NeuLog

Sense of Touch
Experiment

Objectives

- Learn about the **skin** and how objects touching it affect sensory perception.
- Identify which parts of the body are the **most sensitive to touch**.
- To understand that the **skin is the largest sensory organ in the body**.
- Explore how the skin detects touch, pressure, temperature, and pain.
- Examine the **three major layers of the skin**.
- To recognize that **fingers, lips, genitals, and toes** are among the most **sensitive areas** of the body.

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

▪ Water for wash bottle	–

* This experiment is based on Morris Tischler's book ‘Concepts of Biotechnology’.

Introduction

Emotional and sensory stimulation **trigger** the production of sweat. The GSR (Galvanic Skin Response) logger sensor measures sweat secretion from the sweat glands in the hand. As stimulation occurs, the amount of sweat **increases**, 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 survival threat**, preparing the body to **react or retreat**.

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

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

Sweat is released during the fight-or-flight response to **help dissipate excess heat** generated by increased muscle activity.

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

THE SKIN AS a Sensory Organ

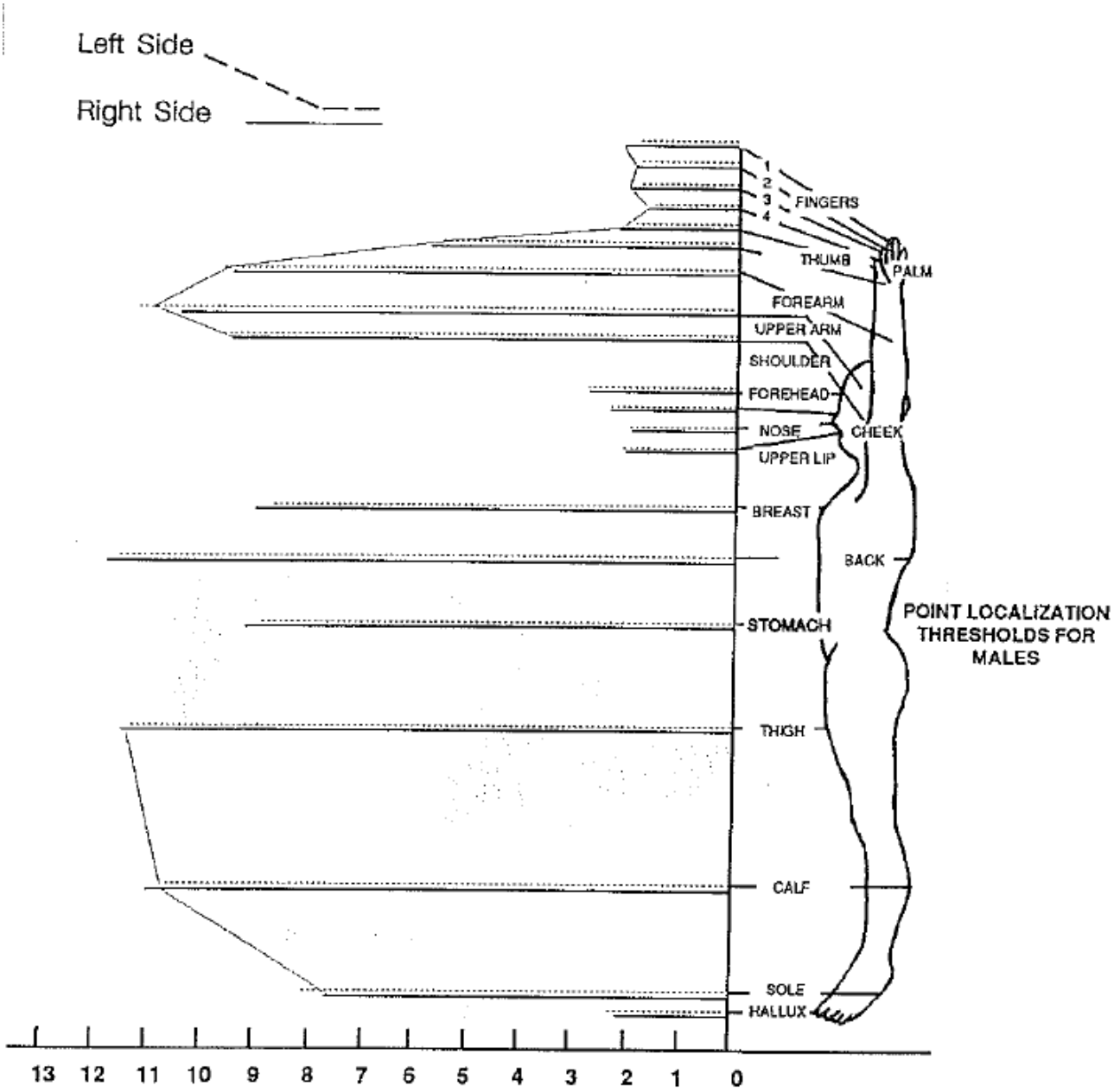
The skin is our largest sensory organ in the human body, **covering** its entire **surface** . In a person standing 1.8 meters (about 6 ft.) tall, the skin measures approximately 1.75 sq. meters (3,000 sq. inches) and accounts for about 15% of total body weight.

