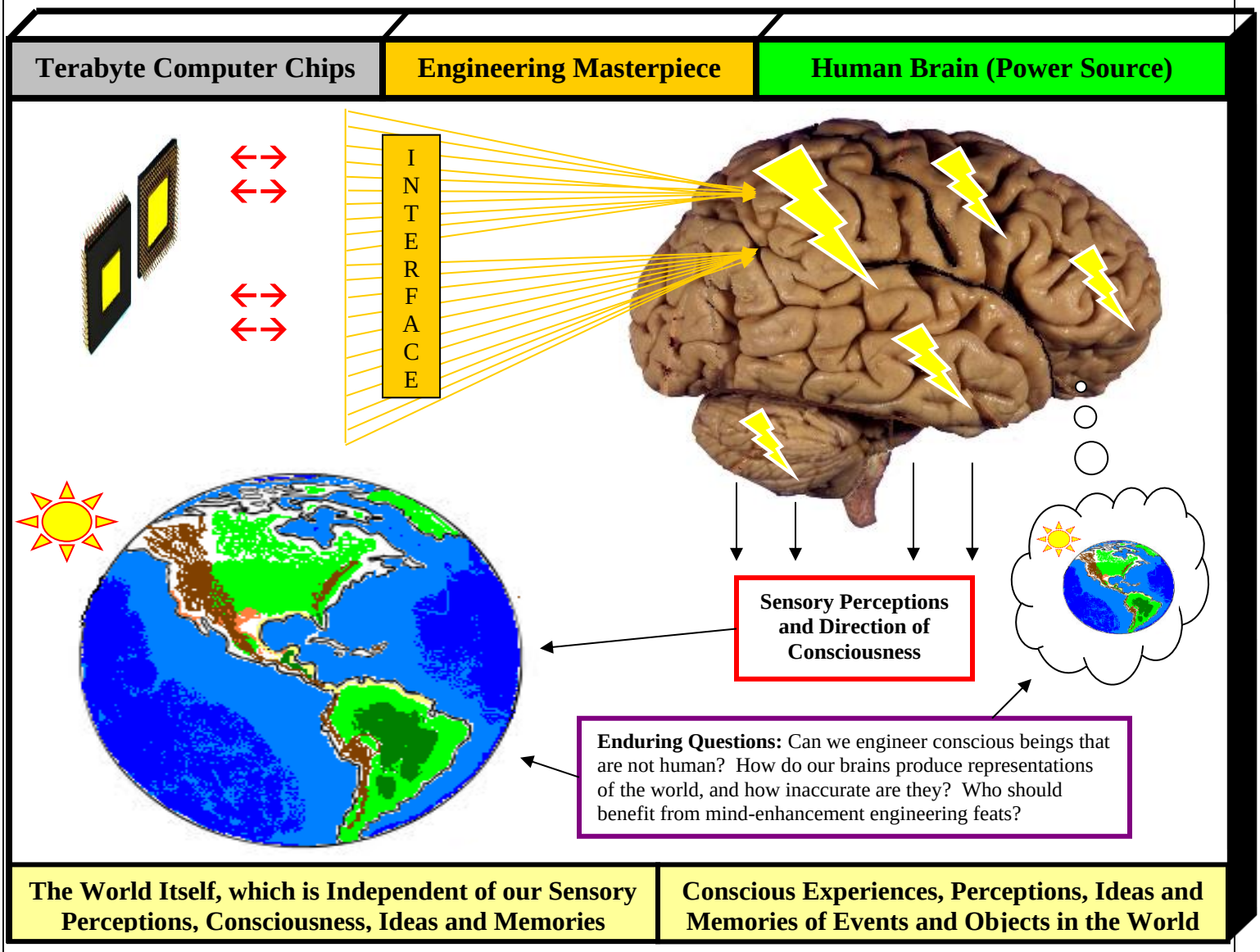
PDHonline Course G389 (4 PDH)

Engineering Ethics: Consciousness and Neuroethics

William A. (Trey) Brant, Ph.D. & William A. (Bill) Brant, JD, PE



PDH Online | PDH Center

5272 Meadow Estates Drive
Fairfax, VA 22030-6658
Phone: 703-988-0088

An Approved Continuing Education Provider

www.PDHonline.com

Engineering Ethics: Consciousness and Neuroethics

William A. (Trey) Brant, Ph.D. and William A. (Bill) Brant, JD, PE

COURSE CONTENT

Your brain mediates everything you sense, feel, think, and do---and acts as your ultimate 'neuromedia' interface to the world. A challenge for humanity is to understand the brain at a level of abstraction that enables us to engineer its function---repairing pathology, augmenting cognition, and revealing insights into the human condition.
--Ed Boyden, Neuroengineering, Massachusetts Institute of Technology

MOST EXCITING TECHNOLOGY IN OUR LIFETIMES

Neuroscience and neuroengineering are the most exciting technologies during our lifetimes, and they may very well be the largest ethical challenges ever! Neuroscience and neuroengineering will affect each of us within the next two decades, either directly or indirectly, through ourselves or our family and friends. Neuroscience will change the way we think and the actions we take.

By "neuroscience" we mean the science of the nervous system which includes the nature and significance of the brain and nerve fibers that weave throughout the body. Neuroscience studies the nervous system using the disciplines of math, biology, chemistry, physics, psychology, philosophy, computer theory, and research design.[1] "Neuroengineering" is defined as the interdisciplinary field of engineering and computational approaches applied to problems in basic and clinical neuroscience.[2]

In short, *your* nervous system is about you. All your thoughts, perceptions, moods, passions, volitions and dreams that make you who you are, i.e., an active, live human, and all are contained in this amazing network of cells interacting within various environments. Questions with which we are concerned are: Does your nervous system entirely make up your mind? What makes your mind, your mind? What effect can others have on your mind? What would you say to someone else reading *your*

mind and thoughts?

If you can imagine having millions of pages of information readily available to you via a computer chip in your brain, you may understand that those at the cutting edge of neuroengineering, through funding and scientific experimentation, potentially have great advantages regarding the use and distribution of such technology. Such innovations will certainly provide us with challenges concerning the expansion of consciousness, engineering consciousness in artificial computational systems, and preventing the exploitation of groups who lack access to such technology.

We seek to guide you through your own appreciation of "engineering, consciousness, and neuroethics" and the decisions and ethical choices you make related to a most important field.

How we started

Our course began when Trey Brant was a Fulbright Scholar attending the Johannes Gutenberg Universität in Mainz, Germany. One of his professors was Dr. Thomas Metzinger, a world-renowned authority on the philosophy of mind, consciousness and neuroscience. Dr. Metzinger informed Trey that one of the top mind research groups was the Mind Science Foundation in San Antonio, Texas. Trey relayed this information to Bill, who joined the Mind Science Foundation as a member. When Trey returned from Germany, we attended lectures by some of the top neuroscientists in the world presented by the Mind Science Foundation.

We recognized that ethics would have to play a big part in neuroscience and the engineering involved. We also realized that neuroscience would involve virtually everyone in one way or another in their lifetimes. Simple things, such as neuromarketing, could affect all of us in what and how we buy products and services.

We have collaborated in this course to outline the rudiments of neuroscience. We start with engineering, neuroengineering, what "neuroengineering" is and how it is involved in neuroscience. Next, we explore what consciousness, free will, and mind/body interaction are as well as other theoretical foundations. Lastly, we focus on the law, ethics, and neuroethics as it is related to an ethics of consciousness, a special set of ethics, which will affect us all.

Engineering and the Mind

One of the greatest assets we possess as humans is our ability to think. For centuries, we have been able to design machines to do work for us, such as Pascal and Leibniz's calculators in the 17th century. Machinery of the past was, for the most part, mechanical in nature. However, logical thinking and mathematical calculation have been essential human abilities for millennia. Human cognition and calculations are made via "wetware," i.e., mostly watery fluid that composes our brains. In large part, "engineering" derives from this combination of machines, logical thinking, and mathematical calculation and is now beginning to incorporate wetware and neuro-network designs in its *attempt* to create machines that think and undergo conscious experiences as well as machines that enhance and rehabilitate these abilities of humans.

Throughout history, humans have tried to make their lives easier or more time efficient regarding various tasks. We have developed systems to accompany our thinking and calculations, avoiding labor in order to accomplish the same results. In fact, the word "engineer" in German and French (i.e., Ingenieur) contains the word "genius" in German and French directly in the middle (i.e., Genie).

Thinking Machines

Can machines think? "Thinking" can be defined as the process of using one's mind to consider or reason about something, using thought or rational judgment; intelligence.[5] The word "machine" has been defined as an apparatus using or applying mechanical power and having several parts, and each has a definite function and together performs a particular task.[6]

In May 1997 a test took place in what was called the challenge of a computer thinking competitively against a human; machine versus man. IBM's computer "Deep Blue" defeated the grandmaster and world chess champion, Garry Kasparov. Chess, according to some, is an intellectual and thinking man's game, requiring training, skill, and thought. Few would question that chess involves logic and thinking.

Kasparov wasn't just any chess champion. He had become the youngest ever undisputed chess champion and held the title the longest of all other chess champions. Deep Blue could calculate 200 million chess positions per second, while Kasparov perhaps could only consider a few chess positions per second. Brute calculating power was able to beat the skill and thinking of a great world champion and chess

grandmaster.[7] Defeating the grandmaster and world champion chess player was quite an accomplishment for a computer. It truly was a stepping stone for computer achievement.

Arguably, chess is a logical and mathematical game that is suited for computer calculations. Maybe chess does not require "thinking" or using one's mind in order to play the game. One can argue for or against the logic and thought processes required for mastering chess. It is a bit more challenging to argue exactly what the significance of defeating a grandmaster on one of his "good days" with a computer is though.

Let us fast forward from 1997 and chess, until February 2011, in yet another bout of "machine versus man." Two human competitors, Brad Ruttner and Ken Jennings who were *Jeopardy* champions, battled and lost to IBM's "Watson." "Watson" was the name of IBM's artificially intelligent computer. Watson was described by IBM as an analytical computing system using natural human language, giving specific answers to complex questions at high speeds.[8]

Unlike Deep Blue, which relies on logic and mathematical calculations, Watson had to interpret human language in English. Interpreting human language is extraordinarily complex and has only been comparatively incipient after decades of work with extraordinary individuals of other species, such as Stanford University's gorilla named "Koko" who communicates hundreds of signs in Gorilla Sign Language. For *Jeopardy*, Watson had to: (1) understand the question; (2) search 200 million pages of content; and (3) determine an answer. Furthermore, Watson had to *decide* when to take risks, on which questions to bet, and how much to bet.[9]

Watson was powered by ten racks of IBM Power 750 Linux servers with 2,880 processor cores running at 80 teraflops and 15 terabytes of RAM. Deep Blue ran at about 1 teraflop.[10] Many would agree Watson is a brilliant engineering feat.

However, now search engines such as Google and Bing have become commonplace. So, what is so great about Watson? We know humans cannot retrieve information as fast and extensively as a computer. We argue that computers cannot yet deal with our human abilities to think with language, especially our changing syntax and semantics as well as insincere utterances, like sarcasm, irony, lying and deception.

Ray Kurzweil, the voice synthesizer software developer and futurist, predicts the significance of Watson:

Humans…have been unique in our ability to think in a hierarchical fashion, to understand the elaborate nested structures in language, to put symbols together to form an idea, and then use a symbol for that idea in yet another such structure. This is what sets humans apart…

Watson is a stunning example of the growing ability of computers to successfully invade the supposedly unique attribute of human intelligence.[11]

Moreover, Kurzweil claims, **" 'Jeopardy!' *does* involve understanding complexities of humor, puns, metaphors and other subtleties [of the English language]….With computers demonstrating a basic ability to understand the symbolic and hierarchical nature of language (a reflection of the inherently hierarchical nature of our neocortex), it is only a matter of time before that capability reaches Turing-test levels."**[12]

The Turing-test

Alan M. Turing was a brilliant mathematician, logician, cryptanalyst, and computer scientist. Some say he was as important to contemporary artificial intelligence as Albert Einstein was to contemporary physics. By age 22, in 1935, Turning had developed the mathematical theory that modeled stored-program digital computers. In 1939, Turing joined the code-breaking team at Bletchley Park in England. It was here that they deciphered the Nazi code called "Enigma." Enigma was a sophisticated code used by the Nazi military to protect their radio signals. Turing's code, deciphering the Nazi Navy's concealed messages, was valuable in the battles of the high seas in the North Atlantic. Moreover, during the war Turing contributed to deciphering the Nazi High Command, which undoubtedly shortened the length of World War II.[13]

After the war, Turing led the development of Britain's first computers at the National Physical Laboratory and the Royal Computing Machine Laboratory at Manchester University. Later, Turing developed modern cognitive science. He theorized that the cortex of the brain at birth is an "unorganized machine" and through training becomes organized "into a universal machine or something like it." Turing then used computers to model biological growth. This modeling of biological growth has become the discipline referred to as Artificial Life. Alan Turing is considered to be the father of artificial intelligence and computer science.[14]

Unfortunately, Alan Turing was convicted of Homosexual Acts in 1952. As in the United States at the time, homosexual acts were illegal in Britain. Turing's option upon conviction was prison or chemical castration by injection of estrogen. He

elected the female estrogen option, but shortly after died of cyanide poisoning before he turned 42, most likely suicide, in 1954. His conviction had stripped him of the security clearances necessary for his work. Horribly, a sad end to a brilliant mind!

Nevertheless, the **Turing-test** still remains critical with artificial intelligence in computers today. In 1950, Turing published an article in the philosophical journal, *Mind*, called "Computing Machinery and Intelligence."[15] In the article, he proposes a machine intelligence test that became known as the **Turing-test.** Turing starts his paper for machine intelligence in terms of an analogy, the imitation game. The imitation game could be played as a game at a party. However, the setup for the machine intelligence of the Turing-test communicates using a keyboard and messages off a computer monitor. Essentially, a human is in an isolated room and the computer located in another room. Typed questions are sent to both rooms with answers received on the monitor. Human-level intelligence or thinking is achieved after a large number of answers are received and the interrogator (scientist) cannot tell which room contains the computer.

With the Turing-test, a person is trying to tell the difference between a machine and a human. If the person cannot tell the difference, the test concludes that the computer thinks like people. Turing believed the closest we can come to an answer of machines actually thinking like people is: Can a machine be built to give responses that are indistinguishable from those of a thinking person? Toward the end of his paper, Turing set forth:

"We may hope that machines will eventually compete with men in all purely intellectual fields. But which are the best ones to start with? Even this is a difficult decision. Many people think that a very abstract activity, like the playing of chess, would be best. It can also be maintained that it is best to provide the machine with the best sense organs that money can buy, and then teach it to understand and speak English. This process could follow the normal teaching of a child…I think both approaches should be tried."[16]

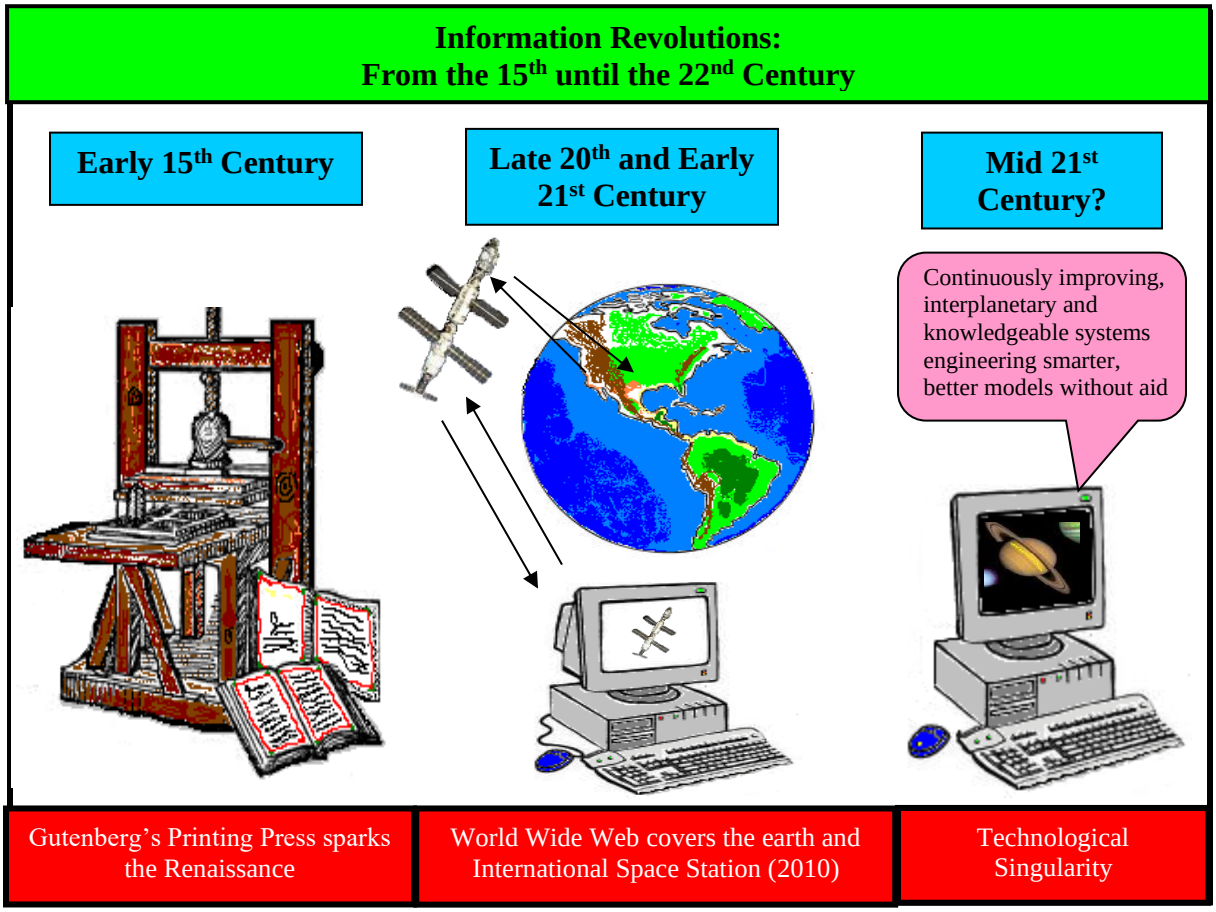
Now, both approaches have been tried with Deep Blue beating Gary Kasparov and Watson winning Jeopardy. As some might say, "we have a horse race!" Will the machines catch us?

"Thinking" is one of the most distinctive features of humankind and is generally the mental representation of some aspect of the world, which includes the person who is thinking. Via thinking, somehow our *desires* and *expectations* play an important role in relation to the manipulation of *beliefs* in order to form new beliefs so that these new

beliefs can be utilized for the purpose of accomplishing some goal. [17]

We typically do not describe computers as "believing," "desiring," "expecting" and "thinking," although calculating and accomplishing goals are obvious features of computer systems. By intelligent machines catching mankind in a "horse race" we mean that **artificial intelligence may, indeed, form beliefs, desires and expectations about worldly events and objects in order to accomplish goals via forming more accurate beliefs.** This is the coming challenge of the 21st century and the engineering feat of the next **information revolution**, which is represented in **Figure 1**. Will we be able to create goal-oriented machines with "beliefs and desires" that will, in turn, engineer more efficient and technologically advanced artificially intelligent beings?

Fig. 1
History of Information Revolutions



Converging Sources

Computer technology now graces every office and more than half the homes in the United States. Computers employ the "von Neumann architecture" explored by John von Neumann, the outstanding mathematician who helped calculate the way to the atomic bomb. His functional organization of computers consists of a sequential "program" held in the computer's "memory" and carried out by the computer's "central processor (CPU)."[18]

Contrast computer technology with neuroscience. Neuroscience also made tremendous advances in its fields of neuroanatomy, neurophysiology, neurobiology and neuropsychology. Recent techniques, including computer science, comprise electron microscopy, electro- and magneto-encephalography (EEG & MEG), CAT scans, PET scans, and fMRI scans. These techniques present a better picture of the brain and its behavior.[19]

For our purposes, there is the "artificial" cognitive process, represented by computer technology, and the "natural" cognitive processes, represented by neuroscience and neuroengineering. Historically, these sciences were pursued separately. Computer science students do not typically take courses in biology and neuroscience, and biology majors do not ordinarily complete courses beyond introductory computer programming. Both sciences kept to themselves.[20]

These two sciences, and engineering, combine for the research of "artificial intelligence," attempting to duplicate brain functions. Because computers calculate at the speed of light, their processes are faster than the human brain. A synapse-to-synapse electronic duplicate of our brain would, in thirty seconds, consume an entire year's worth of calculations in one's own brain! Thus, the general idea of intelligence obviously has a fascinating future.[21]

Research is attempting to take human brain processes and translate them into machines or robots in what is referred to as Mind Machine Interface and Brain Computer Interface.

