NeuLog

Emotional Stress Measurement
Experiment

Biology

Objectives

- Understand the fight or flight response.
- Examine how stimulation of the human system (by touch, smell, sight or sound) causes the sweat glands in the hand to secrete sweat.
- Understand the principles of a polygraph (lie detector).
- Explore the concept of biofeedback.
- Understand Progressive Muscle Relaxation (PMR) and Virtual Reality Exposure Therapy (VRET) using GSR.

Modules and Sensors

- PC + NeuLog application
- USB-200 module or BLT-202 Bluetooth module
- NUL-217 GSR (Galvanic Skin Response) logger sensor

Equipment and Accessories

▪ Wash bottle (or a glass)
▪ Cotton pad
▪ Pen

Materials

▪ Blank cards	5
▪ Water for the wash bottle	–
▪ Bottle of alcohol, perfume or cologne	–

Introduction

Emotional and sensory stimulation triggers sweat production. The GSR (Galvanic Skin Response) logger sensor measures sweat secretion from the sweat glands in the hand. When stimulation occurs, sweat levels increase, leading to **higher skin conductivity**.

Why does emotional and sensory stimulation cause sweating?

The **fight-or-flight** response is activated in reaction to an acute threat, preparing the body to either react or retreat.

When a threat is perceived, the **sympathetic nervous system** (a part of the autonomic nervous system) is activated, releasing the hormones **noradrenaline and adrenaline**. These hormones bind to adrenergic receptors on peripheral tissues, causing:

- **Pupil dilation**
- **Increased heart rate**
- **Elevated blood pressure**
- **Faster breathing**
- **Increased sweat production**

Sweating helps the body dissipate excess heat generated by increased muscle activity.

Humans have several millions **sweat glands**, located in the **dermis** (the middle skin layer)..Sweat is transported to the **epidermis** (the surface layer) through sweat ducts. Sweat glands are concentrated in areas such as the **forehead, palms, armpits and soles of the feet**.

Lie Detection and GSR Measurement

GSR measurement is a key component of a **Polygraph** (lie detector). Lying induces a stress response, which is reflected in physiological changes.

A polygraph records:

- **Skin conductivity** (measured via GSR)
- **Blood pressure fluctuations**
- **Pulse rate changes**
- **Respiration variations**

In this experiment, you will observe how humans react to emotional stimulation. You will measure sweat secretion in response to different stimuli and record the changes over time.

Biofeedback

Biofeedback is a technique that increases awareness of physiological functions using electronic monitoring, allowing individuals to learn how to control bodily responses voluntarily.

The brain plays a central role in regulating the body's systems. Sensory organs relay information to the brain, which processes the input and triggers a corresponding reaction.

Research on biofeedback has been conducted in laboratories and clinics worldwide, focusing on five primary physiological areas:

1. Brain waves
2. Skin temperature and blood flow
3. Heartbeat and blood pressure
4. Muscle tension
5. Changes in skin electrical conductivity (GSR)

Among these, GSR is a simple yet **powerful tool** for analyzing physiological responses in biofeedback therapy.

PMR – Progressive Muscle Relaxation

Progressive Muscle Relaxation (PMR) is a guided exercise where individuals follow instructions to regulate breathing and focus on different muscle groups.

Within **30 to 45 minutes**, PMR can:

- Induce full-body relaxation
- Increase blood flow
- Reduce stress and headaches

Biofeedback instruments monitor physiological responses during relaxation. Some track **temperature changes**, while others measure **sweat secretion**, **respiration** or **pulse rate**. Changes in **skin electrical resistance** also indicate the body's response to anxiety and stress.

A typical **GSR graph** during PMR relaxation shows a **decrease in skin conductivity**:

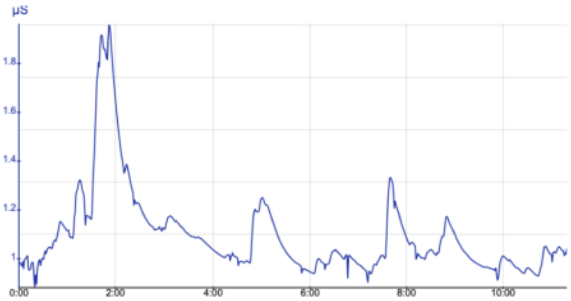
VRET – Virtual Reality Exposure Therapy

Exposure therapy is a well-established treatment for **phobias,** including:

