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Topic
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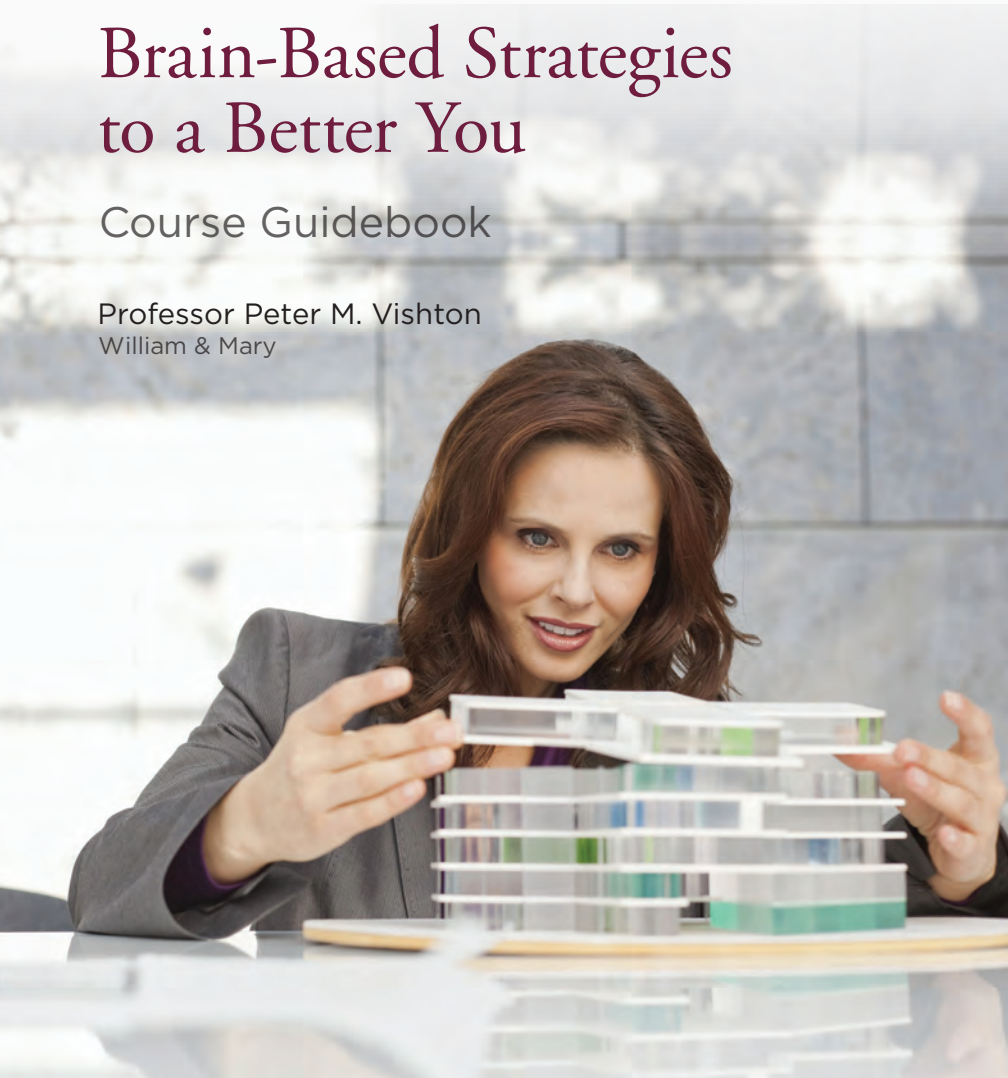
Outsmart Yourself

Brain-Based Strategies to a Better You

Course Guidebook

Professor Peter M. Vishton
William & Mary



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Dr. Peter M. Vishton is an Associate Professor of Psychology at William & Mary. He received his B.A. in Psychology and Computer Science from Swarthmore College in 1991 and his Ph.D. in Psychology and Cognitive Science from Cornell University in 1996. From 2000 to 2004, Dr. Vishton served as an Assistant Professor in the Department of Psychology at Northwestern University. He also has served as the program director for Developmental and Learning Sciences at the National Science Foundation and as a consulting editor for the journal *Child Development*.

Dr. Vishton has published articles in many of the top journals in the field of psychology, including *Science*, *Psychological Science*, *Experimental Brain Research*, *Teaching of Psychology*, and the *Journal of Experimental Child Psychology*. He is also the creator of the DVD *What Babies Can Do: An Activity-Based Guide to Infant Development*.

In addition to teaching, Dr. Vishton studies the perception and action control of both infants and adults. His interests include cognitive, perceptual, and motor development; visually guided action; visual perception; computational vision and motor control; and human-computer interfaces. Dr. Vishton's research has been funded by the Eunice Kennedy

Shriver National Institute of Child Health and Human Development and the National Science Foundation.

Dr. Vishton has presented his research at numerous conferences and invited talks throughout the United States and Europe. He has found a variety of evidence, among both children and adults, that the nature of sensory processing is altered by the actions we choose to perform. In essence, our intention to act on something changes how we perceive it. Dr. Vishton's ongoing work continues to explore how this aspect of the human senses develops and how the motor systems of the brain are involved in mediating the areas of the brain involved in perception.

With The Great Courses, Dr. Vishton has also produced *Scientific Secrets for a Powerful Memory*, *Understanding the Secrets of Human Perception*, and *Scientific Secrets for Raising Kids Who Thrive*. When he isn't exploring human cognition and action, Dr. Vishton enjoys spending time with his family, reading, and distance running. He has completed the Chicago Marathon twice and hopes to complete others in the future. ■

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Outsmart Yourself: *Brain-Based Strategies to a Better You*

Scope

Over the past several decades, cognitive neuroscientists have made immense strides in understanding how the human brain is organized and how the brain mediates our behaviors. This course describes many of these breakthroughs and demonstrates how this knowledge can be used to enhance our everyday lives.

A crucial foundation of this course is the fact that many of our decisions and behaviors are controlled by brain systems that function outside our conscious awareness. While these systems are tremendously significant to our everyday lives, they have many shortcomings. By hacking into these unconscious behavioral-control systems, we can change our behaviors to produce increased happiness, enhanced well-being, and positive outcomes.

For example, if you are eating a snack, most people presume the reason is that you consciously decided to eat that snack. However, many unconscious factors influence that decision to eat, such as how previous eating behaviors have influenced the neural system that controls hunger perception. We can consciously decide to eat or not to eat in a particular situation, but automatic, underlying brain systems control most of our behaviors.

This course applies the knowledge of cognitive systems to a wide variety of topics: procrastination, bad habits, dieting, sleep, phobias, depression,

creativity, multitasking, persuasion techniques, anger, love, happiness, and the aging brain.

The human brain is the most impressive information-processing system that science has ever encountered. Much of its power comes from the brain's ability to perform many processes simultaneously. As astonishing as it is, however, the brain has limits. This course considers one significant bottleneck: Your brain can make only one decision at a time. By avoiding multitasking and instead creating situations in which you can engage in monotasking, you can improve your mental performance tremendously.

This course explores in depth the brain systems that mediate our emotions and considers how you can maintain and improve your close relationships to increase the love in your life. In addition, much has been learned about how your brain processes anger. By intentionally controlling your verbal and physical responses to that anger, you can substantially alter the course of your underlying emotional experience. Similarly, a few simple strategies can turn fear and anxiety into excitement and openness to new experiences.

The human brain is a physical organ that requires particular care to thrive. Sleep and dreaming are critical aspects of that brain-maintenance process. This course outlines the details of what your brain accomplishes while you are asleep and what happens when you disrupt specific parts of that sleep process. This knowledge leads to several easy strategies that will improve your memory and creativity and even your happiness. Simple meditation and imagery practice can augment these benefits as well.

In addition to considering how you can influence the function of your own brain, this course also explains how you can influence the brains of the people around you. We present a variety of techniques that can be used to persuade other people. In addition to actively using these techniques, you should be aware that others will try to use them on you.

This course adopts a skeptical, scientific perspective throughout. Each year, the self-help industry produces thousands of books filled with tips

about how to boost your brain performance and achieve happiness. However, many of those tips are based on individual, anecdotal experiences rather than careful science and empirical evidence. This course focuses on proven scientific research and presents results from replicated studies. The course also suggests several strategies that students should use to become scientists themselves. By collecting data on your own experiences, you can more effectively change your behavior, influence your own mind, and outsmart yourself.

Lecture 1

Take Control of Your Automatic Brain

Experts in cognitive neuroscience and related fields have discovered a great deal about what our brains do when we are engaged in different types of behaviors. In this course, we explore many aspects of human thought and decision making using data and specific knowledge of how our brains actually work. In addition to educating you about how the human brain works, this course focuses on situations where knowledge of the brain can help with specific real-world challenges. Certain patterns of brain activity and associated behaviors produce better results than others. In these lectures, we focus on identifying these brain-based opportunities for behaviors with better outcomes.

The Brain

- The human brain is a network of about 100 billion interconnected neurons. The connections between those neurons—the synapses of the brain—number in the trillions. Everything you've ever seen, heard, thought, or done has emerged from the intricate patterns of chemical and electrical activity produced by the brain.

- A commonly repeated assertion is that we only use about 10 percent of our brains—an assertion that is almost certainly false. Scientists have developed a variety of techniques that are able to recognize and record the patterns of activity in the brain. Results of their studies demonstrate that even during basic, everyday tasks, nearly the entire brain is active.

- While it is clear that humans use far more than 10 percent of the brain, there is some truth to the notion that we only understand about 10 percent of what's going on in the brain. While cognitive neuroscience has learned a great deal about how the brain functions, the brain itself remains one of the great mysteries in all of science.

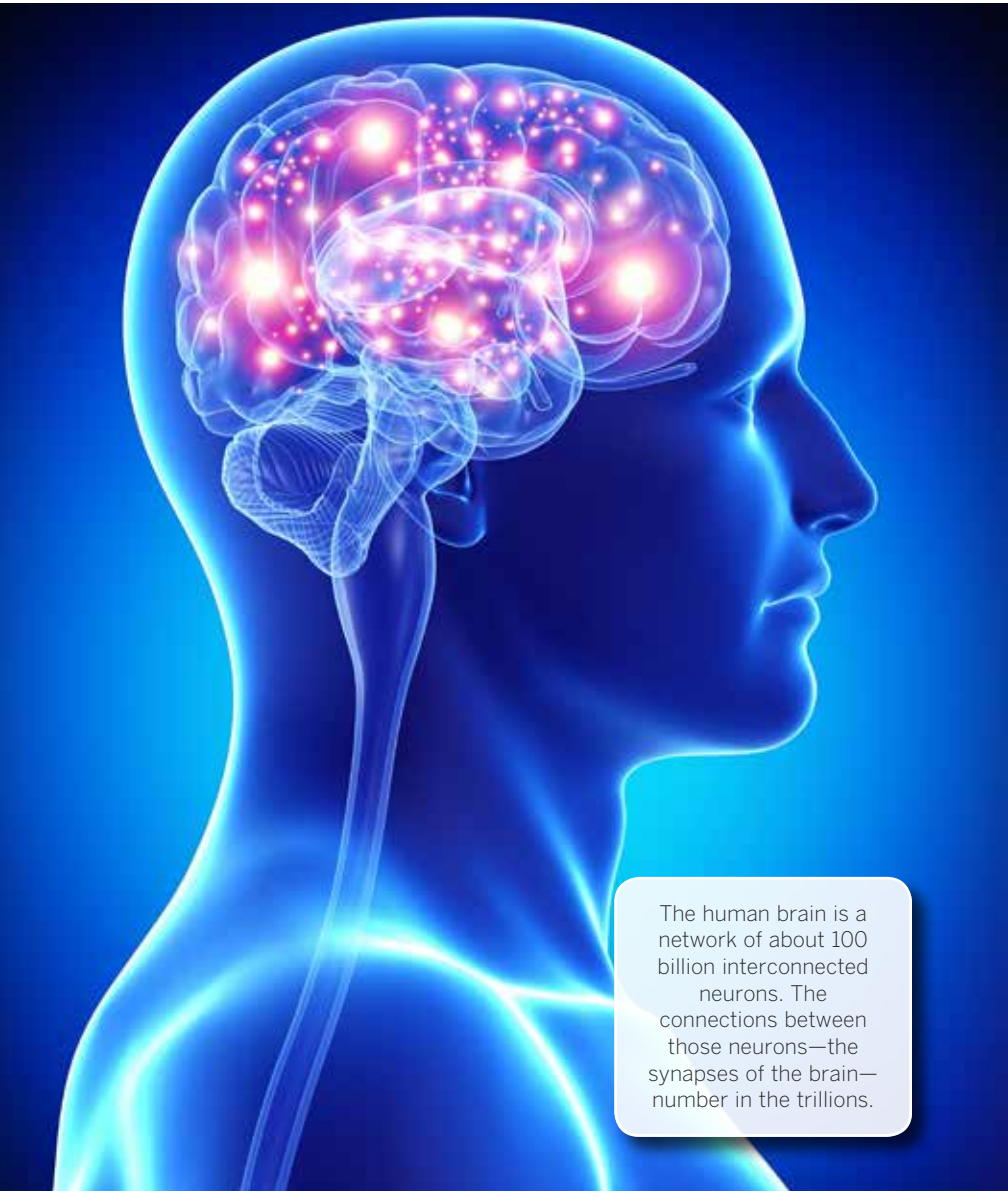
- The past few decades have seen an explosion in our understanding of the brain and how it mediates human behavior. Technologies such as functional magnetic resonance imaging (fMRI) have made it possible to watch the patterns of activation associated with real-time thinking.

The Intention-Behavior Gap

- Brain research has revealed a number of circumstances where the most effective strategies of behavior are counterintuitive—that is, while conventional wisdom and common sense suggest that one type of behavior is the best one to pursue, data from carefully conducted brain-based studies suggest that the opposite is actually the best way to go.

- An example of a counterintuitive strategy is the following: When you set a challenging, long-term goal for yourself, don't tell anyone about it (or tell as few people as possible). The fewer people you tell, the greater your chances are of actually achieving that goal. Research suggests that telling people about your goal won't increase the chance of succeeding. On the contrary, the more people you tell, the less likely that you will succeed.

- Peter Gollwitzer and his colleagues have conducted numerous studies of goal-directed behavior over the years. In one study, students were asked to commit to spending more time studying. In the control condition of that study, the students were then released and contacted later to assess how much extra studying they actually did. In the experimental condition, participants were asked to announce their intention to a group of their peers.


The human brain is a network of about 100 billion interconnected neurons. The connections between those neurons—the synapses of the brain—number in the trillions.

- The surprising result was that the participants who made the public announcement of their intention were significantly less likely to follow through on it. In one particular experiment, they studied for significantly fewer hours.

- Researchers describe the difference between people's plans and people's actions as the intention-behavior gap—the all-too-common disparity between what we intend to do and what we actually do. Announcing one's goals seems to widen that gap.

Benjamin Libet

- Brain research has determined that we don't consciously control our behaviors as much as we think we do. This is a counterintuitive idea, but it's central to much of modern brain science. While this brain research is not proof against the existence of free will, some philosophers do question free will based on the results of certain studies.

- Neuroscientist Benjamin Libet published a number of studies illuminating our understanding of how the brain functions. For a decade, Libet had attempted to understand how the brain produces the conscious experience. Libet worked with a large group of patients who were undergoing brain surgery. For many brain surgeries, the patient remains awake and aware throughout much of the procedure.

- During these procedures, with the permission of the patients, Libet would present brief, mild electrical stimulation to particular sensory regions. For instance, participants in one study would receive stimulation to the somatosensory cortex. This region registers the sensation of touch for different regions of the body.

- Libet's experiments suggested that for a patient to become conscious of something, 500 milliseconds (msec) of brain activity had to be produced—that is, half a second of brain activity. A very brief stimulus, such as a momentary tap on the hand, could produce activity in the

brain, but if that signal was in some way interrupted before 500 msec had elapsed, conscious awareness of it would not occur.

Unconscious Decision Making

- The timing issue occupied many years of Libet's subsequent research. In 1983, Libet conducted one of the most fascinating and influential studies of the human brain. A participant in this experiment would watch a dot moving in a circle around a clock face. The task of the participant was simply to watch the dot and, from time to time, flex his or her wrist.

- The presumption of researchers at the time was that the wrist flexion started with a conscious decision to move. Once that decision was made, a signal was sent from some part of the brain to the motor cortex. The motor cortex then generated a command that was transmitted, via the cerebellum and the spinal cord, to the muscles in the forearm that controlled the wrist. Scientists believed that the order was the conscious decision first, then the motor command, and then the motion itself.

- Participants in Libet's experiment were wired with a variety of instruments. An electroencephalograph (EEG) placed on their scalp allowed researchers to record the tiny electrical activities produced by neural activity in the brain. A separate set of sensors recorded when the muscles were activated and when the movement of the arm occurred. After each movement, the participant would report when he or she first became aware of the intention to act.

- A very consistent pattern emerged when Libet examined the timing of this data. When we perform a movement like wrist flexion, the motor cortex builds up activity for about 500 msec prior to the onset of the action. When that buildup peaks, the signal is sent to the muscles, and the hand moves. But participants in the study only became aware of their decision to act about 200 msec before the action occurred.

- In other words, the motor cortex starts to create the action a full 300 msec before the participant decides to make the move. The data suggest that the brain makes a decision to act—but not a conscious one. A few hundred msec later, a message is sent to our conscious awareness, letting us know that the decision has been made. The decision has already been made before we become consciously aware of it. Our conscious experience of making a decision follows an unconscious process that is actually in control.

Alvaro Pascual-Leone

- Recent studies by Alvaro Pascual-Leone have confirmed the previous findings of unconscious processes. He used a technique called transcranial magnetic stimulation (TMS), which sends a jolt of electromagnetic energy through the skull to the cortex and causes a burst of activity. If that burst is sent to the correct spot in the motor cortex, for example, it's possible to make the arm twitch.

- Pascual-Leone asked participants to watch a screen and, when they were cued, decide whether they would twitch their left hand or right hand. After a delay of a few seconds, a second cue was delivered, at which point the participants made the movement they had decided to make.

- In some trials of this experiment, Pascual-Leone would deliver a TMS jolt to the part of the motor cortex associated with the participant's chosen movement. For a few key trials in this experiment, however, Pascual-Leone would deliver a jolt to the part of the motor cortex associated with the side the participant had not selected, causing the wrong hand to move.

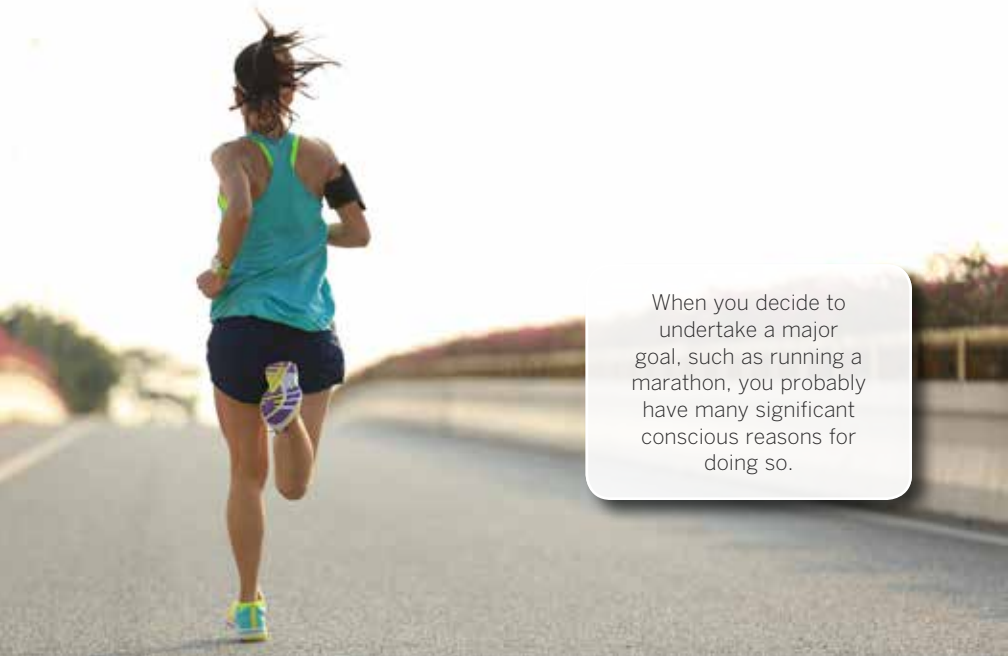
- If our conscious experience of decision making is in control, this reversal should feel peculiar. But most participants had a very simple explanation of the experience: "I just changed my mind." The results of studies by Libet, Pascual-Leone, and others suggest that it doesn't feel unusual when our conscious mind is not in control of our actions.

The Role of Dopamine

- Studies by Libet, Pascual-Leone, and others were the first to demonstrate that the experience of conscious decision making happens after the real decision—an unconscious decision—is made. Their results suggest that consciousness simply goes along for the ride.

- Therefore, if you want to outsmart yourself—to change your own behaviors—deciding to change your behavior is only one very small step toward that goal. Ultimately, to alter your behavior, you have to influence the systems that are in control: the automatic and unconscious decision-making systems.

- Consider how this information is related to the counterintuitive tip: When you set a challenging, long-term goal for yourself, don't tell anyone about it (or tell as few people as possible). The fewer people you tell, the greater your chances are of actually achieving that goal.



When you decide to undertake a major goal, such as running a marathon, you probably have many significant conscious reasons for doing so.

- For example, when you decide to undertake a major goal, such as running a marathon, you probably have many significant conscious reasons for doing so. You might admire someone else who has accomplished a similar goal. Perhaps you have health reasons for pursuing the objective, such as improving fitness.

- A key motivating factor, however, is to experience that extraordinary sense of satisfaction derived from picking a difficult challenge and then overcoming it. Whenever you set a goal and achieve it, your brain gives itself a positive shot of pleasure. The brain delivers a shot of the neurotransmitter dopamine to the nucleus accumbens—a pleasure center of the brain.

- If you constantly tell people about your goal, however, you consistently get a little bit of that sense of accomplishment, that pleasurable boost. In a very real sense, you reduce your drive to achieve the goal.

Questions to Consider

1. There is evidence that we start to implement behaviors before our experience of consciously deciding to act. If you perform a set of actions that results in a crime, are you really responsible for it? Can you say that you didn't really decide to commit the crime?
2. Many of our daily behaviors seem to be performed on autopilot—outside our conscious focus. Are there any actions that could not be performed in this autopilot mode? What characterizes behaviors that do and do not require our conscious attention?

Suggested Readings

Eagleman, *Incognito*.

Mlodinow, *Subliminal*.

Lecture 2

Beat Procrastination by Doing Nothing

Somewhere between 80 percent and 95 percent of people engage in procrastination on a regular basis. In fact, 50 percent of people report that they procrastinate consistently and that their procrastination frequently causes problems in their lives. An H&R Block survey revealed that procrastination-related errors cost taxpayers an average of about 400 dollars per year. Procrastinators also report feelings of distress, anxiety, and guilt. In this lecture, we suggest ways to outsmart yourself and reduce the frequency and severity of procrastination. These tips and strategies are based on an understanding of how the brain functions as it makes decisions and how the brain responds to different types of reinforcement.

Tip 1: Don't Just Do Something; Stand There

- To break free from the grip of procrastination, sit quietly and think for 15 to 20 minutes about what you are going to do. This tip may seem counterintuitive, but there is good evidence that it works. Sitting still can break the cycle of delay, distraction, and time wasting. Several studies that include an explicit relaxation period demonstrate that this practice reduces the frequency of procrastination.

- As we've already learned, a decision to do something does not necessarily lead to action. Something else is in control of many of our moment-to-moment choices and behaviors: the unconscious mind.

- Brain systems in the prefrontal cortex seem to control our intentional, planned behaviors. Consider what happens if this prefrontal cortex is

damaged. One of the most famous patients in the history of neurology was Phineas Gage, who suffered a traumatic brain injury in his work as a railroad construction foreman in the 1800s. When he was 25 years old, there was an accident with dynamite, and a long metal rod went straight through his head and came out the back.

- Amazingly, Gage survived. His personality changed radically, however. The rod had severely damaged Gage's prefrontal cortex. Gage became lazy and lost his capacity for long-term strategic planning. The prefrontal cortex gives us the ability to make long-term work plans and stick to them.

- While the prefrontal cortex is vital, it is not the only system that regulates our decisions. Some researchers refer to an unconscious system of habitual, automatic behaviors that functions like an autopilot. The cortex participates somewhat in the release of these habitual, automatic behaviors, but the primary control of them seems to be based on circuits in subcortical regions of the brain. This unconscious habit system is particularly sensitive to immediate needs and short-term goals.

Procrastination and Anxiety

- Procrastination is often associated with anxiety. A number of studies have found that people who tend to be more anxious in general are more likely to struggle with procrastination. When procrastinators are interviewed about the tasks they avoid, they often spontaneously mention tasks where they have a fear of failure.

- The amygdala is a small region of the brain located deep in the medial part of the temporal lobe. The amygdala is a key part of the limbic system of the brain, which is strongly associated with many of our emotional responses to various stimuli. The limbic system structures are small in comparison to the larger cortex structures on the top and outer parts of the brain, but they are highly interconnected with other

parts of the brain. When you feel anxious, your entire nervous system changes the very nature of its function.

- Procrastination is associated with a great deal of activity; however, it consists of activity directed at less-important pursuits with an immediate reward. In fact, anxiety avoidance is a standard example of negative reinforcement. You feel a negative stimulus—the anxiety. You perform some behavior—procrastination—and the anxiety is reduced. This is a very easy habit to develop and a challenging one to break.

- There are two main reasons that the strategy of sitting and doing nothing for 15 to 20 minutes is effective in reducing procrastination behaviors. First, intentionally doing nothing will prevent you from engaging in avoidance behaviors that are the real grist of the procrastination mill. Second, as you sit and think about the work that you might do, the anxiety will likely abate.

Tip 2: Avoid Choking under Pressure

- A second strategy to reduce the frequency and severity of procrastination is to avoid feeling too much motivation to complete a task. Motivation is much like pressure, and too much pressure can lead to choking under pressure. Too much motivation can actually reduce the amount and quality of performance. Cognitive neuroscientists refer to this as the Yerkes-Dodson law.

- Imagine that you ask a group of experiment participants to shoot a series of basketball foul shots. You also give another group of study participants the same task under the same experimental conditions but with some extra motivation: one dollar for each successful shot. If people know there is some money on the line, they are likely to take the shots a little more seriously and probably make a few more shots. If you offer five dollars per shot to another group, you're likely to get even better performance. In general, more motivation results in better performance—but only to a point.

- If you bring in another group of participants and offer them 1 million dollars for every successful shot, they will likely not improve their performance above that of the five-dollar group. Ironically, the most likely outcome is that they will perform worse. With too much motivation, people choke under pressure.

- If you want to reduce your own tendency to procrastinate, it's a good idea to keep the significance of your work in perspective. While your work may be vitally important, the sun will still rise tomorrow morning.

Tip 3: Break Large Goals into Smaller Tasks

- A third tip for reducing procrastination arises directly from the concept of motivation. This strategy uses the pleasure center—one of the subcortical unconscious control systems that live deep inside the brain. If you want to reduce procrastination, break any large project into parts. As you complete these small parts, keep track of

your progress. Even if the project itself isn't an enjoyable one, simply seeing yourself move closer to the finish line can produce pleasure.

- Humans act because of choices made by unconscious systems within our brain. Rat brains seem to work in the same way, especially under standard laboratory conditions. Rats respond to reinforcement. If you give a rat food whenever it presses a lever, then it will press the lever more frequently in the future.

- One of the central parts of the circuit involved in processing pleasure is called the nucleus accumbens, located in the basal forebrain, tucked up underneath the cortex near the front of the brain. Many of the neurons found there respond to neurotransmitters called dopamine and serotonin. Neurotransmitters are chemical substances produced by the body—many in the brain itself—that influence the function of neurons. Sometimes neurotransmitters can be excitatory, which means they cause a set of neurons to become more active. In other situations, a neurotransmitter will be inhibitory, reducing the activation of a set of neurons.

- The nucleus accumbens is linked to a variety of other areas of the brain that motivate particular actions. If a rat is hungry, this circuit will drive the rat to perform behaviors that it associates within finding food, such as searching and sniffing. If the rat learns to associate pressing a bar with getting food, then when the hungry rat presses the bar, the nucleus accumbens will be activated, and the rat will experience pleasure.

- Many neuroscientists who study learning and motivation describe the nucleus accumbens circuit as the driver of the whole system. The rat seeks food, water, comfort, other rats, and so on, but all its behaviors come back to a single motivator: the drive to release dopamine into the nucleus accumbens.

- Humans also have a nucleus accumbens—two of them, in fact, in the left and right sides of our brain—and many of our behaviors,

particularly unconsciously controlled behaviors, are driven by a desire for dopamine in the nucleus accumbens. When you are hungry and feel the pleasure of a delicious meal, it is your nucleus accumbens dopamine-related activity that gives you that pleasure. In fact, the dopamine-related activity is itself the pleasure.

Celebrate Small Successes

- Consider another type of activity that gives us a shot of pleasure: controlling and affecting the world around us. If we perform some action, and the action causes something we intended to come to pass, we experience pleasure.

- The desire to control the world around us is very fundamental. In fact, even babies seem to experience it. If you put a baby into a crib under a mobile that shakes from time to time, the baby will watch and sometimes kick her legs. If you connect her leg to the mobile so that the mobile shakes when she kicks her legs, the baby will continue to kick. Even a three-month-old baby will learn the relation between action and an environmental outcome in just a few minutes.

