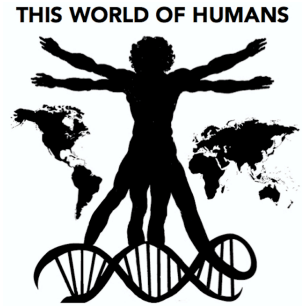

Visionlearning®
your insight into science

This World of Humans: Episode #3
Guide for Educators

Traffic Pollution Shortens Children's Chromosomes

These activities address NGSS ETS1.A, ESS3.A, ESS3.D, as well as specific Cross-Cutting Concepts and Science and Engineering Practices (see page 8). Many are also suitable for courses designated as "Writing-Intensive."

About the Article

This article presents early research into the effect of traffic-related air pollution on telomere length in the cells of children living in Fresno, CA. The authors developed this pilot study to explore connections between the amount of PAH in the atmosphere and telomere length, with the aim of shedding light onto the relationship between air pollution and cardiopulmonary disease.

About the interview

In this interview, Dr. Balmes discusses the research and its implications for society. This includes a more in-depth look into the study design (including modeling PAH exposure) and study population.

Both the article and the interview can be found here: https://www.visionlearning.com/en/twoh/#ep3

Recommended: pair these materials with the Visionlearning modules: *Modeling in Scientific Research* and/or *Using Graphs and Visual Data in Science* (see "Extension Activities" on page 4).

Use in the Classroom

These materials are useful for exploring ways in which scientists build models to understand causation and correlation…. Students should read the article before listening to the interview.

1. **Pre-reading and pre-listening activities** are provided to prompt prior knowledge and help students make connections between their own lives and the research they are learning about. Materials may be used in the classroom to generate discussion, or as homework if the article or interview will be read/listened to in-class. Having students write before speaking helps focus discussions and reading.
2. The **worksheet** is explicitly designed to walk students through the process of reading a scientific paper. It serves as an excellent homework assignment (if the article is read outside of class) and will direct students toward identifying important information about the research. While the answers provided can be used to check student reading, it is really an opportunity to assist students in how to read scientific material. Completed worksheets are excellent for small group discussions, allowing students to solve any discrepancies themselves, or as a debrief with the entire class.
3. **Post-reading and post-listening activities** are designed to extend student thinking and engage them more deeply with the text and interview. These questions are great for small groups, for large class discussions, or for short-answer writing assignments.

Pre-reading and pre-listening activities

1. **Vocabulary preparation:** Provide students with the Vocabulary Worksheet and ask them to provide definitions. Clarifying terminology as a class is recommended. This worksheet is suitable for a 10-15 minute in-class activity if students have access to dictionaries or the internet.

2. **Mind-map a model**: This is best done in small groups of 3 or 4 students and is suited for in-class work where the instructor can regularly offer guidance to each group. This requires ~30 minutes of class time. If internet access is available, students might choose to use the free mapping tool Coggle (http://www.coggle.com) rather than draw on paper. The intent of this activity is to help students begin to see the interrelationships that exist between various forms of data, as well as begin to understand how modeling allows researchers to explore ideas that are otherwise unexplorable. Be certain to take at least 10 minutes to debrief as a class, looking at the maps each group generated and the rationale for their choices. **Instructions to students, already partnered:**

   A mind map is a fun and productive way to organize ideas and concepts in a visual way. Think of the page (or screen) as a subway map, with lines running from station to station. Some intersect, others do not. In this activity, you are going to create a mind map for a potential research project into the relationship between human health and pollution. Rather than identify research methods, though, you will be mapping different factors that could influence the results. Your steps are as follows:

   1. *In the center of your page/screen, place the word "research study."*
   2. *Brainstorm all the different factors that you need to consider with the project. (Hint: Think about who the study population will be, location, what will be measured, etc.)*
   3. *Draw arrows between terms that influence one another (e.g., Will the location influence the population studied?). You can write a short explanation on the line, if you wish, describing the influence.*
   4. *Continue to branch out from each node. What will influence your population? Or location? What factors influence pollution levels?*