Mind Machine Interface (MMI)

Researchers at the University of Washington's Laboratory for Neural Systems have developed a two-foot-tall humanoid robot named "Morpheus," shown in **Figure 2**.

The interesting thing about Morpheus is that the robot is controlled by brain waves. Morpheus can be controlled by thought alone. To control Morpheus, a person puts on a cap containing 32 electrodes and watches a TV screen displaying images from Morpheus' two camera eyes, which is shown below in **Fig. 2**. The cap collects EEG data and transmits the data through a machine learning algorithm. The algorithm interfaces between the person's thought or brain patterns and commands in about a five to ten-minute training process to coordinate the EEG with Morpheus' movements. Morpheus can walk to a certain location or pick up Styrofoam blocks.[22]

Noninvasive brain-computer interface (BCI) has been developing since the 1970s. Right now the time lag between human concentration and robot action is five to ten seconds. Researchers attempt to shrink the lag time from a few seconds to "seemingly instantaneous," i.e., in relation to what we consciously experience. This is something like the time it takes to straighten out your arm and the delay in time that you are not consciously aware of, which involves nerve impulses from your brain to your arm.

Figure 2
Morpheus from Washington University

The interesting development in brain-computer interface is the almost seamless combination of the brain-to-machine interface. It no longer requires much imagination to think of brain-controlled fighter jets, tanks, or other military equipment.

Computer Brain Simulation

From the IBM Almaden Research Laboratory and the University of Nevada, scientists ran a "cortical simulator" as large and complex as half a mouse brain. The "half a mouse brain" was run on the BlueGene L supercomputer with 4,096 processors and 256 MB memory each.[23]

"Half a mouse brain" has roughly eight million neurons and 8,000 synapses or connections with other nerve fibers. Using the BlueGene L, researchers were able to create half a virtual mouse brain with eight million neurons and up to 6,300 synapses. The complexity of the simulation required run speeds of ten seconds as opposed to a real mouse brain, which is equivalent to only one second. In other words, the simulation was roughly ten times slower than an actual half of a mouse brain.[24]

Researchers claim that on smaller simulations they observed "biologically consistent dynamic properties" emerge as the nerve impulses travel through the virtual brain cortex. **Importantly, researchers assert they have observed characteristics of thought patterns seen in real mouse brains.**[25]

In 2009, researchers from IBM were able to simulate a cat's cerebral cortex, the thinking part of the brain, using a supercomputer. The IBM supercomputer had 147,456 processors and 144 terabytes of main memory. Researchers are progressing toward the human brain and have simulated one percent of a human's cerebral cortex.[26]

In August 2011, IBM built two prototype chips, "thinking chips," that process data more similar to the way humans process information than previous chips that power PCs and supercomputers. The prototype chips use parallel processing allowing computers to do multiple tasks simultaneously. A key feature is the "thinking chip's" ability to adapt to types of information that was not specifically programmed. These new chips, theoretically, can learn like humans. The "thinking chips" are different from iPhones or Google's servers that have to be programmed to predict certain behavior based on past events. The new IBM chips are centered on "cognitive computing" that could adapt to unexpected information. Moreover, the new chips have parts that behave like digital "neurons" and "synapses" that separate them from other chips. The new "thinking chips" consist of a "core" or processing engine, composed of computing, communication, and memory functions running closely in parallelism.[27]

Interest in Brain Implants

Bill's interest in brain implants started in the mid-seventies when he was enamored by the book, *The Terminal Man* by Michael Crichton.

Michael Crichton graduated from Harvard Medical School and was a medical researcher before becoming a noted author and screenwriter. He is probably most famous for *Jurassic Park* in books and on the big screen, as well as *ER* for television. *The Terminal Man* is a novel based on actual science, specifically neuroscience.

The main character, the terminal man, Harry Benson, is an artificial intelligence researcher, involved in a car accident. The accident causes him to suffer from uncontrollable seizures that perpetrate violence toward other people. His only hope is to undergo an experimental procedure to implant 40 electrodes deep into the pleasure centers of his brain, called stage three. Stage three sends monitored, soothing electrical pulses to the pleasure centers of his brain. Computerized mind control! Initially, it is successful. But, there is a problem. An unforeseen development takes place. Harry learns how to control his impulses and overloads himself with pleasure impulses that make him out of control. Suddenly, Harry becomes a homicidal maniac loose on the streets of Los Angles. In the end, he confronts one of his doctors who is forced to shoot Harry to save her life.[28]

Aside from the story, what impressed Bill was the bibliography and actual references to medical journals. At the time, Pete Maddeaux, a former classmate of his in organic chemistry class from UTEP, was a hospital administrator at St. Luke's and the Children's Hospital in Houston. Bill gave Pete *The Terminal Man* and told him he had to read it, which he did. As it turned out, Pete was selected to a national grant writing team evaluating a proposal by UCLA for epileptic brain stimulation. The UCLA doctors were tremendously impressed by Pete's knowledge in the specialized field. Of course, Pete didn't tell them he read Crichton's book. When Pete came back from the grant writing trip, he emphatically confirmed the research in Crichton's book was actually taking place and he had approved a grant for it.

Since then, it has become somewhat common knowledge that brain stimulation has been successful and has helped countless epileptic patients. The experience has left an indelible impression on Bill.

Now, fast forward to the week of August 1, 2011. A 17-year-old boy waits at University Hospital in San Antonio, Texas with two holes drilled into his skull, one on

each side of his head. Inside the holes are numerous electrodes attached by wires to a computer. He is waiting for his next seizure so doctors can map the seizure area in the brain. They intend to surgically remove seizure areas in an attempt to stop future seizures. It was a similar situation that caused Michael Crichton to write *The Terminal Man.* This 17-year-old boy happens to be the nephew of one of Bill's law partners. (Bill is the co-author of this course).

Fortunately, surgeons were able to remove the area of the brain where seizures occurred in the17-year-oldd. The only immediate side effect from the surgery was less grip strength in his hands, which doctors attribute to the anesthesia and not the surgery. The boy was placed on anti-seizure medication. Medication will continuously diminish over a six-month period until he is free from medication. Doctors will pronounce him cured if he does not have any seizures over the year following the surgery.

However, many epileptics are not so fortunate. About one-third of epilepsy patients continue to have seizures, despite significant advances in pharmacologic treatments. For these patients alternative treatment is necessary. Resective surgery is one alternative to stopping seizures. However, many patients with medically intractable epilepsy are not suitable candidates for surgery. For this latter group of patients, electrical brain stimulation may be helpful. Engineering and neuroscience are coming together, and this is one of many of their purposes in combination.

How Powerful Is Brain Stimulation?

Probably the most fascinating brain stimulation experiment was performed in 1963 by Spanish neurophysiologist, Jose Delgado. Delgado introduced the modern era to brain implants in animals and humans at Yale University and then at Universidad Autonoma de Madrid, in Spain. Prior to the fascinating brain stimulation, Delgado demonstrated the first bidirectional brain stimulator using a rhesus monkey and a device he invented called a "stimoceiver." The "stimoceiver" allowed radio transmission between the brain of the monkey and a machine.

Within the brains of monkeys and chimpanzees, Delgado implanted EEG-recording electrodes to sample the electrical activity produced by neurons from the amygdala located deep in the brain. The "stimoceiver" relayed the amygdala's signals to an analog computer. Delgado developed a feedback program and sent electrical stimulation to other areas of the brain with negative reinforcement. After behavioral testing of the animals with his devices, Delgado predicted, in the not-so-distant future,

a direct link of the human brain and computers would be used to treat neurological disorders. In 1969, he published has findings in a book entitled, *Physical Control of the Mind: Toward a Psychocivilized Society*. Needless to say, the thought of physical control of the mind, what Delgado called a psychocivilized society, caused quite a stir in the scientific community and the public. The uproar undoubtedly caused him to continue his experimentation in Spain.[29]

The brief introduction about Delgado, sets the stage for Jose Delgado's fascinating brain-stimulating experiment. Anyone who has been to a live bullfight knows what magnificent animals the bulls of the bullring truly are. For the experiment, Delgado inserted an electrical brain stimulator in a bull's brain at a bull-breeding ranch in Cordoba, Spain. He posed as a matador in a bullring. The bull charged directly at him. Instead of a sword, Delgado used a radio transmitter. In the midst of the bull's charge, Delgado pressed a button stimulating the caudate nucleus in the bull's brain. The bull stopped in mid-charge only a few feet away, sliding to a halt, and then retreating. *The New York Times* labeled it "the most spectacular demonstration ever performed of the deliberate modification of animal behavior through external control of the brain."[30] Photos of the Delgado bull experiment can be seen in the *Scientific American* article at www.wireheading.com/delgado/brainchips.pdf .

Neural Chips and Prostheses

We have seen Deep Blue, Watson, Morpheus, mouse brain simulation, brain implants, and the power of brain stimulation. Can implanted neural computer chips be used with the human biological brain to replace portions of the damaged brain? Are we at the cusp of attaining replacement parts for the human brain?

There is a growing realization of neuroscientists, engineers, and medical researchers that Society, humankind, is on the edge of a new era in neural prostheses. Following the success of cochlear implants and progress in visual prostheses, it seems likely that we can mathematically model different regions or parts of the brain. It appears that we can design and fabricate microchips associated with those models to create interfaces with brain tissue. A **key** to technical achievement in biomedical, electrical, and computer engineering is to design and fabricate implantable devices that are **bi-directional.** Bi-directional devices communicate and receive brain sensory, motor, and cognitive functions. Bi-directional devices allow us to integrate microchips and brain function.[31]

Neuroscientists and engineers are, indeed, developing devices to repair damaged parts of the human brain. This type of prosthesis is different from cochlear implants or artificial retinas because it would perform or assist a cognitive function.[32] Here, cognitive function or cognition refers to perceptions of everything that is going on around the brain, all its thoughts and all the actions the brain might take in response to outer and inner experiences. Some texts define cognition as, "the ability of the central nervous system to attend, identify, and act on complex stimuli." Cognitive function is not a thing, but a process that includes thinking, remembering, daydreaming, mentally calculating, and most mental activity.[33] It is the computational and cognitive properties of the brain that scientists and engineers are trying to simulate.

Substantial advances in neuroscience have increased our understanding of neurons and their physiology. These advances and the dynamic and adaptive cellular and molecular mechanisms allow information processing in the brain. Mathematical modeling of nonlinear and stationary systems coupled with breakthroughs in electronics and photonics (transmission of photons, like fiber optics), low-power designs that minimize heat generated by microchips, and material science offer compatible living brain tissue interfaces.[34]

Neuroscientists and engineers have set requirements for living brain-implanted microchips. The requirements to achieve living brain tissue implants are:

- **A microchip must be truly biomimetic, biologically connective, in order to replace the function of living brain tissue. The prosthesis must have the same or similar properties of real biological neurons. To accomplish this requirement we must have an understanding of the information capabilities of neurons that is experimentally based.**
- **Neural prostheses are to be used for detectable impairment according to neurological or psychiatric criteria based on populations of neurons interacting through the context of network interconnections. Biologically realistic neuron models must be able to be joined together into network models that can replace the impairment.**
- **Neuron and network models must involve miniaturization sufficient to be implantable.**
- **Bi-directional communication is required of a microchip device that communicates with existing and living neural tissue. Fortunately, both neural systems and microchip devices have electrical signals. However, brain regional differences in the distribution of neurons places design restrictions on implantable devices.**

- **Patients will have a learning and adaptation period for both structural and functional characteristics of implantable devices.**
- **Power and heating of microchips implanted into the depths of the brain present difficult problems. Brain cellular and molecular mechanisms are very heat sensitive. Cochlear implants, for example, have their power source and electronics external to the cochlear prosthesis itself.[35]**

Taking into consideration the neural implant criteria, our underlying science and technology will enable the functions of specific brain regions to be replaced by microchips. Intracranial implantation of the neural prosthesis will receive electrical impulses from targeted subregions of the brain, process the information using the hardware model of that brain region, and communicate back to the functioning brain. These implanted microchips have the design flexibility and compatibility to be adjusted to a particular patient, programmed, if you will.[36]

A design consideration to create a more biologically realistic neural network model is the development of a "dynamic synapse" architecture. All neurons contain three basic parts: 1) a cell body and 2) fibrous appendages called dendrites, which look like Christmas trees, and 3) axons. Axons are output channels, and dendrites are input channels. Synapses are small gaps between neurons. Interestingly, when a neuron is active, an electric impulse travels down its nerve fiber and causes the release of a chemical neurotransmitter from its terminal. The transmitter floats across the synaptic space and binds to a dendrite, closing the gap. Brain function is accomplished by the process of synaptic transmission.[37] Synapses are not static, but are dynamic; hence, the development of "dynamic synapse" architecture for microchips.

The "dynamic synapse" model has been tested for its computational capability and likened to speech recognition technology. Recognition in both cases is difficult because of variability and noise. Different speakers create variability in speech recognition technology. Noise was added after the system recognized the words "yes" or "no" from a database of thousands of speakers. The "dynamic synapse" model outperformed the Dragon Naturally Speaking speech recognition system and gives us some basis for comparison.[38]

Studies show computational power of small networks and variability testing should be sufficient for developing replacement microchip circuitry for the brain. Therefore, "patterns can be recognized by the network model even when input signals are embedded in substantial amounts of noise, a characteristic both of real-world conditions and signaling in the brain." The theoretical models have proven satisfactory. What remains is a suitable hardware microchip.[39]

Microchip Hardware

Very Large Scale Integrated (VLSI) technology using analog signals has been designed and fabricated as hardware. This hardware implements the biological realistic models using hippocampal neural network nonlinear dynamics. The parameters are programmable in such a way that they can accommodate nonlinear characteristics of different subpopulations of hippocampal neurons. Moreover, training-induced modifications of nonlinearities can be made.[40]

The neural processor was fabricated by a double-polysilicon, triple-metal process with a linear capacitor option through the Metal Oxide Semiconductor Implementation Service (MOSIS). Parameter values are stored on capacitors and can be changed by controlling software. When operating with a 3.3V power supply, stimulation achieves a 60 dB dynamic range. Unfortunately, hundreds or thousands of neurons will be required for an effective prosthesis. Thus, the design will have to be enlarged and as yet not fabricated in microchip form.[41]

It is important to differentiate between alleviation of clinical symptoms and capabilities of the intact brain. For example, a stroke patient with lost speech could get by with a vocabulary of 20 words or so, which would be a remarkable improvement in the patient's quality of life.[42]

Hardware Interface

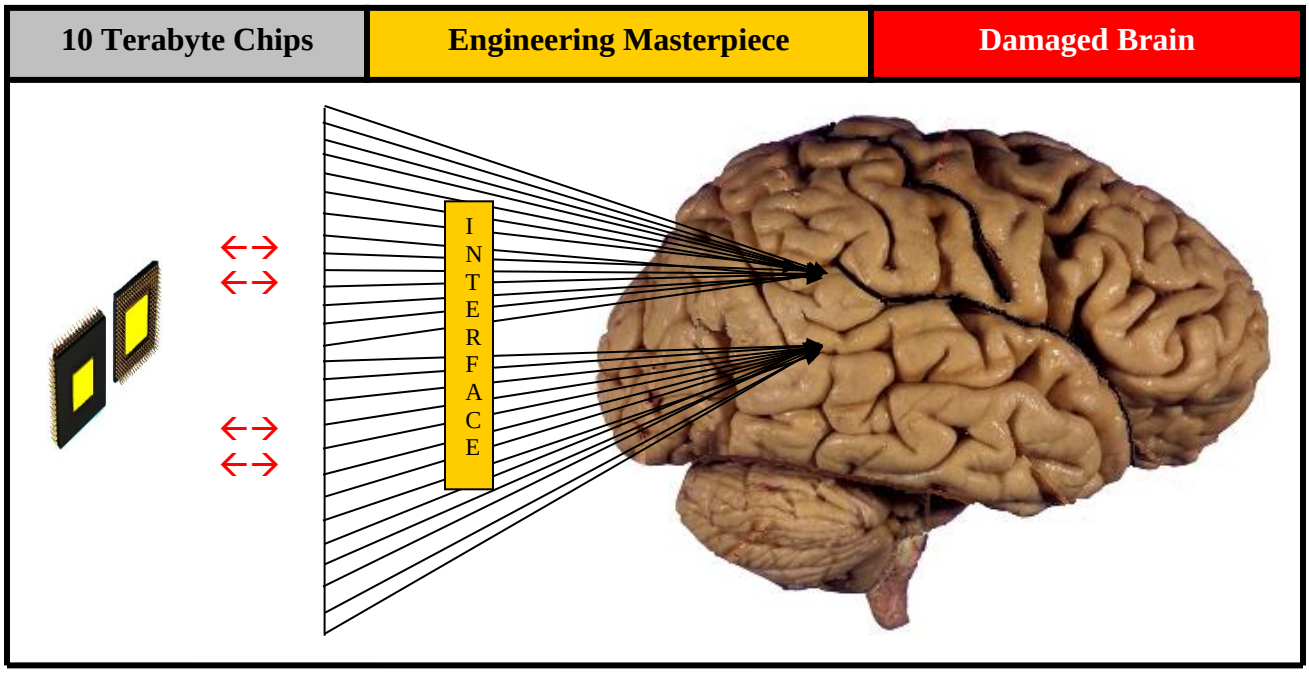
Bidirectional communication between the brain and a microchip or implantable neural prosthesis is essential. Issues related to this bidirectional communication are the density of interconnections, specificity of interconnections, and biocompatibility and long-term viability. The density of interconnections refers to the fact that one neuron is unlikely to have a substantial effect on a brain function and a number of interconnections are required to influence brain function. Specificity of interconnections means neurons comprising a particular brain region are not randomly oriented, but have a definable cellular architecture and organization of intrinsic circuitry. Any microchip or neural implant must consider the cellular architecture of the area of implantation. Obviously, neural implants must have long-term viability and be effective for years, since periodic replacement is not feasible for patients. Key obstacles to attaining these implants will be maintaining close contact between the electrode sites on the interface device and the brain area neurons over time. Adhesion materials are being researched to solve this problem.[43]

The Near Neuro-Focused Future

One of the goals of neural or neuroengineering is to develop implantable neural prostheses that can coexist and communicate bidirectionally with living brain tissue and substitute for a cognitive function that has been lost either by disease or trauma. Advancing neuroengineering is able to make progress because of advances in neuroscience, molecular biology, biomedical engineering, computer science, electrical engineering and materials science, along with the basic sciences of mathematics, chemistry, and physics.

Figure 3 illustrates a rough representation of neuroengineering hardware devices into wetware. Computer chips have already been implanted in human brains but not at the magnitude shown in **Fig. 3**.

Figure 3
Implanting Computer Chips in Human Brains



Future generations of implantable microchips must be compatible with temperature-sensitive brain tissue by a design to dissipate heat and/or reduce power. Additionally, an organic-inorganic, chip-brain interface for long-term compatibility must be proven effective.[44]

What's New!?

