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Session Notes

Frontiers of the Future: Understanding Our Brain and Behavior

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Never before has the prospect for understanding how the brain works been more possible and exciting. We are at the threshold of deciphering human emotions, feelings, consciousness and behavior. Our understanding of our brains and nervous systems—from molecules, cells, circuits and structures to functions for life and human behavior—is one of the most important challenges and opportunities in the 21st century, and is one that Stanford is uniquely poised to play a lead role in unraveling.

The degree of knowledge regarding brain function is proceeding at an amazing pace. The complexity can be very difficult to understand, so we will attempt to simplify the vast amount of data by focusing on the findings related to one study participant who we'll use as the central teaching tool for this session today.

Michael May suffered the tragic misfortune of being blinded by a chemical explosion in a garage at age 3. He lost one eye entirely, and though the other eye was intact, he sustained severe damage to the cornea and lens. He was blind with no hope of seeing again. He went on to live a life that would be the envy of many. A list of his achievements include a degree from UC-Davis in engineering, another degree at Johns Hopkins and the invention of a unique GPS device for the sight impaired. He even managed to coach his own children's soccer team with his seeing eye dog at his side.

Over 40 years after his eye injury, Michael, ever the competitive type, qualified for a study that would involve a very unusual and risky surgery—limbic stem cell replacement of the cornea—to restore vision to his one remaining eye. This procedure has been performed only five or six times in the United States and is not without considerable risk.

The outcome was in doubt until the final bandage was removed. His wife waited nervously, wondering, "What if he doesn't think I'm cute?" She and the team had an emotional moment when Michael indicated he could see the light. He was cured. He could see.

As days turned to weeks, however, it became clear that his perception was so limited that his vision was really not defined. It was like seeing the snow on a television where no channel is transmitting. The light was there, but with very little visual recognition. It was not a full use of the sense we think of as vision.

Using the analogy of a camera, the lens was perfect, the machine was perfect, the signals and light were being transmitted. There was every expectation that he would see.

After eight years, his vision is still severely limited and this leads us to delve further into the question: “What’s wrong with Michael?”

Using sophisticated imaging technology, also known as a functional MRI, we were able to study how the issue of brain plasticity is critical to visual cortex. Our brain circuits are always being tuned up and refreshed. An animal study revealed that a mouse deprived of sight in one eye for 12 months was rendered completely blind in that eye, even though there was nothing wrong with the anatomy. This falls under the oft-used cliché: Use it or lose it.

We continued to study this breakdown in circuitry, and thanks to willing subjects like Mike, we are making great inroads toward understanding the brain and the complex series of everyday brain activity that must happen to maintain the brain. It turns out that without that maintenance, Mike’s brain had not kept up and could not interpret the signals received by his visual cortex.

This field of human health is so complex that only at a place like Stanford with an initiative for this purpose can we draw together an integrated team of experts to tackle each aspect of the puzzle. From advances in stem cell technology to psychology there are myriad factors that have to be taken into account to conquer the mystery of the brain. We are uniquely poised to tackle what may be the greatest achievement of the 21st century: a complete understanding of the brain.

The more we learn more about the 50 billion neurons in the brain, the sooner we’ll find cures for our most daunting afflictions. Until recent times the brain was the least understood part of our body, and now that is changing. It is something of a scientific revolution, and in the coming years we hope to see huge leaps forward.

In the meantime, you might want to read Mike’s book, *Breaking Through*. In it he details the many challenges he faces. You might also be interested in knowing that he holds the world record for blind downhill skiing. A record 60 miles per hour. I have no doubt Mike will continue to put in that kind of effort to fully restore his sight.