moderate drinking can significantly inhibit neuronal function, even in the absence of the facial malformations and mental retardation accompanying classic FAS. "At the level we're exposing our animals to, we're not finding changes in [body] morphology—they look normal," says Savage. "All the changes are at the level of neurochemistry."

The idea suggested by the work of Charness, Savage, and others—that children with full-blown FAS are only the extreme end of a spectrum of effects that tapers in magnitude as the alcohol dose decreases—corroborates a handful of epidemiological studies. These indicate that children whose mothers drank moderately while pregnant are prone to a variety of learning deficits such as slower reaction times, poorer sustained attention, and lower intelligence quotient scores. Indeed, the Institute of Medicine (IOM) has recently suggested a new category of Alcohol-Related Neurodevelopmental Disorders for these more subtle symptoms. "People talk about FAS as though it was a single, clearly defined category, but in reality it's a continuum," says Claire Coles, an associate professor of pediatric psychiatry at Emory University School of Medicine and a member of the IOM committee that suggested the new category. "Probably, moderate consumption is causing effects appearing in the lower end of the continuum."

But Coles cautions that much work remains to be done, particularly in studying humans exposed to lower levels of alcohol. Forging a direct link in humans between low or moderate fetal alcohol exposures and learning problems years later is difficult, she says, because many other factors such as variations in individual sensitivity to alcohol may influence cognitive abilities. "The human studies are much less refined than the molecular studies," she says.

That many questions remain unanswered is illustrated by the fact that no one yet knows why only about 6% of the children born to women who drank heavily during pregnancy display the classic signs of FAS. "Not every fetus exposed to alcohol will show effects," Savage says. "There are probably genetic predispositions and environmental factors that we have very little understanding of." Although the current research doesn't imply that a single drink by a pregnant woman would necessarily harm her fetus, it strongly suggests that even light to moderate regular drinking could have lasting effects. Says Charness: "If one of my daughters were pregnant, I'd tell her not to drink at all."

–Stephen Braun

Stephen Braun's book, Buzz: The Science and Lore of Alcohol and Caffeine, *will be published by Oxford University Press this fall.*

EVOLUTIONARY BIOLOGY

Genes vs. Teams: Weighing Group Tactics in Evolution

In the Olympics of life, most evolutionary biologists say, it is the individual's score that counts. Individual organisms compete with each other, and the winner is the one that passes the most genes to the next generation. But some evolutionary biologists have argued that this view overlooks the struggles and strategies of "teams"—whether they be species, groups of cells, or groups of organisms—in the evolutionary race. And although the idea of group selection was discredited more than 30 years ago, a growing number of researchers say that it deserves a fresh hearing. Group selection, they say, may explain patterns ranging from how cells are kept in check in a developing organism, to the evolution of honeybee dancing, to the way plants grow in a crowded field.

"There are many levels of selection," says David Sloan Wilson, an evolutionary biologist at New York's Binghamton University, "and the group level is probably far more common in nature than is currently recognized." The idea has gained ground in recent years as an increasing number of biologists chafe against the idea that individual competition explains every aspect of evolution. For example, Wilson argues, it does not explain why parasites seem to strike some balance with their hosts, rather than maximizing their virulence as mainstream evolutionary theory would predict.

So he and other partisans are re-entering the arena armed with new models and data that they say answer some of the key criticisms aimed at group selection: that it is weak theoretically, is hard to measure, and lacks hard evidence from the field. Wilson and others will have their say at a symposium next week when the American Society of Naturalists meets jointly with the Ecological Society of America in Providence, Rhode Island, and they are expecting plenty of attention. Notes Yale University invertebrate zoologist and evolutionary theorist Leo W. Buss, "Multilevel selection theory calls into question the sufficiency of the existing genetic theory of evolution. Contrary to current thinking, the history of life cannot be told solely by the frequency of alleles."

Group selection's critics, however, aren't expecting the theory to perform any better in this round than it has in the past. It just isn't necessary to explain the patterns seen in the natural world, they say. "Is there anything in evolution that can't be answered by individual selection, that needs to be explained by selection acting on groups?" asks Jerry Coyne, an evolutionary geneticist at the University of Chicago. "I can't think of any."

Although the concept of group selection dates back to Darwin, it wasn't seriously debated until 1962. In that year, V. C. Wynne-Edwards, an evolutionary biologist at the University of Aberdeen in the United Kingdom, published his book, *Animal Dispersion in Relation to Social Behaviour*, arguing that many social behaviors evolved for the greater good of the group. For example, dominance hierarchies may have evolved in some primate species to reduce intragroup conflict and so promote an efficient community. But only 4 years later, George C. Williams, an evolutionary biologist at the State University of New York, Stony Brook, showed the fallacy of such thinking in his book, *Adaptation and Natural Selection*. Most tellingly, he pointed out that selection is much faster at the level of the individual than at that of the group—a recognition that ultimately led biologists to focus on the individual organism as the vehicle of selection. In this view, the primates' dominance hierarchy actually evolved not as a group benefit, but as a contest between individuals competing to get their genes into the next generation.

TOM SEELEY/CORNELL UNIV.

Do bees do it? Some biologists say honeybee social behavior like this "waggle" dance is a product of group selection.

