

Sleep

Activity Summary

Students practice a procedural skill—knot tying—to investigate if and in what way sleep affects learning and memory in relation to learning a procedural skill.

Materials for Each Person

- copy of “Sleep and Memory” student handout
- copy of “Knot Tying with a Twist” student handout
- timer (seconds and minutes)
- rope (1 meter in length)
- paper and pen

Background

Sleeping is a behavior that is natural and essential for our health and well-being. In fact, it is a biological necessity—we would die without it. Still, sleep is not yet well understood. It is known that sleep is not a time for all body systems to shut down and rest. Some brain activity actually elevates during sleep, and some hormone secretions increase too. Studies show that sleep affects energy, reaction rate, coordination, concentration, and focus. Lack of sleep often results in costly and even deadly consequences. Tens of thousands of people in the United States are injured each year because of automobile accidents that result from drivers’ sleepiness!

Teens need between nine and ten hours of sleep each night, and adults need about eight hours. In general, sleep follows a predictable pattern or cycle of alternating phases of rapid eye movement (REM) and non-rapid eye movement (NREM) sleep. The cycle begins with about 90–100 minutes of NREM sleep followed by a period of REM sleep. The pattern repeats itself, usually about five or six times each night, with varying amounts (but within a predictable range) of NREM and REM sleep. Different physiologic changes occur during the NREM and REM sleep; brain waves, eye movements, and muscle tension also vary.

Scientists suggest that a night’s sleep (and sometimes even a nap) seems to help consolidate memories related to habits, actions, and skills practiced earlier in the day.

Research is beginning to reveal more about the cognitive functions related to learning and memory that are affected by sleep, and the brain regions involved. Scientists have found that sleep seems to improve memory related to some types of declarative (learning facts) and procedural (how to perform a skill) learning, as well as the ability to accomplish some spatial tasks.

LEARNING OBJECTIVES

Students will be able to:

- learn the importance of practice in developing a procedural skill.
- understand that information may become more permanent following sleep.
- make inferences about the effect sleep may have on some types of memory and learning.
- review the investigation and consider how controls strengthen the experiment.

CLASSROOM ACTIVITY (CONT.)

Memory pertains to the way information is encoded, stored, and retrieved from our brains. Short-term memory is related to storage and recall of recent knowledge and events. *Working memory* relates to the active aspect of short-term memory. Recalling directions and gathering a remembered list of items involve working memory. *Long-term memory* relates to the storage and retrieval of relatively permanent information.

Investigators in the program theorize that during sleep, the brain replays memories, modifying and enhancing them. Sleep helps improve some kinds of memory tasks more than others, including recognition of visual patterns, solving some kinds of math puzzles, and such skills as typing. In rats, it seems that at least a part of the mechanism of memory enhancement involves neural communication between two areas of the brain—the hippocampus and the neocortex—both of which play a role in memory storage.

In this activity, students will practice a procedural skill, knot tying, and then investigate the effect of both practice and sleep on learning this type of skill. Investigators in the program emphasize that it is not only practice that makes perfect, but also a night's sleep!

Because it is difficult to perform a highly controlled sleep experiment in a classroom, this activity is an investigation of the possible role sleep plays in learning some types of skills. After completing the lesson, students will analyze the activity and suggest controls that could be included to improve the reliability of their results.

Procedure

- 1 In the week before doing this activity, ask three or four adults to learn the knots. Have them assist students on the day the activity is performed.
- 2 Have students brainstorm and share how they learned to perform skills such as typing, playing a musical instrument, dancing, cycling, snowboarding, playing video games, or driving. (*People often learn these skills initially by being shown the skill by an expert and then practicing it.*) Ask students what, other than practice, contributed to their learning the skill. (*Some students may say: talking to themselves about the process, mentally reviewing the process, paying attention to mistakes, or thinking about and making connections to other similar experiences. Some students may say that during the process they thought about questions to later ask a teacher or friend whom they thought might have the answer.*)

Tell students that being actively engaged in learning a skill involves cognitive, or thinking, processes—using their brains—coupled with physical movement.

CLASSROOM ACTIVITY (CONT.)

After the discussion, you may choose to ask a few students who have learned to play an instrument, perform a dance, or who have mastered another skill if they would like to briefly demonstrate. Ask them how much they practice and have them explain the difference between simple repetition and thoughtful practice (see above). (You may want to demonstrate a skill yourself.)

- 3 Ask students to think about their own learning, and then have them identify factors that can make it difficult to learn something (e.g., illness, injuries, stress, constant distractions, not their best time of day to learn, lack of sleep). List the factors on the board. Tell students that today's activity investigates whether sleep plays a role in learning.
- 4 Supply each student with the materials listed in the Materials section. Review the handouts. Ask students to pair up. Have pairs choose one of the three knots and learn to tie it. Tell students that an adult can demonstrate tying the knot and will help with any questions or problems. Each student should accurately tie his or her knot five times.
- 5 On the "Knot Tying with a Twist" handout, have students circle the knot they chose. After accurately tying their knot five times, and before leaving class, partners will time and score each other's knot tying, and then record on their "Sleep and Memory" student handout, next to Trial 1, their knot score and the time it took to tie their knot.