- Claustrophobia – fear of enclosed spaces
- Arachnophobia – fear of spiders
- Cynophobia – fear of dogs
- Acrophobia – fear of heights

Virtual Reality Exposure Therapy (VRET) presents individuals with computer-generated simulations of their feared environments, allowing them to encounter **controlled phobic triggers.**

A typical **GSR graph** during VRET shows **fluctuations in skin conductivity**:



GSR Measurement Ranges

The NUL-217 NeuLog GSR sensor has two measurement modes:

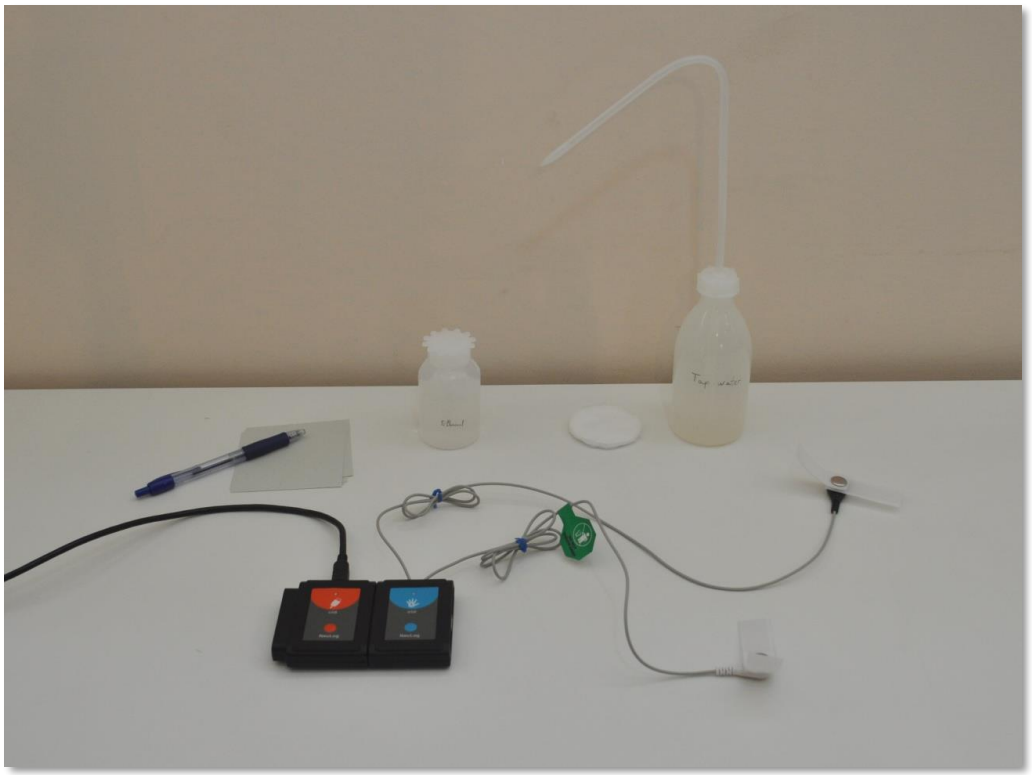
- µS (micro-Siemens):
  Measures **absolute conductivity** in micro-Siemens, which varies between individuals.
- Arb (Arbitrary Units):
  Amplifies **relative conductivity changes** (ideal for lie detection and emotional response analysis).

The **Arb mode** is recommended when monitoring **conductivity changes** rather than absolute values.

Procedure

Experiment setup

1. Set up the experiment as shown in the picture below.



2. Ensure you have:
   - A wash bottle filled with water (or a glass of water),
   - A cotton pad,
   - Five bank cards,
   - A pen,
   - A bottle of alcohol, perfume, or cologne.

