Article | Brain Science in the 21st Century: What Lies Ahead?

By Dorothy Lockhart Lawrence

Much has happened in neuroscience since the “decade of the brain” at the end of the 20th century. We now see new research every week that exposes new insights into how the brain works. Let’s take a look at some of the Mind & Brain News Headlines from Science Daily (www.sciencedaily.com) for the week of January 23-29.

- Mouse Brain Cells Rapidly Recover After Alzheimer’s Plaques are Cleared
- Two Minutes of Magnetic Stimulation Can Change Your Brain For An Hour
- Deciphering the Genetic Babel of Brain Cells
- Multiple Therapies Curb Declining Ability To Learn With Age
- First View of Many Neurons Processing Information in Living Brain
- Cooling Lessens Brain Damage in Sick Newborn Babies

What lies ahead for brain science in the 21st century?

The most exciting aspect of the new brain science for those who work with clients with disabilities is research explaining the dysfunction and the development of rehabilitative programs that exploits this knowledge. The new programs are based on what is known as use-dependent neuroplasticity. This means that the brain can change with new input, with new experience. This direction in brain science is ushering in a whole new era in neurological rehabilitation that uses neuroplasticity-based interventions.

All the new rehabilitation strategies are based on the principle that neural firing patterns in the brain can be retrained. As John Ratey, MD and author of A User’s Guide to the Brain likes to say, “neurons that fire together wire together.” New brain plasticity-based training methods are being developed to address the fundamental behavioral deficits found in many chronic neurological disabilities and diseases. The underlying belief is that by repeated, intensive exposure to correct environmental cues, miswired neural circuitry can be changed. The brain can acquire information and make appropriate adaptive responses with this new information.

When early research showed that intense and frequent repetition could change the firing patterns and wiring in the brain, each area in the brain was explored to determine if plasticity would be exhibited in all areas. If change occurs in the motor cortex, would it also occur in the auditory cortex? The answer was yes. The question that followed became, can we reverse negative change with opposite conditioning?

The first of these new rehabilitation strategies investigated a way to rehabilitate focal hand dystonia, a condition seen most often in musicians, painters, keyboard users, and others who use their hands in an intensive and repetitive manner. The dysfunction overwhelms the capability of the individual sensory neurons to discriminate between the stimuli in various parts of the hands.

Nancy Byl, director of the graduate program in physical therapy at the University of California at San Francisco, UCSF, worked to develop a sensorimotor retraining program to teach the brain to learn to separate the neuronal response for each finger. She reported an 85 to 98 percent improvement in fine motor skills in three musicians who took part in her program in 2000. Edward Taub and his collaborators at the University of Constanz in Germany also developed a therapy based on these findings. They restrained one of the more healthy fingers and exercised the dystonic finger. The concept was to teach the brain that the dystonic finger is a separate entity. All five of the pianists they worked with were rehabilitated.

Dr. Michael Merzenich of UCSF, who is behind much of the research in this new field, believes that as more research is being done, “intensive learning-based therapies shall come to be a common dimension of treatment for a wide range of neurological and psychiatric illnesses and disabilities.” His Fast ForWord program, designed to treat language based learning disabilities, is an example. Other areas being investigated are possible treatments for cerebral palsy, Parkinson’s disease, schizophrenia, and stroke.

One of the rehabilitative programs that falls into the category of use-dependent neuroplasticity is The Listening Program® (TLP). Dr. Tomatis based his early work in the field of auditory stimulation on his own theories and the behavioral responses he saw in his lab and clinic. He didn’t know that that he was creating change in the tonotopic map in the auditory cortex. But he knew that something amazing was happening for his clients.

Today we know much more about how the brain works. We also have many more tools at our disposal. TLP Level One is the result of matching specific research findings with various audio technologies that ABT has developed in order to create a more effective program, one that addresses many more aspects of auditory processing.

One goal for TLP is for individuals with auditory processing difficulties to remap their own auditory cortex. How can this be accomplished? By providing the right input, in a frequent, intense manner for a long enough period of time, firing patterns in the brain become more organized and efficient. This added stimulation helps the auditory pathway to process sound in a more normal fashion. Sound signal reception is changed in the auditory cortex so that the brain can finally make sense of the signals it receives.

Children who have not processed sound normally, may begin to understand speech for the first time. Those who have not been able to tolerate loud sounds no longer cover their ears. Adults no longer avoid noisy, crowded rooms. As sound processing returns to normal, a person may be able to communicate successfully and easily for the first time and enjoy social interaction in a whole new way.

One of the advantages of delivering a therapy with music is that it is so enjoyable and can begin to work even when the listener has a very limited ability to process sound or is unable to sustain attention to a more complex task. If the chosen music is easy to process, the listener can enjoy it without having extensive cognitive processing abilities. The future holds promise for other therapies using music to retrain neural processes.

Use-dependent neuroplasticity is also the basis of ABT’s BrainBuilder® software program. New firing patterns are repeated until retraining is achieved. Through systematic workouts and positive feedback, the brain becomes more adept at remembering pieces of information and processing them with greater ease, speed, and efficiency.

Scientists at one time believed that genetics played the central role in determining our lives. We now know that nature and nurture go hand in hand. We also know that environmental influences can have even more of an impact than previously thought. An environment that has produced dysfunction may be reversed with a more intense, directed intervention so that the brain can learn a positive behavior in a more effective fashion.

Advanced Brain Technologies is committed to being on the forefront of research and development in this exciting and developing field. ABT will be making an exciting press announcement in the very near future about a collaborative research effort between ABT, NASA’s Jet Propulsion Laboratories (JPL), and the California Institute of Technology. The research is an exploration into developing a new, portable brain scan technology that will show localized changes during functional activation.

What lies ahead for brain science in the 21st century? Better diagnoses and better treatments will be available. The knowledge that the brain can change throughout our lifespan will create change in education, rehabilitation, and lifestyles. The new brain science will allow us to take better advantage of our strengths and improve on our weaknesses. It will encourage us to realize we can go far beyond what we thought possible, regardless of our starting point. New tools will allow us to maintain better health and well-being and contribute to our lives in ways we cannot yet imagine.

Resources:

O'Brien, J. (2001) Message to the brain: heal thyself. University of California, San Francisco Magazine. Retrieved 10/23/03 from pub.ucsf.edu/today/trint.php?news_id=200110084

Ratey, J. M.D. (2002) A User's Guide to the Brain, Perception, Attention, and the Four Theaters of the Brain. New York, Vintage Books

Schwartz, J. M.D. & Begley, S. (2002) The Mind and the Brain. New York, HarperCollins Publishers, Inc. p. 212

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