The Science of Sleep and Daily Rhythms

Sleeping in Space

by
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Space is a challenging environment for the human body. With long-duration missions, the physical and psychological stresses and risks to astronauts are significant. Finding answers to these health concerns is at the heart of the National Space Biomedical Research Institute’s program. In turn, the Institute’s research is helping to enhance medical care on Earth.

The NSBRI, a unique partnership between NASA and the academic and industrial communities, is advancing biomedical research with the goal of ensuring a safe and productive long-term human presence in space. By developing new approaches and countermeasures to prevent, minimize and reverse critical risks to health, the Institute plays an essential, enabling role for NASA. The NSBRI bridges the research, technological and clinical expertise of the biomedical community with the scientific, engineering and operational expertise of NASA.

With nearly 60 science, technology and education projects, the NSBRI engages investigators at leading institutions across the nation to conduct goal-directed, peer-reviewed research in a team approach. Key working relationships have been established with end users, including astronauts and flight surgeons at Johnson Space Center, NASA scientists and engineers, other federal agencies, industry and international partners. The value of these collaborations and revolutionary research advances that result from them is enormous and unprecedented, with substantial benefits for both the space program and the American people.

Through our strategic plan, the NSBRI takes a leadership role in countermeasure development and space life sciences education. The results-oriented research and development program is integrated and implemented using focused teams, with scientific and management directives that are innovative and dynamic. An active Board of Directors, External Advisory Council, Board of Scientific Counselors, User Panel, Industry Forum and academic Consortium help guide the Institute in achieving its goals and objectives.

It will become necessary to perform more investigations in the unique environment of space. The vision of using extended exposure to microgravity as a laboratory for discovery and exploration builds upon the legacy of NASA and our quest to push the frontier of human understanding about nature and ourselves.

The NSBRI is maturing in an era of unparalleled scientific and technological advancement and opportunity. We are excited by the challenges confronting us, and by our collective ability to enhance human health and well-being in space, and on Earth.
Language arts activity in which students learn from times they have had difficulty sleeping, read about how astronauts sleep in space, and write about unusual places in which they have slept. Many different factors affect the quality of sleep. Astronauts traveling in space experience many disruptions to their normal sleep patterns.

Why Do We Sleep?
Scientists still are trying to answer this question. Some people believe that by slowing metabolism, sleep helps the body recover from activities carried out during waking hours, and that sleep also helps us form memories. Some animals may sleep to save energy during hours when it is too dark or too dangerous to hunt for food.

Effects of Sleeplessness
Sleeplessness diminishes mental and physical performance. Just one sleepless night can impair performance as much as being intoxicated from alcohol. In addition, we are more susceptible to the effects of drugs and alcohol when we’re sleepy than when we are well-rested. Sleepiness can build up day after day, creating a sleep “debt” that may be hard to “pay back.” Many nights of good sleep may be needed to recover.

Science Education Content Standards*
Grades 6–12

Life Science
• Behavior is one kind of response an organism can make to an internal or external stimulus.

Science in Personal and Social Perspectives
• The potential for accidents and the existence of hazards impose the need for injury prevention.

Science, Health & Math Skills
• Identifying common elements
• Making extensions to new situations

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PROCEDURE

1. Ask students to remember an occasion when they had difficulty sleeping. Have them share their experiences with the rest of the class, and list the experiences on the board or on an overhead. Scenarios suggested by students might include: the night before an exciting event, such as a birthday party; trying to sleep in the car during a long trip; or being awakened by strange or frightening noises at night.

2. Encourage students to think carefully about the list and to identify common elements among the events. Such elements could include: sleeping in places other than home; sleeping before or after unusual events; sleeping when one’s physical state is not normal (sick with an itchy rash, etc.).

3. Mention to students that they will be reading about a situation in which it is very difficult to sleep—being an astronaut in space. Ask, Do you think astronauts can sleep as well in space as they do at home? What might be different about sleeping in space? How do you think the space station environment affects astronauts’ physical and mental performance? How might microgravity—and the feeling of weightlessness experienced while orbiting Earth—affect sleep?

