Skill Sets and Needs for Behavior Science Lab

European Union Project – Work Package 1 (Needs Analysis)

In the first work package of the project, needs analyses for the establishment of the Behavioral Science Laboratory were conducted in partnership with Çanakkale Technopark, Çanakkale Onsekiz Mart University, and Ludwig Maximilian University. The following sections provide detailed information regarding the activities carried out and the meetings held within the scope of this work package.

1. Establishment of the Behavioral Science Laboratory

In addition to the European Union project conducted for the establishment of the Behavioral Science Laboratory at Çanakkale Onsekiz Mart University, an application was submitted for the opening of the Cognitive and Behavioral Sciences Application and Research Center within the university. This application was approved by the Turkish Higher Education Council (YÖK), and the Cognitive and Behavioral Sciences Application and Research Center (ÇOMÜ–BİLDAM) was officially established. The center is located in the Çanakkale Onsekiz Mart University Science and Technology Application and Research Center building. The initiation of the center, the allocation of its location, and the management of technical infrastructure processes were all completed within the scope of the first work package.

Following the identification of the laboratory's location, research was conducted—supported by the views, suggestions, and technical guidance of Ludwig Maximilian University—on the devices that could be procured and utilized within the laboratory. In this part of the report, basic information regarding the potential devices for the Behavioral Science Laboratory, as well as examples of the types of research in which they could be employed, are presented.

2. Meetings Conducted within the Scope of Needs Analysis

To discuss the establishment of the Behavioral Science Laboratory, define the operational processes, and exchange views regarding potential devices for use in the laboratory, the project partners—Çanakkale Technopark, Çanakkale Onsekiz Mart University, and Ludwig Maximilian University—held two meetings: one in person and one online. The first meeting was held online in April 2024, during which discussions focused on devices that could be integrated into the laboratory. Visuals from the meeting are provided below.

The second meeting was held in May 2024 in Çanakkale, hosted at the Çanakkale Technopark Campus. Participants included Prof. Dr. Zhuanghua Shi, Director of the Behavioral Science Laboratory at Ludwig Maximilian University; Dr. Fredrik Allenmark; Assoc. Prof. Dr. Erkan Bil, General Director of Çanakkale Technopark and Project Coordinator; on behalf of Çanakkale Onsekiz Mart University, Project Leader Research Assistant Mert İnal, Research Assistant Murat Özkaya, Research Assistant Atıf Çağlar Ababay, Assist. Prof. Dr. Bengi Ünal, and Lecturer Dr. Savaş Gürdal.

During the face-to-face meetings, the laboratory site was visited, specific infrastructural and technical needs were identified, and plans for future research activities were discussed. Additionally, as part of the project delegation, the team paid a visit to the Rector of Çanakkale Onsekiz Mart University, Prof. Dr. R. Cüneyt Erenoğlu, with whom they held consultations regarding the project.

Photographs from the second meeting are provided below.


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During and after the meetings, the devices required for and potentially usable in the Behavioral Science Laboratory were identified. Their specifications and possible applications within the laboratory were examined, and preparations for procurement were initiated. Detailed information on the devices to be utilized in the Behavioral Science Laboratory is presented in the third section of this report.

3. Devices to Be Utilized in the Behavioral Science Laboratory

3T MRI (3 Tesla MR) Scanner

The 3T MRI system is of critical importance for the investigation of brain structure and function, and for its applicability in behavioral and neuropsychological research. With a magnetic field strength of 3 Tesla, it provides high-resolution images that enable a detailed examination of brain structures and functions. These scanners offer high-resolution imaging that allows for the observation of fine anatomical details and small brain structures. Advanced imaging techniques such as fMRI and DTI further facilitate the study of brain activity and neural pathways.

