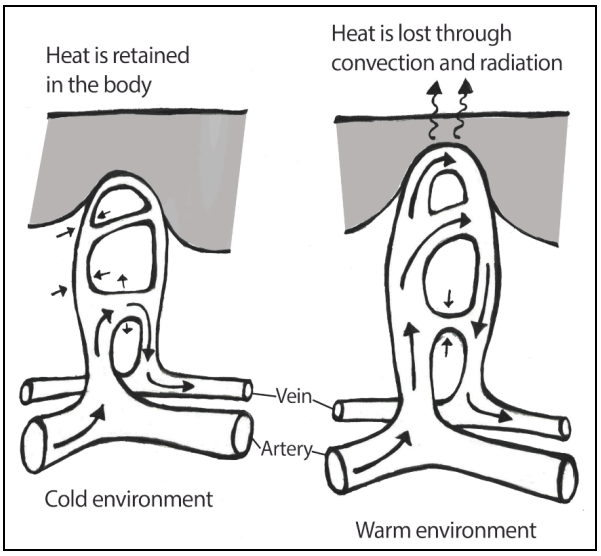
Thermal Stressors

Format: In-person or online



This depicts the vasoconstriction process that occurs when an individual is exposed to cold temperatures and the vasodilation that occurs in warm temperatures.

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Sources: Adapted from Doris Hexsel et al. 2010. Recommendations for Performing and Evaluating the Results of the Minor Test According to a Sweating Intensity Visual Scale. *Dermatologic Surgery.*

Adapted from Sigfrid A. Muller and Robert R. Kierland. 1959. The Use of a Modified Starch-Iodine Test for Investigating Local Sweating Responses to Intradermal Injection of Methacholine. *Journal of Investigative Dermatology.*

Time needed: 30 - 40 minutes

Learning Objectives

- Observe how the body regulates temperature
- Apply both a qualitative and a quantitative test
- Evaluate the difference between “adjustments” and “adaptations”
- Document and compare the body’s physical reaction to different stressors

Supplies Needed

- Timer
- Cold source (e.g. ice cubes, cold pack)
- Heat source (e.g. hair dryer, hand warmers)
- Blank paper cut into small squares of 3x3 cm (4 per group)
- Cotton balls (24 per group)
- Rubbing alcohol
- Iodine
- Cornstarch
- Student worksheet (attached)

Readings

- Fitzpatrick, Leslie. 2019. Chapter 14: Human Variation: An Adaptive Significance Approach. *Explorations.*

Introduction

This lab allows students to experience thermal stressors on a small scale so as to observe the benefits of and physical reactions associated with thermoregulation and homeostasis. Furthermore, this activity will allow the students to explore the nuances of “adjustments” and “adaptations,” as defined in Chapter 14 of *Explorations*. The lab includes two scientific procedures: the Minor Test (which is qualitative), and Randall’s Modification to the Minor Test (which is quantitative).

Steps

- Organize the class into small groups (consisting of 4 or 5 students). Each group should have the following materials:
    - Timer
    - Cold source (e.g. ice cubes, cold pack)
    - Heat source (e.g. hair dryer, hand warmers)
    - Blank paper cut into small squares of 3x3cm (4 per group)
    - Cotton balls (24 per group)
    - Rubbing alcohol
    - Iodine
    - Cornstarch
    - Student worksheet(s) (attached)
- Students will follow the directions on their worksheet to complete the activity. This laboratory exercise consists of four experiments, and each experiment should be undertaken by a different individual in the group, and then discussed among group members.
    - 1. Heat stress exposure
    - 2. Cold stress exposure
    - 3. Exercise/heart rate increase exposure
    - 4. A control exercise with no stressor.
- When the activity has been completed, reunite the class for a discussion based on the review questions below.