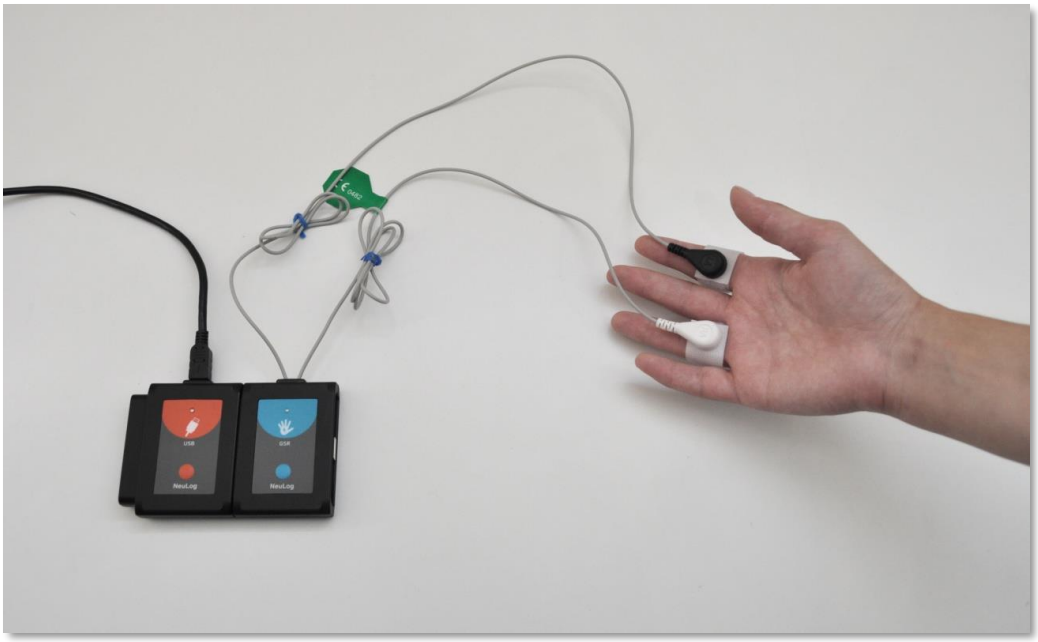
3. Turn off the air-conditioning system in the room.

4. The experiment requires three participants:
   Two experimenters
   One test subject

5. Instruct the subject to **warm their hands** by rubbing them together.

6. Moisten two fingers using **a wet cotton pad**.

7. Attach the GSR electrodes to the moistened areas.



8. Instruct the subject to sit down.
Position yourself behind them, either standing or sitting.
Ensure that the subject cannot see you, the two experimenters and the computer screen.

Sensor setup

9. Connect the USB-200 module to the PC.

10. Ensure that the **GSR sensor** is properly connected to the USB-200 module.

Note:

The following application functions are briefly explained. It is recommended to practice using the NeuLog application in advance, following the instructions in the user manual.