Applications of 3T MRI in Studying Brain Structure and Function

- **Anatomical Imaging:** 3T MRI produces high-resolution images of brain anatomy, enabling detailed mapping of brain regions. It is frequently employed to measure volumes of different brain regions and to investigate variations in brain anatomy.
- **Functional MRI (fMRI):** By measuring blood flow in the brain, fMRI maps neural activity. It provides insights into cognitive processes by observing brain region activations during behavioral tasks.
- **Diffusion Tensor Imaging (DTI):** DTI examines white matter tracts in the brain and evaluates the integrity and connectivity of neural pathways.

Behavioral and Neuropsychological Studies with 3T MRI

- **Neuroimaging:** Used in conjunction with behavioral tasks and neuropsychological assessments to investigate brain activity and structure, thereby clarifying the neural correlates of specific behaviors and cognitive processes.
- **Psychopathology Research:** Facilitates the study of the effects of psychiatric disorders—such as depression, anxiety, and schizophrenia—on brain structure and function.
- **Developmental Neuroimaging:** Applied to study brain development in children and adolescents, providing insights into how different brain regions mature and how this development influences cognition and behavior.

The average cost of a 3T MRI system varies depending on brand, model, and specifications, generally ranging between USD 1 million and 2 million. The 3T MRI scanner to be procured for the Behavioral Science Laboratory will play a pivotal role in neuroimaging and behavioral research by enabling detailed investigations of brain structure and function. Its high-resolution imaging capabilities, advanced functional and structural analyses, and wide range of applications will significantly enhance the laboratory's research capacity and scientific output.

Virtual Reality (VR) Devices

VR devices are equipped with high-resolution displays that provide users with realistic and detailed visuals, thereby enhancing user experience and improving research quality. They track head and hand movements with high precision, increasing immersion and realism in virtual environments. Some VR systems also offer haptic feedback, allowing users to perceive and

interact with virtual objects—an advantage for motor skill and task-based research. With wide fields of view, VR devices create more immersive and comprehensive experiences. Both wired and wireless models are available, with wireless systems offering greater freedom of movement.

Applications of VR Devices in Behavioral and Neuropsychological Research

- **Cognitive Load Testing:** Virtual environments can be designed to measure memory, attention, and problem-solving skills.
- **Motor Skills:** VR can evaluate motor development and performance, for example, through tasks testing hand-eye coordination, fine motor skills, and balance.
- **Social Simulations:** VR can simulate social interactions to investigate behaviors and responses, supporting research on empathy, group dynamics, and social anxiety.
- **Role-Playing:** Participants can adopt different roles in VR scenarios, allowing the study of the behavioral effects of social roles and hierarchies.
- **Emotional Responses:** VR can induce realistic scenarios to elicit emotional responses such as stress, fear, or happiness, enabling their measurement and analysis.
- **Phobias and Anxiety:** VR is widely used in exposure therapy for treating phobias and anxiety (e.g., fear of heights, social anxiety, or arachnophobia).
- **Educational Scenarios:** VR provides safe environments for learning and practicing complex skills.
- **Rehabilitation:** VR is employed in both physical and psychological rehabilitation, including therapy for post-traumatic stress disorder (PTSD) and related conditions.

The cost of VR devices varies by brand, model, and features, typically ranging between USD 500 and 1,500 for advanced systems. Additional expenses include a compatible computer, motion-tracking sensors, and other accessories. VR devices in the Behavioral Science Laboratory will serve as critical tools in cognitive, social, emotional, and motor research. Features such as high-resolution displays, precise motion tracking, and haptic feedback will significantly increase the realism of virtual environments, offering substantial advantages in both research and educational applications.

EEG (Electroencephalography) Devices

Advanced EEG systems record brain activity at high resolution using 32, 64, or more electrode channels, enabling detailed and precise measurement of brainwaves. Modern EEG devices are

often portable and wireless, allowing data collection outside the laboratory and facilitating research in natural settings. Their ability to conduct real-time data analysis makes them ideal for immediate feedback and neurofeedback applications. High sampling rates allow the detection of rapidly changing neural activity. Additionally, integrated software supports data acquisition, analysis, and visualization, helping researchers interpret results effectively.