Review Questions

1. What do the dots on the paper pressed to the left palm represent? (*Answer*: the dots quantify the activation of sweat glands.)
2. What does a color change on the right palm represent? (*Answer*: the color change is a qualitative measure of the activation of sweat glands.)
3. What does sweating accomplish for the body? (*Answer*: Sweating is the body's attempt to lower overall body temperature and maintain homeostasis.)
4. What does shivering accomplish for the body? (*Answer*: Shivering is the body's attempt to raise overall body temperature through heat generation to maintain homeostasis.)
5. How is body temperature regulated in humans? (*Answer*: The hypothalamus, a small part of the brain, regulates body temperature.)
6. What are the differences between "adjustments" and "adaptations" in relation to human evolution? (*Answer*: Adjustments can be behavioral, acclimatory, or developmental, and occur exclusively at the individual level. Adjustments are non-genetic coping mechanisms used to face environmental stressors. They are temporary in nature. On the other hand, adaptations are genetic and micro-evolutionary, permanent in nature, and occur at the population level.)
7. Why do we turn paler in response to cold, and redder in response to heat? Is this an example of an adaptation or an adjustment? (*Answer*: Paleness is a result of vasoconstriction and redness is a result of vasodilation. These are examples of adjustments.)

Adapting for Online Learning

1 Not adaptable **2 Possible to adapt** 3 Easy to adapt

With clear directions students could complete the experiment in their home, though they may need to purchase some supplies. Additionally, using heat and cold sources irresponsibly could be dangerous, so instructors should provide cautions. Instructors could alternatively record a short video showing the experiment for students to watch and reflect on at home.

For Further Exploration

Cognito. GCSE Biology - How We Control Our Body Temperature #73. https://www.youtube.com/watch?v=IGsQi0JZUTw

FuseSchool - Global Education. Temperature Regulation of the Human Body - Physiology - Biology. https://www.youtube.com/watch?v=vJhsyS4ITW0

John Murnan. TED-Ed Lesson: Why do we sweat?
https://ed.ted.com/lessons/why-do-we-sweat-john-murnan

References

Fitzpatrick, Leslie. 2019. “Chapter 14: Human Variation: An Adaptive Significance Approach.” In *Explorations: An Open Invitation to Biological Anthropology,* edited by Beth Shook, Katie Nelson, Kelsie Aguilera, and Lara Braff. Arlington, VA: American Anthropological Association. http://explorations.americananthro.org/

Hexsel, Doris, Ticiana C. Rodrigues, Mariana Soirefmann, and Debora P. Zechmeister-Prado. 2010. “Recommendations for Performing and Evaluating the Results of the Minor Test According to a Sweating Intensity Visual Scale.” *Dermatologic Surgery, 36*(1): 120-122.

Muller, Sigfrid A., and Robert R. Kierland. 1959. “The Use of a Modified Starch-Iodine Test for Investigating Local Sweating Responses to Intradermal Injection of Methacholine.” *Journal of Investigative Dermatology 32*(2): 126-128.

Image Attributions

Vasoconstriction and vasodilation (Figure 14.4) from *Explorations: An Open Invitation to Biological Anthropology* by Mary Nelson is under a CC BY-NC 4.0 License.

Thermal Stressors & Homeostasis: Investigating Adjustments Worksheet

Background

In the following laboratory activity, you will explore your body's physical reaction to small-scale thermal stressors using two scientific procedures: the Minor Test, and Randall's Modification to the Minor Test. Both tests explore sweat gland responses, but while the Minor Test is qualitative, Randall's Modification is quantitative.

Upon completion of this activity, you will have:

- Explored the body's ways of regulating temperature,
- Critically evaluated the difference between "adjustments" and "adaptations"
- Experienced and documented the body's physical reaction to stressors.

Lab Kit Materials

- Timer
- Cold source (e.g. ice cubes, cold pack)
- Heat source (e.g. hair dryer, hand warmers)
- Blank paper cut into small squares of 3x3cm (4 per group)
- Cotton balls (24 per group)
- Rubbing alcohol
- Iodine
- Cornstarch

Instructions

This laboratory exercise consists of four experiments: (1) heat stress exposure, (2) cold stress exposure, (3) exercise/heart rate increase exposure, and (4) a control exercise with no stressor.

Each experiment should be undertaken by a different individual and assisted by their group members. Decide ahead of time which experiment (heat, cold, exercise, control) will be done by which group member. If there is a fifth group member, that individual should be the group's recorder.

Additionally, ensure that you use a fresh cotton ball for each swab application to ensure no cross-contamination.

