# Dark Adaptation and the Purkinje Shift

ISYE 348 Fall 2024 Lab 1

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This lab assignment is due by 23:59 on 2024-09-17. If you have any questions or need clarification, please reach out to me via email or during office hours. The report will be graded on **20 points** based on the following criteria:

| Criteria | Points |
|---|---|
| Introduction | 1 |
| Data Collection | 2 |
| Methods | 4 |
| Results | 5 |
| Discussion | 5 |
| Conclusion | 3 |

**Submission**: Please submit your report as a PDF file on Canvas. Make sure to include your name and your partner's name at the beginning of the report. Include any code, plots, or tables as needed to support your answers. Make sure to answer all questions thoroughly and provide detailed explanations where necessary. Cite any external sources used. Submit one single pdf file with all the answers.

**Collaboration** with your classmates is encouraged, and you will work in pairs for this lab to complete the report. However, each student must collect their own data independently. Please list your partner's name at the beginning of the report. Only one submission per group is required. Must include data from both partners in the report.

**Late submissions** will be penalized by a 1 point deduction every hour past the deadline.

Please read the course policy on academic integrity and collaboration on the course syllabus. If you have any questions about what is permissible, please ask before submitting your work.

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## Introduction

In this lab, you'll explore how your eyes adapt to low light conditions (dark adaptation) and experience the Purkinje shift—a change in how your eyes respond to different colors as lighting changes. These processes are essential for understanding how we see in various environments.

## Background

Understanding how human vision adapts to different lighting conditions is crucial in designing environments and interfaces that accommodate various visual scenarios. This lab will explore:

1. Dark adaptation: How the eye adjusts to low light conditions over time
2. The Purkinje shift: Changes in color perception between bright and dim lighting
3. Cross-modal illusion induced by asymmetric dark-adaptation

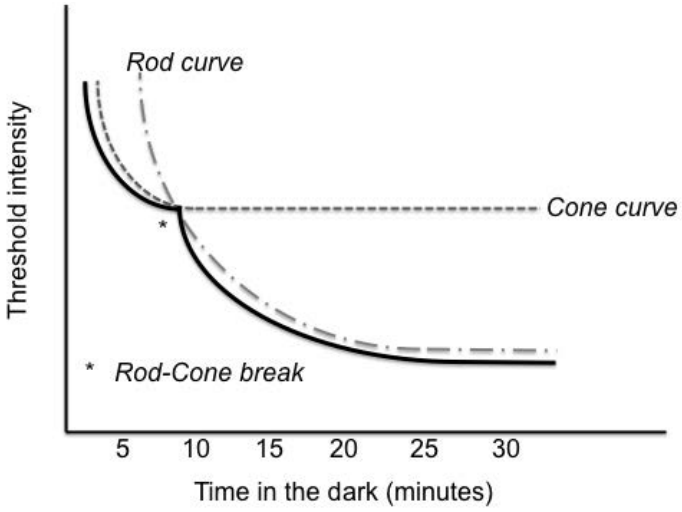


Figure 1: Dark adaptation [1]

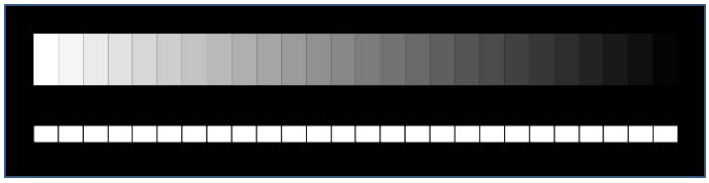

Figure 2: Gray Scale [1]. The leftmost grid has a luminance of 255 units, and each subsequent grid decreases by five in luminance.

## Objectives

By the end of this lab, you should be able to:

- Explain how dark adaptation works.