11. Launch the NeuLog application and verify that the GSR sensor is detected.

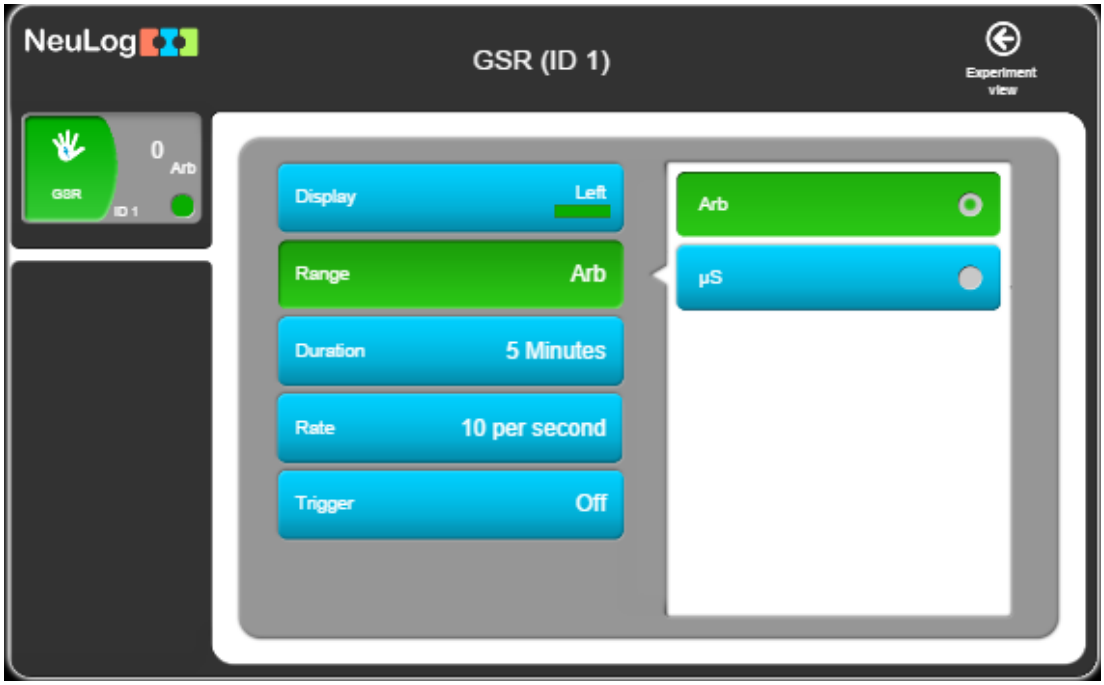
Settings

11. Click on the **Sensor's Module** box.

12. Select the **Arb** button to change the sensor's mode (arbitrary units provide a clearer **response** than µS).

    The **µS range** measures absolute conductivity in micro-Siemens (µS), which varies between individuals.

    The **Arb range** amplifies conductivity changes, making variations more noticeable.



13. Click on the  icon to return to the gr aph.

14. Click on the **Run Experiment** icon  and set the following parameters:

- **Experiment duration**: 10 minutes
- **Sampling rate**: 10 samples per second

GSR Measurement During Sensory Stimulation

People **rely** heavily on sight and hearing, **so** these senses must be minimized to allow **maximum focus on** other sensory inputs.

Stimulation **through** touch and smell is more **effective** when sound and **visual distractions are reduced**. **In such conditions**, the sensory organs **responsible for** touch and smell become more sensitive.

15. Instruct the subject to sit quietly for a few moments with eyes closed, head down, legs uncrossed, and arms resting either on the armchair supports or on their lap. Ensure that no pressure is applied to the finger electrodes.

16. The experimenters should minimize external distractions (e.g., no talking).
17. Observe the measured response value in arbitrary **(arb)** units on the sensor.

    Note: This value varies between subjects and depends on the individual's emotional state.

18. Click on the GSR sensor module box and set the Y-axis limits to approximately 6,000 **units** above and below the measured value.

19. One experimenter will perform the stimulations, while the other will **record** the time of each event and the corresponding arbitrary (Arb) value.

20. Click on the **Record** icon  to start the measurement.

21. Click on the **Arrows** icon  to view the sensor's values during the measurement.

22. To view the entire graph after one minute, use the mouse scroll wheel.

23. The graph may continue to fluctuate. **Remain silent** and wait until only small **variations** appear on the graph.

Stimulation Events

24. **Event 1** – Lightly touch the subject's ear and observe the response on the graph.

    - The production of even a small amount of sweat will cause the measured value to change.
    - The more sweat produced, the greater the change in conductivity.

    Note:
    There is a time delay between stimulation and the sensor's response. It typically **takes 0.8 to 4 seconds** for the hand to produce sweat after stimulation occurs.

25. **Event 2** –lightly touch the subject's other ear and observe the response.

26. **Event 3** – Once the subject becomes **habituated** to touch, try blowing gently across their ear or face to see if they respond to air movement.

    - Habituation is a decrease in response due to repeated exposure to the same stimulus.

27. **Event 4** – Place your hand on the subject's head and observe the reaction.

28. **Event 5** – Open a bottle of alcohol, cologne, or perfume approximately one meter from the subject's nose, allowing them to smell the aroma..

    - The subject should **not** be informed in advance about this stimulus.
    - The GSR response will indicate the moment they detect the scent.

29. Click on the **Export** Icon  then select **Save value table (.CSV)** button to save your graph.

30. Click on the  icon to return to the graph.

31. Analyze your graph to interpret the responses to each stimulus.

Lie detection using GSR

32. Give the subject 5 blank cards and ask him/her to write a name on each card.
    - **One name** should be of someone very close to them (e.g. mother, father, sibling).
    - The **other four names** should be of people they **do not know** (with names matching the gender of the first name).

33. Instruct the subject **to warm their hands** by rubbing them together.

34. Have the subject **moisten small areas** on two fingers using a wet cotton pad.

35. Attach the **finger electrodes** over the moistened areas, as shown in the following figure.

36. Instruct the subject to sit down with eyes closed.

37. Shuffle the cards and instruct the subject to answer 'No' to each question **until the experiment is** completed**.**

38. Wait at least **15 seconds** between questions and ask:

    'Is Paul your brother?'
    'Is Sam your brother?'
    And so on.