- When we decide to take on some challenge and then succeed in accomplishing it, we get a boost of pleasure—a shot of dopamine-related activity in our nucleus accumbens. We don't, however, get that burst of pleasure while we're actually pursuing the goal. We get it when we accomplish the goal.

- Think of yourself as a rat! Imagine you have a big project, one that has been driving you to procrastination for a while. Completing the project will be a huge success and gain you a sizeable reward. Think of your reward, for the moment, as a big pile of rat kibble. Rather than leave all the kibble in one big pile at the end, this tip suggests that you should spread it out. Arrange it in a line between your current location and the location where you want to be.

- As you complete small subtasks, you will earn yourself little pieces of kibble—and receive the associated releases of dopamine to your nucleus accumbens. When you achieve those subtasks, make a point of celebrating them. Keep feeding your pleasure centers enough motivation to keep yourself moving along. Stay focused on the same project long enough so that you achieve the significant goal at the end.

Questions to Consider

1. Beta-blockers are medications that block the receptor sites for adrenaline and noradrenaline, neurotransmitters associated with anxiety. When people take beta-blockers, they tend to feel fewer effects of anxiety. Would it be effective for someone with chronic procrastination to take beta-blockers?
2. Steve Jobs was known to yell at his computer engineers to motivate them. Some people work better when they receive strong motivation like this; the performance of others greatly declines. How could you decide which type of motivation is best for another person? Which type of motivation is best for you?

Suggested Readings

Allen, *Getting Things Done*.

Tracy, *Eat That Frog!*

Lecture 3

Train Yourself like a Dog

While habits can seem like minor, unimportant behaviors, in fact, they are significant activities that deserve our attention. The philosopher Aristotle noted, "We are what we repeatedly do. Excellence, then, is not an act but a habit." Jim Ryun, one the greatest distance runners in American history, said, "Motivation is what gets you started. Habit is what keeps you going." If we can fix our habitual tendencies, we can fix our lives. In this lecture, we consider how we can use the tools of cognitive neuroscience to alter our behaviors.

The Notepad Strategy

- Consider this simple tip—one that is startlingly effective for reducing the frequency of a bad habit. An effective strategy for behavioral training is to call attention to the problem behavior whenever it appears. An additional step is to write down the times when this problem behavior occurs and then read that list at the end of the day.

- Walk around with a notepad and pen. At the start of the day, write the date at the top of a page. Any time you engage in your problem behavior, don't unduly criticize yourself . Just pull out the notepad and write down the time of day and a few words summarizing the details. If you're trying to cut down on television, note the start and end time of the television watching. If you have a doughnut-eating habit, write down the time, place, and flavor of the doughnut. At the end of the day, as you are about to go to sleep, read over your list of incidents. Then, turn the page and put the notepad and pen away.

- Many programs aimed at objectives such as smoking cessation use the notepad strategy as a baseline task. You start by noting how much

you actually smoke for one week, and then you start the intervention—perhaps chewing nicotine replacement gum or exercising to reduce cravings. The baseline procedure itself—simply noting the incidents—often has a very strong effect all by itself.

- Over short spans of time, by exerting our conscious will, we can immediately—often drastically—alter our behavior. That explicit control of behavior takes continual attention and a great deal of mental energy, however. As we get distracted by other concerns, the conscious control drifts away. As it does, the unconscious control takes over.

- Cognitive neuroscientists have identified several few reasons for the success of the notepad strategy. The most basic explanation derives directly from our knowledge about the unconscious processes that control behaviors. Since these unconscious processes are often in control of behaviors, you may not actually be aware of how often you engage in a particular habit. As you see the pages of your notebook filling up, you will tend to eliminate some of the unconscious repetitions of the behavior.

Self-Control as a Muscle

- Researchers have explored another technique of behavioral modification using the theory that self-control is like a muscle. After an exercise workout, the muscle will be fatigued and less useful; however, when it heals, it gets stronger.

- The same process seems to apply to our self-control. In one set of experiments, conducted by a team led by Mark Muraven, participants were recruited and asked to refrain from eating any sweets for two full weeks. The participants noted whenever they ate something sweet. The experiment was largely successful; participants reduced their sweet-eating habits. However, the most interesting result emerged when the participants came into the lab at the end of the two weeks to complete a stop-signal test.

- Participants in the stop-signal test watch a computer screen. If a rectangle appears on the right side of the screen, they quickly press a key with the right hand. If the rectangle appears on the left, participants quickly press a different key with the left hand. For a randomly selected 25 percent of the trials, however, a beep sounds when the rectangle appears. On those trials, and only those trials, participants have to ignore it and make no key press.

- This sounds simple, but the test pits one part of the brain against another. The visuomotor system learns the task very quickly, but when the beep sounds, the voluntary, conscious self-control system has to kick in and stop things. People who are better at stopping themselves from hitting the keys have better general self-control. What's interesting is that this self-control ability is improved after two weeks of avoiding sugary snacks. It seems that if you practice self-control, you improve self control—just like a muscle.

Development of the Frontal Lobes

- Several functional magnetic resonance imaging (fMRI) studies have characterized the location of the self-control ability in the brain. When people are engaged in successful stop-signal behaviors, the superior medial and precentral frontal cortices show greater activation. These frontal lobes are associated with such tasks as problem solving, creativity, and strategic thinking.

- The frontal lobes are also strongly associated with regulating the rest of the brain in impulse control and avoiding overly risky behavior. Areas in the frontal lobes are the latest sections to develop fully.

- In the past, neuroscientists believed that the brain was finished with its primary development by the late teen years; however, some recent work has suggested otherwise. Between 18 and 22 years of age, there is a surge of development in the frontal lobes. Specifically, there is a large increase in the production of myelin—a fatty insulating substance that increases neuronal efficiency. During this same period

of time, people get much better at self-control in general. Most people presume that it is this increase in development of white matter that leads to a reduction in the high-risk, impulsive behaviors that are commonly associated with the teen years.

Alternative Behavioral Associations

- The human brain is remarkably effective at making associative links. In fact, making associative links is an unconscious tendency that we all share and that we cannot fully turn off. If you think about something that you don't want to think about, you are, in a sense, already thinking about it. The same process happens when we try not to think about engaging in some habitual behavior. Calling attention to the behavior will help. What's more, your inhibitory self-control ability will get stronger with exercise.

- Instead of turning off an existing associative link—which is impossible—you can create an alternative associative link and make it stronger. In other words, to stop a bad habit, you need to replace it with another behavior. The goal of this training procedure is not to temporarily change behavior but ultimately to change the underlying mental processes that drive a problematic habit in the first place. You need to create a new, automatic, unconscious process that will take the place of the problematic one.

- A great deal of research supports this strategy. A study conducted by Marieke Adriaanse and her colleagues asked participants to identify situations that triggered the performance of a bad habit—for example, "When I feel anxious, I tend to go to the kitchen for a sugary snack." In the next step, participants were asked to come up with an alternative behavior to pursue when the trigger showed up—for example, "When I feel anxious, I will eat an apple."

- The experimenters found that the focus on associating an alternative behavior with the trigger resulted in a greater reduction in the habitual behavior. The researchers also performed a variety of tests exploring

how this change occurred. The researchers determined that when you form an alternate intention—an alternate behavioral association with the trigger that usually causes a bad habit—your brain changes its internal association structure. After forming and practicing the alternate association, your brain starts to process the new action faster. If this happens quickly enough, that new behavior will tend to be triggered instead of the bad habit.

Positive and Negative Reinforcement

- Both positive and negative reinforcement have been proven to effectively shape behavior.
  - In positive reinforcement, something pleasant gets added to your experience after you perform a behavior.

- In negative reinforcement, something aversive gets removed after you perform a behavior. (Note that negative reinforcement is not the same as punishment.)

- In positive punishment, something negative is added to your experience after you perform a behavior.

- In negative punishment, something positive gets removed after you perform a behavior.

- In general, to promote more general and long-lasting learning, most research suggests that you should focus on the reinforcement side of things. For example, imagine that you have a bad habit of leaving the television on when you leave for work, and you want to lessen the incidence of that habit. Make a contract with yourself: Starting tomorrow, if you remember to turn off the television, give yourself a cookie when you come home.

- Remember that you are not trying to change your conscious behavior. You are, to use the language of a behaviorist like B.F. Skinner, shaping the behavior of your unconscious action control systems. The cookie is for that part of your brain.

Self-Administered Reinforcement

- Over the course of several decades, a wide range of studies have been conducted on self-administered reinforcement. Students have used it to improve study habits. Dieters have used it to enhance healthy eating practices. People with phobias have used self-administered reinforcement to train themselves to deal with their fears. You can pick almost any practice, make a contract with yourself, and then change your behavior.

- One hallmark of behavioral shaping is that it can be a slow process. It might be several weeks before you reach the final behavior that you seek. Often, behavioral scientists who use these techniques to

train animals to perform complex sequences of actions will employ a gradual shaping process.

- While the training process is slow, the good news is that once the new behavior is set, unlearning the training will also function slowly. Eventually, you won't have to reinforce yourself all the time; you will only require periodic reinforcement for good behavior.

Questions to Consider

1. Experiments suggest that our self-control can be increased if it is exercised—that is, it can be strengthened like a muscle. Should we train our children or grandchildren to build this self-control muscle from an early age? How would you do that?
2. Research suggests it's easier to stop performing a bad habit if you replace that habit with an alternate behavior. For example, it's easier to quit excess snacking if you decide to go for a walk whenever you feel like snacking. Do you think some replacement behaviors are better than others? What alternate behaviors would you suggest to someone who was trying to quit smoking, arguing with the kids, watching too much TV, or forgetting to take medication?

Suggested Readings

Duhigg, *The Power of Habit*.

Skinner, *Beyond Freedom and Dignity*.

Lecture 4

Clean Your Kitchen, Improve Your Diet

An estimated 45 million Americans have undertaken a weight-loss plan within a given year. What's more, the weight-loss industry accounts for about 33 billion dollars in revenue annually. Sadly, however, the obesity epidemic is still going strong. Roughly two out of three American adults are overweight or obese. In 1990, most states had fewer than 15 percent of adults in the obese range. Today, it's up to 25 percent or more. To complicate matters, obesity is associated with many other health consequences. In this lecture, we consider a number of strategies to address unconscious eating behaviors. You'll learn how to establish new habits that will help you maintain a healthful eating program even when your conscious thoughts are directed elsewhere.

Clean Your Kitchen

- If you want to reduce your snacking, clean your kitchen.

- Brian Wansink and his research team conducted a study in which participants were asked to accomplish a simple writing task. The study took place in a kitchen environment where snacks were provided. For half the participants, the kitchen was clean and orderly: Dishes were washed, trash was out of sight, and other food in the kitchen was put away. For the other half of the participant group, the kitchen was in a chaotic condition: Furniture was placed haphazardly, papers were strewn about, and experimenters pretended to arrive late and scrambled to get organized as the study began.

- Even though the study lasted only 10 minutes, the participants in the chaotic kitchen consumed about 53 more calories. A pound of fat consists of about 3,500 calories of stored energy. Extrapolating here, this means that an extra pound of fat would be gained for every 12 hours spent in the chaotic kitchen.

- The Wansink study indicates that eating behaviors are, at least in part, influenced by the cleanliness and orderliness of the kitchen. While unconscious decision-making systems are outside our awareness, they dictate what we do, especially if our conscious mind is focused elsewhere.

Reduce Stress Levels

- Wansink and his colleagues interpret their findings in terms of the stress induced by a cluttered environment. In addition to the variable of the chaotic kitchen versus the clean one, the researchers also manipulated the stress levels of the participants. One third of participants were asked to write about a time in their lives when they felt chaotic and out of control. Another third of the participants were asked to write about a time when they felt particularly organized and in control. The remaining participants were asked to write about the last lecture that they attended.

- This mood-induction technique was successful. People who wrote about the times they felt chaotic and out of control tended to snack the most; people in the neutral condition writing about the lecture snacked somewhat less; and people asked to write about being organized and in control snacked least of all.

- The most interesting aspect of the study, however, was the interaction between two types of variables. The participants who wrote about feeling chaotic and out of control were affected substantially more by the chaotic kitchen.

- Based on this finding, we can refine the kitchen-cleaning tip: If you want to reduce your unhealthful snacking behaviors, you should clean your kitchen—especially if you are feeling at all stressed. The combination of feeling stressed and having a messy kitchen seems very likely to induce your unconscious decision-making processes to find and consume food.

Place Food in Opaque (Not Transparent) Containers

- Another strategy to reduce snacking is to put your food in opaque (not transparent) containers.

- Developmental scientists consider object permanence to be a crucial early accomplishment in the cognitive development of young children. Jean Piaget, often described as the father of developmental psychology, noticed that his infant son would reach for a favorite toy when it was placed in front of him. However, if Piaget covered the toy with a small cloth, his son would stop reaching for it.

- Piaget concluded that children lack the ability to maintain a mental representation of objects that they can't see. If an object was out of view, according to Piaget, then to the child it was as if the object had simply ceased to exist. According to later research, though, this interpretation isn't quite true. A variety of studies suggest that infants do know about objects even after they are hidden. While this later research indicates that children do have object permanence even at two or three months of age, it is still a challenge for children to initiate actions based on things that they can't see.

- This situation remains true even in adulthood. When snacks are placed out of sight, it's not that you are unaware of them. What changes is your behavior. Your inner child no longer reaches for food that is out of sight.

Packaging Research

- Raji Srinivasan and her colleagues performed a fascinating set of studies on how different types of packaging influence snacking behaviors. The researchers wanted to determine how much snack food was consumed by participants while they watched television. It's worth noting that most snacking behavior—most estimates indicate about 70 percent—takes place while people are watching television.

- Srinivasan was doing marketing research that was designed to help food companies select the best packaging to encourage consumers to snack more, not less. But those results work for our purposes here. If a particular type of packaging promotes more snacking, then people

aiming to lose weight will want to avoid that packaging. Conversely, if some type of container results in less consumption, we should put our food into that container.

- In one of the experiments, participants were given colorful, sugary cereal to snack on while they watched television. For half the participants, the fruity cereal was in a transparent container; for the other half, it was in an opaque container. Not surprisingly, the participants with the transparent container ate significantly more sugary snacks—about 170 percent the amount that was eaten from the opaque containers.

- The researchers also found that the package didn't need to be completely transparent to generate these effects. Even if the package had a transparent window, that was enough. You didn't have to see all the food, you just needed to see enough to spur your unconscious appetite processes to reach out and start snacking.

Monitor Consumption

- The optimal food container for managing your consumption depends somewhat on the type of foods. Ultimately, the best strategy for reducing snacking and promoting healthful eating is to repackage the foods that you buy. Food manufacturers have developed a great deal of research and are highly motivated. They will likely have selected a type of packaging that will make you inclined to eat more of their product.

- For everything but the cookies in the Srinivasan study, opaque containers were best. They promoted less consumption of small sugary snacks and more eating of healthful—if less appealing—foods. The only food where transparent containers were more effective was with large cookies.

- The Srinivasan study suggests another strategy for reducing unhealthful snacking behaviors: Use containers to increase your

ability to monitor how much you have eaten. Specifically, if you can do something to enhance your perception of how much you've eaten—even when you are consciously counting or weighing things—then you will be more likely to stop eating sooner.

Use Smaller Plates

- Human perception in general functions by comparing. The nature of neuronal sensory networks is to increase activation when a stimulus increases in strength and also to use that information to inhibit the activity of nearby neurons. Our sensory systems thus adapt and respond mostly to particular things in relation to one another rather than in absolute terms.

- Consider the classic visual display called the Ebbinghaus illusion. Two central disks are identical in size. One central disk is surrounded by small disks; the other is surrounded by large disks. Even though the projection of the two central disks onto the retina at the back of the eye is identical in size, most people perceive the one surrounded by small disks as larger than the one surrounded by the large disks. Our perception of an object's size is influenced by its relation to the images around it.

- There is a related pictorial illusion—the Delboeuf illusion—in which two identical disks are surrounded by different-sized circles. The effect of relative size applies here as well, with the disk inside the larger circle appearing smaller.

- Some clever researchers have found that the illusion even applies to food. Brian Wansink and his colleagues initially demonstrated this effect at an ice cream social. The experimenters presented participants with different-sized bowls and then recorded how much ice cream people scooped out for themselves. They determined that if you are placing food on a small dish, you will stop sooner than if

you are putting your food onto a large dish. Your perception of the amount of food on your plate is based on how that amount of food compares to the size of the overall dish.

- The tip here is simple: If you are looking to cut back on your eating, one of the simplest, easiest strategies is to use smaller plates.

Apply Your Comparison Capability

- Consumption of sugary drinks has been identified as a strong contributor to our modern obesity epidemic. A 20-ounce sugary drink contains about 16 teaspoons of sugar. A 32-ounce sugary drink contains about 350 calories. What's worse, sugary drinks don't satiate hunger.

- Consider this illusion if you want to reduce your intake of sugary drinks. Given a choice of glasses of various heights and widths, people will identify a tall, mostly full glass as the one holding the most fluid. Conversely, a very wide glass that is mostly empty appears to have the smallest amount. This illusion holds true even when all the glasses contain the same amount of fluid.

- What this illusion very directly suggests is that you should choose to drink out of a tall, thin glass when you drink anything but water. Essentially, everyone falls for this illusion; in fact, in a study by Wansink and his colleagues, it was found that most professional bartenders fall for it too.

Questions to Consider

1. If you clean and organize your kitchen, you will tend to eat more healthfully. If you clean and organize your office or other workplace, how might that affect your daily life? How about cleaning and organizing your car?
2. Using small plates and utensils encourages people to serve themselves less food and thereby to consume less. A recent result suggests, however, that if you eat at a smaller table, you will eat more food. Why might that be? (*Hint*: Think about the size-contrast illusion.)

Suggested Readings

Kessler, *The End of Overeating*.

Wansink, *Slim by Design*.

Lecture 5

Eat Slow, Eat Small, Eat Smart

Many experts agree that the best diet is one that we don't realize we are on. In this lecture, we look at a variety of studies dealing with how the human appetite and drive systems interact with reasoning and decision-making systems. By examining how the brain mechanisms function in terms of hunger and satiation, we'll explore how to create habits that support a healthful eating plan.

Leptin and Ghrelin

- If you are trying to cut down on the amount you eat, slow down during meals. Eat a moderate amount, and then take a break for about 20 minutes. If you are still hungry after those 20 minutes, you can have more; however, many people find that they just aren't as hungry as they thought they were.

- Consider some of the brain mechanisms involved in regulating hunger and satiation. Eating behaviors influence the amount of the hormones leptin and ghrelin that are released in the body. Leptin is produced by our fat cells. Ghrelin is produced by cells that live in our intestines.

- Fat is an energy-storage mechanism. In the body, excess energy is converted into fat. Then, when we run low on energy, fat is converted back into a form that can be used to power our cells. When your body starts storing energy, leptin is released by the fat cells into the bloodstream and eventually passes into the brain. Some of the leptin reaches the hypothalamus in a region called the ventromedial nucleus.

There, leptin binds with neuronal receptors and boosts activation of certain neural circuits. When these circuits are active, you feel full and typically stop eating.

- Ghrelin does the opposite. When your intestines finish processing food, they start making ghrelin. As time passes, they continue making more and more ghrelin. Like leptin, ghrelin makes its way to the brain, but ghrelin causes you to start feeling hungry again.

The 20-Minute Break

- Together, leptin and ghrelin regulate food intake; however, these hormones act slowly. From the time you start eating, the full impact of the food on ghrelin and leptin can take up to 20 minutes. If you give your body time to finish that process, you might find yourself quite satisfied with less food. On the other hand, if you eat steadily until you feel full, you will continue to feel more full for 20 minutes after you stop eating.

- Most people presume that if you are receiving a strong hunger signal from your body, it means that you are in dire need of a great deal of food. That just isn't true. If you are truly starving—that is, if you are cut off from food for 48 hours or more—you will feel periodic hunger, but most of the time the hunger signals disappear altogether.

Eat with Men

- To reduce your calorie intake, eat with men.

- Molly Allen-O'Donnell and her colleagues recently performed a set of studies in which they observed people ordering food in restaurants. When women ordered food in all-female groups, they tended to order and consume about 833 calories. When women ate with a man in the group, they ordered less—about 721 calories' worth. When there is a man around, women seem to eat about 13 percent less.

- Interestingly, the effect was the same for men. Eating with at least one male in your group seems to lead to less eating. In these studies, when a man ordered food with only women around, he tended to eat about 1,162 calories. If there were other men in the group, the men consumed about 952 calories—about 18 percent less.

Positive Psychology

- Much of the history of clinical psychology has focused on how to fix people with problems. Researchers study groups of depressed people or populations of anxious people. This is a model of research that focuses on negative situations.

- A more recent body of work, however, has focused on studying the positive aspects of psychological well-being, rather than solely focusing on negatives. This school of thought, known as positive psychology, has revolutionized how researchers think about a variety

of different aspects of human perception, cognition, and behavior. The general goal is to identify people who are thriving and then study what factors are associated with that well-being.

- For many decades, researchers have experimented with people who are overweight with the goal of changing their behavior so that they can lose excess weight. From the positive perspective, however, researchers spend their time studying people who are not overweight.

- When you ask people who struggle with a weight problem why they eat and what they choose to eat, you will get a lot of different answers: anxiety, boredom, depression. When you ask these questions of someone without a weight problem, the answers are much shorter and stunningly obvious: "I eat when I'm hungry." "I stop eating when I'm no longer hungry." "I think about what I feel like eating, and then I eat it."

When Hungry, Eat; When Not Hungry, Don't Eat

- Following is a weight-loss strategy on which both modern cognitive neuroscience and nutritional science clearly agree: If you are hungry, you should eat. Conversely, when you are not hungry, you should not eat.

- This doesn't sound like rocket science, but let's unpack those two statements. If you are hungry, your body is sending you a message that it has changed from a mode of processing incoming energy to one of needing more. Restricting your calorie intake is only a short-term solution. Unless you are willing and able to spend all of your waking hours focusing on controlling your eating, you will eventually slip.

- There's another problem with ignoring the hunger signal. The hormones leptin and ghrelin influence the hypothalamus, which regulates your internal sense of hunger. They also influence your body's metabolism. If you restrict too many calories, the hunger hormones will actually reduce the rate at which your body burns energy. Too much ghrelin will also activate the mechanism that stores

energy in fat cells; therefore, you will use fewer of the calories that you eat and store more of them by enlarging fat cells.

- You can fight this process with physical activity, but unless you are planning to go to extremes, exercise can often prove to be a losing battle. Humans are too efficient at acquiring energy from our foods for exercise to work on its own. What's more, if you start a new exercise program, you will burn more calories, but the hunger system in your brain will be further stimulated. If you don't also regulate food intake, a number of studies have found that eating rises to meet the amount of extra calories burned.

Monitor Your Internal Set Point

- A number of neuroscientists have proposed that the human brain regulates body weight based on an internal set point. It's like a thermostat that regulates the temperature by turning on the heat or the air conditioning to keep the temperature relatively constant—only this thermostat regulates your weight and uses hunger to maintain your weight.

- Your body seems built to do this, but there are ways to hack the system and get around this internal regulation process. Eat when you are hungry. If you don't, then your unconscious regulatory systems will simply compensate and wait until you aren't paying attention.

- When you are hungry, eat a small snack, preferably one that is rich in protein and/or high in fiber. There is much research supporting these eating habits. One of the best examples is a study in which people were given servings of various foods of equal caloric value. After they finished, the participants rated how full they felt and how much it had reduced their hunger. The foods that win this competition are always high in fiber and protein. The losers are always foods highest in sugars and fats. Even if you consume the same number of calories, foods high in sugar and fat influence that leptin-ghrelin system to a lesser degree, resulting in less change in your perception of how hungry you are.

Reinforce Positive Associations

- As you alter your eating plan, several crucial areas of the human brain will come to the rescue. The most notable of these is the orbitofrontal cortex, located near the front of your brain just above your eyeballs. This area is activated by many different types of decision-making behaviors and especially by decisions about food.

- There are strong connections between the orbitofrontal region and areas of the brain associated with hunger. In fact, when you are hungry, this area of the brain is primed for activation. When any food-related stimulus appears, the orbitofrontal cortex reacts, but if you are hungry, it responds a great deal. This area of the brain seems to be a major player in decisions about what looks good to eat.

- It should be said that humans are impressively omnivorous. Every time we eat, our body does a little data collection. It encodes the flavors, textures, smells, and even the social context in which the meal occurred. Then, after the food goes into the digestive tract, it waits to find out what happens. If you happen to feel nauseated after eating, then your brain—in cooperation with your orbitofrontal cortex—concludes that those flavors, textures, smells, and social context should be avoided in the future. If, on the other hand, there is an agreeable outcome—that is, if the body gets a boost of energy and feels satisfied—then a positive association is made with the food.

- As you eat a food repeatedly, your brain forms associations with it just as it does with any other experience. If you are reinforced for any behavior, then you will be more likely to perform it again in the future. If you are punished, then you will be less likely to perform that behavior in the future. This flavor-preference learning system is always at work, every time you eat.

- There are many healthful foods that you can teach your brain to crave. When you are hungry, satisfy your hunger with something healthful. Every time you give your body that pleasurable experience of satisfying your hunger, you will appreciate the food you used to

do so just a little bit more. If you do so long enough, you will almost certainly have an experience where you get a craving—a hunger-induced craving—for a healthful food.

Questions to Consider

1. You are headed to a dinner party and are worried that you will overeat. What might you do before arriving at the party to make that overconsumption less likely?
2. Both men and women tend to eat less at restaurants if at least one of their dinner companions is male. What factor(s) might be responsible for this effect? Is there any way to use those factors to produce healthier eating even if there isn't a male companion?

Suggested Readings

Allen, *The Omnivorous Mind*.

Wenk, *Your Brain on Food*.

Lecture 6

The Myth of Multitasking

One of the greatest powers of the human brain is that it can perform many different processes in parallel. While modern computers are, in some respects, much faster and more accurate than the human brain in terms of sequential operations, artificial intelligence is only just beginning to approximate the extraordinary parallel processing that the human brain performs. In this lecture, however, we explore the "thrill of monotasking"—the sense of focus and clarity that comes from performing only one task at a time. Monotasking can expand the brain's capabilities, speed up reaction times, improve memory, enhance creativity, and even boost IQ. What's more, there are hidden costs to multitasking, in both the short and long term.

Classic Research on Multitasking

- Today, there is significant research on task attention that assesses how well humans do and do not multitask, along with some fascinating work examining how the brain implements multitasking behaviors. However, a large body of older literature explores just how many tasks someone can learn to do at the same time.

- In a classic experimental study, expert typists were given a document to type. At the same time, the experimenters played an audio recording of a voice reading some text aloud. The job of the typists in this study was to verbally shadow that audio recording. (Verbal shadowing is a task in which you repeat what the speaker says while he or she is talking.)

- It turns out that this was an easy task for an expert typist. Expert typists can type quickly and accurately while simultaneously

performing verbal shadowing. It seems that the typing is so automatic that the typist can devote attention to the shadowing, and both activities can proceed at the same time.

- Imagine that the typist practiced the verbal shadowing over the course of several weeks or months. Presumably, the typist would eventually become expert at typing and verbal shadowing. If the typists became expert enough, they may be able to add a third, fourth, or fifth task.

Brain Utilities

- It's helpful that the human brain is so effective at multitasking because our modern world demands it. There is actually a feeling of pleasure that many people describe associated with multitasking. It can be invigorating to push your mind and body up near its maximum capacity for processing information.

- The problem is that when researchers carefully assess people's functioning during multitasking, significant reductions in performance are found. Perhaps most troubling is the fact that people are unaware of the drop in performance. While we feel as if we're doing our best work, we are actually performing poorly.

- The older research using the expert typists, cited above, hinted at some of the problems with multitasking. The typists could type written material while verbally shadowing; however, if the typists had to type dictated words, then the task became tremendously difficult.

- It seems that there are certain limits to how well we can process different information streams simultaneously. The human brain can perform many operations in parallel, but there are bottlenecks in that processing. Certain brain utilities that are essential to performing many behaviors can perform only one task at a time.

- The problems with multitasking emerge directly from the bottlenecks. You might feel as if you are performing more than one task at a


There is actually a feeling of pleasure that many people describe associated with multitasking. It can be invigorating to push your mind and body up near its maximum capacity for processing information.

time, but the research demonstrates that you are rapidly switching between two or more tasks to create the illusion of simultaneously performing two tasks at one time. That switch takes time and, it turns out, requires a substantial amount of brain resources to accomplish.

Information-Processing Bottlenecks

- Many studies comparing multitasking and monotasking involve giving a group of participants a particular task, such as writing or solving a set of problems. Half the participants engage in monotasking. The other half of the participants execute the same task and also engage in a monitoring task. The group that multitasks always performs substantially worse than the monotasking group.

- Hal Pashler has performed studies on the information-processing bottlenecks in the brain. A hallmark of many of his experiments is just how simple the tasks are. He demonstrates that even if you set up a pair of very simple tasks, if they both require the same underlying processing utility, then multitasking will produce clear differences in performance.

- In one study, researchers asked people to make two simple decisions at the same time. Every few seconds, the participants' computer emits a tone. If it's a high-pitched tone, they press a key with the left index finger. If it's a low-pitched tone, they press a key with the left middle finger. In the second task, a letter appears on screen. If it's the letter A, participants press a key with the right index finger. If it's the letter B, they press a key with the right middle finger.

