INVESTIGATION 2

Lesson Plan

INVESTIGATION 2

INVESTIGATION FOCUS
Within the Core Experience, this Investigation is designed to:

1. continue students' exploration of perspective.
2. provide students with an opportunity to investigate how the appearance of objects changes when viewed from different distances.
3. help students understand that objects in the distance appear smaller than objects that are closer because they are perceived as BOTH more narrow and shorter.
4. aid students' understanding that perception of depth is related to the relationship between an object's dimensions and a person's field of view.
5. show students that as the distance from an object increases, the visual angle of the object on the retina decreases, producing a smaller image of the object on the retina.
6. Illustrate how artists use a vanishing point to create depth and perspective.

RELEVANT BACKGROUND KNOWLEDGE

In Investigation One, students learned how the human eye and brain perceive depth. They also explored how artists use vanishing point and manipulation of an object's width to portray depth on a two dimensional medium. Investigation Two continues students' exploration into perspective by focusing on the dimension of height and its relationship to depth and vanishing point. As with width, the height of an object changes as it moves farther from the eye. The closer to the eye, the taller an object is and the farther from the eye, the shorter. One way to think about this is to relate the height of the object to the field of view. When the object is closer to the eye, it encompasses more of the field of view. When it is farther, it encompasses less of the field of view. Another way that scientists often use to describe these differences is through something called the visual angle.

The visual angle is a term that applies to BOTH the angle at which light enters the eye and the angle at which light passing through the lens of the eye hits the retina or back of the eye. Because it is easier to measure visual angle than field of view, differences in how objects appear on the retina are generally described in terms of visual angles. Therefore, as students continue to investigate perspective, their explorations include the observation and measurement of visual angles. During this investigation, students measure the visual angles at which light enters the eye as an object moves farther from the eye. Students also measure the height and width of that object as it moves farther from the eye.

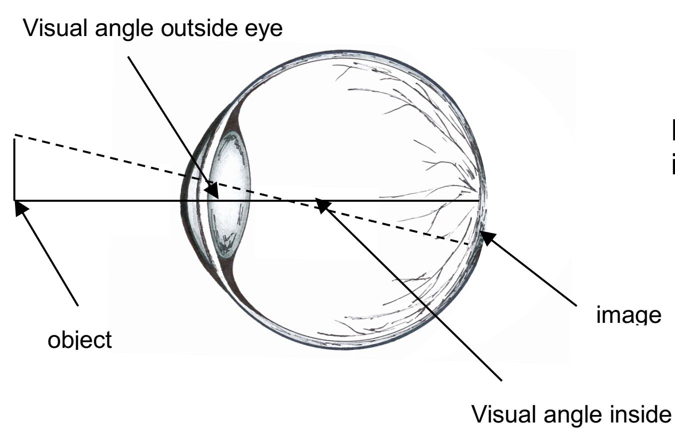

Figure 2.1: Visual angles inside and outside the eye.

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During their analysis students should find that in addition to changes in the width of the object, there are changes in the height of the object as its distance from the eye increases. Moreover, the change and the height and width of the object are proportional. In other words, the dimensions of the object change together. As a result, the overall proportions of the object remain similar as the object moves farther from the eye. It is this phenomenon that allows us to still identify the object at different distances from the eye. Thus, we see a car as a car rather than another shaped object whether it is close to us or twenty feet down the road. Imagine what life would be like if this were NOT true: a square shaped object may look like a square up close, but like rectangle farther away. Identification of objects would be difficult.

In addition to their discoveries about objects' dimensions, students will conclude that as an object's distance from the eye increases, its visual angle decreases. As a result, its image on the retina also decreases in size. Understanding this concept is important not only to understanding perspective and depth perception, but also to understanding how and why tools such as microscopes and telescopes are used. Both of these scientific tools work by increasing the visual angle that is presented to the eye. As a result, objects that are too small to see with the unassisted eye can be viewed because a larger image is presented to the eye. The larger image makes a larger visual angle on the eye and one the retina, allowing the object to be seen.

