BRAIN Initiative
Brain Behavior Quantification & Synchronization Program: Overview and Sensors Technology U01

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New opportunities to study the neural basis of complex behaviors:

Gaps

- Lack of tools to precisely quantify naturalistic behaviors in the context of complex environments
- Lack practical systems for long-term ambulatory recording of neural activity in naturalistic settings
- Lack direct, objective **measures of internal subjective states**
- Lack way to train valid internal state decoders to build closed-loop interventions

Opportunities

- Develop high-resolution **tools, platforms, and theories** to precisely quantify behaviors as a multi-dimensional response with high resolution and to synchronize these with simultaneously recorded brain activity
- Build new conceptual and computational **models** of behavioral systems, with which to establish causal brain/behavior relationships
- Establish a cross-disciplinary **consortium** to develop and disseminate new tools, ontologies, research designs, and ethical frameworks that will transform how mechanistic brain-behavioral research is conducted.

BBQS Program

BBQS Program: *Develop and disseminate new tools, ontologies, research designs, data archives informatics tools, data standards, and ethical frameworks that will transform how* ***mechanistic brain-behavioral research*** *is conducted.*

Research Areas:

- Mental health
- Neurology, including movement
- Substance use disorder / addiction
- Aging and related disorders
- Sensory systems and communication
- Brain development and maturation

For more information: https://braininitiative.nih.gov/research/systems-neuroscience/brain-behavior-quantification-and-synchronization-program

BBQS Program Components

Data Archive, Coordination & Artificial Intelligence Resources

BBQS Data Coordinating and AI Center
Ecosystem for Multi-modal Brain-Behavior Experimentation and Research (EMBER)

Human Clinical Neuroscience

RFA-MH-26-100 (R61/R33)
Brain Behavior Quantification and Synchronization

Organismal Behavior

RFA-DA-24-040 & -041 (U01)
Transformative & Integrative Models of Behavior at the Organismal Level

Sensors Technology

RFA-MH-26-140 (U01)
Brain Behavior Quantification and Synchronization-Next Generation Sensor Technology Development

RFA-MH-26-140 (U01): BRAIN Initiative Brain Behavior Quantification and Synchronization

Purpose: To support development of next generation Sensor Technologies in human and organismal models to improve our understanding of complex behavior.

Goals: To develop novel sensors/bioelectronics, and synchronize data with brain recordings; Milestone-driven projects

- Areas: Electrochemical, micromechanical, optical, electromagnetic, temperature, inertial, acoustic, remote
- Noninvasive or minimally invasive designs
- Considerations for sensor designs (Microsystems vs Nano; flexibility; materials etc.)

Multidisciplinary Teams: Engineers, Material Scientists, Neurophysiologists, Neurosurgeons, Psychologists, Psychiatrists, Neuroethologists, Computational Neuroscientists, Data Scientists

https://grants.nih.gov/grants/guide/rfa-files/RFA-MH-26-140.html

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Sensor(s) or Bioelectronic Device Designs Will Exhibit

- Compactness in design with low or zero power consumption
- Non-invasive or minimally invasive design
- High reliability and repeatability in performance and accuracy
- Stable long-term performance equal to or greater than 48 hours, to capture naturalistic behavior in real time
- High spatial and temporal resolution
- High biocompatibility and low toxicity
- Synchronization of sensor data with brain recordings

https://grants.nih.gov/grants/guide/rfa-files/RFA-MH-26-140.html

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Optional Considerations

If **possible, sensor(s) or bioelectronic device designs may be in:**

- Combination with intracranial recordings
- Have energy harvesting capability
- Combinations of multiple sensors or bioelectronics into a single compact design
- Devices that are easily produced and could be widely disseminated in the engineering and scientific research communities
- Development of computational models of behavior using data

https://grants.nih.gov/grants/guide/rfa-files/RFA-MH-26-140.html

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Types of Sensors: Physical, Chemical, Electrical Domains

Prototypes for:

- Mechanical (force, pressure, piezoelectric)
- Optical (NIRS, photonic, etc.)
- Inertial (velocity, angular acceleration)
- Thermoelectric
- Potentiometric (Solutes, Metabolites, Hormones, etc.)
- Acoustic/Ultrasound
- O_2 and CO_2 blood gas sensing
- Remote Sensing (Doppler radar, LiDAR, etc.)

Considerations for:

- Energy harvesting sensors
- Microsystems- vs nano-scale technology
- Battery free
- Combinations of sensors
- Biocompatibility

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Non-Responsive Areas of Research:

- Devices that are bulky, cumbersome or would need to be carried with respect to organism size and which would interfere with naturalistic behavior
- Devices that require hard-wired configurations
- Devices with short battery life less than 48 hours
- Magnetic resonance and other technologies with relatively low spatial resolution
- Devices with low temporal resolution
- Sensing measurements that require invasive imaging approaches
- Studies that do not propose a sensor device

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Other Considerations:

- These are milestone-driven research projects
- Clear timelines are needed
- Clear justification of the device(s), including what has already been designed

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RFA-MH-26-140 Brain Initiative: Brain Behavior Quantification and Synchronization-Next Generation Sensor Technology Development (U01 Clinical Trial Optional)

Key Dates:

Open Date: May 13, 2025

Letter of Intent (Optional): May 13, 2025

Due Dates: **June 13, 2025, June 15, 2026, June 15, 2027**

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Applicants are strongly encouraged to consult the NIMH Program Contact listed below to discuss the alignment of your proposed work with the goals of this funding opportunity and BRAIN Initiative program goals:

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