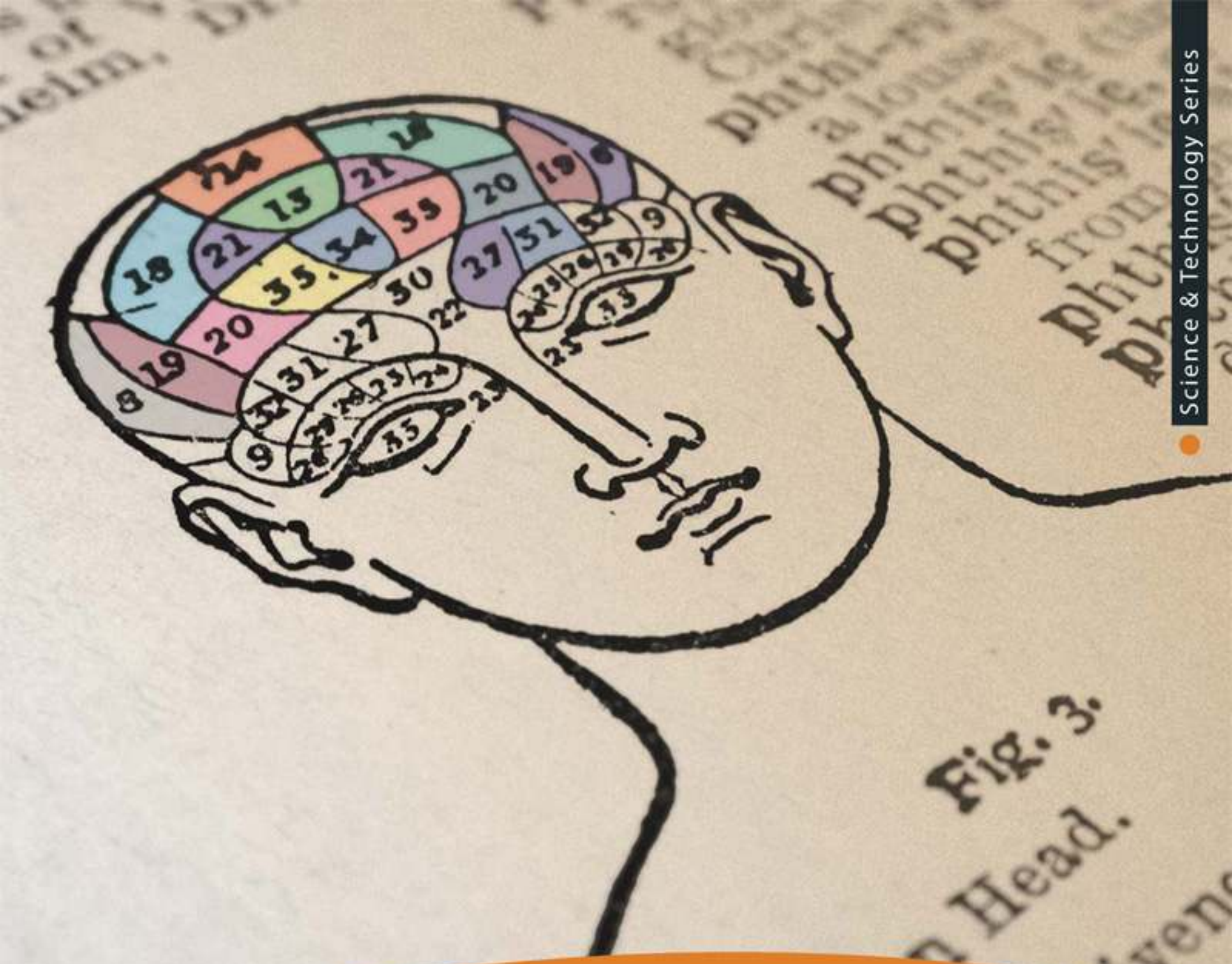

Cognitive Science Research

Thinking about Thought

Tradition of Excellence

Bar-Ilan University

At Bar-Ilan University, cognitive science researchers are clarifying the representational and computational capacities of the human mind, as well as their functional bases in neural structures.

