

Discovering Psychology: Updated Edition

10 Cognitive Process

- 1 01:28:59:12 >> ZIMBARDO: How do we know that these are all the same things, even though they look quite different?
- 2 01:29:07:00 Why have people always been able to link different elements and ideas into a coherent relationship, a process that we only now have begun to understand?
- 3 01:29:20:02 "Cognitive Processes," this time on *Discovering Psychology* .
- 4 01:29:59:20 In the 17th century, the great philosopher Descartes declared, "I think, therefore I am."
- 5 01:30:05:21 Without an awareness of our own thought processes, he reasoned, we would have no sense of personal identity.
- 6 01:30:13:25 It is our thoughts that give meaning to everything -- memories, experiences, expectations.
- 7 01:30:20:12 Among all other creatures, only we humans have the ability to think as widely and deeply, and so we salute ourselves as the true thinking animal.
- 8 01:30:36:07 "I think, therefore I am."
- 9 01:30:39:05 Or in Latin, "*Cogito ergo sum.*" *Cogito* means "I think," and its derivation, cognition, is the general term we use for all forms of knowing.
- 10 01:30:51:07 That includes remembering, deciding, planning, problem solving, and communicating ideas.
- 11 01:30:59:28 The study of all these higher mental processes is known as cognitive psychology.
- 12 01:31:06:09 Cognitive psychologists study how people take in information, store it, transform it, and manipulate it.
- 13 01:31:13:27 Even though people have thought about thinking for countless centuries, it's only recently that researchers have begun to discover how we think.
- 14 01:31:22:18 Howard Gardner of Harvard is one of the country's leading cognitive psychologists.

- 15 01:31:30:02 >> The word cognitive psychology goes back quite a long time, and it basically refers to any kind of research or thinking which has to do with how people solve problems.
- 16 01:31:40:08 And you have cognitive psychologists under that name or another name going right back to the beginning of the century.
- 17 01:31:45:20 After the Second World War, when the computer had been invented, a number of people from different disciplines began to say, "Well, now that we know that computers can solve problems, and we understand something about how they work, maybe we should think about the human mind as being a certain kind of computer, a certain kind of information-processing system."
- 18 01:32:04:01 And these individuals, who came from psychology, philosophy, artificial intelligence, linguistics, sometimes from other disciplines as well, styled themselves as cognitive scientists.
- 19 01:32:15:00 In the '30s and '40s, behaviorism was the most important area of psychology, and psychologists actually believed it was only important to pay attention to actions and behaviors which you could measure.
- 20 01:32:27:10 And they made no distinction between animal behaviors, infant behaviors, and those behaviors of mature adults.
- 21 01:32:32:15 Moreover, the behaviorists were very afraid of talking about any kind of internal representation.
- 22 01:32:36:27 They didn't want to talk about ideas or models in the mind, or anything inside the black box.
- 23 01:32:42:17 Cognitive science has said that's a dead end.
- 24 01:32:45:14 People think, they compute, they solve problems, they have images in their head, they have schematas, they operate upon these things -- that's what thinking is all about.
- 25 01:32:54:25 And for goodness sake, if you allow a machine the right to think, you've got to allow human beings the same kind of right.
- 26 01:33:00:11 So I think a very important part of cognitive science was just to point in a positive direction rather than in a dead-end direction.

- 27 01:33:07:24 >> ZIMBARDO: In 1958, British psychologist Donald Broadbent used the information processing approach to model human thought processes.
- 28 01:33:18:01 He was the first psychologist to use a flow chart to describe what happens to information as it's first received by the senses, then selected as competing information is filtered out, and stored in our memory.
- 29 01:33:35:24 This information processing approach has proven so valuable because it analyzes cognitive processes as a sequence of ordered stages.
- 30 01:33:47:04 These stages can be traced as information flows through the mental system as if the mind were a computer.
- 31 01:33:57:10 Nobel Prize winner Herbert Simon of Carnegie Mellon University has been working since 1955 to make a "thinking machine" that can solve problems the way humans do.
- 32 01:34:10:22 >> We began to get interested in the possibilities of using the computer as a way of modeling and thinking about human thinking.
- 33 01:34:22:19 And the reason we thought the computer might be useful there is that we began to realize that computers can deal with a good many things besides numbers.
- 34 01:34:31:07 They can deal with any kind of symbols, whether they be numbers or letters or words or pictures.
- 35 01:34:36:00 We thought that we could formulate what was going on in the thinking process more effectively with a computer symbolically than we could if we tried to build a mathematical model of it.
- 36 01:34:51:13 Most biologists today think that organisms are machinery -- machinery of a very fancy kind, but they operate according to natural law and according to natural processes.
- 37 01:35:03:04 The mind is part of that machinery, and it gets its work done by doing simple things like inputting information, reading, writing, comparing symbols, storing symbols and memories.
- 38 01:35:20:08 And we know that computers can do exactly those kinds of things, using entirely different hardware, of course -- using glass and metal instead of living tissue.

