Teacher Resource for:

Empathy and Pro-Social Behavior in Rats

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GENERAL USE OF *Science* in the Classroom

Student Learning Goals:

"One fundamental goal for K-12 science education is a scientifically literate person who can understand the nature of scientific knowledge."[1]

The U.S. National Academy of Sciences defines science as: "Any new finding requires independent testing before it is accepted as scientific knowledge; a scientist is therefore required to honestly and openly report results so that they can readily be repeated, challenged, and built upon by other scientists. Proceeding in this way over centuries, the community effort that we call science has developed an increasingly accurate understanding of how the world works. To do so, it has had to reject all dogmatic claims based on authority, insisting instead that there be reproducible evidence for any scientific claim."

An important student learning goal, central to any understanding of "the nature of scientific knowledge," is to give each student an appreciation of how science is done.

This includes knowing why:

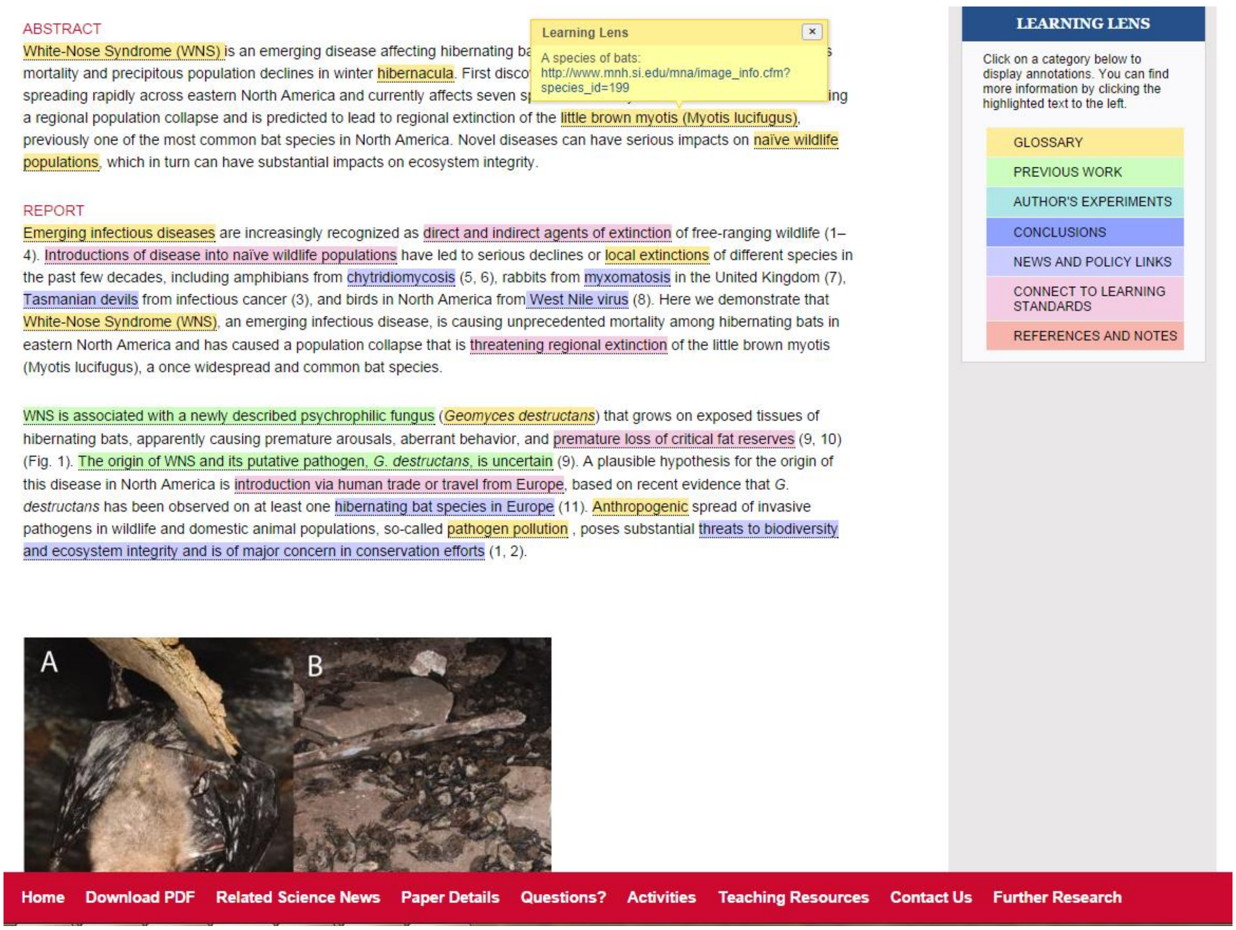
- Scientists must be independent thinkers, who are free to dissent from what the majority believes.
- Science can deal only with issues for which testable evidence can be obtained.
- All scientific understandings are built on previous work
- It is to be expected that one scientist's conclusions will sometimes contradict the conclusions of other scientists.
- Science is a never-ending venture, as the results from one study always lead to more questions to investigate.