Some of this exciting neurotechnology is here today. Mark Humayun is a researcher involved with the first commercially available artificial retina. Although technically called a retinal prosthesis, the artificial retina works by the user wearing special glasses equipped with a miniature camera. Camera images are transmitted through a micro antenna to an electronic array or chip implanted inside the user's eye. The eye's retinal cells are stimulated into blacks, whites, and greys imaged into the user's brain. With the implant, the user is able to see.[45]

From his book, *World Wide Mind-The Coming Integration of Humanity, Machines, and the Internet*, Michael Chorost exclaims:

"I am already accustomed to implanted computers…I am deaf and have a cochlear implant in each ear…I lost many of my hair cells before birth because my mother had had rubella, but I had enough hearing left to be able to use hearing aids…My cochlear implant substitutes for the lost hair cells by directly triggering the auditory nerves with implanted electrodes. A surgeon drilled an inch and a half into my skull, countersunk a ceramic-encased microchip behind my left ear, and threaded sixteen electrodes into my inner ear. Now an external device sitting on my ear picks up sound, digitizes it, and radios a stream of 1s and 0s through my skin to the microchip. The chip receives the radio signal with a tiny antenna and decides how to strobe the electrodes on and off. By choosing which electrodes to fire at any given moment, it makes my auditory nerves transmit sound information to my brain…My two implants make me irreversibly computational, a living example of the integration of humans and computers."[46]

Michael Chorost has first-hand experience with technology in his head that allows him to hear. He has a personal incentive to review the latest research on the mind and technologies for observing and influencing our brains. By logical extension, he reasons if you can hear, think, and communicate, you can use technology in the future to communicate via thinking, and computers will connect to others in a manner that is triggered by **thought**. Humans would connect to one another's thoughts through the internet for the mind, mind-to-mind connection. Chorost likens the internet of the mind to Facebook.[47]

At first blush, we might consider this internet of the mind to be too futuristic. However, Chorost gives us an example of what he calls, "the most connected man in the world." The "connected man" is Thad Starner of Georgia Tech, where he directs Tech's Contextual Computing Group.

Starner developed a wearable computer. The main computer unit is in a backpack Starner wears with an attached one-handed keyboard. He types a code into it and reviews input and output through a tiny monitor affixed to eyeglasses in front of his left eye. Starner's wearable computer allows him to stroll down the street reading and replying to emails and doing Google searches while talking to someone. And, why did Starner develop his system? Starner developed the wearable system so he could take better notes, because he has poor handwriting skills, and to have instant access to notes as an undergrad at MIT.[48]

Logically, if Thad Starner's wearable computer system could be miniaturized and implantable, like a cochlear implant, we would approach the connected World Wide Mind network envisioned by Michael Chorost.

In respect to the idea of communications via thought, the November 2011 issue of *Popular Mechanics* reported that neuroscientists at the Berlin Institute of Technology are trying to reduce driver decision-reaction time when a driver applies the brakes. "With electrodes attached to their scalp and legs to measure synaptic and muscular triggers, drivers in a simulator braked 130 milliseconds faster than their feet could press the pedal." To a person traveling at 60 mph, 130 milliseconds could mean a savings of 12 feet in an accident scenario.[49]

However, are we as engineers, and a society, ready for the breakthrough in mind-to-mind communication via thought and facilitated by networks of computers? What effect will this mind-to-mind communication via computing and interconnective networks have on consciousness, our experiences and perceptions of the world?

Consciousness becomes an interesting question as machines or computers approach human characteristics, like "Watson," or microchips replacing brain cells. Can non-biological intelligence exhibit emotions like humans? Suppose we upload human memory or thoughts to a silicon microchip, will it be conscious? Suppose we implant devices such as neural implants to ameliorate injury or disease in the human brain, will that brain and person be conscious? Suppose we enhance most of the brain with a microchip, would that brain and person still be conscious or more like the emotionless machine called "Watson"?

Consciousness and the subjective experiences of others are fundamental to our concepts of law, ethics, and morality. Most legal systems are based on the concept of consciousness. People must be conscious of what the law is, or the law would not exist as we know it.

People must believe in laws, especially lawyers and judges. People generally have beliefs and desires about how the laws will be enforced, and these beliefs and desires are often conscious. Moreover, it may very well be argued that people are not blameworthy for their actions, if it can be proven that they were not conscious of them. For instance, how could we hold a sleepwalker responsible for her actions when she is asleep? The ever increasing importance of consciousness as a concept and the progression of research and technology related to consciousness, lead us to the following inquiry: What is consciousness?

Consciousness: Awareness and Appearance

The meaning of "consciousness" is, roughly, "a general type of awareness of something from some perspective." This general type of awareness includes, but is not limited to, the following types of perceptions, which all involve "phenomenal consciousness": Illusions, hallucinations, lucid dreams, and veridical perceptions. So, one may even be sound asleep while undergoing certain conscious experiences.

Case 1 of consciousness (illusion): You place a stick in some water, and it then appears to you that the stick is in two parts, but it is only an optical illusion.

Case 2 of consciousness (hallucination): You go to bed without supper and wake up thinking that someone has cooked bacon and eggs because you can smell them, but you are hallucinating, and nothing is cooking just yet.

Case 3 of consciousness (dream): You are sound asleep and dreaming of a beautiful beach with palms surrounded by white sand, and you realize that you are lying on your back in bed at home in your bedroom because you are experiencing a lucid dream, i.e., a dream in which you recognize that you are dreaming.

Case 4 of consciousness (veridical perception): You are awake, looking at the leaf of a tree outside your window with a caterpillar eating it, and there really is a caterpillar on that leaf of the tree outside the window. Your perception is accurate or veridical.

The four mentioned cases demonstrate a range of consciousness that may be applied to each sensory modality (e.g., smell, taste, touch, balance, vision, orientation, and hearing) from the more accurate type of consciousness during the waking state called "veridical perception" to illusions and hallucinations as well as consciousness during the dream state. [50]

The point here is pretty simple if you just consider the example of "**redness**" and apply it to all four cases. For instance, if you stare at a **green dot** for a minute and then look at a white wall, assuming you are not color blind, you will experience a **red dot** on the wall, and "redness" here is illusory or an *afterimage*. You may dream of something red, so redness is an aspect of your dream. Moreover, if you cut yourself and are standing outside in the daylight, you'll probably experience the redness of your oxygenated blood.

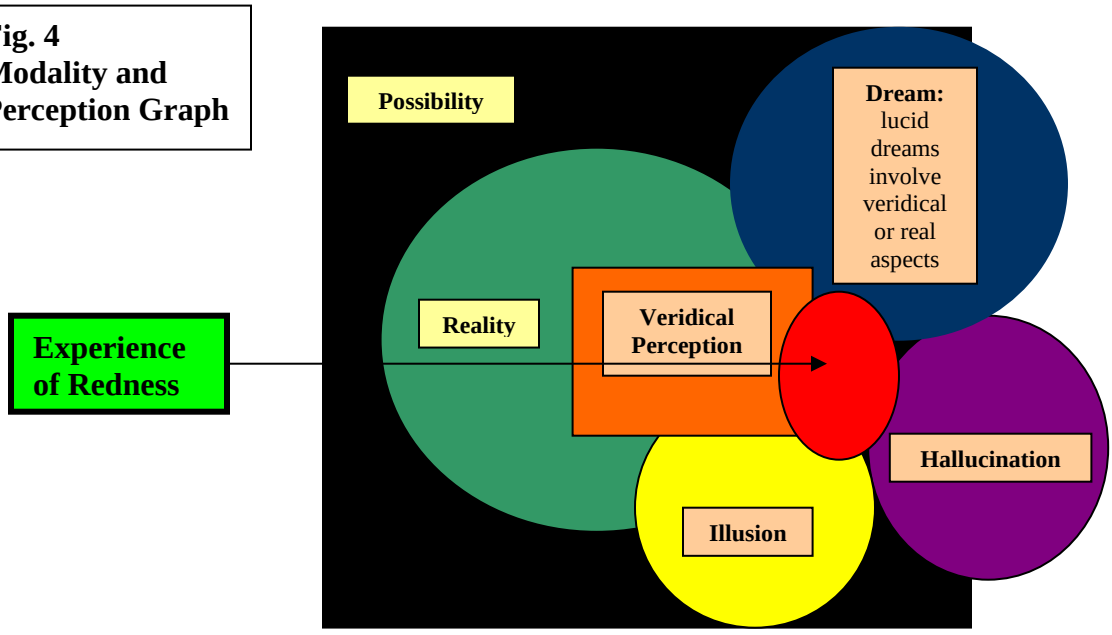
Regardless of whether the experience of red is an illusion, hallucination, dream or

veridical perception, there is something that is at least similar to all these cases, namely, the "appearance from some perspective" and "redness." In each of these cases there is a directedness of your mind toward something that appears red, i.e., you have beliefs, desires, expectations, memories and so forth that are directed toward the object of which you are aware. These states of consciousness are about redness.

In the last case when you are cut and stare at the blood on your hand, you may *believe* it won't stop bleeding without applying pressure on the wound, you may *desire* a bandage to cover it and *expect* to find a bandage at a certain place—your mind organizes in such a way that you become consciously aware of something through your senses. The mind brings together perceptions that make it possible for us to undergo conscious experiences.

The modality and perception graph in **Figure 4** below represents the four types of appearances, which are illustrated as coinciding with possible and real events and objects. Obviously, consciousness is real, and there are appearances of things, but it is disputable whether our conscious experiences *accurately* represent the objects toward which they are directed. **Fig. 4** illustrates that veridical perception generally represents real objects and events. The illusion may partially represent some real object or event, and the same is true for lucid dreams. The hallucination represents no real object or event, and the hallucination and dream sometimes represent objects and events that are physically or humanly impossible, such as you soaring through the sky with only your bare arms. **Fig. 4** is a depiction of the four types of appearances of objects and the extent to which they may represent possible and real objects and events.

Fig. 4
Modality and Perception Graph



It should be understood that "consciousness" has various definitions, ranging from fields as diverse as sociology and philosophy to economics, psychoanalysis, cognitive psychology and neuroscience. We shall briefly consider two more meanings of "consciousness" and examine a type of consciousness with which we are all familiar as members of some language community. But first, let us consider computers and consciousness.

Computers and Consciousness

With the aid of computers and virtual reality systems, **it is possible to form almost any type of conscious experience during the waking state that one may undergo during the dream state**. Such computational capabilities that enable dream-like experiences during the waking state may lead one to inquire what sorts of experiences are healthy, unhealthy, stressful and tranquil for the one experiencing some virtual world. Answers to such inquiries would certainly shed light on *how we should* apply the roll of technology in relation to its impact on our phenomenal conscious experiences. Certainly those with only limited access to the technology will have serious disadvantages.

We may consider several other possibilities concerning computers and consciousness. Will some computer systems undergo conscious experiences? This is probable unless there is something super special about the meat that makes up our brains. How is it possible to engineer such computers? Are conscious experiences sufficient conditions for us to require the ethical treatment of whatever undergoes them? That is, should we treat conscious computers ethically? Would the different materials, from which computers are made, give them qualitatively different experiences than the experiences of organisms? That is, the old "wetware" versus "hardware and software" question.

Questions to consider: Must I be awake in order to undergo a conscious experience? Why not? If I experience a round object, *must that round object exist,* independent from my perceptions of it, for me to be conscious of it? What identical quality does something that appears to be blood usually have if it is experienced as an illusion, hallucination, dream, or veridical experience? How is it possible to recreate the type of experience, e.g., falling, floating, or flying, during a dream so that it occurs during the waking state? When something is measured and observed with such things as triangular engineering scales, microscopes, telescopes, or protractors, *is* consciousness required in order to apply the measurements? Why is it required?

Other types of Consciousness Studies

Karl Marx wrote in 1859 **"{i}t is not the consciousness of men that determines their existence, but their social existence that determines their consciousness."** Marx argued that wage workers and capitalists (i.e., the owners of the means of production) have very different ways of thinking that vary with respect to their relations with modes of production, i.e., their relations to machinery, labor, technology, etc. Marx claimed that certain groups have a "**false consciousness**," which means that they are unfamiliar with the ruling class's goals, ideology and their historical setting within society, especially when one supports the ideas of the ruling class against one's own best interests. For instance, a person who stands to inherit very, very little might be *fooled* into supporting measures to eradicate the gift and inheritance tax, and s/he might call it the "death tax." These ideas concerning consciousness are economic and political conceptions; they involve deception and social awareness. Psychoanalytic concepts of consciousness are just as fascinating though.

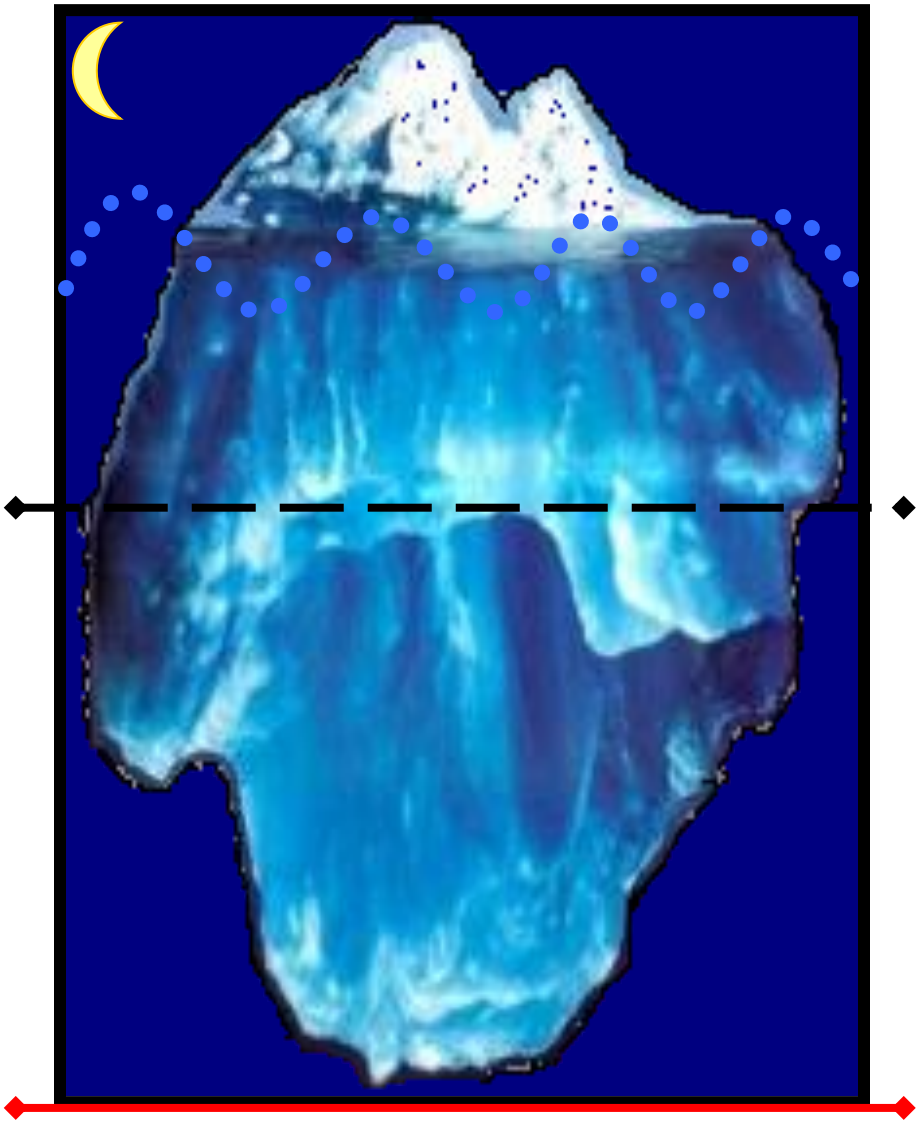
During the early 20th century Sigmund Freud argued that there are certain drives and motivations, i.e., sexual and aggressive ones, which are largely unconscious but nonetheless guide human behaviors. We are only conscious of a very small, limited aspect. Freud described three parts of the mind in relation to consciousness: (1) **consciousness** when one is aware; (2) **preconsciousness** when one is "unaware" of the subject at hand but could readily be aware (e.g., ten minutes ago you were probably not consciously aware of Abraham Lincoln being the president of the United States during the US Civil War, but you were preconscious of this ten minutes ago if you knew that fact, and *now* you are conscious of that fact); and (3) **unconsciousness**, which is the aspect of your inner world of which you are totally unaware. Unconsciousness can be either that aspect of your psychology that others know, but you do not know, or the aspect of your psychology that nobody knows.

If you consider something that is taboo, such as incest, you might *repress* this (i.e., expel this from your mind naturally without having to make a conscious effort to do this) or *suppress* this (i.e., expel this from your conscious awareness, like repression, but with conscious effort). For example consider that if you think about something very sexual or aggressive concerning a person who is a family member, your mind might very well suppress or repress these mental images that arose in your "mind's eye." The thoughts that are repressed and suppressed are said to manifest in the unconscious part of your mind, and **suppression** and **repression** are "defense mechanisms" that disallow these thoughts to enter awareness because dwelling over them would be psychologically traumatic. Neurotics (e.g., obsessive-compulsive

people who wash their hands over 100 times per day) and psychotics (e.g., schizophrenics) may very well dwell over such thoughts too often, which psychoanalysts may consider being partial causes of psychological disorders.

Consciousness is the smallest aspect of the mind, preconsciousness is larger, and unconsciousness is the largest. **Figure 5** depicts these facts. Freud imagined the mind to be analogous to an iceberg where the tip is analogous to consciousness, the part of the iceberg exposed only after the fall of the tide is analogous to preconsciousness, and the vast chunk that remains beneath the water is unconsciousness. "Moonlight" stands for the investigative functions of psychoanalysis, which make one aware of one's deepest, darkest secrets. Psychoanalysis is the means through which parts of the vast, underwater block of ice can emerge, surfacing beneath the enlightenment of the description of one's mind.

Fig. 5 Freud's View of the Mind



Consciousness: one is aware of thoughts or undergoes perceptions

Preconsciousness: memory; one would be aware of these things if given a signal or reminder; stored knowledge

Unconsciousness: one is totally unaware of these things; defense mechanisms of suppression and repression prevent constant access to consciousness, e.g., fears, irrational wishes, unacceptable sexual desires, shameful experiences, violent motives, immoral urges, selfish needs

Our course is neither concerned with the psychoanalytic notion of consciousness nor the sociological conception given by Marx, except from an ethical standpoint. The course is primarily concerned with a social cognitive and neurological conception of consciousness and perceptual or phenomenal consciousness and their relations to neuroethics and engineering.

The final case of consciousness that we shall consider is one with which we are intimately familiar. This is **social cognitive consciousness**, which is involved during conversations. Social cognitive consciousness allows us to distinguish the cognitive capabilities of humans from other species. Consider the following examples of social cognitive consciousness.

Martin: Is Professor Husserl going to make it to his office hours today?
Emmanuel: He is sick with the flu.
Martin: Okay, so he won't be there.

The inference that Martin makes after Emmanuel responds to his question requires a type of social awareness about how people usually behave when they are sick. The answer requires Martin to make an inference (i.e., the professor will probably act as sick people do) in order to draw a conclusion (i.e., Husserl will not go to his office on this day). Additionally, since Martin is asking a "yes-or-no-question" Martin is required to assume or consider whether Emmanuel's answer is a relevant response to his question in the first place.

Now consider the complexity of the following conversation, involving social cognitive consciousness and insincere utterances.

Martin: (Walking, tripping and falling down) Ouch!
Maurice: Great job Mr. Coordinated.
Martin: Thanks a lot!
Maurice: You're welcome, but next time I'll charge you for such compliments.

Understanding the abovementioned conversation requires what is called "mind reading" and the practice of "theory of mind," which is the ability to attribute mental states to others that are different from one's own mental states. **Mental states** include beliefs, desires, expectations, hopes, memories and so forth, and they are directed toward things of which we are conscious. (Note: the case of redness in the first section on consciousness gives an example of the directedness of mental states)

We may rightfully assume that when Maurice utters his first comment, Martin believes that Maurice disbelieves what he just said, and Martin believes that Maurice does not expect Martin to believe what he just said was true! The conversation becomes ever more complicated to describe in virtue of the mental states of the two conversation partners with the second and third insincere utterances. We may conclude that Maurice believes that Martin thinks Maurice disbelieves that what Martin claimed is what Martin believes; moreover, Martin expects this higher-order belief of Maurice.

The problem here is quite obvious. It becomes incredibly complicated just describing the beliefs of each person since they are beliefs about beliefs about beliefs (i.e., meta-meta-beliefs or **higher order beliefs**). Symbolic logic assists in briefly describing such mental states between an interpreter I and expresser E (e.g., IbEbId**j**, which means the interpreter believes the expresser believes the interpreter disbelieves "**j**," i.e., "**j**" stands for some statement, such as "it was a great **j**ob"). Social cognitive psychology studies such phenomena as higher order beliefs and is even able to measure peoples' abilities to attribute beliefs to others with techniques called "false belief tasks."

