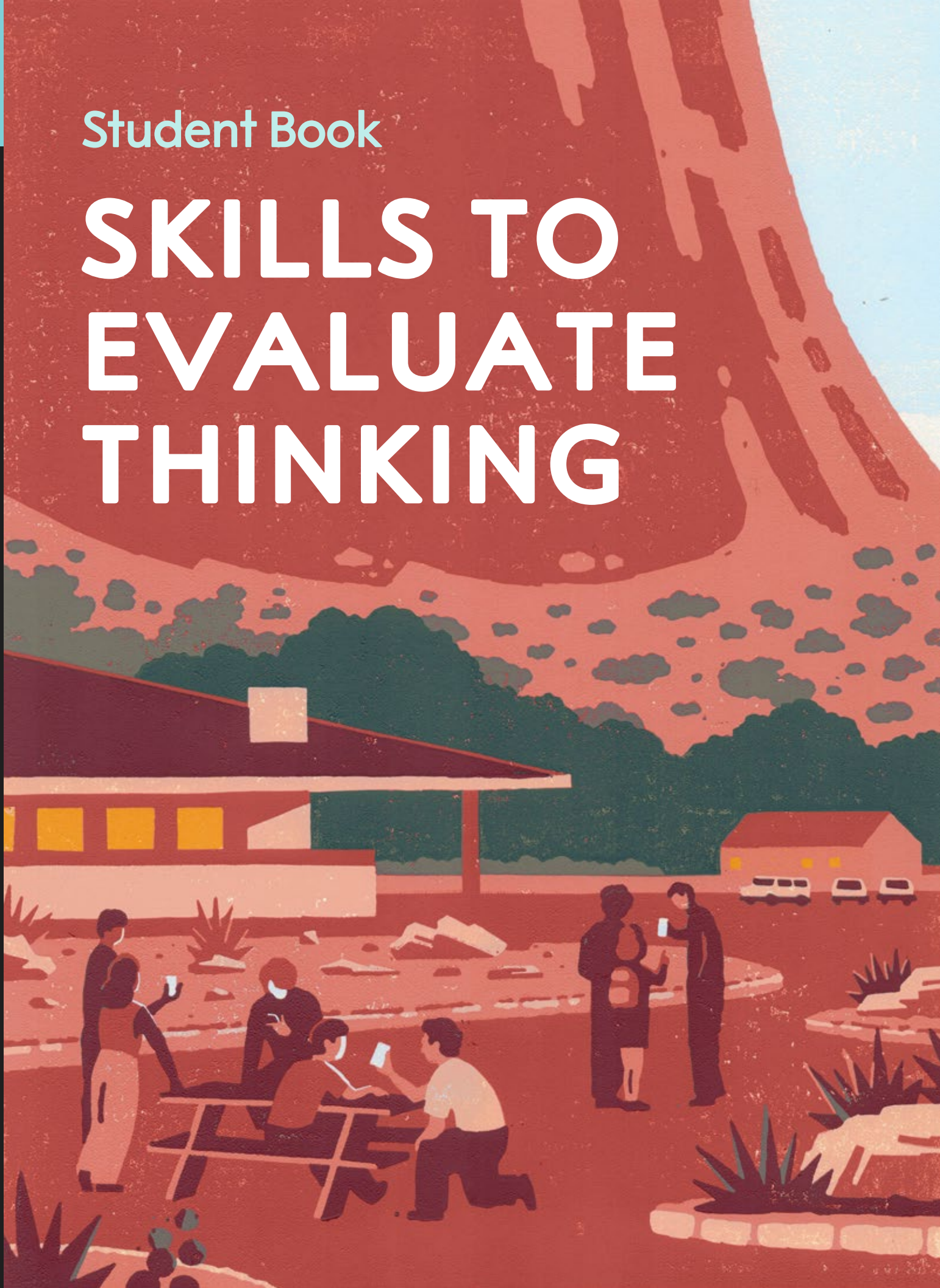


Student Book

SKILLS TO EVALUATE THINKING



This book is part of the *Scientific Thinking for All: A Toolkit* curriculum that is a high school adaptation of the University of California, Berkeley, “Big Ideas” course titled Sense and Sensibility and Science <https://sensibility.berkeley.edu/>. It was developed by professors Saul Perlmutter, John Campbell, and Robert MacCoun and represents a collaboration among physics, philosophy, and psychology. *Scientific Thinking for All: A Toolkit* was developed by curriculum developers and researchers at The Lawrence Hall of Science, University of California. The initiative is a cooperation between Nobel Prize Outreach (NPO) and Saul Perlmutter. This work is supported by a consortium of funders including Kenneth C. Griffin, the William and Flora Hewlett Foundation, the John D. and Catherine T. MacArthur Foundation, the Gordon and Betty Moore Foundation, and The Rockefeller Foundation.

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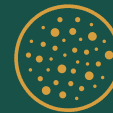
otherwise

TOOL ICONOGRAPHY

DOT Stockholm

COVER ILLUSTRATION

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Scientific Thinking
For All : A Toolkit

UNIT 5

Skills to
Evaluate Thinking
v1.0 AUG 2026

STUDENT BOOK



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THE LAWRENCE HALL OF SCIENCE
University of California, Berkeley
Berkeley, CA 94720-5200

DEAR STUDENT,

Have you ever read a news article and wondered if the information it contained was true? Or had a friend make a claim and wondered if they were right? This curriculum will equip you with ideas and techniques from science that can be applied to everyday life. Your conceptual toolkit will include strategies to help you evaluate information, reflect on your thinking, and make more informed decisions. You will use these tools to ask questions, brainstorm ideas, interpret data, manage trade-offs, and develop solutions.

Scientific tools and techniques can lead to a better understanding of how the natural world works and provide approaches to solving the problems facing individuals, communities, and the environment. Each unit will provide you with additional conceptual tools for your toolkit, and you'll practice applying them to personal and societal issues such as human health, environmental pollution, and energy use. For example, you may consider questions such as: *How much sleep do I need? Is my community's drinking water safe?*

Science offers many useful strategies for learning about the world, including:

- ① working together to share observations, questions, and ideas;
- ② techniques for making sense of observations and data; and
- ③ the iteration of ideas by modifying them as new information becomes available.

Since it's difficult for anyone to catch their own mistakes, you'll collaborate with your classmates to share your thinking and learn from one another. It is our hope that this science toolkit will empower you to think more clearly about the things you care about, to provide you with strategies for addressing problems, and to help you achieve your personal goals.

Sincerely,

Scientific Thinking for All Program Team

UNIT 5: SKILLS TO EVALUATE THINKING

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Skills to Evaluate Thinking

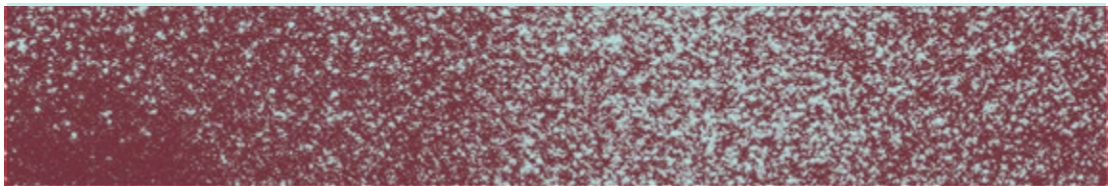
UNIT 5

SKILLS TO EVALUATE THINKING

In this unit, you will learn and practice skills to help you think about information you encounter in your life, such as online information, social media posts, scientific investigations, and everyday situations. You will explore the role of slow thinking when investigating issues related to the social confusion about a disease outbreak. You will practice skills to help determine if a conclusion that is drawn is based on appropriate evidence and reasoning. You will explore different types of thinking, such as cognitive shortcuts and cognitive biases, including confirmation bias. You will consider the impact of these types of cognition on health decisions for individuals, scientific research, and society. You will practice evaluating evidence with an actively open mindset, which can reduce errors from fast thinking and cognitive biases when making conclusions.

UNIT DRIVING QUESTION

**How can people
evaluate their
thinking about
everyday issues,
such as health
and disease?**



CONCEPTUAL TOOLS

In this course, conceptual tools refer to scientific ideas and approaches that can be applied to real-world situations. Each conceptual tool is further explained in the activity in which it is introduced. The conceptual tools found in this unit are shown here and in each activity in which they appear.



Slow Thinking



Cognitive Shortcuts and Biases



Credible Sources



Confirmation Bias



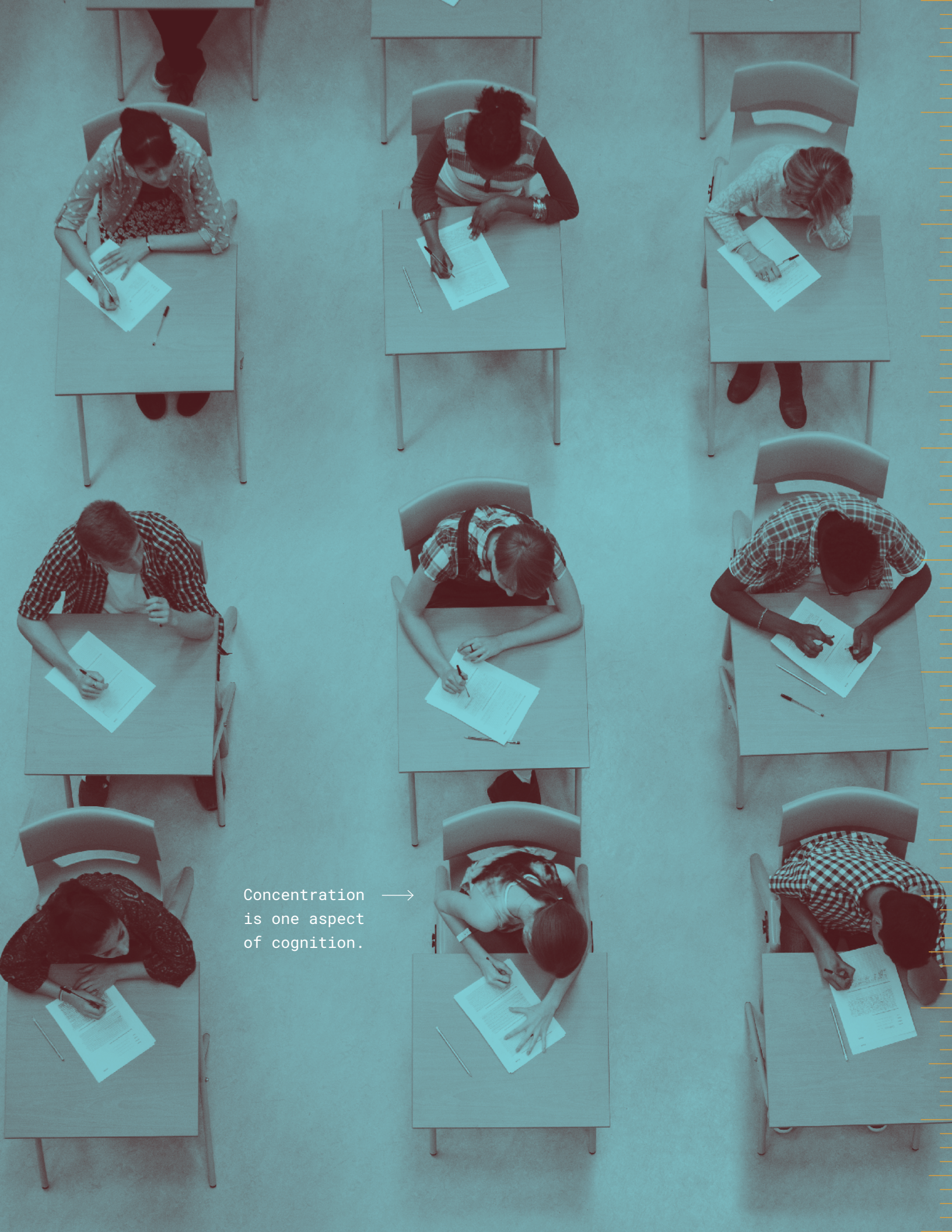
Actively Open Mindset



ACTIVITY 1

Types of Cognition

INVESTIGATION



Concentration →
is one aspect
of cognition.



1 : TYPES OF COGNITION

GUIDING QUESTION

What are two different modes of thinking?

INTRODUCTION

Society often sends mixed messages regarding how people should think. On one hand, movies and social media make trusting your gut look like a superpower. You may hear stories about people such as Thomas Edison or Rosalind Franklin having a sudden *aha!* moment that led to new discoveries. But then you go to school, and the advice flips. You may be told to slow down, double-check your facts, and think everything through as carefully as possible. **Cognition** is the set of mental processes that people use to interpret, imagine, and reason. Cognition helps us learn, draw conclusions, solve problems, and make decisions. In this activity, you will explore two different modes of cognition.

FRONTAL LOBE

Planning and decisions
Focus and attention
Reasoning
Personality
Motor control

TEMPORAL LOBE

Hearing
Memory
Language and speech
Object recognition



PARIETAL LOBE

Spatial awareness
Navigation
Touch and body senses

OCCIPITAL LOBE

Visual processing
Color and shape perception

CEREBELLUM

Balance and coordination
Motor learning (muscle memory)

FIGURE 1.1

Various aspects of cognition occur in different areas of the brain.

CONCEPTUAL TOOLS



MATERIALS LIST

FOR EACH STUDENT

STUDENT SHEET 1.1
"Brain Teasers"

PROCEDURE

- 1 Your teacher will provide you with Student Sheet 1.1, "Brain Teasers." Complete the questions on your own as quickly as you can.
- 2 With your partner, slowly work through all the questions together. Revise your answers as needed and record why you changed your mind. Keep the original answers so you can see which ones were revised.
- 3 Your teacher will provide the answers to all the questions. Check your answers.
- 4 With your partner, discuss which questions were easiest to make a mistake when answering and why. Share your ideas with the class.
- 5 People use different ways of thinking to evaluate information and to reach conclusions. It is likely you used the following two different modes of cognition while answering the questions.

Fast thinking is quick, automatic thinking that uses shortcuts to reach conclusions.

Slow thinking is careful, reflective thinking that uses reasoning to reach conclusions.

With your partner, identify one brain-teaser question when you used fast thinking and one question when you used slow thinking to answer it.

- 6 Share your ideas from Step 5 with the class.
- 7 Each thinking mode, fast and slow, has different characteristics. Read the information in Table 1.1 on the following page that describes the differences.