- 39 01:35:30:28 But the underlying processes are the same, and it's those processes which we model when we simulate thinking.
- 40 01:35:38:08 We used to, in computers, use these punch cards a great deal.
- 41 01:35:42:25 Well, you could ask, "How could a punch card carry information?"
- 42 01:35:46:03 It's made of paper."
- 43 01:35:47:22 Well, the information was in the pattern of things in the card - in that case in the pattern of holes.
- 44 01:35:54:09 Now, you can make patterns out of a lot of things, not just out of one material.
- 45 01:35:58:14 So in computers we use electromagnetic patterns, we use patterns in metal.
- 46 01:36:03:11 In the human brain, we use patterns in neurons.
- 47 01:36:06:10 But we can simulate the same kinds of patterns in both cases.
- 48 01:36:10:19 >> ZIMBARDO: Using the information processing approach as a springboard, cognitive psychologists have begun to answer fundamental questions such as how our experiences get turned into knowledge -- knowledge that can be called upon later to guide our actions.
- 49 01:36:27:18 One of the central operating principles of the mind that cognitive psychologists have studied is our ability to formulate mental representations of the external world, the physical and social reality we experience.
- 50 01:36:41:09 These mental structures are so much a part of us we're not even aware of them.
- 51 01:36:45:08 But cognitive researchers distinguish between different aspects of these representations.
- 52 01:36:50:24 Take a look at these versions of the letter A.
- 53 01:36:54:12 How do we know that they're all A's?
- 54 01:36:57:04 They're not identical.
- 55 01:36:58:11 In fact, some of them are quite different from each other.

- 56 01:37:01:22 Yet somehow, we can identify them instantly.
- 57 01:37:04:18 A typical computer, however, wouldn't be able to recognize them as belonging to the same category.
- 58 01:37:11:07 Here's a harder example of the same mental process.
- 59 01:37:14:21 Try to think what distinguishes the top line from the bottom.
- 60 01:37:18:18 The correct answer is that the top line has rounded letters while the bottom one has letters with straight lines.
- 61 01:37:26:16 And here's another example.
- 62 01:37:28:16 Which phrase doesn't fit with the rest?
- 63 01:37:32:14 The answer is "Stars twinkle," because the others happen during the day.
- 64 01:37:40:02 In all of these examples, your mind has had to perform one of its most basic functions -- categorizing.
- 65 01:37:47:12 We have to know what things are similar and what things are different if we're going to avoid the next danger and pursue our next pleasure, not to mention pass our next test.
- 66 01:37:57:22 The categories we form in our mind are called concepts -- mental representations of related things.
- 67 01:38:04:26 A concept may represent all examples of a physical object, say a shoe, or an event, such as walking, a living organism, such as a person, an attribute, such as fast, or even an abstraction, such as love.
- 68 01:38:24:04 Some concepts are remarkably complex, as demonstrated by these symbolic cave paintings made by Australian aborigines.
- 69 01:38:33:06 These, for instance, are gods who make lightning, which in turn brings rain, which in turn makes life possible.
- 70 01:38:42:05 Our imaginations can construct concepts that link virtually any elements into a coherent relationship.
- 71 01:38:54:08 The aborigines also have a category that includes women, fire, and all dangerous things.
- 72 01:39:01:12 In their mythology, the sun is the wife of the moon, which links women as wives to the sun.