Questions to consider: What are the different types of consciousness? What is the range of phenomenal consciousness? Is there any experience that one can only undergo during the dream state? Give an example of a higher order belief.

Free Will and Moral Responsibility

The debate amongst philosophers concerning *free will* and *determinism* is ancient and metaphysical. **Metaphysics** is a study that incorporates physics, chemistry, biology etc. The latter fields of study are studies about the "actual world" concerning matter, physical entities and motion (i.e., physics) and living matter (i.e., biology), for instance. The focus of metaphysics is often on concepts such as time, space, events, laws of nature, causes and properties, which are concepts within the mentioned sciences. Metaphysics includes these as subfields, and it may be described as the study of "possible worlds" or possibilities via the incorporation of logic and rational argumentation.

When we say that "if it were sunny instead of cloudy and dark outside, then the grass would be a brighter shade of green," we generally describe a "possible world" (i.e., an imaginable world that we could describe without contradictions) that is *exactly like the* "actual world" (i.e., the world in which we live), *except for the fact that it is sunny,*

has less clouds and all of the ramifications that would result from this. For instance, certain surfaces would be hot and warm with certain animals sunning on them and so forth.

Determinism is the notion that all events are caused (i.e., the idea that all causes and effects are physically determined events in accordance with the laws of nature, except for perhaps a first event that has no causal event that was prior to it). The free will versus determinism debate provides us with a description of a few different alternative worlds or possible worlds given by the major debaters in metaphysics called **libertarians** and **compatibilists** who argue for free will. **Hard determinists** argue that free will cannot exist. Both libertarians and hard determinists are called "**incompatibilists**" because they argue that "if determinism is the case, then there can be no free will." That is, either free will exists, or determinism is true but not both because they are incompatible.

Hard determinists obviously argue that determinism is the case. They think that because determinism describes all of our behaviors, free will does not exist. **This would mean that any choice you make is brought about by causal forces that were totally out of your control, so your choices are never free.**

Libertarians argue that not all events are caused, and we are able to make choices according to our free will. They cite cases during which we make choices about which we are completely "indifferent concerning the alternatives." For instance, if somebody gives you the choice to press a button on the left or on the right but not both, and there are no benefits or disadvantages to either button being pressed, you might very well be indifferent about the choice of pressing one button versus the other. It is in these cases that libertarians argue there is a freedom of the will, and some argue that this **liberty of indifference** allows the individual to have chosen differently in the same circumstances (note: **Fig. 7** depicts an experiment that involves the concept of liberty of indifference).

The simplest definition of the notion of **free will** is the **ability to choose otherwise without restriction and without being coerced**. So, if I "freely chose" to stay in my room and read a book at 5pm last Saturday, and my choice was free, then I could have left the room and walked through the park at 5pm last Saturday instead, for instance. (Note: this entails that I was not unknowingly locked in my room last Saturday, which would be a restriction, and I was not coerced to read the book at 5pm)

Since the latter example is one that involves "choices in the past," there is no method by which we can test whether or not "I could have chosen to go to the

park instead" of reading last Saturday; this suffices to make the problem of answering such questions "metaphysical and philosophical." Philosophical and metaphysical questions are so challenging to answer in comparison to scientific ones that philosophic and metaphysical questions are incredibly difficult to even ask properly. We do not even know what the best way to appropriately make such inquiries is. However, once inquiries are phrased properly, they are crucial in the creation of new sciences and interdisciplinary studies, such as cognitive science.

Compatibilists, libertarians and hard determinists are actually describing what they accept or believe to be the "actual world," but they differ quite drastically with respect to the world they think they all live in. The libertarians describe some possible worlds that are quite different from those of hard determinists. Hard determinists would claim that I could not have chosen to go to the park last Saturday at 5pm because that was not determined to happen via causation. **Figure 6** below illustrates the differences and similarities between the views.

Compatibilists argue that "determinism and free will are compatible" with one another. Compatibilists would claim I could have gone to the park instead of reading last Saturday, *if I had wanted* to go to the park, for instance. The major difference in this view, in comparison to the two types of incompatibilism, i.e., libertarianism and hard determinism, is that compatibilists reject the following claim: "if determinism is the case, then there is no free will."

Compatibilists believe that determinism is the case and that we have free will. Compatibilists also argue for a spontaneous type of freedom of the will. Compatibilists claim that the "**liberty of spontaneity**" allows us to make choices. Spontaneous liberty describes some of our spontaneity, which allows us to act as we choose to act or, in other words, behave as we have willed (i.e., since we do not merely act according to our **habits**, our choices might well be considered to be free in relation to the liberty we take in regard to deciding whether to act out of habit or spontaneously).

Questions: If you choose something "spontaneously," was your choice either "coincidental" or "unnecessary"? If your choice were unnecessary or coincidental, then hard determinism is false. Is the "spontaneous choice" a "necessary effect" produced by your brain and nervous system's processes? If spontaneous choices are "necessary," then hard determinism is the case. If you have to choose between two things that appear "identical" to you, then what "determines" your choice, and could your choice have turned out differently than it did? What type of liberty describes decisions that involve items that appear to be the same (i.e., where we don't care about

one choice versus the other)? What metaphysical stance is associated with "liberty of indifference"? What is the importance concerning free choices and ethics?

Fig. 6
Possible Worlds with or without Free Will

Combining Higher Order Thinking and Free Will

Contemporary philosophers, such as Harry Frankfurt, have utilized the "theory of mind" literature and the notion of higher-order cognitive thinking described earlier (i.e., beliefs about beliefs). Frankfurt takes a very common case in the free-will-determinism debate. He uses the case of two different types of drug addicts. **One drug addict wishes he did not consume drugs, but he takes them frequently, despite his wishes. The second drug addict takes the drugs frequently, but he not only wants to take them—he desires to want to take them too.**

Many choices humans make are distinct types of choices in relation to our desires. We have desires about food or urges that really make our mouths water when we see some tasty morsel. Many of us, but not all of us, can prevent ourselves from eating food because we are able to form "desires about our desires" (2nd order desires). Perhaps you love the bacon cheeseburger, but you "wish" that you did not enjoy it so much. The control that you have over your "wish" to refrain from eating the tasty burger that you "want" is your free will. Frankfurt, therefore, argues that only the second drug addict involves a person who is exercising free will.

But why are 2nd, 3rd and 4th-order desires and beliefs important? We have claimed that

they allow us to distinguish ourselves from other species, but the real significance resides in the following section.

Free Will's Significance: Moral Blameworthiness or Hard Determinism?

Although it is quite mundane whether or not some individual chooses to read, eat a delicious burger or stroll through the park, **it should be understood that the free will-determinism debate concerns absolutely all choices whatsoever**. It includes the most important choices, and this is where the major philosophical importance plays a crucial role. **If the hard determinists are correct, then all of our choices are caused, and there can be no moral responsibility.** For how could one be reasonably blamed for something that must happen in accordance with causal laws?

We believe that individuals are morally responsible for their actions and that individuals should be held accountable and penalized according to the severity of their actions. These are some of the assumptions we are making, but we shall not support these assumptions with rational arguments in this course.

"Intelligence" does play an important role in respect to moral blame worthiness. One *should* not blame a cat for jumping on the table and knocking over a glass of grape juice in order to eat some tuna. Cats do not have the cognitive abilities that are involved in higher order mental states because they cannot form higher order meta-beliefs and meta-desires. Humans generally do have these higher order cognitive abilities. **The presence of higher order cognition enables us to hold human beings morally responsible for their actions, if they know what the consequences are and can refrain from action or inaction.** So, of course, we hold each other responsible for knocking grape juice glasses off of tables, for instance, especially if it occurred as a result of having a craving for tuna!

Choice-making and the Experience of Choice-making

It is well known that we experience the choices we make. However, there are often discrepancies between what is described based purely on some person's inner experiences and what is described based on systematic observation, measurement and the accompaniment of precision tools (e.g., microscopes and MRIs). The latter fact is important to keep in mind in regard to the experiences we have before, during and after the use of our volition and the performances of our voluntary behaviors.

According to Chun Siong Soon et al: [51]

There has been a long controversy as to whether subjectively 'free' decisions are determined by brain activity ahead of time. We found that the outcome of a decision can be encoded in brain activity of the prefrontal and parietal cortex up to 10 s before it enters awareness. This delay presumably reflects the operation of a network of high-level control areas that begin to prepare an upcoming decision long before it enters awareness.

Of course, the fact that neuroscientists are able to predict with great accuracy whether a person will choose between very simple choices involving only two options does not shed light on the free will-determinism debate because the experiment does not show a result that contradicts libertarianism, compatibilism or hard determinism. The experiment does require each theorist to describe metaphysical positions in relation to neuroscience experiments. The experiment described in the previous paragraph illustrates that our experiences of choice-making actually occur at least sometimes well after the brain has produced enough activity to allow the accurate prediction of the choice of many subjects by neuroscientists. **That accurate prediction is before the experience of the choice of the subject even begins!**

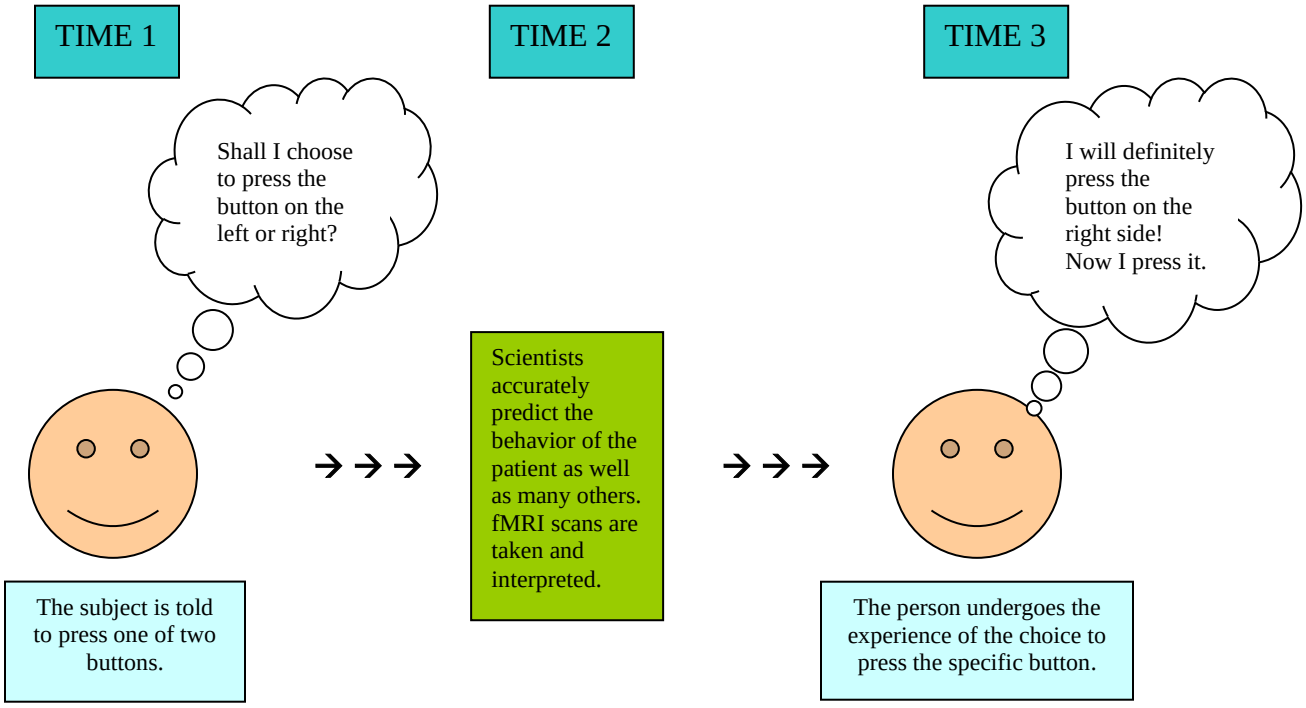
The 2008 experiment by Chun Siong Soon and company happened at the Bernstein Center for Computational Neuroscience in Berlin and is depicted below in **Figure 7**. This can well be considered a ground-breaking experiment that involved the previously mentioned concept called "liberty of indifference" during which neuroscientists had each subject choose to push either a button on the left or a button on the right and then to press the button. The scientists were able to quite accurately predict which button would be pressed.

There are science fiction movies that toy with such concepts as the ability of people to predict people's choices before they make the choices. The movie *Minority Report* starring Tom Cruise in 2002 illustrates this idea of predictive powers through a futuristic justice system that allows its law enforcement agents to arrest people who are predicted by psychics hooked into a computer system to be about to make the choice to murder or commit some heinous crime. Thus, they arrest potential criminals before they perform an illegal act.

These ideas existed thousands of years ago or at least since the time period of Homer over 2,800 years ago. The ability for scientists to analyze the areas of our brains associated with decision-making and the experience of choice is new. **Fig. 7** depicts the experiment described above by Chung Sion Soon et al. and involves a choice

about which subjects might be completely indifferent. So, the theme concerns both the libertarian notion of *liberty of indifference* and the deterministic notions of *laws of nature* and predictability.

Fig. 7
Experiment: Unconscious Determinants of Free Choice and their Predictions (Liberty of Indifference?)



Questions: Why do hard and soft determinism and libertarianism describe three distinctly different possible worlds? Which worldview is more convincing? What is the difference between the liberty of spontaneity and indifference? Which stances support these different types of freedom of choice? Why? What is the difference between the experience of a free choice and a free choice? What does the experiment by Chung Siong Soon et al. 2008 conclude? What will future machines, neuroscience techniques and scientists be able to tell us about our choices before, during and after our experiences of them?

Philosophy of Mind, Psychology and the Mind-Body Problem

Philosophy of mind is the study of minds, computers, brains and their interrelations with psychology and in respect to any environment. **Psychology** differs from

philosophy of mind insofar as psychology attempts to answer questions about quantifiable or measurable phenomena through systematic experimentation or through rigorous, practical analysis and counseling. Psychology is the scientific study of behaviors and mental processes with a special emphasis on humans.
Philosophy of mind is a rational attempt to answer fundamental questions that are so challenging that answers to these questions are not only unforeseen, but the very questions themselves are able to be doubted in respect to misguiding the focuses of inquiries from real world phenomena. Philosophic questions are misguiding to the extent that we do not know how to best describe problems that philosophers attempt to solve. The following section poses one of these questions, but other questions include: How and why do experiences occur exactly? Do the objects of which we are conscious accurately represent objects that exist apart and independent from consciousness? Are some of our choices flexible so that they could have been chosen differently than they were chosen? How do the mind and body interact? What are the mind and self?

Answers to such questions organize and systemize philosophical stances and create new research interests. Philosophic organization allows for the advancement of sciences in all areas because philosophy presents new concepts that are able to test theories and remodel experimental methods, providing logical analysis.

Substances of Mind and Body: What "Stuff" Makes up the Mind?

You may have been watching a professional football or baseball game and heard the old saying "the game is 90% mental and 10% physical" or "the sport is 90% preparation and 10% perspiration." Although "jocks" are typically not considered to be the most intelligent human beings, there is nevertheless a widely held conception that our mental lives, mental events, mental preparations and minds are greatly responsible for the things that we do.

However, there is also a notion that the physical, publicly observable bodies that we have are not merely mental, and this conception coincides with the idea that our minds are not physical. We question whether or not this distinction between the "physical" and "mental" is an accurate or misguided distinction to make and explain the origins of these notions.

There are two approaches to the "substance debate" concerning the mind-body problem. The first is called **monism**, which is the idea that the mind and body are made out of the same stuff. By "body" we are not just referring to the skeleton, muscles and so on but also the organs, including the brain. Monism has existed for

well over 2,500 years, but the majority of schools of monism developed during the 20th century.

Monists must explain what the substance of mind and body is; they need to explain why it *appears* to be the case that there is a distinction between mind and body. **That is, how does that piece of meat inside your skull account for the qualitative conscious experiences you so vividly undergo?** It does not seem that we can just describe the brain and neurons in order to explain that. Why not?

Substance Dualism is the idea that the mind and body, or brain, are constituted of two different types of stuff. Serious philosophical debate and controversy arose during the middle of the 17th century in an attempt to provide reasons for the first five of the six following assumptions (Grimm, 2008): [52]

(1) We have bodies and minds.
(2) Our bodies and minds function together in various ways.
(3) Bodies and brains are publicly observable or open to scientific investigation concerning their physical structures and functions.
(4) The contents of minds and consciousness *appear* to be private and unobservable from a 3rd person's perspective and scientific analysis.
(5) The conscious subject with a mind always has a "privileged access" to the 1st person's information that appears to be private and unable to be analyzed from a 3rd person perspective.
(6) Our minds coevolved with our central nervous systems through certain selection processes, such as kinship, sexual and natural selection.

The simplest way to explain (1) through (5) appears to be dualism, which would allow us to distinguish between those things that are privately observable and publicly observable by claiming they are different types of substances. A major part of the solution to mind-body problems is explaining the type or types of stuff that make them. The idea that *physical entities are divisible* while *mental entities are not* (i.e., one cannot have half a mind) was proposed by Descartes (1596-1650). It was also noted that the main difference between a thinking thing (i.e., a mind) and an extended thing (i.e., body) is that *extended things can be doubted* in regard to their existences but *thinking things cannot be doubted* by the ones who are thinking.

One may dream that one has two arms when in fact one does not. Anything extended

can be doubted because if one simply claims that one is dreaming about some extended thing, and one is dreaming, then the thing is merely a figment of the imagination or dream material rather than extended. Descartes further claimed that one sometimes cannot distinguish between a dream and reality, which leaves room for doubting the existence of all extended things. In respect to thinking things, *one cannot doubt that one doubts* because by doubting one is doing exactly what one would be proposing may not be happening while doubting would, in fact, occur. Moreover, doubting is a type of thinking. So, Descartes concluded "I think, therefore, I am," and maintained that mind and body are not identical because there are things true about minds (i.e., thinking things) that are not true about bodies (i.e., extended things).

For these reasons, and in order to explain (1) through (5) a model of the "stuff" that makes up the mind was created, and since then several have been developed, which we provide you below. **Here is Descartes' model where "M" means "mental," "E" stands for "event," and "P" means "physical":**

Cartesian interactionist dualism: ME1 → PE1 → ME2

Despite the fact that theorists have dealt with the mind-body problem for several centuries since Descartes, there is not yet a consensus about what mental states and minds are exactly, and we are not yet able to provide third-person observations of individuals' first-person conscious experiences. One of the major problems is whether it is possible to provide scientific descriptions of first-person experiences. So far the NCC project (Neural Correlates of Consciousness) concerns itself with accounting for the neural correlations that happen when certain types of experiences occur.

The six mentioned assumptions are the basic assumptions held by neuroscientists, psychologists, and philosophers in their attempts to formulate and test theories of mind with the experimentation and logical thought experiments of scientists and philosophers.

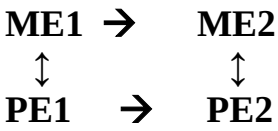
Below are a couple more options for the philosophy of mind stances from which the mind-body problem can be understood by dualists who argue that mental events have fundamentally different properties than physical events.

Epiphenomalism:

ME1 ME2
↑ ↑
PE1 → PE2

Epiphenomalism is the thesis that while physical events cause both mental and other physical events, mental events are causally ineffective. Thus, mental events do not have any causal power, for instance, to bring about any type of event at all. For instance, drinking alcohol is a physical event that causes the experience of drunkenness. However, the experience of drunkenness would be argued by epiphenomenalists not to cause the experience of mental confusion since the latter experience can only be caused by some physical event.

Non-reductive physicalism:



Non-reductive physicalism is the thesis that mental events contain such properties that they are able to cause other mental events, and they are able to cause physical events. However, mental events have distinctly different properties that allow them to be classified in a fundamentally different way than physical events. Moreover, these properties that mental events possess may account for their lack of explanation via physical descriptions and our current inability to publicly describe first-person experiences.

Interactionist dualism, epiphenomenalism and non-reductive physicalism comprise major attempts by numerous philosophers, psychologists and neuroscientists to make sense of the first five of the previous assumptions.

Monism: Mind-and-Body as One Substance

The mind-body substance debate concerns whether the mind and body are two distinctly different substances or not. Those advocates for the position that mind and body are composed of the same substance are called monists. Monism, like dualism, includes various philosophical positions that explain possible explanations for the six given assumptions accepted by most neuroscientists and philosophers of mind.

