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Light and the Brain: Exploring Neurons and Light Sensitivity using the Brainapse App

BIOS4YOU
AR 2.0

BIO-INSPIRED STEM TOPICS FOR ENGAGING YOUNG GENERATIONS
THANKS TO THE USE OF AUGMENTED REALITY

Project Number: KA220-BW-23-30-126516

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TABLE OF CONTENTS

- General Information
- Pedagogical specification
- Technical specification

Project Number: KA220-BW-23-30-126516

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Introduction

Light is one of the most powerful environmental factors influencing the human brain. Beyond enabling vision, it regulates a wide range of biological and cognitive functions, from attention and mood to sleep and memory. Exposure to light activates specific neural pathways that synchronize the body's internal clock, known as the circadian rhythm, and influence how alert or drowsy we feel throughout the day. These interactions between light and brain activity are central to understanding how humans maintain mental well-being, productivity, and overall health. In this exercise, students explore how light interacts with the nervous system, focusing on the brain's ability to receive, interpret, and respond to optical stimuli. Using the Brainapse App, an augmented reality (AR) tool designed for neuroscience education, learners can visualize and interact with 3D models of the human brain and neural networks. The app transforms abstract biological concepts into immersive visual experiences, allowing students to "enter" the brain and observe how light signals travel from the retina through the optic nerve to regions such as the visual cortex and hypothalamus.

The activity shows how light-sensitive neurons not only enable vision but also regulate hormones, sleep, and mood. Students observe how blue light activates alertness centers and how low light triggers melatonin release for sleep. These processes reveal the link between light, neural signaling, and behavior, connecting physics, biology, and psychology.
Through AR exploration, students gain a STEAM-based understanding of how the brain responds to light, exploring real-world applications like light therapy, optogenetics, and circadian design. The exercise helps them see the brain as a dynamic system that constantly adapts to its environment, shaping how we think, feel, and perform.

This document consists of the following points:

- Information about AR technology
- How to define AR exercise thanks to the template:
    - General information
    - Pedagogical specifications
    - Technical specifications

Project Number: KA220-BW-23-30-126516

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General information

Name of the exercise:	Light and the Brain: Exploring Neurons and Light Sensitivity using the Brainapse App This AR-based exercise allows students to explore how light influences brain function and behavior through the Brainapse App, a neuroscience learning platform using 3D visualization. Students interact with a virtual brain model to identify regions that process light-related information, such as the occipital lobe, hypothalamus, and pineal gland.
Description of the exercises:	By following the path of light signals from the eyes to the brain, learners visualize how neurons transmit and process sensory information. The activity helps students understand that light is both a physical and biological signal, initiating neural communication that supports visual perception and the brain's response to external stimuli. Through this exercise, students connect concepts from optics, neuroscience, and digital visualization within a unified STEAM learning context.
Participants:	Recommended for students aged 14–18 years, suitable for secondary school or early university STEAM courses.

Project Number: KA220-BW-23-30-126516

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Participants' age range:	Minimum 14-18 years old
STEM subject and specific topic:	*STEM Subject:* Biology, Physics, Neuroscience *Specific Topic*: Neural processing of light and its effect on brain function, mood, and circadian regulation. *Main challenge (stressful aspect) of the topic:* Students often find it difficult to visualize how light signals influence brain activity beyond vision. Understanding how neural pathways and biochemical reactions regulate hormones, sleep, and emotions can be abstract when presented theoretically. The challenge is to connect microscopic neuronal activity with observable behaviors and biological rhythms. *How AR helps simplify the concept:* The **Brainapse App** allows interactive 3D exploration of the human brain, making invisible neural processes visible. • **Animated light pathways** show how signals travel from the retina to key brain regions. • Students can **zoom, rotate, and highlight** specific areas (e.g., hypothalamus, pineal gland) to understand their roles in light sensitivity. • Real-time **visualizations and pop-ups** explain how light affects hormonal regulation and alertness. • The interactive experience bridges **theoretical neuroscience** with **real-world applications** such as light therapy and circadian design. *Pedagogical Aim (Learning Outcomes):* By the end of this exercise, students will be able to: 1. Explain how **light interacts with the nervous system** and affects brain activity. 2. Identify brain regions involved in **light processing and circadian rhythm regulation**.