3. **Free-writes**: Freewriting is a practice where an individual writes continuously what comes to their mind (by hand or typing) for a specified period of time. The point of the exercise is to generate thoughts, not quality prose. Periods of 5 minutes (timed) are best for the questions posed below. It also helps to write the question on the board, or print it on a handout, so that students can refer back when necessary. Do not collect these – it should be a low-stakes writing task. However, you can ask for students to volunteer what came to mind and use these thoughts to generate discussion about the article they will be reading. ***Instructions to students:***

   We are going to do an exercise called a 'freewrite'. Please take out a notebook or blank sheet of paper, and something to write with. If you're using a computer – open a new file in your word processor. I will give you a question to think about, then set a timer for 5 minutes. During this time, do not stop writing. That means your pen or pencil should keep touching the paper, or your fingers pressing the keys. Write whatever thoughts come to mind without any censoring or editing. If you can't think of anything, write "I can't think of

anything." You do not have to share your thoughts unless you want to – I will not collect these. Here is the question I want you think write about: [instructor: pick one]

1. *Drawing on your own life experience, what effect (if any) do you think air pollution has on a human's life span? Explain.*
2. *Think about a time where you either built or used a model. It could be a model airplane, or a computer simulation, or something completely different. In what ways did that model match the real-life object/experience? In what ways did it* not *match?*
3. *People often use imagery to communicate difficult ideas or concepts, as well as to share data. What rules or guides can you offer someone who is about to create an image for a project (e.g., a poster, a research, an advertisement)?*

Post-reading and post-listening activities

1. **Revisiting vocabulary:** Using the vocabulary sheet students completed at the start, clarify as a group/class how the authors used the terms. Were they used the same? Differently? Explain.

2. **Discussion questions:** Use the following list of questions to engage students in thinking more critically about the research and interview. These questions can be assigned as short-essay prompts, used for small-group discussion, or used to prompt whole-class discussion. Ask students to refer directly to the paper or interview to support their answers.

    - *What reasons do the authors and Dr. Balmes provide for conducting this research?*
    - *How do the authors explain in the paper the use of telomeres as a biomarker for measuring the effect of air pollution on cells? How does this compare to the explanation Dr. Balmes offers in the interview?*
    - *What variables did the research team have to take into account when designing the research project? How did they control (or not control) for these variables?*
    - *What data sources did the research team draw on for this study?*
    - *The study participants were relatively small (n = 14) – in what ways can we extrapolate the data and apply it to other contexts (e.g., larger populations, other locations)?*
    - *How do the researchers account for the multiple variables in their reporting of the data?*
    - *Why would a research team want to conduct a pilot study rather than conduct the larger one from the start?*
    - *The researchers used a "land-use regression model" and a "spatial-temporal model" as part of the research design. What reasons do they offer for the use of these models? How do the models help them work with the other data collected?*

3. **Revisit your mind map:** If students conducted the mind map activity before reading or listening to the materials, ask them to revisit *their* map in light of the materials. Ask them to highlight/circle terms or variables the authors account for in the research. Provide the following questions:

    - *In what ways was your map similar to and different from the article's research team's design?*
    - *What factors did the research team consider that your design did not? What factors did your design include that the research team's did not?*

- *Can you find instances in the article or interview when the variables are discussed* and *the researchers explore how the variables affect the data?*

Extension activities – for use with the learning module *Using Graphs and Visual Data in Science*

(https://www.visionlearning.com/en/library/Process-of-Science/49/Using-Graphs-and-Visual-Data-in-Science/156).

Pre-Reading Activity -- Reading Graphs: The authors provide multiple scatter plots in the article. Scatter plots allow researchers to examine the relationship between multiple variables. The authors include "trend lines" in many of these plots, as well. Provide the "Scatter Plots" handout and ask students to use what they learned about reading graphs in the module and identify the variables and trends for each of the scatter plots provided (*do not* read the text descriptions or captions in the article proper ahead of time):

(For expected answers to these questions, see https://www.visionlearning.com/en/twoh/request)

Figure 2:

Figure 3:

Figure 4:

Figure 5:

Next, ask students to read the descriptions offered in the text for each of the variables presented in the scatter plots.

- *What caveats do the authors offer to explain the results?*
- *What reasons might they have for including this information in text?*

Finally, ask students to review the data provided in the accompanying tables.

- *How does the data differ from what is included in the scatter plot?*
- *How do the tables help the students understand the data collected more fully?*

Vocabulary Worksheet

Below are a list of terms and phrases that you will encounter while reading the article and listening to the interview. Using a dictionary, provide definitions for each term or phrase. If you cannot find a formal definition, write down what you *think* the term or phrase might mean.