- Somehow, these two tasks together are much more difficult than either of them individually. The reason is that the two tasks hit one of the key bottlenecks in your brain's information-processing system. Pashler also found that even when study participants were given a great deal of practice with the two tasks, the processes never got as fast as when the participant was engaged in a single-task condition.

- We can alternate between two tasks quickly, and with practice, that alternation can become very efficient, but there is never a time when the switching back and forth becomes instantaneous. What's more, there is never a time when you can truly be performing two tasks at the same time.

Distracted Driving

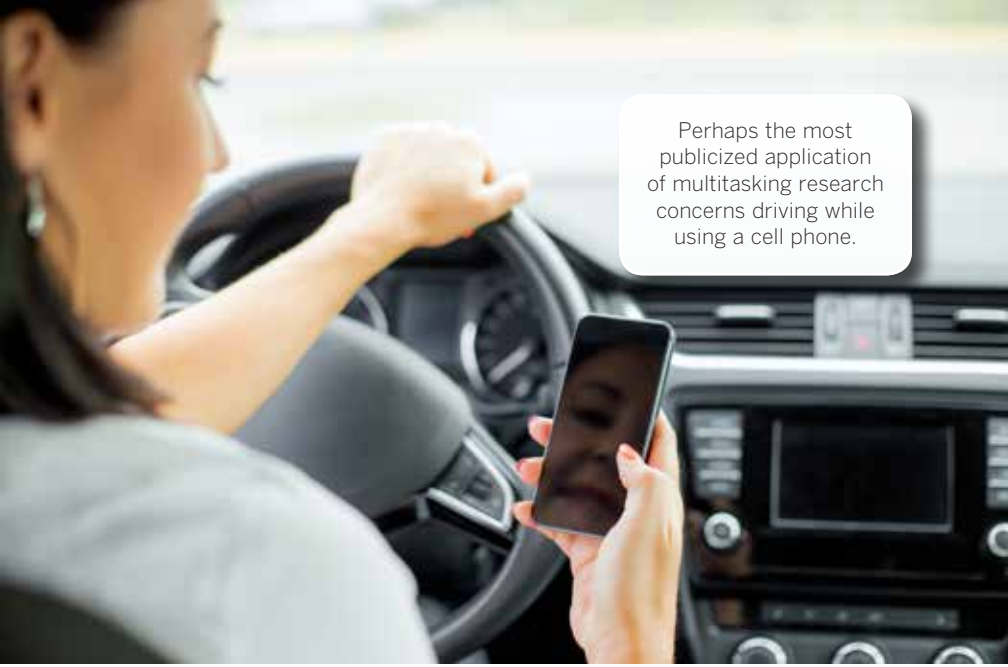
- Perhaps the most publicized application of multitasking research concerns driving while using a cell phone. Phone manufacturers and carmakers have addressed this problem with the hands-free cell phone. Although it is true that a fully hands-free system can enable you to keep your eyes on the road the entire time, several studies have found that the accident rate with hands-free cell phones is nearly as high as it is with handheld cell phones. The problem is multitasking.

- When it comes to processing sensory information and making decisions about it, the human brain is limited to one decision at a time. No matter how expert you are at the other parts of performing a task, the decision aspect remains a single-task bottleneck. When you are pondering or responding to the statements of someone on the other end of a phone or text exchange, you are making a lot of decisions.

- Every time you are making one of those decisions, you are not able to make visuomotor action decisions about driving the car. Those decisions have to wait until the bottleneck is freed up. We may be able to alternate between two or more tasks, but the switching always introduces a little delay. At 60 or 70 miles per hour, a little delay can translate into an accident.

How the Brain Multitasks

- In this section, we discuss how the brain actually implements multitasking, also termed rapid sequential multitask alternation. In the past, researchers believed that there was some sort of brain center responsible for multitasking. They envisioned it as a switching center



Perhaps the most publicized application of multitasking research concerns driving while using a cell phone.

that would store information for an ongoing task that was on hold. If we were going to build a multitasking computer, that would be a sensible component to include. But the human brain doesn't work that way.

- Whenever you engage in some task, you stimulate a network of areas of the brain and activate a large set of circuits that perform the calculations needed to support the work. If it's a spoken-language decision-making task, then the following main areas will be engaged: auditory cortex areas, the Wernicke area for processing speech, temporal cortex memory areas responsible for holding on to different sentence concepts, and the frontal cortex regions involved in intentional decision making.

- If you are also performing a task in which you are visually searching for something, such as a person's face, you will activate these areas: occipital cortex visual regions, face recognition areas in the right

hemisphere, memory regions to consider where you've looked, and frontal cortex attention allocation regions to guide eye movements.

- Some of these areas are unique to one task or another. Inherently, however, some of the areas are involved in both tasks. As you repeatedly switch between the tasks, you ask these overlapping circuits to rapidly perform two separate actions for brief periods. That alternation produces interference.

- If you are multitasking, then, your brain just doesn't work as well. It will be more fatigued at the end of the day—which may contribute to the sense that you have achieved a great deal. The information processing that your brain will have accomplished will be of a distinctly lower quality, however. One small study found that if you administer IQ tests under conditions of typical technological distraction, there is a drop in scores of about 10 points. You are, in a sense, not as smart when multitasking as you are when you are monotasking.

Multitasking Makes You More Distractible

- One line of research set out to determine if people who were experienced multitaskers might be better at it than those who didn't regularly engage in the practice. Perhaps, the researchers speculated, multitaskers deal with brain challenges by getting better at task-relevant strategies. Specifically, the researchers hypothesized that experienced multitaskers might be better at focusing their attention on the key pieces of information that are most important for each task and filtering out the irrelevant information. However, the results of these studies demonstrated exactly the opposite. When you are multitasking, you are generally more distractible.

- Any environment contains potential distractions. We all learn to filter out these distractions and to keep our minds focused on the current task at hand. After a great deal of multitasking, however, our ability to filter out distractions is negatively impacted. If you multitask on a

regular basis, simply keeping your attention on any one task becomes more difficult, not less.

- There are a number of solutions to these challenges, but they all revolve around the same strategy. You should practice doing only one task at a time—that is, single-tasking or monotasking. Think through the activities you want to do and pick one. Then, to the best of your ability, try to block out everything else before you begin working on it.

Questions to Consider

1. "Walking desks" that enable people to work while walking on a treadmill have become more popular recently. Getting exercise while also getting work done seems like a good idea, but is this multitasking? And if so, will the walking hinder the performance?
2. If multitasking reduces human cognitive performance, why do people report that it feels good to engage in multitasking? Is there an unconscious thought system that decides what feels good? And if so, what information is it using here?

Suggested Readings

Chabris, *The Invisible Gorilla*.

Pashler, *The Psychology of Attention*.

Lecture 7

Future You and Better Decisions

To improve your reasoning capability and make better decisions, a very effective strategy is to engage in mental time travel. Having a brief visit with your future self as you ponder what to do can result in a happier, healthier, and even wealthier future you. In this lecture, we examine strategies derived from research that will help us make better decisions—for example, keep your list of options short (around six items), keep the consequences of decisions concrete, and make decisions about categories in a progressive fashion.

Temporal Discounting

- Humans have a tendency to engage in temporal discounting—that is, we prefer to receive rewards sooner rather than later. In fact, we will often choose a smaller reward sooner over a larger reward later.

- From an economics perspective, there is some value to temporal discounting. If someone gives you some cash today, you could invest it, and it might increase in value over time. While temporal discounting is, in principle, sensible in small amounts, hundreds of studies have found that the human brain uses a temporal discounting rate that is far too high. If we can compensate for that tendency, our reasoning can be substantially improved.

- Humans use temporal discounting not only with money, but with a broader class of choices, situations, and behaviors. For example, consider the decision between spending the day relaxing or spending

it working. The pleasure of relaxing is the small but immediate reward here. Reducing our tendency to engage in temporal discounting can reduce the likelihood of making the wrong choice. Mental time travel can help.

Your Future Self

- Several researchers have described the mental process of reasoning through a decision as a negotiation between the present you and the future you. In some cases, we are very willing to incur costs that must be paid back by another person—a future you.

- Brain imaging work conducted by Dan Gilbert and his colleagues has revealed quite a bit about how the brain mediates these internal negotiations. The area of the brain crucial to this process is termed the ventral medial prefrontal cortex (VMPFC). The VMPFC has many connections to the amygdala and is involved in reasoning about emotion-laden stimuli. More recently, this region has been found to be heavily involved in self-referential processing.

- Using functional magnetic resonance imaging (fMRI), the researchers determined that when people think about themselves, there is a substantial surge of activity in the VMPFC. About six seconds after that increase in activity, there is a surge of blood flow in the region. If the person is thinking about other people, activity in this region of the brain drops.

- Participants in the Gilbert study were scanned in an fMRI while they made judgments about how much they would enjoy a range of pleasant tasks. In some cases, the participants judged how much they would enjoy doing this task within the next 24 hours. In other cases, the participants judged how much they would enjoy doing the task in the future, defined as "this time next year." In addition to ratings of how much they would personally enjoy particular tasks in the present and the future, participants also made ratings of how they thought some other person would enjoy the task.

- The experimenters determined that when participants think about themselves in the present, the VMPFC is very active. When participants think about others, either in the present or future, this VMPFC activity is significantly reduced.

- Here's the interesting part. When participants think about themselves in the future, VMPFC activity drops. That is, they use the same brain systems involved in reasoning about other people. It's as if the brain, at a very fundamental level, thinks of the future you as someone else.

Mental Time Travel

- Participants in the Gilbert study also completed a temporal discounting test, where they were offered various pairs of rewards and asked to select one. They were also given the choice between an immediate reward with no delay and a reward in several months. Based on many of these preference judgments, the experimenters could infer a monthly temporal discounting rate for each participant.

- A fascinating pattern emerges when you look at the brains of the people with low and high temporal discounting rates. Some participants were so patient that they were willing to wait a month for even a small increase in the reward. They showed much smaller reductions in VMPFC activity when they shifted from thinking about their enjoyment of present and future tasks.

- The impatient participants were those who were willing to wait a month only if the monetary reward was much greater. This impatient group showed very large reductions in VMPFC activity.

- The data imply that when the patient participants thought about their future selves versus their present selves, their brains treated them very much the same. Conversely, the brains of the impatient people thought about their future selves in much the same way that they thought about other people, as strangers.

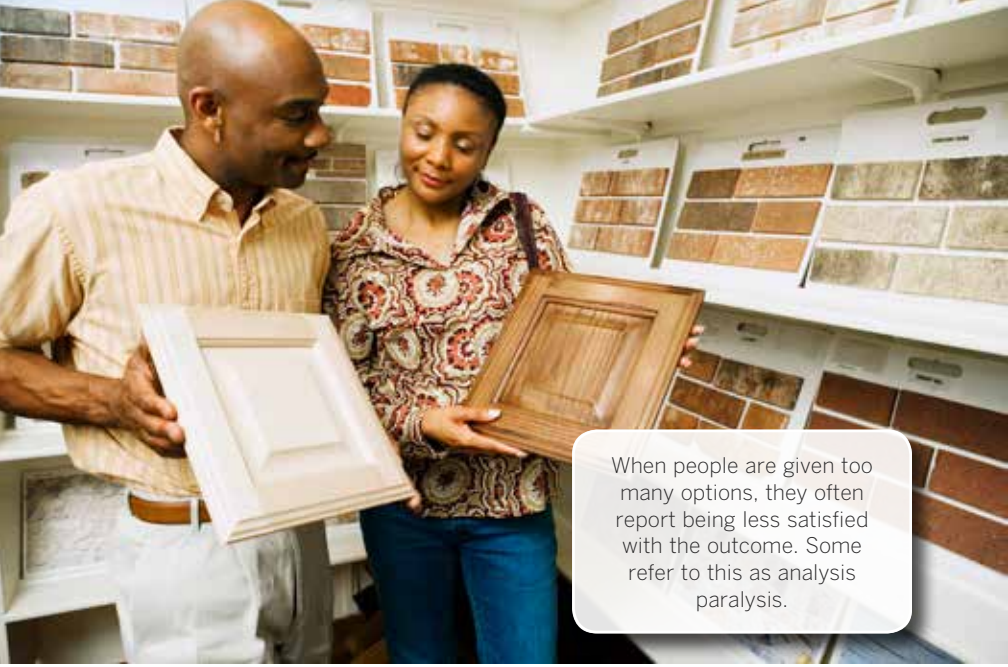
- Future discounting behavior is a problem that leads us to nonoptimal reasoning and decision making. Any choice is driven by a weighing of the positives and negatives associated with it. If something negative is pushed into the future, it doesn't actually make it any less negative. If we can make that negative someone else's problem, however, then it does make it less of a problem for us. Unfortunately, our brains think of our future selves as this someone else. This illusion leads to the reasoning problems.

- Fortunately, there are a variety of ways to outsmart yourself here—that is, ways to outsmart your present self—as you are pondering what to do next. One of the easiest strategies is to take a few minutes to think about the immediate future—that is, engage in mental time travel. Travel forward in your mind to the end of the day. Look back on the day you spent. Consider how you would feel if you spent the day one way. Think about how you would feel if you made the other choice.

Make Firm Decisions

- As we make choices, we take advantage of some opportunities and inherently leave others behind. That can be an unpleasant experience. It's quite common for people to ponder the "road not taken" in their past. Sometimes, we resist closing doors and instead seek to keep our options open as much as possible. While freedom of choice is something we value greatly, several recent lines of research suggest that there is such a thing as too much freedom of choice. In fact, when people are given too many options, they often report being less satisfied with the outcome. Some refer to this as analysis paralysis.

- Consider this study by Jack Brehm. The study begins with participants viewing a selection of six posters of famous paintings. The participants' task is simply to rank these posters from their most favorite to least favorite. After the participants rank the posters and fill out a questionnaire, the experimenter offers them a gift. The two posters that are offered as a gift are whichever posters the participants picked



When people are given too many options, they often report being less satisfied with the outcome. Some refer to this as analysis paralysis.

as their third favorite and their fourth favorite. As you would expect, most people pick the poster that was their third favorite.

- The participants are sent home and, after a delay of a few days, they are asked to come back to the lab again and re-rank the posters. Something very consistent happens: The poster that they picked—the third favorite—moves up in the rankings. The poster that was not picked drops in the rankings—on average, from fourth down to fifth place.

- In other words, once you decide on some option, your brain shifts its future preferences to perceive whatever you have chosen as being more positive. Whatever options you specifically have not chosen seem to decline in positivity.

- If you want to be happier with the decisions you make, then you should make them firmly, and then stick with them. If two choices seem to involve the same risks, benefits, positives, and negatives,

then greater satisfaction can be obtained by confidently staying with one selection.

Reduce the Options

- Another way to improve your reasoning about different choices is to do less of it. While we have a strong desire to maximize our options in life, we should, whenever possible, reduce the number of options to a relatively small number—around six seems ideal. Across a variety of studies, when the choices are limited to six or fewer, human decision making seems to function more optimally.

- Research supporting this strategy starts with a simple study performed by Sheena Iyengar and her colleagues when she was a graduate student at Stanford University. There was a grocery store nearby that sold 348 varieties of jellies and jams. The experimenters set up a tasting booth to let people try different jams.

- Half the time, the experimenters set out samples of 24 different jams. Half the time, the booth only had 6 jams available to try. Many more people stopped to try jam when there were 24 to try; however, when there were only 6 jams offered, the customers were far more likely to buy jam. With the 24-jam display, about 3 percent of visitors purchased jam. With the 6-jam display, 30 percent of customers made a purchase.

Make Consequences Concrete; Create Categories

- In addition to reducing the number of options, Iyengar and her colleagues also recommend making the consequences of decisions concrete. For example, in studies in which people are asked to imagine specifically what their life will be like in the future, they tend to save and invest more. These studies provide more evidence for the benefits of mental time travel.

- Another way to proceed with reasoning about decisions and keep the number of choices low is to make decisions about categories in a progressive fashion. Say that you are deciding where to take a vacation. One way of narrowing your master list from hundreds to six would be to divide your options into categories first, such as geographic location. Then, choose the type of trip, such as hiking, beach, or city tour. Now, your original master list of hundreds of potential trips has been winnowed down to a small number of possibilities.

- By progressing in terms of small numbers of categories, a complex decision can be broken into a sequence of stepwise decisions that fit well within the constraints of the human brain.

Questions to Consider

1. When you think of the future, the brain reasons about it as if the future you is a different person. Are there other situations in which you might think of yourself as another individual?
2. Too much freedom of choice seems to create problems for human decision making. Might this also be true in terms of how modern people—living in the world of Internet dating—select romantic partners?

Suggested Readings

Ariely, *Predictably Irrational*.

Kahneman, *Thinking, Fast and Slow*.

Lecture 8

How to Become an Expert on Anything

For most people, their level of achievement and expertise in a domain is not predicted by any innate characteristic—physical or mental. It is, however, predicted by their level of experience and training. Here, we argue that the difference between experts and novices is not talent but practice—that is, the difference is quantitative, not qualitative. In this lecture, we explore how to develop expertise using a number of strategies, such as the 10,000 hours of practice, deliberate practice, the significance of feedback and mentors, achieving efficiencies in information processing, the quiet eye, and avoiding *Einstellung*, or "mechanization of thought."

Aptitude Tests

- It is crucial to remember that even if you fail the first few times that you try to master something, that is not a predictor of your potential ability in that realm. There have been a number of studies aimed at predicting how adept someone will eventually be at some set of tasks. We usually call them aptitude tests. An IQ test is basically an aptitude test for later academic performance.

- Aptitude tests are used to try to assess people's talent, ability, or aptitude for various skills. The impetus behind the use of aptitude tests is an implicit belief that is not supported by modern research on expertise, however. The implicit belief is that the aspects that will make you expert at something are already present in you at the time of the initial aptitude test.

- The data do not support this. In the entire multi-billion-dollar industry that is aptitude testing, the correlations that are found between talent and performance are consistently very small. The SAT predicts about nine percent of the variance in freshman grades. That is, if you know a student's SAT score, you will be about nine percent more accurate at predicting performance than if you just took a guess.

10,000 Hours of Practice

- Innate talent does not provide a reliable prediction of overall performance. Practice does.

- Obviously, the more you practice, the better you become. What is not obvious is that no matter how much you have practiced, additional practice will always continue to produce more improvement, even after you've practiced for thousands of hours.

- Anders Ericsson and his research team have conducted some of the most detailed research on expertise. They've studied experts from many different domains: doctors, athletes, musicians, chess players. Across all these varied fields, a number of trends stand out.

- One trend is that the most rapid improvements arise as you are starting to learn something new. That is, in your first 100 hours of practice, you will improve by a certain amount. In the next 100 hours, you will still improve but will show less of an improvement than for those first 100 hours. Every 100 hours, you will continue to improve but will improve less than the previous 100 hours.

- As this process develops, many people perceive a plateau, which can create a sense that you are no longer improving. But it is extremely clear from dozens of studies that the upward progress toward better performance continues. The law of diminishing returns is at work here. The more you improve, the more energy you need to invest to improve further. But the returns never diminish all the way to zero.

- When practice time increases, however, improvement becomes more rapid. According to Ericsson and his colleagues, a significant measure is cumulative hours of practice. In general, across a remarkably wide range of endeavors, expertise in some domain is achieved with 10,000 hours of practice. If you have practiced something for 1,000 hours, you are likely to be proficient but not an expert. Something about that 10,000-hour number seems to represent a level of extraordinary achievement of mastery.

Deliberate Practice

- A variety of researchers have studied how experts practice and work and identified four principles that you should follow as you seek mastery. Ericsson coined the term deliberate practice to define these four principles:
  1. When you engage in deliberate practice, you should focus your attention on the work with the intention to improve—that is, to be

When you are learning something new, the most rapid improvements arise in the beginning.

better after you perform the practice than you were before you started.
2. Your practice should be targeted to your current level of skill. A task should be difficult enough to be challenging but not so difficult that it is impossible.
3. After you attempt something, you should have access to immediate, informative feedback. The only way you can know when you have happened onto a process that works is if you are told which attempts were hits and which were misses.
4. Repeat the third step multiple times per practice session. Go over the same task again and again until it is clear that you have achieved mastery.

- Feedback is especially significant when you are beginning a new type of task. Before you invest too much time practicing on your own, find someone who is already an expert to give you instruction. An expert instructor will not only speed your initial improvements in your new endeavor but also lay a foundation for continued improvement.

Efficiencies in Information Processing

- Some of the best cognitive neuroscience work on the development of expertise comes from some elegant studies performed by Isabelle Gauthier, Michael Tarr, and their colleagues. The researchers were interested in two questions: how the brains of experts differ from the brains of novices, and how the brains of novices change as they become experts.

- To address both these questions, they had to invent a novel task—one in which all participants would be novices. The participants would then practice and become experts. The researchers created a family of 3-D structures that they called Greebles. Each Greeble was given a particular name and categorized as part of a particular family. Participants in these studies would view individual Greebles and attempt to guess their individual and family names.

- Initially, of course, the participants did very poorly. The number of individuals and families was large enough that this task required a great deal of practice. At various times during this training process, the participants practiced while they lay inside a functional magnetic resonance imaging (fMRI) scanner. The experimenters characterized the participants' pattern of brain activation as they viewed Greebles and attempted to identify them.

- If someone's performance is especially expert, you would expect that they would be harnessing tremendous brain power. You might speculate that the participants, as they grew faster and more accurate, would have developed ways to recruit more brain regions to better support their performance. The results were exactly the opposite.

- When participants were first learning to recognize Greebles, a broad expanse of the visual cortex and surrounding brain regions were boosted in activation. As expertise was developed, however, less of the brain exhibited boosts in activation. The areas that remained active became more active, but less cortical real estate was involved.

- Similar results have come from studies of other types of experts. For instance, Christopher Jannelle and his colleagues studied rifle shooters, comparing the brain activity of experts and novices. In the moments leading up to the trigger pull, the experts showed a marked increase in activity in their left hemisphere and a marked decrease in right hemisphere activation. For novice shooters, both hemispheres remained generally active. A variety of studies like this suggest that expert performance doesn't involve more brain activation; rather, experts are more efficient at processing information.

The Quiet Eye

- Related data from studies of eye-tracking movements of experts also fit the theory of efficiency in information processing. Joan Vickers was the first to characterize this phenomenon associated with experts: the quiet eye.

- As we move around in the world, our eyes jump from place to place, scanning our surroundings. About three times per second, on average, we make one of these abrupt eye movements. Most of the movements are controlled outside of your conscious awareness, but as you focus on some task, you direct your eyes to the most relevant areas.

- Experts exhibit remarkably long eye fixations leading up to when they perform some action. As they are about to act, their eye movements stop—sometimes for nearly a second. This is the phenomenon of the quiet eye.

- Becoming an expert seems to involve moving the eyes less, not more. Just as the patterns of brain activity in experts suggest less information processing, the changes in eye-scan patterns suggest experts are picking up less information as well. Becoming an expert, it seems, is about learning where the most relevant information is and where it is not.

Einstellung, or "Mechanization of Thought"

- As you practice some endeavor and attempt to become an expert and achieve mastery, you will naturally gather information and develop neural circuits to process that information. Initially, this will likely be done in a very conscious fashion. As you practice, however, the task will become more automatic and will switch from more broad activation and conscious control to more focused activation and unconscious control.

- Cognitive neuroscientists have found evidence for what they call *Einstellung*, which is German for "setting" or "attitude." For brain researchers, it is usually defined as a "mechanization of thought."

- If a researcher gives participants a number of problems that can all be solved using basically the same technique, two things happen. First, the participants get adept very quickly. They might not even be able to articulate the trick that they are using, but their brains

will discover it. Second, if you give these participants a new problem, one that cannot be solved with this same technique, they will find the new problem very difficult to solve. In some studies, the experienced participants were worse at solving the new problems than people who had no practice at all.

- When you start to learn a new skill, you bring tremendous mental flexibility with you. As you become more skilled, however, you get faster but also become less flexible. Therefore, at the beginning of your learning process, it is especially helpful to have an instructor to nudge you in the right direction, get you focused on sources of information that are the most important, and to keep distinctive biases you have in your initial performance from becoming problematic.

Questions to Consider

1. Talent plays some role in determining how well someone performs a task, but the amount of experience-based improvements can play a larger role. Could someone have a talent for learning new skills? How could you measure such a talent? How could someone best make use of it?
2. What would you recommend to parents or grandparents as they encourage (or perhaps discourage) a child from undertaking a new endeavor? How might the child's talent, preference, and personality influence your recommendations?

Suggested Readings

Ericsson, *Peak*.

Gauthier, Tarr, and Bub, *Perceptual Expertise*.

Lecture 9

Tune Up Your Brain with Meditation

In this lecture, we suggest that you spend about 20 minutes a day not thinking—or rather, engaging in the "not thinking" practice called meditation. A wealth of evidence demonstrates that if you spend time in meditation, your brain will function more efficiently and you will be less anxious, more creative, and generally healthier. The art and practice of meditation is older than cognitive neuroscience by many centuries; indeed, it is older than science itself. Historians and anthropologists believe that the earliest meditation was associated with religious practice. As you become practiced in performing a ritual, it becomes largely automatic, leaving your conscious mind to think about other concerns—or nothing at all.

Concentration Meditation and Mindful Meditation

- Some researchers consider two broad categories of meditation: concentration meditation and mindful meditation. Both types of meditation typically involve sitting quietly in a place that is relatively free of distraction.

- Concentration meditation involves focusing your mind on something as completely as possible. Many people focus on their breathing. Some focus on a particular word—a mantra—repeating it over and over in their mind. In concentration meditation, by focusing only on one thing, you stop thinking about everything else that would normally occupy your mind.

Some researchers consider two broad categories of meditation: concentration meditation and mindful meditation. Both types of meditation typically involve sitting quietly in a place that is relatively free of distraction.

- Mindfulness meditation is, in some respects, the opposite of concentration meditation. During mindfulness meditation, you seek to be aware of yourself and your surroundings without thinking about anything in particular. This notion of not thinking is somewhat foreign to most people. Our brains naturally tend to wander from thought to related thought all the time. This flow of ideas is what psychologists refer to as our stream of consciousness.

How to Meditate

- Find a quiet place where you won't be disturbed. There should be a clock nearby so you can check when you think about 10 minutes have elapsed. Find a comfortable chair, but stay upright. Taking a nap won't do the job.

- Once you are in your chair, with the clock ready, close your eyes and simply try to put your brain in neutral. Let your thoughts wander and

observe what comes up. You might find yourself drawn to think about a particular problem or task or future plan. Let yourself think about it for a few moments, but try not to get drawn into a consciously driven set of thoughts. Whenever you notice that happening, don't panic; simply decide to stop thinking about it and set your thoughts to wandering again.

- When you think about 10 minutes have passed, glance up at the clock. If you are like most people, it won't be very close to 10 minutes yet. That's okay. Just close your eyes again and continue. What you are doing is one of the simplest forms of meditation.

- Try to work up to meditating for 20 minutes at a time three or more times per week. Experiment with both concentration meditation and mindfulness meditation. If one of them feels better or easier, then go with that, but also feel free to switch back and forth depending on your mood on any given day.

Measuring the Effects of Meditation

- A wide range of research has assessed the nature of how regular meditation affects your brain. One of the most common techniques has been to look at how patterns of electrical activity change in the brain during meditation. The electroencephalograph (EEG), which involves placing electrodes on the scalp, makes it possible to record and analyze the tiny amounts of electrical activity produced by neurons in the brain. The EEG has very good temporal resolution but relatively poor spatial resolution—that is, it determines when the brain is active but can't tell where the activity is in much detail.

- To see spatial patterns in the brain more clearly, a technique that has been used to explore how your brain activity changes when you meditate is functional magnetic resonance imaging (fMRI). fMRI can record the amount of blood flow to different regions of the brain. When an area becomes more active, it uses up oxygen and fuel and creates waste products. Blood vessels in that brain region dilate to

enable more blood flow to deliver more resources and carry away waste products. By looking at the circulation patterns, we can see what areas of the brain become more active.

- Both EEG and fMRI methods illustrate that the meditative brain is very active, particularly in certain areas. The particular areas that are activated seem to vary with the type of meditation that is practiced. If you engage in meditation focused on a particular word or mantra, language regions are activated. If you focus on being aware of particular parts of the body, increases in activity are seen in sensorimotor regions of the cortex.

When people engage in meditation, they report higher levels of everyday happiness.

- Several studies have found that during meditation, the amygdala and other subcortical regions associated with emotional processing become more active. Several studies have found that when people engage in meditation, they report higher levels of everyday happiness. Those who meditate also report fewer problems with regulating their own emotions.

A Practice from Prehistory

- Many researchers believe that people have historically spent a great deal of time meditating—even if they didn't call it meditation per se. We think of modern life as being much easier and more convenient, but that's a bit of a myth.

- Humans have been around for about 300,000 years, as near as modern paleoanthropologists can figure. For about the first 280,000 of those years, humans survived as hunters and gatherers. Their job was basically to harvest food that nature produced. When food was plentiful, it's estimated that people could find what they needed to feed themselves and their children surprisingly quickly.

- Studies of the few remaining modern hunter-gatherer societies suggest that the work week for ancient humans was about two and a half days per week, at about six hours per day. Since then, of course, the world has changed a great deal. We work more hours, we live longer, and our world is much more defined by technology. But our brains are basically the same as those of our prehistoric ancestors.

- Humans have engaged in idle—perhaps meditative—thinking for millennia. It seems reasonable to expect that our modern brains have adapted to use this idle time effectively and perhaps even to depend on it for regular maintenance activities.