As in Investigation One, students will relate what they have learned about the mechanics of depth perception to how artists use the same principles to create the appearance of three dimensions on a flat, two-dimensional surface.

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KEY SCIENCE TERMS AND CONCEPTS

1. **Depth:** How deep something is. Depth may be described differently from different perspectives. It may be the distance or measurement from the top of an object to its bottom, from its front to back, or from its outside to its inside.
2. **Depth perception:** The ability to see in three dimensions.
3. **Dimensions:** The measurements of an object such as its length, width and height.
4. **Eye:** The organ that contains all of the structures needed for sight.
5. **Field of view:** The entire area that is able to be seen at any one time.
6. **Image:** The appearance of an object produced by the reflection or refraction of light. An image of an object is formed on the retina when light passes through the lens of the eye
7. **Point of view:** The direction from which an object or scene is observed.
8. **Perspective:** The way in which objects appear in a person's view.
9. **Retina:** The lining in the back of the eye where images formed by the lens are focused.
10. **Vanishing point:** A point in a drawing, painting or in space at which parallel lines seem to meet. A point in space at which objects seem to disappear.
11. **Visual angle:** The angle at which light from an object enters the eye. The visual angle can be measured either as light enters the eye or inside the eye when light is focused on the retina.

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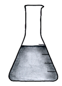
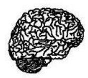
PROCEDURAL TOOLBOX



Modeled Tools	New Tools	Previously Used Tools
		Metric Ruler Use and Operation *Completion of Data Table* *Completion of Line Graph*

COGNITIVE TOOLBOX



Modeled Tools	New Tools	Previously Used Tools
		Look For *Prediction* *Recall* *Rehearsal* *Rules*

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PRE-LAB

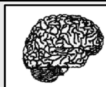
Supplies and Equipment:

Class materials:
1 *Cross Section of the Eye Transparency (located on the Art and Science CD)*
1 *Perspective and the Retina Transparency (located on the Art and Science CD)*
1 *Retina and Visual Angles Transparency (located on the Art and Science CD)*
1 *Visual Angles and Art Presentation (located on the Art and Science CD)*
5 protractors
5 metric rulers

Individual materials:
1 *Scientist's Glossary*
1 *Scientist Data Record*

Procedure:

A. Begin the investigation by reviewing what students learned about perspective, point of view and field of view in Investigation One.



Tool: **Recall**

Ask students: **What do we do when getting ready to learn something new?**
*Students should realize that the **Recall** tool is appropriate.*

Pose the following questions to prompt student recall about art and perspective.

1. **What do you think of when I say the word "perspective?"**
Student answers may vary. However, their answers should reflect what they learned about perspective from Investigation One such as the way in which an object appears depending upon your point of view, the ability to produce a three dimensional image in two dimensional art work, or the change in the appearance of an object as the distance from the object changes.

2. **Imagine you are looking at a building up close and then later from farther away. Will the building look the same each time? Why or why not?**
Students should indicate that the building will appear different when viewed close and farther away because the point of view has changed. In addition, the field of view changes and the part of the field of view that the object takes up changes as when viewed from different distances.

3. **How will the building look different? Why?**
The building will look wider when it is closer because it takes up more of the field of view. The building will look more narrow when it is farther because it takes up less of the field of view.

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B. Continue the discussion of perspective and field of view by inviting students to look at a model of the eye. Use the *Cross Section of the Eye Transparency* as a visual aid. Encourage students to complete problem 1 in their *Scientist Data Record* as a part of the discussion.

1. Draw students' attention to the diagram of the eye on the *Cross Section of the Eye Transparency*. Point out the various labeled parts of the eye.

2. Walk students through the process by which images appear on the retina. Use the steps below as a guide:

   a. Explain to students that light reflects off of an object and then passes through the outer layer of the eye, called the cornea.

   b. Light then enters the eye through an opening called the pupil. The size of the pupil is controlled by the iris, which is the colored part of the eye.

   c. Light from the object then passes through a lens that focuses the image of the object onto a structure in the back of the eye called the retina.

   d. Cells in the retina convert the light falling on them into nerve signals that are carried by the optic nerve to the brain.

   e. The brain then interprets these signals allowing the identification of the object.

