On Aggression — What Makes Us Fight?

Secrets of the Sequence Video Series on the Life Sciences • Grades 9 — 12

Teaching materials developed by **VCU** Life Sciences

Virginia Commonwealth University

Classroom Tested Lesson

Video Description

"Secrets of the Sequence," Show 102, Episode 1
"On Aggression" – approximately 9 minutes viewing time

Ed Kravitz doesn't want to control the masses or create supermen but he does want to understand the complex genetic circuitry of aggression responsive behavior. He's studying the genetics of aggression by observing aggression in flies and lobsters. Could we be more like them than we want to admit?

Ward Television
Producer: Paul Gasek
Featuring: Edward Kravitz. Department of Neurology at Harvard Medical School
Lesson Author; Reviewers: M.B. Elder, Selvi Sriranganathan; Catherine Dahl; Dick Rezba
Trial Testing Teachers: Dawn Kessler, Amy Benton

National and State Science Standards of Learning

National Science Education Standards Connection

Content Standard A: Science as Inquiry

As a result of activities in grades 9-12, all students should develop:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard C: Life Science

As a result of their activities in grades 9-12, all students should develop understanding of

- Behavior of organisms

Selected State Science Standards Connections

Use http://www.eduhound.com (click on "Standards by State") or a search engine to access additional state science standards.

Indiana

Developmental and Organismal Biology

B1.18 Explain that the regulatory and behavioral responses of an organism to external stimuli occur in order to maintain both short- and long-term equilibrium.

Genetics

B1.29 Understand that and explain how the actions of genes, patterns of inheritance, and the reproduction of cells and organisms account for the continuity of life, and give examples of how inherited characteristics can be observed at molecular and whole-organism levels-in structure, chemistry, or behavior.

Evolution

B1.31 Describe how natural selection provides the following mechanism for evolution: Some variation in heritable characteristics exists within every species, and some of these characteristics give individuals an advantage over others in surviving and reproducing. Understand that the advantaged offspring, in turn, are more likely than others to survive and reproduce. Also understand that the proportion of individuals in the population that have advantageous characteristics will increase.

Florida

Processes of Life

Standard 1:

The student describes patterns of structure and function in living things. (SC.F.1.4)

1. knows that the body processes involve specific bio-chemical reactions governed by biochemical principles.
6. knows that separate parts of the body communicate with each other using electrical and/or chemical signals.
7. knows that organisms respond to internal and external stimuli.

The Nature of Science

Standard 1:

The student uses the scientific processes and habits of mind to solve problems. (SC.H.1.4)

1. knows that investigations are conducted to explore new phenomena, to check on previous results, to test how well a theory predicts, and to compare different theories.
5. understands that new ideas in science are limited by the context in which they are conceived, are often rejected by the scientific establishment, sometimes spring from unexpected findings, and usually grow slowly from many contributors.

Standard 3:

The student understands that science, technology, and society are interwoven and interdependent. (SC.H.3.4)

3. knows that scientists can bring information, in-sights, and analytical skills to matters of public concern and help people understand the possible causes and effects of events.
4. knows that funds for science research come from federal government agencies, industry, and private foundations and that this funding often influences the areas of discovery.

Overview

In this video, students learn about the chemistry and genetics of aggression. It provides students with a basic understanding of this complex behavior and how it is initiated by the nervous system of the organism. Two experiments – one using lobsters and another using fruit flies — are highlighted. These organisms are raised in total isolation and used in well-controlled studies so that any behaviors observed can be attributed

to inherent genetic traits and not learned behaviors. Aggressive behavior is viewed as leading to higher survival rates and therefore in these particular species, aggression is a desirable trait that is linked with higher levels of reproduction (increased fecundity). Prior to presenting this lesson, you may wish to discuss other genetically-determined behaviors, such as migration, nest building, and so on.

This video also provides an opportunity for students to analyze the design of experiments. Dr. Kravitz has been studying lobster aggression for twenty years. Fruit flies are now being studied because their entire genome has been mapped and it will be easier to determine which genes are responsible for aggressive behavior. Students will discover that the experimental design, even though presented light-heartedly, has been carefully planned to test hypotheses and collect data.