39. Observe the subject's response on the graph for each question.

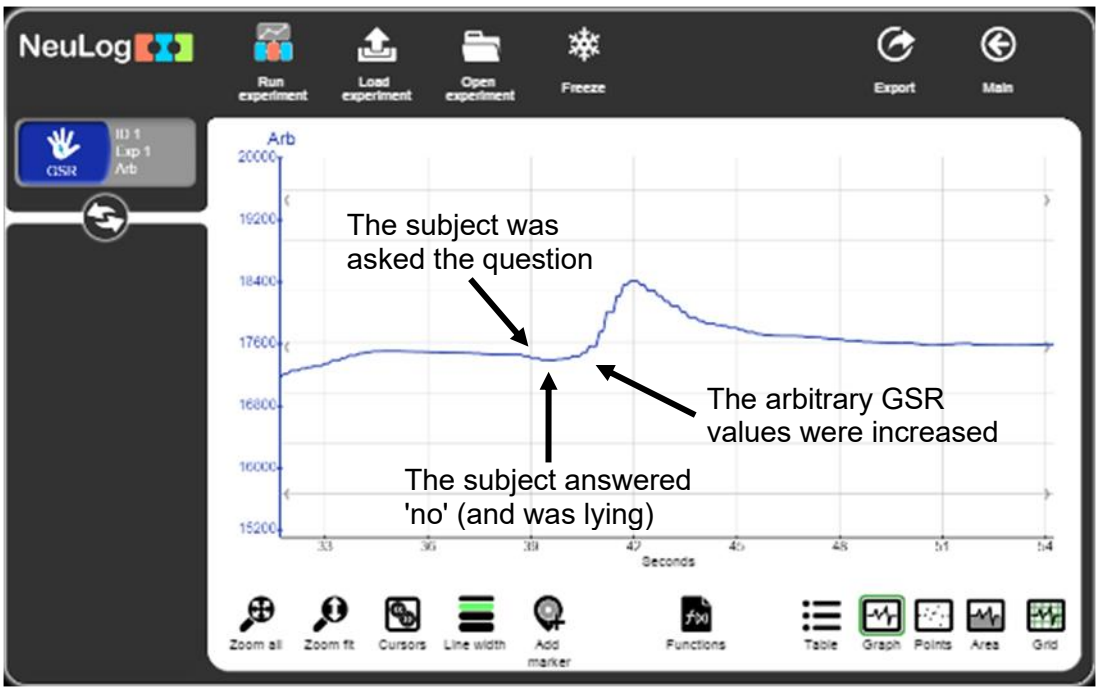
40. Vary the phrasing of the questions, for example:

    'I think that Paul is your brother.'
    'So, Charles is your brother?'

41. Identify the highest response for a specific name (or two names). Continue questioning in different ways and observe any patterns.

42. Conclude the experiment and **guess the correct** name based on the highest recorded response.

43. Below is an example of a graph segment showing the subject's response when asked about a person they are emotionally close to:



44. Click on the **Export** Icon  then select **Save value table (.CSV)** to save your graph.

45. Click on the  icon to return to the graph.

46. Analyze your graph to interpret the subject's responses.

PMR – Make them relax

47. Click on the **Sensor Module** box.

48. Select the **µS** button to change the sensor's mode.

    In this experiment, we aim to observe **changes in the subject's skin conductivity** throughout the session.

49. Instruct the subject **to warm their hands** by rubbing them together.

50. Have the subject **moisten small areas** on two fingers using a wet cotton pad.

51. Attach the **finger electrodes** over the moistened areas, as shown in the following figure.

52. Instruct the subject to sit down with eyes closed.

53. Stand or sit behind **the subject**, ensuring they do not feel your presence too closely.

54. Click on the **Run Experiment** icon  and set the following parameters:

    Experiment duration: 30 minutes
    Sampling rate: 10 samples per second

55. Click on the **Record** icon  to start the measurement.

56. Click on the **Zoom fit** icon.

57. Guide the subject through the PMR script in appendix A, while observing the GSR graph.

    Below is an example of a **successful PMR session graph**:

Make them nervous

58. Click on the **Sensor Module** box.

59. Select the **µS** button to change the sensor's mode.

    In this experiment, we aim to observe **how the subject's skin conductivity changes** in response to nervousness or stress.