Increases in Gray Matter

- The MRI has shown that meditation can change the anatomical structure of your brain. In one study, a team led by Britta Hölzel recruited a group of 17 people who had signed up for a meditation course. As a control, they recruited 17 others who did not participate in the course. Before the course started, all the participants visited an MRI facility, where the researchers conducted a high-resolution scan of each participant's brain anatomy. The meditation participants then took their meditation course.

- Over the eight-week course, the participants reported engaging in about 23 hours of meditation practice. After this period, the researchers found increases in the gray matter concentration in several areas of the brain. The left hippocampus showed a clear effect, as did the posterior cingulate cortex, the left temporoparietal junction, and the cerebellum.

- The brain is made up of gray matter and white matter. The white matter consists primarily of myelin, a fatty substance that coats the axon part of neurons. The white matter enhances the efficiency and speed of neuronal communication.

- The gray matter of the brain is everything else: dendrites, cell bodies, and axons. Therefore, if your brain has more gray matter, it has more neurons. According to the Hölzel study, meditation practice caused the brains of those meditating to produce more neurons and to retain more of them over time.

A Boost to Brain Neurons

- The regions enhanced by meditation, as shown in the Hölzel study, are crucial areas of the brain.
  - The hippocampus, a highly connected structure, plays a role in a wide range of functions ranging from memory to reasoning about how to navigate through the world.

- The posterior cingulate cortex is also highly connected and is considered part of the brain's default network—the area of the brain that is activated regardless of what you are doing, even when you are doing nothing at all. It is associated with emotion regulation and the control of general arousal.

- The left temporoparietal junction contains a part of the brain referred to as the Wernicke area, which is heavily involved in our ability to parse and understand both written and spoken language.

- The cerebellum, densely packed with neurons, is a highly interconnected region of the brain that plays an important role in the control of body movement. Other research has suggested that the cerebellum also participates in computations about other complex interrelated systems, such as coordinating responses to threatening stimuli.

◆ Overall, the Hölzel study and many like it suggest that engaging in meditation practice on a regular basis, over the course of even a few weeks, can boost the number of neurons in the brain. Humans typically peak in terms of the overall number of neurons in their brain around three years of age. For the rest of your life, that number steadily declines. Age-related decline in cognitive function is presumed to be related to this general shrinkage of the brain.

Enhanced Performance

◆ Studies on the Stroop effect demonstrate that meditation also seems to enhance the ability to filter out miscellaneous information. Some studies have suggested that this improvement in attentional allocation happens not only on a long-term basis but also even shortly after a period of meditation. As you spend time allowing your brain to focus on one particular thing or allowing it to focus on nothing at all, after the meditation session, you improve your ability to concentrate on certain information in particular.

- In general, meditation is associated with increases in concentration, clearer thinking, and even creativity. Focusing on nothing at all actually requires a great deal of concentration. As you get more adept at not allowing intruding thoughts to enter your mind, you may be improving your ability to specifically allocate your attention to things when you aren't meditating.

- Whether or not you adopt the practice of meditating a few times a week, there is good evidence that you should meditate for 10 minutes or so as you prepare to undertake any mentally challenging task. If you begin by meditating for a few minutes, studies of post-meditation performance suggest that your cognitive performance will be enhanced.

Questions to Consider

1. Widely varying types of meditation seem to produce similar benefits in terms of health and mental well-being. Why might this be? Could activities that we don't normally think of as meditation have meditation-like benefits? What are the characteristics of those activities?
2. What are the key differences between mindful meditation and simply thinking about things? Why do you suppose these differences matter in terms of brain activity as well as behavioral outcomes?

Suggested Readings

Davidson and Begley, *The Emotional Life of Your Brain*.

Tang, Hölzel, and Posner, "The Neuroscience of Mindfulness Meditation."

Lecture 10

Take the Sleep Challenge

Let's jump right into it: You should get about eight hours of sleep a night, almost every night. A wide variety of data suggest that when we don't get eight hours of sleep per night, our cognitive performance is substantially reduced. Decision making, memory, control of physical movements, emotional regulation, memory, and even basic perception become more prone to error. Tests of intelligence, creativity, attention, and memory all show lower performance with cumulative sleep deprivation. In this lecture, we consider the consequences of lack of sleep, examine the stages of sleep and the importance of REM sleep, suggest ways to combat insomnia, and explain the relevance of circadian rhythms and blue-light wavelengths.

Four Stages of Sleep

- The most important tool in the sleep researcher's kit is the electroencephalograph (EEG), which records tiny electrical signals produced by neurons in the brain. Circuits in the brain produce variations in the amplitude of our brain waves. Some brain circuits oscillate quickly, producing high-frequency waves; other circuits cycle slowly, producing low-frequency waves. The EEG captures a sum of all the waves.

- The first thing that a sleep scientist will do with this EEG data is to apply a mathematical process called a Fourier transform. The process decomposes the signals into the underlying frequencies, revealing how much energy is present in the brain at different frequencies. The outcome of the Fourier transform is called a power function.

- When you are awake, your power function has a lot of energy in the range of 13 to 24 cycles per second. Sleep researchers refer to energy in this frequency range as beta waves. This power spectrum indicates an active, wakeful brain. As you relax and get ready to fall asleep, the energy in that beta range drops, while the energy in the alpha range of 8 to 12 cycles per second increases. (This also happens when you meditate.)

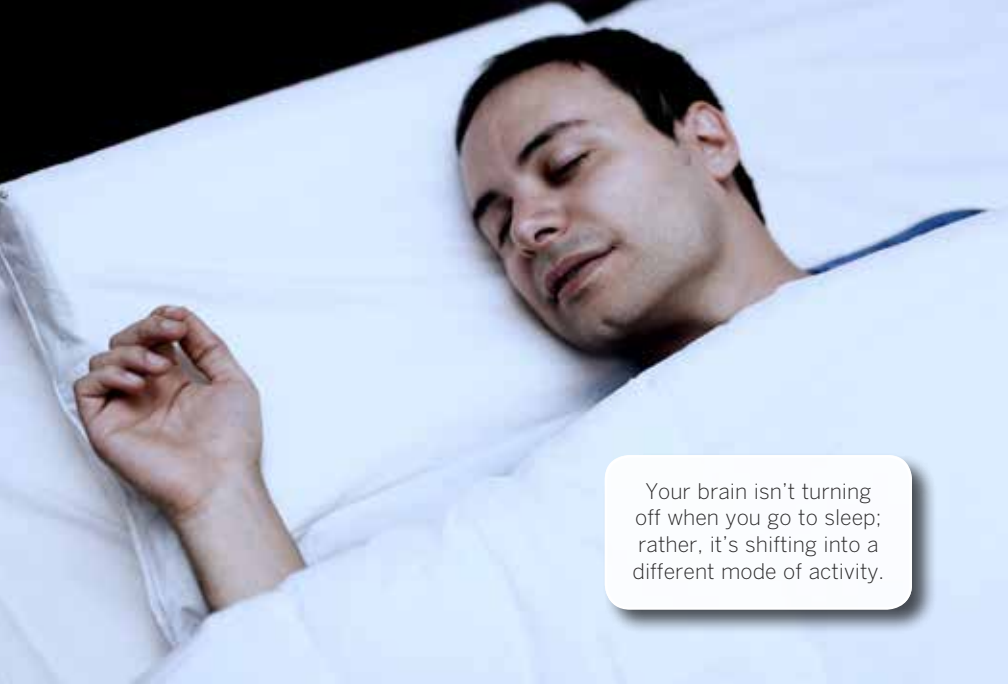
- As you drift off to sleep, the energy in the alpha range drops off and is replaced by theta waves, which are in the range of 4 to 7 cycles per second. As this happens, you lose consciousness and are lightly asleep. Sleep researchers call this stage 1 sleep. You will typically remain in this state for 10 to 30 minutes before shifting into stage 2 sleep.

- As you pass into each of the four stages of sleep, your brain continues to produce more energy in slower frequency ranges. In the deepest stage of sleep, your brain will be producing a great deal of delta wave activity, at a frequency of fewer than 4 cycles per second.

REM Sleep

- During sleep, the energy output of the brain does not change significantly. The waves of activity that it produces are slower than when you are awake, but the deeper the sleep, the higher the amplitude. Your brain isn't turning off when you go to sleep; rather, it's shifting into a different mode of activity.

- After you fall asleep, you remain in deep, delta-wave sleep for about half an hour. After this, your brain begins stepping up its rate of activity, producing fewer delta waves and more theta and beta waves. Now, you are back in stage 1 sleep. At this point, a remarkable set of changes occurs. The activity level of the brain becomes very much like that of someone who is awake. Lots of energy shows up in the alpha range. This is called REM (rapid eye movement) sleep.



- While the brain becomes very active at this point, the muscles in most of the body become deeply relaxed. The muscles that control eye movements are an exception. The eyes become very active, darting back and forth, up and down, as if rapidly scanning something. These rapid eye movements are the feature that give the REM sleep stage its name. This is also the stage at which we dream.

Significance of REM Sleep

- There is a wealth of evidence that during REM sleep, your brain does essential work that supports regular brain function.

- We tend to dream about what has happened during the recent past—indeed, most frequently about what happened the previous day. Early in the evening, those dreams will tend to be very literal; later in the evening, the dreams tend to become more abstract.

- This replay and abstraction process is critical to optimal memory, high-level creativity, and problem-solving ability. What's more, those memories seem to be consolidated during the following night of REM sleep. If you prevent someone from getting REM sleep, detailed memory for experiences and learning will suffer. Cognitive function also declines.

- Your brain needs REM sleep like it needs nutritious food. The vast majority of your REM sleep takes place in the last two sleep cycles of an eight-hour sleep session. If you reduce your sleep by a couple of hours a night, you might feel that you've still gotten most of a good night's sleep. In terms of total hours, that's correct: You've only missed out on about 25 percent of your sleep time. But in terms of REM sleep time, you may have cut your night down by 40 percent.

Power Napping

- Napping can be destructive to REM sleep. If you nap for 90 minutes, you will get a full sleep cycle in, including a brief bit of REM sleep. However, if that reduces the amount of sleep you get the following night, even by a couple of hours, you will greatly reduce the total amount of REM sleep by as much as 40 percent.

- Consider the workplace power nap, a topic that has been the subject of much scientific investigation over the past few decades. The thinking is that if people nap for 20 minutes, employers can get a lot more productive work out of them the rest of the day. That sounds better than dealing with a groggy employee performing poor (or no) work.

- The good news for power nappers is that a nap of 20 to 60 minutes (less than a full sleep cycle and without REM sleep) does boost cognitive function in many people, who demonstrate faster reaction times, better working memory, and enhanced problem-solving abilities.

- The bad news for power nappers is that essentially all this data has been collected from experiment participants who were sleep deprived.

If you are sleep deprived, a power nap will help you. If you are not sleep deprived, then you probably won't nap when you are given the opportunity—and the power nap won't help.

Combating Insomnia

- Insomnia, or trouble falling or staying asleep, is a condition that affects millions of people. A study by the Centers for Disease Control and Prevention found that 9 million Americans are regular users of prescription sleep medication. A problem is that standard sleep medications disrupt REM sleep. What's more, humans develop a tolerance to sleep medications and supplements such as melatonin.

- The best way to combat insomnia is to strengthen your unconscious association between your bedroom and sleep. Many people who report problems with insomnia also perform other activities while sitting in bed—they watch movies, work on the computer, make calls, and even eat meals.

- The unconscious systems that regulate your sleep associate all these non-sleep activities with your bed. Over time, after you change your associations with your bedroom, your unconscious mind will learn to sleep normally again. If you put a tired body into a fully dark, quiet, cool, comfortable space and make it lay very still for a while, it is very likely to fall asleep.

Circadian Rhythms

- Before you go to bed, there are a few steps that you can take to ensure an effective night of sleep. Avoid bright lights—especially lights with a blue component to them—for several hours before bedtime. Bright incandescent or fluorescent lights are bad; computer screens and LED television screens are even worse. Consider how the brain and our eyes regulate sleep.

- First, proper sleep relies on a 24-hour timing cycle—a circadian rhythm—maintained by the brain, particularly the part of the brain that regulates sleep function. Second, the clock in your head runs slowly. Fortunately, that clock has a natural mechanism for setting the right time every day. Third, there is a great deal of blue light in light that doesn't look blue.

- The internal clock inside your brain is a tiny region called the suprachiasmatic nucleus, which contains about 20,000 neurons. It is located in the hypothalamus, right above the optic chiasm, the place where the optic nerves from your two eyes come together. Every evening, the clock triggers a cascade of physiological events. It causes the release of melatonin, a hormone that works to lower your heart rate and body temperature and eventually to bring on sleep. There is one problem with the clock: It runs a bit slow—about one hour slow each day.

- Researchers have conducted studies in which participants lived in an environment without external time cues, sequestered in an isolated basement living area. All clocks were removed, as were other time cues. The participants in these studies were allowed to turn the lights on and off whenever they wanted. When they felt it was time to go to sleep, they could turn the lights out and do so.

- The participants slept for about eight hours a night. However, each eight hours of sleep started about 25 hours after the last one started. The human circadian rhythm clock directed the normal sleep pattern, but it waited consistently longer than 24 hours from cycle to cycle.

Blue-Light Wavelengths

- The suprachiasmatic nucleus has a reset mechanism: sunlight. In 1998, researchers discovered a type of receptor in the human retina that is critical to this process. These receptors, called melanopsin retinal ganglion cells, connect almost directly from the eye, down the optic nerve, and then to the suprachiasmatic nucleus.

- These particular receptors are most sensitive to blue-light wavelengths. Sunlight—even bright-white sunlight—contains an evenly distributed mix of many wavelengths of light, including blue. When this blue-frequency light strikes the receptors, it disrupts the suprachiasmatic nucleus function. If you look at a computer screen, it greatly reduces your brain's release of melatonin.

- On the flip side, when you wake up, first thing in the morning, you should look out a window at blue sky. Or if your daily schedule calls for you to rise before the sun, you can downregulate your melatonin production and wake up more quickly by staring at a computer screen or television. Broad-spectrum or bluish illumination, especially bright illumination, will reset your internal clock and get your brain active and on its way.

Questions to Consider

1. Studies of preindustrial sleeping behaviors have uncovered evidence of what is called second sleep. After going to bed around sunset, many people awaken around midnight, engage in singing, prayer, or other activities for about an hour, and then go back to sleep until sunrise. How does this fit with our discussion of healthful sleep habits?
2. Lack of sleep is often related to poor decision making—even about when to sleep. The theory is that if we don't sleep enough tonight, we can simply get some extra sleep tomorrow. How might mental time travel be used to improve upon this problematic decision?

Suggested Readings

Cvetkovic and Cosic, eds., *States of Consciousness*.

Stickgold and Walker, eds., *The Neuroscience of Sleep*.

Lecture 11

Boost Insights and Creativity

Creativity may well be the most valuable product of our brain functions. Constant innovation is a hallmark of human history. Only in the last few decades have researchers studied creativity from the perspective of cognitive neuroscience, however. In this lecture, we present the findings of scientific studies that support strategies to boost creativity.

Remote Associates Test

- To develop more creative solutions, listen to happy music. One of the best studies of this effect, conducted by Gene Rowe and his colleagues, used a type of puzzle called a remote associates test. In the remote associates test, you are given three words. Your task is to come up with a fourth word that is closely associated with all three. For example, say that the three words are "cottage," "Swiss," and "cake." The related fourth word is "cheese"—creating "cottage cheese," "Swiss cheese," and "cheesecake."

- While these are simply word puzzles, a significant step in most creative processes is to consider how very different pieces of information relate to one another.

- Participants in the Rowe study were randomly assigned to one of three mood-induction conditions: positive, negative, and neutral. In the positive condition, participants listened to a jazz version of one of Bach's *Brandenburg Concertos*. Participants in the negative condition listened to Prokofiev's music score of *Alexander Nevsky*. For the neutral condition, participants read a series of facts and figures about Canada.

- After 10 minutes engaged in one of these three tasks, participants in the positive condition gave higher ratings of their positive mood level; neutral participants were in the middle; and the negative group's moods were significantly lower. Participants then engaged in the remote associates test.

- As you might guess, the performance tracked with the mood level. People who listened to the positive music answered significantly more remote associates test questions correctly. To the extent that this test taps into significant aspects of creativity, we can conclude that listening to happy music boosts creativity.

Eriksen Flanker Task

- The Eriksen flanker task was also performed by participants in the three experimental mood-induction conditions. In this test, participants watch a computer screen and respond as quickly as possible to the appearance of a letter in the middle of the screen. The task is to focus your attention on one location on the screen and to ignore flanker letters.

- Listening to happy music makes you worse at this task. Listening to sad music, however, improves performance. The researchers argue that a happy mood broadens your focus of attention and makes your brain more open to considering a wider range of diverse information.

Sudden Insight

- Mark Beeman has studied brain activation during remote associates tests using functional magnetic resonance imaging (fMRI) and the electroencephalograph (EEG). Beeman was keenly interested in the experience of sudden insight when we try to solve complex problems.

- In Beeman's studies, whenever participants had an insight experience, they would press an insight button. Beeman's analysis of the brain-imaging data revealed that a particular region in the anterior superior

temporal gyrus became very active shortly before this moment of insight. This area is located at the top of the right temporal lobe.

- Three-tenths of a second before participants pushed the insight button, a burst of high-frequency activity was emitted from the anterior superior temporal gyrus. This region is associated with many tasks involved in integrating distant semantic relations or finding connections between information that is only loosely related.

Sympathetic and Parasympathetic Nervous Systems

- Research on the sympathetic and parasympathetic portions of our autonomic nervous system can help explain why happy music affects the brain regions associated with creativity. When we find ourselves in threatening, potentially dangerous situations, we activate our sympathetic nervous system. This prepares our body for a potential fight-or-flight reaction, aimed at increasing the likelihood of survival.

- When we don't sense a threat, our body activates the parasympathetic nervous system and enters into a tend-and-befriend mode of processing. Activation of the parasympathetic system is associated with complex cognition and creative problem solving.

Alternative Uses Test

- Walking is associated with boosting happiness as well as creativity. Marily Oppezzo and her colleagues explored this phenomenon with a task that has often been used to assess creativity: the alternative uses test. In this test, participants are given four minutes to come up with as many different uses as they can for a common object.

- Oppezzo's group had their participants complete the remote associates test and the alternative uses test while participating in one of several experimental conditions. Some participants sat in a chair; others stood; some walked inside or outside; and some were pushed

in a wheelchair. Walking significantly boosted the creativity of the study participants.

Stimulate Your Brain with Variety

- The best creative thinkers tend to be those who engage in a wide variety of tasks. In typical studies, researchers have surveyed participants about the variety of activities they pursue. The participants then complete tasks such as the remote associates test and the alternative uses test. In general, the more varied the participants' typical activities, the higher they score on tests of creative thinking.

- If you feel stuck with a particular problem or set of challenges and want to develop more creative solutions, try something new. Doing so can stimulate your brain in novel ways.

- As your senses (and body) are stimulated with a wide variety of different inputs, the internal state of your brain's activation will tend to vary more as well. Finding a creative connection between two pieces of information will only happen if the brain circuits that encode those two pieces of information are active at the same time. If you increase the variety of ways in which your brain is stimulated, this increases the chance of sparking these unusual co-activations.

Avoid Pre-crastination

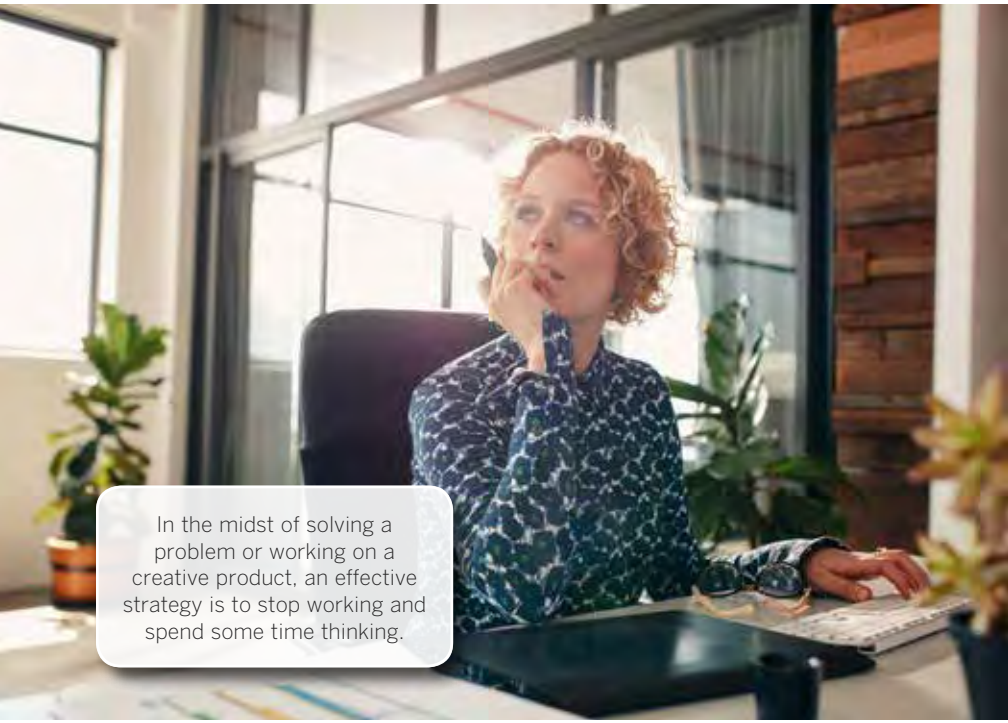
- A successful strategy associated with improved problem solving and creative work in general is to do nothing—at least not right away. Simply take some time to think about the problem or your general goals before you seriously undertake the work of addressing them.

- Counterintuitively, doing nothing for a little while is effective advice for overcoming procrastination. For the purposes of creativity, however, there is evidence that doing nothing can also help avoid the opposite problem, known as pre-crastination.

- Pre-crastination is the tendency to begin work prematurely on some critical task simply for the sake of getting it done and out of the way, even when the timing is detrimental to success. A few studies have found that procrastinators often come up with more creative solutions to problems. More thinking leads to more creativity in general.

The Incubation Effect

- Another effective strategy is to stop working and spend some time thinking in the midst of solving a problem or working on a creative project. Several studies have found evidence for the incubation effect. The general model of these studies is to give people a difficult problem to solve that will take several minutes.



In the midst of solving a problem or working on a creative product, an effective strategy is to stop working and spend some time thinking.

- In an incubation study, half the participants are randomly assigned to a control condition and are given several minutes to solve the problem. Some will solve it; some will not. The experimental group is given half as much time to work on the problem and then forced to take a break. This group is given another task to perform during that time and specifically instructed not to think about the problem during the break.

- After the break, participants in the experimental group are allowed to work on the original problem. At the end of this second work phase, both the control and experimental participants will have had the same amount of time to work directly on the problem.

- In the many studies of the incubation effect, more of the experimental participants solve the problem than control participants. During the break period, although the experimental group participants aren't explicitly working on the problem, many have argued that their brains may still be implicitly and unconsciously chipping away at the problem.

- The break period is often referred to as the time when the problem solution is incubating. Neuroscientists speculate that during the incubation period, the neuronal circuits involved in solving the problem remain active, continuing to search for associations and possible solutions.

REM Sleep

- Several studies suggest that if you include some sleep and dreaming in the incubation period, the effects are significantly enhanced. Denise Cai and her colleagues presented sleep-deprived participants with a set of remote associates test items along with challenging analogy problems. Some were answered correctly during an initial session, while others were not. The participants then took a nap or stayed awake while resting quietly for 90 minutes.

- Some participants in the nap group entered the rapid eye movement (REM) phase of sleep, which is strongly associated with dreaming.

The participants who produced REM sleep returned to the problems and performed significantly better than the quiet-rest group and even the nap participants who did not exhibit REM sleep.

- Sleep research suggests that your brain enters the REM stage of sleep several times every night. During REM sleep, the brain partially replays experiences of the previous day, consolidates them into long-term memory, and seems to find abstract relations between different sources of information. All this is helpful for creativity and problem solving.

1 Percent Inspiration, 99 Percent Perspiration

- That sudden insight that comes right before the solution to a complex problem is a magical experience—but it represents the end of the creative process, not the beginning. To be creative, you have to work at it very diligently.

- In fact, most successful creative people are extremely disciplined about when they work and even where they work. Thomas Edison famously said that genius is one percent inspiration and 99 percent perspiration.

- Most people think of creativity as unbridled thought and consider the creative process as a practice in which you simply wait for an inspired solution to come to mind. The tips outlined here will all help with creativity, but they won't work in isolation. Even if you listen to happy music, incubate your thoughts across a night of sleep and dreaming, take a walk, avoid pre-crastination, stimulate your brain with variety, or give yourself time to think before you start working, you will still need to invest substantial effort in actively working to find creative ideas and solutions.

Questions to Consider

1. Many creative thinkers have credited the use of particular drugs with boosting their creativity. How does this fit with the current understanding of the creative process? How does it contradict it?
2. Incubation research suggests that our brain unconsciously continues to work on solving problems even as we direct our attention to something else. Might it be that the mental break improves later performance even if there is no unconscious problem-solving system engaged in ongoing processing? Could an experiment answer this question? Does it matter in terms of how you use incubation to enhance your creative problem solving?

Suggested Readings

Gladwell, *Outliers*.

Kounios and Beeman, *The Eureka Factor*.

Lecture 12

Enhance Performance with Imagery

William Arthur Ward famously said, "If you can imagine it, you can achieve it." The human imagination is an extraordinarily powerful instrument. In this lecture, we explore how the brain makes use of mental imagery and outline the process for outsmarting yourself into using mental imagery to enhance your visuomotor skills, cognitive abilities, and even social and emotional capabilities.

The Power of Imagination

- Following is an astonishing example of what the human imagination can accomplish.

- Imagine that you are standing with your legs about shoulder-width apart. Feel the pressure of the solid floor against your feet. Feel your body swaying back and forth, ever so slightly, the way that it usually does when you stand very still. In your right hand, imagine holding a heavy barbell. The texture of the metal is rough, and the barbell feels cooler than your skin where it touches your hand.

- Maintain a clear image of that in your mind. Now, imagine lifting the barbell all the way to your shoulder. When you've bent your arm as far as it will go, lower the barbell slowly until it's back at your side. Imagine relaxing your arm.

- Note that physically you have done nothing with that arm; rather, your brain did a lot of work imagining what your body was doing. While

your brain gets a great deal of exercise, what is even more amazing is that your muscles get a workout as well.

The Shackell and Standing Study

- Erin Shackell and Lionel Standing designed one of the best studies demonstrating the remarkable effects of mental imagery. Their research team recruited participants and tested the strength of their hip flexor muscles. Once the participants' baseline strength had been assessed, they were randomly assigned to one of three conditions.

- The control participants left and returned two weeks later. Participants in the physical-training condition undertook a strength training program for their hip flexors. Participants in the mental-training condition were shown the hip flexor machine during the first visit, but they did not use it for the next two weeks. Instead, they imagined using it. Specifically, they imagined performing the same exercise that the physical-training participants actually performed.

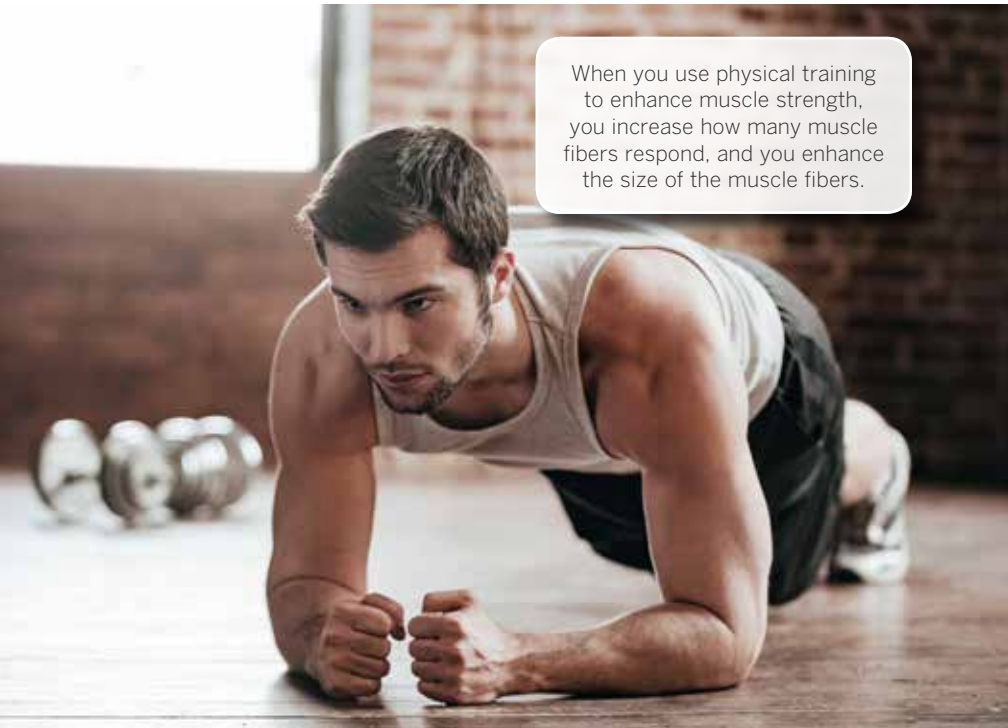
- At the end of the study, everyone returned to the gym for a repeat of the strength assessment. Participants in the physical-training group increased their performance on the strength test by 36 pounds. Participants in the control group did not change significantly. Participants in the mental-training group, without ever touching the weight machine, improved their hip flexor strength by 32 pounds—just a few pounds less than the physical-training group.