Project Number: KA220-BW-23-30-126516

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	3. Understand how **light exposure influences mood, alertness, and sleep cycles**. 4. Apply interdisciplinary knowledge from **physics, biology, and neuroscience** to real-world health and design contexts. 5. Develop **scientific reasoning and visual-spatial understanding** through AR exploration.
Gamification process:	Students explore the 3D brain model in Exploration Mode, tracing the path of light signals and identifying brain regions. In Challenge Mode, they answer quiz questions to test their understanding, while a Progress Tracker monitors their learning. Virtual rewards and short reflection prompts encourage engagement and reinforce key takeaways about neural structure and function.
Written or graphic description of Augmented info:	In the **Brainapse App**, students activate a 3D model of the **human brain** in AR. • The model highlights main lobes and sensory regions through color-coded layers. • When selecting the visual pathway, an animated beam of light travels from the eyes to the occipital lobe and hypothalamus. • Zooming in reveals neural activity, synapses lighting up as signals are transmitted between neurons. • Pop-up boxes explain how melatonin production changes under different light conditions. • A "compare" mode displays how daylight vs. dim light affects neural activation patterns and mood.
External (or extra) tools required	**Tablet or smartphone** with AR capability. **Brainapse App** (available for Android and iOS). Optional classroom resources: projector for group visualization, worksheet for reflection. Suggested video resource: Is Blue Light Bad For Sleep?
Links (video, images, text online and so on).	Video: Is Blue Light Bad For Sleep? Link: https://youtu.be/6QnhKUWTnWU?si=TNi3gOwObvnBZr_J

Project Number: KA220-BW-23-30-126516

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Pedagogical specifications

Here we will collect information on how to use the exercise in the learning session and the results and benefits of using it, from a pedagogical perspective.

How can this augmented information be used to address a STEAM topic in a more interesting way for students?

Interactive 3D Models

Goal:
Help students visualize how light interacts with the brain and how neurons transmit sensory information related to vision and perception.

Use:
Students can explore 3D brain and neuron models using the Brainapse App, zooming and rotating to view different regions involved in light processing.
By following the path of light signals from the eyes to the brain, they observe how neurons communicate and how visual information is organized in the occipital lobe.
The app's animated pathways and pop-up explanations transform complex neurobiological processes into tangible, visual experiences, integrating physics (light), biology (neural signaling), and technology (AR visualization) within a single STEAM framework.

Interactive Buttons

Goal:
Encourage students to engage with the AR brain model and deepen their understanding of neural communication and sensory pathways.

Use:
Students can tap on labeled brain regions (e.g., *occipital lobe*, *optic nerve*, *hypothalamus*) to activate short animations and explanations.
Each button highlights a specific step of the visual information process, from light detection to neural transmission.
Through this interactive design, students actively connect anatomical structure to function, reinforcing scientific understanding through exploration rather than memorization.

Project Number: KA220-BW-23-30-126516

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Possible Classroom Session Plan

Introduction (5–7 mins)
Goal: Introduce students to how light is processed by the brain.

- Begin with a question: *"How does your brain know what your eyes see?"*
- Show a short introductory video (e.g., Is Blue Light Bad For Sleep?).
- Discuss how light is converted into electrical signals and transmitted to the brain.

Main Activity – AR Exercise (30-35 mins)

Exploring the Brain with AR
AR Model Interaction (10–15 mins):

- Students open the Brainapse App and activate the 3D brain model.
- Rotate, zoom, and select brain regions related to light perception.
- Follow the animated path showing how light signals travel from the retina to the visual cortex.

Guided Learning Tasks (10–15 mins):

- Compare the structure and function of different brain regions.
- Explore the neuron model to visualize electrical impulses.
- Reflect on how light information becomes perception.

Conclusion & Recap (10-15 mins)

Goal: Reinforce understanding through discussion and reflection.

- Project or share one brain model and discuss:
  - *Which brain region processes visual information?*
  - *How do neurons communicate using electrical impulses?*
- Reflection Task: Write a short paragraph answering:
  "Is Blue Light Bad For Sleep*?"*
- Wrap up by connecting neuroscience to STEAM, showing how biology, physics, and technology come together to explain brain function.

Project Number: KA220-BW-23-30-126516

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Which pedagogical objectives are addressed through this scenario?