TABLE 1.1

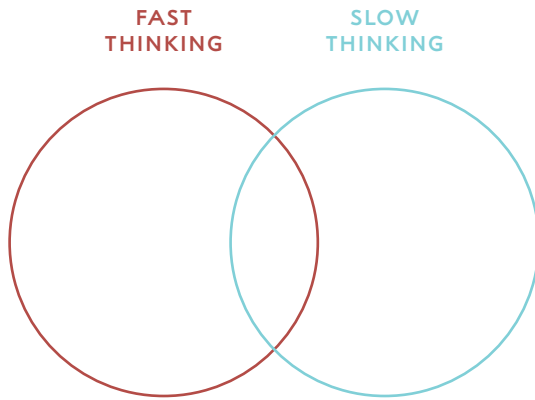
Characteristics of Fast Thinking vs. Slow Thinking

FAST THINKING	SLOW THINKING
Jumps to conclusions Relies on: • simple information. • information that first catches one's attention. • information that comes easily to mind.	Double-checks reasoning Considers: • complex information. • math or reasoning steps. • the likelihood of an event. • alternative possible causes.

- 8 Choose your favorite brain-teaser question.
 - a Using the characteristics from Table 1.1, explain how fast thinking could lead to the wrong answer for that question.
 - b Then explain how the slow-thinking characteristic(s) could lead to the correct answer.
- 9 Share your examples from Step 8 with the class. Then provide some additional examples from your everyday life that use fast, slow, or both kinds of thinking. Discuss the examples and how the mode of cognition may have impacted the outcome for those examples.

BUILD UNDERSTANDING

- ① Make a Venn diagram like the one below. Fill out the areas in the circles to compare and contrast fast thinking and slow thinking. Consider the features of each mode of thinking, the advantages and disadvantages of each, and situations in which each is useful.



The Build Understanding and Connections to Everyday Life items are intended to guide your understanding. Some of these items may be discussed with a partner, be part of a class discussion, or require an individual written response. Your teacher will guide you as to how these items will be used in your class.

- ② Which would be more useful to apply in the following situations: fast thinking and/or slow thinking? Explain your reasoning.
- a Choosing what to eat for breakfast.
 - b Responding to a fire alarm that goes off in your classroom.
 - c Changing your diet to improve your health.
 - d Communicating to the coach what has happened when a teammate gets hurt.
 - e Deciding who to vote for in the class election.
 - f Providing directions to a location that you are very familiar with.
 - g Responding to a common question such as, *What's your favorite movie?*
- ③ Imagine that an emergency responder comes upon a scene where someone has been badly hurt. Think about the knowledge, skills, and experience the emergency responder has. How would the responder's fast thinking be different from an ordinary person's fast thinking?

CONNECTIONS TO EVERYDAY LIFE

- ④ You are meeting friends downtown. The fastest way for you to get there is on your bike, but your bike lock is broken. Your only other option is to walk, which will take much longer. You have recently seen a news headline that states: *The City Experienced a 300% Increase in Bicycle Thefts Last Month!*
- a What would you be most likely to do? Explain your reasoning.
 - b You later find out that the average number of stolen bikes in the city was 1 per month, but there were 4 bikes stolen in the previous month—a 300% increase. How would this information change, or not change, your behavior?
 - c Was your decision affected by fast thinking and/or slow thinking? Explain.



← School bike rack

- ⑤ Describe a recent example when you used fast thinking but would have been better served by using slow thinking. How could slow thinking have changed the outcome?

EXTENSION

Have a friend or family member solve the brain teasers on Student Sheet 1.1. Evaluate which thinking strategies they used.

KEY SCIENTIFIC TERMS

cognition

fast thinking

slow thinking



ACTIVITY 2

Thinking About Thinking

DISCUSSION

NEWS

BUSINESS NEWS

High exchange rate, high inflation and low growth. The epidemic, which affected the whole world, also affected the economy. It is possible to experience economic crises during the pandemic period. By taking precautions, the primary goal should be to overcome the epidemic period in the highest way. This epidemic has affected the economies of all countries of the world.



The pandemic process caused the economic and social order to slow down.

High exchange rate, high inflation and low growth.

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NEWS

Have you ever had a strong response to a media headline?





2 : THINKING ABOUT THINKING

GUIDING QUESTION

How do people use fast thinking and slow thinking in everyday situations?

INTRODUCTION

Imagine someone getting seriously hurt during a sports game and needing immediate care. The situation may depend on the knowledge and actions of first responders. In an emergency, healthcare professionals often have to balance fast thinking and slow thinking. Neither approach is perfect on its own. Instead, the goal is to find a middle ground between making a snap judgment and overthinking a situation. In a similar way, people make choices every day about how to evaluate information. In this activity, you will investigate the use of cognition in a fictional scenario about a disease outbreak.

If you need to review the concept of infectious and noninfectious disease, you will find a Science Review at the end of this activity.



First responders rely on both fast and slow thinking.

CONCEPTUAL
TOOLS



MATERIALS LIST

FOR EACH GROUP OF
FOUR STUDENTS

— SET OF 8 MEDIA
STORIES CARDS

FOR EACH STUDENT

— STUDENT SHEET 2.1
“Responding to
Media Headlines”

— STUDENT SHEET 2.2
“Analyzing Media”

PROCEDURE

PART A: SOUTHSAND NEWS HEADLINES

- 1 Read the following fictional scenario.

Southsand City has had a sudden increase in cases of respiratory illness in the community. There have been many hospitalizations and several unexpected deaths. Some people assume it is an outbreak of a bad flu, but health officials suspect it is a new disease. Rumors are spreading in the community based on stories from local media outlets. Many sources have started calling the illness the Southsand fever, and people are worried about getting sick.

- 2 Imagine you are a resident of Southsand City and see the following media headlines. Read each headline and decide if you would click for more information, repost/share, or ignore the headline. Record your responses on Student Sheet 2.1, “Responding to Media Headlines.”

Phoenix-area residents are now in the peak months for Valley fever infection, and new federal data confirm the threat is... Mortality W... as Valley fe... Maricopa C... is the high... making this... stretch of the year... — a 42 percent... News Today tr... 22,244 in 2024... Being M... is happ... southwe... historica... likely to consider Valley fever as a possible... limited. The... population g... and climate... heavy r... anyone... Its earl... mimic... that pat... or months before the... the United States is... Who Is at Risk and... certain groups are at... Filipino (due... or a weaken... recreation in... landscapers... ATVs, n... to perso... percenta... coccidio... mycosis, a severe form in which the fungus spreads from the lungs to bones, joints, skin, or the brain, causing fungal meningitis that can be fatal even with treatment. Phoenix-area residents who...

HOSPITAL OVERWHELMED!!!
Fever Likely To Be the End of Southsand City

24% Spike in Southsand Fever Follows Wind Festival Event, Say Festival Goers

Lemon Water Proven to Kill Bacteria and Fight Off Southsand Fever

“Neighbors Helping Neighbors”
Volunteer Network Delivers Millions of Groceries to Southsand Fever Families

So-Called “Experts” Blame Southsand Fever Surge on Both Rainfall and Drought

Health Officials Identify Southsand Fever as Infectious and Map Cases

“Don’t breathe on me!”
Local Man Demands Masks After Roommate Contracts Southsand Fever

Differential Diagnostic Tests Confirm Absence of Typical Infectious Disease Markers in Southsand Cohorts

- 3 In your group, share your responses to Student Sheet 2.1 and discuss why you responded as you did. Make sure to address the role of fast thinking and/or slow thinking. Remember to listen to and discuss the ideas of other group members. If you disagree with others in your group, explain why you disagree.
- 4 Slowly reread each headline and work with your group to identify the tone of each media story (not the news itself) as positive, negative, or neutral. Record the group's ideas in the second column on Student Sheet 2.2, "Analyzing Media."
- 5 As an individual, rate how believable the idea about Southsland fever is in the headlines, using a scale of 1–3 where:
 - 1 is believable
 - 2 is somewhat believable
 - 3 is not believable
 Record your responses in the third column of Student Sheet 2.2.
- 6 In your group, discuss what made each headline more believable or less believable, including its tone (positive, negative, or neutral).
- 7 Research studies show that people judge negative headlines faster than neutral ones and that negative headlines are more likely to be clicked on and shared. Look back at your responses on Student Sheets 2.1 and 2.2 and compare this finding with (a) your experience in this activity, and (b) in your everyday life.
- 8 Share your ideas with the class.

PART B: SOUTHSAND NEWS ARTICLES AND POSTS

- 9 Carefully read the fictional Media Stories cards, which include headlines from Part A, sources, and the beginning of each news article or post.
- 10 Using the additional information from the Media Stories cards, reconsider what makes each story more believable or less believable. Then, complete the last two columns of Student Sheet 2.2.
- 11 With your group, review your responses on Student Sheet 2.2 and discuss:
 - how your ratings of the believability of each story did or did not change.
 - the role that fast thinking and/or slow thinking played in interpreting the headlines and stories.
- 12 Share your ideas from Step 11 with the class.
- 13 Discuss the role of metacognition in consuming media. **Metacognition** is the practice of thinking about one's own thinking. Use the following questions to guide the discussion about how you were thinking during the activity and in your everyday life:
 - Were you aware of when you used fast thinking and/or slow thinking?
 - Does social media lend itself more to slow thinking or fast thinking? Why?
 - How can metacognition change how you respond to media stories?

BUILD UNDERSTANDING

- ① Imagine that Southsand City resident Lumi is walking her dog along a crowded sidewalk. She sees a person coming toward her who is about to sneeze. As the person approaches to pass her, Lumi can tell that the person is not planning on covering their mouth and nose as they sneeze. Lumi is not sure how Southsand fever actually spreads, but she does not want to get the disease.
 - a If you were Lumi, what would you do?
 - b Would your response be a result of fast thinking and/or slow thinking?
 - c How might your actions be different if you relied solely on fast thinking or solely on slow thinking?
- ② Imagine going online and reading the following post. Do you think most people would believe this post? Explain why or why not. Be sure to use ideas about cognition in your response.



@Juniorrr

April 5

PEOPLE! Green juice can cure your flu! I heard about this from my favorite influencer @DrWellnessGuru. His most recent video states that the fruits and vegetables in Green Juice activate the immune system. My friend drank a glass of green juice and felt better right away. It must work!



- ③ A friend claims that fast thinking is not as useful as slow thinking. Do you agree or disagree? Provide an example(s) to support your reasoning.

CONNECTIONS TO EVERYDAY LIFE

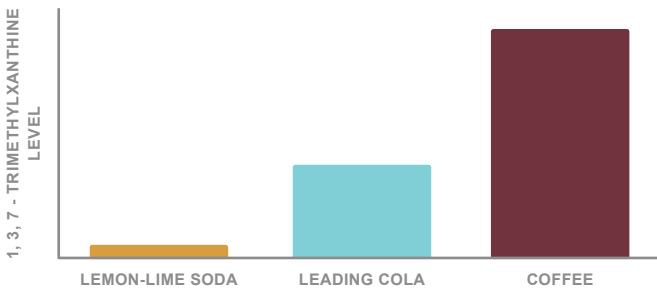
- ④ Imagine someone sees the following photo. They conclude, “The white object in the photo is a UFO! I know that shape. It looks exactly like the flying saucers I’ve seen in movies and pictures.” How is this an example of fast thinking?



- ⑤ Misinformation is false, inaccurate, or misleading information, and it is often spread by people who think it is true. The following post shows an example of misinformation. Do you think misinformation is more likely to be spread as a result of fast thinking or slow thinking? Explain your reasoning using the post as an example.

**@HealthTruthNow**
Official Source for Wellness Facts!

WARNING: Is your coffee TOXIC?
Shocking new research reveals a hidden danger in your daily cup!



Drink	1,3,7-Trimethylxanthine Level
LEMON-LIME SODA	Low
LEADING COLA	Medium
COFFEE	High

Industry won't tell you, but toxin levels in coffee are HIGHER than in sodas! Don't be a victim! Tap the TRUTH! #CoffeeScam #Detox #HealthAlert

 78.9K Likes  1.2K Shares  257 Comments

 I knew it. Sharing this now.
 Umm... that chemical in the graph is just caffeine.

KEY SCIENTIFIC TERMS

metacognition

SCIENCE REVIEW

Infectious and Noninfectious Diseases

A disease is a disorder of structure or function in an organism. An *organism* is an individual animal, plant, or other living life-form. Unlike an injury, diseases are not caused by direct physical harm (such as a bruise or a cut). Diseases produce specific symptoms depending on the molecules, cells, and organs in the body that they affect. Diseases are generally grouped into two main categories: infectious and noninfectious.

A disease is considered an *infectious disease* if it can pass from one organism to another. These could be the same organism, as in person-to-person transmission, or from one type to another, such as from an insect to a plant.

In contrast, a *noninfectious* disease cannot be passed from one organism to another organism. These include deficiency diseases caused by a lack of nutrients in someone's diet (such as minerals or vitamins), hereditary diseases, and physiological diseases (such as asthma or heart disease that result from lifestyle or environmental factors). However, many diseases do not fit neatly into just one of these categories. For example, some cancers are linked to both hereditary and physiological factors.



ACTIVITY 3

Cognitive Shortcuts

INVESTIGATION



A shortcut heading to the
right of the main road.



3 : COGNITIVE SHORTCUTS

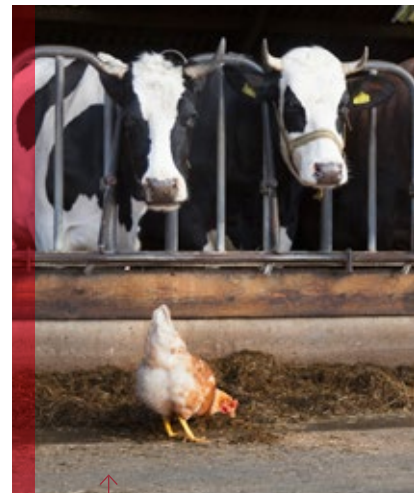
GUIDING QUESTION

How do people avoid errors from cognitive shortcuts?

INTRODUCTION

Fast thinking is sometimes called “jumping to conclusions” because it skips the steps of careful evaluation of information. While fast thinking is useful, it can lead to cognitive errors and an incorrect conclusion. Fast thinking can include several kinds of cognitive shortcuts. A **cognitive shortcut** is a specific pattern of fast thinking that can lead to errors when evaluating information. For example, observing that a person has one positive trait, such as intelligence, might lead you to assume that the person has other positive traits, such as kindness. However, this may not be true. This cognitive shortcut is called the Halo Effect, where one good trait makes people expect other good traits.

