

DESCRIPTION	<b>Round and Round</b>		CONTENTS
<u>Science Concepts</u>	<ul style="list-style-type: none"> <li>● Collect, organize, analyze, evaluate, make inferences, and predict trends from data.</li> <li>● Investigate and identify how organisms, including humans respond to external stimuli.</li> </ul>	<ul style="list-style-type: none"> <li>● Information for Teachers</li> <li>● Student Activities</li> <li>● Assessment</li> </ul>	
<u>Math Connections</u>	<ul style="list-style-type: none"> <li>● Gather and record data to determine functional relationships between quantities.</li> </ul>		
<u>Grade Levels</u>	<ul style="list-style-type: none"> <li>● Grades 7-10</li> </ul>		
<u>Instructional Strategy</u>	<ul style="list-style-type: none"> <li>● Guided Inquiry</li> </ul>		
<u>Time Line</u>	<ul style="list-style-type: none"> <li>● Laboratory Activity: 2-3 hours with pre-lab and post-lab assignments</li> </ul>		
<u>Standards</u>	<ul style="list-style-type: none"> <li>● National Science Education Content Standards</li> <li>● <u>5-8 and 9-12 Science Content Standard A</u></li> <li>● Abilities necessary to do scientific inquiry</li> <li>● Understandings about scientific inquiry</li> <li>● <u>9-12 Science Content Standard C</u></li> <li>● The Behavior of Organisms: Multicellular animals have nervous systems that generate behavior. Nervous systems are formed from specialized cells that conduct signals rapidly through the long cell extensions that make up nerves. The nerve cells communicate with each other by secreting specific excitatory and inhibitory molecules. In sense organs, specialized cells detect light, sound, and specific chemicals and enable animals to monitor what is going on in the world around them.</li> </ul>		

### Background Information

The microgravity environment in space causes disorientation and motion sickness in many astronauts. These problems occur because of the way the brain evaluates information from numerous sense organs, particularly the eyes, inner-ear vestibular organs and mechanoreceptors in muscles and joints in the absence of 1 G gravity. We normally use these organs to maintain balance and detect body orientation on Earth. An astronaut's neurovestibular system usually adapts to microgravity after a few days of adjustment during space flight, though a few crewmembers continue to occasionally experience visual illusions and three dimensional navigation problems. Most astronauts must readjust to 1 G upon return to Earth. Immediately after landing, crewmembers experience motion sickness or vertigo, and have problems standing up, stabilizing their gaze, walking and turning. During the readjustment to 1 G, some astronauts report that the world appears to be tilted and appears to move when they turn or tilt their heads. The readjustment period varies according to individual and is related to the duration of the space flight. The readjustment period for a 1-2 week Shuttle flight is usually a day or two, while disequilibrium can be severe and long lasting after extended flights.

On a two-year mission to Mars, neurovestibular adaptation problems will probably be significant, even if the decision is made to create "artificial gravity" on the space ship by spinning the ship to produce centripetal force. Crewmembers may have to repeatedly move between different areas of the ship where the forces vary from microgravity to about 1 G, and adapt to the additional Coriolis accelerations produced by the centrifuge rotation of the spacecraft. The NSBRI Neurovestibular Adaptation Team focuses on describing how the body's balance and orientation systems adapt to new and changing gravireceptor and visual cues during and after space flight. The goal of this basic research is to develop neurovestibular countermeasures, including preflight and in-flight training and postflight rehabilitation techniques. The research may also help the develop new treatments for patients suffering from diseases of the inner ear or brain balance centers. The NSBRI countermeasures research supports basic and clinical neurovestibular research programs at NASA, NIH and NIH-NSBRI.

Resources for background information:

"Neurovestibular Research" National Biomedical Research Institute  
<http://www.nsbri.org/Research/Neuro.html> (11 June 2002)

"Team Goals" Neurovestibular Adaptation Integrated Research Team  
<http://mvl.mit.edu/Neurovestibular/Pages/goals.html> (11 June 2002)

Recommendations for Teaching **Round and Round****WARNING**

Students may become disoriented, dizzy, or have motion sickness from being spun around on a chair. If you don't have a safe, open area to do this lab, or if your students do not follow directions, then do not attempt this lab in your class. Students who are feeling dizzy, nauseous, or who have neurovestibular problems should not participate as test subjects in this lab.



Be sure students remain in an upright position while being spun in the chair.