- 73 01:39:09:29 And, of course, the sun gives off heat like fire does.
- 74 01:39:13:28 So fire is linked to women too.
- 75 01:39:16:20 And because fire is dangerous, all dangerous things are thrown into the pot for good measure.
- 76 01:39:27:00 But how do we store a concept in our minds?
- 77 01:39:30:26 Do we have a definition of a bird, for instance, locked in our brains that can be read whenever we need it?
- 78 01:39:39:16 Actually, it's now believed that many of our concepts include a representation of the most typical member of a category, called a prototype.
- 79 01:39:49:19 For example, we tend to have in our minds a prototype of bird that most resembles a robin, while few of us think of a turkey as the prototypical bird, except around Thanksgiving, of course.
- 80 01:40:04:18 We also tend to organize concepts in hierarchies.
- 81 01:40:08:26 Is this a piece of furniture, a desk chair, or just a chair?
- 82 01:40:13:17 For most purposes we think of it as the latter, just a chair.
- 83 01:40:18:11 This so-called basic level in the hierarchy of the concept "chair" gives us as much detail as we usually need.
- 84 01:40:26:08 It's generally believed that most of our thinking about concepts is done on this basic level.
- 85 01:40:34:04 Concepts are one way our minds categorize things.
- 86 01:40:38:19 But what happens when the information we process contains many concepts?
- 87 01:40:43:12 How do we handle complex ideas and experiences?
- 88 01:40:46:12 The answer is with schemas.
- 89 01:40:50:06 Take this sentence as an example: Why do we instantly understand what it means?
- 90 01:41:02:08 We understand because we've organize a body of information and expectations around a picnic basket schema.

- 91 01:41:08:22 Thus we can infer a great deal about the basket without any other information.
- 92 01:41:15:16 We can infer what's likely to be in the basket.
- 93 01:41:18:22 >> Yummy sandwiches.
- 94 01:41:20:27 >> ZIMBARDO: And what's not.
- 95 01:41:22:16 >> A bicycle wheel and a snake.
- 96 01:41:24:14 >> ZIMBARDO: Moreover, when new information clashes with an established schema, there's a violation of our expectations, and our mind reacts instantly.
- 97 01:41:32:06 >> I love the taste of wicker.
- 98 01:41:34:03 Mmm.
- 99 01:41:35:23 >> ZIMBARDO: Just compare your reaction to this sentence to this one.
- 100 01:41:43:04 This violation of your expectations is detected instantly by your brain even before you're consciously aware of it.
- 101 01:41:52:18 Now ,sometimes we don't have enough information to activate the right schema until we add the right cue.
- 102 01:42:04:03 (*bagpipes playing*) And sometimes, we activate the wrong schema entirely.
- 103 01:42:18:22 Take a good look at this drawing.
- 104 01:42:21:05 It's an example of how our interpretation of new information can become faulty or biased.
- 105 01:42:26:16 Try to remember the image you just saw.
- 106 01:42:29:29 What do you think was happening there?
- 107 01:42:32:16 For a number of research subjects, the knife was perceived to be in the hands of the black man.
- 108 01:42:37:27 These subjects reconstructed the information found in the picture around their own biased schemas in which blacks are always seen as the aggressors.
- 109 01:42:47:17 And so the knife changed hands in their mind from the white aggressor to the innocent black man.

- 110 01:42:56:04 Here's another way we go wrong.
- 111 01:42:58:08 Which is farther north, Seattle or Montreal?
- 112 01:43:05:22 And which is farther west, the entrance to the Panama Canal on the Pacific Ocean side, or the entrance on the Atlantic side?
- 113 01:43:15:10 In fact, Seattle is further north, but we usually think it's Montreal because we picture Canada as always being north of the U.S.
- 114 01:43:26:02 And it's the Atlantic entrance of the canal that's further west despite our assumption that the Pacific is always west of the Atlantic.
- 115 01:43:36:09 What's happened is that we've been led astray by the mental maps we have in our minds.
- 116 01:43:41:05 These maps can enlarge nearby familiar places and foreshorten faraway places like this satirical picture of the world from a Bostonian's perspective.
- 117 01:43:54:09 We also store mental pictures of objects like this one and scan them in our minds in much the same way we scan actual objects with our eyes.
- 118 01:44:05:29 Now, think back to the picture of the motorboat.
- 119 01:44:09:17 Did it have a windshield?
- 120 01:44:11:10 Did it have an anchor?
- 121 01:44:13:03 When researcher Steve Kosslyn asked subjects each of these questions, they tried to answer as fast as they could by pressing a button.
- 122 01:44:21:13 Results indicated that it took them longer to remember that there was an anchor than a windshield.
- 123 01:44:28:09 This longer reaction time was taken to mean that the subjects were scanning a visual image of the motorboat in their minds.
- 124 01:44:36:28 And because the anchor was farther away than the windshield when they scanned the image starting from the back of the boat, it took longer to see the anchor with the mind's eye.