After that, group selection seemed dead. But Wilson and others began reviving—and reinventing—the idea about 20 years ago. Even if selection acts primarily on the genes of individuals, Wilson argues, it is also felt at other levels, which in his view may be the cells in a multicellular organism, a parasite and its host, or even ephemeral groups such as the members of a school of fish. All members of such groups share a common fate—the cells must cooperate or their organism will die, and how the fish behave determines the success of the entire group if a predator attacks. Unlike Wynne-Edwards, who used group selection to try to explain altruism, Wilson stresses how competition among groups forges them into adaptive units: Groups that work well together enjoy greater reproductive success. "That's the heart of the issue," says Thomas D. Seeley, an evolutionary biologist and honeybee expert at Cornell University. "Are the differences in reproductive success only due to competition between individuals, or are they sometimes due to competition between groups?"

Seeley thinks he has hard data for the effects of group competition in honeybee colonies. "In most other animal groups, you see a mixture of cooperation and conflict—that is, group and individual selection going on simultaneously, so the issue remains gray," he says. A honeybee colony, however, operates as an individual unit or superorganism, because all of the individuals are genetically related (only the queen reproduces, and workers' genes are passed along through her). Competition and selection of traits therefore occur among hives, not among individual bees. That makes a hive an ideal setting for observing group traits—among them, says Seeley, the honeybee communication system, which includes such behaviors as a "waggle" dance performed to alert hive mates to the location of nectar-rich flowers. "The dances are all adaptations at the group level," he says. "The payoff comes only in terms of the economics of the hive as a whole."

But critics of group selection point out that honeybees and other social organisms are a special case, because genetically they are in effect a single organism. An individual honeybee can boost its own reproductive score by cooperating with its kin or even sacrificing itself for them, because its genes will get into the next generation via its relatives. Seeley concedes that such "kin selection" explains the bee results. But he and others argue that kin selection is actually a subset of group selection; other examples of group selection may turn up in less closely related individuals, he says. That's a semantic twist that Coyne, for one, isn't buying. "I think that's a sneaky ploy to lend credibility to the idea of higher levels of selection," he sniffs.

Meanwhile, other researchers are looking at levels below the organism for examples of group traits—the groups in this case being groups of cells. For example, Richard E. Michod, an evolutionary biologist at the University of Arizona, is developing mathematical models to address the question of why cells in multicellular organisms cooperate to produce a coherent whole—an organism—that itself becomes a unit of selection. Theorists John Maynard Smith at the University of Sussex in the United Kingdom and Eors Szathmary of the Hungarian Academy of Sciences have argued that such cell–cell cooperation within a single organism arises simply because such cells are essentially clones and therefore, much like honeybees, are "kin" of the closest kind. But Michod notes that when cells divide, they mutate, so that they are no longer genetically identical.

CHARLES GOODNIGHT/UNIV. OF VERMONT

Togetherness. In a crowded stand of *Impatiens*, individual plants seem to restrain their growth.

His model suggests that if only kin selection were operating, such cellular variation would be a threat to the integrity of the organism. Cells would become sufficiently different for their "selfish" interests to take over. The cells in one's little finger, for example, might routinely go on binges, reproducing at will. That's just what happens in cancer, of course. But it is the exception rather than the rule.

Other researchers have argued that animals keep this internal conflict between the organism and its cells in check in two ways: by segregating the germ line (eggs and sperm), so that any mutations that benefit a single cell cannot be passed to the next generation, and by policing the cells via processes such as reducing the number of cell divisions, which limits the number of mutations. When Michod expanded the basic kin-selection model to include these traits, he found that in combination with the close genetic relationship among cells, they fostered the cell–cell cooperation that eventually leads to a functioning organism. And he argues that these control mechanisms must have evolved through multilevel selection—a kind of group selection.

Michod's approach wins praise from multilevel selection supporters, such as Yale's Buss. "He's treated these multilevel hypotheses formally" by including them in a model—a step that Buss and others say could provide a framework for subsequent investigations. But those who favor individual selection are dubious. "I don't see how you can test his model against empirical data," complains Brian Charlesworth, a population geneticist at the University of Chicago. In fact, says Charlesworth, that is a problem with all of the new theoretical models. "This group selection could be going on all the time, but since we have no way of documenting it, how do you know it's ever happened?"

Group selection proponents are seeking such evidence, but so far their results are suggestive rather than conclusive. For example, at the symposium, Charles J. Goodnight, an evolutionary geneticist at the University of Vermont, will present data on natural stands of *Impatiens capensis*, an annual plant. He and his colleagues found that when *Impatiens* grows in dense stands, the plants turn out smaller and produce fewer flowers than in less crowded stands—yet produce just as many seeds. Goodnight suggests that these *Impatiens* plants are in a sense cooperating by restraining their growth. "It may be that individuals in these smaller groups are doing better because they are sharing resources," he says.

But other biologists aren't ready to call this group selection, for at the moment there's no evidence that the plants are actually cooperating. All in all, the theory of group selection needs some beefing up before it steps onto the mat with the proven champion, individual selection, say both supporters and critics. "It's very abstract and confused right now because there are a lot of different definitions about what group selection is," says Harvard University's Stephen Jay Gould. "But it is also vitally important to evolutionary theory; it will sort itself out." Perhaps a few rounds of selection among competing bands of evolutionary biologists will do the trick. May the best group win.

–Virginia Morell