In Activity 2, you were introduced to a fictional scenario and thought about what makes something more believable or less believable in the media. In this activity, you will investigate a selection of cognitive shortcuts in the context of a real disease known as avian influenza, or bird flu. Then, you will explore some skills to slow down thinking and reduce errors due to cognitive shortcuts.



Avian flu can affect birds and other animals, both in agricultural and natural settings.

CONCEPTUAL
TOOLS



MATERIALS LIST

FOR EACH PAIR
OF STUDENTS

COMPUTER WITH
INTERNET ACCESS

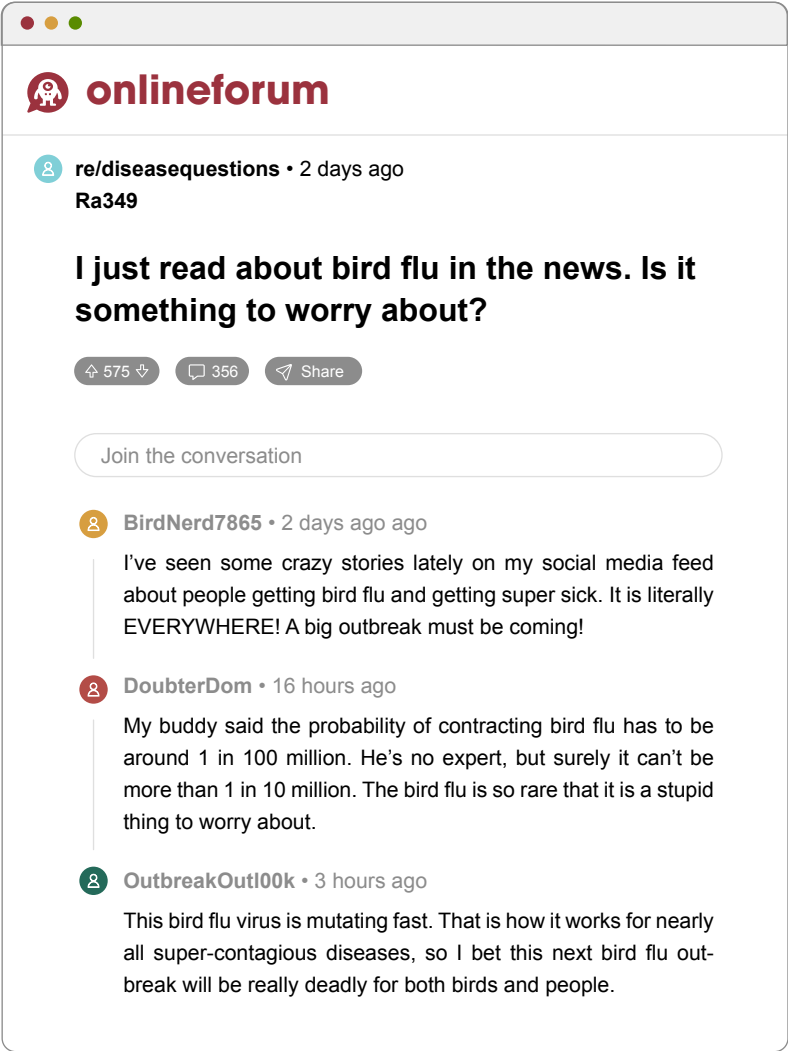
FOR EACH STUDENT

STUDENT SHEET 3.1
"Evaluating Posts for
Cognitive Shortcuts"

PROCEDURE

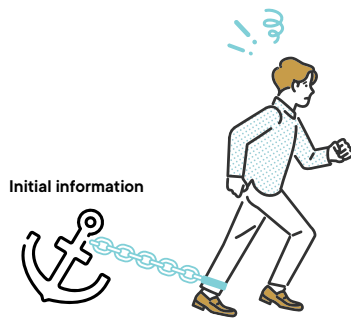
PART A: COGNITIVE SHORTCUTS

- 1 Read the following fictional social media posts that were written in response to news reports about the real disease of bird flu.



- 2 With your group, discuss what each person is claiming about the bird flu. A **claim** is a statement that asserts something is true. Record the claims in the first row of Table 1 on Student Sheet 3.1, "Evaluating Posts for Cognitive Shortcuts." Discuss if you agree, disagree, or are not sure about the reasoning they provided for their claims. Record your responses in the second row of Table 1.

- 3 Read the following descriptions of three common cognitive shortcuts: the anchoring shortcut, the availability shortcut, and the representativeness shortcut.

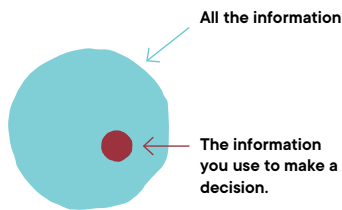


Anchoring

The **anchoring shortcut** is a cognitive shortcut where a person relies too much on an initial piece of quantitative information to make a conclusion.

EXAMPLE

When shopping for a pair of sneakers, if the cost is marked up but then discounted, it seems like it is a good deal, even if it isn't. This is because the buyer's thoughts are anchored at the higher price.

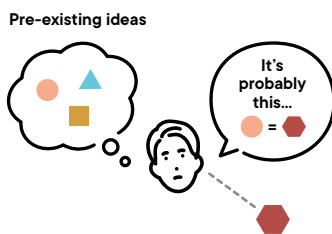


Availability

The **availability shortcut** is a cognitive shortcut where a person depends on easily recalled or recent information to make a conclusion.

EXAMPLE

Many more people are afraid of flying than of driving. Airplanes seem more dangerous due to the extensive media coverage of crashes. However, car fatalities are much more common, but they are rarely publicized.



Representativeness

The **representativeness shortcut** is a cognitive shortcut where a person depends on a pre-existing idea or category to make a conclusion.

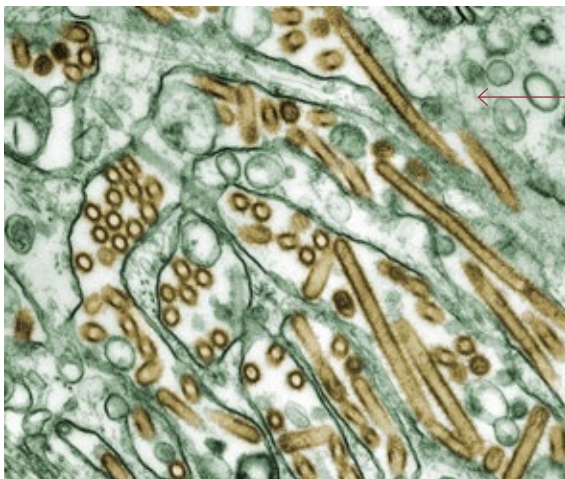
EXAMPLE

Someone you met really likes books, so you assume he is a librarian. In fact, he is more likely to be a salesperson because there are a lot more salespeople in the general population than librarians.

- 4 Compare the three common cognitive shortcuts to the posts in Step 1. Each post uses a different type of fast-thinking shortcut to reach its conclusion. Identify the type of cognitive shortcut used to make each claim and record your responses in the third row of Table 1 on the student sheet.
- 5 As a class, discuss how the cognitive shortcut may be influencing the conclusion made in each post.

PART B: EVIDENCE FOR CLAIMS

- 6 Cognitive shortcuts often happen in situations where a lack of information leads to fast thinking. With a partner, revisit the posts from Part A. For each post, come up with two pieces of evidence that could help to evaluate the claim. **Evidence** is information that can support or refute a claim. Record your responses in the first row of Table 2 on the student sheet.
- 7 You will look for evidence from credible sources for one of the claims. A **credible source** is a source with relevant expertise that provides accurate information that is free from bias. Your teacher will provide some online sources for avian influenza. Evaluate the credibility of each source by considering whether the author has
 - relevant training or experience,
 - listed references to other trustworthy sources, and
 - a perspective that is balanced or neutral.Record the credible sources for one of the claims in the second row of Table 2.
- 8 Discuss with the class which sources are most credible and least credible and why.
- 9 With a partner, use credible sources to look for evidence to support or refute one claim made in Part A. Record your findings in the third and fourth row of Table 2.
- 10 Decide if you agree or disagree with the claims in the posts based on the evidence you found. Explain your reasoning.
- 11 As a class, discuss your findings from Step 10.
- 12 Describe how your own thinking process in Part B differed from the thinking process shown by the social media posters in Part A. Make a recommendation to the social media posters on how they could slow down their thinking in the future.



An artificially colored electron microscope image shows virus particles of the H5N1 avian flu (gold) surrounded by infected cells (green).

BUILD UNDERSTANDING

- ① Review the following headline and beginning of a fictional post from Activity 2. What type of cognitive shortcut is the person posting using? Explain your reasoning.

 **re/southsandchat** • 2 days ago
CarlWatts

“Don’t breathe on me!”

Local Man Demands Masks After Roommate Contracts Southsand Fever

I found this post from a neighbor. Should I be worried?

My roommate came home from an ER visit last Monday after having a high temperature and trouble breathing; doctors diagnosed it as Southsand fever. I’m not going to get sick like all those people, so now I am making my roommate wear a mask, and I’m wearing one even inside our apartment. I can feel the germs in the air every time he walks by!

 77  12  Share

- ② Large Language Models (LLMs), such as ChatGPT or Gemini, use artificial intelligence (AI) technology to answer questions by gathering information available on the Internet to construct a response to a search or a question. Most LLMs do not identify the source of the information or list the evidence used to construct the answer. Would you consider an LLM to be a credible source? Why or why not?

- ③ Many social media posts focus on personal anecdotes, which are single stories or one-time events, usually involving one person. How could using an anecdote lead to one or more cognitive shortcuts?
- ④ In the Southsand fever scenario, Trevor reads an article that states: *Adults are most at risk of this disease*. Trevor suspected that the claim involved a cognitive shortcut, so he went to the Southsand fever public health website to get more information. He found the following data from the local hospital, a credible source. Based on analysis of the data, which age group (children, adults, or seniors) do you think is most at risk from the disease? In your response:
- a make a claim about which age group is most at risk.
 - b support your claim, using at least 2 pieces of evidence from the data in Table 3.1. Use reasoning to explain how each piece of evidence supports your claim.

TABLE 3.1
Southsand Fever Hospital Data

	CHILDREN (0-14 years)	ADULTS (15-59 years)	SENIORS (60+ years)	TOTAL
Number of cases	13	68	19	100
Number hospitalized	2	27	10	39
Number who died	1	2	4	7
Average length of hospital stay (days)	10	5	14	

CONNECTIONS TO EVERYDAY LIFE

- ⑤ Imagine that the very first piece of information Sam receives about a severe weather event is a social media post. The post claims the storm will be a Category 5 hurricane that will hit the town. The storm turned out to be strong, but was rated a Category 3. Sam's home had expensive damage but it wasn't structural, and he was still safe. Sam felt like he was lucky. Which cognitive shortcut could have affected his interpretation of the situation? Explain.



FIGURE 3.1
Hurricane Categories

- ⑥ Imagine you have a friend who complains about a stomachache. He says, "I had a stomachache a few months ago when I had the flu. I must have the same illness again." Which cognitive shortcut could have affected his interpretation of the situation? Identify the cognitive bias and explain how you would advise him.

KEY SCIENTIFIC TERMS

- anchoring shortcut
- availability shortcut
- claim
- cognitive shortcut
- credible source
- evidence
- representativeness shortcut



ACTIVITY 4

Looking at Evidence

CARD-BASED INVESTIGATION

People depend on their phones to
access social media.



4 : LOOKING AT EVIDENCE

GUIDING QUESTION

How do existing beliefs affect the way people seek information?

INTRODUCTION

The growth of social media has strongly influenced the speed at which ideas can be spread. The first social media platform to reach 1 million users was MySpace in 2004. Since then, social media usage has exploded, with approximately 5.7 billion user identities in 2025. While a common source for news and health information, social media's impact on society is widely questioned. Researchers are studying whether its effect on people's mental health and well-being is beneficial or harmful. In this activity, you will practice skills for evaluating information as you consider whether or not social media is harmful to teens' mental health.

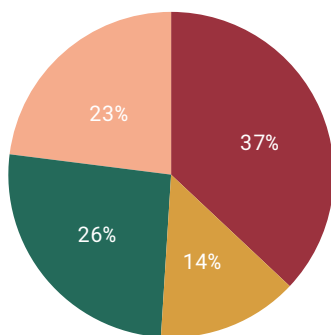


FIGURE 4.1

Time Spent on Social Media

Results of a 2024 survey of almost 1,600 teenagers in the United States.

- 5 or more hours
- 4 to 5 hours
- 2 to 4 hours
- Less than 2 hours

CONCEPTUAL
TOOLS



MATERIALS LIST

FOR EACH PAIR
OF STUDENTS

— SET OF 4 EVIDENCE
FOR CLAIM YES CARDS
(in envelope)

— SET OF 4 EVIDENCE
FOR CLAIM NO CARDS
(in envelope)

FOR EACH STUDENT

— STUDENT SHEET 4.1
“Evidence About
Social Media”

PROCEDURE

PART A: SELECTING SOME EVIDENCE

- 1 Read the following fictional scenario.

Trevor has started to feel sick with symptoms of Southsand fever. Even though he tried green juice to cure his illness, he's not getting better. While he is home sick from school, he spends a lot of time scrolling social media. He keeps seeing more frequent and eye-catching posts from people who are voicing information and opinions about the disease. The more he looks at his feeds, the more anxious he starts to feel about the spread of Southsand fever in his community. He wonders if it would be a good idea to take a break from social media for a little while.

- 2 Consider the following health question: *Is social media harmful to teens' mental health?* Decide which of the following two claims you agree with more.

Claim YES

Yes, social media is harmful to teens' mental health.

Claim NO

No, social media is not harmful to teens' mental health.

At the top of Student Sheet 4.1, “Evidence About Social Media,” circle the claim you selected.

- 3 Follow your teacher's instructions to find a partner who chose the same claim.
- 4 You will be given two envelopes: one labeled “Evidence for Claim YES,” and one labeled “Evidence for Claim NO.” The information on the cards in the envelopes are drawn from actual studies. Pull one Evidence card from *either* envelope and do not look at the other cards.
- 5 Discuss with your partner what the evidence on the card shows and how it relates to your claim. Decide if the evidence supports your claim or helps refute it. Record your ideas on Student Sheet 4.1. Remember to identify the claim you are investigating by circling it at the top of the student sheet.

