is too blunt a tool to distinguish between different types of agency. Since inanimate objects like doors and computers, as well as animate beings like bacteria, scallops, baboons, or honeybees, can all be characterized as 'actants', the latter concept is useless in distinguishing between ascribed and intrinsic intentionality, and cannot speak to the question of animal mind in any robust sense.
37. In 1646, Descartes stipulated that 'when the swallows come in the spring, they operate like clocks', and added that 'the actions of honeybees are of the same nature' (1981 [1646–49]: 207). Descartes reasoned that if we attribute 'thought' to animals, then they must have 'immortal souls', and then proceeded to use insects (and other invertebrates) to rebut such a possibility: 'it is more probable that worms and flies and caterpillars move mechanically than that they have immortal souls' (1981 [1646–49]: 208, 244).
38. Rejecting the dance language, Rosin wrote, 'maintains honeybees at a state of ordinary insects, which may be disappointing. But then, it also retains our old-fashioned phylogenetic system in a relatively intact state, which is no small consolation' (1978: 600). One might well wonder, in the post-Darwinian life sciences, what an 'old-fashioned phylogenetic system' exactly is, and why it is a consolation to retain it (see for example, Gould, 1977: chapter 3, on Darwin's non-hierarchical conception of evolution and phylogeny). Rosin's critiques of the dance language are the most transparent in showing that the dance-as-code was objectionable for disturbing a priori hierarchical assumptions.
39. See Harré & Reynolds, 1984; Savage-Rumbaugh, 1986; Savage-Rumbaugh & Lewin, 1994; Shanker, 1994; Savage-Rumbaugh et al., 1998.
40. 'Forms of life' is a notoriously terse and vague expression that Wittgenstein only used a handful of times (see Hunter, 1971). Stanley Cavell lucidly describes the connection

between sharing a language and 'form of life': 'That on the whole we [make and understand the same projections in language] is a matter of our sharing routes of interest and feeling, modes of response, senses of humor and of significance and of fulfillment, of what is outrageous, of what is similar to what else, what a rebuke, what forgiveness, of when an utterance is an assertion, when an appeal, when an explanation – all the whirl of organism Wittgenstein calls "forms of life"' (1976 [1969]: 52). Much of the 'whirl' of other creatures is, clearly, unavailable for human apprehension.

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