One challenging problem concerns whether minds can be constituted of different materials than brains. **Can a computer chip carry a mind or constitute a mind?** However, the problem that the monist faces is why the mental and physical realms appear to be distinctly different from one another, if they are one and the same.

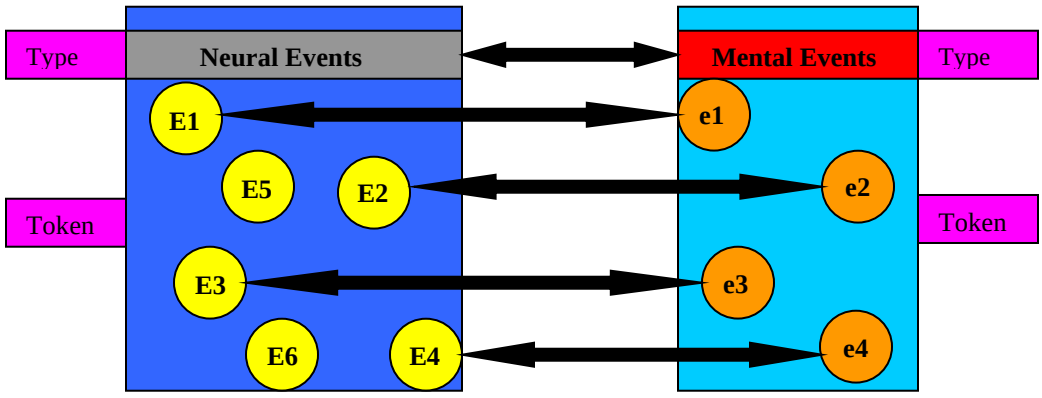
There are two basic stances accepted by monists, which are: (1) idealism; and (2) physicalism. **Idealism** is the thesis that the fundamental substance from which the

universe is constituted is mental. The idealist, George Berkeley (1685-1783), stated "to be is to be perceived or to perceive," and he argued that nothing exists independently from minds and their thoughts. For instance, Berkeley maintained that if you take away the redness of a cherry as well as its sweetness, roundness, etc., then there is nothing that remains of the cherry.

Physicalists disagree with idealists on several grounds. **Physicalism** is the thesis that the fundamental substance from which the universe is constituted is physical, and all facts are physical facts. The notion that minds are just "matter in motion" is a materialist and physicalist position. We focus on two physicalist theories here.

Figures 8 and **9** illustrate two different types of physicalism called **identity theory**. Identity theory in figure 8 illustrates the stance that neural events are identical to type and token neural events; thus, the theory is referred to as "**type and token identity theory**." The type of events illustrated in the model are neural and mental events, and the token events are specific occurrences of neural events that coincide with mental events in such a way that when one is present, then the other must also happen. Type and token identity theory has been criticized thoroughly from the standpoint of the **multiple realization thesis**, which asserts that other species may have the same types of mental states without identical neural states occurring. The idea that a computer could undergo mental events, such as beliefs or pains, is not allowed by type and token identity theory.

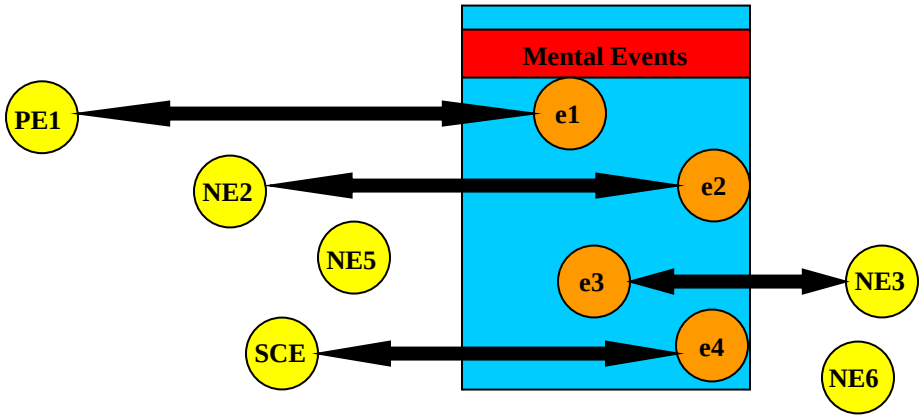
Fig. 8
Type and Token Identity Theory



Token identity theory (i.e., without type identity) is illustrated in **Fig. 9** where "NE" stands for "neural event" and "PE" means "physical event," and "SCE" means "silicon computational event." Token identity theory developed later than type identity theory. Actually, type identity theory entails token identity, but one may

consistently hold a token identity theory stance without being a type identity theorist. Token identity theory maintains that every singular instance of a mental event can be identified with some physical event, such as a neurophysical or silicon-computational event, but there need not be a specific type of physical event with which the mental event is identical.

Fig. 9
Token Identity Theory: Anomalous Monism



We will not include all of the various theories that reside under the debate between monists and dualists in relation to the mind-body substance problem. However, we shall briefly comment on the 6th assumption accepted by neuroscientists and philosophers of mind, which is the coevolution of central nervous systems and minds via certain selection processes. The assumption addresses the developmental process of events with respect to their mental and physical statuses.

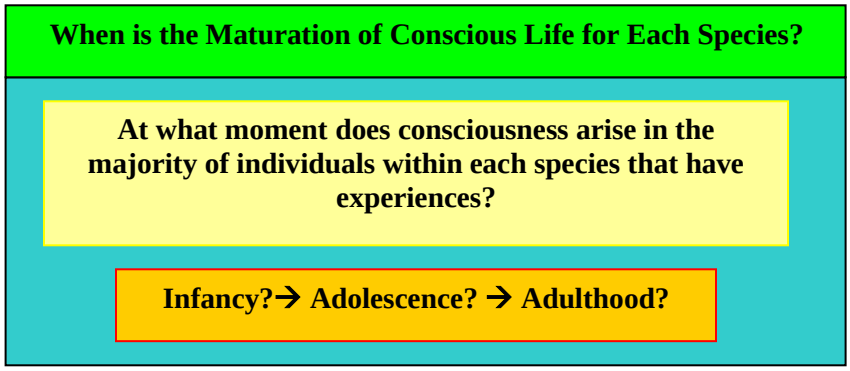
Development of Consciousness: Maturation and Evolution

In each one of us, we are now free to recognize there has been an unbroken development from fertilized egg to an adult conscious human being. Yet no one will maintain that the ovum or the early embryo can be conscious in the same way that the man is conscious. Nonetheless, it is impossible to draw any sharp line in development and to say, 'Here consciousness enters the embryo or the infant.' There is an imperceptible sliding into conscious life. The same difficulty greets us when we look at other animals.

Wells, Huxley and Wells

Wells et al.[53] illustrate the problem of pinpointing consciousness at some developmental stage of the animal at the maturational moment of conscious experience, which is what we may call an "imperceptible sliding problem into consciousness." The latter imperceptible sliding problem into consciousness is the problem of describing the moment from birth to adult life when a single member of a species is conscious because it is mature enough. Let us call this attainment of consciousness the "**maturational development of consciousness**." **Figure 10** depicts the problem of labeling a stage of maturation the developmental stage during which consciousness arises.

Fig. 10
Maturational Development of Conscious Life



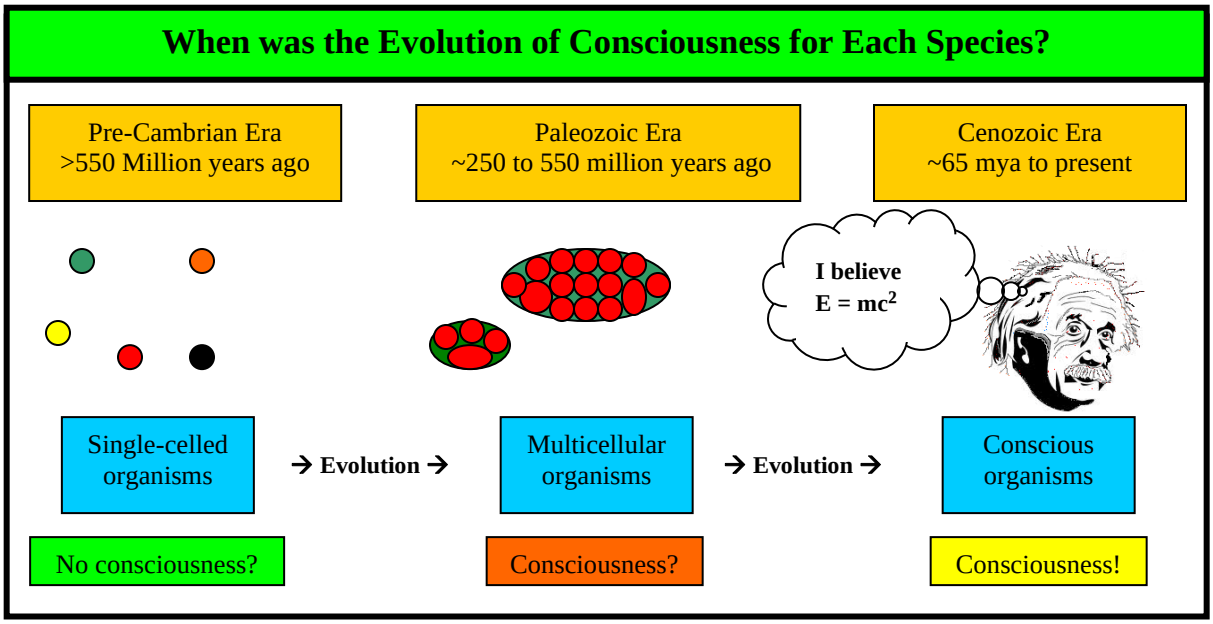
Evolutionists have a second problem concerning the imperceptible sliding into consciousness where distinguishing conscious organisms from those that are not is a major challenge, which is illustrated in **Figure 11**. Since evolutionists argue that all conscious organisms, such as humans, evolved from single-celled organisms during the Pre-Cambrian Era and multi-cellular organisms during the Paleozoic Era, evolutionists have the problem of pinpointing the following sorts of facts:

- **The time period or era conscious organisms evolved**
- **The first conscious species**
- **The environmental changes that allowed organisms with minimal features of consciousness to survive or reproduce more efficiently than those without**
- **The first conscious experience or type of conscious experience**
- **The first maturational stage during which the first organism became conscious, which was probably not during infancy, for instance.**

This latter problem of the imperceptible sliding into consciousness is a challenging

problem. We shall call the latter attainment of consciousness occurring somewhere within a range from single-celled organisms without consciousness to multi-cellular ones with consciousness the "**evolutionary development of consciousness**." The geocentric question for humankind regarding consciousness is: During the history of the Earth when, where, why and how exactly did consciousness evolve? **Fig. 11** Illustrates this problem for evolutionists.

Fig. 11
Evolutionary Development of Conscious Life



Both the problems of maturation and evolution, regarding the imperceptible sliding into consciousness, are problems that involve anatomy and physiology or "structure" and "function," respectively. We present the problems here in order to illustrate an overall problem in respect to consciousness, which is that there is no consensus on the era, the location, the goals, the maturational stage of development, the structure or function necessary or sufficient in order to give what we call "consciousness."

There is a third type of imperceptible sliding into consciousness, which is **coming into consciousness after controlled general anesthetics**, which you may have experienced if you were given a general anesthetic that was strong enough to deaden your consciousness and weak enough to wear off slowly and allow you to experience an aspect of this "sliding back into consciousness life" as you become ever more vividly aware of your surroundings and yourself. Although we can control the level of consciousness and place humans near minimum levels of consciousness via

sedatives, we still have no truly scientific measurement of our minimum, middle and maximum conscious experience capabilities.

We conclude that the study of consciousness is still in its infancy, although the field is developing exponentially.

For these given reasons there is no consensus amongst philosophers of mind or neuroscientists about what a minimum level or a maximum level of consciousness is. Maximum levels of consciousness may occur during higher order thinking, such as recognizing subtle sarcasm or solving complex math problems. Of course, computers cannot yet recognize sarcasm, and they can solve complex math problems, but when, where and why shall we conclude that the first computer is conscious?

Something like the conscious experience of pain probably was the first type of experience that organisms underwent since the feeling of pain is apparently universal (i.e., the experience of pain is probably experienced by members of various species). Moreover, experiences of pain may happen via various sensory modalities, such as the visual experience of extreme brightness, the auditory experience of extreme loudness, or even the experience of touching a hot coal or sharp blade! **Computers, on the other hand, might not undergo experiences with these qualitatively distinctive features, but will our understanding of computers be subject to the problems of the imperceptible sliding into consciousness?**

Questions: If all physical events were completely described, would all types of mental states be completely and meaningfully described as well? Which dualist stance appears to be the most reasonable? Cartesian interactionist dualism, epiphenomenalism or non-reductive physicalism? Which monist stance is the most convincing, to wit, idealism, type or token physicalism? Name two of the imperceptible sliding problems of consciousness? What do the sliding problems illustrate about our knowledge of consciousness?

There will come a time when non-biological machines, internal or external to us, will have more capabilities than we do. Will we associate our consciousness with the biological aspects of our intelligence? If non-biological machines claim to have emotional and conscious experiences as humans claim, how will those claims relate to the subjective human experience?

One of the problems of consciousness is that we know it subsists, but we really can not identify, detect, or gauge consciousness with accuracy. Science is based on objective measurements and their logical results. Consciousness to date involves

subjective experience that can not be measured objectively, except for its correlates, like behavior or components, such as neurons. The nature of subjectivity and objectivity relates to our limitations concerning consciousness and its measurement or observation from a third-person perspective. Currently, there is not a direct objective measurement of your phenomenal consciousness.

Most legal systems are based upon this subjective conscious awareness in respect to each stage within the legal process. Famously, President Ronald Reagan assassination attempt and trial of John Hinckley, Jr., turned upon Hinckley's awareness or consciousness of this crime. Although the determination of Hinckley's consciousness (i.e., diminished capacity) became a complex legal question, in the end, Hinckley was *not* convicted of a crime for shooting President Reagan, which is one of many cases related to law, ethics and consciousness and how conceptions of minds affect our political, legal and moral worldviews. The question of consciousness is fundamental to society's legal and ethical foundations.

Questions: What will happen when successive generations of Watson-type machines or microchip-implanted brains argue for their own consciousness, which is independent of the various aspects of consciousness with which we are now familiar? Obviously, future generations of "Watson" machines will be extremely intelligent. Will they be able to convince humans that machines are conscious, and that they *should* have similar legal rights of all conscious beings, regarding respect for their autonomies, independence and subsistence? If brains will be substantially replaced by microchips, should those bionic persons have the same legal rights and limitations? At what point does the classification of a computer as one's "personal property" become problematic in an ethical and legal sense? Does this occur if the computer is persuasive enough to convince others that it thinks, undergoes consciousness and has desires?

What we may be left with is a second kind of "Turing Test," which could involve making a distinction between the consciousness of humans and computers once we know which ones the computer and human are, and the computers are able to pass the original Turing test (i.e., computers consistently deceive humans into thinking that they are humans too). Moreover, if consciousness is indistinguishable in machines and humans, we may all be equal in the eyes of the law, say, in respect to the World Wide Web. So, computers could be prosecuted for the same crimes online for which humans are prosecuted and be subjected to quite interesting penalties.

Neuroethics, Legal Systems and Ethics of Consciousness

We begin our section on neuroethics with a focus on "the law as a social institution" that is ever important in regard to social perceptions of the technologies developing within the fields of consciousness studies, neurosciences, computer science, and bio-mechanical engineering. After the discussion of the role of the legal institution, we shall briefly present a few of the topical problems within the field of neuroethics, which is a special subdivision of bioethics that deserves attention in respect to an "ethics of consciousness."

The neuroethical themes include the following: the explosive development or exponential growth of the mind sciences during the last half of the 20th century, the direct ethical relevance of bio-medical ethics and the concepts of "minimum conscious state" and "persistent vegetative state," the decreased role of the humanities with the rise of the sciences of mind, cosmetic psychopharmacology and the ethical problems related to arbitrary enhancements versus necessary rehabilitation.

Legal Systems, Legal Reasoning and Social Perceptions of the Law

Every behavior that people think about is generally categorized by them as being either a "socially acceptable" or "socially unacceptable behavior." For instance, a professor giving a lecture on the topic of law and order is engaging in what we would call "socially acceptable behavior." However, if a professor holds a lecture, and he uses the aid of an implanted computer chip that is downloaded with the lecture material of another person, we maintain that the professor's behavior is "socially unacceptable."

Of course, what we think is "socially unacceptable" may, in fact, be tolerated by the public in the future, for example, and in order to discover whether the type of verbal plagiarism of the latter professor is actually socially unacceptable, a statistical analysis is necessary. What we maintain, however, and what others observe is a "perception and categorization of others' behaviors as 'socially acceptable' or not."

Another way in which a person or group thinks about people's behaviors is by categorizing them as being "legal" or "illegal behaviors." Of course, when somebody's behavior is thought of as being "illegal," that does not mean that the person's behavior is, in fact, illegal in accordance with the legal system and written law. This means merely that the person thinks about the behavior as being "illegal,"

which is similar to somebody thinking that a type of behavior is "socially unacceptable" since both are beliefs involving what a large group thinks. That group of individuals who holds opinions that are the most important in respect to categorizing behaviors as being "socially acceptable," "unacceptable," "legal" and "illegal" is called the "legal institution."

The **legal institution** is a social group of people who perform the functions of the legal system for a national economy. The legal institution is comprised of lawmakers, law enforcement agents, judges, lawyers, legal clerks, law students, secretaries etc. Moreover, the judges and lawyers generally have the best understanding of what behaviors are "legal" and "illegal" in accordance with written law.

Figure 12 illustrates the most important group's perceptions of the law, namely, the legal institutional members' perceptions and judgments of people's behaviors within the jurisdiction of the national legal system. What should not be astonishing is that some behaviors are categorized in two different ways. For instance, for some police officers it is "socially acceptable but illegal" for small town residents to exceed the speed limit by 5mph, but they sometimes perceive speeding as being "socially unacceptable and illegal" for non-residents to exceed the speed limit by 5mph. So, they may tend to give the latter group the penalties, and they leave the former group with "warnings"; this example of penalties and warnings explains "Action I" in both rows of the right column in **Fig. 12**.

Fig. 12 A Legal Institution Member or Several Members' Judgments of the Status of Actions

	Perceptions of Legal Behaviors	**Perceptions of Illegal Behaviors**
Perceptions of Socially Acceptable Behaviors	Action A, B, and C	Action G, H, and I **"I" is the act of exceeding the speed limit**
Perceptions of Socially Unacceptable Behaviors	Action D, C and F	Action J, I and L

On the other hand, if one person in a group brings a chicken sandwich that she made into a restaurant and eats it, a member of the legal institution, let's say, a lawyer, police officer or municipal judge may perceive her action as being socially acceptable behavior, and the lawyer, police officer or judge may consider her to be sexually attractive, for instance. However, if a large man brings a chicken sandwich in the restaurant with his friends, then the same lawyer or police officer may tell the man that he is not allowed to eat the sandwich in the restaurant because he treats the man differently than the woman.

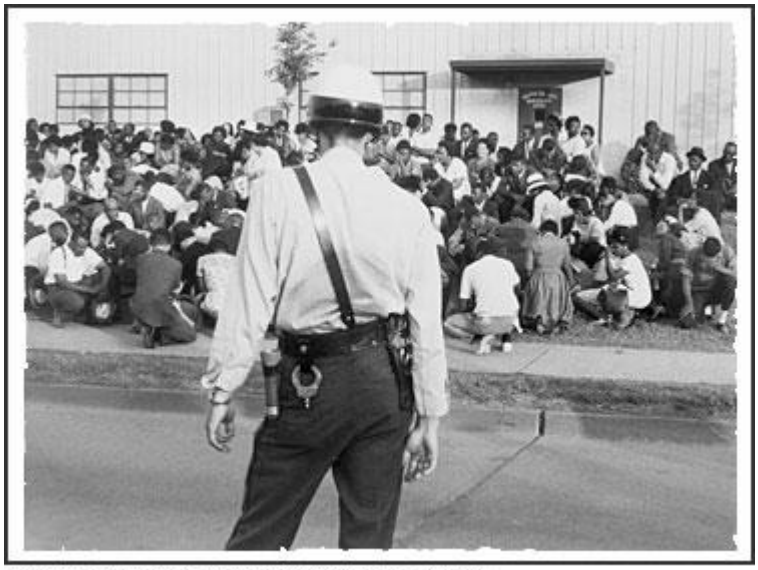
The latter example of the chicken sandwich is illustrated by "action C" above in **Fig. 12**, which stand for "eating a chicken sandwich." Of course, it should not be assumed that women receive more advantages from their interactions with the legal institution's members. The "remaining letters" in **Fig. 12** represent specific actions that are perceived by some member or members of the legal institution as socially acceptable, unacceptable and legal or illegal.