Testing: A sample related multiple choice item from State Standardized Exams

Scientists studied a flock of tundra swans that spent the winter along rivers in Virginia. The swans migrate in the spring to other locations. What would be the *best* way for scientists to distinguish between the birds they study in Virginia and flocks in the summer location?

a. Capture and put coded bands on the birds in Virginia, then record the bands seen on birds in the summer location *
b. Take detailed photographs of winter flocks in Virginia and summer flocks in other locations and compare photographs
c. Follow the Virginia flock by vehicle on a daily basis
d. Capture birds in the expected summer location and dissect them to find clues that show the birds were in Virginia during the winter

Source: Virginia Standards of Learning Assessment, End of Course Biology Assessment, 2003

Video Preparation

Preview the video and make note of the locations at which you will later pause the video for discussion.

Before Viewing

1. Write the following phrases on the board and ask: "What do the following colloquial phrases and expressions mean?" Can you add any similar ones?
   - Going berserk
   - Flying off the handle
   - Seeing red
   - Running amok

   Other expressions may include, "coming unglued", "having a fit", and "smoke coming out of your ears".)

2. Ask: "Do you think that aggressive behavior runs in families?
3. Have the students list 3 ways that being aggressive may help animals survive better. (*reproduction opportunities, protecting territory, protecting their offspring)*

During Viewing

1. START the video.

2. PAUSE the video (4:11 into the video) after the narrator says, “These genes produce compounds that trigger and support that behavior.”

   Ask: “What determines if these lobsters know how to fight since they have never done it before?” “Give one way that this behavior may benefit the lobster.”
   Aggressive behavior can help an animal claim territory and defend it, as well as get resources and a mate; for many animals, survival depends on aggression.

3. RESUME the video.

4. PAUSE the video (7:32 minutes into the video) after the segment on fruit fly fights when the typical fight begins with “wing threats” and escalates to “boxing”.

   Ask: **“**While fruit flies may use “wing threats”, what kinds of behaviors do humans use to signal aggressive behavior?”
   Making fists, body postures, gestures, yelling, and use of certain words (“fighting words”).

   Ask: “Do you think aggressive people get more opportunities in life? Do you think it is a bad thing or a good thing to be aggressive?”

5. RESUME the video and play to the end.

After Viewing

1. In the video, you saw a section on the aggressive behavior in lobsters. Ask: “Why was it so important in the design of the experiment that the lobsters be raised in isolation?”

   It is important so that no behaviors could be “learned” in dealing with “social” situations. Because all the lobsters had not “learned” to fight, any observed aggressive behavior can be attributed to a genetic basis.

2. Have students relate the 4 stages of aggression to what they themselves observe in their lives by asking them the questions below:
   a. *1st stage of aggression -display of weaponry*
   b. *Mid-level aggressive behavior - pushing and shoving*
   c. *High-level aggressive behavior – slugging it out*
   d. *Loser stops fighting and winner displays prowess*

   - How do the stages listed in the video compare with your own experiences with aggressive behaviors?
   - What kind of aggressive behaviors have you seen students use in school? (*Words, fists, body-posturing, and gestures).*

Optional Extension:
Dr. Kravitz admits that it is not clear where the research on the 4 levels of aggression is headed but he believes having some insight into aggressive behavior may be useful.

Ask: “How do you think this insight will be useful in dealing with aggression in society today?” *See*

http://labworks.hms.harvard.edu/fruit_fly/training_room/index.html for an interview with Dr. Kravitz on human aggressive behavior.

Teacher Notes for the Student Activity: Fighting and Reproducing--Does aggressive behavior always mean reproductive success?

Aggression is a nearly universal feature of the behavior of social animals. In the wild, it is used to obtain food and shelter, for protection from predation and for selection of mates, all of which are essential for survival. Fecundity is a measure of and organism's reproductive success – that is, how many offspring it is able to produce.