3. Ask students: **Think about the meter sticks and the wood block from Investigation One. Remember that they appeared differently when they were close and far from the eye. Do you think the image of the wood block on the retina was the same when it was close the eye and far from the eye? What about the meter sticks?** *Student answers may vary. Accept all student answers at this time. The activity that follows is designed to help students answer this question.*

4. Draw students' attention to the *Perspective and the Retina Transparency.* Explain the following parts of the transparency.

   a. Two diagrams are shown. Each models the field of view for an eye and the appearance of the wood block from Investigation One in front of the eye.

   b. Notice that the field of view is the same for each diagram. The field of view for a human eye is about 150 degrees. The diagrams have a field of view close to this.

   c. One diagram models the wood block when it was 2.5 cm from the eye. The other diagram is a model of when the wood block was 5 cm from the eye.

   d. Both the solid black lines and the dotted lines show how refraction of light through the lens produces an image on the back of the retina. The solid black lines show the connection between the field of view outside the eye and on the retina.

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e. The dotted lines illustrate the connection between the wood block outside the eye and the image of the wood block on the retina.

5. Continue working with the *Perspective and the Retina Transparency*. Tell students that they can find similar figures in problem 2 on their *Scientist Data Record.* Explain that problems 2 and 3 should help them to better understand why an object appears smaller the farther it is from the eye.

a. Divide students up into the same five cooperative groups from the Investigation One lab section.

b. Briefly walk students through the directions for solving problem 2. Students should measure the width of the image on the retina for each diagram.

c. Students should notice that in the diagram the field of view is the same for each retina because the field of view for an eye is the area is space that is visible to an eye. The field of view for an eye encompasses part of the area on the retina.

NOTE: In the diagrams, the width of the field of view and images have been exaggerated so that students are able to make measurements of the image size, field of view and later the visual angle. The ratio of the image to the field of view correctly models what happens in the eye. However, in reality, both the field of view and the image of the object would be focused on an area of the retina that is only **1.5 millimeters** in diameter called the fovea. Obviously this is a much smaller area than that shown on the diagram. After students have completed the activity, it may be helpful to discuss this fact with them so as to limit any misconceptions they have about the size of the image on the retina.

d. Once students have measured the width of the images on the retinas, they should use the values to calculate the ratios of object width/field of view width for each circumstance.

e. Provide time for students to compare the ratios and to compare these ratios with those they calculated in the Post-Lab of Investigation One.

f. Ask students**: What did you discover about the ratios of object/field of view on the retina when the wood block was at different distances?**
The ratio of the object/field of view on the retina was larger when the wood block was closer to the eye and smaller when it was farther from the eye.

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g. Ask students: **How do these ratios compare to those you calculated in Investigation One. Do you see the same trend?**
The ratios show the same pattern. The farther the object is from the eye, the smaller the ratio of the object/field of view. In other words, when the object is farther from the eye, it takes up less of the field of view of the eye. Investigation One looked at this ratio when comparing the object to the field of view outside the eye. The model that students just completed shows that the same relationship exists INSIDE the eye on the RETINA.

6. Tell students that most of the time, scientists use another type of measurement to compare images formed on the retina. Instead of ratios, they often use angles. Direct students' attention to the term *visual angle* in their *Scientist Glossary.*

   a. Discuss the term with students by encouraging them to look at problem 3 in their *Scientist Data Record.* The *Retina and Visual Angles Transparency* may also serve as a visual aid.

   b. Students should see the same diagrams. In these diagrams, however, *theta* (θ) or the symbol for angle is shown on the diagrams. Theta illustrates the visual angle for each diagram. The visual angle can be measured two ways. In these diagrams it is measured as the angle formed at the retina by light entering the eye.

   c. Encourage students to work in their cooperative groups to measure the angles with a protractor.