The skin is not only a sensory organ but also serves as a protective **barrier** that insulates the **body's** nerves, muscles, and organs from mechanical and electrical injury. Additionally, it helps retain vital body fluids. The skin protects the body from the sun's harmful **ultraviolet** (UV) and infrared radiation and regulates temperature to prevent excessive fluctuations.

The skin contains a variety of **nerve endings** that are **highly responsive to** pressure, pain, and **temperature changes (hot or cold).**

Continuous pressure applied to the skin, particularly on the fingers, can lead to a temporary reduction in sensitivity.

The following figure illustrates the **most and least sensitive** of the body. **The skin** around the mouth, fingers, and toes is the most sensitive, as these areas contain the **highest concentration** of nerve fibers.



Sensitive Body Areas

The skin is sensitive to several **types** of stimulation:

1. Touch
2. Pressure
3. Cold
4. Heat
5. Pain

The fingers **contain up to** 800 nerve endings per square centimeter (1 cm x 1 cm). The following figure illustrates the areas of greatest sensitivity in the hand.

Sensitive Areas of the Hand

GSR Measurement **ranges:**

The NUL-217 NeuLog GSR logger sensor has two measurement modes: µS **(microSiemens)** and Arb **(arbitrary units)**.

- The **µS range** measures **absolute conductivity** in microSiemens, which varies between individuals.
- The **Arb range** amplifies changes in conductivity, making it more useful for detecting **relative responses**.

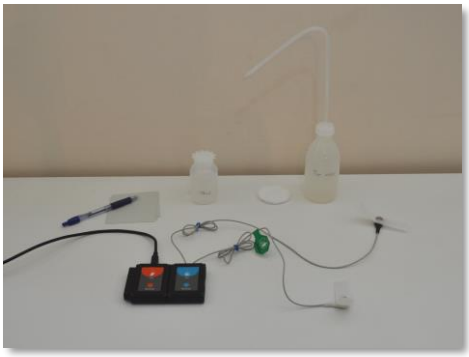
When a person's **baseline conductivity is high, small changes may not be easily detected**.

Therefore, **Arb mode is preferred when tracking changes is more important than measuring absolute values**, such as in **lie detection experiments**.

Procedure

Experiment setup

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



2. Ensure you have the following materials:
   - a wash bottle filled with water (or a glass of water),
   - a cotton pad,
   - five blank cards, a pen
   - a bottle of alcohol, perfume or cologne.

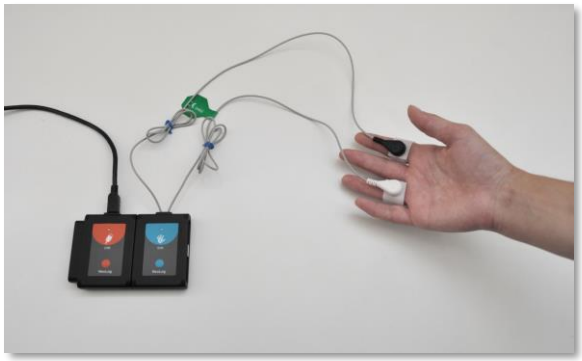
3. Turn off the air-conditioning system in the room to minimize external influences on the results.