Active Engagement
Students actively explore how light is processed in the brain through hands-on AR interaction.
By manipulating the 3D model in the Brainapse App, they observe brain regions from multiple perspectives and follow the visual signal pathway, fostering curiosity and participation.
This interactive engagement replaces passive observation with exploratory learning, helping students grasp the flow of sensory information more intuitively.

Critical Thinking
The activity promotes critical thinking by prompting students to connect neural anatomy with function. As they identify brain regions and observe the flow of electrical signals, students interpret how light perception results from neural communication rather than simple visual input.
They analyze cause-and-effect relationships, how light triggers neuronal responses, and begin to question how these processes underlie perception and awareness.

Application of Knowledge
Through AR visualization, students apply knowledge from biology, physics, and neuroscience to understand how light becomes a neural signal. They move from textbook definitions to spatial, interactive learning, applying theoretical knowledge to a simulated biological system. This reinforces their ability to transfer classroom concepts to real-world phenomena, such as optical technologies or visual cognition studies.

Multimodal Learning (Visual, Hands-On, Inquiry-Based Learning)
The scenario combines visual, interactive, and inquiry-based learning, catering to diverse learning styles. AR visualization helps students see otherwise invisible neural processes, such as synaptic transmission or light pathway activation, making abstract neuroscience concepts concrete and memorable.
This multimodal experience enhances understanding by engaging sight, touch, and reasoning, promoting deeper cognitive retention.

Project Number: KA220-BW-23-30-126516

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Which results are expected to be reached with its use?

Enhanced Understanding of Brain Function and Neural Communication
Students will develop a deeper understanding of how light signals are converted into electrical impulses and transmitted through neurons in the brain.
By engaging with interactive 3D AR models, they will visualize how light interacts with neural structures such as the optic nerve and visual cortex, reinforcing theoretical concepts through direct observation and interaction.

Increased Engagement and Interest in Neuroscience and STEAM Fields
The immersive nature of the Brainapse App is expected to enhance students' curiosity and motivation toward neuroscience, biology, and technology.
By exploring the human brain in a realistic, interactive environment, learners connect scientific theory with visual experience, making abstract neurobiological processes more tangible and inspiring interest in biomedical and cognitive sciences.

Improved Retention and Recall of Key Concepts
The combination of AR visualization, animated pathways, and guided interaction supports long-term comprehension and memory retention.
Students can recall complex topics such as neural signaling, sensory transmission, and brain anatomy more effectively because they experience them through interactive exploration rather than static representation.

Development of Analytical and Observational Skills
As students explore light pathways and neural communication, they practice scientific observation, interpretation, and hypothesis formation.
By linking visual data with biological processes, they learn to analyze and explain how sensory input is transformed into perception, improving their scientific reasoning and problem-solving abilities.

Awareness of Interdisciplinary Connections Between Science and Technology
The exercise encourages students to see the integration of physics (light), biology (neural activity), and digital visualization (AR technology) in understanding the human brain.
This interdisciplinary awareness helps them appreciate how modern science combines multiple disciplines to advance knowledge in health, cognition, and learning technologies.

Project Number: KA220-BW-23-30-126516

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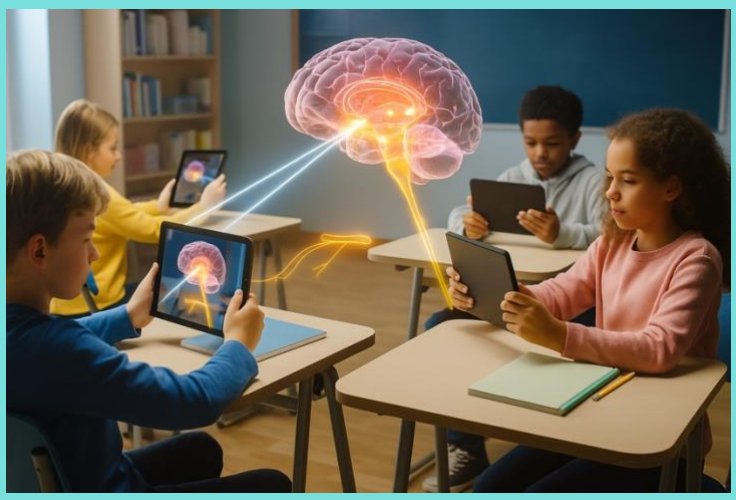
Technical specifications