- 6 Repeat Steps 4 and 5 until you have considered at least three pieces of evidence.
- 7 Discuss how confident you are about your claim, using a scale from 0% to 100%, where:

0% = there is no chance your claim is correct
50% = your claim is just as likely to be wrong as it is to be correct
100% = you are absolutely sure that your claim is correct

Record your responses in your science notebook and then share your ideas with the class.

- 8 Consider if you and your partner engaged in confirmation bias when you selected the Evidence cards. **Confirmation bias** is the tendency for a person to seek out and interpret information in a way that supports their existing ideas. Confirmation bias also leads a person to ignore or undervalue information that does not support their existing ideas and is usually unintentional.

PART B: ANALYZING THE EVIDENCE

- 9 Follow your teacher's instructions to form a group of four with another pair of students who chose the opposite claim. Share your evidence and record the other pair's evidence on Student Sheet 4.1.
- 10 Pull the remaining Evidence cards and record them on Student Sheet 4.1. Read each card and compare how each piece of evidence relates to each claim.
- 11 An effective way to reduce confirmation bias is to engage with an actively open mindset. An **actively open mindset** is a metacognitive thinking approach in which one evaluates source credibility, seeks evidence, and considers alternative explanations.
- 12 In your group, use an actively open mindset to consider all the evidence and alternative ideas. Be open to evidence against your claim. Discuss how your thinking about teen mental health and social media may have shifted by talking with the other pair and evaluating all the evidence.
- 13 Discuss and record in your science notebook how confident you are now about your claim, using a scale from 0% to 100%, where:

0% = there is no chance your claim is correct
50% = your claim is just as likely to be wrong as it is to be correct
100% = you are absolutely sure that your claim is correct

Share your ideas with the class, including how your confidence has increased or decreased during the activity.

- 14 As a class, discuss ways that you could have reduced your confirmation bias when selecting evidence.

BUILD UNDERSTANDING

- ① Recall that in the scenario in Procedure Step 1, Trevor asked himself whether he should take a break from social media. Based on what you learned in this activity, how would you advise him? Support your answer with evidence from this activity and identify the trade-offs of your decision. A **trade-off** is a desirable outcome given up to gain another desirable outcome.
- ② Sometimes confirmation bias results in selectively choosing information that supports a claim. This is called *cherry-picking* because the focus is on the pieces of evidence that support our existing ideas and ignoring those that don't—such as picking the most appealing cherries from a tree. Consider the following story:

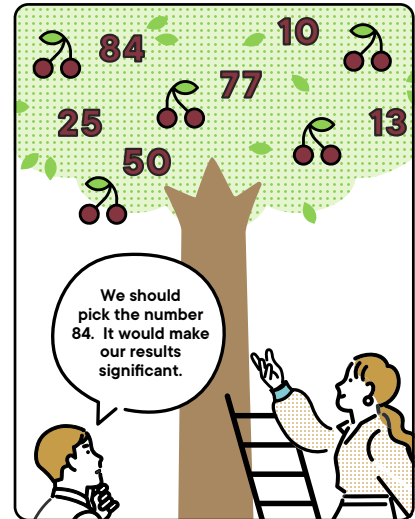
A research team did an experiment to prove that the corn grown locally in Southsand City was making people sick. After conducting the experiment, they found that 20% of their tests supported the idea that the corn could cause disease, while the other 80% did not support it. One researcher on the team decided to present only the 20% of their results that supported their claim.

- a What was the data that the researcher cherry-picked?
- b What are the possible consequences of this cherry-picking?

- ③ Sometimes confirmation bias comes from the tendency to seek out and interpret information in a way that supports an existing idea. This leads to dismissing other interpretations that do not support the existing ideas. Consider the following story:

A local poultry farmer reported symptoms of the Southsand fever. The week before he became ill, he was pecked in the leg by a chicken while working. Later that day, he went to a party where one of his friends was coughing. What could be a biased interpretation of this evidence if you believed that the Southsand fever was transmitted.

- a from person-to-person?
- b from animal-to-person?



This cartoon example shows how selecting only the data points that support your idea is a form of cherry-picking.

CONNECTIONS TO EVERYDAY LIFE

- ④ If a social media app is designed to keep you scrolling by showing you things similar to what you already like, how could this amplify confirmation bias? Explain the possible consequences of this amplification.

EXTENSION

Amanda Yarnell, at the Harvard University Center for Health Communication, leads a research team who aims to improve the quality of mental health information on social media. One promising project encourages influential creators to share evidence-backed insights and solutions. Find out more about Yarnell's research, why it works, and other similar projects. Share your insights with your friends and family.



Social media creators and researchers attend a conference on mental health in 2023.

KEY SCIENTIFIC TERMS

actively open mindset

confirmation bias

trade-off



ACTIVITY 5

Reducing Cognitive Biases

INVESTIGATION



Cognitive biases shape
how we see the world.



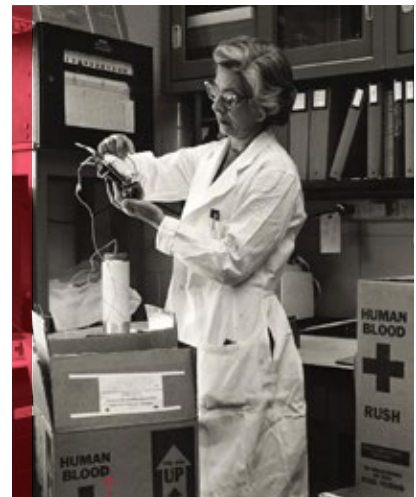
5 : REDUCING COGNITIVE BIASES

GUIDING QUESTION

How do cognitive biases shape everyday decisions?

INTRODUCTION

For a long time, cancer was thought to only have noninfectious causes. In the 1930s–1940s, Mexican-American microbiologist Sarah Stewart challenged this idea by proposing that viruses could cause cancer. Confirmation bias was one factor in the repeated rejection of her work. Her idea was finally accepted after her experiments showed that viruses could cause tumors in mice. Confirmation bias, as shown in this example, is a particular kind of cognitive bias. A **cognitive bias** is an unconscious and systematic error in thinking. Cognitive biases lead to conclusions that are off in a predictable way. In this activity, you will learn about three more common cognitive biases and how reducing cognitive biases is a part of an actively open mindset.



Scientist Sarah Stewart works in the laboratory, circa 1950.

CONCEPTUAL
TOOLS



MATERIALS LIST

FOR EACH GROUP
OF STUDENTS

— SET OF 7 SOUTHSAND
FEVER STORY CARDS

FOR EACH STUDENT

— STUDENT SHEET 5.1
"Evaluating Cognitive
Bias in Southsand
Fever Stories"

PROCEDURE

- 1 Your group will receive a set of 7 Southsand Fever Story cards. Have each member of your group read one of the fictional stories aloud until all 7 cards have been read.
- 2 Read the following descriptions of four common cognitive biases: confirmation bias, conflict of interest, conformity bias, emotion bias.

Confirmation Bias

The tendency for a person to seek out and interpret information in a way that supports their existing ideas.



What to look for:

- personal anecdotes
- cherry-picked information
- evidence and arguments all on one side
- alternatives are dismissed

Conflict of Interest

A **conflict of interest** is a situation in which an interest in the outcome may compromise a person's actions or conclusion.



What to look for:

- author is paid by a company that sells a related product
- offering information while also selling a product
- prioritizing loyalty to a person or organization
- recommendation by someone who stands to gain something

Conformity Bias

A **conformity bias** is a tendency for a person to change their thoughts and actions to fit in with the other people around them. This can be conscious or unconscious.



What to look for:

- trying to fit in with a group
- following trends because they're popular, regardless of if you like them
- pressuring nonconformers (*Everyone's doing it...*)

Emotion Bias

An **emotion bias** is a tendency for a person to depend on their emotions to make a conclusion.



What to look for:

- being driven by sympathy, fear, anger, or disgust
- urgent, sensational, or exaggerated language
- vividly described anecdotes that may or may not be representative of wider patterns

- 3 Work together to identify which cognitive bias(es) are present in each Southsand Fever Story card. Discuss how you think each story demonstrates this bias. Remember to listen to and discuss the ideas of other group members. If you disagree with others in your group, explain why you disagree. Record your ideas in the second and third columns on Student Sheet 5.1, "Evaluating Cognitive Bias in Southsand Fever Stories."
- 4 As a group, brainstorm 1–2 strategies to reduce each kind of cognitive bias described in the stories and record your responses in the last column on Student Sheet 5.1.

- 5 Compare your responses on Student Sheet 5.1 to the following actively open mindset summary. Circle the strategies on the student sheet that are part of an actively open mindset.

Actively Open Mindset

A metacognitive tool



Sources

Evaluate the credibility of your source.



Evidence

Seek out evidence for and against claims.



Alternatives

Consider alternative explanations.



New Information

Consider how new information might change your thinking.

- 6 Discuss the following questions with your group:
- How representative are the Southsland fever stories to real-world behavior?
 - How might you apply the strategies from Step 4 in your everyday life?
- 7 Share your responses to Step 6 with the class.

BUILD UNDERSTANDING

- ① With a partner, come up with your own everyday example for each cognitive bias presented in this activity. Choose one of the following activities to creatively communicate the bias.
- Write a narrative story.
 - Draw a picture or diagram.
 - Make a short video.
- ② The presentation of information may contain cognitive bias. Does that mean you should always doubt the information it provides? Why or why not?

CONNECTIONS TO EVERYDAY LIFE

- ③ Rage bait is a type of content that is designed to get a strong reaction from the viewer. The purpose is to spread ideas (often misinformation) or to generate engagement on social media. Explain which cognitive bias(es) from this activity could influence someone's reasoning when they see rage bait.
- ④ Many social media platforms use a format of a short video where the person posting speaks directly to the camera, which mimics having a personal conversation with the viewer. In addition, influencers often share stories about their lives, which makes their posts feel authentic and relatable.
 - a What cognitive bias(es) does this kind of format promote? Explain your answer.
 - b What might be some of the consequences of this cognitive bias?



A social media influencer recording at home.

EXTENSION

Look for cognitive biases from this activity in online posts. Share the post, the cognitive bias, and the misleading reasoning with family and friends. Explain why you think the cognitive bias is present in the post.

KEY SCIENTIFIC TERMS

cognitive bias
conflict of interest
conformity bias
emotion bias



ACTIVITY 6

Evaluating a Scientific Claim

GAME



Epidemiologists look for trends
in large sets of health data.



6: EVALUATING A SCIENTIFIC CLAIM

GUIDING QUESTION

How can an actively open mindset help to make a scientific claim?

INTRODUCTION

Previously, you used an actively open mindset to weigh evidence for and against claims, search for alternative explanations, and look for cognitive biases. Another important aspect of having an actively open mindset is to consider what new information might change your thinking. This kind of thinking is important to scientists when trying to find the cause of a disease spreading through a community. An **epidemiologist** is a scientist who studies the patterns, causes, and control of disease in groups of people. They gather and analyze data on who, where, and how people could have gotten a disease. In this activity, you will role-play as a team of epidemiologists trying to determine the mode of transmission for Southsland fever. To do so, you will use a scientific approach, which uses slow thinking and an actively open mindset.



An epidemiology team in Indonesia interviews a patient during a 2014 outbreak of the bacterial disease leptospirosis.

If you need to review concepts related to disease transmission, you will find a Science Review at the end of this activity.

CONCEPTUAL
TOOLS



MATERIALS LIST

FOR EACH GROUP
OF FOUR STUDENTS

SOUTHSAND CITY
GAME BOARD

SET OF 12
INTERVIEW CARDS

SET OF 6 DATA CARDS

SET OF 6
EVENT CARDS

NUMBER CUBE

4 GAME PIECES

STUDENT SHEET 6.1
"Southsand Fever
Hypotheses"

STUDENT SHEET 6.2
"Evidence from
Interviews:
Infected People"

STUDENT SHEET 6.3
"Evidence from
Interviews:
Healthy People"

STUDENT SHEET 6.4
"Field Notes from Data
Cards and Event Cards"

PROCEDURE

PART A: COLLECTING EVIDENCE

- 1 Read the following fictional scenario.

The number of cases of Southsand fever continues to rise, and the situation is becoming urgent. It is still unclear how people are becoming infected by Southsand fever. Public health officials have put together a Southsand Fever Investigation Team to study the situation. As experts, your team of epidemiologists will gather and evaluate evidence to find out how Southsand fever is spreading.

Southsand City has a small urban center in a mostly rural area. The economy depends on healthcare, agriculture, and construction. Many residents work at the local county hospital, on farms, or as construction workers building housing developments on unused land outside the city center. Animals that can be found in and around some of the homes and farms include rats, cats, dogs, cows, and chickens. Three weeks ago, the community showed up for the city's annual summer kite festival. Fresh locally grown food such as corn on the cob, chicken, and tomatoes was served. Everyone enjoyed the festival until the weather got too windy, and conditions became very dusty.

- 2 With your group, discuss how Southsand fever could possibly be spreading, based on the fictional scenario and your background knowledge. Consider factors such as how people interact with one another; what people eat, drink, breathe, and touch; the animals people come in contact with; and where people live or work.
- 3 Your group will role-play a team of epidemiologists investigating how Southsand fever is transmitted. Before you begin the game, discuss how your team will approach the evidence you will get during the game. Ask yourselves the following questions:
 - What role will fast thinking and slow thinking play in our decision-making?
 - What types of cognitive shortcuts and cognitive biases might we want to watch out for when gathering and interpreting data?

Share your responses to these questions with your group.

- 4 Distribute one copy each of Student Sheets 6.1, 6.2, 6.3, and 6.4 to each group so each group member has one sheet. Each student will be responsible for recording and updating information on their student sheet during the game play, as needed.
- 5 With your group, discuss some initial hypotheses that could explain the spread of the disease. Record at least two initial hypotheses on Student Sheet 6.1, “Southsland Fever Hypotheses.” For now, do not fill in the “Relevant Game Card(s)” column. Remember to listen to and discuss the ideas of other group members. If you disagree with others in your group, explain why you disagree.
- 6 Set up the game board and place the Interview cards, Data cards, and Event cards into three separate face-down stacks. All players place their game pieces on the START space.

