

Reading Explorer 5 Unit 8 Lesson A

DIRECTIONS: Choose the best answer for each question.

The Genius of Swarms

A single ant or bee isn't smart, but ant and bee colonies are. The reason, as writer Peter Miller discovers, is something called swarm intelligence.

[A] I used to think ants knew what they were doing. The ones marching across my kitchen counter looked so confident, I just figured they had a coherent plan, knew where they were going and what needed to be done. How else could ants create highways, build elaborate nests, organize epic¹ raids, and do all the other things ants do?

[B] Turns out I was wrong. Ants aren't clever little engineers, architects, or warriors after all - at least not as individuals. When it comes to deciding what to do next, most ants don't have a clue. "If you watch an ant try to accomplish something, you'll be impressed by how inept² it is," says Deborah M. Gordon, a biologist at Stanford University.

[C] How do we explain, then, the success of Earth's 12,000 or so known ant species? They must have learned something in 140 million years. "Ants aren't smart," Gordon says. "Ant colonies are." A colony can solve problems unthinkable for individual ants, such as finding the shortest path to the best food source, allocating workers to different tasks, or defending a territory from neighbors. They do it with something called swarm intelligence.

[D] Where this intelligence comes from raises a fundamental question in nature: How do the simple actions of individuals add up to the complex behavior of a group?

[E] One key to an ant colony is that no one's in charge. No generals command ant warriors, no managers boss ant workers, and the queen plays no role except to lay eggs. Even with half a million ants, a colony operates as a single entity without any management at all - at least none that we would recognize. Such a system - described by scientists as *self-organizing* - relies upon countless interactions between individual ants, each of which is following simple rules.

[F] That's how swarm intelligence works: simple creatures following simple protocols, each one acting on local information. No ant sees the big picture, or tells any other ant what to do. Some ant species may go about this with more sophistication than others. (*Temnothorax albipennis*, for example, can rate the quality of a potential nest site using multiple criteria.) But in each case, says Iain Couzin, a biologist at Oxford and Princeton Universities, no leadership is required. "Even complex behavior may be coordinated by relatively simple interactions," he says.

[G] Inspired by this idea, computer scientists have been using swarm behavior to create mathematical procedures for resolving complex human problems, such as routing trucks and scheduling airlines.

[H] In Houston, for example, a company named American Air Liquide has been using ant-based guidelines to manage a complex business problem. The company produces industrial and medical gases at about a hundred locations in the United States and delivers them to 6,000 sites, using pipelines, railcars, and 400 trucks. Air Liquide developed a computer model inspired by the foraging behavior of Argentine ants (*Linepithema humile*), a species that, like other ant species, deposits chemical substances called pheromones.

[I] "When these ants bring food back to the nest, they lay a pheromone trail that tells other ants to go get more food," says Charles N. Harper, who oversees the supply system at Air Liquide. "The pheromone trail gets reinforced every time an ant goes out and comes back, kind of like when you wear a trail in the forest to collect wood. So we developed a program that sends out billions of software ants to find out where the pheromone trails are strongest for our truck routes."

[J] Air Liquide used the ant approach to consider every permutation³ of plant scheduling, weather, and truck routing - millions of possible decisions and outcomes a day. Every night, forecasts of customer demand and manufacturing costs are fed into the model. "It takes four hours to run, even with the biggest computers we have," Harper says. "But at six o'clock every morning, we get a solution that says how we're going to manage our day."

[K] Other companies have also profited by imitating ants. In Italy and Switzerland, fleets of trucks now use ant-foraging rules to find the best routes for bulk deliveries. In England and France, telephone companies improved their network speed by having messages deposit virtual pheromones at switching stations, just as ants leave signals for other ants to show them the best trails.

[L] But ants are not the only insects with something useful to teach us. On a small island off the southern coast of Maine, Thomas D. Seeley, a biologist at Cornell University, has been studying how colonies of honeybees (*Apis mellifera*) choose a new home. In late spring, when a hive gets too crowded, a colony normally splits. The queen, some drones,⁴ and about half the workers migrate a short distance to cluster on a tree branch, while a small number of scouts go searching for a new site for the colony.

[M] To find out how, Seeley's team put out five nest boxes - four that weren't quite big enough and one that was just about perfect - and released a colony of bees. Scout bees soon appeared at all five boxes. When they returned to the main group, each scout performed a waggle dance urging other scouts to go have a look. These dances include a code giving directions to a box's location; the strength of each dance reflected the scout's enthusiasm for the site.

[N] The decisive moment didn't take place in the main cluster of bees, but out at the boxes, where scouts were building up. As soon as the number of scouts visible near the entrance to a box reached about 15 - a threshold confirmed by other experiments - the bees at that box sensed that a quorum⁵ had been reached, and they returned to the swarm with the news. "It was a race," Seeley says. "Which site was going to build up 15 bees first?"

