

# Honey Bee Network

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## *Outreach Activity*

### **I. Overview**

This is a game that attempts to model the basic principles of division of labor—the idea that if a complicated task is divided into steps for different individuals to specialize on, the whole task will go more smoothly than if every individual tried to perform all the steps. Some students will model the foragers in a honey bee colony, helping to detect pictures of different food sources on environment cards. Other students will model solitary bees, looking for all of those resources themselves. Students will evaluate who is faster at this task, and speculate about who would be faster in different situations. For interested students, this activity could be related to how the brain works—different types of neurons are responsible for detecting and responding to different stimuli, and this cooperation of the network allows more complicated computation to be performed.

### **II. Learning Objectives**

- Honey bee colonies need to collect several different types of resources to survive; foragers are responsible for finding and collecting those resources.
- Honey bee foragers can communicate to each other that they have found a resource (through the dance language).
- In many biological contexts, complex tasks are handled by groups through specialization—individuals within the groups each efficiently perform a single step of the task.
  - This is true for bees, when the environment is complex and resources are widely scattered.
  - This is also true of neurons in the nervous systems of almost all species.

### **III. Adaptations/Accommodations**

If there is extra time, or if students are very engaged, help them brainstorm how this activity might relate to neurons in the brain. Pick a “simple” act like seeing a flower, or hearing a word, and help them think of what different tasks neurons might specialize on to contribute to that function of the brain.

If some students aren’t comfortable reading the instructions on the card, it will be really important to have a demonstrator group to a practice round before starting (but after all the groups are assembled and have their role cards). Have each student in the demonstrator group hold up their card, so other student will know which demonstrator to watch. Go through the practice slowly, giving time to ask questions. Then let all the groups do a practice round before recording data.

## IV. Timeframe for activity

15-20 minutes

## V. Advance prep and materials

### Activity: Honey Bee Network

#### Materials:

- Role cards (sets of 5 for each 5 students), extra solitary bee cards
- Scenery cards (xx)
- Results sheet and pen/pencil

#### Preparation:

- Order scenery cards according to the small numbers on the back, so that they can easily be held up in the correct order. Keep them face down for now.
- Make sure that the role cards are present and bundled correctly, in sets of 5, with one card for each role per bundle.

## VI. Resources and references

### Facilitator resources

- <http://neuron.illinois.edu/>

## VII. Activity Implementation

### Main Activity

Before beginning, get the attention of all the students in order to discuss the activity and give instructions. Ask about what types of jobs bees do—you may get several responses, hopefully including foraging, visiting flowers, collecting nectar, etc. If you don't get any responses like this, you can prompt them by asking questions:

- What do bees eat?
- What is honey made of?
- How do bees get the nectar to make honey?
- Do you think that bees eat anything besides honey?
- Do bees need to drink water?

Explain that honey bees have many foragers, all collecting different types of resources. Ask students for some reasons why bees might focus on looking for one type of food at a time. Say that the activity will

help show why it's sometimes better, when working in a group, for everyone to work independently, and sometimes better to divide up tasks.

Now have students get ready to do that activity. Have them get together in groups of 5, and hand each group a role card bundle. Students not in a group can have solitary bee cards. Instruct each student to pick a card, and read it to learn about their role. Make sure each student understands their card; provide a chance to ask questions.

- Nectar forager: Stand to the left of the recruit bee, facing the activity leader. Look for the blue flowers in the scenery. If blue flowers are present, as quickly as possible (but gently!) touch the recruit bee's hand.
- Pollen forager: Stand to the right of the recruit bee, facing the activity leader. Look for the yellow flowers in the scenery. If yellow flowers are present, as quickly as possible (but gently!) touch the recruit bee's hand.
- Water forager: Stand in front of the recruit bee, facing the activity leader as much as possible. Look for the pond in the scenery. If the pond is present, as quickly as possible (but gently!) touch the recruit bee's back.
- Recruit bee: Stand in between the foragers, facing AWAY from the activity leader. When three simultaneous touches are felt (one on each hand, one on the back), all three resources are present; as quickly as possible, yell "forage!"
- Solitary bee: Stand slightly apart from the other bees. Look for blue flowers, yellow flowers, and a pond all present in the same scenery. If all are present, yell "forage!"

Pick a group that seems comfortable with their cards, and ask them to demonstrate. Ask all the students to raise their hand as they hear the name of their role; slowly say each role's name, and make sure that each group has one bee of each kind.

Tell the demonstrator group to get ready, make sure they are in position, and then hold up practice card one. The pollen forager and water foragers should touch the recruit forager, but no one else in the group should act. Then hold up practice card two; this time all three foragers should touch the recruit bee, who should yell "forage!" The solitary bee should also yell "forage!" If students make errors on either practice card, review the rules and have them try it again.

Next, have all the groups get ready and make sure they are in position. Hold up practice card three. This time, the pollen and nectar foragers should respond. Then hold up practice card four; again, all bees should respond to this card. Make sure everyone understands the rules and is comfortable with what they should be doing.

Tell the students that you will now switch to real cards, some of which may be more complicated than the practice cards. Tell them to look carefully and only respond if they are sure they see what they are looking for. Cycle through the rest of the cards. The table below shows what reaction should occur for each card. For the cards where students correctly yell "forage!", record on your results sheet whether the network or the solitary bee was faster.

Regardless of what happens as students go through the activity, try to bring the discussion afterward back to the idea of division of labor, and when it is helpful or not.

- Solitary bees will probably be faster in the practice rounds, once students understand the task. They may also be faster in all the other rounds, if those go well and the sceneries are too simple for the students. Ask students:
  - On what rounds were the solitary bees faster?
  - Why were the solitary bees faster?
  - What is the cost of division of labor, or having individuals specialize on different tasks?
  - What could have made it harder for the solitary bees? Would the same changes have made it easier for the bee network?
- For the complicated sceneries, the bee network may actually be faster. Ask students:
  - On what rounds were the bee networks faster?
  - Why were the networks faster?
  - What made it harder for the solitary bees? What changes could have made it easier for them?
- Students may also simply get confused about the rules, forgetting to respond, responding incorrectly, or responding when it's not appropriate.
  - Point out that animals in the wild can also make mistakes. What are some mistakes bees might make, in foraging or communicating with nestmates?
  - What might be some consequences to those mistakes?
  - What different types of mistakes might bee colonies (networks) makes? What mistakes might solitary bees make?
- Remind students that in a real environment, there would be a different challenge associated with timing—flowers are scattered widely, and bees may have to fly far and hunt carefully to find good ones. Not all flowers are the same—some have better nectar or pollen, or more of it, than others.
- How do real honey bees communicate about resources inside the hive?
  - Discuss the dance language: honey bee foragers perform a “waggle dance”, which looks like running in a figure 8 pattern on the honey comb. As they run along the center stroke of the “8”, bees waggle their abdomen back and forth. The angle of the run during this waggle, relative to straight up the comb, shows the direction to the resource relative to the sun. The length of the waggle run indicates the distance flown to the resource. The number of cycles of the dance performed indicates how good the resource is.
  - Ask the students who have already seen the video what the dance looked like, or remind those who haven't to look for it when it's their turn to view the video.
- How might the neurons in the brain be like the bees in the network?
  - What types of tasks does the brain have to do?
  - What might be some specializations that individual neurons have to contribute to those tasks?

As the activity comes to an end, let students record the results into their own booklet if they can't remember what happened.