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Part 1: Heat Stress - For Group Member #1

1. Using rubbing alcohol on a cotton ball, swab the left palm. Let it dry completely. Once the alcohol has dried, swab the same palm with iodine. Let the iodine dry completely.
2. Apply iodine to a fresh cotton ball and swab the right palm directly. Let it dry completely. Once the iodine has dried, apply cornstarch to the right palm using a fresh cotton ball.
3. Apply the heat source to both palms for 5 minutes. During this time, pay attention to any visual changes that occur on the right palm.
4. Once five minutes have elapsed, press a square of blank paper firmly into the left palm for approximately 30 seconds.
5. Record the number of dots you see on the paper pressed into the left palm in the respective box in the activity chart.
6. Record physical observations you see on the right palm in the respective box in the activity chart.
7. Record physical sensations or visual observations you made about your body during the experiment in the respective box in the activity chart.

Part 2: Cold Stress - For Group Member #2

1. Using rubbing alcohol on a cotton ball, swab the left palm, Let it dry completely. Once the alcohol has dried, swab the same palm with iodine. Let the iodine dry completely.
2. Apply iodine to a fresh cotton ball and swab the right palm directly. Let it dry completely. Once the iodine has dried, apply cornstarch to the right palm using a fresh cotton ball.
3. Apply the cold source to both palms for 5 minutes. During this time, pay attention to any visual changes that occur on the right palm.
4. Once five minutes have elapsed, press a square of blank paper firmly into the left palm for approximately 30 seconds.
5. Record the number of dots you see on the paper pressed into the left palm in the respective box in the activity chart.
6. Record physical observations you see on the right palm in the respective box in the activity chart.
7. Record physical sensations or visual observations you made about your body during the experiment in the respective box in the activity chart.

Part 3: Exercise Stress - For Group Member #3

1. Using rubbing alcohol on a cotton ball, swab the left palm, Let it dry completely. Once the alcohol has dried, swab the same palm with iodine. Let the iodine dry completely.
2. Apply iodine to a fresh cotton ball and swab the right palm directly. Let it dry completely. Once the iodine has dried, apply cornstarch to the right palm using a fresh cotton ball.
3. Perform jumping jacks for 5 minutes. During this time, pay attention to any visual changes that occur on the right palm.
4. Once five minutes have elapsed, press a square of blank paper firmly into the left palm for approximately 30 seconds.
5. Record the number of dots you see on the paper pressed into the left palm in the respective box in the activity chart.
6. Record physical observations you see on the right palm in the respective box in the activity chart.
7. Clean both palms with a cotton ball and rubbing alcohol.
8. Record physical sensations or visual observations you made about your body during the experiment in the respective box in the activity chart.

Part 4: Control With No Stress - For Group Member #4

1. Using rubbing alcohol on a cotton ball, swab the left palm, Let it dry completely. Once the alcohol has dried, swab the same palm with iodine. Let the iodine dry completely.
2. Apply iodine to a fresh cotton ball and swab the right palm directly. Let it dry completely. Once the iodine has dried, apply cornstarch to the right palm using a fresh cotton ball.
3. Rest for 5 minutes. During this time, pay attention to any visual changes that occur on the right palm.
4. Once five minutes have elapsed, press a square of blank paper firmly into the left palm for approximately 30 seconds.
5. Record the number of dots you see on the paper pressed into the left palm in the respective box in the activity chart.
6. Record physical observations you see on the right palm in the respective box in the activity chart.
7. Record physical sensations or visual observations you made about your body during the experiment in the respective box in the activity chart.

Observations

	Randall Modification: Number of Dots (Left palm)	**Minor Test:** Physical Observations (Right palm)	**Physical Feelings, Sensations, and Observations**
HEAT Exposure (5 minutes)			
COLD Exposure (5 minutes)			
EXERCISE (5 minutes of jumping jacks)			
CONTROL (5 minutes rest)			

Reflection

After you have recorded your observations in the table above, discuss the following questions with your group:

1. What do the dots on the paper pressed to the left palm represent?
2. What does a color change on the right palm represent?
3. What does sweating accomplish for the body?
4. What does shivering accomplish for the body?
5. How is body temperature regulated in humans?
6. What are the differences between “adjustments” and “adaptations”? How are they relevant to understanding human evolution?
7. Why do we turn paler in response to cold, and redder in response to heat?