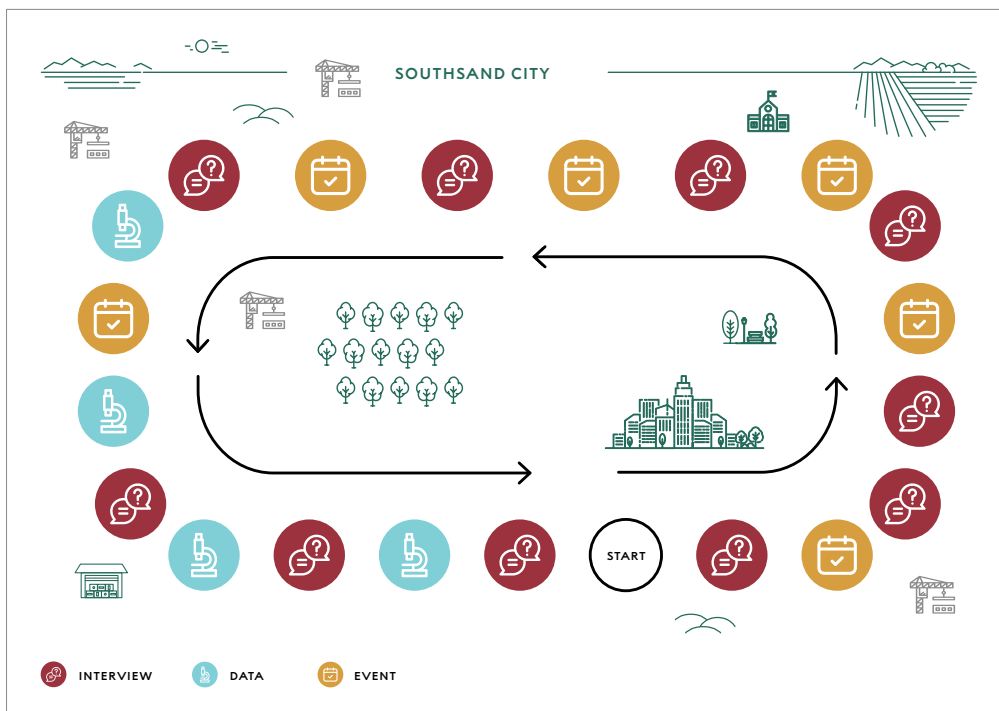


FIGURE 6.1
Game Board

- 7 Start the game. Each player takes a turn rolling the number cube and moving their game piece the corresponding number of spaces. Whenever you land on a space, draw the corresponding card and read it aloud. Record the information from the card on one of the following student sheets:
 - Interview card: Student Sheet 6.2, “Evidence from Interviews: Infected People”
 - Interview card: Student Sheet 6.3, “Evidence from Interviews: Healthy People”
 - Data card or Event card: Student Sheet 6.4, “Field Notes from Data Cards and Event Cards”

If there is no remaining card to draw on the landed space, stay on the space, but move to the next player.

- 8 After recording information from the cards, place them in separate discard piles.
- 9 Once all players have taken a turn, pause play. After each round of play, do the following:
 - a Use slow thinking to analyze the evidence gathered in that round. Discuss which of your hypotheses on Student Sheet 6.1 the evidence may support or refute. In the “Relevant Game Card(s)” column, record the cards that are relevant to the hypothesis and whether they support or help refute that hypothesis.
 - b All group members use an actively open mindset to decide if there is enough evidence to rule out each hypothesis. Update Student Sheet 6.1 based on the group’s findings by crossing out the hypotheses that have been refuted and adding any new hypotheses supported by evidence from the cards.
 - c With your group, discuss whether or not your thinking is influenced by cognitive bias (confirmation bias, conformity bias, emotion bias, conflict of interest).
- 10 Seek new evidence by continuing to play the game until the second person in your team passes the START space, remembering to complete Step 9 after each round. Turn over all the remaining cards, record all the evidence on the student sheets, and update your group’s hypotheses.

PART B: ANALYZING THE EVIDENCE

- 11 When the game is complete, use the collected evidence to compare the infected and healthy individuals. Each group member should copy the following table into their science notebook. Then use the data on Student Sheet 6.2, “Evidence from Interviews: Infected People,” and Student Sheet 6.3, “Evidence from Interviews: Healthy People” to complete the table. For example, a factor might have 6 out of 10 people who replied Yes on Student Sheet 6.3, which is 60%.

TABLE 6.1

Comparing Infected and Healthy Individuals

FACTOR	INFECTED INDIVIDUALS (%)	HEALTHY INDIVIDUALS (%)
ate locally grown corn		
works outside		
attended the kite festival		
has dog(s)		

- 12 Based on the results from Step 11, discuss with your group which factors showed the greatest differences between infected individuals and healthy individuals. Use this, along with your hypotheses and evidence from Part A, to make a claim about how the disease is spreading.
- 13 Share your group’s final claim with the rest of the class. Discuss the evidence that supports and refutes each group’s claim. As a class, compare ideas and try to come to a consensus on a single explanation for how Southsland fever is transmitted.
- 14 Reflect on your own responses and actions during the game and analysis. Ask yourself the following questions:
- Did I find myself prone to cognitive errors due to fast thinking?
 - Did I take any cognitive shortcuts while evaluating information?
 - Did I fall prey to one of the cognitive biases? If so, explain which one and why.

Share your responses to these reflection questions with the class.

BUILD UNDERSTANDING

- ① How do you think Southsand fever is being transmitted? Develop an argument supported by evidence from your disease investigation. In your response:
 - a make a claim about how Southsand fever is or is not being transmitted.
 - b support your claim, using at least 3 pieces of evidence gathered in the activity. Use reasoning to explain how each piece of evidence supports your claim.
 - c describe and explain at least 1 piece of evidence against your claim or that supports an alternate claim. Use reasoning to explain why you still support your claim as the most likely.
- ② Identify at least two cognitive thinking skills that were helpful in conducting your investigation. Explain why each was helpful.
- ③ What is the difference between simply agreeing with evidence that supports your hypothesis and maintaining an actively open mindset?



← Genuinely listening to others' viewpoints is a key part of an actively open mindset.

CONNECTIONS TO EVERYDAY LIFE

- ④ Imagine you were diagnosed with a medical illness. Why would it be important for you that the scientists studying that illness use slow thinking and an actively open mindset?
- ⑤ Describe a situation in your everyday life when using an actively open mindset could help you make a better decision.

KEY SCIENTIFIC TERMS

epidemiologist

SCIENCE REVIEW

Disease Transmission

Disease transmission describes the various ways that an infectious disease can spread. Infectious diseases can be contagious or non-contagious. They are noncontagious when they do not easily spread through close contact between organisms. Food poisoning is an example of a noncontagious infectious disease.

Infectious diseases are contagious when they are easily spread from person-to-person through close contact. This can happen through direct contact, such as touching or kissing, or through indirect contact with contaminated surfaces or objects.

Some diseases can be carried by animals and transmitted to other species. In fact, many human diseases originated in nonhumans. For example, infected mosquitoes can transmit certain diseases when they bite people. Some common diseases transmitted by mosquitoes are malaria, dengue, and West Nile fever. Rabies, also a relatively common disease, is caused by a virus that is spread from the bite of an infected animal.

Diseases can also be transmitted through things in the environment, such as air, water, soil, or food. For example, tuberculosis can spread through tiny droplets in the air. Cholera can spread in water contaminated with human feces. When someone improperly handles food, disease can spread to those who eat it. Some infectious diseases can even spread through multiple modes of transmission, making them more challenging to control. For instance, the bacteria that causes cholera can spread through contaminated water, food, and even flies.

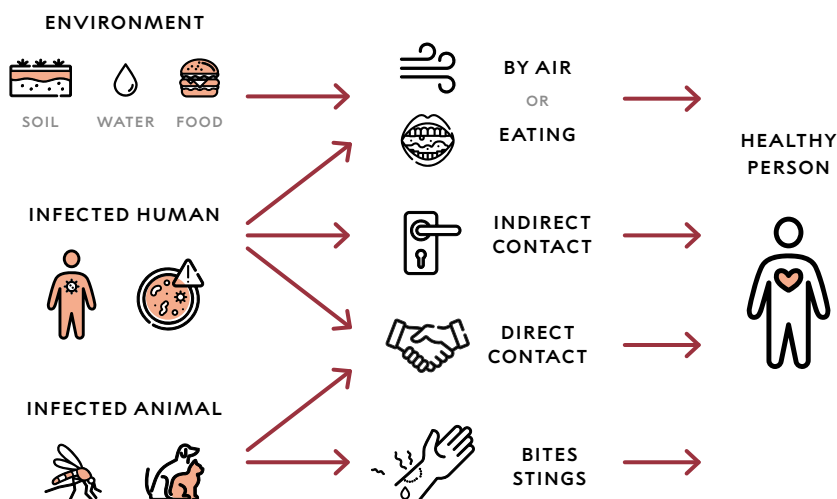


FIGURE 6.1
Different types of
disease transmission



ACTIVITY 7

Addressing Cognitive Bias in Science

READING

Cognitive biases can impact a
scientific investigation.





7: ADDRESSING COGNITIVE BIAS IN SCIENCE

GUIDING QUESTION

How does slow thinking improve scientific conclusions?

INTRODUCTION

Like any human, scientific researchers can be unconsciously influenced by cognitive shortcuts or pre-existing ideas. For instance, they might unknowingly pay more attention to data that supports their first guess and ignore data that goes against it. To reduce the chance of errors from cognitive shortcuts and cognitive bias, the scientific process includes steps to support slow thinking and an actively open mindset. In this activity, you will learn about scientific practices that limit a researcher's personal bias when designing studies, analyzing data, and forming conclusions. By looking at examples from historical and modern disease outbreaks, you'll explore how these practices help make scientific information more reliable.

CONCEPTUAL TOOLS



MATERIALS LIST

FOR EACH STUDENT

— 3–5 STICKY NOTES

PROCEDURE

- 1 Read about the scientific investigations of a disease called pellagra and the more recent outbreak of COVID-19. Use the Read, Think, and Take Note Guidelines as you read.

READ, THINK, AND TAKE NOTE GUIDELINES

Stop at least three times during each section of the reading to mark on a sticky note your thoughts or questions about the reading.

As you read, use a sticky note from time to time to:

- explain a thought or reaction to something you read.
- note something in the reading that is confusing or unfamiliar.
- list a word from the reading that you do not know.
- describe a connection to something you've learned or read previously.
- make a statement about the reading.
- pose a question about the reading.
- draw a diagram or picture of an idea or connection.

After writing a thought or question on a sticky note, place it next to the word, phrase, sentence, diagram, drawing, or paragraph in the reading that prompted your note.

After reading, discuss with your partner the thoughts and questions you had while reading.

READING

CASE STUDY 1 THE PELLAGRA EPIDEMIC

Pellagra is a disease that causes a red scaly rash, dementia, diarrhea, and sores in the mouth. Ultimately, pellagra can lead to death. Pellagra has been found in the United States, Indonesia, Europe, China, and throughout Africa. From 1900 through 1940, over 3 million people suffered from it in the United States, and more than 100,000 died from it. The epidemic struck the southern part of the United States hardest, mostly affecting those who were living in poverty, such as farmers and mill workers.



A man (left) and 4-year-old child (right), both showing severe pellagra rashes.

In the early 1900s, new diseases were often thought to be caused by infectious microbes (sometimes called germs). The cause of pellagra was unknown, but most scientists thought that pellagra was caused by a microbe that made people sick. This idea was influenced by pellagra's similarities to well-known contagious illnesses such as typhus and cholera, which spread through contact with infected human feces. This idea was strengthened by the Thompson-McFadden report in 1912. It included evidence that pellagra occurred more often in neighborhoods without sewers or proper sanitation. Another researcher proposed that pellagra was spread by black flies, which were often found where the disease was severe. Because the flies were so annoying, the fly explanation came easily to mind for researchers.

Goldberger's Actively Open Mindset

Although the pellagra-germ hypothesis was accepted among researchers, not much progress was made in proving a microbe was the cause. For example, it was true that the fly lived in the same poor areas as people with the disease, but pellagra was also found where the fly was absent. Researchers were also unable to transmit the disease to animals by using samples from patients with the disease. New ideas needed to be considered.

In 1914, the United States government hired Joseph Goldberger to investigate. As Goldberger began his research, he relied on scientific practices that used slow thinking and an actively open mindset. He began to explore alternative explanations for what was causing pellagra. One was a toxin hypothesis that claimed that the disease came from eating spoiled corn. Pellagra appeared in areas where corn was regularly eaten, and some of pellagra's symptoms resembled those from food toxins. However, the corn did not make everyone sick, and no specific toxin was found.

Another explanation Goldberger considered was a missing-nutrient hypothesis. This hypothesis suggested that pellagra had a nutritional cause. Many people who developed pellagra ate a very limited diet of cornmeal, fatty pork, and molasses syrup, with few fruits or vegetables.



The Spartanburg General Hospital in South Carolina, 1914. It was created to study and treat pellagra patients.

Goldberger decided to seek out new information to help narrow down the possibilities. He observed that in orphanages and mental institutions, the children and residents frequently got pellagra, but the staff (doctors, nurses), who were in constant contact with the sick, never did. This seemed unlikely if the disease was infectious. He also noted that the staff had access to better food, while residents ate the limited cornmeal diet. Goldberger could not find any contamination in the corn and food supplies. He wondered if the difference was in the quality of food eaten. He thought this could explain why children and residents at institutions developed pellagra while the nurses and doctors did not.

Goldberger's observations were not enough to prove that the poor diet caused the disease. To address this, he designed an experiment. In 1914, Goldberger tested the missing-nutrient hypothesis at an orphanage in Mississippi by adding fresh meat, milk, and vegetables to the children's diet. He left other factors, such as sanitation, the same. The disease cleared up, and no new cases developed in the children who received the better diet. However, when funding ran out in 1916, the old diet resumed, and pellagra returned. Similar results developed in other experiments. Goldberger concluded that it was not bad sanitation but a poor diet that caused people to develop pellagra.

Facing Skepticism

Despite Goldberger's evidence that pellagra was caused by a poor diet, most scientists were convinced of the pellagra-germ hypothesis. Wealthy business owners also rejected the link to a poor diet because this meant admitting that they did not pay their employees enough to afford better food.

To prove the disease wasn't infectious, Goldberger hosted a series of "filth parties." He had volunteers intentionally consume capsules made from the skin, feces, mucous, and urine of pellagra patients. None of the volunteers developed pellagra. This further supported the idea that pellagra was not caused by a germ. The outrageousness of the parties brought needed attention to Goldberger's ideas. This led to his ideas being eventually accepted by the scientific community.

