Social, Behavioral and Economic Sciences

The National Science Foundation's Social, Behavioral, and Economic Sciences Directorate
The social, behavioral and economic sciences illuminate many aspects of human behavior, from how we think and learn to how we interact individually and in groups. SBE-funded researchers develop and use scientific methods to discover fundamental principles of human behavior, at levels ranging from cells to society, from neurons to neighborhoods, and across space and time. Such fundamental principles help us understand patterns of stability, change, conflict, and cooperation which can be applied to promote the progress of science; to advance the national health, prosperity and welfare. From cybersecurity to social security, the results of SBE research will provide a deeper understanding of what we can do to ensure a more prosperous future.

How Does the Human Brain Produce Cognition and Behavior?

Understanding the brain and how it produces behavior is one of the most persistent mysteries of modern science. What is the nature of consciousness? How do patterns of brain activity translate into thought, emotion or action? How do humans perceive the environment around them, communicate, understand and learn? These are just a few of the questions SBE-supported scientists seek to answer.

Learning to Talk
SBE-funded research on learning, cognition and the brain provides fundamental insights about the social foundations of learning.

A University of Washington team led by Patricia Kuhl has shown that babies' brains lay the groundwork for word formation when they're just 7-11 months old — before they can talk[1]. Using a non-invasive brain scanner, Kuhl's research has shown that speech sounds stimulate areas of babies' brains associated with the motor movements used in speech. Her findings suggest that when adults "baby talk," they may be prompting infants to try imitating what they've heard.

Her research has implications that reach far beyond the early stages of childhood. Kuhl and her team have discovered that parents who are stressed or depressed — characteristics that tend to be tied to socioeconomic status — are less able to produce the happy enthusiasm vital to the communication that she calls "motherese." Children who receive less of that type of talk can end up on the wrong side of a "vocabulary gap" that can create problems with reading and verbal comprehension that can last into high school. By studying critical stages of language learning, Kuhl is laying a foundation to develop interventions for children who have trouble with specific types of learning, harnessing the power of social interaction in ways that could yield significant improvements in learning.[2]

Body Language and National Security
The ability to express and perceive emotion is a crucial component of communication — one that can be particularly important for military and national security purposes.

In situations where a U.S. soldier interacts with someone from another country who speaks a different language, cross-

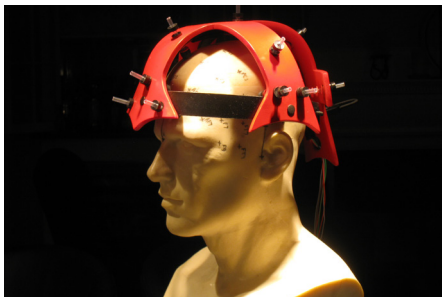
cultural communication errors can be disastrous. Hillary Anger Elfenbein of Washington University in St. Louis recognized that in many theaters of war, the military has too few translators, and soldiers must rely heavily on nonverbal communication.

Using data collection and analysis, Elfenbein and her collaborators challenged conventional wisdom, showing that while people may assume that they can accurately read emotions from nonverbal communications, including facial expressions, vocal tones and body language, the average person is only able to do so about 33 percent of the time. She also found that practice, not classroom-style instruction, is essential for people to improve their emotional recognition[3].

Those findings prompted the Army Research Institute to incorporate education on non-verbal communication into soldier training. Enhancing troops' interpersonal skills can enable them to anticipate and lessen conflict and facilitate cooperation, negotiation and compromise. Elfenbein has testified before Congress that without SBE, work like hers would not find funding.

Computer-Brain Interface

What happens when a person is thinking about speaking, but has been left unable to translate that intent into action? The inability to speak severely afflicts the lives of the profoundly paralyzed.



Boston University's Frank Guenther and Philip Kennedy are working on solutions that could bring hope to those left unable to communicate. With SBE support, they developed a brain-computer interface that creates synthetic speech sounds from thought[4]. An implanted electrode picks up brain signals from nearby activated neurons, transmitting them to a computer that translates them into sound.

The researchers worked with a severely paralyzed volunteer suffering from "locked-in syndrome" caused by a stroke. The volunteer was able to use the brain-computer interface to create vowel sounds when he imagined producing them. The project integrated cutting-edge computing, implementing a software decoder that could rapidly translate the neural signals into sound. That fast feedback allowed the patient to be able to improve the sound production with practice.

SBE Investments

SBE supports fundamental research across the social, behavioral, and economic sciences and collaborates with other scientific disciplines, providing an invaluable perspective on the human dimension of complex challenges facing our nation: cybersecurity, disaster response, sustainability, national security and inequalities. The directorate accomplishes this work through its Division of Behavioral and Cognitive Sciences, Division of Social and Economic Sciences, Office of Multidisciplinary Activities, and the National Center for Science and Engineering Statistics (NCSES), which is the nation's premier source for data on science and engineering.

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[1]NSF award 0835854 "Sensorimotor influences on speech perception in infancy," *Proc. Natl. Acad. Sci.* USA 2015 112 (44) 13531-13536 http://www.pnas.org/content/112/44/13531.full.pdf

[2]NSF awards 0354453, 0835854

[3]NSF awards 0909615, 0617634 "Individual differences in expressing and perceiving nonverbal cues: New data on an old question," *Journal of Research in Personality* p. 199, vol. 44, (2010). http://www.sciencedirect.com/science/article/pii/S0092656610000024

[4]NSF awards 0835976, 0118917 "A Wireless Brain-Machine Interface for Real-Time Speech Synthesis," *PLOS One*, DOI: 10.1371/journal.pone.0008218 (2009) http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0008218

Image credits: page 1 (left) Institute for Learning & Brain Sciences, University of Washington; (right) Sebastian McCormack, U.S. Navy; page 2 Frank Guenther, Boston University