The Science behind the Study

- To understand the extraordinary results of the Shackell and Standing study, consider how your brain controls your muscles. Contraction of a muscle is caused by a continuous train of signals sent from the brain via the spinal cord to the efferent nerves embedded within the muscle tissue. As these neuronal signals arrive, muscle fibers contract.

- The overall power that a muscle produces is a function of how big the muscle fibers are and how many of the muscle fibers contract. When you use physical training to enhance muscle strength, you increase how many fibers respond, and you enhance the size of the muscle fibers. When you fatigue and damage those muscle fibers during physical training, the body responds by repairing them and making them a little bigger than they were initially. Physical training makes muscles bigger.

- Mental training, by contrast, doesn't change the size of muscle fibers very much. Imagery, however, seems to increase the strength of the signals sent to the muscles. After imagery practice, when you make an actual movement, your motor cortex will become more active than it otherwise would be. A greater number of action potentials is conveyed to the muscles, causing a greater number of muscle fibers to respond when your brain calls on them to do so. The result is that more force is generated by the muscles.



Imagination and Neural Processing

- Many areas of the brain participate in mental-imagery processes. It has been known for more than a century that crucial visual processing takes place in the visual cortex in the occipital lobe, located in the back of your brain.

- There are connections from certain places on your light-sensitive retina to particular locations in the occipital lobe. If light is projected onto your eyes, a region of the visual cortex will become active.

- Stephen Kosslyn and his colleagues placed study participants in a functional magnetic resonance imaging (fMRI) scanner in complete darkness. Kosslyn then asked participants to imagine a spot of light. When they did, an area of the occipital lobe became active. When he asked them to imagine a larger spot of light, a larger area of the occipital lobe became active.

- This basic relationship between imagination and neural processing has been found across a large number of domains. When you imagine moving your arm, the part of your cortex that is activated when you actually move your arm becomes active. When you imagine hearing a sound, activation appears in the auditory cortex.

Four Key Aspects of Imagery Practice

- If you've ever watched a professional athlete—or even any expert—you've likely seen how visual imagery is used to enhance visuomotor performance. Before performing, good athletes will use their imagination to simulate the action. Such a strategy is well supported by research. Performance is essentially always better when athletes imagine the task beforehand.

- Hundreds of studies have provided evidence for the effects of imaging performance. Large-scale analyses have pulled together data from thousands of participants and identified four key aspects of imagery practice.

1. The mental rehearsal should be from a first-person perspective. When you imagine making a golf putt, you should mentally view it from the perspective of your own eyes.
2. The imagery should be multimodal. To get the most out of imagery, you want to mentally simulate the full sensory experience—including even the parts that don't seem directly relevant to performance.
3. The imagery should be precise. Our mental images of things also contain conceptual information. Indeed, for mental visual images, the identity of the object is much clearer than the sensory information itself.
4. Imagine succeeding when you perform the task. In the golf example, the ball should go in the hole. Mental images not only activate sensory and motor processing areas of the brain, but they also activate semantic processing. Semantic information is associated with labels, such as "success" and "failure."

The Science behind the Semantics

- Patterns of activity in the sensory areas of our cortex produced by actual sensory input are created in a bottom-up fashion. The activity of sensory neurons identifies low-level features of the input and builds up a mental representation of the state of the outside world.

- On the other hand, patterns of activity in the sensory areas of our cortex produced by imagined sensory input are created in a top-down fashion. Our brain starts with a high-level, rough description of the imagined world and then activates the lower-level features that are associated with it. Starting with a particular high-level, semantically labeled description of the world is a crucial part of effective mental imagery.

- Although imagined visual images are processed in the same regions of the brain as actual visual images, they aren't the same thing. When we think of those parts as separate objects, they retain that identity in the image. Integrating them together as a unit simply doesn't work.

Your mental images are images plus attached information about the identities and roles of the parts. For a successful visual-imagery practice, it's important that your mental rehearsal of the activity contains that semantic label of "successful" right from the start.

Long-Term Benefits of Mental Imagery

- In addition to research supporting an immediate advantage of using mental imagery, many studies have shown long-term benefits.

- If you find yourself suffering through an injury or experiencing physical fatigue that prevents you from practicing or exercising, here's how to improve. It's a fact that your muscles get tired faster than your brain. Even when your body isn't ready for more, the brain might be. This can be an especially good time to use mental practice as a supplement to physical practice. There is good evidence that mental imagery, used three or four times per week, can result in improvements in a wide range of different physical activities.

Therapists work on flexibility and strength of the affected limb, and over time, some function is typically recovered.

- Mental imagery may even help you to recover faster from an injury. An extreme case has been studied by Jennifer Stevens and her colleagues. They recruited patients who had suffered strokes that resulted in near-paralysis of the arm on one side of the body. The normal rehabilitation strategy for this condition takes a bottom-up strategy: Therapists work on flexibility and strength of the affected limb, and over time, some function is typically recovered.

- Stevens and her team developed a top-down strategy, in which participants engaged in mental-imagery exercises. They imagined moving the limb in ways that it could no longer move. When this practice was used in combination with standard rehabilitation techniques, participants exhibited increased recovery of motor function. Their limbs even got stronger when imagery was used.

Hebbian Learning

- Mental imagery has the immediate effect of warming up the particular brain circuits that will ultimately be responsible for controlling an action. Because mental imagery provides low-level activation to these brain regions, they are able to function more efficiently when the time comes to perform for real.

- A second, slower effect of mental-imagery practice has to do with refining patterns of neuronal connectivity. Everything you do is controlled by networks of neurons that fire in a precise, coordinated order. When you imagine performing a task, those neurons become more strongly connected to one another.

- Donald Hebb was noted for discovering that when two neurons become active at the same time, they tend to become more strongly connected to each another. Conversely, if there are two connected neurons and only one of them is active, then the connection between them tends to be weakened. This fundamental property of neurons has come to be known as Hebbian learning, and it has been implicated in nearly all experience-dependent learning that we do.

- Hebb summarized the process with a very simple phrase: "Neurons that fire together, wire together." When you engage in mental imagery, you are giving your neural networks extra repetitions of a behavior in which they can engage in this Hebbian learning process.

Questions to Consider

1. When you practice a new activity with the goal of developing expertise, it is critical that you get feedback on your behaviors. For example, after you try to make a basketball free throw, you need to know if your actions produced a successful shot. In imagery practice, however, your brain generates the outcome. How can both real-world and imagery practice be so beneficial?
2. There is strong evidence that positive imagery helps to enhance performance and outcomes. Some people, however, engage in too much imagery: They dream big but never seem to make those dreams a reality. How can you tell when you have engaged in too much imagery practice and not enough real-world action?

Suggested Readings

Doidge, *The Brain that Changes Itself*.

Finke, *Principles of Mental Imagery*.

Lecture 13

Overcome Your Aging Brain

Beyond about 20 years of age, many basic aspects of human brain function decline. While currently there is no way to fully and permanently prevent this process, there are a variety of ways to slow the decline and even to compensate for the decline that does occur. The human brain seems remarkably capable of compensating for age-related changes as long as you remain active and engaged in both routine as well as novel challenging behaviors. What's more, these behaviors also have the potential to greatly enrich the quality of your life—and the function of your brain—at any age.

Age-Related Decline of Cognitive Function

- Cognitive neuroscience research suggests that an effective way to fight age-related mental decline is to take up an activity you have never done before. It is best if you find the activity very challenging—mentally and perhaps physically. Try to make it a new activity every month.

- To understand why this is a successful strategy for countering the effects of aging on the brain, consider what causes the decline of mental function. Until you are about two years of age, your brain grows in both its size and the number of neurons. During early development, the brain is programmed to overproduce neurons.

- Then, the process during childhood and early adulthood involves the planned elimination of an enormous number of these neurons. This process, often referred to as neuronal pruning, is central to improving the function of the brain as we mature.

- Around 20 years of age, the human brain seems to peak in terms of many basic functions assessed by cognitive tests. This is the time when most people are fastest in reaction time and decision-making ability. Our capacity to alternate rapidly between two different tasks is best around this age. Our ability to focus our attention completely on one location in space while ignoring peripheral locations peaks as well.

- These peaks, however, refer only to specific tests of isolated cognitive faculties, such as memory, attention, and processing speed. They do not apply to complex behaviors, such as writing, problem solving, and creativity. In terms of many complex behaviors, humans usually continue to improve beyond 20 years of age.

Procedural and Implicit Memory

- While age-related decline in cognitive function is significant, it is smaller than we used to think. Florian Schmiedek and her colleagues looked in detail at cognitive function differences between younger and older adults. They recruited a large number of participants between 20 and 30 years old and another group between 65 and 80 years old. The participants performed a variety of different cognitive tests 10 times on 10 different days over the course of about two months.

- On memory tests, young adults scored around 0.25. Older adults scored around 0.15. That seems like a significant drop, but this test was aimed at the very peak of rapid encoding and memory abilities. When the task was slowed down enough, these memory differences became substantially smaller.

- It's also worth noting that some abilities decline much more slowly than others. For instance, our procedural memory—the memory for how to perform tasks—declines very slowly. What's more, our implicit memory seems barely to decline at all. Implicit memory is our encoding of information and associations that seem familiar, even if we can't explicitly remember where the knowledge comes from.

Brain Shrinkage and Neuronal Death

- A main reason that basic cognitive faculties decline beyond 20 years of age is that the brain shrinks. Neurons die off faster than they are replaced, leaving us with a smaller brain.

- The cells in your brain are organized in an extraordinarily intricate fashion. Your memories and skills are built into the patterns of connections between billions of brain cells. When new cells are added into this system, the process of integrating them into those existing circuits takes a lot of work. Those new cells have to learn to contribute to the existing computational system. As neurons die off, the brain loses some of its computational ability.

- The human brain is remarkably robust, however. When we encode a memory, it's not saved in a single place. All our memories are encoded across thousands—in some cases, millions—of neuronal cells. If a few of those cells die, the memory will still be accessible. If a few neurons involved in performing some skill are destroyed by injury, you will still be able to perform that skill. But if enough neurons die off, eventually the system is compromised, and the basic abilities measured by cognitive testing decline.

- Neurons die as a result of physical injury, disease, or circulatory issues that prevent blood from flowing to a region of the brain. The majority of neuronal death, however, is a result of simple inactivity. Neurons exhibit bursts of electrochemical activity called action potentials that cause signals to be sent to neurons nearby. If one neuron receives enough signals from excitatory neurons around it, then that neuron may be excited enough to exhibit its own action potential.

- Action potentials make up the code that our brain uses to perform computations that support our perception, cognition, and action control. Those action potentials are also a critical part of the neuronal cells' physiology. It's part of how they pull nutrients and oxygen from the bloodstream and how they expel waste products. If a neuron stops exhibiting action potentials long enough, it will starve.

Try New Activities

- The best way to reduce age-related brain shrinkage is to keep your brain active. Physical activity—even moderate exercise like walking—inspires neural activation and even the creation of new neurons in certain areas of the brain.

- One of the best ways to inspire broad-based neural activity, however, is to try new activities. As we become more experienced at some activity, our brain becomes faster and more accurate in producing the proper actions at the right times. As we become very expert at that activity, several lines of research have shown that we don't employ

more of our brain to support the activity. On the contrary, we learn to use less of our brain, developing specialized circuits that rapidly, automatically mediate the task performance.

- To maintain brain health, you need to stimulate your brain. What is counterintuitive is that one of the best ways to broadly stimulate brain activity is to take on new activities—activities for which you are specifically not an expert. The more challenging the task, the more of your brain will be recruited to support it, and the less your brain will shrink.

Laugh a Lot

- There is good evidence that laughter helps keep your brain especially stimulated. A great deal of progress has been made in understanding our brain's processing of humor. One of the central mechanisms is incongruity detection and then resolution.

- As your brain identifies incongruity and then corrects its initial interpretation of the incongruity, it engages a remarkably wide range of brain areas. Language areas become more active when a stimulus is funny. The medial prefrontal cortex, posterior cingulate cortex, precuneus, superior temporal gyrus, and superior temporal sulcus show similar boosts in activation. Laughter is also associated with a substantial release of dopamine into the pleasure circuits of the brain.

- When you watch funny movies, listen to or read funny stories, or have a funny conversation with a friend, your brain lights up in terms of widely distributed activity.

Overcome Limitations

- To outsmart the aging brain, in addition to trying new activities, it's important to keep performing familiar activities. As our basic cognitive faculties slowly decline, one of the ways we maintain our performance—indeed, one of the ways we often improve our

Laughter is associated with a substantial release of dopamine into the pleasure circuits of the brain.

performance—is by developing ways to compensate for those losses.

- Timothy Salthouse and his colleagues conducted a study of how well people type as they age. Typing tests allow researchers to assess both overall performance and basic cognitive functions. A group of experienced, expert typists were recruited for the study. They visited the Salthouse lab and completed several different types of tests. The first was to type several passages as quickly and accurately as possible. Participants also completed a wide range of tests of basic cognitive, perceptual, and motor abilities related to typing.

- The researchers determined that there is almost no effect of age in the actual typing speed of experienced typists. While a 70-year-old typist is slower in terms of cognitive and motor assessments, when you present these typists with a passage of text and ask them to type it as quickly as possible, their speed is almost identical to that of younger experienced typists.

- Salthouse performed several clever experiments in which he restricted the number of characters ahead on the line of text that the typists were allowed to look. If you are looking only 10 characters ahead on the line, then if researchers block characters 15 and more ahead of where you are currently typing, it won't affect you. However, if researchers block all the characters beyond 5 ahead of where you are looking, then your performance will suffer.

- The experimenters found that older typists were maintaining their speed by looking farther ahead in the line of text than the younger typists. As their basic sensory and motor capacities declined, they discovered new strategies to overcome their limitations.

Compensate for Cognitive Loss

- In many domains, adults continue to improve in mental performance beyond 20 years of age. Imagine that you have developed the ability to perform some task at 20 years of age—for example, driving a car in busy city traffic. Your brain has organized itself to process the relevant sensory information, make strategic plans, and mediate your control of the vehicle. If your brain tries to do exactly the same thing in exactly the same way when you are 40 years old, then your performance of this task will be worse.

- However, if you learn to drive better by the time you are 40, you may be able to compensate for that basic cognitive loss. For example, you may learn more efficient routes to take at particular times of the day. You may learn to recognize earlier when pedestrians are about to walk into the street. You may learn that when your car makes a particular

noise, then pressing the accelerator won't produce as much speed as it usually does.

- If the 40-year-old you is able to use these extra sources of strategic information well enough, you might not simply be as good as the 20-year-old driver, you might even be better.

Questions to Consider

1. Much research literature on overcoming the effects of aging describes an ongoing battle—with physical decline on one side and expertise increase on the other. Performance improves beyond 20 years of age because the expertise side is making gains. If this theory is correct, what does it indicate about how we should most effectively stave off the effects of age on the brain?
2. Assessments of mental decline associated with aging are overly influenced by the presence of early-stage dementia in older populations. For the great majority of the population who are not affected by dementia, the declines in mental performance are often very small. If people suspect they are declining quickly, however, what steps should they take to minimize future decline?

Suggested Readings

Cabeza, Nyberg, and Park, eds., *Cognitive Neuroscience of Aging*.

Horstman, *The "Scientific American" Healthy Aging Brain*.

Lecture 14

Grow Your Brain Out of Depression

Depression is sometimes called the common cold of mental illness. Many people have suffered some level of depression at some point in their lives. In a survey by the National Institutes of Health in the United States, nearly 16 million adults reported at least one major depressive episode in 2014, slightly less than 7 percent of the adult population. If milder symptoms or shorter durations of depression are included, those numbers go even higher. Another reason that depression is considered the common cold of mental illness is that mild depressed feelings often go away on their own. In this lecture, we'll explore some of the causes of depression and the actions you can take to help depression diminish more quickly.

Effects of Exercise

- A wide range of research suggests that physical activity can help effectively battle depression. Studies of the effects of exercise on depression date back to at least 1981. A large study published in the *Archives of Internal Medicine* in 1999 involved 156 participants who reported symptoms of major depression. The participants were randomly assigned to three different experimental groups: a medication group, an exercise group, and a group receiving both medication and exercise.

- After 16 weeks, about 65 percent of participants reported that their symptoms had been reduced to the extent that they no longer fit a diagnosis of major depression. The medication group reached this

state faster than the exercise-alone group, but by 16 weeks, there were no significant differences between the groups. Exercise seems to work a little more slowly than medication, but the overall effects seem to be about the same.

- A follow-up study was conducted, in which 133 of the participants were recruited six months after the end of the original study. It was found that for the people who continued with the exercise program, the rate of depression was significantly lower. While exercise seems to work more slowly than medication over the first few weeks, the lasting effects of exercise seem to be substantially greater.

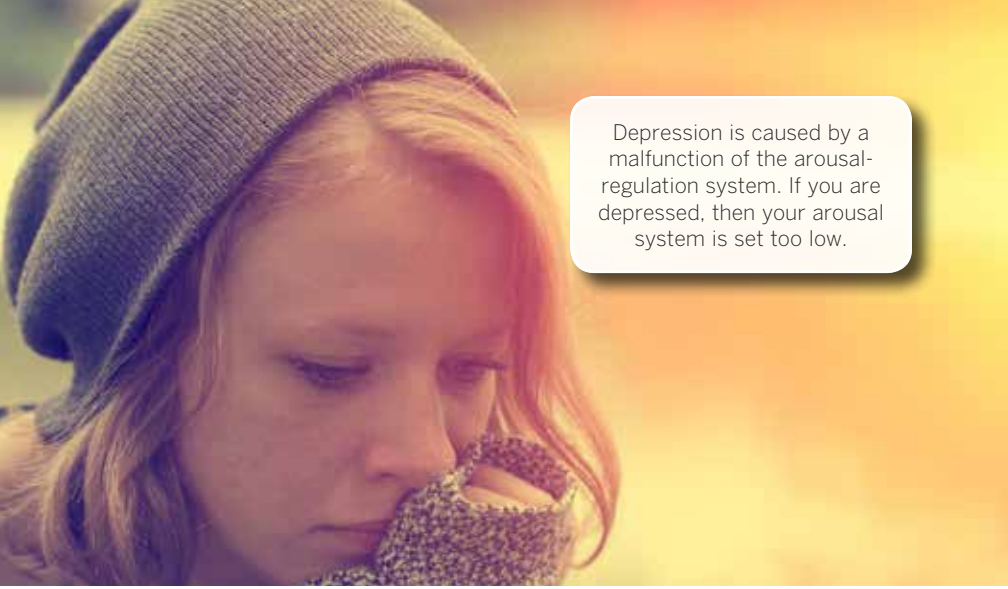
Homeostasis

- To understand how exercise helps to boost mood and reverse the effects of depression, consider what causes depression. One of the central organizing principles of the human brain—in fact, for the human body in general—is homeostasis. Your brain also regulates your level of general arousal. If you are ever overly excited by surrounding stimuli, your brain will down-regulate the responses to new stimuli. On the other hand, if you are immersed in a sedate environment, then your brain will up-regulate its responsiveness.

- According to most theories, depression is caused by a malfunction of the arousal-regulation system. If you are depressed, then your arousal system is set too low. When you are in a high-stimulation environment, the brain down-regulates its responsiveness too much. In a low-stimulation environment, the system doesn't up-regulate enough. One theory for how this might be implemented in the brain is through the production of different neurotransmitters.

Neuronal Communication Process

- Periodically, a neuron produces an action potential near the cell body. The voltage spikes from −70 millivolts to around +40 millivolts and then back down again. This pulse propagates down the length of the



axon portion of the neuron until it reaches its terminals. Within these terminals are storage sites called synaptic vesicles. Every time an action potential reaches one of these axon terminals, some of these vesicles burst open, releasing the neurotransmitter stored within them.

- The neurotransmitter is released into the synapse, a microscopic gap between one neuron and the next. The neurotransmitter diffuses across the gap and adheres to receptor sites on a neighboring neuron called the post-synaptic neuron. As the neurotransmitter adheres to the surface of that postsynaptic neuron, it influences the likelihood that it will produce an action potential of its own.

- Different neurons contain different types of neurotransmitters. Some are excitatory—that is, the more excitatory neurotransmitter released into the synapse, the more likely is the chance of a postsynaptic neuron action potential. Some neurotransmitters are inhibitory—that is, the more inhibitory neurotransmitter released into the synapse, the less likely is the chance of a postsynaptic action potential.

- Reuptake is the final step in the neuronal communication process. Our brains invest a great deal of energy to produce neurotransmitters. Rather than use them once and then discard them, neurons recycle the neurotransmitter. After the neurotransmitter is released from the synaptic vesicles, it gets absorbed back into the synaptic vesicles. If the action potentials of a neuron slow down enough—or stop entirely—the amount of neurotransmitter in the synapse itself will quickly drop down close to zero.

Serotonin in the Synapse

- One neurotransmitter that has been implicated in theories of depression is serotonin. People who suffer from major depressive disorder have substantially fewer serotonin receptors in their midbrain than do nondepressed control participants.

- The midbrain is a region that contains the hypothalamus and the limbic system, the region of the brain associated with emotion and mood regulation. It seems that part of the process that leads to depression involves a reduction in the sensitivity of these regions to serotonin.

- When serotonin is released into the synapse, it greatly magnifies the effect of any action potential. It effectively strengthens the connections between midbrain neurons and reduces the symptoms associated with depression. The best evidence for the serotonin theory of depression is the proven effectiveness of a variety of serotonin-specific medications, a family of drugs that function as selective serotonin reuptake inhibitors (SSRIs).

Function of Endorphins

- Exercise can have the same effect as SSRIs on the midbrain because during physical activity, our brains produce extra neurotransmitters, such as endorphins.

- Endorphins are neurotransmitters associated with the regulation of pain perception. When your body is physically damaged, your brain computes a perception of pain. If you are running or biking, for example, the consistent stress placed on the muscles results in damage and a pain perception associated with it. This exercise-induced damage is a positive outcome, however. As you recover from that damage, your muscles repair themselves and, in addition, make themselves stronger than they were before the exercise.

- The homeostasis concept applies here as well. If you feel a consistent amount of pain, your brain takes steps to reduce it. Endorphins are released that inhibit the brain's response to that discomfort. When you exercise and you fatigue and damage your muscles, your brain starts to produce endorphins to counteract the painful effects. When you stop exercising, eventually, the endorphin production drops again—but not immediately. For a while, those endorphins continue to be produced and influence the brain. The endorphins not only dull the physical pain of exercise but also inhibit the mental and emotional symptoms of depression.

- In fact, a variety of other neurotransmitter systems are also activated by exercise. Norepinephrine, for instance, is produced much more during physical activity than during periods of rest. This neurotransmitter increases general arousal for the sake of physical activity. Like the endorphins, norepinephrine production continues for a while even after you stop exercising.

Neurogenesis

- A new theory suggests a completely different pathway by which both exercise and SSRIs might impact depression symptoms. It may be that the key to reducing depression is to make more neurons.

- In the 1980s and 1990s, several teams of researchers found evidence for adult neurogenesis—the creation of new neurons. The original work was done with songbirds, which typically learn new songs every

spring. As the birds undergo this seasonal learning process, their brains substantially change size to support this new learning. The new cells are created, recruited into learning circuits, and then used like older cells. In humans, it seems that new neurons are produced in at least two parts of the human brain where rapid learning takes place.

- The first area is called the striatum, a subcortical part of the brain that is central to implementing our responses to positive and negative reinforcements. This is the part of the brain where continual learning and restructuring takes place.

- The other region where rapid neurogenesis seems to take place in humans is the hippocampus, the part of the brain critical to many significant cognitive functions. Our mental map of the surrounding environment seems to be implemented here, including our sense of where we are on that mental map. Our ability to form new long-term memories is implemented in the hippocampus as well. In addition, the hippocampus is involved in many aspects of information processing.

- Neurogenesis is much rarer in people who suffer from depression symptoms. Several studies have found that people who suffer from major depression for several months actually have measurably smaller hippocampus regions.

Role of Inflammation

- A strategy to fight off depression is to take aspirin. A number of large-scale studies found that people who suffer from inflammation-related illness are more likely also to suffer from depression. Most of those studies have been correlational.

- Several recent studies have more directly explored the hypothesis that depression may result as an inflammatory disorder of the body as a whole. Some studies have targeted populations that did not exhibit depression symptoms—some of whom were prescribed anti-inflammatory medications for reasons unrelated to depression and

some of whom were not. The people who took the anti-inflammatory drugs exhibited lower rates of depression after taking the medications.

- Taking aspirin, ibuprofen, or other anti-inflammatory drugs is worth a try if you find yourself struggling through an extended period of negative mood.

Benefits of Fermented Foods

- To boost your mood when you are feeling low, try adding fermented foods to your diet. Fermentation is used in the production of many foods. In general, it involves exposing foods to a family of bacteria called lactobacilli. These helpful, friendly bacteria eat the starches

To boost your mood when you are feeling low, try adding fermented foods to your diet. Common examples of fermented foods are kimchi, sauerkraut, and yogurt.

and sugars in food and convert them into lactic acid—a sour-tasting substance. Common examples of fermented foods are kimchi, sauerkraut, yogurt, sourdough bread, tempeh, and miso.

- There is a growing body of evidence that the incidence of depression is lower in people who regularly consume fermented foods, although the exact mechanism for this is still a mystery. Similar to the results of taking anti-inflammatory medication, however, the data on fermented foods seem to suggest that the effects are much larger for some people than others.

Questions to Consider

1. Depression is associated with emotion centers of the brain, such as the limbic system. How might the creation of new neurons in learning regions such as the hippocampus lead to improvements in emotional well-being?
2. If so many people suffer from depression, what is the origin of its social stigma?

Suggested Readings

Eriksson et al., "Neurogenesis in the Adult Human Hippocampus."

Korb, *The Upward Spiral*.

Lecture 15

Hack Your Brain to Unlearn Fear

According to cognitive neuroscience, we can learn to conquer even our most debilitating fears or phobias. Fear responses are learned; in most cases, fears are not innate. A phobia is an extreme or irrational fear or aversion. We know a great deal about how the brain implements learning and association of a situation with emotion. In this lecture, we will consider how the cognitive systems function and describe ways in which you can unlearn your fears and manage phobias.

Functional Fear of Heights

- Fear isn't necessarily a negative emotion. For example, most people have at least some fear of heights. Consider, however, the consequences of falling from a great height. Actually, a functional fear of heights is built directly into the human visual system. Dennis Proffitt and his colleagues have documented a fascinating depth-perception illusion that they discovered while standing on a balcony in the psychology building at the University of Virginia.

- This particular balcony is about 20 feet above the ground and extends for much of the length of the building. In the experiment, person A stood on the ground below the balcony. Person B stood on the balcony directly above person A. Person C stood on the balcony off to the right side of person B. The job of person B was to ask person C to move gradually farther away until the distance between person B and person C matched the distance between person B and person A on the ground.

- When person B felt that the vertical distance matched the horizontal distance, the experimenters measured the two distances and compared them. Virtually every participant dramatically overestimated the distance to the ground. When the experimenters repeated the process from the ground looking up, however, the effect went away.

- When you look down from a height, your visual system seems to know that vertical distances require great caution. Whatever the distance actually is, your automatic, unconscious visual system takes that value and multiplies it before passing the information on to your conscious perceptual system.

Short-Term and Long-Term Memory

- Emotional states are part of our system of memory encoding and processing. If you experience a neutral stimulus and then experience an extreme emotion such as terror, you will come to associate that stimulus with that particular emotion.

- Human memory is often described in terms of two separate brain systems: short-term memory and long-term memory. When you perceive something in the environment, you first store it in your short-term memory. If you want to remember something for a long time, you have to transfer it from your short-term memory into your long-term memory. To recall the information, you summon it from your long-term memory back into your short-term memory. Short-term memory is often called working memory.

- When you create a long-term memory, you encode the specific information as well as the context in which the information was learned, including a number of extra yet related details. When you encode a long-term memory for some new piece of information, you capture much of the context in which that information was delivered.

- In addition to the external context—for example, the place and time of day—you also encode the context of your internal state. Most relevant to our discussion of fears here, your internal emotional state is a part of that context.

Fight-or-Flight Reaction

- The human nervous system possesses fundamental mechanisms for regulating arousal. When your brain detects a threat, it shifts its resources to activating the muscles and augmenting sensory processing. Your heart rate and breathing become faster as blood is pumped to the muscles to oxygenate them. Blood vessels in the digestive system contract so that the oxygen and fuel there can be diverted elsewhere. When people experience fear, they tend to open their eyes widely. When you do this, you can see a little better, especially in the periphery. Your body is prepared for a fight-or-flight situation.

- Fear of flying may be common because of excess carbon dioxide in the plane while people are boarding. Often, pilots shut down the

air conditioning while the plane is being serviced and inspected between flights. It typically stays off until everyone is on the plane, but people keep breathing, taking in oxygen and exhaling carbon dioxide. One of the best ways to induce a fight-or-flight arousal response is to have someone breathe air that is rich in carbon dioxide. Our body's deep-seated survival instincts take over and an association is formed.

- For strong phobias, you don't necessarily have to have especially bad experiences to maintain or even strengthen them. If you have a substantial fear of flying, then if you simply think about flying, you will start to feel nervous. As you remember a time when a flight got very bumpy as you landed, your sympathetic nervous system will ramp up its activity. Even though nothing new has happened, the memory of flying will become even more strongly associated with the fear.

Systematic Desensitization

- Because phobias and fears, in general, are learned, we can break that learning cycle. Successful methods to manage fears and phobias involve recalling memories of fear-inducing situations and then weakening the associations between those memories and the fear.