## Suggested Pre-Lab Questions for Students:

1. How many of you have ever heard of the neurovestibular system? (answers vary)
2. Where is the neurovestibular system located in your body? (inner ear & brain)
3. Why do you need your neurovestibular system? (to maintain balance and detect the location & direction of your body in 3-dimensional space)
4. How many of you have ever been on a roller coaster? (answers vary) Did you get a funny feeling in your head or your stomach? (answers vary) Guess what, that was your neurovestibular system at work!

## Teaching Hints:

1. Group sizes should be kept between 3 and 4 students per group.
2. Make sure there is ample room around the test area to avoid accidents.
3. Flour may be used in place of dry tempera paint, but the paint works better.
4. A rotating swivel chair with arms, with the wheels removed, and placed on top of a rubber mat works better and is safer.
5. Pay close attention to your students to be sure that test subjects aren't spun too fast or too long, and that subjects stay upright in their chairs.
6. Velcro blindfolds are recommended for easy removal.
7. Younger students will need to be reminded of graphing procedures and should be guided when choosing units of measurement to be used for calculations.
8. For safety, do not hold a stopwatch while rotating test subject.

# Round and Round

Student Activity

## INTRODUCTION

- Close your eyes and shake your head slowly up and down as if you are nodding “yes.” Could you feel your head go up and down?
- Can you tell when a car you are riding in is accelerating or decelerating, even with your eyes closed?

That was your neurovestibular system at work!

The neurovestibular system is located in the ear. There are a series of spaces, tubes, and tiny hair-like cells that all work together to make the system function. It is responsible for allowing you to maintain your balance. It lets you know when your body is moving as opposed to when things near you are moving. It helps you to determine up from down, backwards from forwards, and side-to-side motion. The neurovestibular system of some people does not work properly and causes them to feel dizzy, a condition called vertigo.

The pull of gravity decreases the further we travel away from Earth into space. In the microgravity of space, astronauts do not feel “up” or “down”, and the neurovestibular system has difficulty helping the body maintain balance. Most astronauts get space motion sickness due to conflicting sensations in their neurovestibular systems. You will model this disruption to the neurovestibular system in our lab, *Round and Round*.

## PRE-LAB QUESTIONS

1. If you get vertigo from riding on a roller coaster, what symptoms do you feel? \_\_\_\_\_
2. Motion sickness is due to problems with what sensory system? \_\_\_\_\_
3. What changing force causes car motion sickness? \_\_\_\_\_
4. What changing force causes space motion sickness? \_\_\_\_\_
5. An eye is to vision, as a/an ??? is to the sense of balance. \_\_\_\_\_

## INVESTIGATION QUESTION

What conditions affect your sense of balance and your neurovestibular system?

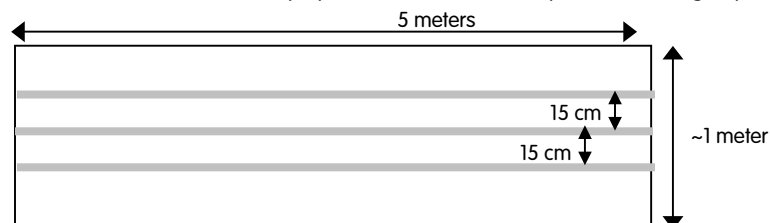
## MATERIALS

1. brown butcher paper or colored craft paper, 5 meters long x about 1 meter wide
2. masking tape
3. meter stick
4. dry temperapaint in a shallow box, about 40 cm by 40 cm on a side
5. stopwatch
6. rotating chair, to spin the test subject around
7. blindfold
8. broom

## PROCEDURE

Prepare your test area:

1. Lay paper 5 m long and about 1 m wide on the floor in an area clear of obstructions. Tape the paper securely to the floor.
2. Place one 5 m strip of tape down the center of the paper, and two 5 m strips of masking tape 15 cm from the center.

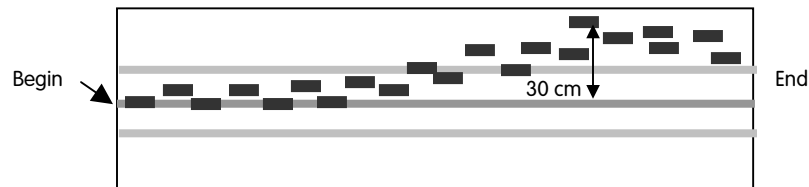


Prepare your test subject:

3. The test subject removes her/his shoes and socks.
4. The test subject places her/his bare feet in the flour box to coat the bottoms of her/his feet.
5. Have the test subject walk down the center of the paper to be sure the dry tempera paint foot prints are visible. Sweep the dry tempera paint from the paper. The test subject needs to coat her/his feet before every test, and the lab group needs to sweep the dry tempera paint from the paper after each test run.