Be sensitive to differences in ability. Individual student scores and times may vary greatly. Each student will be recording and tracking his or her individual results. When the class analyzes the data, only common patterns will be discussed.

- 6 That evening before going to bed, each student should test his or her knot-tying ability, writing the time and score on the "Sleep and Memory" student handout next to Trial 2. A family member should assist, acting as a partner and timer.
- 7 When students wake up the next morning, they should record on their "Sleep and Memory" handout the number of hours they slept, how well they slept, and how rested they feel. (See the Questions page of the handout.) Students should again tie their knot after breakfast and record their knot-tying time on their "Sleep and Memory" student handout, next to Trial 3. (Or, if class meets early in the morning, have students repeat tying their knot in class, recording their times and scores.)
- 8 Have students complete the rest of the questions on their "Sleep and Memory" handout.
- 9 Draw two four-column charts on the board with the following headings: Knot, Trial 1, Trial 2, and Trial 3. (See activity answer, student handout question 3.) Have students enter their data into one of the charts. Average the data for each knot and enter it in the other chart.

CLASSROOM ACTIVITY (CONT.)

10 As a class, analyze the results in the charts (first in the chart with the averaged data, then in the chart with the whole-class results) by discussing knot times and comparing time differences before and after sleep. Ask: “Is there a common pattern in relation to time and score differences before and after sleep?” Have students describe any pattern they see. Ask: “What role did practice play in learning to tie the knot?” “Is there any evidence that indicates sleep may have played a role in learning?” “Are there other factors that may have influenced results?”

Then discuss students’ answers to the questions on the “Sleep and Memory” student handout.

11 As an extension, perform the activity again but instead of knot tying have students explore the effect of sleep on memorizing a short poem or speech. (Ask students to brainstorm a learning activity to test.) Or try the same activity before and after a nap rather than a full night’s sleep.

STANDARDS CONNECTION

The “Sleep and Memory” activity aligns with the following National Science Education Standards (see books.nap.edu/html/nses).

GRADES 5–8

Life Science

- Regulation and behavior

Science in Personal and Social Perspectives

- Personal health

GRADES 9–12

Life Science

- The behavior of organisms

Science in Personal and Social Perspectives

- Personal and community health

*Video is not required
for this activity.*

Classroom Activity Author

Developed by WGBH Educational Outreach staff.

ACTIVITY ANSWER

Student Handout Questions

- 1 About how many hours did you sleep last night? *Answers will vary.*
- 2 Check one of the following statements:
 - I slept well, and I am well rested.
 - I slept somewhere in between well and poorly, and I'm somewhat rested.
 - I slept poorly, and I am tired.
- 3 Put your three knot-tying times and scores in order, from least to greatest. *Answers will vary. Typical expected results for times: Trial 3 < Trial 1 ≤ Trial 2; Typical expected results for scores: Trial 2 ≤ Trial 1 ≤ Trial 3.*

Knot-Tying Results Chart (sample results)

| Knot | Trial 1 | | Trial 2 | | Trial 3 | |
|------------|---------------|------------|---------------|------------|---------------|------------|
| Square | Time 7 sec | Score 5 | Time 7 sec | Score 4 | Time 5 sec | Score 5 |
| Bowline | Time 7 sec | Score 5 | Time 8 sec | Score 4 | Time 6 sec | Score 5 |
| Sheepshank | Time 8 sec | Score 5 | Time 9 sec | Score 5 | Time 6 sec | Score 5 |

- 4 Consider whether the times suggest that sleep played a role in learning in relation to your knot-tying ability. *Knot-tying scores may be greater and times shorter after sleep.* What factors other than sleep may have influenced results? *Factors may include simply the passage of time, or being a “morning person”.*
- 5 Describe the role that practice played in helping you master your knot. *Practice has the greatest influence on learning.* While practicing tying your knot, what sorts of questions did you ask yourself? What thoughts did you have that may have helped you be successful? *Student responses may include talking through the steps, reminding themselves about one or more difficult steps, or remembering a helpful saying about the process.*
- 6 Analyze the activity and suggest controls that could be included to improve the reliability of results. *Students may suggest the following: control the sleep period as best as possible; choose participants with the same amount of knot-tying or equivalent experience; control diet; and control stress as best as is possible.* Then, propose an experiment with additional controls that would increase the reliability of the results. *Students may suggest that participants undertake the challenge together in an environment that is as similar as possible for all participants.*

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LINKS AND BOOKS

Links

NOVA scienceNOW

pbs.org/nova/sciencenow/3410/01.html
Offers sleep-related resources, including additional activities, streamed video, and reports by experts.