- One of the oldest techniques is called systematic desensitization. You start by calming your mind and body and willfully place yourself in a state of complete relaxation. Sit still, do nothing, focus on your breathing, and concentrate on relaxing all your muscles one at a time.

- Once you are fully relaxed for 10 minutes or so, you then think about the source of your fear. This memory will cause you to become tense as the anxiety and fight-or-flight response kick in. Relax and wait for these to pass, and then repeat the process. Eventually, you will be able to think about that fear-inducing experience without feeling the paralyzing anxiety associated with it.

- If you can fly and stay relaxed a few times, you will have mastered your phobia. One way of accomplishing the desensitization process is to create new memories—that is, to overwrite the old ones—in which the external cues are associated with relaxation rather than fear. Decades of research support systematic desensitization for treating fears.

Reconsolidation of Memory

- Recent research has produced a fascinating new way of thinking about desensitization and suggests a way to accelerate the process. This new research also has the potential to provide a much better understanding of how memory and fear actually function. The key here is to interfere with reconsolidation of a memory.

- This new research starts with an innovative view of short-term and long-term memory. In the traditional view of memory, we perceive the world around us and pull that information into our short-term memory. Some of that information gets consolidated into our long-

term memories. Later, when we want to remember something, we pull that long-term memory back into our short-term, working memory. In the traditional model, what is moved to the working memory is a copy of the long-term memory, not the long-term memory itself. Recent research suggests that this is incorrect.

- According to the new theory, remembering is like checking a memory out of a library. After you pull a memory into working memory and use it, you need to re-make that long-term memory again. The initial transfer of information from short-term to long-term memory is called memory consolidation. The transfer from short-term memory back to the long-term memory library again is called reconsolidation. If you don't reconsolidate a memory—if you don't re-make it after recalling it—then the memory gets lost. In fact, the very process of remembering something might result in its being forgotten.

- There is clear evidence that when a memory is recalled from long-term memory back into working memory, then it is placed in a state of flux, a state in which it can be changed or even erased.

Propranolol

- Recent studies have used the drug propranolol to rapidly reduce or even eliminate phobias. Propranolol is a beta-blocker medication, often used to treat high blood pressure, irregular heartbeat, migraine headaches, and a variety of other ailments. Beta-blockers block the receptor sites for adrenaline and norepinephrine—substances associated with stress-based arousal. When your fight-or-flight system is activated, it does so on the basis of these neurotransmitters. If a beta-blocker is in your system, the neurotransmitters are released, but the ability of the neurotransmitters to affect neurons on the receiving side of a synapse is reduced. Propranolol is also used to treat many anxiety-related disorders.

- In a study recently published by Merel Kindt and her colleagues at the University of Amsterdam, participants were recruited who had

particular phobias—for example, arachnophobia, or fear of spiders. Others were recruited who suffered from anxiety associated with some past experience—for example, painful memories of being mugged and assaulted at gunpoint.

- Kindt was very directly inspired by studies of memory consolidation and reconsolidation. She didn't aim to eliminate the memory but to change its emotional associations.

- In her studies, participants experienced the fear-inducing stimulus. Once the fear state and the memories associated with it had been activated as fully as possible, some participants took a dose of propranolol. In the days and even months after this experience, these patients reported a dramatic drop in their fear. It was as if the propranolol, by blocking the participants' ability to fully experience the fear, also blocked the tendency to reconsolidate that fear into long-term memory.

Talk Therapy

- Another strategy that doesn't involve propranolol may have the same result of managing fears and phobias: talking to someone. There is a wealth of evidence from clinical psychology that talk therapy produces a reduction in anxiety associated with fear.

- There are many different types of talk therapy: Freudian psychoanalysis, psychodynamic therapy, behavior therapy, cognitive therapy, humanistic therapy, integrative holistic therapy. As different as they all are, they all seem to work (although not all the time and not with every person).

- It might be that the benefits of talk therapy have been based on the reconsolidation mechanism all along. As you sit in a therapist's office and have a conversation, you are relaxed. As you discuss your fear, you recall what has troubled you. As you reconsolidate those memories, over and over, while being in a relatively safe, calm

environment, you will tend to weaken the associations between those memories and fear. As you do, you will gradually diminish the effects of the fear on your life.

Questions to Consider

1. Some recent evidence demonstrates that recalling fear-inducing events while under the influence of beta-blocker medications—which reduce the brain's fear response—can quickly reduce phobias. Many substances have similar relaxing effects: alcoholic beverages, a cup of tea, and even comfort foods like macaroni and cheese. Would recalling negative events while consuming these substances produce the same results?
2. Flooding is a method for treating fears in which the feared stimulus is continually presented to someone until the phobia subsides. If the process is interrupted before the phobia subsides, however, the intense and unpleasant experience of long-term exposure can increase the fear. When might flooding be an effective method to use, and when not? What steps should people take if they use this method to rapidly treat a phobia?

Suggested Readings

Knaus, *The Cognitive Behavioral Workbook for Anxiety*.

Soeter, "An Abrupt Transformation of Phobic Behavior after a Post-Retrieval Amnesic Agent."

Lecture 16

Use Your Body to Alter Your Mind

To a great extent, the brain controls the body. The act of waving your right arm, for example, is caused by a particular pattern of neural activity in a certain place in your brain—specifically, the motor cortex in your left frontal lobe. In this lecture, however, we challenge the assumption that the brain fully controls the body. A great deal of research suggests that your thought processes don't stop when they leave the confines of the skull. In fact, your body influences the state of your brain as well.

Facial Feedback Hypothesis

- If you are unhappy and want to feel happier, smile. In the 1970s, James Laird conducted studies in which he asked participants to contract certain muscles in their faces while they watched cartoons. He found that if the participants were making exaggerated smile expressions, then they were more likely to report that the cartoons were more humorous than if they did not make the smile expressions.

- This basic effect has been replicated many times. If you adopt a smile posture for a few minutes, you will generally report feeling more positive afterward. If you make a frown, then you will begin feeling bad.

- Researchers refer to this as the facial feedback hypothesis. Most people readily accept the notion that your emotional feelings influence the way you act: If you are happy, you are more likely to smile. The facial feedback hypothesis suggest that information flows

in the other direction as well. If the emotional centers of your brain detect that you're smiling—presumably based on signals coming from the muscles and the brain areas that control them—then they encode that as evidence that you must be happy.

- What's more, smiling doesn't just make you feel happier; it also seems to reduce your responses to pain or stress. Tara Kraft and Sarah Pressman published a study in which participants completed a series of challenging, stress-inducing tasks that increased the heart rate. Once participants finished the task, they would probably take a deep breath and relax as their heart rate returned to normal. When participants held a chopstick in their teeth, forcing a smile posture, the response of their heart to the stress was diminished. What's more, the time it took the heart to return to baseline levels was also reduced.

- Similar studies suggest that smiling enhances the function of the immune system and even boosts the brain's release of serotonin and endorphins. Serotonin is associated with feelings of satiation. Therefore, smiling can help "stress eaters" in a very direct way, reducing the cravings associated with that stress.

Use of Botox

- If the facial feedback hypothesis is correct, then the use of Botox can affect emotional calculations. It has become routine for medical professionals to inject botulinum toxin into the skin of patients with the goal of producing smoother, less-wrinkled skin. Botulinum toxin paralyzes some muscles on the face.

- In one study, participants who had received facial Botox injections were placed in a functional magnetic resonance imaging (fMRI) scanner. This type of scanner senses the patterns of blood flow in the brain and can determine when different parts of the brain become especially active or inactive. If you look at pictures of faces and mimic those expressions, the emotion-processing centers of the brain will

light up. Botox patients, however, produce significantly less activity in those emotional centers than do typical participants.

- What's more, it seems that how you process the emotional states of the people around you is also affected by what you do—and don't do—with your face. In a related study, experimenters asked people to read short text passages and judge their emotional content. Participants who had received general Botox treatments that reduced their ability to make emotion-laden facial expressions were slower at this task than were standard control participants.

- This evidence supports the facial feedback hypothesis. The very nature of your emotional reasoning is based on what you do with your body—specifically, with your face.

Embodied Cognition

- Much of modern science considers the brain a stand-alone instrument for information processing, much like a monarch of the body that makes unilateral calculations and hands down orders. Many cognitive neuroscientists have adopted an alternative approach, however, centered around the concept of embodied cognition.

- The basic idea behind embodied cognition is that many of the impressive feats that we credit to our cerebrum are actually accomplished by a complex interaction between the brain and the rest of the body. Certainly, in emotional processing, that seems to be the case. What you do with your body—and your face in particular—plays a significant role in how you feel.

- Consider what happens when your adopt the power pose Amy Cuddy and her colleagues refer to as Wonder Woman. Stand with your shoulders back. Your legs are spaced apart, your neck is extended, and your head is facing forward. As you stand like this, even for about two minutes, your body changes the way your brain is functioning. There are some unconsciously controlled systems in your brain that are ramping up in activity, while others are being suppressed. In just a few minutes, your personality actually changes; you become more confident and more assertive.

- What's more, if you are faced with a stressful situation 30 minutes after you have stood like this for two minutes, your body will react to the stress differently than if you had not stood like this.

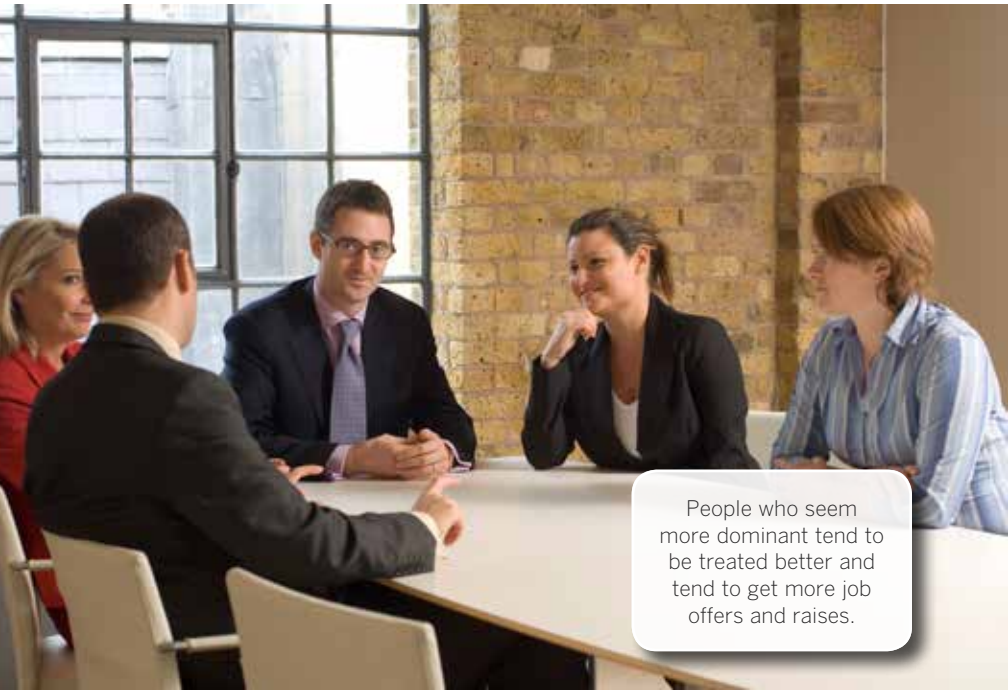
Dominant Postures

- When we are faced with a stressful stimulus, such as a confrontation with a colleague or superior, we face two very different options. One strategy is to engage in the conflict. The other strategy is to back down—to agree simply to end the argument. Even before a confrontation like this takes place, you can people posturing in preparation for it. The

senior or dominant member of the group will tend to adopt a spread-out posture, the back straight.

- Less-dominant people in the group will do the opposite; they will cross their legs and arms and hunch their shoulders. They will seem to do everything they can to make themselves smaller and to consume less of the space in the room.

- For many reasons, people who seem more dominant tend to be treated better. They tend to get more job offers and raises; they tend to receive a larger share of contested resources; and they even seem to get better grades. If you can do something to make yourself more assertive and dominant, the outcomes are likely to be positive for you.



People who seem more dominant tend to be treated better and tend to get more job offers and raises.

Hormonal Changes

- As with our emotional systems, it seems that our bodies play a significant role in mediating how we respond to others. In fact, our bodies seem to dictate to our brain how dominant we are.

- In several classic studies performed by Cuddy's research group and since replicated by several others, participants were randomly assigned to three experimental groups. One group spent several minutes standing in a power pose. A second experimental group adopted a nondominant pose: shoulders hunched, legs and arms crossed, head down. A third experimental group did neither.

- After spending several minutes in one of these three pose conditions, participants were then placed in a stressful situation. Those in the power-pose condition performed better than the nondominant posers.

- A second effect, however, was even more striking. After completing the stressful task, the participants provided a saliva sample. The experimenters found that the power posers had lower concentrations of cortisol, a stress-related hormone. Power posers also had greater concentrations of testosterone, a hormone strongly associated with confident, dominant performance.

The Two-String Problem

- For centuries, researchers have been interested in how humans creatively solve problems. A classic research method called the two-string problem can help us understand the insights that enable us to solve problems.

- In this research, study participants enter a large room. In the middle of the room, two strings hang down from the ceiling. Initially, they are about four feet apart. On the floor nearby are a book of matches, a pair of pliers, and a few pieces of cotton. The task that the experimenter gives the participant is to touch the ends of the two strings together.

- This test is easy when the strings are only four feet apart. However, then the experimenter moves the strings farther apart, to five, six, and seven feet.

- Most participants quickly realize that they can extend their reach using the pliers on the floor. But this won't work when the strings are farther apart. The solution, which most participants eventually discover, is that if you tie one of the strings to the pliers, it can act as a weight at the bottom of a pendulum. The participants then set one of the strings swinging, grasp the other string, and then grab the second string as it swings back to them.

Keep Moving

- The process of problem solving is clearly enhanced if participants are allowed to keep moving around as they try to solve the problem. If participants are instructed to sit down and think, it will take longer to solve the problem, and they are more likely to give up without actually solving it.

- Alternatively, if an experimenter instructs the participants to remain standing and to move around while thinking, they often begin to do something really interesting. They will often swing an arm from side to side like a pendulum. Moving the body doesn't merely get the blood flowing, it seems to contribute directly to finding a solution.

- A recent study suggests that even sitting in a chair reduces our thinking effectiveness. If you ask people to perform mathematical computations or come up with as many creative uses as possible for a brick, they will perform faster if they are standing than if they are sitting. If they are lying down, the performance gets much worse.

- Your brain is a significant part of your body—but it is only a part. Our cognition clearly seems to extend to the body as a whole. Even complex concepts can have connections to physical actions.

Questions to Consider

1. Amy Cuddy and her team have focused on the use of the Wonder Woman pose to boost assertiveness and reduce stress reactivity. What other body postures might work to promote positive changes in mental state? Is there a happy posture? A creative posture? A smart posture?
2. Engaging in physical actions that are consistent with some mental state seems to change your brain. How might professional actors and con artists make use of these tendencies? Might professional actors suffer—or benefit—from performing certain roles?

Suggested Readings

Csikszentmihalyi, *Flow and the Psychology of Discovery and Invention*.

Spivey, *The Continuity of Mind*.

Lecture 17

Suppress—Don't Repress—Anger

While extreme anger can create numerous problems, mild anger can be a valuable source of energy and motivation. In this lecture, we explore how we can outsmart anger and turn it into positive, productive action. Some of humankind's greatest accomplishments began when someone became outraged over the world as it is, rather than as it could—or should—be.

Mirror Neurons

- The next time someone is being mean to you, try an experiment. Be nice—be unexpectedly, shockingly nice—and see what happens. Research suggests that when you take this kind of action, you will partially take control of the emotional centers of the aggressor's brain and turn off his or her ability to be unkind.

- The reasons for the effectiveness of this technique begin with the brain's mirror neuron system. When you perform a movement of your body, you activate particular neural circuits in your motor cortex. What's more, even when you simply watch someone else making that same motor movement, the same region of your brain will become active.

- Mirror neurons were first discovered by a research team led by Giacomo Rizzolatti. The researchers described them as mirror neurons because the neural system was, in essence, mirroring the activities of another individual, as if the observer were performing the actions.

- Humans learn a great deal through imitation. If you've ever taught a child how to tie shoelaces, you likely didn't simply describe it verbally. If you watch someone perform a dance a few times, even if you've never tried it yourself, you will likely be able to approximate it the first time you try. While you were watching the dance being performed, your brain was interpreting the dance by simulating your own performance the entire time.

- There is substantial evidence for the motor theory of speech perception as well. When you listen to someone speaking, particular regions of your brain parse the sentences and derive meaning from them. An important step in that process is that your brain activates the regions that would be involved in producing the same sounds. In fact, there is evidence that simply listening to speech produces low levels of activation in your own vocal tract.

A Counterintuitive Strategy: Be Nice

- Recent research suggests that the mirroring tendency isn't limited to motor activities. If someone behaves aggressively toward you, your brain's default response is aggression in return. When you observe the aggressive behavior, your brain will already be mirroring it—priming an in-kind response.

- As your brain mentally simulates performing those actions, it will tend to activate the associated systems. Regions of the amygdala associated with the sympathetic nervous system will become active—inspiring a fight-or-flight mode. Situations in the past that have made you angry are associated with this information, and the circuits that encode this information in the frontal lobes will become active as well.

- Conversely, if someone is very warm and friendly to you, your brain will mirror that. The parasympathetic nervous system will become active. Your brain will prepare itself to say words and perform actions that are typically linked with friendliness. Because of your mirroring

brain's pattern of activation, from a neural perspective, a friendly response will be easier.

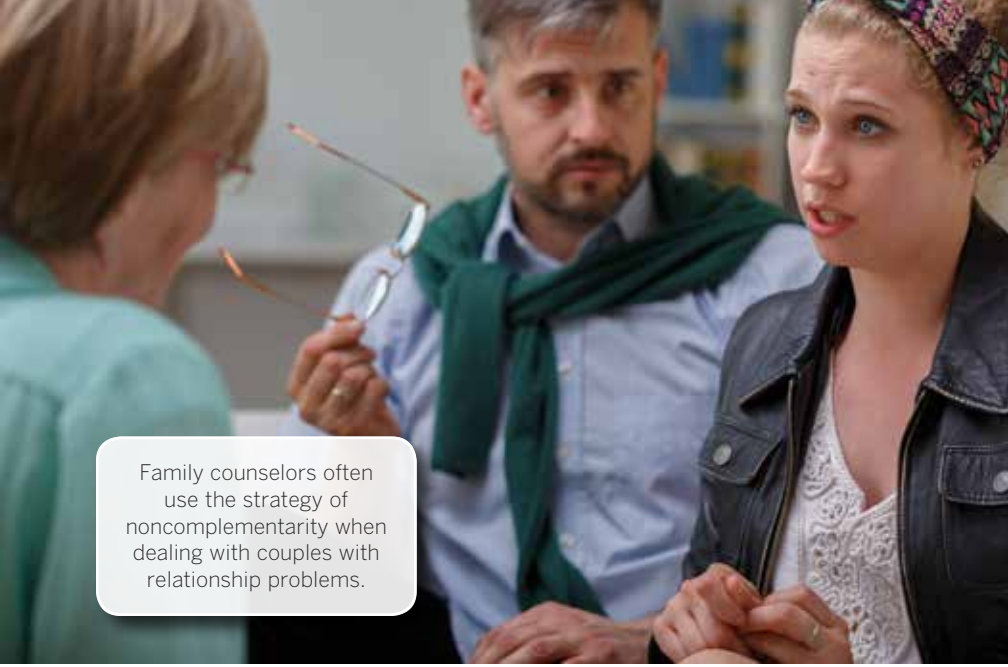
- This brings us back to the counterintuitive strategy of being nice to someone who is mean to you. When someone behaves aggressively toward you, you will have a natural tendency to respond in kind. Your brain will mirror the behavior you see and prepare to respond to malice with malice. Your behavior, of course, will tend to be mirrored by the other person's brain, and the malice will build between the two of you. If you can short circuit this cycle, mean can change to nice.

Shift to a Noncomplementarity Mode

- Researchers refer to our tendency to imitate one another as complementarity. Our behaviors tend to match the tone and content of the person with whom we are interacting. Fundamentally, the human brain is wired to interpret and respond to the actions of others.

- It can be incredibly difficult to resist the unconscious complementarity reflex. When someone expresses anger at you, your brain is adept at finding connections to words and actions that are related to anger because anger is so firmly activated in your brain. But if you can respond to aggression with kind behaviors, you can often defuse a negative interaction. Researchers refer to this shift away from complementarity as noncomplementarity.

- Family counselors often use the strategy of noncomplementarity when dealing with couples with relationship problems. If two people continually argue aggressively with each another over an extended period of time, the aggression response will be stimulated even before the first word is spoken. The brain gets into a defensive posture even before any actual attack. Once two people are stuck in this mode of processing, it can be very difficult to find a way to live happily. If one person periodically expresses something genuinely positive and demonstrates real kindness to the other person, however, the vicious cycle can broken.



Family counselors often use the strategy of noncomplementarity when dealing with couples with relationship problems.

Misdirected Anger

- While extreme anger and rage can be very destructive, mild anger has the capacity to produce actions that result in positive outcomes. For example, if someone is harming you or someone you love, it is quite reasonable to get angry. What's more, you shouldn't short circuit that process. If you are angry and it spurs you to positive, meaningful action, go with it.

- The problem with anger, however, is that it has an unfortunate tendency to get misdirected. Imagine that you have had a bad morning and experienced a highly unpleasant interaction with a colleague. Although you felt angry, it wasn't appropriate to express it at the time; therefore, the anger gets repressed. Then, imagine when you get home later that day, you find that the dog has chewed up one of your socks. Your reaction at this point may be much greater than is proportionally appropriate—certainly much more than the poor dog deserves.

- When humans get angry, we feel as if we direct our anger at a particular something; however, the anger doesn't seem to remember that particular something very well. If another situation or individual taps into our established reservoir of anger, it can all come rushing out at the same time.

Suppression, Not Repression

- When you feel anger, a variety of research suggests that you should suppress it, but you should not repress it.

- The theory behind some anger-management therapies is that anger is like a poison created by your brain. If you express that anger, then you let that poison out. Screaming, letting off steam, venting grievances, and not bottling up anger are all expressions that focus on the concept of catharsis. According to the theory, by engaging in certain actions, it may be possible to reduce or eliminate anger.

- As compelling as these concepts are, recent evidence suggests that catharsis is a myth. In fact, particularly at certain phases during the process of becoming angry, expressing anger will result in more, not less, overall anger.

- Consider this research by Brad Bushman and his colleagues. They began their study by recruiting participants and making them angry. Half the participants were randomly assigned to a catharsis condition and were allowed two minutes to vent their frustration by hitting a punching bag. The other participants simply waited for those two minutes.

- In the testing phase of the experiments, the participants played a game against an opponent in another room. At various points during the game, the participants were given the opportunity to punish their opponent with loud blasts of noise. The hypothesis here was that if catharsis works, then attacking the punching bag should reduce the amount of anger left in the brains of the participants. This lower level

of anger should result in shorter, quieter bursts of noxious sound being directed at the opponents.

- Exactly the opposite result was obtained, however. Using the punching bag did not reduce anger; it significantly increased it.

Consciously Redirect Anger

- Repression is a highly problematic approach to anger management. If you repress some feeling of anger, you pretend that the anger doesn't exist. Many of the worst outcomes associated with misdirected anger come from the repression process.

- An alternative to repression is suppression of the anger. Suppression of an angry feeling involves resisting the urge to scream, yell, and fully express the anger in the most obvious way. In that sense, it is similar to repression. But if you are suppressing the anger, you can still express the anger—but without the overt, aggressive aspects usually associated with that expression.

- Say that you are really angry. You might feel like yelling to express this anger. But you know, based on four decades of research on catharsis, that yelling will not make you less angry; on the contrary, it will make you more angry. The tip when you are in this situation is to verbally convey the same information about being angry but to do so in the most monotone, boring voice possible.

- You are suppressing the bad aspects of the anger—the parts that will inspire an aggressive response on the part of the other person. Better still, you are making it clear what the anger is about. By keeping the discussion calm, both parties can use their full complement of frontal-lobe brain tissue to resolve the problem.

- Suppressing anger isn't about pushing away the anger, it is about consciously redirecting the anger response away from the activities—like shouting and cursing—that are often the most instinctual.


You might feel like yelling to express anger. Yelling will not make you less angry; on the contrary, it will make you more angry.

Count to 10

- Evolutionary biologists describe the systems that mediate our angry emotions and behaviors as very ancient and very fast. As our ancestors competed with others for limited resources, being able to generate a strong aggressive response quickly was a competitive advantage associated with survival. Anger is fast. Thinking—and calmly responding—is slow.

- There's a time-honored anger-management strategy worth mentioning here that is strongly supported by research on the brain. If you feel a surge of anger and want to get it under control, slowly count to 10. Simply waiting for the slower cortical systems to catch up with the faster subcortical systems that mediate anger can greatly reduce irrational anger behaviors.

Questions to Consider

1. Catharsis of anger seems to work for some people if they go for a very long run. It's difficult to be angry when you're on the verge of exhaustion. Is this claim inconsistent with the evidence that catharsis is actually a myth?
2. The strategy of expressing anger in a monotone voice can be a very effective way to convey your concerns without ramping up your anger. It can also sound a little humorous and feel incongruous. If you crack a smile while conveying your anger, when is that likely to help the situation? When is it likely to make the situation worse?

Suggested Readings

LeDoux, *The Emotional Brain.*

Sander et al., "Emotion and Attention Interactions in Social Cognition."

Lecture 18

How Little Things Cause Big Persuasion

In this lecture, we look at ways you can outsmart others (or realize how they are trying to outsmart you). Understanding the workings of the brain and human decision making can help enhance our own persuasive abilities. What's more, by exploring how other people's decision making can be influenced, you will come to better comprehend your own decision-making process and avoid some of the biases that affect us all.

The Reciprocity Principle

- Imagine that you are selling raffle tickets. There are two possible scripts you can follow:
  1. "*Hello. My name is Peter, and I'm selling tickets for a charity raffle. All the raffle proceeds go to support the Juvenile Diabetes Research Foundation. Tickets cost 10 dollars, and every ticket gets you a chance to win a prize worth 10,000 dollars. How many would you like today?*"

  2. *"Hello. My name is Peter, and I'm selling tickets for a charity raffle. Actually, I have these cool Juvenile Diabetes Research Foundation pens to give out too. Here, take one! All the raffle proceeds go to support the Juvenile Diabetes Research Foundation. Tickets cost 10 dollars, and every ticket gets you a chance to win a prize worth 10,000 dollars. How many would you like today?"*

- The more effective script is number 2. Across a wide range of studies, it has been found that if you offer people a gift before you ask them for something, they are far more likely to donate and much more likely to

make a larger donation. What is remarkable is that the magnitude of the gift almost doesn't matter. The gift can be a pen, a slice of pizza, a cup of coffee. The return on investment from a small gift can be enormous—300 percent in some studies.

- The effect of this strategy, caused by the reciprocity principle, is seen in many areas beyond charitable donations. A classic study of the reciprocity effect was conducted by Robert Cialdini and his colleagues using waiters and diners. Waiters gave their normal service: took orders, delivered food, conversed with the diners, and brought the bill. For half the patrons, the bill was delivered along with a single after-dinner mint. For the other half, the bill arrived without the mint. The researchers recorded the tips that the patrons left.

- The single mints resulted in a 3 percent increase in the size of the average tip. While that is a small increase, it was statistically very significant. What's more, when the bill was delivered with two mints for every person at the table, the tips increased by 14 percent.

- In another condition of the study, the waiters emphasized the gift-giving aspect of the interaction. The waiter would deliver the bill with one mint per person and then start to walk away. The waiter would then stop, turn back to the table, and say, "You've been really nice tonight. Here are some extra mints." Now, the tips went up by 23 percent.

The "Because" Reflex

- Researchers interested in persuasion—very notably Cialdini and his group—have elucidated a wide range of principles that seem to exert a powerful influence on our decision-making processes. When someone asks you to do something, how they ask often has a great deal to do with whether or not you say yes.

- The reciprocity principle is only one of many unconscious reflexes that operate in the human decision-making process. Consider this study of the "because" reflex. Experimenters went to a library where there was

In one study, when a restaurant bill was delivered with two mints for every person at the table, the tips increased by 14 percent.

a public photocopier used by students and faculty. The experimenter would wait until someone was using the photocopier and a second person was waiting to use it next. The experimenter would approach the waiting person and ask if he or she could use the photocopier first. Some people would say yes, but most people would say no.

- If the experimenter asked to go first but also gave a reason for it, a greater percentage of the people said yes. The third experimental condition of this study was the most interesting one, however. It turns out that the word "because" is significant in the request. The word "because" triggers an unconscious reflex that makes us more likely to say yes.

Foot-in-the-Door Technique

- Consider another persuasion method called the foot-in-the-door technique. If you have worked as a salesperson, you might already be familiar with this sales technique. It gets at a central part of how the human brain makes decisions: How we frame the decision makes a lot of difference.

- The basic idea of the foot-in-the-door method is to get people to say yes to some small request. Once you've done this, you can frame future decisions. The most frequently cited study of this phenomenon comes from Robert Cialdini's group. They picked out an area near Phoenix, Arizona, and randomly divided houses into two groups: the foot-in-the-door group and a control group.

- For the control group, the researchers visited each house and asked homeowners to participate in a new safe-driving campaign. They asked each homeowner if they could put a large wooden sign in the middle of their front yard that read "Drive Safely." Think of an enormous wooden sign cluttering up the front yard. Only 20 percent said yes.