60. Instruct the subject to **warm their hands** by rubbing them together.

61. Have the subject **moisten small areas** on two fingers using a wet cotton pad.

62. Attach the **finger electrodes** over the moistened areas, as shown in the following figure.

63. Ensure the subject **cannot see the computer screen** during the experiment.

64. Click on the **Run Experiment** icon  and set the following parameters:

    Experiment duration: 10 minutes
    Sampling rate: 10 samples per second

65. Click on the **Record** icon  to start the measurement.

66. Instruct the subject to **sit comfortably and read the first page** of the story **The little red cap** (appendix B) **out loud**, while you observe the screen for changes in conductivity.

67. Click on the **Zoom fit** icon as needed to adjust the graph view.

Conclusions

1. **Emotional and sensory stimulation** (via the five classic senses) triggers **sweat production**, which is a key component of the **fight-or-flight response**.

2. The graph shows that **when the subject is under stress**, **sweat is released**, and this can be accurately measured using the GSR logger sensor.

3. Sweat glands are highly concentrated in specific areas of the body, including the forehead, palms, armpits, and soles of the feet, Measuring sweat in areas like the forehead, back or chest is more challenging due to lower gland density or accessibility.

4. **Sweat production changes** occur 0.8 to 4 seconds after the subject experiences stimulation.

5. GSR measurement is **a key component of** polygraph (lie detector) tests. In addition to skin conductivity, a polygraph can simultaneously measure **changes in blood pressure**, **pulse rate, respiration and other physiological responses**.

Summary questions

1. What **conclusions can you draw** from your results?

2. Besides skin conductivity, a polygraph (lie detector) also records changes in blood pressure, pulse rate and respiration.
   - Explain how these physiological variables are related to the fight or flight response.
   - How do they change during acute stress?
   - How do these changes help **humans or animals** when facing a perceived threat?

Appendix A
Progressive Muscle Relaxation Script

Take a deep breath and feel the air filling your lungs.
Hold your breath for a few seconds.
(brief pause)

Release the breath slowly and let the tension leave your body.
Take in another deep breath and hold it.
(brief pause)

Slowly release the air.
Take another slow breath. Fill your lungs and hold the air.
(brief pause)

Slowly release the breath.

Move your attention to your feet.
Tense your toes and the arch of your foot.
(5 second pause)

Release the tension in your foot. Notice the new feeling of relaxation.

Focus now on your lower leg.
Tense the muscles in your calves.
Hold them tightly and pay attention to the feeling of tension.
(5 second pause)

Release the tension from your lower legs.
Notice the feeling of relaxation.
Continue all the time to take deep breaths.

Tense the muscles of your upper leg and pelvis.
Do this by tightly squeezing your thighs together.
(5 second pause)

Release.
Feel the tension leave your muscles.

Tense now your stomach and chest.
Do this by sucking your stomach in.
Squeeze harder and hold the tension.
(5 second pause)

Release the tension.
Let yourself notice the feeling of relaxation.

Continue taking deep breaths.
Breathe in slowly, fill your lungs, and hold it.
(brief pause)

Release the air slowly. Feel it leaving your lungs.

Tense now the muscles in your back.
Bring your shoulders together behind you and hold them tightly.
(5 second pause)

Release the tension from your back.
Feel the tension slowly leaving your body, and the new feeling of relaxation.

Tense now your arms all the way from your hands to your shoulders.
Make fists and squeeze them tightly. Hold it.
(5 second pause)

Release the tension from your arms and shoulders.
Feel the relaxation in your fingers, hands, arms, and shoulders.

Move up to your neck and your head.
Tense your face and your neck by distorting the muscles around your eyes and mouth.
(5 second pause)

Release the tension.

Tense all your body by tensing your feet, legs, stomach, chest, arms, head, and neck.
Hold the tension.
(5 second pause)

Release the tension.

Begin to wake your body up by slowly moving your muscles.

Stretch your muscles and open your eyes when you're ready.

Appendix B
Little Red Cap / Jacob and Wilhelm Grimm

Once upon a time there was a sweet little girl. Everyone who saw her liked her, but most of all her grandmother, who did not know what to give the child next. Once she gave her a little cap made of red velvet. Because it suited her so well, and she wanted to wear it all the time, she came to be known as Little Red Cap.