Goldberger continued his research and eventually discovered an inexpensive cure for the disease. A daily dose of brewer's yeast, which is used to make bread and beer, could get rid of pellagra symptoms. This provided even more evidence that the disease was caused by a missing nutrient. Goldberger suspected that lack of a specific vitamin was the cause. In 1937, years after Goldberger's death, researchers discovered that a lack of Vitamin B₃ (niacin) was the specific cause of pellagra.

Goldberger was successful, in part, because he did his best to avoid cognitive biases and use slow-thinking techniques. His actively open mindset also motivated him to explore different hypotheses about the cause of pellagra. Goldberger experienced more resistance than he should have to his ideas, but challenging ideas is a normal part of the scientific process. Instead of settling on the easiest answer, researchers regularly question one another's reasoning. This practice keeps the scientific community open to alternative explanations. Eventually, enough evidence is collected over time to reach a reliable conclusion.

CASE STUDY 2 THE mRNA VACCINE

Since the time of Goldberger's investigations, the process of science has evolved. While the practices of slow thinking and an actively open mindset remain central, there have been formalized scientific practices to support it. These practices help ensure accuracy, reduce bias, and improve conclusions in scientific research.

A great example of this progress is the development of the vaccines for SARS-CoV-2, the virus that causes COVID-19. In 2020, the dangerous COVID-19 pandemic swept the world and has since claimed over 7 million lives worldwide. The start of the pandemic led to an urgent search for solutions, such as treatments and vaccines. Vaccines help prevent an infectious disease or drastically reduce the severity of the illness. However, scientists quickly realized that traditional vaccine development—which can take up to 15 years—was too slow for this global emergency. The clock was ticking. Scientists looked for alternatives. The solution was found in a decades-long idea that led to the development of the COVID-19 vaccines in less than 1 year. It was one of the fastest, yet effective, medical advancements in history.

A Decades-Long Idea

It began in 1997, with a chance meeting of biochemist Katalin Karikó and immunologist Drew Weissman. Karikó, an immigrant from Hungary to the United States, had struggled to fund her research but had a new idea for using messenger RNA (mRNA) as a way to transport a new type of medicine in the body. When Karikó met Weissman, he was working on vaccine research for Human Immunodeficiency Virus (HIV) and other diseases. He was open to her ideas. For many years, they worked together to develop an mRNA technology for delivering medication to the body. Progress was slow and their ideas were not well accepted at the start, but their persistence helped their work gain acceptance.

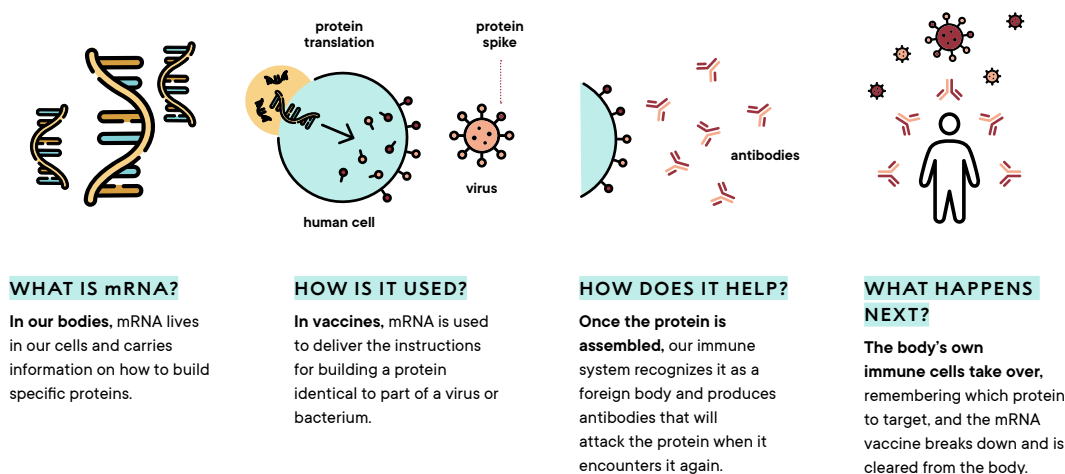


FIGURE 7.1
Information about mRNA vaccines

Before the COVID-19 pandemic, the mRNA delivery technology that Karikó and Weissman created was used for years to safely deliver cancer treatments. Other researchers recognized the potential of mRNA vaccines as a solution to preventing infectious disease. This is because mRNA is a key component of a cell's protein-making machinery. An mRNA vaccine works by using a specially engineered piece of mRNA that signals your body's own cells to produce pieces of protein that look like the virus. Then, like other vaccines, your immune system recognizes and attacks the virus-looking proteins. This leaves the immune system primed and ready to fight off the real virus if it encounters it later.

Karikó and Weissman were not the only ones working on vaccine solutions during the pandemic. A team led by Chinese virologist Zhang Yongzhen identified the virus that causes COVID-19 and mapped out its genetic code by early 2020. A United States' research team led by Barney Graham and Kizzmekia Corbett had spent years working on an mRNA vaccine for a different virus. They quickly switched their focus to the COVID-19 virus. Using the genetic code, they engineered a modified version of the virus' mRNA with the natural spike protein that could be used for the vaccine. The spike protein is a marker found on the surface of the virus that the immune system can recognize and attack. The researchers combined the spike protein mRNA sequence with Karikó and Weissman's proven mRNA delivery technology. These breakthroughs led to the two similar vaccines that were available about the same time. They were the first vaccines approved for emergency use to fight the pandemic.

Throughout the decades of work on the mRNA technology and viral vaccines that led up to the COVID-19 vaccines, scientists used a well thought out and complete scientific process. Unlike treatments developed in the era of the first pellagra outbreaks, these new vaccines had to pass rigorous testing to prove that they worked and wouldn't cause harm. The COVID-19 vaccine research relied on strict scientific practices.

Experimental Design

To test the COVID-19 vaccines, researchers held large-scale clinical trials. A **clinical trial** is a carefully controlled experiment to test a medicine's safety and effectiveness. For example, in the clinical trial for the Pfizer-BioNTech COVID-19 vaccine, over 40,000 participants from 6 different countries participated. They were randomly split into 2 groups. One group received the actual mRNA vaccine, while the other received a placebo. A placebo is a treatment that looks exactly like the real medicine but contains no active ingredients. This approach improves scientific conclusions by reducing cognitive bias while gathering data, such as confirmation bias from patients knowing if they got the vaccine or not.

Another way to reduce the cognitive bias during data collection is to use a double-blinded experiment. In the COVID-19 clinical trials, neither the doctors giving the shots nor the participants knew who got the real vaccine and who got the placebo. This is an important procedure that keeps the data collection unbiased and without

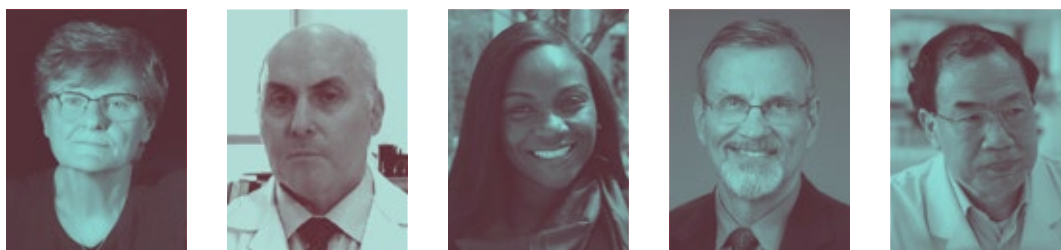
a conflict of interest. For example, if a doctor knew a participant got the real vaccine, they might ignore a mild cold symptom that could be a potential side effect. Similarly, if a participant knew whether or not they got the vaccine, they might ignore or exaggerate a symptom. By keeping everyone “blind” until the study was over, researchers ensured the evidence was genuine and reliable.

The clinical trials for the COVID-19 vaccine had exceptional results. The vaccine was 90% effective at preventing the infection. Nine out of 10 cases of severe COVID-19 occurred in the placebo group during the clinical trial. The careful and methodical way the data were collected helped make this evidence convincing. As a result of the clinical trial, the vaccine was approved and administered to millions of people over the next year, which altered the course of the pandemic by preventing millions of cases of severe illness and deaths worldwide.

Peer Review

Careful experimental design is only one aspect of scientific research that helps increase the accuracy of conclusions. Another critical piece of regular scientific practice is that of peer review. **Peer review** is a process in which a scientist’s research is critically evaluated and judged by other independent experts. The experimental design, results, and conclusions are scrutinized. This practice pushes scientists to use slow thinking and an actively open mindset to consider evidence both for and against their ideas and to notice when they are interpreting their results in a biased way. While peer review is not fail-proof, it has an important role in increasing the accuracy of scientific conclusions over time.

Peer review of the science behind the COVID-19 vaccines was an important step in the vaccines’ approval. This allowed other people to rigorously examine the experimental methods and data. The reviewers also reviewed the claims about vaccine safety and effectiveness. The success of the mRNA vaccines showed that even during a global crisis, science works best when researchers collect unbiased evidence, use carefully designed experiments, and work together to discover and critique new ideas.



Key contributors to the COVID-19 mRNA vaccine: Katalin Karikó, Drew Weissman, Kizzmekia Corbett, Barney Graham, and Zhang Yongzhen.

BUILD UNDERSTANDING

- ① Give an example of a scientific practice from the reading that shows the following approaches, using an actively open mindset.
 - a Seek out evidence for and against a claim.
 - b Consider alternative explanations.
 - c Be open to others' ideas.
 - d Evaluate the need for more evidence.
- ② Give an example from the case study about the pellagra epidemic that illustrates
 - a a cognitive shortcut.
 - b slow thinking.
- ③ Explain how the scientific practices described in the reading require scientists to apply slow thinking rather than relying on cognitive shortcuts.

CONNECTIONS TO EVERYDAY LIFE

- ④ Imagine that when you finish a big project for school, you ask a friend to read it over before you turn it in.
 - a How is this process similar to and different from what scientists do in a peer review?
 - b How might your friend's objective feedback help you avoid a cognitive bias in your own work?
- ⑤ You see an article that states: *A new study showed that a newly developed vaccine for tuberculosis (TB) prevents over 50% of TB infections.* You decide to look up the study to see if you trust the results. What would you look for in the study?



X-ray imaging of the lungs can help diagnosis tuberculosis, a very contagious respiratory disease.

KEY SCIENTIFIC TERMS

clinical trial
peer review

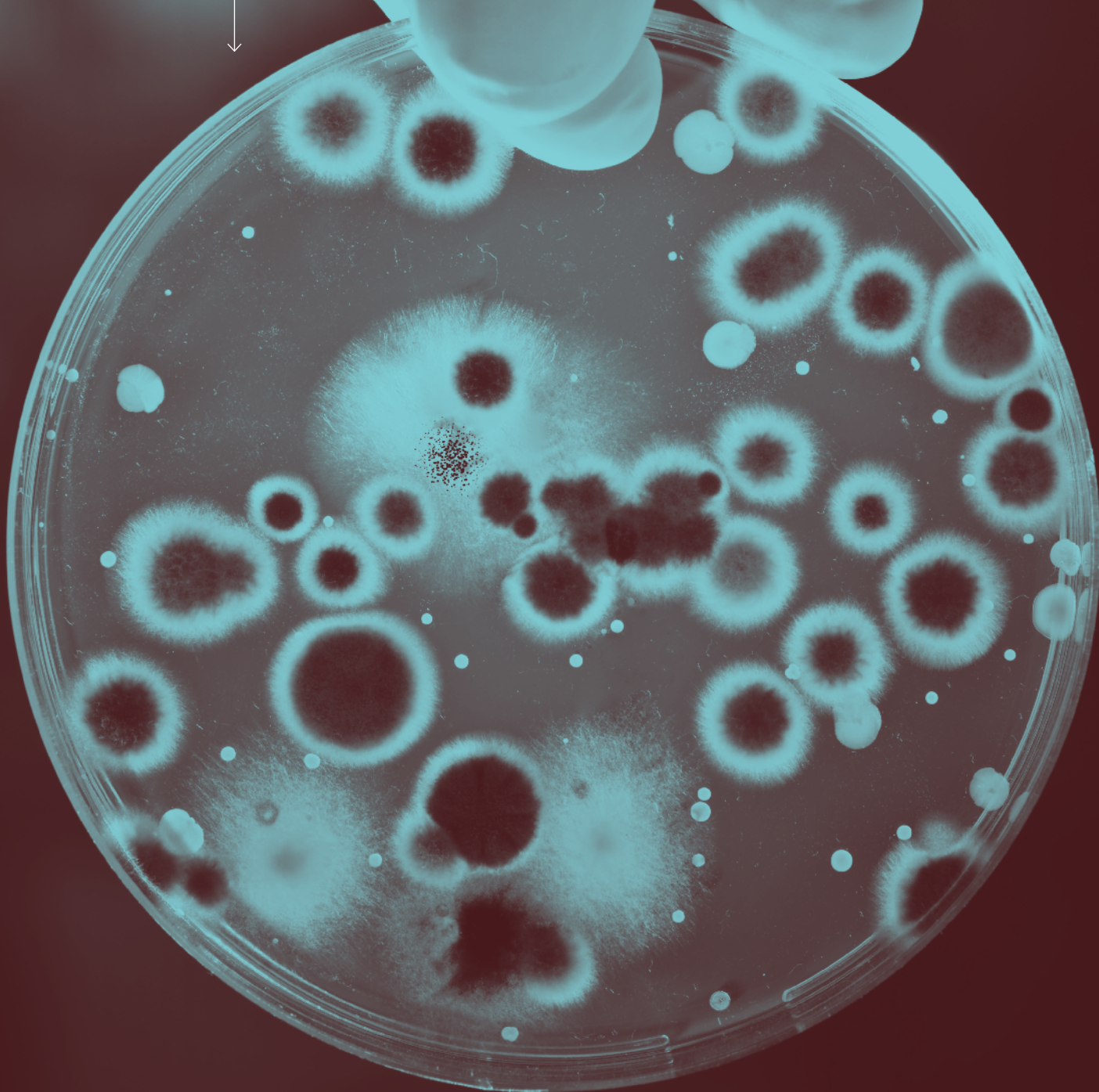


ACTIVITY 8

Investigating a Pathogen

CARD-BASED INVESTIGATION

Various
microorganisms
grown in a lab





8: INVESTIGATING A PATHOGEN

GUIDING QUESTION

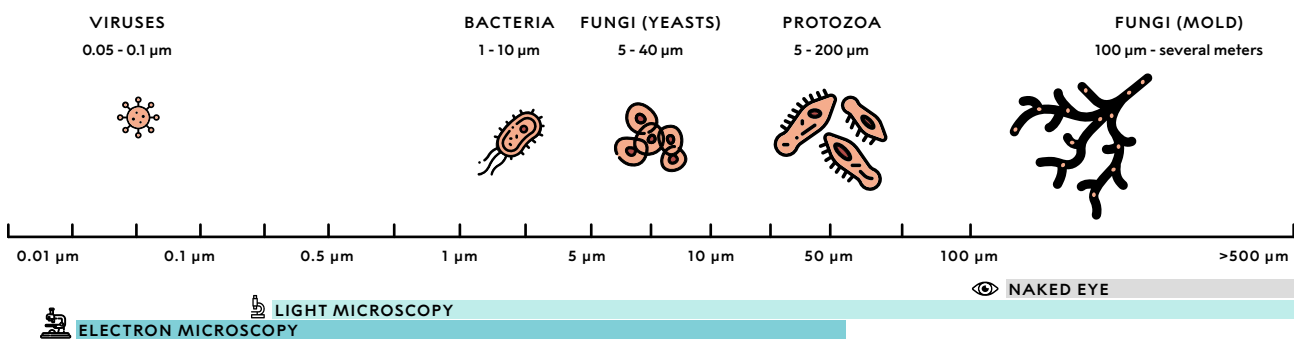
How do epidemiologists use an actively open mindset?