   d. Students may find it necessary to use a pencil to extend the lines for the angles so that the lines cross the protractor. If necessary, review with students how to use a protractor to measure angles.

   e. Complete this section of the Pre-Lab by helping students find patterns and draw conclusions about visual angles, distance of objects from the eye and how large or small objects appear. After this discussion, students should be able to answer problem 4 in their *Scientist Data Record* and draw the following conclusions:

   *Objects that are closer to the eye appear larger because they take up **more** of the field of view and have a **greater** visual angle on the retina.*

   *Objects that are farther from the eye appear smaller because they take up **less** of the field of view and have a **smaller** visual angle on the retina.*

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C. End the Pre-Lab by having students apply what they've learned thus far about perspective, visual angle and dimensions.

   1. Show the *Visual Angles and Art Presentation.*

   2. This presentation shows various paintings or pictures. Each slide contains a question about the objects in the paintings with regards to visual angle and field of view.

   3. After all of the slides have been viewed, explain that during the lab portion of this Investigation, students will continue to investigate how humans view depth or objects at different distances from our eyes. However, instead of focusing on only the width of objects, students will also focus on the appearance of an object's height at different distances from the eye.

      Students should consider the following questions as they prepare for the lab.

   - **Does the distance from an object changes its appearance?**

   - **What is the relationship between the distance from an object and how its height appears?**

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LAB

Supplies and Equipment:

Group materials:
- 2 meter sticks
- 1 metric ruler
- 1 50 ml centrifuge tube
- 1 protractor

Individual materials:
- 1 *Scientist Data Record*

Preparation:
1. Organize the required materials at a distribution point.
2. Divide students into cooperative groups of three.

Instruction:
1. Direct each student group to obtain the following necessary materials from the distribution point: two (2) meter sticks, one (1) metric ruler, one (1) 50 ml centrifuge tube, and one (1) protractor.

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Procedure:

1. The trials in this Investigation focus on how objects appear from different points of view, including those objects that are near to the observer and those that are farther from the observer. Each trial includes steps that are used to set-up the experiment. In following the directions for set-up, students may be tempted to focus more on the steps of the procedure and less on the observations they will make after the experiment design has been prepared.

Tool: **Look For**

Ask students: **What will you Look For when observing objects in the investigation?**
Students should indicate that they should observe how objects that are near and far appear.

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2. Trial 1: In Trial 1, students will investigate changes in the perceived height and width of objects at different distances from the eye. Students will investigate these changes by measuring the width and height of a 50 ml centrifuge tube when it is placed at six different distances from the eye.

   This Investigation has been designed to continue what students previously explored in Investigation One: how and why the appearance of the width of an object changes as it moves farther from the eye. Therefore, students should approach this trial with some prior knowledge and the ability to make predictions about changes in the width and height of the centrifuge tube as it is moved farther from the eye.

   During their Post-Lab discussion, students will be asked to consider why objects appear smaller when they are farther from the eye. Based on their data from this trial, they should be ablet to explain that both the height and width of the object appear to decrease as the object moves farther from the eye. The identity of the object is maintained because BOTH the width and height decrease in relative proportion to each other. Thus, the object appears smaller but not distorted.

   As students complete this trial, ask them to consider the following question:

   Does the distance from which an object is viewed change its appearance?

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3. Trials 2: In Trial 2 students will continue their investigation of perception by exploring the types of angles that light rays form when entering the eye. The term visual angle is used to describe the angle of light rays entering the eye as well as the angle of light rays that focus on the retina. As students conduct their experiment they will model the changes in the visual angle outside the eye as the centrifuge tube is moved closer the eye. Students should observe that as the centrifuge tube is moved closer to the eye, the angle at which light rays enter the eye increases.

   When the results of this trial are combined with those from Trial 1 in the Post-Lab, students should begin to understand that objects in the distance appear more shorter because they form a shorter image on the retina of the eye. The shorter image occurs because light rays enter the eye at smaller angle (smaller visual angle). As a result a smaller visual angle is formed as light rays pass through the cornea and lens of the eye. The smaller visual angle produces a smaller image of the object on the retina. This phenomenon involves both the image that is formed on the eye's retina and the interpretation of the image by the brain.