[1] *A Framework for K-12 Science Education*, National Research Council, 2012

Using This Resource

Learning Lens:

The Learning Lens tool can be found on the right sidebar of each resource and is the source of annotations. Click on the headings to highlight portions of the text of the corresponding research article. A subsequent click on the highlighted text will produce a text box containing more information about that particular piece of text. Below is an example of the Glossary function of the Learning Lens.



An example of the resource with the Glossary, Previous Work, Author's Experiments, News and Policy Links, and References and Notes tools turned on. The Glossary tool is in use.

Learning Notes:

Learning Notes accompany each figure and are designed to help students deconstruct the methods and data analysis contained within each figure.

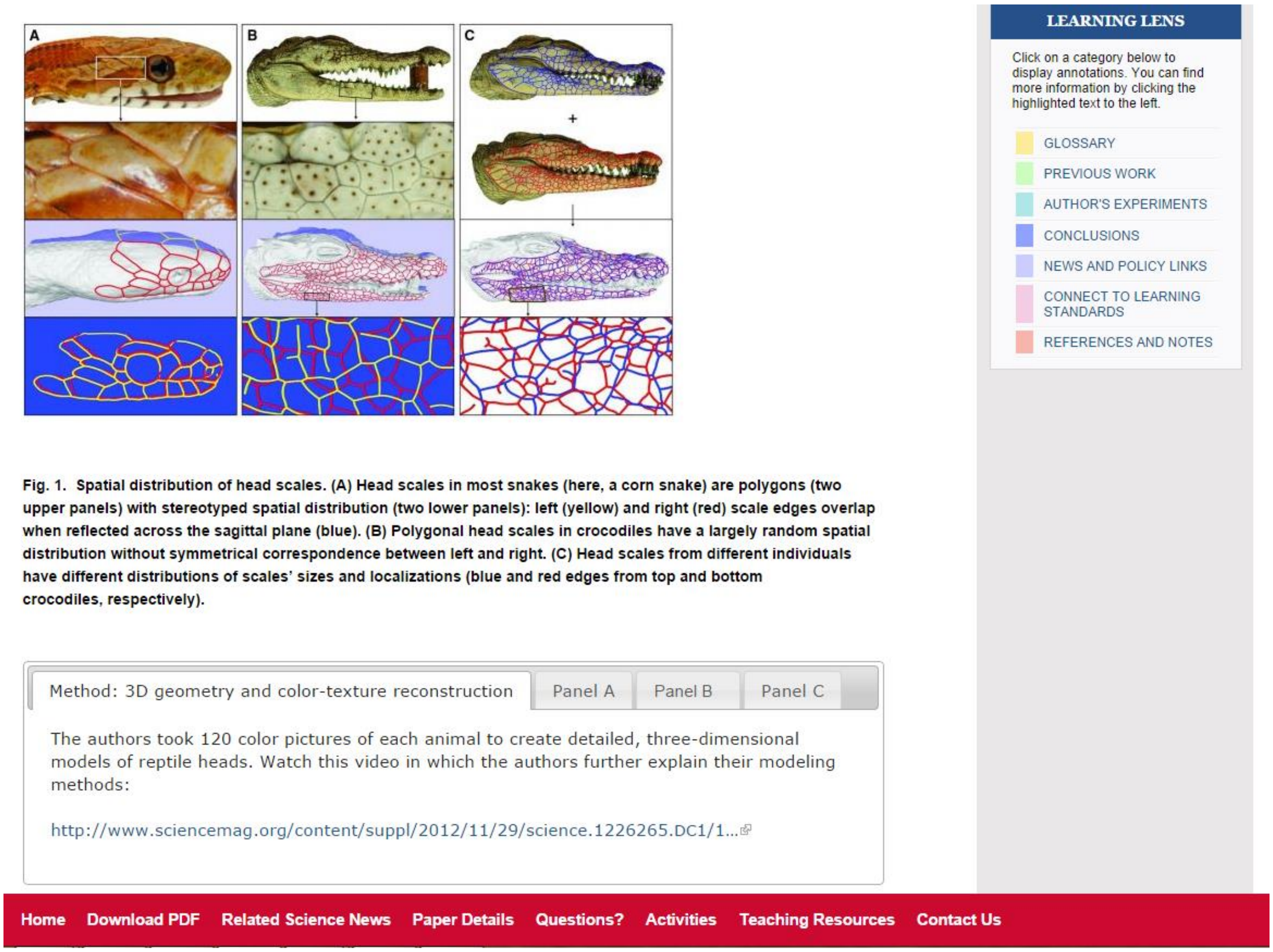
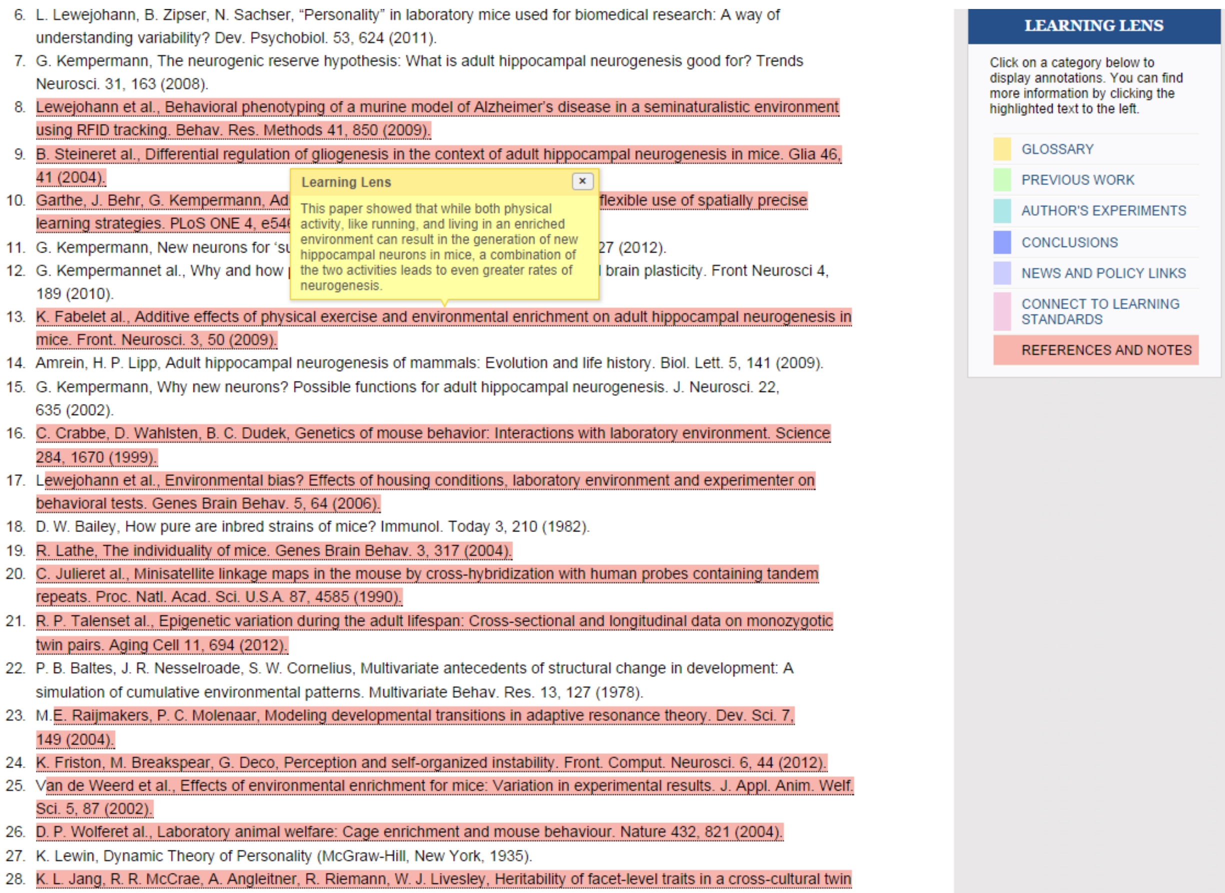