INTRODUCTION

Researchers in Wuhan, China, identified the virus that causes COVID-19. This virus was the **pathogen**—an organism or biological agent that causes infectious disease. Viruses, bacteria, fungi, and even parasites can be pathogens. Identifying the cause of an infectious disease involves detecting a harmful pathogen in a medical, food, or environmental sample. This kind of scientific work serves as an example of how scientific progress depends on slow thinking and an actively open mindset. In this activity, you will evaluate information related to Southsland fever to identify the pathogen responsible for the infection.

FIGURE 8.1
Pathogen Size

The sizes of various pathogens on a scale that uses factors of 10. These images show just a few examples—there are many types of each pathogen. NOTE: Images not shown to scale.



CONCEPTUAL
TOOLS



If you need to review concepts related to microbes, you will find a Science Review at the end of this activity.

MATERIALS LIST

FOR EACH GROUP
OF FOUR STUDENTS

— SET OF 4 PATHOGEN
TYPE CARDS

PROCEDURE

- 1 With your class, read the following fictional scenario.

In order to find effective solutions to treat and prevent Southsand fever, the Southsand Fever Investigation Team needs to identify the pathogen responsible for the illness. They know that Southsand fever causes respiratory symptoms that affect the lungs, though the infection can spread to the skin and other parts of the body. In the lab, scientists on the Investigation Team isolated a Southsand fever microbe that might be the pathogen from the diseased lung tissue of a Southsand fever patient.

- 2 With your group, carefully read each Pathogen Type card. With the class, clarify any questions you have about the information.
- 3 With your group, make one or more guesses about which pathogen type might be the cause of Southsand fever. Discuss whether your guesses involved any cognitive shortcuts or cognitive biases.
- 4 Compare the images on the Pathogen Type cards to the following image of the Southsand fever microbe in the lung of an infected patient. The patient is a contractor working at one of the new construction sites in Southsand City. As a group, use the comparison to identify the most likely pathogen. Record your claim, evidence, and reasoning in your science notebook.

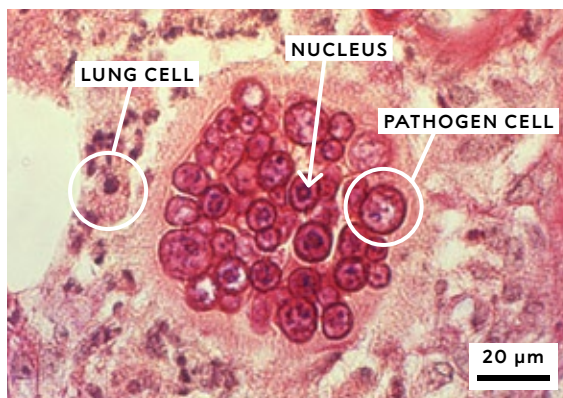


FIGURE 8.2
Pathogen Cell

A microscope image of pathogen cells from a Southsand Fever patient. It shows a spore consisting of many pathogen cells.

- 5 Share with the class your ideas and evidence about which types of pathogens are likely to be the Southsand fever pathogen.
- 6 Read the following continuation of the fictional scenario.

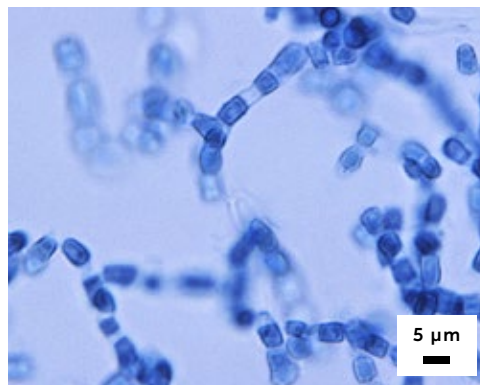
The scientists formed an initial hypothesis that the pathogen is a protozoa. To confirm this finding, they took a lung sample from the Southsand fever patient and tried to grow the pathogen in a few petri dishes. Then they looked at the organism growing on the petri dish under a microscope.

- 7 The following images show the petri dish and the microscope slide from the scenario. Compare the images, including the scale of the organism, to the Pathogen Type cards. In your group, determine whether or not this evidence supports the scientists' hypothesis.

FIGURE 8.3

Petri dish and microscope slide

View of the organism growing in the petri dish (left) and a microscope image of the organism from the same petri dish (right).



- 8 Read the following continuation of the fictional scenario.

After looking at the images, one scientist said, "This must be a mistake because the pathogen is a protozoa. I think that our patient sample must have been contaminated with mold." Later, the scientist returned to the petri dishes and found that the mold had dried up. When he opened one of the petri dishes, he accidentally inhaled some of the particles from the dried-out dish. Less than a week later, he developed symptoms of Southsand fever! The scientist was sure that he was not infected from something else. He realized that he contracted the disease from what he inhaled from the dried-up petri dish.

- 9 With your group, consider the evidence thus far about the pathogen. Decide if you would like to keep your claim from Step 4 about the pathogen type or revise it. Record your claim, evidence, and reasoning in your science notebook.
- 10 In real life, scientists have to confirm that the microbe collected from an infected patient is the same as the ones that are present in the location where the person got the disease. In the Southsand fever scenario, scientists need to confirm that the microbe found in the infected patient is the same as the one found in the soil where the patient was infected. They sampled a mold found in the soil near where an infected patient worked. Your teacher will show you an image of the microscope image of the mold. Use the image to evaluate your claim from Step 9.
- 11 As a class, discuss the evidence from this activity and other activities. Revisit your predictions and then come to consensus on
- how the pathogen appears inside the body and in the soil. Specifically,
 - in Step 4, the image shows the pathogen inside an infected patient.
 - in Step 7, the image shows the pathogen cultured from the infected patient.
 - in Step 10, the image shows the pathogen from the soil.
 - the pathogen type causing Southsand fever.
 - how infection most likely occurs in Southsand.
- 12 Think about what you just read about the mold in the petri dish. Identify places in the scenario where cognitive biases affected the scientist's thinking and how he overcame the bias. Discuss your ideas with the class.

BUILD UNDERSTANDING

- ① What is the pathogen of Southsand fever? Use the evidence from this activity to make a claim about the pathogen type and how it appears inside the body and in the soil. Include your reasoning.
- ② How did confirmation bias appear in the investigation to identify the pathogen?

CONNECTIONS TO EVERYDAY LIFE

- ③ What were the most important aspects of an actively open mind-set you used to identify the pathogen in this activity? Explain.

KEY SCIENTIFIC TERMS

pathogen

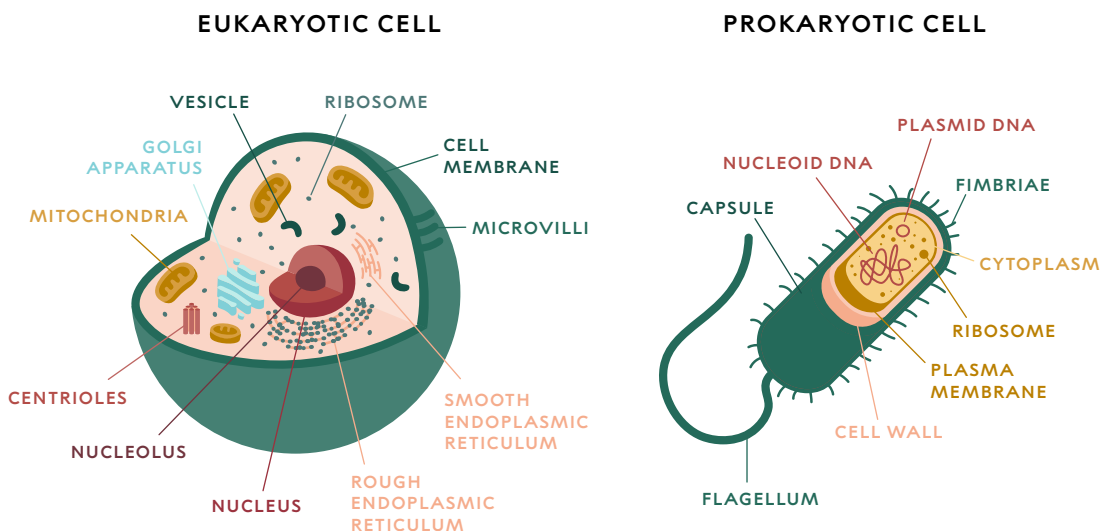
SCIENCE REVIEW

Types of Organisms

All living organisms can be classified into two broad categories based on the location of their genetic material (DNA) and cell structure. *Eukaryotes* are organisms whose cells contain a nucleus. The nucleus is a large organelle surrounded by a double membrane where the DNA is stored. Eukaryotes can be one cell or many cells. Examples of unicellular eukaryotes include some fungi—such as yeasts—and amoebas, paramecium, and protozoa. Multicellular eukaryotes are made of multiple cells that work together to form tissues, organs, and organ systems. Examples of multicellular eukaryotes include animals and plants.

Prokaryotes are cells that do not have a nucleus, and their DNA is located in the cytoplasm of the cell. They are simpler in structure than eukaryotes. All prokaryotes are unicellular organisms and consist of a single cell that performs all life functions. An example of prokaryotes are bacteria. The relatively simple prokaryotes were the first forms of life on Earth.

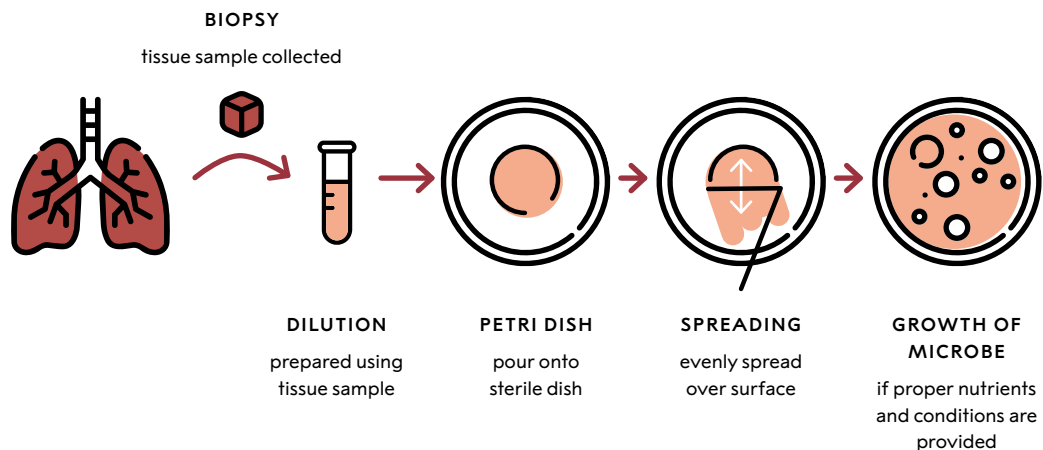
FIGURE 8.4
Two Types of Cells



Culturing Microorganisms

Cell culture is the process of growing cells under controlled conditions outside of their natural environment. Culturing microorganisms is one way in which scientists investigate disease-causing organisms. In a lab setting, scientists grow microorganisms from samples on solid agar in petri dishes or in liquid broth in tubes. The agar or the broth provide nutrients that support the growth of bacteria or fungi. Sterile techniques prevent contamination, with samples incubated at specific temperatures to create pure cultures for diagnosis. A pure culture is one that only contains the species being investigated. For optimal growth, conditions are adjusted to suit the target species. For example, species found in atmospheric conditions, such as on the skin's surface or in the upper respiratory tract, will typically grow well in the presence of oxygen. Species that are naturally found in low oxygen environments, such as in deep wounds, will typically grow best in the absence of oxygen. Selecting appropriate nutrients and restricting growth conditions can encourage the growth of the target species and help to eliminate the growth of non-target species.

FIGURE 8.5
Cell Culture



The steps of cell culture when testing for a microorganism in a patient. Tissue samples are collected, diluted, and spread on petri dishes.



ACTIVITY 9

Community Health Solutions

DATA ANALYSIS



A dusty construction site



9: COMMUNITY HEALTH SOLUTIONS

GUIDING QUESTION

How can communities evaluate science-based recommendations?

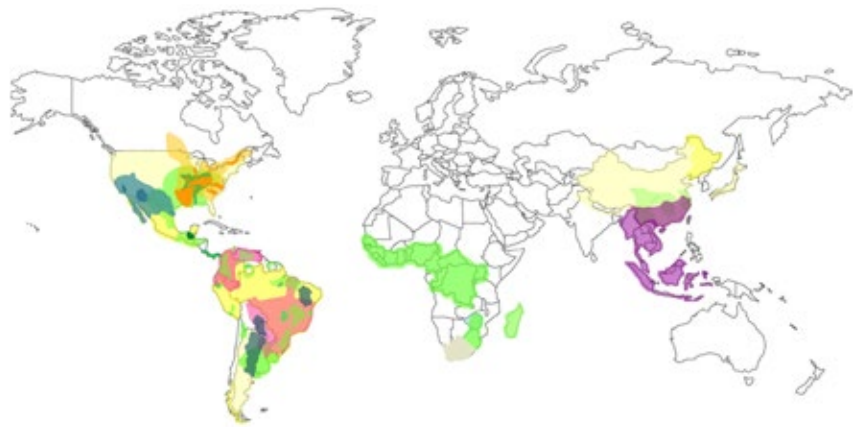
INTRODUCTION

Throughout this unit, you have learned many skills for evaluating different types of information that rely on slow thinking and an actively open mindset. Using these skills, you have investigated cognition and cognitive bias in personal health decisions and scientific investigations, including the fictional Southsand fever outbreak. In this activity, you will use what you have learned to evaluate proposed recommendations that could help Southsand reduce the number and severity of Southsand fever cases in the community.