In this activity students will simulate the interaction of a group of fruit flies to explore the relationship of aggressive behavior and fecundity. Following the simulation are discussion questions as well as an Internet-based activity on aggression and reproduction that is currently (2005) available: If class time, Internet access, and the following Web site are available, have student explore a case study of dominance and reproduction in nature based on Harris' hawks at
http://biology.arizona.edu/sciconn/lessons2/Vuturo/vuturo/add_info1.htm

Materials needed

- 3X5 index cards. Prepare about 10 cards of each of the following so that you have one card per student in your class. If you plan on doing this lesson more than once, you may wish to laminate these cards and have students record any changes with an erasable marker or on a separate piece of paper.
    - Cards labeled "Aggression Level 35" on one side and "Fecundity Level 15" on the other side
    - Cards labeled "Aggression Level 25" on one side and "Fecundity Level 25" on the other side
    - Cards labeled "Aggression Level 15" on one side and "Fecundity Level 35" on the other side
- A source of music to turn on and off. If you don't have music, you could just tell the students when to stop and when to go.
- Pennies to resolve ties
- Pencils to keep score.

Procedure

1. Distribute an equal or near equal number of the three types of cards so each student has just one of the marked cards. Explain that the aggression level number represents tendency for aggressive behavior, while the other number on the back represents fecundity, or success in reproducing.

2. Have the students take a pencil, their card, and a penny and form two circles (inner and outer) for the first round of an activity similar to musical chairs. An equal or near equal number of students should be in each circle. Make sure the different groups intermingle during this exercise; otherwise the results may be skewed. In a small class, or where there is not enough room, you can have the students wander and find a different partner each round.

3. First Round – to compare aggression numbers. Start the music. Outer circle goes clockwise, inner circle goes counterclockwise. Stop the music. Have students compare the aggression number on their cards with the person directly in front of them. (A student *without* someone directly in front of him/her will just wait until the next round; alternatively, you may wish to participate to make an even number of students). The winner adds five points to his/her fecundity number and the loser subtracts five points. If there is a tie between the two students (i.e., they both have the same aggression level), they should flip a coin to determine the winner.

4. Second Round – to compare fecundity total numbers. Start music. Outer circle goes clockwise, inner circle goes counterclockwise. Stop the music. Have students compare their new fecundity totals with the person directly in front. Whoever is less fecund is "out-competed" and does not reproduce – that is, they don't move on to the next round. Losers take their seats. Again, if students are tied with the same fecundity number, they should flip a coin to determine who wins and loses.

5. Repeat a series of these first and second rounds until about a quarter of the students remain. Compare the distribution of aggression numbers among the "survivors" to the distribution at the beginning of the simulation.

Discussion Questions

If you plan on using this lesson more than once, you may wish to put the following information up on an overhead projector; that way, Student Handouts can be reused by the next class.

1. When the activity began, there were about equal numbers of the different aggression levels (35, 25, and 15). What is the distribution now?
   Results will vary

2. What does aggressiveness have to do with fecundity?
   Aggressive individuals will probably win more fights, however, the more energy that is expended while fighting, the less is devoted to reproduction. Thus, there is a trade-off between aggression and fecundity.

3. At the start of the activity everyone had the same number of points (total of 50) divided between aggression and fecundity. In nature, might similar differences in traits occur? Why or why not?
   Species often cannot maximize one trait or behavior without drawing resources (energy) away from another. Thus, as with aggression and fecundity in our example, each member of a species may differ slightly on the way they allocate their finite resources. Natural selection will act upon these differences, causing the overall population to contain more and more individuals who have the most adaptive allocation of resources.

4. What might the coin toss represent in this simulation?
   The coin toss reflects random environmental events that are unrelated to genetics or natural selection.

Optional Extension

If class time, Internet access, and the following Web site are available, research Harris' hawks at http://biology.arizona.edu/sciconn/lessons2/Vuturo/vuturo/add_info1.htm

Ask the following questions:

- How does genetic fitness work in the animal world?
- Do only the alpha (most dominant) males and the alpha (most dominant) females reproduce?

No, Harris' hawks have adapted to the very extreme environmental conditions found in the desert in the Southwest US and Mexico. Survival depends on a large gene pool, not a narrow one.

Student Handout: Fighting and Reproducing – Does aggressive behavior always mean reproductive success?

In this activity you will simulate the interaction of a group of fruit flies to explore the relationship of aggressive behavior and reproductive success (fecundity)

Materials

- An index card with two numbers on it.
- A pencil to record your scores
- A penny to break any ties.

Procedure

1. Examine your card. The aggression level number represents tendency for aggressive behavior, while the second number on the other side represents fecundity, or reproductive success.