(For expected answers to these questions, see https://www.visionlearning.com/en/twoh/request)

Telomere:

PAH – polycyclic aromatic hydrocarbon:

Ambient (e.g., ambient air pollution):

Critical length (e.g., telomere reaches critical length):

Carcinogen / Carcinogenic:

Reading Guide and Worksheet

Use this worksheet to guide your reading of the primary article. As you read, answer the questions in your own words. Whenever possible, make notes as to where in the text you found your answer (e.g., in the Methods section, in the fifth paragraph on page 446).

(For expected answers to these questions, see https://www.visionlearning.com/en/twoh/request)

1. Who are the authors of the article? What information can you find about them in the article directly?

2. Who financially supported this research? How do you know?

3. What specific problem is this research attempting to address? (Another way to think of this: What reasons do the authors give for conducting this research?)

4. What group(s) of people does the research focus on?

5. What were the specific research questions the study attempted to answer? (Another way to think of this is: What were the researchers' hypotheses? What were they trying to find out?)

6. List the methods the researchers used to collect data.

7. What did the researchers find? Summarize the key points.

8. What questions were raised in your reading of the article?

Scatter Plot Worksheet

Scatter plots allow researchers to examine the relationship between multiple variables. The authors include "trend lines" in many of these plots, as well. Review the scatter plots provided below. Use what you learned in the reading *Using Graphs and Visual Data in Science* (https://www.visionlearning.com/en/library/Process-of-Science/49/Using-Graphs-and-Visual-Data-in-Science/156). Based on these plots alone, what can you conclude?

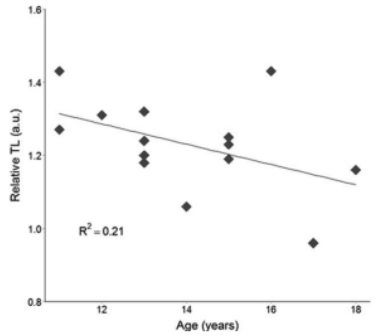

Figure 2

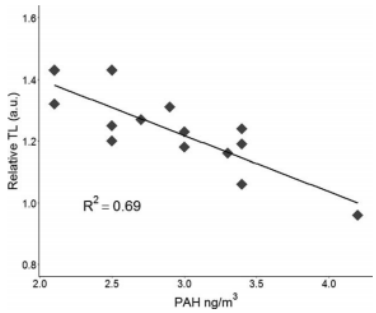

Figure 3

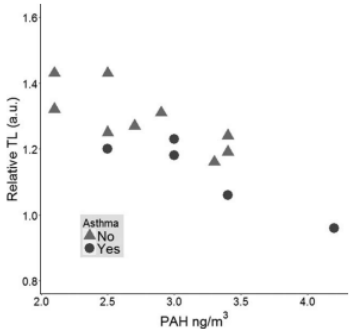

Figure 4

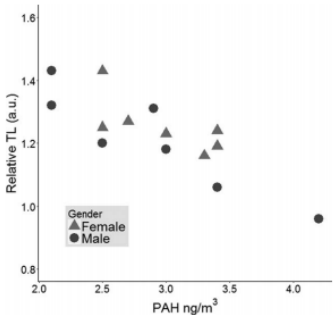

Figure 5

Targeted NGSS, Cross-Cutting Concepts, and Science and Engineering Practices

The activities in this guide can be used to address the following standards, concepts, and practices.

Next Generation Science Standards	
ESS3.A: Earth and Human Activity	• All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors (HS-ESS3-2).
ESS3.D: Global Climate Change	• Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5) • Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact
ETS1.A: Defining and Delimiting an Engineering Problem	• Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1)
Science and Engineering Practices	
Asking Questions and Defining Problems	• Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. • Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.
Developing and Using Models	• Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. • Develop a complex model that allows for manipulation and testing of a proposed process or system.
Obtaining, Evaluating, and Communicating Information	• Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. • Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.
Cross-Cutting Concepts	
Cause and Effect: Mechanism and Prediction: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.	• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system • Changes in systems may have various causes that may not have equal effects.
Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.	• The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. • Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. • Using the concept of orders of magnitude allows one to understand