Applications of EEG Devices in Behavioral and Neuropsychological Research

- **Neurological Research:** EEG is widely used to examine neurological disorders such as epilepsy and sleep disturbances, playing a vital role in diagnosis and monitoring.
- **Cognitive Processes:** By recording brainwaves during cognitive tasks, EEG provides insights into attention, memory, learning, and decision-making.
- **Emotional Arousal:** EEG enables measurement of responses to emotional stimuli, such as stress, fear, or happiness.
- **Emotion Regulation:** Research into strategies for regulating emotions and their neural correlates can be conducted, offering value for clinical interventions.
- **Psychopathology:** EEG is employed to study the effects of depression, anxiety, schizophrenia, and other psychiatric disorders on brain activity, contributing to biomarker identification and monitoring treatment effectiveness.
- **Neurofeedback:** EEG allows for neurofeedback training, helping individuals regulate their own brain activity.
- **Sleep Stages:** By recording brain activity during sleep, EEG facilitates the study of sleep stages (REM, NREM) and sleep disorders.

The price of advanced EEG systems depends on brand, model, number of channels, and features, generally ranging from USD 20,000 to 100,000. Additional costs include electrodes, maintenance, software licenses, and data storage. The EEG system to be procured for the Behavioral Science Laboratory will play a critical role in neurological, cognitive, emotional, and psychological research by providing high-quality data. With its large channel capacity, portability, real-time analysis, and high sampling rate, the EEG device will significantly increase both the accuracy and the scientific contribution of the laboratory's research.

Eye Tracking Devices – Features

Eye tracking devices record eye movements with high temporal and spatial resolution, precisely capturing the position and dynamics of the pupils. By sampling eye movements at high frequencies (typically 60–120 Hz or higher), these systems are able to detect rapid and short-duration eye movements. They determine eye positions with millimetric accuracy, providing detailed and reliable data. Both desktop and wearable versions are available, offering flexibility for different research environments. Integrated software packages support data acquisition, analysis, and visualization, enabling efficient interpretation of results. Certain eye tracking systems also allow the simultaneous tracking of multiple participants, making them particularly suitable for group-based studies and research on social interaction.

Behavioral and Neuropsychological Studies with Eye Tracking Devices

Eye tracking devices can be employed in a wide variety of studies, including visual attention and perception, decision-making and problem-solving, advertising and marketing research, education and learning, as well as neuropsychological and clinical investigations. Examples include:

- **Visual Search Tasks:** Examining how participants allocate attention and process visual information during search tasks.
- **Reading Research:** Measuring reading speed, word recognition, and comprehension through analysis of eye movements.
- **Decision-Making Processes:** Investigating how individuals use information and make decisions through their eye movement patterns.
- **Problem-Solving:** Analyzing strategies and attentional distribution during problem-solving activities.
- **Advertising Effectiveness:** Assessing which elements of advertisements capture attention and which areas attract the most viewing time.
- **Consumer Behavior:** Studying how consumers visually engage with products and make purchase decisions.
- **Educational Materials:** Evaluating the effectiveness of instructional content by tracking how students process visual information.
- **Learning Processes:** Identifying effective learning strategies by observing attentional distribution and gaze behavior.

- **Autism and ADHD:** Investigating cognitive markers of autism spectrum disorder and attention deficit hyperactivity disorder by tracking gaze patterns.
- **Neurodegenerative Disorders:** Exploring how conditions such as Alzheimer's and Parkinson's disease affect visual attention and perceptual processes.

Conclusion

Within the scope of the first work package of the European Union project, the Cognitive and Behavioral Sciences Application and Research Center was established, and it was decided that the Behavioral Science Laboratory would be developed within this center. To plan the laboratory and conduct needs analyses, two meetings—one online and one face-to-face—were organized in collaboration with Çanakkale Technopark, Çanakkale Onsekiz Mart University, and Ludwig Maximilian University. Through these meetings, research efforts, and mutual consultations, the foundation was laid for the laboratory to become a hub for research in cognitive and behavioral sciences.