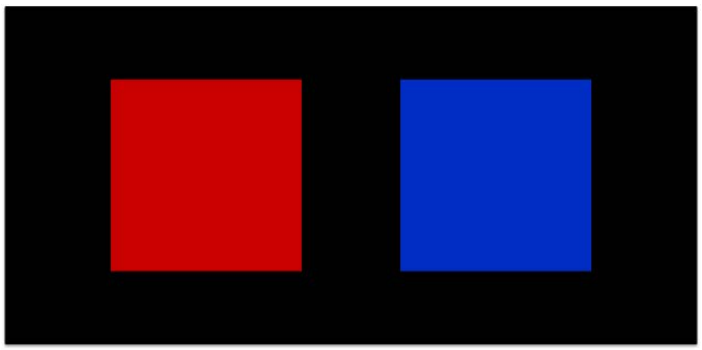

Figure 3: Color Squares [1]

- Observe and describe the Purkinje shift.
- Collect, graph, and analyze data related to visual thresholds.

## Materials

- Printed grayscale chart (24 rectangles of decreasing luminance)
- Printed color squares (one red, one blue, iso-radiant)
- Stopwatch or timer
- Access to a dark room or a space where lighting can be controlled.
- (Optional) A photometer to measure light levels.

## Procedure

### Part 1: Light Adaptation

1. Start in a well-lit room (about 750 lux) so your eyes can adjust to bright light.
2. Take a look at the grayscale printout and mark which rectangles you can see against the black background. Write time (in minutes) under the rectangles you can detect.
3. Now, compare the red and blue squares. Which one looks brighter to you? Make a note of it.

### Part 2: Dark Adaptation

1. Turned off the lights, creating a very low light environment (about 0.5 lux).
2. As soon as the lights go off, mark which part of the grayscale you can still see (this is your 0-minute mark).
3. Every two minutes, update your chart by marking the rectangle you can just barely see. Write the time (e.g., 2, 4, 6 minutes) under the corresponding rectangle.
4. After 30 minutes, when your eyes are fully dark-adapted, check the red and blue squares again. Which one looks brighter now? (Remember, you wouldn't see color anymore since your rod cells are now doing most of the work.)

**Part 3: Asymmetric Dark Adaptation**

1. Close one of your eyes and cover it tightly with your hand.
2. The lights will be turned back on for two minutes to re-adapt your open eye to the light.
3. After two minutes, turn off the lights again (i.e. dark room)
4. Open each eye separately and see how well you can detect the grayscale. Mark your results for each eye.
5. Now, open both eyes and pay attention to any unusual sensations or differences in vision, especially with the eye that was covered.

## Results

1. You'll plot your data showing how your ability to detect light changes over time as your eyes adapt to the dark (Plot individual and class average dark adaptation curves)
2. Look for the "rod-cone break" on your graph—this shows when your vision switches from using cones to rods.
3. Compare your results with your classmates'. Discuss any differences and think about factors like your position in the room, individual differences in dark adaptation, and how quickly your eyes adjust to low light.

| Time (minutes) | Threshold Luminance |
|---|---|
| 0 | |
| 2 | |
| ... | |
| 30 | |

## Discussion

1. Discuss your findings and how they compare to the expected results for each of the three objectives.
2. Discuss what dark adaptation and the Purkinje shift are and why they matter.
3. Discuss any two of the following:
   - How might dark adaptation curves inform the design of environments that transition from bright to dark areas (e.g., movie theaters, cockpits)?
   - Given the Purkinje shift, how should this influence the color choices for emergency or low-light signage?
   - How could the cross-modal illusion impact the design of virtual reality systems or other immersive environments?
   - What are some real-world applications where understanding these visual phenomena would be crucial for human factors specialists?
   - How might these visual adaptations differ among various user populations (e.g., elderly, color-blind individuals)?
   - What are some limitations of this lab setup, and how could you improve the experiment to gather more accurate data?

## Conclusion

Include a brief summary of your findings and any insights you gained from this lab. What did you learn about how your eyes adapt to different lighting conditions, and how might this knowledge be useful in other contexts?

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## References

1. Wolfe U., Ali N. (2015). Dark Adaptation and Purkinje Shift: A Laboratory Exercise in Perceptual Neuroscience. *Journal of Undergraduate Neuroscience Education*, 13(2):A59-A63.