FIGURE 9.1
Fungal Diseases Map

There are many fungal diseases around the world that affect millions of people each year.

- Blastomycosis
- Histoplasmosis
- Paracoccidioidomycosis
- Coccidioidomycosis
- Emmonsiosis
- Sporotrichosis
- Penicilliosis



CONCEPTUAL TOOLS



MATERIALS LIST

FOR EACH GROUP
OF STUDENTS

— SET OF 4
COMMUNITY MEMBER
COMMENT CARDS

— SET OF 8
HEALTH DEPARTMENT
EVIDENCE CARDS

FOR EACH GROUP
OF STUDENTS

— STUDENT SHEET 9.1
“Evaluating Community
Member Comments”

PROCEDURE

- 1 With your class, read the following fictional scenario.

The Southsand Health Department has released a set of recommendations to help residents reduce their risk of exposure and severe illness from Southsand fever. The city has set aside special funding to implement the various recommendations. The goal is to reduce the number of Southsand fever cases, health complications, and deaths in the community. City leaders are gathering feedback from the community before deciding which recommendation(s) to prioritize.

- 2 Read the following recommendations from the Southsand Health Department.

FIGURE 9.2

Recommendations for Reducing Risks from Southsand Fever

**SOUTHSAND HEALTH DEPARTMENT**

Recommendations for Reducing Risks from Southsand Fever



DIAGNOSTIC TESTING

Funding for medical providers to use a newly developed diagnostic blood test to quickly and accurately diagnose Southsand fever. This helps prevent unnecessary treatments and prolonged illness that could lead to long-term care or death.



PUBLIC EDUCATION

A public health campaign to educate community members about the symptoms of Southsand fever and the outdoor exposures that put people at risk of contracting Southsand fever. The campaign will encourage residents to contact their doctor if they believe they have been exposed to the fungus or notice symptoms.



PROTECTIVE GEAR

Grants for companies and community organizations to buy and use devices that can successfully filter particles such as pollen, dust, and airborne microbes out of the air. This includes:

- protective gear (such as masks) to reduce breathing in the fungal pathogen when outdoors.
- high efficiency particulate air (HEPA) filters to reduce the number of fungal pathogens in indoor spaces.



SOIL STABILIZATION

Grants for companies and community organizations to reduce activities that disturb soil or produce dust, including money to:

- support soil wetting (for individual community members) to reduce the amount of airborne dust and particles.
- fund soil-stabilization projects such as planting ground-cover plants to retain soil and prevent airborne dust.
- buy advanced soil-wetting equipment and large-scale soil dust covers for companies.

- 3 Southsand community members have been commenting on the recommendations. Your teacher will hand out one set of Community Member Comment cards to your group. Each group member should get one card. Take turns reading the cards aloud and work together to identify:
 - the claim by the community member.
 - any potential cognitive shortcuts or cognitive biases in the community member's comment.
- 4 As a group, use what you shared to complete columns 2 and 3 of the table on Student Sheet 9.1, "Evaluating Community Member Comments." Do not complete the last two columns at this time.
- 5 The Southsand Health Department has worked with the local university to release data about Southsand fever. Your group will receive one set of Health Department Evidence cards.
 - a Divide up the evidence cards among group members.
 - b Read and analyze the data found on your cards.
- 6 Take turns briefly describing your evidence cards to the rest of your group. As a group, use slow thinking to determine whether any of the data can be used as evidence that supports or helps refute each community member's claim. Record all ideas in the last two columns on Student Sheet 9.1.
- 7 As an individual, review each community member's comment and the evidence related to that member's claim. Decide if you agree or disagree with the claim made for each community member and circle "agree" or "disagree" in the box under the community member's name.
- 8 In your group, share why you agree or disagree with each community member's comments, the evidence that supports your positions, and your reasoning. Record any additional notes for each community member in the "agree" or "disagree" row.
- 9 Now that your group has looked at the evidence and some arguments for each of the recommendations, discuss with your group what you believe is
 - the most effective solution to reduce the number and severity of Southsand fever cases.
 - the priority for funding.
- 10 With your class, use a Walking Debate to show which recommendation you believe should have funding priority for Southsand City.

BUILD UNDERSTANDING

- ① Which recommendation do you think is the highest funding priority for helping Southsand City reduce risks from Southsand fever? Develop an argument supported by evidence from the Health Department Evidence cards and the Community Member Comment cards. In your response:
 - a make a claim about which recommendation best reduces the risk from Southsand fever.
 - b support your claim, using at least 3 pieces of evidence from the activity, and use reasoning to explain how each piece of evidence supports your claim.
 - c describe and explain at least 1 piece of evidence against your claim or that supports an alternate claim. Use reasoning to explain why you still support your claim as the strongest.
- ② Consider your response to Build Understanding item 1 and then describe
 - a any of your own cognitive biases or cognitive shortcuts that may have affected your thinking.
 - b at least one trade-off for the solution you have chosen.

CONNECTIONS TO EVERYDAY LIFE

- ③ Provide an everyday example of how online comments that include cognitive biases, cognitive shortcuts, and limited evidence can still be persuasive to a reader.

EXTENSION

Think about a disease or a health or safety problem in your community. Investigate what actions have been taken to help the situation and the evidence on which those actions were based.



A volunteer leads students in an AIDS awareness exercise during a development fair for youth in Santo Domingo, Dominican Republic.



ACTIVITY 10

Cognitive Skills in Communication

PRESENTATION

A 1950s school-wide public health campaign encouraged people to get the newly invented polio vaccine.





10: COGNITIVE SKILLS IN COMMUNICATION

GUIDING QUESTION

How can you apply knowledge of cognition to communicating information?

INTRODUCTION

One common way of addressing community health problems is through education. Public service announcements (PSAs) are educational messages created to raise awareness and change people's attitudes or behaviors. They are intended to provide useful and important information to the public; they are not selling a specific brand or service. The most effective PSAs give people a clear way to take action, use a relatable messenger (a doctor or peer, sometimes a celebrity), and are memorable and seen often enough to “cut” through the noise of daily life.

One example of a PSA campaign was titled Seize the Awkward. This public health campaign started in 2018 to promote mental wellness and reduce risk of suicide in young adults ages 16–24. The PSA advised people on how to start difficult conversations with their friends and loved ones about mental health. In this activity, you will apply what you have learned about types of cognition to create a PSA about Southsland fever and evaluate others' PSAs.



Some PSAs encourage people to talk with their friends and family about mental health.

CONCEPTUAL
TOOLS



PROCEDURE

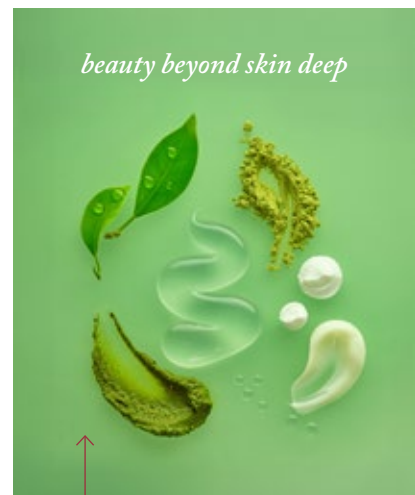
- 1 Southsand City leaders have asked your team to create a PSA to share on the city's social media page to help reduce the spread of Southsand fever. With a partner, choose one of the Health Department's recommendations for reducing risks from Southsand fever (introduced in Activity 9) to highlight in your PSA.
- 2 Your PSA should communicate at least one important aspect from the recommendations. With your partner, decide on your audience (for example, parents, teens, general public, outdoor workers) and brainstorm ideas about the content and images of your PSA.
- 3 Purposefully create a biased PSA that uses cognitive shortcuts and cognitive biases to persuade the reader to support your recommendation. Make sure that it:
 - contains information about the Southsand fever recommendation.
 - is approximately 50 words or less.
 - includes an image or video.
 - applies what you know about cognitive shortcuts and cognitive biases.
 - addresses any other requirements from your teacher.
- 4 Trade your biased PSA with one from another pair of students. Work with your partner to apply your skills for evaluating information that you've gained throughout the unit to review the other pair's PSA. Look for misuse of evidence, cognitive shortcuts, cognitive biases, and/or fast thinking. Discuss how these features might affect a reader's thinking.
- 5 Brainstorm ideas on how to improve the biased PSA you are reviewing to make it less misleading and reduce cognitive bias.
- 6 Share your suggestions with the other pair of students. Listen to their suggestions for how to improve your PSA.
- 7 Based on the feedback from the other pair and your own ideas, make a second PSA—an unbiased PSA—that supports the same recommendation. Keep your original biased PSA to share with the class during your presentation as you explain the changes you made to it.
- 8 Share your PSAs with the class. Make sure to explain why you think your unbiased PSA is more likely to succeed than your biased PSA in the community of Southsand.
- 9 As a class, reflect on your experience creating the PSAs. Discuss the following questions related to everyday life:
 - Have you encountered the use of cognitive shortcuts and cognitive biases in advertisements and promotions?
 - Do you think the use of cognitive shortcuts and cognitive biases in advertisements and promotions is fair or unfair and why?
 - What actions related to this issue do you believe should or should not be taken?

BUILD UNDERSTANDING

- ① In this activity, you compared a cognitively biased PSA to an unbiased PSA. Describe a situation in which you would want to receive information that is more like
 - a the biased PSA.
 - b the unbiased PSA.
- ② Think about the media (news articles, posts, videos, images, music) you consume every day. How have your experiences with this instructional unit changed your thinking about how to process that media information?
- ③ Southsland fever is based on a real-life disease called Valley fever. Scientists began investigating Valley fever in the late 1800s. One set of researchers, Emmett Rixford and Thomas Caspar Gilchrist, isolated the organism causing the disease and thought it looked like a type of protozoa called *Coccidia*. They sometimes found mold growing on their petri dishes and dismissed this mold as a contaminant instead of a pathogen. Rixford and Gilchrist's ideas matched the thinking of earlier doctors studying the disease. Explain how fast thinking and/or confirmation bias may have played a role in their conclusions.

CONNECTIONS TO EVERYDAY LIFE

- ④ Product advertising often relies on messaging that appeals to people through cognitive shortcuts and cognitive biases. Imagine a popular skincare brand that markets one of their products as environmentally friendly.
 - a How could the product advertisements take advantage of cognitive shortcuts or cognitive biases in people who value environmental protection?
 - b How could skills from this unit help you evaluate claims in the advertisement?



Advertisements for environmentally friendly products often display natural settings or items.

STUDENT GLOSSARY

actively open mindset

a metacognitive thinking approach in which one evaluates source credibility, seeks evidence, and considers alternative explanations (This is also known as actively open-minded thinking.)

anchoring shortcut

a cognitive shortcut where a person relies too much on an initial piece of quantitative information to make a conclusion (In psychology, this is called anchoring heuristic.)

anecdote/anecdotal

a single story or one-time event

availability shortcut

a cognitive shortcut where a person depends on easily recalled or recent information to make a conclusion (In psychology, this is called availability heuristic.)

biased interpretation

a type of confirmation bias where a person interprets information to confirm an existing idea (In psychology, this is called biased assimilation.)

biased selection

a type of confirmation bias where a person seeks information to confirm an existing idea (In psychology, this is called selective exposure.)

cell culture

the process of growing cells under controlled conditions outside of their natural environment

cherry-picked data

information that is selectively chosen to support a claim

claim

a statement that asserts something is true

clinical trial

a carefully controlled experiment to test a medicine's safety and effectiveness

cognition

the set of mental processes that people use to interpret, imagine, and reason

cognitive bias

an unconscious and systematic error in thinking

cognitive shortcut

a specific pattern of fast thinking that can lead to errors when evaluating information

confirmation bias

the tendency for a person to seek out and interpret information in a way that supports their existing ideas

conflict of interest

a situation in which an interest in the outcome may compromise a person's actions or conclusion

conformity bias

a tendency for a person to change their thoughts and actions to fit in with the other people around them

credible source

a source with relevant expertise that provides accurate information that is free from bias

disease transmission

the various ways that infectious diseases can spread

emotion bias

a tendency for a person to depend on their emotions to make a conclusion

epidemiologist

a scientist who studies the patterns, causes, and control of disease in groups of people

eukaryotes

organisms whose cells contain a nucleus

evidence

information that can support or refute a claim

fast thinking

quick, automatic thinking that uses shortcuts to reach conclusions

hypothesis

a possible explanation for observations, facts, or events that may be tested by further investigation

infectious disease

a disease that is passed from one organism to another organism

metacognition

the practice of thinking about one's own thinking

microbe

a microscopic cellular organism or a virus

misinformation

false, inaccurate, or misleading information often shared by a person who thinks it is true

mode of transmission

the way an infectious disease spreads

noninfectious disease

a disease that cannot be passed from one organism to another organism

organism

an individual animal, plant, or other living life-form

pathogen

an organism or biological agent that causes infectious disease

peer review

a process in which a scientist's research is critically evaluated and judged by other independent experts

prokaryotes

cells that do not have a nucleus, and their DNA is located in the cytoplasm of the cell

protist

an organism made up of a single cell or many cells with a nucleus and that is not an animal, plant, or fungus

protozoa

types of protists that are unicellular eukaryotes

public service announcement (PSA)

an educational message created to raise awareness and change people's attitudes or behaviors

quantitative

relating to, or expressible as, a number or amount

reasoning

the process of thinking in a structured way in order to interpret information and draw conclusions from it

representativeness shortcut

a cognitive shortcut where a person depends on a pre-existing idea or category to make a conclusion (In psychology, this is called representativeness heuristic.)

slow thinking

careful, reflective thinking that uses reasoning to reach conclusions

spore

a reproductive cell that can develop into a new individual without fusing with another reproductive cell

trade-off

a desirable outcome given up to gain another desirable outcome

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