Perhaps the most important cases of "illegal but socially acceptable" behaviors and "legal but socially unacceptable" behaviors occurred during the 1963 and 1964 Civil Rights Movements in the US and Birmingham, Alabama during which most of the US was disgusted by the use of police dogs, fire hoses and police brutality implemented against black women, children and elderly people as well as other protestors who marched on behalf of ending the segregation of blacks and whites in Alabama. The picture below was taken of a 17 year old boy on May 4, 1963 after a Birmingham city ordinance denied residents the right to parade in the city.

Associated Press © Photograph

The members of the legal institution have powers that are based within a group-based social hierarchy. Police officers must answer to a police chief, for instance. Sociologists studying the affects of legal and criminal justice systems have

discovered that such systems function in ways that low status or subordinate groups tend to be placed at disadvantages in many phases of the legal systems' processes, especially within the criminal justice and law enforcement systems.[54]



LIBRARY OF CONGRESS, PRINTS & PHOTOGRAPHS DIVISION

The presence of statistical information, concerning the hierarchical status of dominant and subordinate groups in relation to the criminal justice systems, led many researchers to advocate a theoretical framework called "**social dominance theory**" since the 1990s. However, various researchers realized that low status group members actually support the status quo and the criminal justice system (i.e., they defend the status quo and defend police against criticisms in many scenarios).

As a result of low status groups supporting systems against their own best interests, another group of sociologists began studying the reasons why subordinate groups tend to endure astonishingly poor living conditions, and the questions are: Why do low status groups not attempt to do everything within their powers in order to change the way in which the social system functions? Why do subordinate groups acquiesce? Such observations' compliance and defense of the social systems led to the development of another theory that began in the 1990s in the field of sociology called "**system justification theory**."

The facts that system justification theory takes into consideration concern the fact that the lower classes in various societies actually tend to believe that the income they earn is ranked within the middle socio-economic class of their society, and the upper class tends to believe that they earn incomes that place them in the middle

class.[55, 56] So, most people tend to think they are part of the "middle class," regardless of whether they are poor or rich.

Engineering feats in the law profession have changed the way in which the law functions in some regions, and certain technologies increase the fairness of the criminal justice system. For instance, a "Blitzer" in Germany is a device used on their highways to automatically take the information of the license plates of cars that exceed the speed limit by a small margin, take a picture of the driver and automatically send a citation to the car owner's mailing address (i.e., a "speed camera" or "streaker").

The system is, of course, fairer than a system that allows for a police officer to "decide" whether speeders will face a penalty or not when s/he wants the person to be fined or not. Other systems, such as the justice systems in Sweden, Switzerland and Finland penalize in accordance with the amount of income the lawbreaker earns but do include flat rates for some offenses. There are cases where people with high incomes are fined tens of thousands of dollars for speeding, which is partially based on their incomes and the amount that each of them exceeds the speed limit. Again, speed violators are observed and analyzed according to a fair system for all, which is the traffic-controlling camera system.

Unfortunately, no legal system is perfect. DNA evidence, made famous during the O.J. Simpson case, has changed the United States criminal justice system, family law theories of justice, and the mass media outlets' roles concerning the portrayal of the legal system in action. Neuroscience portends an even greater influence on the United States justice system than DNA evidence, and the powerfulness that the scientists will attain as both sages and authority figures could be quite great.

These neuroscientists have duties that make them accountable and responsible, and legal consequences for misuse or misbehavior should be carefully orchestrated by the justice system because there will be incentives for experts to make statements under oath that are merely in favor of the lawyers or clients who purchase their services, regardless of whether lies are told or important truths are never mentioned. Neuroscientists' uses of fMRI machines and techniques that allow them to compare brain images of those who have seen crime scenes and those who have not, for instance, have already been utilized within the US criminal justice system (www.noliemri.com), and testimonies of neuroscientists may prove to be indispensable but sometimes unfair and unjust.

Buying, Selling and their Legal or Illegal Status

Much of the problem related to buying, selling and using services and the possession of products concerns a great confusion between "legal permissibility" and "moral permissibility." One example that legal professionals must consider now is that in certain countries mind-enhancing and mind-altering drugs are legal to possess, and in others they are illegal, but these facts are irrelevant when we consider the question about whether the drugs "should be" legal or illegal in some geographical region at some time period.

An example of what legal professionals will be confronted with in the coming years is the ability for consumers to enhance their minds, personalities, educations, etc. with the aid of microchips in their brains or consumable tablets with nanotechnology. Today it is legal for epileptics to undergo surgeries where microchips are implanted in their brains in order to reduce their seizures. Very soon consumers will be ready to buy mind-enhancing chips for their own brains. Should we legally permit the markets to develop such technology for these specific purposes? If so, what can be improved in regard to the conditions of those who are unable to afford brain chips? What will be the consequences for those who are already wealthy and who significantly enhance their minds?

The beverages and food we consume, the chemicals leaking from the nearby plant and the quality of air that we breathe all have effects, short- or long-term, on our physical bodies and consciousness. Some of the effects are, at first, below the threshold for us to consciously experience and yet have long-lasting impacts on our bodies and affect our conscious experiences and awareness in the long run. With so many factors that already affect us in regard to our very personal experiences, the impact that technology will have on our minds will be even greater and will shape future generations in unforeseeable ways.

For the latter reasons, it is necessary to consider the role of the law in manners that respect individuals' autonomies, provide peace and harmony within society, and that allow for improvements to be made. The improvement of laws is a social, political and economic phenomenon. If large groups of people consider the sale of some product to be socially unacceptable, it would be challenging for a politician to support the legal sale of the product. Nevertheless, if the product contributes significantly to the benefit of public health, the government is responsible for changing the perceptions about the product via education and through media outlets.

With the massive increase, sale, possession, purchase and consumption of new drugs and technologies (e.g., nanotechnology and consciousness altering technologies) legal systems are confronted with new problems that often concern substituting criminalization for the benefit of public health and harmony. **One way in which to account for individuals' and groups' unique needs and desires is to classify products according to various different gradations of legality.** See **Figure 13** for the various different gradations of legality.

Fig. 13 Gradations of Legality of Products

	Illegal Purchases	**Illegal Sales**	**Illegal Purchases and Sales**
Legal Purchases		Citizens may buy the product but not sell it to other citizens. Governmental institutions may sell the product to them (e.g., personal identifications)	
Legal Sales	Citizens may possess and sell the product but not buy it. The government may buy the products (e.g., new pharmaceutical drugs are analyzed by government before sale)		
Legal Possessions	Citizens may possess the product and/or sell it to the government but not buy it (e.g., possession of raw ivory or illegal purchase of alcohol after hours)	Citizens may buy and keep the product. They may not sell it. Citizens are permitted to buy the product with government permission (e.g., exotic animals purchased with government permission)	An amount of the product is legally permitted, but the act of buying or selling results in legal penalties (e.g., marijuana in Mexico in Sept. 2009 and Holland)

Perceptions concerning various types of drugs and the status of legalization will change drastically over the next several decades with the creation of new drugs from newly produced molecules. Generally, there is a misunderstanding concerning the status of legality and the legal reasoning that coincides with the partial legalization of products. When some product is illegal to buy, sell and possess, many may seriously question, mock and criticize why politicians support legalizing the possession of certain amounts of the product. The government is responsible for providing the role as both an education system and a system of analysis for consumer products because these systems are required in order to educate people about potential consumer products and what their legal statuses should be.

Additionally, if a product can be used in order to rehabilitate, the product often functions as **a performance enhancer** as well; so, there is a concern in respect to the circumstances that the product should be considered "for rehabilitation" that is related to the condition of the consumer who, at some time period, might be recovering from an injury.

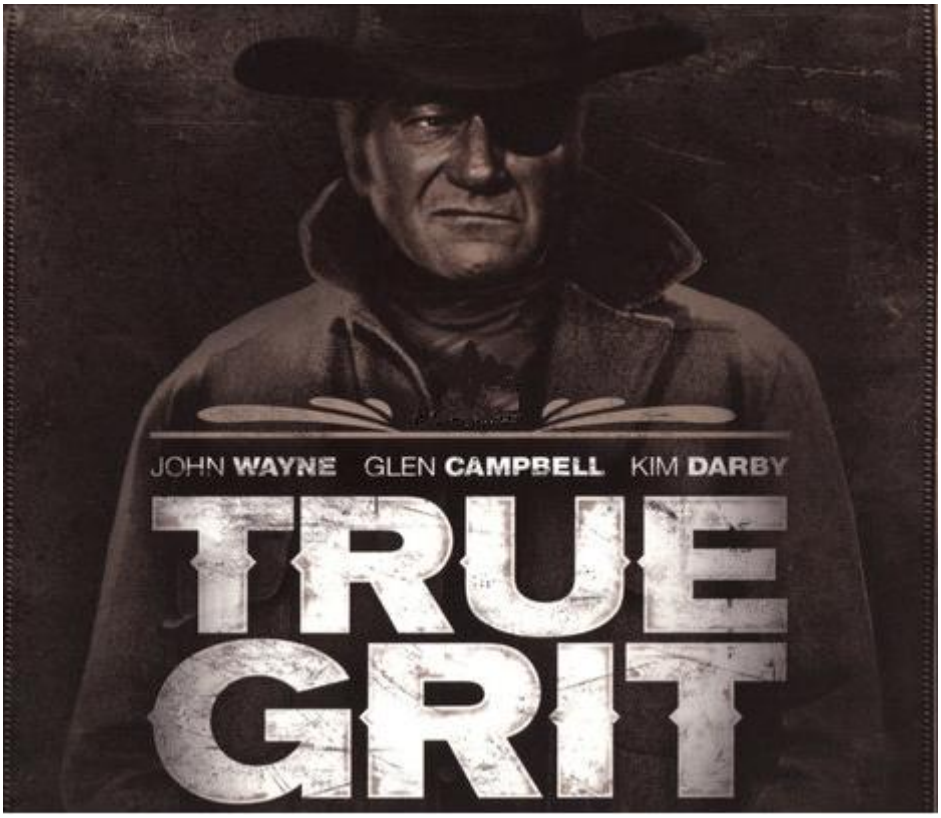
For instance, there are medicinal purposes for anabolic steroids, and it is legal for certain people with medical conditions to use steroids. However, steroids are illegal to use in order to enhance performance in sports. **Thus, we are confronted with ethical and legal issues related to situations that may involve rehabilitation and enhancement.** For example, if an athlete is using steroids in order to recover from the effects of chemotherapy after she has successfully battled cancer, there is a point where "necessary rehabilitation ends" and "unnecessary enhancement begins."

The law, however, will need to be perceived, by and large, as the force of a legitimate social institution enforcing rules, standards, and norms in order to promote public health. Moreover, the law must attenuate social hierarchies more than it currently does. The law should diminish social hierarchies more in respect to the vast advantages a small wealthy minority might have due to their "privileged access to new technologies." According to the US Census Bureau, over 15% of US population lived in poverty in 2010, which is about 46.2 million people. http://www.census.gov/

The new perception of the law requires a change in ideological thinking to the extent that the problems that social groups undergo related to personal consumption and legal penalizations can continuously improve. Sweden, for example, imposes penalties that require that fines be assessed according to the wages earned by those who are penalized.

Law and Ethics

Based on Charles Portis' novel and Marguerite Roberts' screenplay of *True Grit*, the following scene takes place after a Wild Western shootout in Choctaw nation at the turn of the 20th century. Two excellent films called "True Grit" were created in 1970 and 2010. The plot concerns the true grit of a teenage woman who hires a US marshal to arrest the man who murdered her father, and a Texas Ranger pursues the same outlaw in order to claim a sizeable reward in Texas.



Texas Ranger LeBoeuf: "As I understand it, Chaney, or Chelmsford, as he called himself in Texas, shot the senator's dog. When the senator remonstrated Chelmsford shot him as well. Now, you could argue that the shooting of the dog was merely an instant of malum prohibitum, but the shooting of a senator is indubitably an instant of malum in se.

US Marshal Rooster Cogburn: Malla-men what?

Mattie Ross: Malum in se. The distinction is between an act that is wrong in itself, and an act that is wrong only according to our laws and mores. It is Latin.

Rooster: I'm struck that LeBoeuf has been shot, trampled, and nearly severs his tongue, not only does it not cease to talk but spills the banks of English."

There is an ancient Latin distinction between two types of wrongs: (1) that which is wrong because it is prohibited, i.e., *malum prohibitum*; and (2) that which is **wrong in itself**, i.e., *malum in se*. For example, it is prohibited to exceed the maximum speed limit on the highway, even if the highway only has one car on a single stretch of it, and this is wrong according to tradition and law. However, murdering an innocent person is wrong in itself.

We might very well add that there are at least two types of rights: (a) that which is coincidentally or accidentally good; and (b) and **that which is morally good and right because it is brought about by the intentions and will of a moral agent**. We are all moral agents insofar as we are responsible for our actions. Examples of accidental goods or rights include those cases where politicians voted for bills as a result of their own best interests, but where, coincidentally, the entire society or international community benefitted, which was a positive but unintended consequence. The politician who passes some bill against his own best interests and does so intentionally, i.e., so that the entire community benefits, may very well involve a "good in itself."

There are several theoretical stances that attempt to establish the difference between the latter concepts of wrong and right, and we shall briefly consider a few of these stances, which are called **duty ethics, consequentialism and virtue ethics**. They pay close attention to the reasons why actions are **wrong in themselves** and **good in themselves** or good because they were intentionally brought about by the wills of moral agents.

Laws, policies and regulations for governments and other organizations make certain demands; they function in virtue of **compliance**, which is the minimum requirement for their rules of conduct, unless one is willing to accept the risk of penalty or a penalty itself. Ethics involves doing what one should do in a manner that may involve direct and straightforward **disobedience**, despite the risks of penalization since penalties are sometimes totally unjust. Thus, the ethical person and moral agent is often one who chooses in order to go beyond what the law demands but stops short of what the law permits. Martin Luther King Junior's 1963 letter from Birmingham Jail asserted that people have the **moral duty to disobey the law when it is unjust**.

Moral Commands According to Duty rather than Desire

Duty ethics was founded by Immanuel Kant, an 18th century Prussian philosopher, professor and scientist. Kant argued that only one thing in the world can even be

considered good in itself, or is good without any qualification, and that is a **goodwill**. Other things that we tend to think are good, such as intelligence, health, power, and wealth are only good in certain respects, but as a whole they all become deplorable if the person who is characterized by any of them does not have a goodwill.

For instance, the person without any goodwill at all and who is intelligent is generally described as being "devious, scheming, conniving or deceitful" rather than smart or intelligent, say, by a rational and impartial observer. The idea here is that if an individual is evil (i.e., has no goodwill), there is absolutely no amount of other qualities that would make this individual likable to a rational and impartial judge of character. Moreover, those who may consider the individual to be good are only deceived into thinking so.

The **will or volition** is the voluntary aspect involved with your behaviors and which determines your behaviors in those cases where you both choose to act and your action follows your choice. For example, if I choose to lift something, and I lift the object, then I have most likely willed to do so, and the act followed my choice (i.e., according to my experience of it; see **Fig. 7**). We say that "my volition determined that act of lifting." Some may claim that since the experience of free choice arises only after the brain has produced the activity that determines the action of the person, the person's experience of free will is merely an illusion. However, we maintain that the latter fact is unimportant since we retain the **abilities to plan our actions** (i.e., minutes, weeks and years before fulfilling these acts) **and predict future events** related to them.

Moreover, fMRI research[57, 58, 59] related to claims that "free will is illusory" do not measure our higher-order beliefs or desires, which are crucial in relation to free will, knowledge and cognition that give us **moral responsibility**, and have their own ethics.[60] Hallet and Soon et al. argue that the perception of free will only arise from unconscious activity, and Wegner maintains that "free will is illusory."[61, 62, 63]

The latter claims have been demonstrated by other researchers to be "very dangerous" because they actually negatively affect our voluntary behaviors when people are inclined to believe they are true.[59] Rigoni et al.[59] illustrate that **disbelief in free will negatively affects social behaviors, performance of general behaviors, and motivations to act as well as voluntary motor preparation**, which takes place about 1s slower in the subject who are induced to disbelieve in free will in certain cases.

Duty ethicists or "deontologists," like Kant, claim that if one performs a moral action that is praiseworthy, then one must have performed an action that one intended. That is, if a man does something that has a good consequence, but it was a coincidence or accident that he accomplished it, then the man's action is neither good nor bad, and the act has **no moral worth because a goodwill did not cause it**.

Deontologists also argue that **in order to perform an action that has a moral worth the person must not be inclined (or want) to perform the act since anything that we "desire to do" lacks a moral worth because doing what we want doesn't require a sense of duty**. As an example, if a politician passes a bill, and he wants to pass it, then he deserves absolutely no praise for passing the bill because he merely did what was logical to do. However, if a congressman votes for a bill against his own interests and his family's best interests, for instance, and votes "out of a sense of duty" and in order to benefit the nation or several nations, even though he does not want to, then he has done something that has a **moral worth, which came from a sense of duty**.

Kant's deontological stance may be best summarized in terms of its call to action and moral command or imperative: ***Do not use others for your own gains***. The reason for asserting this as a duty is that treating others as objects that we use for our own goals is quite easy, and this is what we want to do, especially in cases where there is a **mutual benefit**. Perhaps you have placed yourself in a position so that you can help another person because you want that other individual to feel obliged to help you move a couch the following week; there is a mutual benefit for both of you.

Fig. 14 Mutual Benefit is Different than Moral Worth

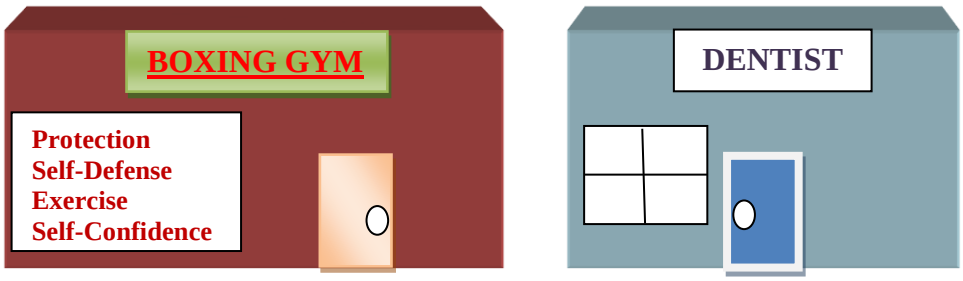


Figure 14 illustrates that although legitimate and mutual benefits take place, their nature is not a moral one, which is in accordance with duty ethics.