Pictured from left to right:
Prof. Susan Rothstein
Dr. Nira Mashal
Prof. Miriam Faust
Dr. Esther Adi-Japha

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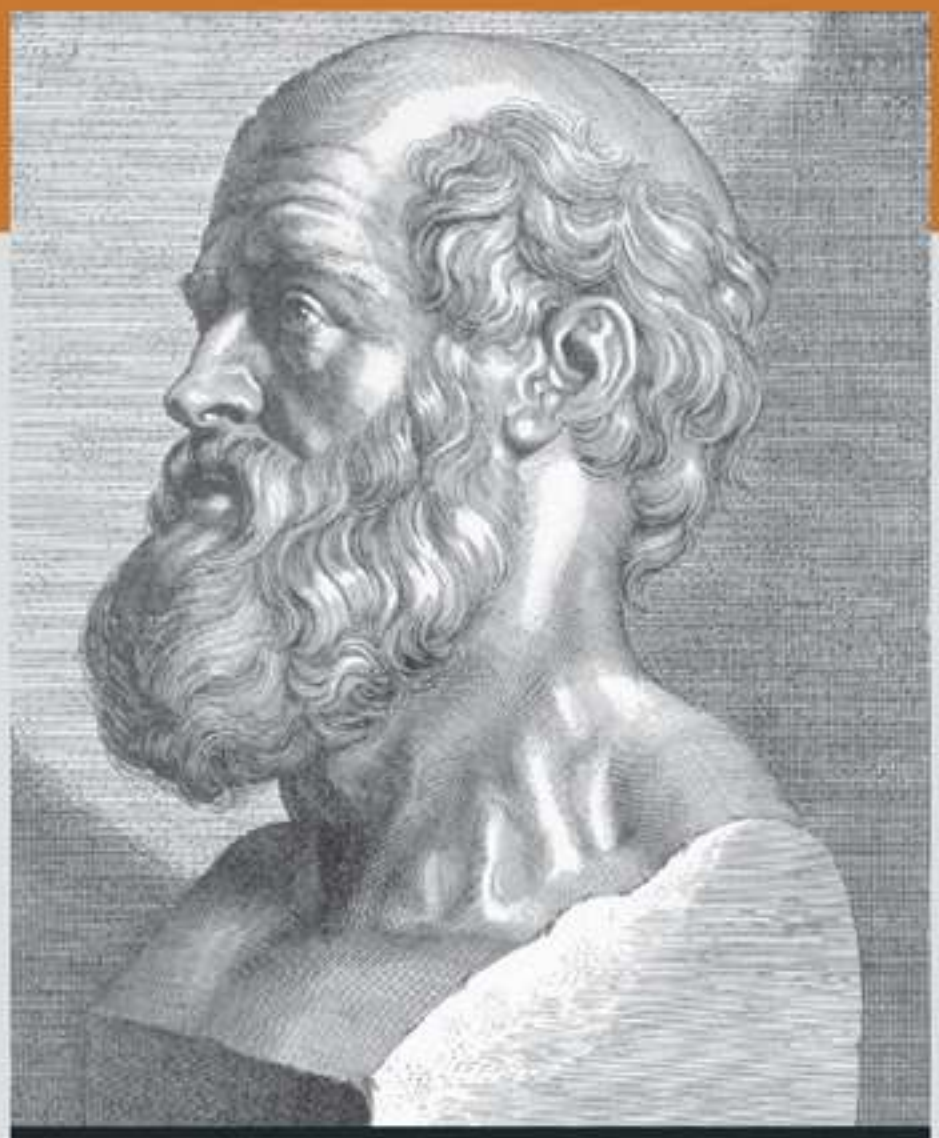

Hippocrates

When Hippocrates – the ancient Greek physician known as the "father of medicine" – stated that the brain is involved with sensation and is the seat of intelligence, he was putting forth a theory that was far ahead of its time. Even today, the specifics of brain function arouse strenuous scientific debate – with much of this debate centering on a relatively new specialization known as cognitive science.

Cognition – the mental process by which we perceive the world and acquire knowledge – is notoriously difficult to observe because the "platform" that supports it – the human brain – is staggeringly complex. Understanding the relationship between the mind and the brain demands a cognitive science-based, interdisciplinary approach.

At Bar-Ilan University, cognitive researchers are thinking about thought. They are clarifying the representational and computational capacities of the human mind, as well as their functional bases in neural structures. By making new connections, Bar-Ilan researchers are painting a clearer picture of how the mind helps us understand the world in which we live.

Words, Words, Words

University Vice Rector Prof. Miriam Faust studies the link between sound and language production. She has demonstrated how problems related to "word finding" can stem from difficulty in retrieving sounds from long-term memory in different groups with language difficulties such as dyslexia, as well as in unsuccessful foreign language learners. Faust also examines the role played by the left and right sides of the brain during creative comprehension tasks and has shown that the right hemisphere – long considered the "non-linguistic" side of the brain – is dominant in the processing of "unexpected" language patterns characteristic of poetry, metaphors and ambiguity.

BIU labs use advanced technology to analyze how the human brain processes language-related tasks.