[O] Scouts from the chosen box then spread through the swarm, signaling that it was time to move. Once all the bees had warmed up, they lifted off to secure their new home. To no one's surprise, it turned out to be the best of the five boxes. The bees' rules for decision-making - seek a diversity of options, encourage a free competition among ideas, and use an effective mechanism to narrow choices - so impressed Seeley that he now uses them at Cornell as chairman of his department.

[P] "I've applied what I've learned from the bees to run faculty meetings," he says. He wants to avoid going into a meeting with his mind made up, hearing only what he wants to hear, and pressuring people to conform. Therefore, Seeley asks his group to identify all the possibilities, discuss their ideas for a while, and then vote by secret ballot.⁶ "It's exactly what the swarm bees do, which gives a group time to let the best ideas emerge and win."

[Q] In fact, almost any group that follows the bees' rules will make itself smarter, says James Surowiecki, author of *The Wisdom of Crowds*. "The analogy is really quite powerful: The bees are predicting which nest site will be best, and humans can do the same thing, even in the face of exceptionally complex decisions." Investors in the stock market, scientists on a research project, even kids at a county fair guessing the number of beans in a jar can be smart groups, he says. That is, if their members are diverse, independent-minded, and use a mechanism such as voting, auctioning, or averaging to reach a collective, aggregate decision.

[R] That's the wonderful appeal of swarm intelligence. Whether we're talking about ants, bees, or humans, the ingredients of smart group behavior - decentralized control, response to local cues, simple rules of thumb - add up to an effective strategy to cope with complexity.

[S] Consider the way an Internet search engine like Google uses group smarts to find what you're looking for. When you type in a search query, the engine surveys billions of Web pages on its index servers to identify the most relevant ones. It then ranks them by the number of pages that link to them, counting links as votes. The most popular sites get weighted votes⁷ since they're more likely to be reliable, and the pages that receive the most votes are listed first in the search results.

[T] With free collaborative encyclopedias available to anyone online, "it's now possible for huge numbers of people to think together in ways we never imagined a few decades ago," says Thomas Malone of Massachusetts Institute of Technology (MIT) Center for Collective Intelligence. "No single person knows everything that's needed to deal with problems we face as a society, such as health care or climate change, but collectively we know far more than we've been able to tap⁸ so far."

[U] Such thoughts underline an important truth about collective intelligence: Crowds are wise only if individual members act responsibly and make their own decisions. A group won't be smart if its members imitate one another, unthinkingly follow fads, or wait for someone to tell them what to do. When a group is being intelligent, whether it's made up of ants or attorneys,⁹ it relies on its members to do their own part. For those of us who sometimes wonder if it's really worth recycling that extra bottle to lighten our impact on the planet, the fact is that our actions matter, even if we don't see how.

[V] "A honeybee never sees the big picture any more than you or I do," says Thomas D. Seeley, the bee expert. "None of us knows what society as a whole needs, but we look around and say, oh, they need someone to volunteer at school, or mow the church lawn, or help in a political campaign." If you're looking for a role model in a world of complexity, you could do worse than to imitate an ant or a bee.

¹ If something is **epic**, it is very large or grand.

² People or animals that are **inept** are awkward, clumsy, or unable to do things.

³ A **permutation** is one of the ways in which a number of things can be ordered or arranged.

⁴ A **drone** is a male bee that does not work but can fertilize the queen. The term can also be used to describe one who performs menial or tedious work.

⁵ A **quorum** is the minimum number of members required to be present in a meeting before any business can be transacted.

⁶ A **ballot** occurs when people select a representative or course of action by voting.

⁷ **Weighted voting** systems are voting systems based on the idea that not all voters are equal.

⁸ When we **tap** something, like a resource, we access and use it.

⁹ **Attorneys** is another term used for lawyers.

- _____ 1. What does biologist Deborah M. Gordon mean when she says, *"If you watch an ant try to accomplish something, you'll be impressed by how inept it is"*?
- a. Each ant is able to build a nest all by itself.
 - b. Ants are impressive to watch in a colony.
 - c. A single ant knows exactly what to do next.
 - d. On their own, individual ants are not very capable.
- _____ 2. Which is the best definition of *pheromone* in paragraph I?
- a. a substance used mostly by Argentine ants
 - b. a chemical signal that is recognized by others
 - c. a gas that has a very strong smell
 - d. a computer software program to study ants
- _____ 3. Which field is NOT mentioned as having adopted the idea of swarm intelligence?
- a. the choosing of construction sites
 - b. the delivery of industrial gases
 - c. the creation of airline schedules
 - d. the improvement of telephone networks
- _____ 4. Which of these happens first when a bee colony gets too crowded?
- a. about 15 bees gather at one location
 - b. bees spread the message with directions to the new hive
 - c. scouts search for a suitable new nest
 - d. bees dance to tell about sites they've found
- _____ 5. How does Google use swarm intelligence?
- a. by searching for the most frequently linked sites
 - b. by asking users to refine their search strategies
 - c. by consulting the list of websites you access often
 - d. by focusing on sites used by people at MIT
- _____ 6. The following sentence would be best placed at the end of which paragraph?
- Seeley reports that faculty members are more likely to contribute constructive ideas under the new system.*
- a. at the start of paragraph B
 - b. at the end of paragraph F
 - c. at the end of paragraph P
 - d. at the start of paragraph T
- _____ 7. Which opinion is the author most likely to agree with?
- a. Ants are confident because they know what they are doing.
 - b. Ants are capable of achieving amazing things as a group.
 - c. Ants are highly intelligent creatures and skilled architects.
 - d. Ant colonies rely on their queen to help them solve problems.
- _____ 8. Based on the information in paragraph Q, what can we infer about James Surowiecki's opinion on bees?
- a. Humans and bees are too different to be compared.
 - b. Bees' rules only work for simple decisions.
 - c. Bees make smart groups because they are like-minded.
 - d. Crowds that copy bee behavior will make better decisions.