4. **Note:** You cannot measure **your own** emotional responses.
   - Two students will conduct the experiment.
   - A third student will be the test subject.

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

6. Have the subject **moisten** two fingers using a wet cotton pad.

7. Attach the **finger electrodes** to the moistened areas as shown in the figure.



8. Instruct the subject to sit down.
   Stand or sit behind them to ensure they **cannot see you, the other student, or 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:

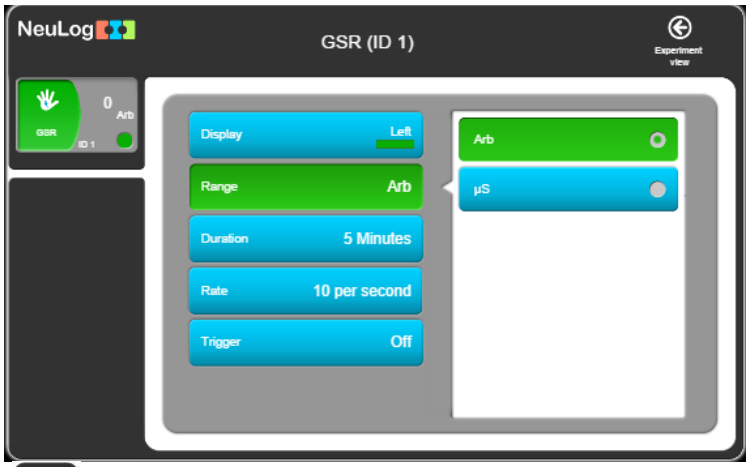
The following application functions are **briefly explained**. It is recommended to practice using the NeuLog application in advance by following the **user manual**.

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 mode** to change the sensor's measurement setting. .
    - The **µS (microSiemens) mode** measures **absolute conductivity**, which varies between individuals.
    - The **Arb (arbitrary units) mode** amplifies changes in conductivity, making it better for detecting **relative responses**.



13. Click on the icon to retuen to the graph.

14. Click on the **Run Experiment** icon and set the following parameters:
    - **Experiment duration**: 10 minutes
    - **Sampling rate**: 10 samples per second

Stimulating response

People **rely heavily** on their **sight and hearing**, so **minimizing these senses** enhances attention to **other sensory inputs**. Touch and smell **stimulation** is more effective **without visual or auditory distractions**, as these sensory become more sensitive in their activity.

15. Instruct the subject to **sit quietly** for a few moments with eyes closed, head down, legs uncrossed, and arms resting on the armchair supports or lap.
    - **Ensure the subject does not exert pressure** on the finger electrodes.

16. **Maintain silence** to prevent auditory stimulation. These conditions should be maintained throughout the measurement.

17. Observe the measured response value in **Arb units** on the sensor.

    Note: This value varies between subjects and is influenced by **emotional state**.

18. Click on the GSR sensor module box and set the **Y-axis limits** to be approximately 6000 **units** above and below the measured value.

19. One student will **perform the stimulations**, while the other will **record the time of each event** and the **corresponding 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. The graph may **fluctuate**. Wait silently until only **small variations** appear.

Touch Sensitivity Testing

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 **alter** the measured value.
- **More sweat production → Greater change in conductivity**.

Note:
There is a time delay (0.8 to 4 seconds) etween **stimulation and the sensor's response** as sweat is produced**.**

Event 2: Lightly touch the other ear and observe the response.

Event 3: Blow gently across the subject's ear or face after repeated touch stimulation to see if they respond to air movement.

- **Habituation**: **A decrease in response** due to repeated exposure to the same stimulus.

Event 4: Conditioning Test

Conditioning is the process of training a subject to perform in a certain way.