AR INFORMATION

Technology	Tablet-based Augmented Reality (AR) delivered through the Brainapse App, which allows users to project and interact with 3D models of the human brain and neurons in real-world environments. The app uses markerless AR, enabling easy activation of the 3D brain model on any flat surface without printed targets.
If it's needed a marker, description of the marker	
Hardware and software needed:	Hardware: Tablet or smartphone with AR capability (camera and gyroscope). Optional: interactive whiteboard or projector for group learning. Stable internet connection for downloading the app and accessing optional multimedia. Software: **Brainapse App** (available for iOS and Android). Compatible with most AR-enabled devices and mobile browsers.
Type of Augmented data	• **3D interactive brain model** showing the main lobes and sensory pathways. • **Neuron-level model** displaying electrical impulse transmission. • **Animated pathways** visualizing how light signals travel from the eyes through the optic nerve to the brain.

Project Number: KA220-BW-23-30-126516

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	• **Pop-up information boxes** identifying key brain regions and explaining their roles. • **Layered visualization** of brain structures for anatomy-focused exploration. • **Zoom and rotation controls** to explore models from multiple perspectives.
Written description of the AR data	When students launch the Brainapse App, a 3D human brain model appears in AR, allowing them to explore its structure and function interactively. • Students can rotate and zoom the model to examine each lobe and neural pathway. • When selecting the visual pathway, they follow an animated line showing how light signals travel from the retina through the optic nerve to the occipital lobe. • The neuron model can be activated to show synaptic connections and electrical signal transmission through animated pulses of light. • Pop-up panels provide short explanations of sensory processing, signal transmission, and brain region roles. • The AR model reinforces how light is transformed into neural information, connecting structure to function in an engaging and accessible way. **Additional features:** • **Interactive labeling system** highlighting major brain regions and functions. • **Animated sequences** showing neuron firing and information transfer. • **Scale adjustment** to switch between whole-brain and neuron-level views. • **Quiz and challenge mode** with in-app questions for self-assessment. • **Reset button** allowing users to restart exploration from any stage. • **Reflection prompts** encouraging students to summarize what they observed about neural communication and sensory pathways.
Scene	Four scenes:

Project Number: KA220-BW-23-30-126516

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If Image	**Scene 1 – Introduction: Overview of the Brain** Students view a full 3D model of the human brain with labeled lobes. They identify key regions related to light perception and sensory input. **Scene 2 – Pathway of Light** An animated beam of light travels from the eyes through the optic nerve to the **visual cortex**, illustrating the conversion of light into neural signals. **Scene 3 – Neuronal Activity** Students zoom in to observe a neuron firing, showing electrical impulses and synaptic transmission through animated flashes of light. **Scene 4 – Reflection and Knowledge Check** Students complete a short quiz within the app or classroom worksheet, summarizing what happens when light is processed in the brain.
If Text	- What Happens When Light Reaches the Brain? Light entering the eyes triggers electrical signals that travel through the optic nerve to the visual cortex, where the brain interprets them as images. Why Is It Important to Study This? It helps students understand how physics (light) and biology (neurons) work together to produce perception, one of the brain's most complex functions.
If video	-
If audio	-

Project Number: KA220-BW-23-30-126516

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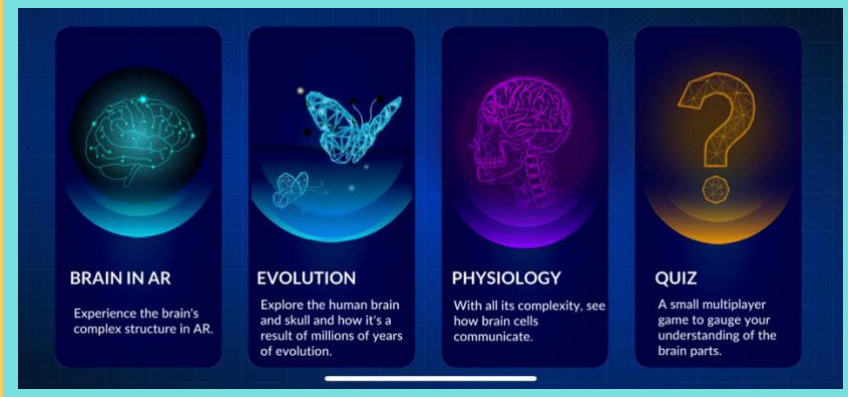
If 3D model	-

Using APP: Brainapse APP



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