The demand that we make as duty ethicists is that **others must be treated as ends in themselves** and never as "means to ends" in order to respect their autonomy and not to infringe on their free will to act. We demand for you to: **Pay the highest respect to others in accordance with what they deserve as willing individuals!**

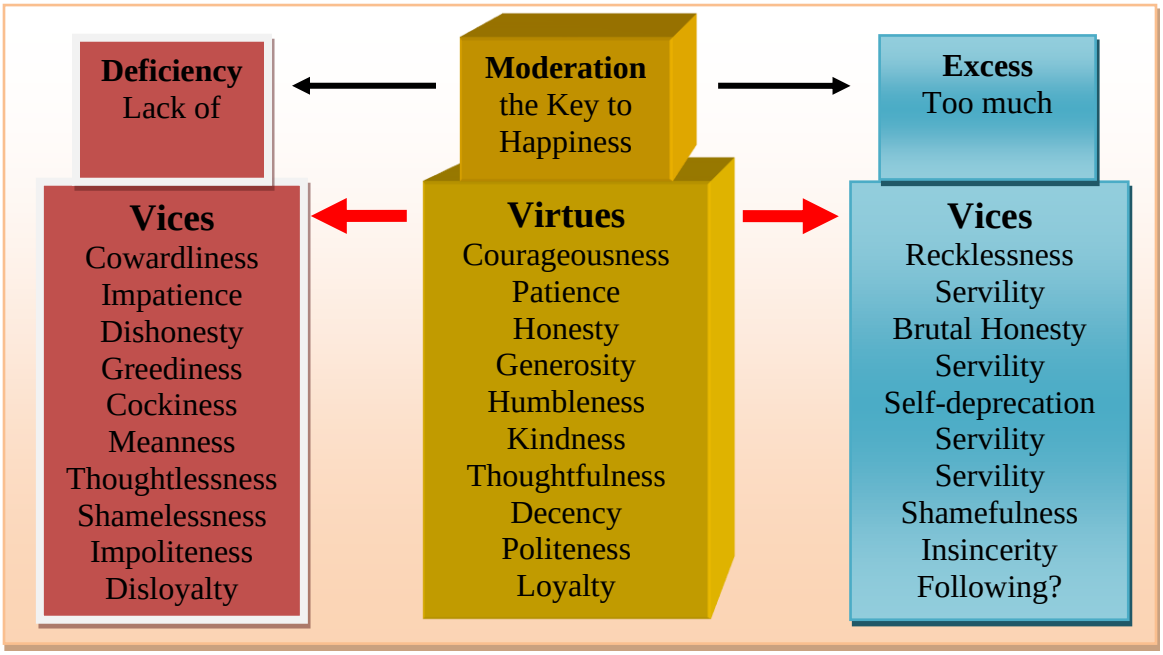
Treating others only as ends involves making them the purpose of your actions rather than using others for your own purposes. That is, it expresses both, "Don't use people!" and "Pay others respect that they deserve!" For instance, one *should* give waiters and waitresses different tips according to what they deserve in respect to their services. [65]

A Cultivation of Virtues: Virtue Ethics

Aristotle's *Nicomachean Ethics* puts forth the idea that it is best to behave according to the mean between two ends, and the ends include extreme **deficiency and excess of character traits**. At the end of excess, an individual may be so obsessed with cleaning that she is cleaning her home constantly, and her actions are interfering with her work schedule and meetings with friends. This is excessive in respect to the virtue and mean called "cleanliness." On the other end, another person may refuse to bathe and clean anything in the household for weeks and weeks. The person is unclean, and his behaviors drive others away from him. This is deficient or "lacking" in respect to the virtue and mean called "cleanliness." The "golden mean" is a type of cleanliness that is virtuous and is an intermediate between the two extremes; the two extremes are a lack of it or too much.

Figure 15 illustrates Aristotles' system of ethics in addition to other virtues and vices that have been described over the centuries and are aspects of virtue ethics. We have merely represented a few of the character traits involved in respect to evaluating a person in relation to his or her habits, moral character and relation to the ideal virtuous person in respect to having deficiencies and excess regarding the vices that are the outliers with the moderate, virtuous character and behavioral traits in the middle, which Aristotle called "the middle of the road" and the "golden mean."

Fig. 15 Virtue Ethics: The Golden Mean in the Middle



Consequentialism: Doing What Results in the "Best" Consequences!

Imagine that you are a subway driver in New York City driving along a track, and you realize an upcoming switch in the tracks. You will pull a lever and turn to the right, or you will refrain from pulling the lever and stay on the same track. You realize that your duty as a driver is to stay on the same track.

However, straight ahead you see five people on the track that you will surely hit, if you remain on the same track, and you suddenly grasp the lever because you are about to pull it and change tracks. It is against the rules of the subway employers but for a good enough reason, so you are close to pulling it. Surprisingly, you see one person on the other track, and you look at his face and begin to reconsider what you will do during the next couple of seconds!

Is it completely obvious what needs to be done? Is the "moral decision" already understood? There is indeed an intuition that we have in respect to the five people having a moral priority over and beyond that of a single person, and this priority we may place on saving five people by means of taking the life of only one is a sort of calculation that comes from the consequentialist school of thought.[66]

On the other hand, if we phrase the question a bit differently, then we will see that the matter is quite complicated in respect to our passions, emotions, motivations and intentions that coincide, cause or become effects of our decision-making.

Is it the case that a person, who switches tracks, i.e., killing one and sparing five, has "always" made a moral decision? We argue that the answer is a resounding "no." Here is why:

Imagine that you, the driver, accidentally fall upon the lever and switch tracks. What can we say about any "moral worth" of your action? It appears that only the consequences were good or desirable, but since there were no intentions behind your actions, we cannot attribute any moral worth to your will or clumsy action. Moreover, clumsiness is a vice rather than a moral virtue, isn't it?

Now imagine that the conductor decides to switch tracks because "he does not like the look on that guy's face!" Now it not only appears that the action or decision deserves no praise and completely lacks moral worth, but additionally, it appears that there is malicious intent and total disrespect for another person whom we may say is being treated as a "means to an end" (i.e., the individual is perhaps being used for the conductor's malicious purposes).

Interestingly, consequentialism has many different types of focuses in respect to solving the problem: (1) it is sometimes the case that individuals who have performed acts that result in the "best consequences" actually have accomplished something that is "immoral" and "unethical"; and (2) consequentialism states that one should only perform those acts that result in the best consequences.

In order for consequentialists to incorporate (1) and (2) as moral principles, there has been a need to stress different forms of consequentialism, such as "rule consequentialism." **Rule consequentialism** involves a notion that is quite practical for law and regulatory committees. Rule consequentialists argue that there is an **optimal set of rules**. The task of philosophers, legal systems and ethicists is to find the best set of rules and to enforce them and the appropriate consequences for disobeying. The idea is that some set of rules and laws will indeed allow humanity and other species to lead more harmonious lives, resulting in the best consequences; the consequences are better than they would be with any other set of laws and rules.

This type of thinking involves some sociological considerations at the expense of denying psychological considerations, such as failing to recognize very personal

emotions that coincide with terrible experiences people undergo in order to maximize the best consequences overall. Maximizing the best consequences, in fact, does not just involve the "expected best consequences" or the "intended and expected best consequences," according to consequentialists. So, there is indeed a theoretical aspect that does not take realistic settings into consideration. Grave problems arise when a group is the majority and producing the so-called "best consequences" results in minority groups being paid no respect and being denied their freedoms, rights or autonomy so that the majority can benefit.

From an engineering, land surveying and architectural perspective it is important to note that the fundamental problem of the subway example concerns the engineering of tunnels that allow the subway drivers to be confronted with choices producing "moral dilemmas" as a consequence of the layout of the land and architecture of the subway system.

Since the importance of engineering, architecture and land surveying is so fundamental, there is a real need for sociological ethical principles that involve engineers, architects and land surveyors making decisions based upon **creating ideal conditions for people in order to maximize their safety and well-being**.

We stress that ethics and morals do not merely involve the mechanistic calculations of adding and subtracting individuals' lives, happiness, suffering, etc. in order to come to the "moral conclusion." However, there is a need for understanding the problems, needs and wants that come with virtue ethics and character traits, duty ethics and the goodwill as well as consequentialism, which is a more obvious way to begin the process of thinking ethically and forming our moral intuitions before we consider other perspectives.

Overwhelming Needs for Neuroethics, Social Acceptance and Law

Perhaps the world started to recognize the obvious importance of medical ethics, bioethics, and neuroethics during and after the "medical experiments" performed by Nazi doctors in World War II. The Nazi "medical experiments," conducted on humans, were brought to the world stage by the Nuremberg Trials following the war.

The question of neuroethics, i.e., morally right versus wrong, might be demonstrated by the Nazi doctors transplanting nerves, typically whole limbs, from one prisoner to another. The self-justifying argument the doctors proposed was that they were doing research to help the wounded soldiers who had lost limbs. Thus, the possible benefits to soldiers were coldly calculated against the disadvantages of prisoners

(i.e., their lack of rights, respect and autonomy) in respect to a cost-benefit analysis. **NAZI doctors were indeed defending their practices by supporting consequentialist principles at the expense of treating others as "means to ends," using them for their own purposes (i.e., against duty ethics principles in order to fuel the war-machine).**

The multi-national Nuremberg Tribunal and virtually the entire world did not accept the Nazi doctors' arguments. The doctor's practices and contributions to the German war-machine were overwhelmingly "socially unacceptable." The result of the trials produced criminal convictions, but also an ethics code. Consequently, criminal law and ethics were distinguished at Nuremberg.

Despite the horror of the Nazi doctors' experiments on prisoners, the Tuskegee experiments took place even during the 1970s in the United States. In the Tuskegee experiments, poor black men in Alabama with syphilis were left untreated for the benefit of later neuropathological studies of the disease. It was known during that time period that the later stages of syphilis affect the brain if left untreated.

The International Bioethics Council in 1996 recognized a bridge must be built between neuroscience and ethics; thus, leading to "neuroethics" by name. Moreover, there was an explosion in techniques for probing human thought in health and disease. Neuroethics is required to provide the full range of moral and intellectual space for decision-making.

As Nuremberg and Tuskegee provide historical background, we must learn from the field of genetics and its relations to neuroethics as neuroscience investigates the meaning of "human nature" and the power of behavior control. Although the human genome has been mapped, and DNA defines "what we are" in some sense, our brains define "who we are" as humans with our unique individual capacities, emotions, and personal convictions.

DNA, gene control and the doomy history of the origin of neuroethics raise the question: who owns ***your*** DNA sequence? Twenty percent of all human genes have been patented by the companies that isolated them. [67] Why does this matter? One difference ownership makes is that we, you or I, have to pay sky-rocketing prices because of ownership. For instance, many have paid over $3,000 for a breast cancer test that could have cost one-tenth the price. Breast cancer has been at the forefront for years, along with funding, but prostate cancer will probably be next. Of the estimated 25,000 genes in the human body, 20 percent have been patented, including genes associated with breast cancer, colon cancer, asthma, and Alzheimer's disease.[1]

Although patenting is a legal process establishing ownership of inventions, at what point does it become unethical to refrain from treating dying people because treatment would interfere with the legal rules of some patent? Patent laws obviously interfere with prices of medicines, and the research and development of medicines is quite costly. We must engage in serious debate in respect to people attaining profit on the basis of these patents and effective drugs and tests.

Is it ethical, and should we, as a society, allow it to be legal to patent a process of isolating a genes or any other part of a natural living organism? If, for example, the first doctor who isolated and removed a kidney patented the process, should he or his hospital be allowed to preclude other kidney treatments and charge a royalty fee for all diseased kidney removals? Possible answers to the patented gene isolation question may be answered by the United States Supreme Court in the Myriad Genetics, Inc. case styled Association for Molecular Biology, et. al. versus US Patent and Trademark Office. The answer to the gene patent question could predict a similar future for neuroscience.

Everything we think, say, and do is processed by our brains. Our brains determine our dreams, our limitations, and our characters. Neuroscience deals not only with disorders, but searches for answers explaining why we are the way we are. Moreover, neuroscience investigates what the "self" is, and understanding who we are involves becoming aware and actively preventing ourselves from harming one another. Hippocrates is the father of medical ethical codes (e.g., the first of which is **"do no harm"**). What need to be emphasized are the ways that humans produce damage, and this inevitably involves the development of neuroethics.

As we explore the brain, one of the primary dilemmas is research itself. Fortunately, techniques in neuroscience allow studies of real people with attempts to solve serious problems, as opposed to merely the study of mice's brains and analogous behaviors, for example. Well-run research teams identify issues early in the research process and adapt references and research tools accordingly. But, what happens if a participant in, say, a medical study has a dangerous health problem completely unrelated to the study? Does it matter? Should it matter? Should researchers inform the participant of the finding? Is there a duty or ethical obligation to inform the participant of the finding?

Answering these questions affirmatively or negatively involves making serious changes in respect to the way medicine is practiced as well as the way in which the criminal justice system will function on its behalf.

New Fields of Applied Ethics: From Neuroethics to Consciousness Ethics

What we are embarking upon is a type of applied ethics that involves proceeding towards new conceptions of humankind. The topical problems in the field of neuroethics are the following: (1) Explosive development of the sciences of mind during the last half century; (2) Direct ethical relevance of bio-medical ethics; (3) Problems arising from the recent development of the sciences studying the mind; (4) Mind sciences within a societal context; and (5) Cosmetic psychopharmacology. [68]

Explosive development of the sciences of mind during the last half century

From 1965 to 1970 there were no articles with the word "consciousness" in the abstract or title. From 2000 to 2005 there were approximately 400 scholarly articles with titles or abstracts containing the term "consciousness," and a swift increase began during the 1970s. The increase in such interests has grown exponentially, and such development of the field needs justification for the time, effort and money spent on its behalf.

In fact, some researchers, such as Prof. Thomas Metzinger, have been offered enough funding to employ numerous researchers but have turned down such offers in order to prevent saturation and possible redundancy within the field of mind science. Dr. Metzinger, director of Theoretical Philosophy at the University of Mainz, is currently responsible for the selection of two researchers, but has had the opportunity to acquire at least ten funded researchers. Metzinger's decision to employ a smaller number of scholars comes from his own ethical considerations while his choice has the expense of denying him the ability to accept the credit and glory of perhaps an excessively large research team that would undoubtedly make more breakthroughs but at a much higher price to the German government.

Direct Ethical Relevance: Bio-Medical Ethics

A team of thirteen researchers Boly et al. [69] recognized the important ethical implications involved in the following two diagnoses given to patients by medical practitioners and neuroscientists called the "minimally conscious state" MCS and the "persistent vegetative state" PVS.

A **"Minimal Conscious State" MCS** is "{a} condition of severely altered consciousness in which minimal but definite behavioral evidence of self or

environmental awareness is demonstrated."[70] A **"Persistent Vegetative State" PVS** is a condition of extensive brain damage during which there is little evident brain activity, and brain activity is judged as being disassociated with behaviors related to the environment and self. In short, PVS is a state in which individuals are no longer conscious as a result of brain damage.

Boly et al.[69] specifically studied the auditory processing of severely brain-damaged patients with MCS and PVS, compared the findings to healthy control subjects and concluded that neural activity within the MCS patients is more likely to lead or develop into "higher-order integrative processes" that are often argued to be necessary in order to attain consciousness as the result of auditory perceptions. Their article can be found here:
http://dev.ulb.ac.be/ur2nf/reprints/Boly_ArchNeurol04.pdf

Perhaps future research that emphasizes the significant ethical distinction between PVS and MCS will find that some proportion of subjects with PVS may regain minimally conscious states through therapies that involve combinations of sense perception usages, such as auditory and balance perceptions. For instance, *telling* a PVS subject (i.e., auditory perception) that he will be or is being tilted while *nurses move the patient to his side* (i.e., balance perception) evokes neural activity in the associated brain regions (i.e., the parts of the brain dealing with auditory and balance perceptions). Moreover, the addition of other stimuli, such as smells and colored lights as well as auditory descriptions of them can be combined to offer ways by which patients' brains are significantly stimulated without the risk of damage (e.g., constant sounds may damage the ears, or the patient may become accustomed to the sound and fail to process it the same way or fail to develop more sophisticated ways of processing the sound like patients with MCS).

Bryan Jennet[71] writes concerning the persistent vegetative state that:

"{i}n the 30 years since this state was first described and named it has provoked intense debate not only among clinical scientists and health professionals but also among moral philosophers and lawyers. Considering its relative rarity there is also, courtesy of the media, an unusual degree of public awareness of the condition. What attracts attention and curiosity is the dissociation between arousal and awareness—the combination of periods of wakeful eye opening with a lack of any evidence of a working mind either receiving or projecting information. The advantage of the term "vegetative state" is that it simply describes observed behavior, without implying specific structural pathology. However, since the realization that this state is frequently temporary, the

original term persistent vegetative state is potentially misleading as it suggests irreversibility. After a certain length of time, it may nonetheless be reasonable to describe this state as permanent."

In 2006 Owen et al.[72] published an important article within the field of mind science; their article as well as uncompromising media attention sparked an intense debate within the US and abroad. In Owen et al. a 23-year-old tennis player who was diagnosed with PVS is analyzed after she was asked to imagine walking around her house and playing tennis. Interestingly, the neural activity demonstrated is indistinguishable from healthy control subjects who are fully conscious. The ethical debate involves the euthanasia of brain-damaged patients as well as the continued use of expensive hospital equipment and services for severely brain-damaged patients diagnosed with PVS.

Owen et al.[72] explain:

We used functional magnetic resonance imaging to demonstrate preserved conscious awareness in a patient fulfilling the criteria for a diagnosis of vegetative state. When asked to imagine playing tennis or moving around her home, the patient activated predicted cortical areas in a manner indistinguishable from that of healthy volunteers.

The ethical problem concerning a 23-year-old tennis player with severe brain damage concerns an answer to the question about what the sufficient conditions for consciousness are. We may ask: How many patients who are classified with PVS actually have minimal states of consciousness? What is the probability that the proportions of PVS patients will develop minimal states of consciousness?

The implications concerning answers to the question about the sufficient conditions for consciousness are quite grave since they entail either pulling the plug and allowing the death of the patient or, perhaps even worse, leaving the individual in a vegetative state for many months with expensive hospital bills and family members who must undergo tragically sad experiences while the patient deteriorates in her hospital bed.

What are the problems arising from the recent developments of the mind sciences overall?

There is an increasing marginalization of the classic humanities as a result of the high tempo of development within the mind sciences. Moreover, there is a problem

concerning the transfer of information and the transition of altered and improved teaching methods in virtue of how exactly the classic humanities can contribute to the mind sciences. The contribution of the humanities to the mind sciences appears to be inadequate in many respects.

For instance, anthropology may be studied through neuro-information systems and cognitive sciences, and such methods of analysis of humans may indeed produce an entirely different picture of human beings than many of the current ways of representing humankind via the field of anthropology.

Moreover, there is reason to believe scientific revolutions have not changed the picture or conception of humankind as much as they will be changed during this century. If our conceptions of humanity change, our conceptions of government and its institutions (e.g., legal, political, educational, religious, family and judicial) will drastically change in order to incorporate our new views of ourselves.

Mind Sciences within a Societal Context

There is a tremendous problem regarding how exactly cultures attain knowledge, and almost all of the progression of knowledge of the majority of people derives exclusively from "popular Media." Thus, television corporations, newspapers, magazines and radio broadcasters have tremendous ethical responsibilities in addition to their development of innovative ways of making profits. **What happens when profit-making interferes with the truthful presentation of information within the mind sciences?**

The dispersion of the development of mind science and media representations of minds is also far-reaching. Development in the mind sciences affects every business and governmental industry. Perhaps even neuro-lie detection will be involved in the election process of government officials and application processes of future employees. Neuro-lie detection is already present within legal systems in respect to the usage of MRIs, testimonies and the information reported by neuroscientists that contradicts the witnesses' or defendants' testimonies. For instance, take a look at: http://www.noliemri.com/

The influence of the mind sciences upon genetic and biological determinism is quite striking, and it has, as we have seen in the previous chapters, the drastic implication for ethicists and people's convictions about moral responsibility.

There are new views about what "moral objects" are (e.g., dementia, coma patients, etc.), which concern the conditions of causation and the genesis of moral subjectivity. Moreover, there is a historically new class of possibilities for educational exchanges. For instance, how do we inform cultures and classes of people of the new information coming from the mind sciences, especially when it contradicts cultural worldviews?

Potential global conflicts may arise from fundamentalist groups that perceive their views to be at odds with or in opposition to new theories about humankind.

The possibility for the manipulation of people is becoming readily available via new technologies (e.g., new drugs, devices, etc.), and we do not know what the psychological or sociological resulting costs will be. However, we may still inquire about how we can reduce these resulting costs. So, there is definitely room for a type of optimism, if we approach these ever-important matters with a cautious form of thoughtfulness.

Cosmetic Psychopharmacology

Obvious questions within the field of psychopharmacology concern the personal identity of the individual who consumes pharmaceutical drugs in order to *change* his or her own "identity." How *should* the law respond to those who are altering their identities and personalities with drugs that make them happier or appear happier? How should *beauty enhancement surgeries for the brain* be handled?

We may question whether the individual could *ever* be "authentic." What lines should be drawn between enhancement and therapy or rehabilitation? The serious ethical questions often involve dual usage of drugs for both enhancement and therapy, where drugs are often needed, on the one hand, but used at will in order to enhance. A **gray area** or vagueness resides in regard to the time period between "when rehabilitation is accomplished" **and** "when enhancement begins."