In related research, Dr. Nira Mashal is using Functional Magnetic Resonance – an imaging technique that monitors blood flow to identify areas of high activity – to study language processing both in the healthy brain and in schizophrenics. Her studies demonstrated that the right hemisphere has a special role in understanding novel metaphoric language. Dr. Mashal also uses behavioral studies to examine hemispheric differences in processing the literal interpretation of idioms.

Also focusing on hemisphere-based language processes is Prof. Michal Lavidor. Lavidor investigates prerequisites of interhemispheric cooperation in word recognition. She is also exploring cognitive processes relating to the recognition of emotions encoded in gestures, as well as the variations of stress, tone, and timing characteristic of spoken language. Using Transcranial Magnetic Stimulation (TMS) – a non-invasive technique for mapping and manipulating brain function – as well as direct neurostimulation via electrodes, Lavidor examines interhemispheric asymmetry during complex cognitive tasks.

The brain is colloquially called "grey matter." But just as important to cognitive function is "white matter" – the extensive network of pale, myelin-sheathed network connections that allows effective information transfer between distant parts of the brain. Using Diffusion Tensor Imaging (DTI), fMRI and behavioral measurements, Dr. Michal Ben-Shachar has demonstrated how white matter properties mediate specific aspects of reading and arithmetic skills in children. In her most recent research, Ben-Shachar is elucidating the link between white matter properties and stuttering, and is also examining how the acquisition of reading skills by adult illiterates affects the neurological basis of their language processing.

In the 1950s, the founders of cognitive science proposed that memory limitations are central to the mediation of cognitive behavior. Today, Dr. Ronit Ram-Tsur has demonstrated that memory – specifically, a deficit in working memory – plays a central role in reading acquisition. Ram-Tsur's study – done in collaboration with BIU's Prof. Faust and Dr. Ari Zivotofsky – suggests that poor working memory may be one of the underlying causes of dyslexia. In another project, Ram-Tsur recently demonstrated that asynchronous perception of auditory and visual stimuli can lead to poor working memory – something that can interfere with the acquisition of reading among young children.

Prof. Jonathan Fine, author of a book on language in clinical psychiatry, is involved in a series of studies in which he examines normative and aberrant language use in populations ranging from bilinguals to schizophrenics to individuals on the autism spectrum. Using semi-structured conversational models that highlight specific communication difficulties, Fine's research has revealed important data that may help in the creation of better diagnostic and therapeutic tools.

English, Hebrew and Chinese look and sound very different. However, according to Prof. Susan Rothstein, the linguistic structures used to communicate basic concepts - such as counting and measuring - are remarkably similar. Working on a model of how we interpret language, Rothstein uses linguistic theory, which describes our knowledge of language in abstract structural terms, to formalize constraints on linguistic structures that may have their basis in physiological constraints on neural communication – defined in terms of measurable electrochemical impulses between brain cells.

How Thoughts Grow

How do children create categories? According to Prof. Gil Diesendruck, children process incoming information according to language-based, culture-specific cues. In studies of three- and four-year-old Israeli children, Diesendruck revealed that ethnicity is the most informative of all social categories – with religious Jewish children showing a stronger adherence to this conceptual "boundary" than non-religious Jews, or Muslim Arabs. In another project, Diesendruck has demonstrated how children infer meaning based on whether an agent's action is intentional or accidental. In his most recent work, Diesendruck is studying whether – and at what age – children begin to discriminate between different social groups as potential sources of cultural information.

Experts in cognitive development are revealing important data about how children perceive and learn about their world.

Children's drawings reveal emotional clues, but drawing – as well as writing – can reveal cognitive data as well. Dr. Esther Adi-Japha has demonstrated that children raised in a bilingual environment show increased "cognitive flexibility," producing boundary-busting drawings – such as "house-chairs" and "giraffe-flowers" – with greater frequency than their monolingual peers. She has also shown that training in writing is a process that contributes to the development of neural structures that separate "writing" from "drawing," and is less effective in children with ADHD. In another project, Adi-Japha has demonstrated that young children who enjoy high-quality parenting, alongside 10–32 hours per week spent in childcare, did much better on basic preschool concepts than children who are in childcare for longer or shorter amounts of time.

Another researcher focusing on early cognitive development is Dr. Ronny Geva. Geva studies the relationship between neural abnormalities and behavior through long-term tracking of infants who are at-risk for learning disabilities and attention deficit disorders. By clarifying the earliest indicators of developmental problems, Geva's work is paving the way toward earlier and more effective preventative interventions. In another area of her research, Geva is examining working memory, emotional reactivity and impulse control in young children and young adults being treated for attention deficit, and is also studying how emotional regulation affects cognitive processes of children and adults as they navigate complex social situations.