Design your tests:

- **Test at least three people** in your lab group. Each subject has the task to walk down the center line of the paper during each test. You will **measure the distance that the subject deviates the farthest from the center line**. Measure from the outside of the center tape to the inside of the farthest footprint. In this example, the deviation is 30 cm. You will also **measure the time that the subject takes to walk the 5 m**.



- **Choose at least three tests for each person.** Choose your tests to **compare different amounts of the same condition**, such as with (1) both eyes open, (2) one eye covered, and (3) both eyes covered. An alternative set of comparisons is to test performance when the subject has had (1) no chair spins, (2) four spins in the chair, and (3) eight spins in the chair. Be sure to make one of your tests a control (no treatment or intervention) for a fair comparison.
- **DON'T spin subjects until they feel nauseous and dizzy. Eight spins is the maximum for most people.**

Who are the three test subjects?

(A) \_\_\_\_\_ (B) \_\_\_\_\_ (C) \_\_\_\_\_

Describe the three tests you will run on each subject. The three tests should be the same for each person.

(test 1)

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(test 2)

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(test 3)

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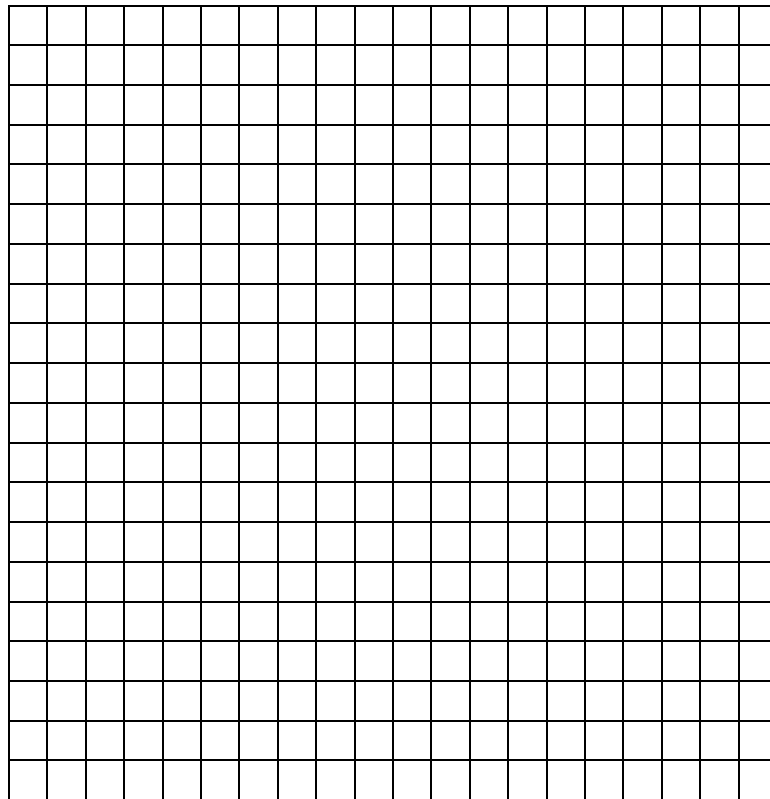
Run your three tests on the three subjects, recording your data in the table below. Remember to include units of measurement.


Average the results of the three tests.

Subject	Test 1 Deviation from the center line	Test 1 Walking time	Test 2 Deviation from the center line	Test 2 Walking time	Test 3 Deviation from the center line	Test 3 Walking time
A						
B						
C						
Average						

Present your averaged data on this graph:

*HINT:* Remember to title the graph and label the axes.



What was/were the manipulated variable(s) in your tests? \_\_\_\_\_

What was/were the responding variable(s) in your tests? \_\_\_\_\_

What were some sources of error in your tests? \_\_\_\_\_

ANALYSIS

The stated question for this laboratory activity was:

- What conditions affect your sense of balance and your neurovestibular system?

1. Restate the question to specifically describe the conditions you chose to test:

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2. Answer your question:

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3. What kind of relationship do your manipulated and responding variables have? (*HINT*: if one variable increases, does the other one increase?)

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4. Find another student group that chose the same kinds of tests that you did. Are your results the same? Report and explain any similarities or differences.

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5. How would you improve the way you designed and tested conditions that affect the neurovestibular system?

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