Visual Perception

Station 1: Two Eyes Are Better Than One

Science Concepts

- Binocular vision
- Depth perception

Background

Organisms with two eyes have binocular vision. When the two eyes are positioned on the sides of the head, the organism has a greater field of view. When the two eyes are positioned in the front of the head, as with humans, better depth perception results. Depth perception enhances the ability to judge distance or tell how far away things are. The eyes are arranged so the image received by each retina is slightly different. As the brain receives impulses from each eye, the two images are fused, and a single, three-dimensional effect is experienced.

Experiment Overview

In this activity, discover your depth perception skills and what affects the ability to accurately gauge distance. Two craft sticks will be aligned while the test subject looks first with one eye closed and then with the other eye closed and then repeats the activity with both eyes open.

Materials

Depth perception test setup:
- Rulers, 2
- Craft sticks in supports, 2
- String, 2 m (tied to one support)
- Background card
- Vision blocker
- Chair (optional)

Procedure

1. One person should be the test subject and the other the tester. Once the activity is completed, reverse roles.

2. The test subject should sit in a chair or kneel on the floor at least one foot away from the table or desk. The subject’s eyes should be about even with the top of the vision blocker. The subject should lean over in the chair or adjust the kneeling position until just the tops of the two craft sticks can be seen, but not the plastic supports or the rulers (see Figure 1).

3. Shielding the test subject’s view, the tester should place the stationary craft stick (without the string) at the 15-cm mark on the outside of one ruler. This stick should remain at the 15-cm mark throughout this activity.

4. Continuing to shield the subject’s view, the tester should place the movable craft stick (with the string) between the two rulers within 5 cm of the background (see Figure 2). Once the sticks are in place, the tester should move to allow the subject to see the tops of the sticks over the vision blocker.

5. The tester should make sure the string is threaded through the window and hanging over the edge of the table.

6. The subject should cover one eye with one of his or her hands and look at the tops of the two sticks while the tester slowly pulls the string, moving the stick forward toward the subject.

7. When the subject thinks the two sticks are the same distance away, he or she should tell the tester to stop pulling the string. If the subject thinks the string was pulled too far, the tester may be asked to adjust the movable stick until it appears even with the stationary stick.
8. The tester should then look at the two sticks and measure the distance between them (if any) in millimeters. For example, if the movable stick was stopped at 15.5 cm, the distance between the sticks is 5 mm. If the two sticks are perfectly aligned, then the distance is zero. The tester should record the distance in the subject’s Data Table 1 for Trial 1 for Left/Right Eye Covered on the Visual Perception Worksheet, without telling the subject the results.

9. Repeat steps 4–8 for Trial 2.

10. The subject should then cover the other eye.

11. Repeat steps 4–9 with the subject keeping the other eye covered and the tester recording the results in Data Table 1.

12. Repeat steps 4–9 with the subject keeping both eyes open.

13. Switch roles and repeat steps 2–12.

Station 2: Running the Mirror Maze

Science Concepts

- Hand–eye coordination
- Visual-motor feedback

Background

Writing with a pencil or pen involves hand–eye coordination. The eyes send a message to the brain, telling it where the pencil is and where it needs to move. The brain in turn sends a message to the muscles in the hand, and the hand moves the pencil. Both the eyes and the muscles send messages back to the brain. Over time and with practice, this visual-motor feedback results in more coordinated movements, and the brain depends less on visual feedback. What happens when the feedback gets mixed up?

Experiment Overview

In this activity, discover what effect looking in a mirror has on hand–eye coordination while tracing a path through a maze.

Materials

- Books
- Mirror, 10 cm × 15 cm
- Plastic supports, 2
- “Running the Mirror Maze” Test B, 1 copy for each student
- “Running the Mirror Maze” Test A, 3 copies for each student
- Stopwatch
- Tape, transparent

Safety Precautions

*Handle the mirror carefully by the edges and keep it away from the edge of the testing surface. If the mirror falls and breaks, notify your instructor. Do not attempt to pick up the sharp pieces.*

Procedure

1. One person will be the test subject and another will be the recorder. Once the activity is completed, switch roles.

2. Stack several books as shown in Figure 3. Make sure the subject can easily slide his or her writing hand under the “bridge.”

3. Place the mirror vertically in the plastic supports (see Figure 4).

4. Obtain three copies of “Running the Mirror Maze” Test A and one copy of Test B for each student, then fill in the name blank at the top of each paper.

![Figure 3.](image)

![Figure 4.](image)
5. With the subject sitting at the table, place one copy of “Running the Mirror Maze” Test A with the subject’s name on it under the bridge—the “Start” of the maze should be toward the subject and “Finish” away from the subject. Pull the maze away from the subject until the subject can just see his or her name at the top of the paper. The books should block the subject’s view of any part of the maze from Start to Finish.

6. Using four small pieces of tape, one for each corner, secure the paper in place.

7. Position the mirror at the top of the paper. Adjust the mirror so the subject can see the entire maze while looking in the mirror.