- For the people assigned to the foot-in-the-door condition, the researchers first visited the house and asked for something very

small. Homeowners would put a small card in their window reading "Drive Safely." A full 76 percent said yes.

- A few weeks later, the researchers visited the foot-in-the-door houses again. During the second visit, they asked to place the large wooden sign in the yard. Now, however, a much higher proportion of the people said yes—55 percent. By asking for the small window display first, the researchers yielded almost three times as many people willing to put in the large yard sign.

Drive for Consistency

- Cialdini and his colleagues interpret this as evidence of humans' drive for consistency. While you don't often think explicitly about who you are and what your values are, every time you make a decision, some part of your brain seems to do that.

- For the people in the safe-driving study, when they said yes to the small window sign, it changed them. It changed their brains. It reinforced in them the notion that they care about driving safety. As they weighed the pros and cons of saying yes to the yard sign, a greater value was put on the self-perceived commitment to driving safety, and 400 percent as many people said yes.

- The foot-in-the-door technique can be adapted to almost any situation in which you are looking to persuade someone to do something. The tip here is to seek an initial small commitment from someone that has three characteristics: voluntary, active, and public. Our unconscious drive for consistency is amplified if we have the sense that others are aware of our decisions. We have an internal drive to be perceived by others as principled, character-driven people.

Minimize Cognitive Dissonance

- To make full use of the consistency reflex, make sure there is a delay between the small request and the large one. The unconscious

process of changing our sense of who we are and what's important to us seems to take at least a day. Most studies that have shown the largest effects have involved delays of about a week.

- Methods of persuasion that focus on the unconscious consistency reflex capitalize directly on our desire to minimize cognitive dissonance. Cognitive dissonance is a situation in which we hold two different contradictory beliefs or sets of information. In general, humans do what they can to reduce cognitive dissonance.

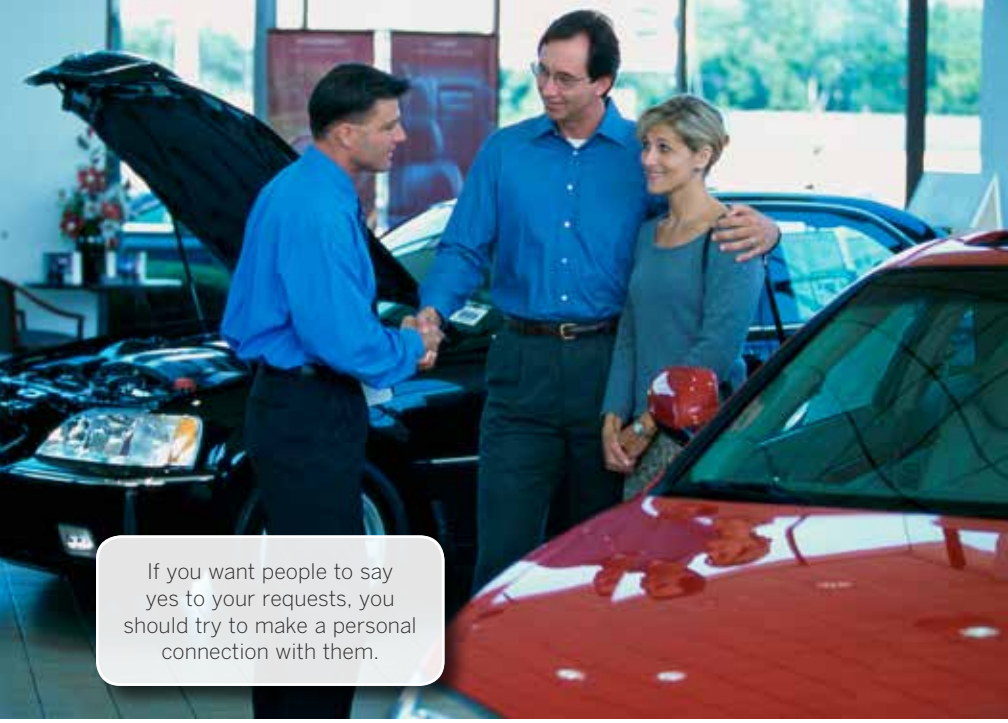
- A state of cognitive dissonance is associated with activity in a variety of regions of the brain, notably the dorsal anterior cingulate cortex and anterior insula. When the person whose initial request you have granted makes a second, larger request, the activation in these regions of the brain are likely increased. You might want to say no to the larger request, but the disconnect between that no and your prior behavior would create a large amount of dissonance.

- The unpleasantness of the dissonance becomes a factor in your decision making. It might be unpleasant to put a giant wooden sign in your yard, but it might be even more unpleasant to have to deal with the negative feeling of cognitive dissonance.

The Personal Connection

- If you want people to say yes to your requests, you should try to make a personal connection with them. Consider this Karen Wynn study of the morality of infants. Infants in her study start by choosing food from one of two bowls—green beans or graham crackers. Not surprisingly, nearly all the infants choose the graham crackers.

- The babies then watch a rabbit puppet make the same choice. Sometimes, the puppet chooses the same food as the child; sometimes the puppet chooses the green beans. The infants then watch the rabbit puppet attempting a task and having some trouble. As the rabbit is struggling with the task, another puppet comes on



If you want people to say yes to your requests, you should try to make a personal connection with them.

stage. Sometimes the second puppet helps the rabbit; in other cases, the second puppet hinders the rabbit.

- After all of this, the babies are allowed to play with a choice of puppets. Two important tendencies were observed in these studies. First, if the rabbit chose the same food as the child, the infant expressed a preference for puppets that had helped the rabbit and an aversion to puppets that had been mean to the rabbit. If the rabbit chose a different food, however, the children expressed a positive preference for puppets that had been unkind to the rabbit.

- If the rabbit is seen as "like me," then the baby seems to want to see that rabbit treated well. If the rabbit is seen by the infant as "unlike me," the kids seem to want to see the rabbit punished.

- Fast forward a few decades, and you have an adult. Adults have learned a great deal, collected thousands of social experiences, acquired language, and made tremendous strides in intellectual and social development. But this tendency to be nice to people whom we perceive as "like me" is still there.

Questions to Consider

1. Many studies demonstrate that we tend to say yes to people who are "like us" more frequently than to people whom we perceive as "unlike us." Which bias is right? If we perceive people as being like ourselves, should we resist agreeing to what they ask? Or should we intentionally say yes more often to people who are very different from ourselves?
2. Many charities collect the bulk of their annual donations around the end of the year. Given the nature of human decision making, what are some of the reasons for this?

Suggested Readings

Cialdini, *Influence*.

Gladwell, *Blink*.

Lecture 19

How Framing Changes Decisions

In this lecture, we continue our discussion of effective persuasion techniques and explore how an understanding of unconscious, automatic reflexes can help us avoid making poor decisions. The persuasion techniques discussed in both these lectures include the following: Give a gift; make your expertise salient and have someone else communicate that expertise on your behalf; emphasize the extent to which your request represents a scarce opportunity; make a small request first to get your foot in the door; make a large request first to make the second request seem smaller; and make a personal connection, highlight your similarity to someone, and then make your request.

Door-in-the-Face Technique

- To increase the probability of persuading someone to say yes to a request, start by asking for something very large. People will almost certainly say no to the large request. Then, when you ask for a smaller favor, they will be more inclined to say yes. This strategy, the converse of the foot-in-the-door method, is called the door-in-the-face technique.

- The best support for this technique comes from a study by Robert Cialdini's research group. The experimenters stood along a busy walkway and asked pedestrians if they would be willing to serve as volunteer youth counselors. The following script was used on the control group:

1. *"Hello. We are recruiting people to chaperone a group of children from the County Juvenile Detention Center on a trip to the zoo. It will take about two hours of your time some afternoon or evening. Would you be interested in applying to help out?"*

- A little less than 17 percent of people said yes to request 1. Another group of participants was randomly selected to hear a much larger request:

  2. *"Hello. We are recruiting people to work as volunteer counselors at the County Juvenile Detention Center. If you volunteer, you will need to work for about two hours per week for a minimum of two years. Would you be interested in applying?"*

- There were 72 participants in this study, and different versions of it have been run with hundreds of participants over the years. No one has ever said yes to request 2.

- After participants declined to volunteer for request 2, they were then immediately asked for the smaller volunteer commitment from request 1: to help out with the one-time two-hour trip to the zoo. The control group had said yes about 17 percent of the time. For the people who were first asked for the much-larger favor, however, the proportion who said yes skyrocketed to 50 percent.

Reciprocity Reflex

- One explanation for the success of the door-in-the-face technique is a contrast effect. If you anchor the participants' notion of a standard request as a very large one, then a smaller request seems tiny by comparison. Cialdini and his group believe the explanation goes deeper than that, however. They argue that the unconscious reflex that gets triggered has to do with the discomfort that is created by refusing a favor.

- This phenomenon is closely related to the reciprocity reflex. When someone gives you a gift, it creates a social pressure—and a strong

unconscious desire—to give a gift as well. When a person asks you for a favor, your brain activates a deep desire to say yes. You have to exert mental effort not to say yes. If you've already said no once, it's that much harder to say no again.

- Cialdini's group tested the reciprocity effect in a clever way—by having two different people make the initial large and the second small requests. If two separate people make the two requests, the reciprocity effect almost vanishes.

Scarcity Effect

- Consider this story in Mark Twain's *The Adventures of Tom Sawyer*. Tom Sawyer skips school to go swimming and has to whitewash Aunt Polly's fence as punishment. In the events that follow, Mark Twain reveals himself to be a shrewd social psychologist.

- When one of the other neighborhood boys passes by, Tom pretends that he's enjoying the painting task immensely. The boy asks Tom if he can try it. Tom refuses, insisting that only very fortunate people can be lucky enough to perform the task. Of course, the boy suddenly wants very badly the chance to paint the fence. Tom agrees to permit the other children in the neighborhood to paint the fence only if they are willing to trade various toys and trinkets for the opportunity.

- Here, Mark Twain provides an excellent example of a persuasion principle that Cialdini's research group calls scarcity. Most people think the value of something is calculated on the positive aspects of it. In the Tom Sawyer story, painting fences has a negative value—usually, people get paid for painting fences. By making the opportunity to paint a scarce resource, the value to paint becomes a positive—something for which the neighborhood kids will pay.

- A variety of studies demonstrate that the amount people are willing to pay is heavily driven by their perception of how scarce an item is. For example, if there are only 25 tickets left for an upcoming basketball

game, people are willing to pay more than twice the amount for exactly the same seats as they would if there were more than a thousand tickets remaining.

Expertise Effect

- In many cases where decisions require a great deal of research or even training, people rely on the decision making of experts. If you have relevant expertise, be sure that you make your expertise known when you prepare to make a request.

- A variety of studies suggest that expertise information can influence people's decision making. Some of the experiments are quite simple. For instance, in some studies, participants view an advertisement for a new health-related product in which a spokesperson describes a series of benefits associated with it.

- A randomly selected group of participants watch the same person deliver the same advertisement, with one small change. At the beginning of the ad, the spokesperson mentions that he or she is a licensed physician with many years of experience. Not at all surprisingly, people indicate a greater willingness to buy the product if it is recommended by someone with relevant expertise. It's no accident that many professionals hang their diplomas on the walls of their offices.

- There have been a range of more subtle studies that further characterize the expertise effect. For example, if an expert wears a suit and tie, people are more likely to follow their buying suggestions. If you want to persuade people to follow your lead, dress for the occasion.

Expertise Effect through Surrogates

- A number of studies have found that the expertise effect is substantially stronger if the information is delivered by a surrogate. The boost in the effect is even greater if the information is delivered


If an expert wears a suit and tie, people are more likely to follow his or her buying suggestions.

by someone who does not have an apparent, vested interest in the goals of the expert.

- One of the best examples of the expertise effect delivered by another person comes from a study conducted with a real estate firm. People frequently call the firm asking for information about properties for rent or sale. The firm tracks the number of calls received as well as data about the percentage of calls that result in a sale or rental contract.

- When a prospective buyer calls, the receptionist's original script was to say, "Okay, you're interested in rental properties. Let me transfer you to Bob. Just one moment, please."

- The researchers in this study asked the receptionist to add a line about Bob's credentials. The receptionist was instructed to say, "Okay, you're interested in rental properties. Let me transfer you to our expert in this area, Bob. He's been working with rental properties in this region for more than 12 years." The number of calls received stayed the same during the course of the study, but two very notable increases were found.

- Fully 20 percent more of the people who called agreed to set up an appointment to come in and meet with the realtor. There was also a 15 percent boost in the number of signed contracts that resulted from those interactions.

Brain Activation in the Expert Effect

- We know that decision-making processes are altered and people become more receptive to suggestions made by an expert. Consider how your brain changes when you are exposed to the expert effect.

- Some recent neuroimaging research by Vasily Klucharev and his colleagues suggests that the primary effects of the expert effect can be found in brain areas associated with memory. Participants in the Klucharev study viewed sequences of pictures while their brain

activity was assessed in a functional magnetic resonance imaging (fMRI) scanner. One picture was of a celebrity (tennis pro Andre Agassi, for example) and the other picture was of an object.

- Sometimes the object was something about which participants would infer expertise on the part of the celebrity—for example, Agassi was followed by a picture of a tennis racket. Sometimes, the second picture was of an object where the celebrity would have no obvious expertise—for example, orange juice. After participants viewed the photo pairs, they went home and returned the next day. Now, they viewed all the object pictures without the celebrity endorser and gave a rating of how positively they felt about each item.

- The researchers determined that people remembered an object better if it was paired with an expert. What's more, people rated the object more pleasing after it was paired with the celebrity. Interestingly, in many cases, this seems to happen even when participants don't remember which celebrity was associated with an item. This is the expert effect.

- In examining the areas of brain activation associated with the expert effect, we see a very interpretable pattern. Areas associated with memory—the hippocampus and parahippocampal gyrus—showed increased activation. These areas of the brain play a crucial role in converting our short-term, immediate experiences into more durable long-term memories.

- Greater activation was also identified in the left prefrontal and temporal regions of the cortex. When we remember, we are relating the new information to what we already know. The elaboration part of the memory process is associated with activity in the left prefrontal and temporal cortices.

Questions to Consider

1. Car salespeople often use a technique in which they consider a customer's offer and then take it to the sales manager for final acceptance. Often, the sales manager asks the customer to pay a bit more; often, the customer does. Why does this sales technique work?
2. There is evidence that after a successful negotiation, both the seller and the buyer feel that they benefited from the negotiation. On average, both parties feel they have won. Given the nature of human decision making, why is this exactly what we should expect?

Suggested Readings

Cialdini, *Pre-Suasion*.

Lindstrom, *Brandwashed*.

Lecture 20

How Language Changes Your Brain

In this lecture, we explore how language processing works in the brain. Words matter: The mere fact of speaking can have a strong influence on how you think. Words you simply imagine in your mind can affect your brain functions. Every day, numerous words pass through our stream of consciousness. By intervening in and altering the flow of that stream of self-talk, we can change our behaviors, our emotions, and even our physical health.

Language Determines Thought

- Can't find your keys? As your walk around your house looking for them, say the word "keys" aloud over and over again. You will be more likely to find them.

- Kit Cho and her colleagues performed a study of how humans visually search for target objects among distractor objects. In some trials, the participant would simply search for the target object. In other trials, the participant would repeat the target label (such as "key" or "dog") over and over again while searching. Simply saying the target word aloud made the search go faster.

- When you say the word "keys," your visual system changes the way that it processes incoming information. It becomes more sensitive to the visual features that are associated with keys, and you become faster at finding them.

Whorfian Hypothesis

- A theory that has moved in and out of fashion among cognitive neuroscientists is the Whorfian hypothesis, sometimes called the linguistic relativity hypothesis. It is named for Benjamin Whorf, who suggested that language may determine our thoughts.

- The strongest form of this hypothesis is that you cannot think anything that you cannot put into words. It suggests that the language or languages we know comprise the system that our brain uses whenever it processes information. According to the strong version of this theory, language and thought are, in many respects, the same.

- While the strong version of the Whorfian hypothesis has largely disappeared from serious consideration, a weaker version of the Whorfian hypothesis has gone through a bit of a revival. Language doesn't seem to determine or preclude what our brains can think; however, language very much seems to influence our brain's performance in significant, measurable ways.

Broca Area

- Production of language takes place in the Broca area of the brain, named for its discoverer, Pierre Paul Broca. Broca studied patients who could no longer talk after suffering a brain injury. Based on careful work, Broca found that the patients could still understand spoken and written language. The Broca area is located in the frontal lobe just behind the prefrontal cortex. Neuroimaging studies have confirmed the importance of the Broca area for language production.

- Whether you are right handed or left handed affects how your brain is organized for language production. For right-handed people, language processing causes a large increase in activity in the Broca area in the left hemisphere of the cortex. For right-handed people, damage to the right side of the brain rarely results in language deficits. Damage to the left side is far more likely to produce these problems.

- Left-handed people are a little more complicated in this regard. One might presume that the organization would be reversed—that is, lefties would exhibit language dominance on the right side. They don't, however; most lefties show a more equal activation across the two hemispheres. The Broca areas of both hemispheres seem to participate more equally in language production.

Wernicke Area

- Like Broca, Carl Wernicke worked with brain-injured patients. He found that damage near the back of the temporal lobe often produced a loss of the ability to comprehend written or spoken language. This area has come to be known as the Wernicke area. Neuroimaging studies have shown the same lateralization of function associated with the Broca area. Right-handers tend to show strong activation in the left hemisphere when engaged in comprehension. Lefties show a more balanced pattern of activation.

- Language production and comprehension are implemented by these two different brain regions. Given the close relation between speaking and listening, it is surprising how far apart the two regions are. Speech production is accomplished by the Broca area near the front of the brain, while language comprehension is accomplished by the Wernicke area near the back.

- The Broca area is located closer to the motor cortex in the frontal lobes. The motor cortex is involved in controlling voluntary movements, including those that produce speech. The Wernicke area is located very near the auditory cortex, a region of the brain devoted to processing incoming sounds.

External and Internal Motivation

- Language affects many kinds of brain activity that might not appear to depend on language at all. For example, if you want to change a certain behavior, how you talk about that process greatly affects the

outcome. Changing how you talk about it to others (and yourself) can increase your chances of succeeding. Specifically, you should use the word "don't" rather than "can't."

- Vanessa Patrick and her colleagues explored this phenomenon with the task of promoting healthful eating, but related studies suggest that the results apply to other behaviors as well. Imagine you are at a dinner with someone. You've decided to cut down on desserts. Many people would say, "No thank you. I can't eat desserts anymore." It is more effective to say, "No thank you. I don't eat desserts anymore."

- Patrick and her colleagues drew from a range of research on how people respond to different types of motivation, whether external or internal. When people are motivated by external controls, they tend to be less consistent in their behaviors over the long term—especially if the external controller is absent. The phrase "I can't do X" is associated with external controls. "I don't do X" is associated with more robust internal controls.

Linguistic Distancing

- The language we use also seems to affect our emotional responses. Ethan Cross and his colleagues have found that self-talk can help us regulate our own emotions. If you want to reduce your levels of stress and anxiety about a situation, refer to yourself in the third person. This is known as linguistic distancing.

- Cross and his colleagues studied linguistic distancing in the context of social anxiety. In one study, they recruited participants and had them try to make a good first impression during a conversation with a stranger. The conversations were videotaped, and participants provided a rating of how anxious they were during the process.

- The key experimental manipulation here took place before the videotaped conversation. Half the participants were randomly assigned to a first-person condition and asked to reflect on their

feelings using "I" and "my." The participants randomly assigned to the non-first-person condition were urged to make use of second-person ("you") and third-person ("he," "she") pronouns or to use their own names.

- Two clear differences emerged from the groups. The first-person group reported higher levels of anxiety during the interaction with the stranger. In addition to reporting lower levels of anxiety, the non-first-person group performed substantially better than the first-person group in terms of a variety of social-performance criteria, such as perceived nervousness, vocal quality, and eye contact.

Language and the Emotion Centers

- Language areas are strongly connected to many areas of the brain, including the emotion centers. A couple of synapses away from the Wernicke and Broca areas is the limbic system. A particular emotion can influence the language we use; what's more, particular words can influence those emotion centers.

- Alison Brooks has published research using a simple linguistic strategy for dealing with anxiety: Restate that anxiety as excitement. When participants in her studies are feeling anxious, they are instructed to say, "I am excited." This not only reduces the anxiety somewhat, but it seems to enhance performance. Anxiety and excitement are both states of high arousal, and so the trick is to capture that high state of arousal for positive purposes.

- Both anxiety and excitement are associated with diffuse frontal cortex activation in the brain. The primary difference is that anxiety shows additional activation in the amygdala and the sympathetic nervous system.

- Usually, when people try to reduce their anxiety, they are urged to become calm—to reduce activation across all the brain regions associated with anxiety. The Brooks method suggests instead that the anxious person use the power of language to alter the pattern of activation.

Language and Physical Fitness

- The language centers of the brain seem to connect to the systems in your body that regulate your expenditure of calories. To be more physically fit, if you associate your daily physical activities with the word "exercise," your fitness level will improve.

- Alia Crum and Ellen Langer recruited a group of hotel room attendants and explained that they were interested in better understanding physical fitness in the workplace. For the experimental

group, they presented information about the caloric expenditures associated with different aspects of their work. They noted that when you add up eight hours of work, it is clear that the attendants easily exceed U.S. recommendations for daily physical exercise. For the room attendants in the control group, researchers specifically did not provide information about how their work could be described as exercise.

- For both the experimental and control groups, a variety of physiological measures were taken: blood pressure, height, weight, percentage of body fat, waist-to-hip ratio. The experimenters then waited for one month and returned. The two groups didn't change their eating or exercise habits outside of work.

Language and Eating

- Alia Crum, one of the researchers involved in the physical fitness study, found that the words you use to describe eating also have an effect on your sense of satiation. Participants in her study consumed a 380-calorie milkshake. Half the participants thought of the shake as an indulgent 620-calorie milkshake. Others thought of it as a sensible 140-calorie milkshake.

- The participants who used the word "indulgent" felt more full and satisfied than did the group that used the word "sensible." What's even more surprising is that the body's response to the food was physiologically different. The intestinal cells of the "indulgent" participants produced significantly lower levels of the hunger-related hormone called ghrelin than did those of the "sensible" participants.

- Same milkshake—but with a different mind-set, even the digestive system alters its function.

Questions to Consider

1. Repeating the words "I am excited" seems to mitigate the negative effects of anxiety on performance. What other phrases might be expressed to mitigate the effects of other negative emotions? What phrases seem unlikely to work in this fashion?
2. Electronic devices that track daily activity and record exercise and fitness have recently become very popular. How might a personal activity tracker promote fitness through the language centers of the brain?

Suggested Readings

Schwartz, *The Paradox of Choice*.

Lakoff, *Metaphors We Live By*.

Lecture 21

How Your Brain Falls in Love

Love is perhaps the most powerful of all human emotions; in fact, the desire to be loved is a fundamental human drive. In this lecture, we consider how love is mediated by systems in the brain and examine what the brain looks like when it is in love. We also explore phenomena such as the significance of eye and pupil size, the mere-exposure effect, the Stockholm syndrome, and universal markers of attractiveness. Cognitive neuroscientists have discovered a great deal about love circuits in the brain, offering us a far better understanding of the implications of love at first sight and the potential for love addiction.

Eye and Pupil Size

- Cognitive neuroscience has demonstrated that our brain captures information from the eyes that is significant to the incidence of attraction and the formation of romantic relationships. Some studies suggest that the ratio of eye size to ear size is a predictor of reproductive success. As we age through adulthood, our ears continue to grow, while our eyes tend to remain about the same size. Thus, as we get older, the eye-to-ear ratio gets progressively smaller. Evolution may have selectively bred us to look for potential mates with eyes that are especially large in relation to the rest of the face.

- The pupil of the eye operates as a key mode of social communication, especially in potentially romantic situations. Your brain is wired to dilate the eye muscles when you see someone for whom you feel romantic attraction.

- Humans are very sensitive to changes in pupil size when looking at another person's face. A variety of studies have been conducted in

which participants were asked to view a selection of face pictures and rate them according to attractiveness. In many studies, faces with very large pupils had significantly increased ratings. Even participants' ratings of how much they trust someone were increased when viewing people with larger pupils. Trust and love certainly tend to operate in tandem.

Mere-Exposure Effect

- If you want someone to love you, a brain-based strategy is to maximize the amount of time they spend with you. Brain-imaging studies have shown that particular brain systems are activated when you look at attractive or unattractive faces. It will be no surprise that systems associated with pleasure—subcortical circuits near the nucleus accumbens—show greater activity when you perceive a face as attractive. For very unattractive faces, increases appear in the amygdala—a region associated with negative emotions and even the fight-or-flight response.

- As you continue to stare at an unattractive face, however, it gradually seems to become less distorted. That feeling of aversion dissipates. Over time, it starts to look much more normal. This is called the mere-exposure effect. The mere-exposure effect applies to almost all the stimuli we encounter, not just faces. Robert Zajonc demonstrated it with words and even line drawings.

- The mere-exposure effect stimulates the brain in many different ways. As stimuli are presented repeatedly to the sensory systems, the brain requires less and less activity to process them. Repeatedly presented stimuli are also generally processed more quickly than novel stimuli. This processing ease—or sensory fluency—may be related to the sense of pleasure that comes with familiarity.

- Novel stimuli also tend to cause at least a slight activation of the sympathetic nervous system—that part of our autonomic nervous

system that prepares our bodies for a fight-or-flight response. As you become familiar with people and places, this response is reduced.

Stockholm Syndrome and Reaction Formation

- There have been numerous documented cases of the Stockholm syndrome, which occurs in situations in which a captor holds someone hostage for an extended period of time. In some cases, the hostages develop an emotional attachment to—and sometimes a love for—their captors.

- Perhaps the most famous case of this was the 1974 kidnapping of Patty Hearst, a 19-year-old woman from a wealthy and prominent California family. Members of the Symbionese Liberation Army (SLA) kidnapped her from her apartment. Although Hearst had no political affiliation with the SLA, after her capture, she released a tape announcing that she had decided to change her name and join the SLA. She even participated in bank robberies with the group.

- Hearst is not the only documented case of Stockholm syndrome. The term comes from a hostage situation that emerged from a failed bank robbery attempt in Stockholm, Sweden, in 1973. During negotiations between police and the robbers, it gradually became clear that the hostages felt sympathy and even a strong affinity for their captors. At several times during the negotiations, the hostages communicated with the police—and in one case, the prime minister of Sweden—to criticize the operation and request that the robbers be set free.

- Stockholm syndrome has been described by Freudian theorists as a result of reaction formation. The idea here is that the mind, to protect itself from breakdown in a high-stress situation, changes the framework that it uses to interpret the surrounding situation. This theory would describe a hostage as initially feeling a strong hatred for the kidnappers. This powerful level of emotion creates an increasing stress on the mind and body. To reduce that stress, the mind reacts by focusing more on the positive aspects of the kidnappers.

Stockholm syndrome occurs in situations in which a captor holds someone hostage for an extended period of time.

Love at First Sight

- Consider the notion of love at first sight. Most relationship-science experts would refer to it as lust at first sight, but the phenomenon is still a viable one. The idea is that you see someone and then some undefined feeling arises—or doesn't. Cognitive research, however, suggests that real life doesn't work that way. How attracted you are to someone on day 1 isn't a perfect predictor of how attractive you will find them on day 7. For day 700, the connection is even weaker.

- There's an important tip here about searching for love. It sounds a little corny, but the data support it. You should keep an open mind and an open heart. Even if love at first sight doesn't show up at all, it doesn't mean that "love at thousandth sight" is not on its way.

Skin-Conductance Level

- One of the most consistent neuroscience markers for love or longing is found completely outside the brain, in the skin. Your skin contains some water and can conduct electricity. When you are generally aroused by something, your body ramps up its activity and begins to push more water into the skin. If the process continues long enough, you will begin to sweat. Long before the sweating starts, however, this greater water concentration results in a lower electrical resistance.

- When you look at a picture of someone you love, your skin-conductance level rises within a few seconds and continues rising for several seconds after.

- At the same time, at least two other operations occur in the peripheral nervous system. First, the zygomatic muscles of the face become slightly tensed—a tension that can be measured in terms of electrical activity. If you place an electromyograph over the cheek muscles in the face, an increase in electrical activity is found. When these particular muscles are fully tensed, they pull the sides of your mouth upward into a smile.

Love Addiction

- The state of the brain in love is often studied by recording nervous-system activity while a person thinks about or looks at a photograph of someone they love. The data is then contrasted with the nervous-system activity while the person is looking at other kinds of photos. Helen Fisher and her colleagues have run several studies in which they looked at people experiencing those sensations of love while in a functional magnetic resonance imaging (fMRI) scanner.

- The research team found activation in a variety of regions—most notably in the ventral tegmental area, a small region located near the bottom of the brain. The ventral tegmental area shares numerous connections with the nucleus accumbens, which is one

When you look at a picture of someone you love, your skin-conductance level rises within a few seconds and continues rising for several seconds after.

of the areas associated with desire in general—desire for food and water as well as a loved one. When you introduce dopamine into the cells in this nucleus accumbens region, the experience is of a rush of pleasure.

- If you are hungry and you take a bite of a food you like, the nucleus accumbens area is activated. If you have a goal of completing a project and you make progress on it, the nucleus accumbens area is activated. What's more, if you take a dose of cocaine, you get an enormous amount of activation at the nucleus accumbens.