Touch the subject's skin in each of the following areas and **observe the graph**:
a. **Shoulder**
b. **Calf** (lower leg)
c. **Forearm**
d. **One toe**
e. **One toe** → Wait → **Then touch the arch of the foot**
f. **Forefinger (index finger)**
g. **Forehead**
h. **Nose, then lips**

23. **Repeat the experiment** with another subject, and compare the results. Observe how **different individuals respond differently** to touch stimuli.

Note:
- This experiment does **not exclusively measure touch sensitivity**.
- **Emotional factors** can also **influence the results**.
- Simply **thinking about a frightening event** may **trigger a response** on the recording device.

PAIN MEASUREMENT

24. Observe how the subject responds to **mild pain stimuli**.
    - Use a **toothpick or pin** to touch the areas that were previously tested.
    - Apply **light pressure** to induce a **very slight pain sensation** at the contact point.
    - **Compare the response** to previous measurements taken **without pain stimulation**.
    - **Is the response greater than that recorded for non-painful touch?**

NOTE:
- Touch the skin quickly rather than pressing slowly.
- **Why?** Slow, sustained pressure allows the skin to **adapt to pain**, reducing the response.

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

Conclusions

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

2. The graph confirms that when the subject is **under stress**, sweat secretion **increases** and can be accurately measured using the GSR logger sensor.

3. Certain areas of the body have **higher concentrations of sweat glands**, such as the forehead, palms, armpits, and the soles of the feet. Sweat measurements in regions like the forehead, back or chest are more **challenging** to obtain due to **variability in gland distribution**.

4. Sweat level **changes** occur **within** 0.8 to4 seconds after the subject experiences stimulation.

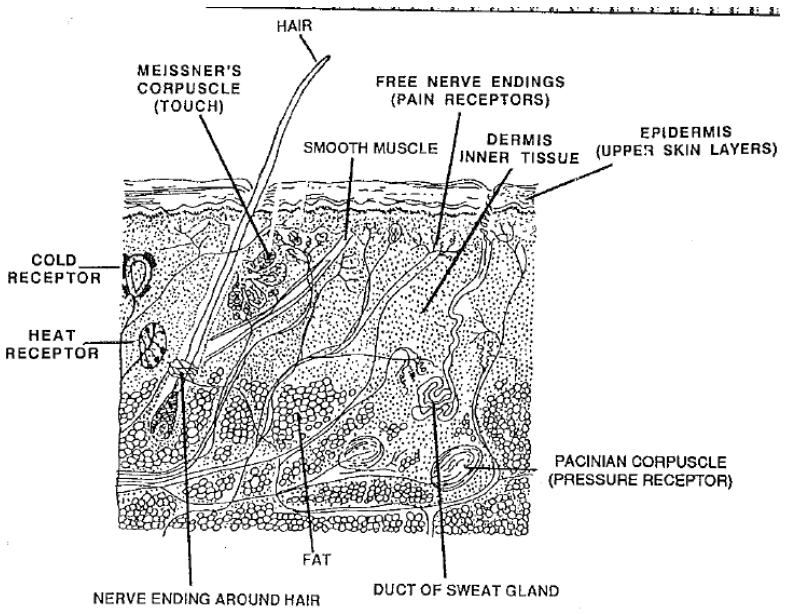
Summary questions

1. Based on your results, which **areas** of the body **exhibited the highest sensitivity to touch**?

Appendix

SKIN STRUCTURE

The skin consists of multiple layers of cells, with sensory nerve endings located beneath the outer layers. The following figure provides a simplified illustration of the skin's structure



Sensory Receptors in the Layers of the Skin

The **three major layers of the skin** are:

1. **Epidermis (outer layer)**
2. **Dermis (inner layer)**
3. **Subcutaneous layer (deepest layer, containing fatty tissue)**

Hair fibers which are anchored in the subcutaneous **layer**, penetrate through the epidermis.

- Near the root of each hair, nerve endings around the follicle.
- If the hair is pulled, these nerve endings send a **pain signal** to the brain.