- ____ 9. What is the main idea of paragraph U?
- a. Strong leadership is essential for attorneys.
 - b. People often follow fads by imitating others.
 - c. There is a need for effective management of recycling.
 - d. Individual participation is important for group intelligence.
- ____ 10. In paragraph V, which of the following does Thomas D. Seeley imply?
- a. Everyone should do their part to help, even if it seems very small.
 - b. It's important to understand the big picture before starting any task.
 - c. Human society is much more complex than an ant or bee colony.
 - d. The worst thing to do would be to imitate an ant or a bee.

DIRECTIONS: Complete the sentences. Choose the correct word.

- a. aggregate
- b. code
- c. coherent
- d. criteria
- e. faculty
- f. imitate
- g. index
- h. procedure
- i. protocol
- j. territory

- ____ 11. If something is _____, it is clear, sensible, and well-planned.
- ____ 12. A(n) _____ is an area that is defended by animals against others of the same species.
- ____ 13. A(n) _____ is a set of rules about the correct way to act in formal situations, for example, when meeting the President or the King.
- ____ 14. _____ are factors based on which you judge or decide something.
- ____ 15. The computer program has a unique _____ that tells it how to react to spoken orders.
- ____ 16. If you follow the standard claim _____ explained in the manual, you'll be able to get a full refund.
- ____ 17. A(n) _____ is a department or group of departments in a university.
- ____ 18. A(n) _____ amount or score is made up of smaller amounts or scores added up together.
- ____ 19. A(n) _____ is a list of items arranged in alphabetical order.
- ____ 20. If you _____ someone, you copy what they do.

Reading Explorer 5 Unit 8 Lesson A

Answer Section

1. ANS: D PTS: 1 REF: Pages 161-164
OBJ: Paraphrase TOP: Social Behavior
2. ANS: B PTS: 1 REF: Pages 161-164
OBJ: Unfamiliar Vocabulary TOP: Social Behavior
3. ANS: A PTS: 1 REF: Pages 161-164
OBJ: Negative Detail TOP: Social Behavior
4. ANS: C PTS: 1 REF: Pages 161-164
OBJ: Sequence TOP: Social Behavior
5. ANS: A PTS: 1 REF: Pages 161-164
OBJ: Supporting Detail TOP: Social Behavior
6. ANS: C PTS: 1 REF: Pages 161-164
OBJ: Cohesion TOP: Social Behavior
7. ANS: B PTS: 1 REF: Page 167 OBJ: Making Inferences
TOP: Social Behavior
8. ANS: D PTS: 1 REF: Page 167 OBJ: Making Inferences
TOP: Social Behavior
9. ANS: D PTS: 1 REF: Pages 161-164
OBJ: Main Idea TOP: Social Behavior
10. ANS: A PTS: 1 REF: Page 167 OBJ: Making Inferences
TOP: Social Behavior
11. ANS: C PTS: 1 REF: Page 168 OBJ: Vocabulary
TOP: Social Behavior
12. ANS: J PTS: 1 REF: Page 168 OBJ: Vocabulary
TOP: Social Behavior
13. ANS: I PTS: 1 REF: Page 168 OBJ: Vocabulary
TOP: Social Behavior
14. ANS: D PTS: 1 REF: Page 168 OBJ: Vocabulary
TOP: Social Behavior
15. ANS: B PTS: 1 REF: Page 168 OBJ: Vocabulary
TOP: Social Behavior
16. ANS: H PTS: 1 REF: Page 168 OBJ: Vocabulary
TOP: Social Behavior
17. ANS: E PTS: 1 REF: Page 168 OBJ: Vocabulary
TOP: Social Behavior
18. ANS: A PTS: 1 REF: Page 168 OBJ: Vocabulary
TOP: Social Behavior
19. ANS: G PTS: 1 REF: Page 168 OBJ: Vocabulary
TOP: Social Behavior
20. ANS: F PTS: 1 REF: Page 168 OBJ: Vocabulary
TOP: Social Behavior