4. After students have offered their comments, distribute the student sheets.

5. Students may read the essay and complete the writing extensions on their own or in small groups.

6. Allow students to share their work by having them read their paragraphs or by displaying their paragraphs somewhere in class.

7. Conduct a class discussion about the importance of getting enough sleep. Begin by telling students that when you don’t get enough sleep, it can be hard to stay alert, especially if you work at night. Ask, What could happen if someone drives or operates dangerous equipment when he or she is drowsy? Help students understand the connection between sleep and performance on mental or physical tasks.

EXTENSIONS

• Have students create drawings to accompany and illustrate their paragraphs on sleeping.

• Encourage students to learn more about living and working in space by visiting websites of the National Space Biomedical Research Institute (www.nsbri.org) and NASA (www.nasa.gov); and/or have them investigate research on the relationship between sleep and performance at Harvard University’s Healthy Sleep website (http://healthysleep.med.harvard.edu).

• Scientists are using mathematical models to predict alertness levels for astronauts and airplane pilots under a variety of conditions. These predictions can increase safety by enabling astronauts and pilots to know when they are most prone to mistakes caused by sleepiness. Have students think of other ways we use mathematical models to make predictions (weather predictions, stock market predictions, etc.).

Tips for Students

Students can do several things to make sure they are rested and ready to perform well in school.

• Avoid soft drinks or foods with caffeine (e.g., chocolate, some carbonated beverages, coffee, tea), especially close to bedtime. Nicotine (from smoking) and alcohol also interfere with sleep.

• Stick to a regular schedule for going to bed and waking up, and get bright light in the morning to help program your biological clock.

• Do some light exercise in the late afternoon (but not in the evening before going to bed).

• Recognize that most students need at least nine to ten hours of continuous sleep per night, and plan schedules accordingly.

• If you have trouble falling asleep, drink a glass of warm milk, which contains tryptophan, an amino acid that can aid sleep.

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Have you ever slept in a sleeping bag? Maybe when you went camping or slept over at a friend’s house? When astronauts sleep on the space shuttle or the International Space Station (ISS), they fasten themselves into special sleeping bags. In space, there is no “up” or “down,” and the effects of gravity are minimized. As a result, astronauts feel weightless, and can sleep in any orientation. But they have to attach themselves to a seat or wall inside the crew cabin or sleeping compartment, so they don’t float around and bump into something while they sleep.

Generally, astronauts are scheduled for eight hours of sleep each mission day. But like on Earth, they may wake up in the middle of their sleep period, or stay up late to look out the window. The excitement of being in space, motion sickness, and other factors can disrupt an astronaut’s sleep pattern. Crewmembers easily can hear each other, so they may need to wear earplugs during their sleep periods.

Sleeping in the shuttle’s cockpit is especially difficult because the sun “rises” every 90 minutes while the shuttle orbits Earth. The sunlight and warmth entering the cockpit window are enough to disturb a sleeper who is not wearing a blindfold. When it is time to wake up on the space shuttle, the Mission Control Center in Houston, Texas, plays music to the crew. The ISS crew must use an alarm to wake up.

Getting enough sleep is a priority for astronauts in space. Without sufficient sleep, they are more likely to make mistakes and may not perform well during their complex tasks. Researchers with the National Space Biomedical Research Institute are working to improve astronauts’ sleep and scheduling of work shifts. For instance, these scientists are learning how specific types of light can increase alertness and performance in space. Their findings also will help people on Earth who have sleep problems.

1. List at least three ways in which sleeping in space is just like sleeping on Earth.
2. List at least three ways in which sleeping in space is different from sleeping on Earth.
3. Write a paragraph about the most unusual place in which you ever have slept. Include answers to the following questions.
   a. Where did you sleep?
   b. How well did you sleep?
   c. How did you feel when you woke up?
   d. Would you like to sleep there every day?