The epidermis **undergoes continuous renewal**:

- **Cells migrate** to the surface over **1–3 months**, replacing older cells that **shed naturally**.
- **Melanocytes** in the **deepest epidermal layer** produce **melanin**, which determines **skin color**.

Factors Affecting Skin Color

- Melanin quantity, size, and distribution influence skin tone, not race or sex.
- Sun exposure triggers melanin production, resulting in tanning.
- Carotene, a yellow pigment, also contributes to skin coloration.
- Albinos, who lack melanin production, have very pale skin and are highly sensitive to UV radiation.

Touch & Sensory Receptors in the Skin

The skin contains **various sensory receptors**, each specialized for detecting different stimuli:

1. **Free nerve endings** – Found throughout the skin and in sensory organs like the eyes, responsible for **light touch and pressure sensitivity**.
2. **Meissner's corpuscles** – **Encapsulated nerve endings** that are **highly sensitive to touch and low-frequency vibrations**. These are abundant in the **fingertips, lips, and genitals** and adapt **within seconds**.
3. **Merkel's discs** – These receptors **maintain a continuous response to steady pressure**, allowing the brain to **detect sustained contact** (e.g., clothing against the skin).
4. **Hair follicle receptors** – Nerve fibers **wrapped around hair roots**, responding to **even slight hair movement**.
5. The **brain becomes aware of the burn** only **a few seconds later**.
6. This rapid **reflex arc mechanism** is **essential for survival**, preventing **serious injuries** before the brain even processes the pain.

Another type of **sensory receptor** is the **Pacinian corpuscle** which detects **rapid changes in pressure** and **vibrations**.

- When pressure is applied, **fluid shifts within the corpuscle**, generating **vibrations** that are transmitted to the **brain** as touch and pressure sensations.

The **immune system** plays a vital role in **skin protection**:

- It sends signals via the lymphatic system to **detect** foreign **substances** in contact with the skin.
- It reacts rapidly to **objects piercing the skin or causing injury**, triggering **inflammatory and immune responses**.

As shown in the diagram, different nerve fibers are distributed at **various depths** beneath the skin.

- The nerve fibers **respond to** surface changes, making some areas **more sensitive** than others.

Highly sensitive areas include:

- Fingertips
- Mouth region
- Tip of the tongue
- The triangular area between the mouth and lower nose is particularly sensitive to touch.

- Less sensitive areas include:
  - legs,
  - arms,
  - trunk of the body.

The brain contains 99% of the nervous system, yet the remaining 1% controls most involuntary body functions without conscious thought.

THE REFLEX ARC

The nervous system consists of two main pathways**:**

1. Voluntary actions - Controlled by the brain and its subsections.
2. Involuntarily actions - Controlled by the spinal cord, bypassing conscious thought.

Some actions require an immediate response without brain involvement.

Example: The Knee-Jerk Reflex

- Tapping the knee with a **rubber mallet** causes **an automatic leg movement**.
- This involuntary response is called a reflex arc, defined as a rapid **automatic reaction** to a stimulus.
- The autonomic nervous system also controls many routine functions, including:
  - heartbeat **regulation**,
  - breathing patterns,
  - Skin temperature control.

The following figure **illustrates** a person **reflexively pulling** away from a painful stimulus without **conscious thought**. This is an example of how the **reflex arc** functions.

1. The skin receptors **detect the painful stimulus (e.g., heat).**
2. A rapid **nerve signal** (action potential) is transmitted through the **afferent nerves** (**sensory neurons**) to the spinal cord.
   - Afferent nerves carry signals **towards** the spinal cord or brain.
3. The **spinal cord processes the information and immediately sends a response** via the **efferent nerves** (**motor neurons**).
   - **Efferent nerves** carry signals **away** from the spinal cord or brain to the muscles.
4. The **effector muscle contracts**, causing the person to **quickly withdraw from the stimulus**—all within **milliseconds**.

This **reflexive response** occurs **before the brain fully processes the pain**, ensuring **rapid protection from harm**.