2. Take a pencil, your card, and a penny and form two circles (inner and outer) for the first round of an activity that is somewhat similar to musical chairs. An equal number of students should be in each circle.

3. In the First Round you will compare aggression numbers that represent level of aggressiveness.
   - When the music starts, move clockwise if you are in the outer circle, and counterclockwise if you are in the inner circle.
   - When the music stops, compare the aggression number on your card with the aggression number of the person directly in front of you.
   - The winner adds five points to the number written on the back of the card (fecundity level) and the loser subtracts five points from the fecundity number. If there is a tie between the two, flip one coin to determine the winner.

4. In the Second Round you will compare fecundity numbers that represent the level of reproductive success.
   - When the music starts, move clockwise if you are in the outer circle, and counterclockwise if you are in the inner circle.
   - When the music stops, compare your new fecundity number with the fecundity number of the person directly in front of you.
   - Whoever is less fecund is "out-competed" and does not reproduce. Losers take their seats and do not participate in additional rounds. Again, if there is a tie, flip a coin.

5. Repeat a series of these first and second rounds until only about a quarter of the class remains. Compare the distribution of aggression numbers among the "survivors" to the distribution at the beginning of the simulation.

Discussion Questions

1. When the activity began, there were about equal numbers of the different aggression levels (35, 25, and 15). What is the distribution now?
2. What does aggressiveness have to do with fecundity?
3. At the start of the activity everyone had the same number of points (total of 50) divided between aggression and fecundity. In nature, might similar differences in levels of traits occur? Why or why not?
4. What might the coin toss represent in this simulation?

Additional Resources

Because Web sites frequently change, some of these resources may no longer be available. Use a search engine and related key words to locate new Web sites.

Experimental Design and Data Analysis for middle and high school students
Cothron, J., Giese, R, and Rezba, R. 2000. Students and Research: Practical Strategies for Science Classrooms and Competitions. Dubuque, IA: Kendall/Hunt Publishing.

Neurons and neurotransmitters
http://nobelprize.org/medicine/educational/synapse/index.html

How a neuron works
http://faculty.washington.edu/chudler/synapse.html

Harvard Medical School and Dr. Kravitz
Kravitz and fruit flies. A technical paper
http://www.brembs.net/aggression/kravitz_pnas.pdf

Neuroethology of aggression in decapod crustaceans.
http://caspar.bgsu.edu/~lobsterman/research/RHcrusties.html#SerFight

Fighting lobsters and fighting flies: Two model systems for the study of aggression.
http://www.hms.harvard.edu/bss/neuro/kravitz/currentresearch.html

Research briefs from Harvard Medical School: Winner and Losers Exhibit Model Fighting Behavior
http://focus.hms.harvard.edu/2002/May3_2002/research_briefs.html

The Agonistic Behavior of Lobsters. A technical abstract.
http://caspar.bgsu.edu/%7eHuberlab/private/KingSolomon.html

Fruit Fly Fight Club. A great site for students (with music)
http://labworks.hms.harvard.edu/fruit_fly/thriller/

Discovery channel: Aggressive Fighting: Cat Behavior
http://animal.discovery.com/guides/cats/behavior/aggressive.html

Experimental Design and the Scientific Process
http://www2.nau.edu/~gaud/bio372/class/behavior/sciproc.htm

http://whyfiles.larc.nasa.gov/text/educators/tools/pbl/scientific_process.html
http://helios.bto.ed.ac.uk/bto/statistics/tress2.html#DESIGN%20OF%20EXPERIMENTS

A WebQuest rubric for testing the scientific process.
http://www.netxv.net/esc/technology/InstructionalTechnology/webquest%20examples/061903WebQuests/scientific%20process.htm

Scientists from the University of Tasmania explain experimental design.
http://agsci.eliz.tased.edu.au/default.htm

Scientists from the University of West Virginia plant science explain experimental design.
http://www.wv-hsta.org/gradcourse/fall04/syllabus.htm

Genomic Revolution
http://www.ornl.gov/sci/techresources/Human_Genome/education/education.shtml
The Web site to the government-funded Human Genome Project with links about genomics, the history of the project, and more.

Secrets of the Sequence Videos and Lessons
This video and 49 others with their accompanying lessons are available *at no charge* from
www.vcu.edu/lifesci/sosq