   Students should consider the following questions:

   What is the relationship between the distance from an object and how its height appears?

4. Upon completion of the investigation, permit enough time to clean up the lab and return the materials and equipment to their assigned locations.

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POST-LAB ANALYSIS

Supplies and Equipment:

Class materials:
1 *Visual Angles Inside and Outside the Eye Transparency (located on the Art and Science CD)*
1 *Visual Angles Pattern Transparency (located on the Art and Science CD)*
1 *Vanishing Point and Dimensions Presentation (located on the Art and Science CD)*

Individual materials:
1 *Scientist Data Record*

A. Begin this part of the investigation by encouraging students to summarize their activities in the Lab. Prompt student discussion by posing the following questions:

1. **What were the main questions we wanted to investigate in this lab?**
Students should indicate that the questions were: Does the distance from which an object is viewed change its appearance? What is the relationship between the distance from an object and how its height appears?

2. **How would you summarize the types of experiments that you performed to investigate these questions?**
Students should indicate that in Trial 1, they placed a meter stick on the lab table. The 0 cm end of the meter stick was at the end of the table and approximately 30 centimeters from their eyes. They then measured the height and width of a centrifuge tube when it was placed at the 0, 20, 40, 60, 80, and 100 centimeter marks. In Trial 2 they measured the visual angle or the angle at which light would enter their eyes when the centrifuge tube was at the 0, 20, 40, 60, 80 and 100 centimeter marks.

B. Begin the analysis of the experiment by encouraging students to review and organize their data from Trial 1.

1. Begin by telling students to locate problem 7 in their *Scientist Data Record.* This question asks students to graph their results from Trial 1. As students approach this problem they should first locate Table A in their *Scientist Data Record.* Table A includes all of the data they recorded from both Trials 1 and 2 in the Lab.

2. Encourage students to think about the process involved in completing a line graph. Many of the processes used to create and complete a line graph are similar to those used to create and complete a bar graph. Students will likely have seen a line graph and bar graph modeled in previous Core Experiences. However, they may benefit from a review of the steps from the *Procedural Toolbox.* A quick summary of some of these steps is provided below.

    a. Notice that grid with lines and an x and y axis is already present in problem 7 in the *Scientist Data Record.* The x-axis is the horizontal axis and the y-axis is the vertical axis.

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b. Evaluate the data. Determine which variable you will plot along each axis. When plotting values of different categories, scientists typically place the category that they changed along the x-axis and the value that they measured along the y-axis. Notice that where you placed the centrifuge tube is along the x-axis. This is what you changed in the experiment. The dimensions of the centrifuge tube (height and width) are placed along the y-axis. This is what you measured in the experiment.

c. Determine the beginning and ending numbers you will plot on the x-axis and y-axis. The beginning and ending numbers should be selected so that you can plot all of the points on the graph. Notice that the x and y-axis begin with the number zero (0). The x-axis ends with the number 120 so that the points 0 to 100 cm can all be plotted on the graph. The y-axis ends with the number 12 because it is greater than the greatest measurement recorded for height (11 cm).

d. The scale for each axis has already been determined. For the x-axis, each line represents a change of 20 centimeters. For the y-axis, each line represents a change of 1 centimeter.

3. Once students have familiarized themselves with the grid, encourage them to work independently or in pairs to plot the data from Trial 1 on the graph. Students will likely find it easier to plot one dimension at a time. For example, plot the points for the change in width and connect those points with a solid line. Then plot the points for the change in height and connect those points with a dotted line.