Are You a Lark, an Owl, or a Hummingbird

nasw.org/users/llamberg/larkowl.htm
Presents an excerpt from a book about daily rhythms and the body clock.

Information about Sleep

science.education.nih.gov/supplements/nih3/sleep/guide/info-sleep.htm
Includes information about the function of sleep, and sleep disorders.

Neuroscience for Kids

faculty.washington.edu/chudler/chmemory.html
Provides a variety of memory-related experiments.

Clockwork Genes

hhmi.org/biointeractive/clocks/index.html
Contains four animations, pertinent articles and an online biological clock exhibit.

Researchers Find the Snooze Button

hhmi.org/news/sehgal20060608.html
Describes research using fruit flies and considers the role of “mushroom bodies” on regulating sleep.

Sleep Forms Memory for Finger Skills

pnas.org/cgi/doi/10.1073/pnas.182178199
Describes results of a finger-to-thumb motor skill task.

Books

The Body Clock Guide to Better Health

by Michael Smolensky and Lynne Llamberg.
Henry Holt and Co., 2000.
Discusses the importance of body rhythms in relation to health.

The Promise of Sleep

by William C. Dement and Christopher Vaughan.
Dell, 2000.
Describes sleep disorders and discusses the importance of sleep.

Sleep and Memory

Have you ever wondered how a skill, such as playing the piano, typing, swimming, or playing a video game, is learned and becomes nearly automatic? In this activity you'll practice tying a knot that may be new to you, and then you'll investigate the roles practice and sleep play in learning and improving your knot-tying ability.

Procedure

- 1 With your partner, choose one knot on your "Knot Tying with a Twist" handout for both of you to learn to tie. Circle the knot you chose.
- 2 Use the illustrations and follow the knot directions to help you learn the steps. Your teacher or another adult can demonstrate.
- 3 Once you and your partner have learned how to tie the knot, each of you should accurately tie your own knot 5 times.
- 4 Next, you and your partner will take turns timing and scoring (simultaneously) each other's knot tying. Use the timer to find the time it takes to tie the knot. To score, give one point for each tying step accurately accomplished; then total the points. A perfect score for each knot equals five points. Now record your own total time (to the nearest second) and score for Trial 1.

Trial 1: Time: _____ Score: _____

If you are unable to complete the knot, note the time when you realize you are stuck and record this time.

- 5 Do not practice tying your knot again until you retest yourself right before going to bed that same evening. Have someone time you. Record your time and score for Trial 2.

Trial 2: Time: _____ Score: _____

- 6 The next morning, retest your knot-tying ability. (Your teacher will tell you if this test is to be performed before class or during class.) Record this time and score for Trial 3.

Trial 3: Time: _____ Score: _____

Questions

Write your answers on a separate sheet of paper.

- 1 About how many hours did you sleep last night?
- 2 Check one of the following statements:
 - I slept well, and I am well rested.
 - I slept somewhere in between well and poorly, and I'm somewhat rested.
 - I slept poorly, and I am tired.
- 3 Put your three knot-tying times and scores in order, from least to greatest.
- 4 Consider whether the times and scores suggest that sleep played a role in learning in relation to your knot-tying ability. What factors other than sleep may have influenced results?
- 5 Describe the role that practice played in helping you master your knot. While practicing tying your knot, what sorts of questions did you ask yourself? What thoughts did you have that may have helped you be successful?
- 6 Analyze the activity and suggest controls that could be included to improve the reliability of results. Then, propose an experiment with additional controls that would increase the accuracy of the results.

Knot Tying with a Twist

How to Tie a Square Knot

- 1 Take the ends of the rope and make an "X" with the left end of the rope placed over the right.
- 2 Cross the "new" right end around the rope to make an overhand knot.
- 3 Take the right and left ends and put the right end over the left.
- 4 Tie a second overhand knot.
- 5 Pull the ends tightly so that they make a neat, square knot.



1



2



3



4



5

How to Tie a Bowline Knot

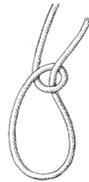
- 1 Hold the two ends of your rope together, then lay your rope flat on a table.
- 2 Take the left half of the rope and make a small loop about half way down. (This loop is sometimes called the hole.)
- 3 Take the right end of the rope (the tag end), and bring it up through the hole.
- 4 Pass the tag end under and around the left strand of the rope.
- 5 Then bring the tag end back down through the hole and pull the knot tight.



1



2



3



4



5

How to Tie a Sheepshank Knot

- 1 Lay the rope on a table and make an "S" with rope.
- 2 Make a loop at the bottom left.
- 3 Pass the top part of the S through the bottom loop.
- 4 Make a small loop at the top right.
- 5 Pass the bottom part of the S loop through the top loop and tighten so that the looped ends on the left and right are about the same size.



1



2



3



4



5