Fig. 1. Spatial distribution of head scales. (A) Head scales in most snakes (here, a corn snake) are polygons (two upper panels) with stereotyped spatial distribution (two lower panels): left (yellow) and right (red) scale edges overlap when reflected across the sagittal plane (blue). (B) Polygonal head scales in crocodiles have a largely random spatial distribution without symmetrical correspondence between left and right. (C) Head scales from different individuals have different distributions of scales' sizes and localizations (blue and red edges from top and bottom crocodiles, respectively).

References:

The Reference section of each resource is annotated with a short statement about how or why each reference relates to the current research study.



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Learning Lens

This paper showed that while both physical activity, like running, and living in an enriched environment can result in the generation of new hippocampal neurons in mice, a combination of the two activities leads to even greater rates of neurogenesis.

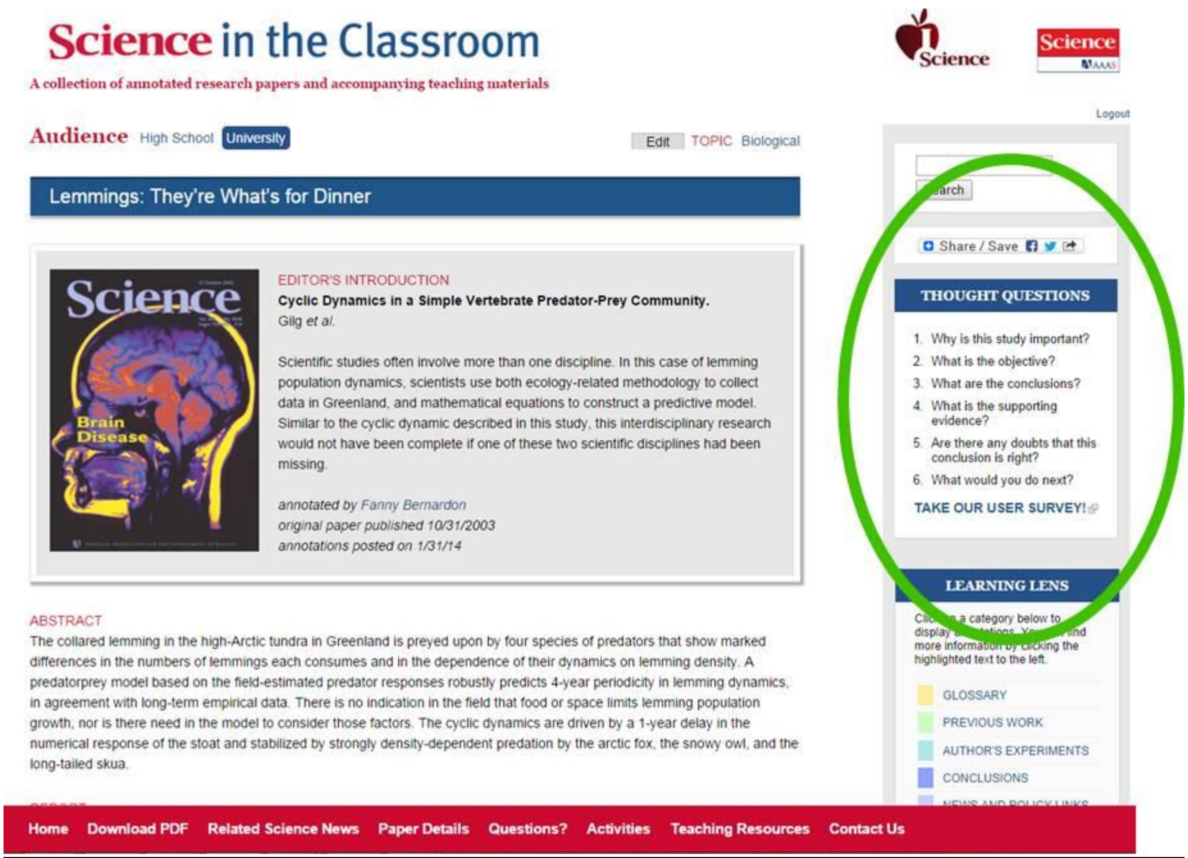
LEARNING LENS

Click on a category below to display annotations. You can find more information by clicking the highlighted text to the left.

GLOSSARY
PREVIOUS WORK
AUTHOR'S EXPERIMENTS
CONCLUSIONS
NEWS AND POLICY LINKS
CONNECT TO LEARNING STANDARDS
REFERENCES AND NOTES

Thought Questions

Thought Questions are located above the Learning Lens in the right sidebar of each resource. These questions were written to be universal and applicable to any primary research paper. Thought questions do not have a single answer, or a correct answer for that matter, and can be used to stimulate discussion among students.



Suggestions for Classroom Use:

In addition to the thought questions discussed above, other resources are provided for use in the classroom. These can be found toward the end of the teacher guides associated with each specific article and include:

1. Discussion questions specific to the article, related to the standards, and/or associated with the figures.

2. Activities tied to the articles.

Some ways to use the *Science* in the Classroom articles:

1. Assign to student groups to read and discuss during class.

2. Assign small sections of the article to student groups to read and discuss during class, with the expectation that they will present or use jigsaw to teach the entire class what is in their part of the article.

3. Assign to individual students to complete during class or as homework.

4. Assign reading as an extra credit project.

Some ideas for interactive student engagement after reading the article:

1. Students write answers to discussion questions (for example, those linked to the standards or those linked to the diagrams).

2. Go over the abstract, as well as information about the purpose and structure of an abstract, and have students write their own abstracts for the articles in language that could be understood by their peers.

3. Have students edit the article, or parts of the article, to a simpler reading level.

4. Have students, alone or in small groups, use the annotated list of references to explain how the scientists who wrote this article built on the published work of at least one independent group of scientists in making their discoveries. In the process, did they produce data that supports the findings of the earlier publication that they have cited in the text? In what way does this article support the statement that scientific knowledge is built up as a “community effort”?

5. Use the article and discussion questions linked to the standards and the diagrams for a teacher-led classroom discussion. The discussion can focus on the nature of science and scientific research, as well as on the science in the article itself.

6. Have students give a classroom presentation about the article, parts of the article, or their answers to discussion questions.

ARTICLE-SPECIFIC MATERIALS

Connections to the nature of science from the article

- Why do scientists want to look at the driving force behind helping behavior in rats?

The importance of this scientific research

- Nonprimate mammals are driven by empathy to help one of their own.
- The biological roots of helping may be traced back to nonprimate mammals such as rats.
- The helping action is socially beneficial.

The actual science involved

- Neurobiology
- Psychology
- Behavioral biology
- Biostatistics
- Location and movement tracking

Connect to Learning Standards:

The Next Generation Science Standards

- Science and Engineering Practice 4: Analyzing and interpreting data
- Science and Engineering Practice 6: Constructing explanations (for science) and designing solutions (for engineering)
- Science and Engineering Practice 7: Engaging in argument from evidence

The AP Biology Standards

- Science Practice 5: The student can perform data analysis and evaluation of evidence.
- Science Practice 6: The student can work with scientific explanations and theories.

Common Core English Language Arts

- 11-12.4: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
- 11-12.6: Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
- 11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

<u>Summary of the Article for the Teacher:</u>

It is recommended that this not be used by students in place of reading the article.