One day her mother said *to her*, "Come Little Red Cap. Here *is a* piece of cake and a *bottle of* wine. Take them to your grandmother. She is sick and weak, and they will do her well. Mind your manners and give her my greetings. Behave yourself on the way, *and do* not leave the path, or you might fall down and *break the* glass, and then there will be *nothing* for your sick grandmother."

Little Red Cap promised to obey her mother. The grandmother *lived out* in the woods, a half hour from the village. When Little Red Cap entered the woods, a wolf came up to her. She *did* not know what a wicked animal he was, and *was* not *afraid* of him.

"Good day *to you*, Little Red Cap."
"Thank you, wolf."
"Where *are* you going so early, Little Red Cap?"
"To grandmother's house."
"And what are you carrying under *your apron*?"
"Grandmother is sick and weak, and I am taking her some cake and *wine*. We baked yesterday, and they should give her strength."
"Little Red Cap, just where does your grandmother live?"
"Her house is a good quarter hour *from here* in the woods, under the three large oak trees. There's a hedge of hazel bushes there. You must know the place," said Little Red Cap.

The wolf *thought* to himself, "Now there is a tasty bite for me. Just how are you going to catch her?" Then he said, "Listen, Little Red Cap, haven't you seen the beautiful *flowers* that are blossoming in the woods? Why don't you go and take a look? And I don't believe you can hear how beautifully the birds are singing. You are walking along as though *you were* on your way to school in the village. It is very beautiful in the woods."

Little Red Cap opened her eyes and saw the sunlight breaking through the trees and how the ground was covered with beautiful flowers. She

thought, "If I take a bouquet to grandmother, she will be very pleased. Anyway, it is still early, and I'll be home on time." And she ran off into the woods looking for flowers. Each time she picked one she thought that she could see an even more beautiful one a little way off, and she ran after it, going further and further into the woods. But the wolf ran straight to the grandmother's house and knocked on the door.

"Who's there?"
"Little Red Cap. I'm bringing you some cake and wine. Open the door for me."
"Just press the latch," called out the grandmother. "I'm too weak to get up."

The wolf pressed the latch, and the door opened. He stepped inside, went straight to the grandmother's bed, and ate her up. Then he took her clothes, put them on, and put her cap on his head. He got into her bed and pulled the curtains shut.
Little Red Cap had run after flowers, and did not continue on her way to grandmother's until she had gathered all that she could carry. When she arrived, she found, to her surprise, that the door was open. She walked into the parlor, and everything looked so strange that she thought, "Oh, my God, why am I so afraid? I usually like it at grandmother's." Then she went to the bed and pulled back the curtains. Grandmother was lying there with her cap pulled down over her face and looking very strange.
"Oh, grandmother, what big ears you have!"
"All the better to hear you with."
"Oh, grandmother, what big eyes you have!"
"All the better to see you with."
"Oh, grandmother, what big hands you have!"
"All the better to grab you with!"
"Oh, grandmother, what a horribly big mouth you have!"
"All the better to eat you with!" And with that he jumped out of bed, jumped on top of poor Little Red Cap, and ate her up. As soon as the wolf had finished this tasty bite, he climbed back into bed, fell asleep, and began to snore very loudly.
A huntsman was just passing by. He thought it strange that the old woman was snoring so loudly, so he decided to take a look. He stepped inside, and in the bed there lay the wolf that he had been hunting for such a long time. "He has eaten the grandmother, but perhaps she still can be saved. I won't shoot him," thought the huntsman. So he took a pair of scissors and cut open his belly.

He had cut only a few strokes when he saw the red cap shining through. He cut a little more, and the girl jumped out and cried, "Oh, I was so frightened! It was so dark inside the wolf's body!"
And then the grandmother came out alive as well. Then Little Red Cap fetched some large heavy stones. They filled the wolf's body with them, and when he woke up and tried to run away, the stones were so heavy that he fell down dead.
The three of them were happy. The huntsman took the wolf's pelt. The grandmother ate the cake and drank the wine that Little Red Cap had brought. And Little Red Cap thought to herself, "As long as I live, I will never leave the path and run off into the woods by myself if mother tells me not to."