8. Using his or her writing hand, the subject holds a pencil at the start while looking in the mirror (see Figure 5).

9. The tester obtains a stopwatch.

10. When the tester says, “Start,” he or she starts the stopwatch, and the subject follows the path of the maze with the pencil, trying to finish as quickly as possible without touching any boundary lines.

11. As soon as the subject’s pencil reaches the finish, the tester stops the stopwatch. The maximum time allowed is three minutes. If the subject does not reach the finish in three minutes, he or she must stop.

12. Remove the test paper and mark it as Run #1.

13. Record the time on the test paper. If the subject did not finish in the maximum allowed time, record 3:00.

14. Repeat steps 5–13 two more times, marking the test paper as Run #2 and Run #3, respectively.

15. The tester counts the errors for each run. An error is any point where the pencil touches or crosses the boundary line of the path, but not the point where the pencil returns to the path (see Figure 6). Record the number of errors on each test sheet.

16. Repeat steps 5–11 with the Test B maze, keeping the same roles. Record the time and count the errors as with the other three trials.

17. Switch roles and repeat steps 5–16.

Station 3: Seeing out of the Corner of Your Eye

Science Concepts

- Peripheral vision
- Rods versus cones

Background

Stare at an object straight ahead. Can you see anything else out of the “corner of your eye”? Seeing beyond the center of our visual field (everything seen while looking straight ahead) is known as peripheral vision. Two types of nerve cells contained in the retina of the eye are rods and cones. Cones are concentrated in the center of the retina called the macula, and are responsible for color vision and the ability to see fine details. Rods are concentrated around the periphery of the retina and are more sensitive to light, helping us see in dim light. Rods are also good at detecting motion (see Figure 7).
Experiment Overview

In this activity, explore the range of your peripheral vision. The angle at which motion can be detected and letters or numbers can be identified will be measured using a peripheral vision disk.

Materials

Peripheral vision disk
Reading sight cards, set of 8

Procedure

1. Choose one member of the group to be the subject, and one to be the tester. After the activity has been completed, switch roles. Read the Procedure section completely before beginning the activity.

2. The subject obtains the peripheral vision disk and sits at a desk or table.

3. The subject holds the vision disk horizontally to his or her face, placing his or her nose in the center curve. The disk should be about halfway between the top and the tip of the nose. Use the thumb and forefinger of either hand to hold the disk at the zero point, with the forefinger on the zero (see Figure 8).

4. The tester obtains the reading sight cards and stands in front of the subject.

5. The tester chooses one of the eight reading sight cards without letting the subject see which one.

6. The tester holds the lower half of the sight card with letters facing inward against the disk before the largest angle (110°) on the subject’s left side, out of the subject’s sight. The vision disk should intersect the card, with the letters above the disk and the tester’s hand below the disk (see Figure 9).

7. The subject focuses on his or her index finger at the zero point, not moving his or her eyes to the right or left at any time during the test. The tester must watch the subject’s eyes to make sure they stay focused straight ahead. This task may be somewhat difficult for the subject initially, as the eyes may tend to wander, especially as the card becomes easier to distinguish. The subject may try to peek to see if the guesses are correct. (It may help if the tester audibly reminds the subject periodically by saying. “Look straight ahead.” or “Stay focused on your finger.”)

8. If at any time during the test the subject averts his or her eyes from the center gaze and glances toward the card, the tester should choose a different card and place the new card at the same place the original card had reached. Continue the procedure with the new card.

9. The tester slowly and steadily moves the card toward the zero point. As soon as the subject detects the card moving into the field of vision, he or she should say, “Motion.” The tester removes the card at this point (without letting the subject see it), and uses a pencil to mark the angle on the left side of the diagram of the disk on the Station 3 Observations section of the subject’s worksheet, using the letter “M” for motion.

10. The tester returns the sight card to the angle on the disk at which it was detected and continues to move the card slowly toward the zero point, reminding the subject to continue gazing straight ahead. When the subject can recognize the two letters and/or numbers on the card, he or she should say the letters/numbers out loud. For example, if the card shows 3T, the subject should say “Three tee.” If correct, the tester marks this point on the diagram with the letter “R” for reading. If the subject does not correctly read the card, the tester does not mark on the diagram and the tester continues to move the card toward the zero point, until the card is read correctly by the subject.

11. Repeat the entire procedure using a different sight card on the subject’s right side. Mark the angles on the right side of the disk diagram.

12. Switch roles and repeat steps 1–11 with a new sight card.
Station 4: Colorful Afterimages

Science Concepts

- Afterimage
- Color
- Cone cells

Background

Cones are nerve cells of the retina that are sensitive to colors—each cone cell is sensitive to a primary color of light (red, green, or blue). Prolonged viewing of a particular color—blue, for example—causes over-stimulation of the blue sensitive cones where the image is projected on the retina. These cones will stop firing (responding) temporarily. If the stimulus (the blue color) is taken away and the retina is exposed to a white light, the eye “sees” an afterimage for a few seconds. The afterimage is a result of the “cease-fire” of the blue sensitive cones, while the red and green cones continue to fire. A combination of red and green light produces a yellow afterimage. A combination of green and blue light produces cyan, and combining red and blue light produces magenta. Combining all three colors—blue, red, and green—produces white light (see Figure 10).