General Overview:

Humans and other primates such as apes are intellectually advanced mammals capable of helping one of their own who is experiencing distress. Several studies in nonhuman primates indicate that acting to help another in distress is driven by empathy as indicated by facial expression, etc. Where in the tree of life (what are the biological roots of) did this prosocial activity driven by empathy arise? Are nonprimate mammals such as rats capable of acting to help one of their own in a manner driven by empathy? Rats have already shown that they can act to help their own, but the motivation for their helping could not be satisfactorily proven. By setting up a paradigm in which a rat's helping action to free one of its species is not easily learned or instinctual, some proof for deliberate helping action as a result of empathy is met.

Topics Covered:

- Pro-social behavior
- Emotional contagion
- Empathy
- Learned helplessness
- Location and movement monitoring techniques

Why this research is important:

"Why study helping in rats? The answer is simple. Rats don't have religion or culture; adult rats don't teach rat pups to follow the Golden Rule. Therefore, evidence that rats help is evidence that helping may be an evolutionarily conserved behavior. Simply put, if rats help another in distress then maybe at least part of what motivates us humans to help is similar to what motivates rats to help. Maybe the Golden Rule is not our motivation for helping. Maybe we help because of a biological inheritance that we share with rats and other mammals." –Dr. Peggy Mason

Methods used in the Research:

- Alarm call sampling using a bat detector
- Categorizing door-opening style
- Location and movement monitoring
- Measuring freezing time
- Statistical analysis

Conclusions:

- Rats moved faster around the arena and spent more time in the center of the arena close to the restrainer when another rat was in the restrainer.
- Trapped rats emitted alarm calls that indicate distress.
- Rats open the restrainer containing a real rat significantly more than an empty restrainer or one containing a toy rat.
- Rats continue to liberate trapped cagemates even when social interaction after freeing was not possible.
- Female rats were more active than male rats and freed their trapped cagemates more frequently than male rats.
- Rats set their cagemates free even when a separate container with chocolate chips was present.

Areas of Further Study:

- Will helper rats be similarly motivated to aid a rat they never “met” before?
- Does this helping behavior hold true across rodent species?
- Will less bold rats ever rescue a trapped cagemate?

Discussion Questions:

1. The authors claim that the helper rats were acting out of emotional contagion. Based on the definition of emotional contagion, do you agree? What experimental evidence is provided in the paper to support this? What additional experiments (if any) do you think would help establish emotional contagion in the helper rat?

2. Helper rats that opened the restrainer for their cagemates were bolder. How did the authors assess and define boldness? Does this change your interpretation of the authors' conclusion that empathy drives the door-opening action?

3. What evidence is given to support the statement that the door-opening action of the helper rat was deliberate? Describe at least two. Give an alternative explanation for the results of those experiments.

4. The authors state that the prosocial action of the helper rat was driven by emotional contagion and empathy, and that this points to biological roots of such activity. They also state that these actions occur because it benefits group survival. If rats are acting to benefit their entire species, why were the rats housed together to become "friends" before being tested? What is the next step in proving that these actions are broadly benefiting the species?

Discussion questions associated with the figures

1. Fig.1B. Panel: Why does the rat in the 2+empty condition only move along the perforated divide?

2. Fig.2. Panel A: At what percentage did the rats in the control conditions open the door on day 1 compared with day 12?
    a. Panel B: Do the rats in the control conditions (empty and 2+empty) ever open the door to the restrainer before the experimenter does?
    b. Panel C: Are there any other sections of the graph where an increase in activity is seen?
    c. Panel D: How many more times does the rat lift the door with its head than from the side on day 7? Are there any other sections of the graph where an increase in activity is seen?
    d. Panel E: What was the longest amount of time the rats spent frozen? The shortest? On which testing days did this occur?

3. Fig. 3. Panel A: How much faster did the average female mouse open the restrainer door than the average male mouse?
    a. Panel B. Do you consider a difference of 2 cm/s by the average female helper rat to be noteworthy?

4. Fig.4. Panel A&B: Is the opening action driven by empathy for the distressed cagemate, or by the expectation to interact socially with the freed rat?
    a. Panel C: Look closely at the lines connecting the open circles (the chocolate chip condition). On what day did the helper rat in the chocolate chip condition open the door before the experimenter?
    b. Panel D: Compare the times it took for door opening on days 7–12. Why would the rat open the empty container at all?