4. When students have finished their graphs, ask a student volunteer to draw his or her graph on the board. Discuss the completed line graph with the class.

a. Look at the x-axis on the graph. Begin on the left side: **What happens to the distance from the eye as you move from left to right?**
The units increase in magnitude.

b. Look at the y-axis on the graph. Begin at the bottom: **What happens to the units of height or width as you move from the bottom to the top of the graph?**
The units increase in magnitude.

c. Focus on the width of the centrifuge tube. For each measurement of distance along the x-axis, you plotted a point along the y-axis that corresponded to the width of the centrifuge tube. Look at the line that connects the points. **Does it go up or down?**
It goes down.

d. **Can you describe what happened to the width when the distance from the eye increased?**
As the distance from the eye increased, the width of the centrifuge tube decreased.

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e. Focus on the height of the centrifuge tube. For each measurement of distance along the x-axis, you plotted a point along the y-axis that corresponded to the height of the centrifuge tube. Look at the line that connects the points. **Does it go up or down?** *It goes down.*

f. **Can you describe what happened to the height of the centrifuge tube when the distance from the eye increased?**
As the distance from the eye increased, the height of the centrifuge tube decreased.

g. Look at the lines for the height and width of the centrifuge tube. **What do you notice about the shape of the lines? Are they very different shapes? Are they similar? Are they almost parallel?**
The lines appear to be almost parallel. They are very similar in shape.

h. Ask students: **The lines for the change in the width and height of the centrifuge tube are parallel at almost all points. What do you think this tells you about how the width and the height of the object change in relation to each other?**
The lines show the same trend for the height and width of the centrifuge tube as the viewing distance from the tube increases. This indicates that the height and width of the centrifuge tube change in proportion to each other.

i. Ask students: **Why do you think this is important?**
Because the height and width change in proportion to each other, the identity of the object is maintained as the viewing distance changes. In other words, the object is not greatly distorted. Thus, a car appears as a car when viewed at different distances. If this were not the case and the height and width did not change in proportion to each other, then the object would be distorted as the viewing distance changed. This would make it difficult to correctly identify objects when they were far as opposed to near the viewer.

NOTE: There is a point at which some distortion will occur for some objects when viewed at very small visual angles. For example, imagine looking up at a skyscraper from directly below. The overall shape of the building may appear slightly different than if the building were viewed from a block away. This is because the distance between the top and bottom of the building is greater than the distance between the viewer and the building. As a result the top of the building has a smaller visual angle than the bottom of the building because it is farther from the viewer than the bottom of the building. However, this is a specific phenomena that involves small distances between the viewer and the object and very tall objects.

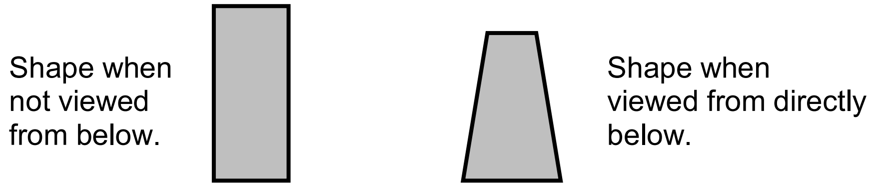

Figure 2.2: Distortion with small visual angles

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3. Provide an opportunity for students to apply what they have just learned by looking at the three sets of figures in problem 9 in their *Scientist Data Record.* This problem shows a square object at different distances from the eye. Each set presents how the square would look at those different distances. Students should think about how the height and width of the object change in relationship to each other in order to select which set of objects shows how the square would look at the different distances. Students should realize that Set C correctly shows how the object would look at different distances because BOTH the width and height of an object change in proportion to each other as the distance from the eye increases. Sets A and B do not show how the object would appear at different distances.

C. Continue the analysis by questioning students about why the height of the object appears to decrease as the object is moved farther from the eye.

1. Remind students that in the previous investigation they concluded that the width of an object decreases as the object moves farther from the eye because the object takes up less of the field of view. Students also related the width of an object to the size of the visual angle that the object encompassed as it passed through the lens of the eye. The smaller the visual angle, the more narrow the object appeared.

2. Tell students that part of their experiments in Investigation Two was to discover what happened to the appearance of the height of an object as it moved farther from the eye. To do this, students measured not only the height of the centrifuge near and far from the eye, but they also measured the visual angle of the centrifuge tube as it entered the eye at different distances.