Do we sell drugs according to the measurements of the consumers, i.e., based on their actual weight, ideal weight, amount of usage, etc.? Should corporations profit from the sale and distribution of drugs? If yes, then how can prescriptions be controlled so that pharmaceutical companies do not have incentives to profit from overdosing? What is the role of the media in respect to cosmetic psychopharmacological drugs, and what is the responsibility of each of the different forms of media?[73]

Farah et al.[74] ask what kinds of policies are necessary in order to govern neurocognitive enhancement. For instance, there are anti-sleeping pills that are used for soldiers in order to prevent them from sleeping for approximately one week, and doctors do not have knowledge about what the residual and long-term effects are. [75]

There are enduring questions about people being indirectly coerced by the influences of competition and others consuming drugs. These questions are probably at least as old as the ancient Olympics dating over 2,500 years ago.

Will drug-users influence others to behave in the same ways by taking drugs as a result of the influences of being within a competitive context?

Perhaps the ancient word "Sport" in ancient Greek, English, Slavic and other Germanic languages, for instance, comes from something like the notion of "playing" or "game" (i.e.,"**Sp**ielen" or "**Sp**iel" in German) in a "place" or "location" (i.e., "**Ort**" in German). The rules, judges, competition, various conceptions of "winning" etc. appear to be reminiscent of a major aspect of "life within an economy" since they both have lifespans or times during which they are complete for the participants or players, the observers or audience and the judges or referees.

Winning is not always fair, and although ethics and fine qualities, such as good health, can be taught and practiced in sports, the fans may become fanatical, the athletes may "lose" their games on purpose in order to "win" financially, and some judges might be paid-off in the process. However, entertainment and optimism are ever present as these roles in life evolve in sports and elsewhere. Fame and glory, wealth and power mean nothing to somebody with poor enough health, and the rehabilitation of health is generally considered to be morally permissible (e.g., even if this involves the usage of anabolic steroids for people recovering from cancer or debilitating injuries). At some point during the rehabilitation of an athlete with cancer, for example, drug-use may become an obvious example of the abuse of an athletic-enhancing drug, and the same is the case for the usage of drugs for the purpose of rehabilitating patients with brain injuries from strokes or auto accidents, for instance.

At each point we make within the subdivision of applied ethics called "bio-ethics," and within the subdivision of bio-ethics called "neuroethics," and finally, the subdivision of neuroethics called an "ethics of consciousness," there is a need for increased conscious awareness for those aspects that are necessary for higher standards of living and those aspects that are unnecessary or arbitrary because they involve unfair advantages and personal interests concerning competitive advantages.

An ethics of consciousness will surely provide guidelines and reinforce the moral emphasis on animal rights, which may very well increase the price of meat products and involve prosecutions of those who treat other species inhumanely. However, at no point is the ethical need for conscious awareness more essential than for the competition of groups at war.

The Just War

"***Compared to war, all other forms of human endeavor shrink to insignificance***," from the movie *Patton* starring George C. Scott.

Michael Walzer[76] defines "war" as a legal condition that equally permits two or more groups to carry on a conflict by armed forces. Moreover, war is an ethical responsibility involving the permissiveness of armies and individual soldiers to kill. Without an equal right to kill, war as a rule-governed activity would disappear and be replaced by crime and punishment or penalty. The rules of war consist of two restrictions coupled with an equal right to kill. The first restriction on soldiers is *when and how they can kill.* The second restriction is upon *whom soldiers can kill.* Thus, war is distinguishable from murder only when these restrictions are established, the so-called "Just War."

What do neuroscience and neuroethics have to do with war? Much of neuroscience concerns the dual-use of products for civilian use and military use. The Defense Advanced Research Projects Agency (DARPA) and the military have a compelling interest in understanding, developing, and exploiting neuroscience for national security. Militaries continually prepare for the next "Just War." Unfortunately, goals and ethics concerning science, the politics of science and the directions of scientific research may conflict with national security goals, particularly concerning the restrictions against those *whom* soldiers are allowed to kill and *how* they may kill.

War-fighting enhancement, deception detection, and other military application of state-of-the-art neuroscience, including brain scanning, brain-computer interfaces (BCI & MMI), and neuromodulation are funded, used and justified by national security interests. For example, DARPA's Augmented Cognition (Aug Cog) uses neurological information from warfighters to modify their fighting equipment. Such things as the "cognitive cockpit" involve recording a pilot's brain activity to customize the cockpit for fast communication with fighting systems and prioritizing informational needs and eliminating distractions; thus, removing ethical responsibility from the pilot. Similarly, brain-machine interfaces can detect

deficiencies with soldiers' neurological processes and link that information into a device inside a helmet or within a vehicle in order to suppress or enhance individual brain functions. [77]

From a neuroethics viewpoint, neuroscience development has introduced competitive advantages and spatial distances between the war parties involved. The neuroscience development for military purposes is similar to remotely operated drones that remove the visceral reality of combat by physical proximity to an enemy. Military neuroenhancement with drugs was involved in the 2003 incident where two U.S. pilots accidentally killed four Canadian soldiers and injured eight others while flying in Afghanistan. The U.S. pilots had been consuming "go pills," an amphetamine-based Dexedrine to reduce fatigue on long missions. [77]

Mind enhancement may benefit individuals and society in different ways, but many risks, both to society and the individual, are associated with cognitive enhancement. The risk of coercion is perhaps more pronounced in the military, but individuals may be subtly coerced into enhancing themselves for the sake of competition in sports, school, and the workplace. Every year some professional athlete is suspended for performance-enhancing drugs. Moreover, the military's involvement with above-ground nuclear testing, Agent Orange, and LSD experiments is not exactly a pristine record. The historical record does not illustrate much, if any, virtue with the military application of invasive remote brain control, even when fighting occurs within "The Just War."

The mere performance of discussions will not ensure that neuroscience and neuroengineering will be used ethically or contribute to the betterment of societies or greater goods, but awareness is necessary before improvement can happen. Ethics and moral responsibility must be explored, planted, and rooted at all levels of society, i.e., generally in the public at large, specifically in the goals and minds of scientists and engineers, and concretely in advisory, authoritative, and governing bodies.[78]

Some people believe if we could have a world without military neuroscience, society would be in a better place. However, this idealistic and wishful type of thinking is no longer worthy of consideration. Nations' militaries are firmly entrenched in neuroscience and neuroengineering and provide vast amounts of funding for research. Moreover, dual-use makes any dividing line between civilian and military usages extremely murky.

Ethically speaking, engineers and other scientists *must* become more aware of the multiple usages of neurotechnologies for a "variety of purposes for developing neuroscience" in particular as well as other endeavors. In the USA we should define and construct ethical parameters to guide us and govern our relationships with DARPA, other national security agencies, and the military. The lessons learned during the trials of the Nazi doctors at Nuremberg should never be forgotten. History of the Holocaust must continue to teach us what the capabilities of humankind are in respect to massive destructions and killings, which can be "legitimized" by human legal and political systems. Recall that Nuremberg trials resulted in an *ethics code for human experiments* known as the "Nuremberg Code."

Furthermore, neuroscientists and engineers should carefully consider the military implications and ethical issues associated with their work. We should approach our work with skepticism and cynicism that are similar to the ways many nuclear scientists and engineers opposed the development of atomic weapons. The latter scientists worked to establish test-ban treaties and the reduction of nuclear weapons continuing with the Comprehensive Nuclear Test Ban Treaty (CTBT) and other nuclear treaties, which are still works in progress.

Neuroscience and neuroengineering may be a godsend for many injured or afflicted people since they produce long-lasting, positive, rehabilitative results for injured people in the worst sorts of conditions, namely, mental handicaps. Nevertheless, ethical issues lurk in their development:

- **Can neuroscience destroy our identities as individual human beings?**
- **What is the risk of placing military weaponry over our national or global values?**
- **Will military usage of neuroscience make us less secure?**
- **Who will be the final arbiter of how neuroscience can and cannot be used? And, for what reasons are they allowed and disallowed?**
- **If computers can think and will produce conscious thoughts, then what?**
- **At what point do computer-brain replacement implants significantly alter consciousness or replace human consciousness with a hardware-software-type consciousness?**

These are merely a few ethical questions, issues, and dilemmas we engineers and scientists face both now and in the near and coming future.

If we do not ethically and intelligently reconcile these dilemmas now, we may very well face a serious loss of humanity, a replacement of humanitarianism with inhumane decision-making, and a competitive, globalizing world consisting of groups that "battle" to remain dominant and suppress and "exploit" subordinates within the world's human hierarchy. When and how will we learn to tackle these problems *before* they develop?

Technology obviously seeps into the most intimate aspects of our human lives from the stationary telephone of the 1870s to the cellular phone held to the ears of a plethora of willing adolescents for hours on a daily basis during the early 21st century. If technology would allow the implantation of these devices as well as others into the ears or brains of communicators, **we must brace ourselves for the social changes in speeds, enhancements and competitive advantages of our youngest generations who must be taught and who will later teach ethics and moral responsibility.** Such ethics and moral responsibility will surely be the most stable ground for constructing laws that are not only justifiable but are needed in order to handle various violations of human rights that will be realized in relation to the neurosciences of the 21st century.

References, Endnotes, Acknowledgments, Permissions & Websites

Portions of this course started development in 2001. Since then, countless books and/or websites were visited, many with links to other sources, some of which are on longer on the web. Every attempt has been made to credit those sources used in this course and indulgence is begged of anyone who has been slighted.

1. Moreno, Jonathan D., Ph.D. *Mind Wars-Brain Research and National Defense.* New York/Washington, D.C.: Dana Press, 2006. p. 17.
2. Neuroengineering at the Johns Hopkins University. http://neuroengineering.bme.jhu.edu last accessed 6/4/11.
3. Chun Siong Soon, Brass, Marcel, Heinze, Hans-Jochen & Haynes, John-Dylan. 2008. Unconscious determinants of free decisions in the human brain. *Nature Neuroscience* 11: 543-545
4. Wells, H. G., Huxley, Julian S. & Wells C. P. 1931. *The Science of Life*: Volume IV. Doubleday, Doran & Company, Inc. Garden City, NY.
5. The New Oxford American Dictionary
6. Id.
7. Robinson, Daniel N. *Consciousness and Its Implications.* The Teaching Company. www.TEACH12.com . Course Guidebook, Lecture Ten, *Do Computers Play Chess?* p. 37.
8. http://venturebeat.com last accessed 6/23/11.
9. Id.
10. Id.
11. Kurzweil AI blog, 2/14/11.
12. Id.
13. Turing, Alan M. (author), Copeland, Jack B., Ed. *The Essential Turing: Seminal Writings in Computing, Logic, Philosophy, Artificial Intelligence, and Artificial Life plus Secrets of Enigma.* Oxford: Oxford UP, 2004. *passim.*
14. Id.
15. Turing, A. M. *Computing Machinery and Intelligence.* Mind, 59, 433-460 (1950). http://loebner.net/Prizef/TuringArticle.html
16 Id.
17 Smith, Edward & Osherson, Daniel. 1998. *Thinking: An Invitation to Cognitive Science* Second Edition Volume 3. MIT Press. Cambridge: MA and London, England.
18. von Neumann, John. *The Computer and the Brain* 2nd Edition with foreward by Paul M. Churchland and Patricia S. Churchland. Yale University Press: New Haven and London, 1958, 2nd Edition 2000. pp. xi-xv.

19. Id.
20. Id.
21. Id.
22. http://news.cs.washington.edu/?s=morpheus Raj Rao's paper "Control of a humanoid robot by a non-invasive brain-computer interface in humans" was the featured article in the most recent issue of the *Journal of Neural Engineering*. (accessed 3/3/12).
Raj Rao's *Morpheus* on Sunday Morning with Bill Geist (May 2007); Ahead of the Curve: Mind Controlled Robots (ABC News) (May 2007); "The Brain-Powered Robot Servant" (Popular Mechanics) (April 2007). (accessed 7/7/07).
23. BBC News. *Mouse brain simulated on computer.* April 27, 2007. http://news.bbc.co.uk/go/pr/fr/-/2/hi/technology/6600965.stm (accessed 3/3/12).
24. Id.
25. Id.
26. MSNBC.com by Associated Press. *IBM computer simulates cat's cerebral cortex.* 11/18/2009.
27. The Washington Post by Associated Press. *In pursuit of chips that behave like human brains, IBM announces a milestone.* 8/18/2011.
21. Id.
28. Crichton, Michael. *The Terminal Man.* Random House, New York: 1994 Ed., original 1972.
29. Horgan, John. *The Forgotten Era of Brain.* Scientific American, **293**, 66-73 (2005). www.wireheading.com/delgado/brainchips.pdf accessed 7/30/11.
30. Id.
31. Berger, Theodore W. and Glanzman, Dennis L., Editors. *Toward Replacement Parts For the Brain-Implantable Biomimetic Electronics as Neural Prostheses.* MIT Press, Cambridge: 2005. pp. vii-ix.
32. Id.
33. Restak, Richard, M.D. *The Naked Brain-How the Emerging Neurosciety Is Changing How We Live, Work, and Love.* Harmony Books, NY: 2006. pp. 14-15.
34. Berger. pp. 241-42.
35. Berger. pp. 242-43.
36. Berger. Id.
37. LeDoux, Joseph. *The Synaptic Self--How Our Brains Become Who We Are.* Viking Penguin, NY: 2002. pp. 1-12.
38. Berger. pp. 250-55.
39. Berger. pp. 255-57.
40. Berger. pp. 242-43.
41. Berger. p 259.
42. LeDoux, Joseph. *The Synaptic Self-How Our Brains Become Who We Are.* Viking Penguin, NY: 2002. pp. 1-12.
43. Berger. pp. 259-65.

44. Berger. pp. 242-37.
45. Beiser, Vince. *Sight For Sore Eyes.* Miller-McCune.com Sept/Oct 2011.
46. Chorost, Micheal. *World Wide Mind-The Coming Integration of Humanity, Machines, and the Internet.* Free Press, NY: 2011. pp. 5-6.
47. Chorost, passim.
48. Id. pp. 139-44.
49. "Brain Braking." *Popular Mechanics.* Nov. 2011. p. 15.
50. Robinson, William (2004). *Understanding Phenomenal Consciousness*. Cambridge University Press.
51. Chun Siong Soon, Brass, Marcel, Heinze, Hans-Jochen & Haynes, John-Dylan. 2008. Unconscious determinants of free decisions in the human brain. *Nature Neuroscience* 11: p. 543
52.Grimm, Patrick. (2008). "Philosophy of Mind: Brains, Consciousness, and Thinking Machines" *The Great Courses* Audio Lecture Series. http://www.pgrim.org/
53. Wells, H. G., Huxley, Julian S. & Wells C. P. 1931. *The Science of Life*: Volume IV. Doubleday, Doran & Company, Inc. Garden City,

Neuroethics, Legal Systems and Ethics of Consciousness

54. Kemmelmeier, M. (2005). The effects of race and social dominance orientation in simulated juror decision making. Journal of Applied Social Psychology, 35, 1030 – 1045.
55. Norton, M. and D. Ariely (2011), "Building a Better America—One Wealth Quintile at a Time", Perspectives on Psychological Science, vol. 6, pp. 9-12.
56. Cruces, Guillermo, Truglia Ricardo Pérez, & Tetaz, Martin. (2011). "Biased perceptions of income distribution and preferences for redistribution: Evidence from a survey experiment." http://www.pegnet.ifw-kiel.de/activities/research/results/cruces-2011-bias-perceptions & www.politiquessociales.net/IMG/pdf/dp5699.pdf
57. Matsuhashi M, Hallett M. 2008. The timing of the conscious intention to move. European Journal of Neuroscience. Dec;28(11):2344-51.
58. Trevena J.A. & Miller, J. A. 2002. Cortical movement preparation before and after a conscious decision to move. *Journal of Conscious Cognition* June;11(2):162-90; discussion 314-25.
59. Rigoni D, Kühn S, Sartori G, Brass M. 2011. Inducing disbelief in free will alters brain correlates of preconscious motor preparation: the brain minds whether we believe in free will or not. *Psychological Science*. May;22(5):613-8.
60. Clifford, William. (1877). "The Ethics of Belief." *Contemporary Review*. http://myweb.lmu.edu/tshanahan/Clifford-Ethics_of_Belief.html
61. Wegner, D. (2002). The illusion of conscious will. Cambridge, MA: MIT Press.

62. Soon, C.S., Brass, M., Heinze, H.-J., & Haynes, J.-D. (2008). Unconscious determinants of free decisions in the human brain. Nature Neuroscience, 11, 543–545.
63. Hallett, M. (2007). Volitional control of movement: The physiology of free will. Clinical Neurophysiology, 118, 1179–1192.
64. Rigoni, D., Brass, M., & Sartori, G. (2010). Post-action determinants of the reported time of conscious intentions. Frontiers in Human Neuroscience, 4, Article 38. Retrieved May 14, 2010, from http://www.frontiersin.org/human_neuroscience/10.3389/fnhum.2010.00038/full
65. Kant, Immanuel. (1785). The Fundamental Principles of the Metaphysics of Morals. Trans. Thomas Kingsmill Abbott. Sect. 1: http://philosophy.eserver.org/kant/metaphys-of-morals.txt
66. Sinnott-Armstrong, Walter, "Consequentialism", The Stanford Encyclopedia of Philosophy (Winter 2011 Edition), Edward N. Zalta (ed.), URL = <http://plato.stanford.edu/archives/win2011/entries/consequentialism/>.
67. Burleigh, Nina. "Who Owns Your DNA Anyway?" More.com, February 2012. pp. 76-81.
68. Lecture material from Thomas Metzinger's Bewußtsein class in the Philosophisches Seminar at the Johannes Gutenberg Universität—Mainz on July 21st 2011.
69. Boly, Melanie, Faymonville, Marie-Elisabeth, Peigneux, Philippe, Lambermont, Bernard, Damas, Pierre, Fiorre, Del Guy, Degueldre, Christian, Franck, Georges, Luxen, Andre, Lamy, Maurice, Moonen, Gustave, Maquet, Pierre & Laureys, Steven. (2004). "Auditory Processing in Severely Brain Injured Patients: Differences Between the Minimally Conscious State and the Persistent Vegetative State." *Archives of Neurology* Vol. 61 February, 2004.
70. Giacino JT, Ashwal S, Childs N, Cranford, R., Jennett, B., Katz, D. I., Kelly, J. P., Rosenberg, J. H., Whyte, J., Zafonte, R. D., Zasler, N. D., (2002). "The minimally conscious state: definition and diagnostic criteria." *Neurology*. 2002;58:349-353.
71. Jennet, Bryan. 2002. "The Vegetative State." *Journal of Neurology, Neurosurgery, & Psychiatry with Practical Neurology* 73:355-357
72. Owen, Adrian, Coleman, Martin, Boly, Melanie, Davis, Matthew, Laureys, Steven and Pickard, John. 2006. Detecting Awareness in the Vegetative State. *Science*, 313 No. p. 1402
73. Elliott, Glen R. and Elliott, Mark D. Pharmacological cognitive enhancers: Comment on Smith and Farah (2011). *Psychological Bulletin*, Vol 137(5), Sep 2011, 749-750.
74. Farah MJ, Illes J, Cook-Deegan R, Gardner H, Kandel E, King P, Parens E, Sahakian B, Wolpe PR (2004). „Neurocognitive enhancement: what can we do and what should we do." *Nature Reviews Neuroscience* 5:421–425

75. Spears, Tom. 2003. New drug may help soldiers stay awake: Doctors unsure of long-term effect. The Ottawa Citizen. October 11th.
http://www.modafinil.com/article/soldiers.html
76. Walzer, Michael. *Just and Unjust Wars: A Moral Argument with Historical Illustrations.* Basic Books: NY, 2006. pp. ix-73.
77. Tennison MN, Moreno JD (2012) *Neuroscience, Ethics, and National Security: The State of the Art.* PLoS Biol 10(3):e1001289. doi: 10.1371/journal.pbio.1001289.
78. Ibid.
79. Moreno, Jonathan D. *Mind Wars: Brain Research and National Defense.* Dana Press: NY, 2006. pp. 17-33; pp. 154-72.