- Cocaine is obviously an addictive drug. You might feel as if some people you've known—perhaps even yourself—are addicted to love

(or at least to the rush that they feel with a new love). This brain-imaging work suggests that a love addiction is certainly a possibility because many of the same brain circuits are involved.

- Many of our moment-to-moment behaviors are driven by our subcortical brain systems. Interestingly, while the system is activated by cocaine or other drive-based activities, it also becomes very active even before the need is met. That is, this isn't so much a pleasure system of the brain; rather, it's more of a craving system.

Significance of Symmetry

- A great deal of research has gone into what makes certain people seem more attractive than others. Several universal characteristics have been identified.

- In a typical study, researchers recruit a group of 50 participants and show them all a set of 100 pictures of faces. For each picture, they ask the participants to rate how attractive the faces are, where 1 is unattractive and 10 is absolutely gorgeous. Studies like this have been conducted many times and have shown a remarkable amount of consistency. One of the very striking results from this kind of work is that it generalizes cross-culturally.

- Researchers have identified several characteristics that humans seem to favor. The closer a face is to perfectly symmetrical, the more attractive it will be rated. There is strong evidence that even young infants like symmetry. Babies will look longer at faces that are symmetrical than at those that are asymmetrical.

- David Buss and his colleagues have argued that symmetry is a basic instinct of reproductive fitness. On average, people with highly symmetrical features tend to live longer and be healthier. They tend to have fewer problems with fertility. It may be that through many generations of evolution, we have been bred to favor symmetry.

Questions to Consider

1. Some have suggested that we place too much emphasis on physical attraction in our selection of romantic partners. Given your understanding of the brain's process of falling in love, might it make sense to be somewhat shallow in this regard?
2. The mere-exposure effect seems to make people and things more attractive (or less unattractive) as the amount of time you spend with them increases. Might that be explained, at least in part, by our tendency to discover complexity and inner beauty as we spend more time with something or someone?

Suggested Readings

Buss, *The Evolution of Desire*.

Gottman and Silver, *What Makes Love Last?*

Lecture 22

The Neuroscience of Lasting Love

Falling in love is much more common than staying in love. What's more, cognitive neuroscience demonstrates that falling in love and remaining in love involve separate and distinct brain systems. In this lecture, we explore the underlying neural systems that mediate lasting love and suggest strategies to nurture lasting love: overwhelm your partner with five or more positive events for every negative one, avoid being dismissive or aggressive in arguments, and seek exciting new experiences with your romantic partner.

Avoid Dismissive Behaviors

- When you have an argument with your partner, don't roll your eyes. This kind of dismissive behavior impacts your partner's brain in consistent and negative ways. Your partner's amygdala, for instance, will become more active. As it does, the negative emotions that are associated with that subcortical brain region will emerge, making the rest of the argument that much more difficult.

- Long-term love and attachment are associated with oxytocin, a hormone produced by your brain that promotes deep social attachments. Amygdala activity and its associated fight-or-flight response weaken those bonds. If you too frequently tip the scales in favor of that amygdala system, love will lose.

- Moreover, oxytocin itself can influence behavior in two very different ways. It can promote social cohesion and cooperation, but it can also

strengthen the memory for negative events. Examples of this can be seen among couples who find themselves in a toxic divorce situation. The same oxytocin that creates love can contribute to its destruction.

Gottman's Approach to Arguments

- John Gottman and his colleagues have done scientific research on how to make love last. He and his team have become celebrated for being able to predict—with greater than 90 percent accuracy—which marriages will last and which will end in divorce. A key part of Gottman's process is to ask the two members of the couple to discuss something that has been a point of disagreement. In essence, Gottman asks them to engage in a bit of conflict. A typical Gottman study involves collecting data and then waiting—in some cases, for several years.

- After this time interval, some of the participants are still married; others have divorced. The research team then analyzes the data to see if there is anything in those records that was consistently present for the still-married couples that was not present for the now-divorced couples. They determined that there are several features that are present for the divorced couples that are only rarely present for the still-married couples. The significant factors center on how they argue.

- An unhealthy way to start an argument is with blame and harsh criticism. Several processes will kick in if the argument begins this way. First, the blood pressure, heart rate, and skin-conductance levels of the recipient of the criticism will rise. His or her cognitive function will decline as the fight-or-flight system is activated. If the recipient of criticism rolls the eyes, looks away, and is dismissive of the criticism, then this discussion is already doomed. The marriage may be as well.

- Many other conflict-related behaviors can lead to a downward spiral of negativity in a close relationship. The most important strategy that Gottman's research has yielded is the following: If you want to

maintain a lasting romantic relationship, learn to argue without being sarcastic, overly critical, or dismissive of your partner.

- Gottman and his colleagues have repeatedly found that marital arguments that involve a gentle start-up lead to better outcomes. An argument with a gentle start-up specifically avoids assigning blame. Following are examples of an unhealthy beginning and a gentle start-up.
  Wrong: "The problem is that he doesn't want to spend time with the family. He just spends all his time working."

  Right: "I feel unhappy that he doesn't spend more time with the family. I wish that we could find a way he could spend more time with us, even though I understand that might involve taking some time away from work."

- Gottman has found that if arguments and discussions begin the right way, they tend to become more productive; they become more like group problem-solving activities.

Three Brain Systems

- Three distinct brain systems are involved in falling in love and staying in love. Consider the three-tiered system proposed by Ruth Feldman and her colleagues.

- The first system is associated with general sexual libido. Many subcortical brain systems are involved in coordinating human sexual behavior and regulating the hormones estrogen and androgen. The hallmark of this aspect of physical attraction is that it is rarely directed at any particular individual. This system is often mapped to the general term "libido."

- A second brain system is associated with more focused romantic attraction. These brain areas are related to feeling the desire associated with a romantic attraction to one person. The system connected to falling in love is a dopamine-based system associated with the nucleus accumbens and the ventral tegmental area.

- Deeper, more lasting love is associated with a third system, which is affected by specific brain regions and hormonal systems. The basic systems involved in the attachment aspects of love seem to function from the time that we are born, if not before. They are associated with two hormones: oxytocin and vasopressin. Oxytocin affects attachment behavior in the brain.

Impact of Oxytocin

- Perhaps the strongest of human attachments is that between a mother and child. This attachment is heavily mediated by a large production of oxytocin. In circumstances in which the mother and child are separated for weeks after the child is born, this attachment does not

form normally. It's not that the mother will never be able to have an attachment and loving relationship with the child, but the intensity of that initial attachment relationship seems quite difficult to replace.

- The effect of oxytocin on attachment don't stop with the mother-child relationship, however. Oxytocin seems to cause all our strong attachment bonds to form with other humans. Oxytocin binds to many receptors in the brain, but the area most implicated in the attachment facets of love are located in the anterior insula, part of the outer cortical layer of the brain. The insula is on the side, tucked deep within one of the folds of that cortical sheet. The anterior cingulate cortex is an adjacent area of the brain with a high density of oxytocin-related receptors.

- In studies of how oxytocin relates to human behavior, including romantic behavior, researchers take a blood sample and test for the density of oxytocin. The more oxytocin in the bloodstream in general, the more oxytocin is present in the brain as well. In fact, when people are involved in a new romantic relationship, they tend to produce higher levels of oxytocin.

- Ruth Feldman and her research team conducted studies by recruiting people involved in a new relationship. They saved that data for six months and then re-contacted those participants. The greater the levels of oxytocin produced by the new couples, the more likely that they were still together six months later. There is an abundance of evidence that our bodies produce oxytocin as a central part of forming and maintaining attached romantic relationships. The greater the oxytocin concentration, the stronger the bond.

Seek New Experiences Together

- A strategy that emerges from our understanding of the three brain systems affecting love is that if you want someone to fall in love with you, do exciting and novel things together. When we are excited by something—not simply by a potential romance but by our environment or activities—our brain produces adrenaline, norepinephrine, and

dopamine. This dopamine is the same neurotransmitter that activates the system of falling in love.

- Many relationship experts suggest the importance of breaking out of routines with your partner from time to time. Doing novel activities together can be very important for maintaining those dopamine-related circuits that spark the romantic, loving connection.

Effect of Antidepressant Drugs

- Some researchers have expressed concern that certain drugs might be antithetical to the love and attachment processes in the brain. The use of antidepressant medications in the United States

Doing novel activities together can be very important for maintaining the dopamine-related circuits that spark the romantic, loving connection.

has skyrocketed in recent years. Most antidepressants function by boosting serotonin function in the brain. For instance, the class of drugs referred to as serotonin selective reuptake inhibitors (SSRIs) greatly increase the amount of time that serotonin remains in a synapse after it is released. It therefore greatly increases the general amount of freely active serotonin molecules in the brain as a whole.

- When you boost serotonin systems in the human brain, you reduce the activity of dopamine-related systems. A common side effect of SSRIs is reduced libido and sex drive. This is a direct result of the suppression of that nucleus accumbens and ventral tegmental area system associated with arousal and falling in love.

Strive for Five

- John Gottman's research about improving a couple's argument style fits in with our understanding of the oxytocin-related attachment system in the brain. When a romantic attachment is formed, it's not set in stone. Over time, that attachment can erode. Unless there are regular, periodic releases of oxytocin that are associated with the partner, the attachment will decline.

- Oxytocin doesn't simply make us all love one another unconditionally. In fact, it makes us become more cooperative and positive with in-group members and more negative with those we perceive as the out group. A fascinating memory study suggests that the release of oxytocin can produce very vivid and detailed memories for any negative events that are experienced along with that oxytocin. If a partner accumulates enough negative associations, the process will undo the positive attachment that is essential to meaningful love.

- Gottman has explored this aspect of his data and found that a 1:1 ratio doesn't seem to be enough. If you experience an equal number of positive and negative associations with a romantic partner, the most likely outcome is divorce. In fact, a full 5:1 ratio seems to be needed.

- If you were in a Gottman study, you might be asked to write down a summary of each positive event and negative event you can remember taking place with your partner over the past week. The number of items on each list turns out to be critically important. Partners who tend to stay together can report five positive events for every one negative event that has happened over the past week. For people in Gottman's studies whose ratios were substantially lower, the most likely outcome was divorce.

Questions to Consider

1. Arranged marriages were the norm for many centuries and are practiced in some cultures even today. Numerous arguments can be made against this system, but how might it fit well with the human brain's love processing? How might it contrast with it?
2. Excitement seems significant to promoting strong social bonding. What types of romantic activities seem in line with this? Are romantic couples always thrill seekers?

Suggested Readings

Berns, *How Dogs Love Us*.

Gottman, Gottman, and DeClaire, *Ten Lessons to Transform Your Marriage*.

Lecture 23

How Your Brain Creates Happiness

Cognitive neuroscientists have long sought to identify the patterns of neural activity associated with happiness. A range of studies have found that there are consistent differences between happy brains and unhappy brains. Happy brains show more activity in left frontal regions of the cortex, while unhappy brains tend to have more activity in the right frontal and amygdala areas. In this lecture, we examine cognitive research that demonstrates that the greatest happiness is possible when we create it ourselves—through the processes of imagination, mindfulness training, expressing gratitude, or other actions that boost left prefrontal cortex activity.

The Power of Imagination

- Imagine being happy. There is strong evidence that this simple strategy will lead to increased happiness.

- In one happiness study, Nakia Gordon and her colleagues had a group of participants pretend to laugh or pretend to cry. After participants had practiced actually performing the actions, they shifted to imagining performing the actions. The researchers found that when participants imagined crying, they later produced lower mood ratings. Thinking about crying makes you feel a little sad. Conversely, thinking about laughing makes you feel a bit happier.

- Most people presume that we decide to do something before we actually do it. However, a series of studies suggest that the feeling

you are making intentional decisions actually follows the moment when you start to make those decisions. One of the areas in which automatic processes of the brain are most directly relevant is in the domain of happiness.

Adopt an Attitude of Gratitude

- To make yourself happy, find something to be thankful for, and then thank the person most responsible for it. Write, call, or visit this person and communicate how much you appreciate his or her positive impact on your life. Expressing gratitude will likely make the person you thank feel good, but you will also feel happier. Thank people on a regular basis and you will find yourself becoming a happier person.

- The science is quite clear on this. Researchers conducting experimental studies recruited a group of participants and then randomly assigned half to a gratitude condition. The participants were asked to spend several minutes a day for a week thinking about aspects of their lives for which they were grateful. The control group spent equivalent amounts of time thinking and writing about recent experiences; however, the control participants were not explicitly asked to focus on gratitude.

- Across a range of different situations, the participants who focused on gratitude later reported feeling happier about their lives and themselves. That is, the results strongly suggest that there is not simply a relationship between gratitude and happiness; this is an actual intervention that works.

- An underlying theme in much of the research on happiness is that happiness is generated by the brain itself. This is counterintuitive to most people, who presume that things or people or events are what make us happy.

Money Buys Happiness—to a Degree

- It is often said that money can't buy happiness. A research team led by Daniel Kahneman recently shed some light on a fundamental question related to money and happiness. His team set out to determine just how much money buys happiness and at what point will money no longer buy additional happiness.

- The simple answer here is an annual household income of about 81,000 dollars (in 2016 dollars). It's important to note that this number varies quite a bit from place to place. In an expensive location such as Hawaii, additional money keeps increasing happiness up to about 122,000 dollars of annual household income. In Alabama, the cost of happiness is quite low, with happiness peaking around 65,000 dollars per year.

- Kahneman and his colleague Angus Deaton analyzed about 450,000 responses given by U.S. residents in a telephone survey conducted by the Gallup organization. A set of questions included in that survey was used to calculate people's emotional well-being. The survey also included questions about the level of household income. The primary analysis here explored the relationship between the amount of money a person made per year and the level of general happiness.

- Not surprisingly, there was a clear positive relation between income and happiness. The crucial result, however, was that the amount of extra happiness you get for each additional dollar becomes smaller as the income rises. By the time you get up to an annual household income of around 50,000 dollars, the increases become extremely small. By the time the income rises to another plateau—around 81,000 dollars in many locations—the average happiness score peaks. There were some increases beyond that level, but the increases were neither statistically significant nor substantively large.

- Therefore, money can buy you happiness—at least to a degree. To become truly happy, however, you will need to look beyond money.

Basal Ganglia Activity

- In older models of brain activity, our sense of pleasure and happiness are associated with stimulation of a particular subcortical structure of the brain: the basal ganglia. The nucleus accumbens—which is part of the motivation circuit in the basal ganglia—and the subcortical automatic motivation systems crave the release of dopamine within this pleasure circuit.

- In the 1950s, James Olds and Peter Milner found that if they delivered mild electrical stimulation to this brain region in rats, the rats acted as if it was a powerful positive reinforcement. When the researchers hooked up their system so that the rats could obtain this electrical stimulation by pressing a bar in their enclosure, the rats stopped eating and drinking and continued to press this bar for hours on end.

- It's not surprising that many addictive drugs increase activation in this same brain region. Activity in the basal ganglia is directly connected to our experience of intense pleasure. However, if you interview most heroin addicts, they don't seem very happy. Indeed, even when they receive a dose of heroin, they often describe feeling relief, not happiness.

- More modern work on brain activity has re-characterized basal ganglia activity with the emotional feelings of liking or wanting—but that is not the same thing as happiness.

Affective Neuroscience

- The search for the brain circuits that are active in humans and other animals when they are actually happy or unhappy has spawned an entirely new subfield of cognitive neuroscience.

- Richard Davidson is often described as one of the founders of a field that people now call affective neuroscience. This branch of neuroscience seeks to determine how the brain regulates emotion, how changes in emotion are mapped onto various patterns of brain activity, and the how we can change emotional states by changing the brain.

- By studying hundreds of people in different emotional states, Davidson and his colleagues have begun to develop an outline of the characteristics of a happy brain and the ways that the brain activity of a happy person differs from that of an unhappy person.

The Happiness Ratio

- In general, when you are unhappy or feel stressed or anxious, particular regions of your brain become active. The amygdala is a relatively small subcortical region of the brain. It is an important part of the limbic system, a highly connected brain structure that seems to regulate negative emotions. If you stimulate a particular part of the amygdala of most animals, they become strikingly agitated and

aggressive. What's more, when animals are agitated and aggressive, it turns out that their amygdala is highly active.

- If you feel angry, anxious, or unhappy, it's very likely that your amygdala is exhibiting high levels of activation. Along with the amygdala, negative emotions are associated with activity in the right prefrontal cortex. When you are distressed, this right prefrontal cortex seems to regulate a heightened state of vigilance.

- In contrast, the brains of people who report relatively high levels of happiness and enthusiasm are associated with low activities in both the amygdala and right prefrontal cortex regions. Instead, higher activity is found in the left prefrontal cortex.

- If you put someone into a functional magnetic resonance imaging (fMRI) scanner and examine the activity produced in the right prefrontal cortex and the left prefrontal cortex, you can calculate a ratio of activity: the amount of left prefrontal cortex activity divided by activity in right prefrontal cortex and amygdala. This ratio is a remarkably effective predictor of someone's reports of their everyday happiness. Happier people tend to show a larger ratio. Unhappier people tend to show a substantially smaller ratio.

Mindfulness Training

- In addition to quantifying the happiness ratio, Davidson and his colleagues have explored several methods to alter this ratio. One of the most successful is mindfulness training.

- Although mindfulness training is associated with the practice of meditation, you can engage in mindfulness at any time. Training aimed at enhancing mindfulness will typically involve spending 15 to 20 minutes per day in quiet meditation. Often, this method involves focusing your attention on your breathing and not dwelling on thoughts about the past or plans for the future.

- There is another aspect of the mindfulness training that is particularly relevant to happiness. As you quietly sit and meditate, you may become aware of the emotions you are feeling—specifically, you might feel happy or you might feel sad. Mindfulness training instructors will typically tell you to simply feel that feeling. Be aware of it. Embrace it. Students of mindfulness training are taught to focus periodically on being very aware of what is happening right now—that is, to be self-aware in the particular moment.

- Most people spend much of their day thinking about what has happened in the past and making plans for the future. As important as this is to our daily cognition and decision making, the focus on what is outside the domain of our immediate context seems to generate stress, anxiety, and unhappiness.

- Consider the intervention that Davidson and his colleagues used. After several weeks of mindfulness training, the happiness ratio became larger. It's not clear what aspects of the mindfulness training accomplish this, but across many studies, when mindfulness training is used as an intervention, the brains of the participants change. Their brains produce different patterns of activity, and participants report that their everyday happiness levels increase.

Questions to Consider

1. Students of Buddhism pursue a goal of reducing desire rather than satisfying it. How does this align with our description of happiness as having a thermostat-like set point?
2. If you win a large lottery jackpot, you will be happy, but there is evidence that the happiness will fade as you adapt to the changes associated with it. If a lottery paid out prizes in gradually increasing amounts over time, could this lead to greater happiness?

Suggested Readings

Pink, *Drive*.

Thaler, *Misbehaving*.

Lecture 24

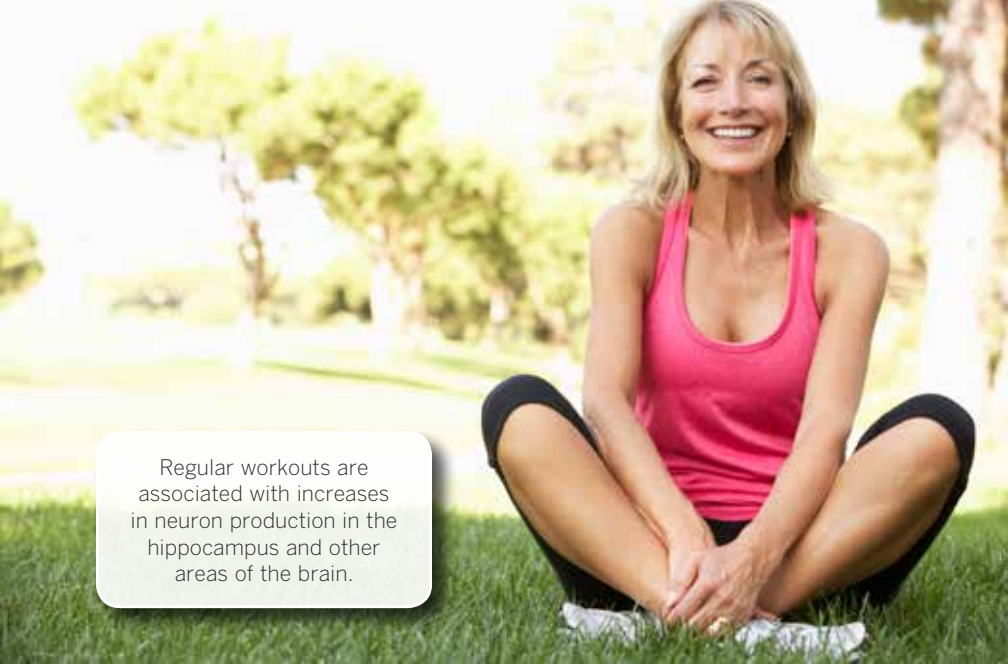
Happy Brains Are Smart Brains

Cognitive neuroscience research can help you understand how to make yourself happier. For example, when people are exposed to natural surroundings, their brains show patterns of activation associated with relaxation and happiness. Focusing on the value of time can affect automatic, unconscious processes in your brain that can lead to greater happiness. What's more, across several studies using different types of happiness-induction procedures, the results are the same: Happy workers are more productive. Happy people also demonstrate enhanced immune function. Moreover, by intentionally practicing optimism, there is strong evidence that you will become more optimistic, leading directly to higher levels of happiness.

Significance of Green Spaces

- A simple way to make yourself happier is to go outside and visit a place that is rich in natural vegetation—a forest, an open field, a city park, or a desert landscape. Studies demonstrate that this visit to nature will have an effect on your brain that is on par with taking a dose of prescription antidepressants. Even better, while you are out there, get some exercise.

- Clearly, physical exercise is good for your brain. Regular workouts are associated with increases in neuron production in the hippocampus and other areas of the brain. In fact, several recent studies suggest that it's even better if you perform that exercise in green, natural surroundings.



Regular workouts are associated with increases in neuron production in the hippocampus and other areas of the brain.

- Peter Aspinall and his colleagues had participants hike around Edinburgh while wearing a portable electroencephalograph and GPS system. The device monitored patterns of brain activity over the course of the walk. The researchers found that when participants were in green spaces, they exhibited patterns of brain activity associated with happiness. Frustration levels fell. Patterns of brain activity associated with meditation increased. When participants were in more urban spaces, these patterns were reversed.

- Colin Capaldi and his colleagues conducted a meta-analysis of these types of studies. They identified 30 different experiments—including 8,523 participants—that had explored the relation between natural surroundings and happiness. When they analyzed these studies together, the average effect on happiness was impressively large. Perhaps most remarkable was that the effect was consistent across a wide range of different types of studies.

Look Outside

- Cognitive research suggests that you don't have to change your activities, you can just take your current activities outside. In fact, you don't even need to go outside. Simply viewing natural settings can affect patterns of neural activation.

- A study by Roger Ulrich and his colleagues was based on hospital records at a facility in suburban Pennsylvania. Some of the hospital rooms had windows that looked out on the surrounding countryside; other rooms were windowless. Patients in both types of rooms received the same quality of care. They were served by the same staff with the same medications and protocols.

- Based on a review of hospital records, Ulrich found that the people assigned to window rooms recovered from surgeries more quickly and with fewer complications. Window-room participants checked out of the hospital, on average, about a day sooner than those in the windowless rooms. For the windowless patients, nurses' notes contained nearly four times more negative assessments than they did for the window patients.

Value Your Time

- Another strategy to boost happiness is to value your time highly. A recent study by Ashley Whillans and her colleagues assessed the trade-offs between time and money to determine how much monetary value people place on their time. The authors found that individuals tend to place a fairly consistent value on their own time. In addition, the researchers determined that people who place a greater value on their time tend to be happier.

- Cassie Molginer published a set of experiments exploring how time, social behavior, and happiness interact. In several of her experiments, participants started by completing a word-scramble puzzle. Participants had to unscramble the letters as quickly as possible and then come up with sentences that included the words.

- After completing this puzzle task, the study participants completed a questionnaire containing a list of daily activities, such as socializing, working, and commuting. The participants were asked to rate how much time they were likely to spend on each activity during the next day. They were also asked to rate how happy they expected to be while doing those tasks.

- The key manipulation in the study was the content of the word puzzle. For some participants, the words were related to time; for other participants, the words were related to money. A control group unscrambled neutral words.

- Cognitive scientists think of the word-scramble puzzle as a priming task. While you are doing the puzzle, you're inherently thinking about the related concepts, such as money or time. Once you finish the puzzle and go on to the survey, your conscious mind probably doesn't focus on money or time. However, there is strong evidence that the unconscious neural networks that are used to process information related to the priming task remain active for at least several minutes.

- Results of the experiment demonstrated that if you prime people to think about money, they indicate that they will spend more of their next 24 hours working. If you prime the concept of time, people unconsciously shift their plans to include more time in social activities. What's more, the time participants also anticipated being happier than the money participants.

Increased Work Production

- A wide range of studies find that happier people produce more work and superior work. Productive work, of course, is itself a source of satisfaction; however, a number of studies have found that when you experimentally boost people's happiness, they tend to improve in their work as well.

- To test the relationship between happiness and work, Andrew Oswald and his colleagues recruited about 300 students and randomly assigned them to either a control condition or a happiness-induction condition. To induce happiness, participants watched a funny movie clip or were provided free drinks and snacks. As simple as these happiness-induction steps were, they increased the happiness level of these participants. Participants assigned to the control conditions had about the same level of happiness as when they started.

- Oswald then asked these participants to perform some work, such as solving math puzzles. Across several studies using different types of happiness-induction procedures, the results were the same: Happy workers are more productive. When your brain is happy, it produces superior work. Happy people are less distractible, less irritable, and seem to have enhanced memory performance.

Enhanced Immune Function

- As we learned from Richard Davidson's research, happy brains have greater patterns of activity in the left frontal cortex, as opposed to the right frontal cortex and amygdala areas. As part of the Davidson study, researchers collected blood samples from participants who had recently received flu shots. Davidson's group found that the number of influenza antibodies in the bloodstream of the happy people was significantly greater than those in the bloodstream of the unhappy people.

- It may be that when you are unhappy, even if you aren't experiencing the surge of adrenaline that we associate with a strong activation of the sympathetic nervous system, perhaps there are milder activations that suppress processes such as digestion and immune function. If so, then being happy will result in more resources being devoted to immune function.

- If you are happier, studies have shown that you will tend to be more energetic and productive. The influenza antibody result suggests a

very direct mechanism for that observed effect. Happy people have better immune function and therefore fewer illnesses—and fewer sick days out of work.

Practice Optimism

- A successful strategy for promoting happiness is to practice being optimistic. By intentionally practicing optimism, there is strong evidence that you will become more optimistic, which will lead directly to higher levels of happiness.

- A theory often associated with Rick Hanson and his colleagues is that humans are born pessimists. While this is debatable, there is evidence that we tend to be more affected by negative events than positive ones. A number of brain mechanisms may be responsible for this tendency. For example, the amygdala—an area greatly activated by

negative experiences—has strong connections to the hippocampus, which is responsible for encoding information into long-term memory. Thus, a negative memory will likely be encoded more strongly than a positive one.

- This creates a problem for happiness. If humans are inherently somewhat pessimistic, then the brain is wired to resist when positive events happen. Even if you experience an equal number of positive and negative events, your brain will remember a greater proportion of those negatives.

- The best way to be more optimistic, however, is to practice. A system that David Fresco and his colleagues have explored in several studies simply involves keeping track of the times when you engage in a pessimistic-explanation strategy.

- When some event or uncertain situation arises, you can interpret it in either an optimistic way or a pessimistic way. If you make a note of those times and then intentionally try to be more optimistic, then optimism will become a habit. In as little as two weeks of using this intervention, participants' explanatory styles are altered significantly.

Human Connectome Project

- Our brains contain unconscious control systems, and we have tendencies to think and behave according to certain cognitive reflexes. All of us are embodiments of an ongoing battle between these reflexive, automatic tendencies and our conscious, intentional mind.

- Throughout this course, we've considered ways to outsmart these automatic brain systems. We have provided numerous tools that you can use in that battle, and now you know enough to seek out additional tools adapted even more specifically to your individual situation. If you are patient and persistent, you can outsmart many of those automatic processes and take control for yourself.

- What's more, cognitive neuroscientists aren't finished with their research on the brain. If anything, the rate of new discovery has accelerated in recent years. For example, the Human Connectome Project has developed new neuroimaging techniques that combine assessments of connectivity and myelination with correlations in activation. The underlying circuit diagram of the human brain has uncovered more than 100 newly identified processing systems. Right now, we don't know what many of these systems do. But we will.

- It may be that you have little or no conscious control over your moment-to-moment behaviors; there's good evidence for that from cognitive neuroscience research. Over longer periods of time, however, you do have the ability to consciously shape those unconscious systems. The battle can be a challenging one, but the outcomes can be tremendously rewarding. You can outsmart yourself.

Questions to Consider

1. Spending time in natural surroundings engaged with nature promotes happiness. Even simply looking out a window seems sufficient to promote happiness. Do you think nature-themed art or computer screen savers would have a similar effect? How could you test for this in your own life?
2. Simply mentioning the concept of time a few times seems to promote greater socialization. The concept of money seems to promote more work behavior. What other key concepts might modulate our behaviors in this fashion?

Suggested Readings

Diamond, Scheibel, and Elson, *The Human Brain Coloring Book*.

Satel and Lilienfeld, *Brainwashed*.

Verstynen and Voytek, *Do Zombies Dream of Undead Sheep?*

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