3. Review the definition and concept of visual angles. Use the questions below to help guide the discussion. In addition the *Visual Angles Inside and Outside the Eye Transparency* may be a useful visual aid during the discussion.

   a. **When you are viewing an object, what is meant by the visual angle?**
   The visual angle can either refer to the angle at which the light from an object enters the eye or the angle the light rays form as they pass through the inside of the eye to the retina.

   b. **Look at Table A in your *Scientist Data Record.* Compare the outside visual angles for the centrifuge tube when it was placed at different distances from the eye. What happened to the visual angles as the centrifuge tube moved farther from the eye?**
   The visual angles decreased as the centrifuge tube moved farther from the eye.

4. Tell students that there is a special relationship between the visual angles outside and inside the eye. Direct students to problem 11 in their *Scientist Data Record.* The *Visual Angles Pattern Transparency* may also be used as a visual aid for this discussion.

   a. Encourage students to look at the four diagrams in problem 11.

b. These diagrams illustrate the movement of the centrifuge tube during Trials 1 and 2.

c. Ask students: **Look at the visual angle outside the eye in the diagrams. Is it increasing or decreasing as the centrifuge tube moved farther from the eye?**
It is decreasing as the centrifuge tube moved farther from the eye.

d. Ask students: **Look at the visual angle INSIDE the eye in the diagrams. Is it increasing or decreasing as the centrifuge tube moved farther from the eye?**
It is decreasing as the centrifuge tube moved farther from the eye.

e. Ask students: **What do you notice about the change in the visual angle INSIDE the eye and the visual angle OUTSIDE the eye as the centrifuge tube moved?**
Both visual angles decreases as the centrifuge tube moved farther from the eye.

5. Explain that the visual angles inside and outside the eye are very similar to vertical angles. Vertical angles are angles that are across from each other. Vertical angles have the same measurement.

6. Tell students that the visual angles inside and outside the eye are not exactly the same because of the substance inside the eye. However, when scientists estimate, they often think of the two visual angles as vertical angles—that is having the same measurement.

7. Encourage students to use the data from Table A to write the magnitude of the visual angles both inside and outside the eye in the diagrams in problem 7.

8. Direct students to look at the size of the image of the object on the retina in each of the diagrams. Ask students: **What happens to the height of the image as the centrifuge tube moved farther from the eye?**
The height of the image decreases as the centrifuge tube moved farther from the eye. This occurs because the height of the image is directly related to the visual angle of the object inside the eye.

Tool: **Rules**

Complete this part of the analysis by directing students to answer question 12 in their *Scientist Data Record.* This question requires students to combine what they learned from Trials 1 and 2 and the Post-Lab discussions to recognize patterns in their data.

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D. Explain that the patterns that students just discovered and those they made in Investigation One explain the way in which we see depth.
   1. Our eyes have a field of view. Objects in that field of view take up a certain portion or ratio of it. The closer the object, the more of the field of view that is taken up. The farther the object, the less of the field that is taken up. This applies to both the height and width of an object.

   2. Another way to think about this is to describe what happens to the visual angles when an object is moved different distances from the eye. As an object moves farther from the eye, the visual angle decreases and the image formed on the retina becomes both shorter and more narrow. As an object moves closer to the eye, the visual angle increases and the image of the object on the retina is taller and wider.

   3. Discuss how vanishing point is related to this concept: in terms of our eyes, a vanishing point is the distance that is so far away that an object takes up so little of the field of vision it appears to disappear. At the vanishing point, the visual angles are so small that the image on the retina is almost non-existent.

   4. Although not specifically addressed in this CELL, students may find it interesting that microscopes and telescopes use lenses to create a magnified image of objects so that a larger visual angle is shown to the eye. If the microscopes and telescopes are not used, the visual angle of the objects that a person is observing are so small that the eye cannot resolve the image.

   5. Conclude the Post-Lab by encouraging students to apply what they have learned by looking at the paintings in the *Vanishing Point and Dimensions Presentation*.