Mental Mechanisms

Dr. Abraham Goldstein seeks to understand how brain structure and electrical activity contribute to the processing of basic mental operations. Using EEG sensors that "eavesdrop" on the brain while subjects are presented with various tasks, Goldstein studies functional differences between the right and left hemispheres of the brain as well as the neural mechanisms related to attention and emotional attachment in children and adults. He is also collaborating with BIU developmental psychologists, measuring neural activity in infants in order to create a more complete picture of babies' mental development.

At BIU, experts in electrophysiology work together with psychologists to "eavesdrop" on everything from vision to aggression to creative thinking.

According to Prof. Joseph Glicksohn, anti-social personality traits – especially those related to impulsivity and aggression – can be traced to impaired brain function. Using a combination of EEG, psychological testing and the administration of computer-generated tasks, Glicksohn has shown that pathological behaviors such as impulsivity, risk taking and sensation seeking are linked to frontal lobe dysfunction. Glicksohn is also examining the relationship between consciousness, creativity and problem solving, and has shown that altered states of consciousness – brought on by the use of drugs, meditation, "trance" or other behaviors – correspond to a less logical, more metaphorical form of thinking. In a separate project, he demonstrated that the ability to creatively change one's view is linked to changes in electrical patterns of the brain.

According to cognitive neuroscientist Dr. David Anaki, the lifelong ability to perceive visual categories such as faces, objects, scenes and words depends on dedicated brain mechanisms. Anaki investigates the unique, memory-linked processes that allow us to integrate and form a unified representation of temporally separated visual stimuli. Using electrophysiological studies as well as behavioral techniques – and examining both healthy individuals and those with specific neurological deficits that affect vision – Anaki is creating a more complete picture of how visual perception and cognitive processes work together.

Because of its security situation and high rate of traffic accidents, the State of Israel has become one of the world's centers of expertise on rehabilitative medicine. The research of rehabilitative psychologist Prof. Eli Vakil focuses on memory impairment, and the various ways in which head-injured patients re-learn specific skills. By contributing to our understanding of the nature of memory, and of the neural structures that support memory-related tasks, Vakil's work is helping to identify new strategies for diagnosis and rehabilitation, as well as for the treatment of neurological disorders that involve memory impairment.

Another scientist examining neurocognitive deficits following traumatic brain injury – as well as the abnormal psychology of patients suffering from schizophrenia – is Dr. Yuri Rassovsky. In quantitative studies of the relationship between defeatist attitudes and the level of real-world functioning among schizophrenics, Rassovsky has shown that therapeutic interventions targeting attitudes could potentially improve functional recovery. In another study, he demonstrated a unique and statistically-significant aberration in visual processing among schizophrenics, identifying a fundamental neurological difference between normal individuals and people with this disease.

Being in the World

BIU cognitive science researchers are developing quantitative methods for understanding and improving clinical treatment in social anxiety, post-traumatic stress disorder (PTSD) and depression. In a recent study, Prof. Eva Gilboa-Schechtman focused on the treatment of children and adolescents suffering from post-traumatic stress disorder, or PTSD. Following adolescent survivors of terror attacks, Gilboa-Schechtman has determined that the most effective treatment for PTSD involves a combination of behavioral and trauma-reconstruction approaches, rather than relying solely on dynamic "talk" therapy. Gilboa-Schechtman's research integrates experimental and clinical studies, and seeks to identify the mechanisms that contribute to the maintenance and etiology of social anxiety and PTSD disorders.

Where Minds Meet

As cognitive science teaches us, human consciousness is far more than the physical workings of the brain. By using experimental, theoretical, technological and computational approaches, BIU cognitive scientists are making important contributions to unraveling the mysteries of the mind.

For more about the research of BIU faculty listed in this brochure go to: www.biu.ac.il and click Research.

The Leslie and Susan Gonda (Goldschmied) Multidisciplinary Brain Research Center

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Bar-Ilan University
Science and Technology

Bar-Ilan University stands at the forefront of cutting-edge research. Bar-Ilan researchers are making breakthroughs that improve life around the globe in areas such as drug-development, nanotechnology, medical research, bio-engineering, microscopy, optics, communications, energy, security, and more. As part of a national program to combat Israel's brain drain, BIU has taken the lead by committing to absorb dozens of returning experimental scientists within its world-class research infrastructure, and has added state-of-the-art physical facilities in engineering, brain sciences and nanotechnology to house these innovative initiatives. The Science and Technology Series highlights some of the University's most exciting research endeavors.

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