Figure 10.

Experiment Overview

In this activity discover the afterimages produced after a minute of concentration on pictures of strangely colored, yet familiar objects.

Materials

- Colorful Afterimages cards, 2
- Colored pencils
- Paper, white
- Timer or clock with second hand

Procedure

1. Obtain one Colorful Afterimages card and a sheet of white paper.
2. Using colored pencils, color the Before picture on the Colorful Afterimages Worksheet. The colors should match the colors on the card as closely as possible.
3. Locate the point-of-focus for the card. The point-of-focus for each card is:
   - Apple card—the spectacles on the worm
   - U.S. Flag card—the star in the lower right corner
4. Place the Colorful Afterimages card and the sheet of white paper side by side.
5. While your partner times you, stare at the point-of-focus on the card for one minute. Do not allow your eyes to wander. Stare intently only at the point-of-focus.
6. After one minute, quickly look at the sheet of white paper. What colors do you see?
7. Using colored pencils, record your results as the After picture on the Colorful Afterimages Worksheet. Note: To save time during the activity, color only part of the afterimage. Fill in the rest of the worksheet after the activity is completed.
8. Trade places with your partner (letting your eyes rest), and repeat steps 1–7.
9. Trade places again and repeat steps 1–8 using a different Colorful Afterimages card.
Visual Perception Worksheet

Station 1: Two Eyes Are Better Than One

Data Table 1

<table>
<thead>
<tr>
<th>Left Eye Covered</th>
<th>Distance between Sticks (mm)</th>
<th>Right Eye Covered</th>
<th>Distance between Sticks (mm)</th>
<th>Both Eyes Open</th>
<th>Distance between Sticks (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td>Trial 1</td>
<td></td>
<td>Trial 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trial 2</td>
<td>Trial 2</td>
<td></td>
<td>Trial 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>Average</td>
<td></td>
<td>Average</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Calculate the average distance between sticks when the left eye was covered; add the measurements for the two trials and then divide the total by two. Record the average in Data Table 1. Do the same for the other two tests.

2. In which test was the average distance between the sticks the smallest?

3. How did keeping both eyes open affect how well you could judge distance?
Station 2: Running the Mirror Maze

Data Table 2

<table>
<thead>
<tr>
<th>Trials</th>
<th>Time (min:sec)</th>
<th>Errors</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test A/Run 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test A/Run 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test A/Run 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test B</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Calculate your score for each trial in the following manner. Count every 10 seconds (round to the nearest 10 seconds) as one point. Count each error as one point. A lower score indicates a better performance than a higher score. See Examples 1 and 2. Record your score in Data Table 2.

   Time 0:55    Errors: 3    Score: 6 + 3 = 9    Example 1
   Time 2:04 (124 seconds) Errors: 0    Score: 12 + 0 = 12    Example 2

2. Where in the maze did you have the most difficulty following the path for Test A? Give an explanation.

3. Describe how your score changed from Run 1 to Run 3 for Test A. Why do you think it changed in this way?

4. How did changing from Test A to Test B affect your score? Why do you think this happened?

5. Do you think doing more runs with Test B would result in an improved score? Why or why not?
Station 3: Seeing Out of the Corner of Your Eye

Observations

Visual Field: Motion and Reading
Mark an “M” for motion and an “R” for reading at the appropriate angles on each side of the diagram.

Data Table 3

<table>
<thead>
<tr>
<th>Detail</th>
<th>Angle of Correct Identification (degrees)</th>
<th>Total Visual Field (Degrees Left + Right)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left</td>
<td>Right</td>
</tr>
<tr>
<td>Motion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Compare your motion and reading fields of vision (Total Visual Field). Which one is greater?

2. On what area of the retina was the image of the sight card focused when it was first detected? On what area of the retina was the image of the letters focused? Which type of nerve cell is more numerous in each area of the retina?

3. Think of activities or occupations where good peripheral vision would be advantageous. List several and explain why peripheral vision is important in each.
Station 4: Colorful Afterimages

The cone cells in your eyes are sensitive to the three primary colors of light—red, green, and blue. The images on the Colorful Afterimages cards are printed in magenta, cyan, and yellow. For each card type (U.S. Flag and Apple), color the image before and after one minute of focus on the card.

1. Use Figure 10 from page 5 to determine which color-sensitive cones were over-stimulated with each colored part of the U.S. Flag image. Which ones were over-stimulated with each colored part of the Apple image?

2. What afterimage color did you see in place of the black stars and stripes on the U.S. Flag image? Why do you think this happened?