During the first work package, the location of the laboratory was determined, the necessary equipment was identified, and detailed analyses of the devices and their features were conducted.

Requirements for the Behavioral Science Laboratory

Laboratory Space and Infrastructure

- Adequately sized laboratory space meeting necessary technical conditions.
- Infrastructure support (electricity, internet connectivity, climate control).

Research Equipment

- **EEG (Electroencephalography) Device**
    - High-resolution brainwave recording with portable and wireless options.
    - Average price: USD 20,000 – 100,000.
- **VR (Virtual Reality) Device**
    - High-resolution displays, precise motion tracking, and haptic feedback.
    - Average price: USD 500 – 1,500.
- **Eye Tracking Device**

- High-resolution tracking, high sampling frequency, millimetric accuracy, desktop and wearable models.
- Average price: USD 10,000 – 30,000.

Software and Hardware

- Integrated software for data collection, analysis, and visualization.
- High-performance computer systems and secure data storage solutions.

Training and Certification

- Training programs for laboratory personnel in device operation and data analysis.
- Participation in certification programs on neuroimaging, VR, and eye tracking technologies.

Devices and Research Applications in the Behavioral Science Laboratory

- **EEG Device**
  - *Features:* 32–64+ electrode channels, portability, real-time analysis, high sampling rates.
  - *Applications:* Neurological research (epilepsy, sleep disorders), cognitive processes (attention, memory, learning), emotional arousal and regulation, psychopathology (depression, anxiety, schizophrenia), neurofeedback, and sleep stage analysis.
- **VR Device**
  - *Features:* High-resolution displays, precise motion tracking, haptic feedback, wide field of view, wired and wireless options.
  - *Applications:* Cognitive load testing, motor skills and social simulations, emotional responses and phobias, educational and rehabilitation scenarios.
- **Eye Tracking Device**
  - *Features:* High-resolution gaze tracking, high-frequency sampling, millimetric accuracy, desktop and wearable models, integrated analysis software.
  - *Applications:* Visual search, reading research, decision-making and problem-solving, advertising and marketing research, educational and learning processes, neuropsychological and clinical studies.

Steps for Establishing the Behavioral Science Laboratory

- **Physical Setup**
  - Laboratory site determined; infrastructure installation in progress.
  - Procurement, installation, and calibration of equipment required.
- **Personal Training**
  - Training in device use and data analysis.
- **Research Program Development**
  - Identification of research projects to be conducted in the laboratory.
  - Strengthening collaboration with project partners.
- **Financial and Administrative Planning**
  - Budget planning for laboratory sustainability.
  - Definition of management and operational procedures.
- **Training Needs**
  - *Basic and Advanced EEG Training:* EEG data collection and analysis, neurofeedback applications.
  - *VR Technology Training:* Design and implementation of virtual environments, VR-based research and therapy techniques.
  - *Eye Tracking Training:* Collection and analysis of gaze data, applications of eye tracking in research.

Final Remarks

The Behavioral Science Laboratory is of critical importance for neurological, cognitive, and behavioral research. The required infrastructure, equipment, and training programs for its establishment and operation have been identified, and the steps to be taken have been planned. The work conducted within the scope of the European Union project will substantially enhance the laboratory's scientific output and research capacity.

This needs analysis outlines the essential components required for structuring the Behavioral Science Laboratory as a research infrastructure that meets international standards. When considered together—physical space, equipment, software and hardware, training, human resources, and collaborative partnerships—the laboratory is envisioned to become:

- a **pioneer in neurological, cognitive, and behavioral research**,

- an **innovator in marketing and consumer behavior studies**,
- and a **functional hub for applications in education, health, and technology**.

Conducted within the scope of the European Union project, this analysis contributes to taking concrete steps toward the establishment of the laboratory and significantly enhances its research capacity.