- 125 01:44:49:02 A similar result occurred when subjects were asked whether each of these letters was a normal R or a mirror image.
- 126 01:44:56:02 The further the R had been rotated, the longer it took subjects to answer because in their minds they had to rotate the R's back into an upright position.
- 127 01:45:08:00 Unlike computers, we humans often process information inefficiently.
- 128 01:45:13:20 When subjects are asked to plan a shopping trip, for instance, they do so by skipping back and forth.
- 129 01:45:19:20 That's because instead of reasoning out the problem in a direct linear way, we tend to process information according to the meaning it has for us.
- 130 01:45:29:15 If you like going to a bookstore better than going to a drugstore, that's going to affect how you solve the problem of planning a shopping trip.
- 131 01:45:39:16 In fact, the content of a problem often determines if and how well we can solve it.
- 132 01:45:46:06 If the elements aren't familiar enough, we're apt to have trouble, although if we were truly logical, the form of the problem, not the content, would be the crucial factor.
- 133 01:45:58:16 So even though the human problem solver can be rational, can reason, we aren't designed to be particularly logical.
- 134 01:46:04:26 And that's where we part company with computers.
- 135 01:46:09:12 >> I think that the very fact that we have used a computer as a model of thinking has showed us many ways in which human beings are not terribly rational -- ways in which we do stereotypical kinds of thinking, prejudicial kinds of thinking, thinking which proceeds from an image rather than from a set of reasoned propositions.
- 136 01:46:26:05 And the paradox is it was only by using the computer as a model of thinking that we saw the various ways in which human beings actually deviate from that kind of systematic, logical, step-by-step rationality.
- 137 01:46:40:14 While researchers have been trying to understand the functioning of the mind, both rational and irrational, most have tended to overlook the machine that actually runs us.

- 138 01:46:51:15 But now, some cognitive scientists are starting to ask how the physiology of the brain enables us to reason, learn, and remember.
- 139 01:47:02:11 Michael Posner of the University of Oregon uses brain imaging techniques to explore what parts of the brain are used in specific cognitive tasks such as reading.
- 140 01:47:13:21 >> Recently, it's become possible to study problems like reading in normal people by using a method called positron emission tomography which allows one to look at the blood flow in different localized areas of the brain in normal people as they perform cognitive tasks like reading.
- 141 01:47:37:08 In our studies, we had people read single visual words which were presented directly in front of them, and we tried to study the component operations that are involved in that very simple task.
- 142 01:47:50:26 In one condition, we had the people simply look at the visual words without doing anything with them.
- 143 01:47:57:23 In another condition, we had them read the words aloud.
- 144 01:48:01:13 In yet a third condition, we asked them to classify the words - that is, to give us the use of each word.
- 145 01:48:08:20 For example, if they got the word "hammer," they were to say "pound."
- 146 01:48:13:27 In each of these tasks, we were able to look at the areas of the brain which were active -- that is, in which we saw different levels of cerebral blood flow.
- 147 01:48:24:19 In general, we plot these areas in different colors.
- 148 01:48:28:23 So when an area is very active, it's in a bright color, white or bright red, whereas when it is quite inactive, that is, when it differs only in a very small degree between its control condition and the experimental condition, it's in a dark color, purple or blue.
- 149 01:48:49:01 And we found that very localized, very specific areas of the brain were active during different aspects of word reading.
- 150 01:48:58:01 For example, when we asked people to give the use of a noun, say "pound a hammer," we found two areas of the brain active for that specific task, and really only two areas in

- the whole cortex seemed to be specially active for that task.
- 151 01:49:17:13 By other experiments, we were able to show one of those areas, which is on the left... in the left frontal lobe was... it related to the association between "hammer" and "pound."
- 152 01:49:30:12 And another area located on the midline seemed to be more related to our attention -- that is, to the attention necessary to generate that association and to be aware of the association so that one could store it or tell someone else about it.
- 153 01:49:45:06 It was surprising to us that these higher-level mental processes were this well localized, and in particular that they were so common among the various subjects that we ran.
- 154 01:49:56:25 That is, that it was not the case that each person showed different types of activation, but rather, all the people that we ran showed the same type of activation, suggesting that these operations are done in common ways among different people.
- 155 01:50:13:00 >> ZIMBARDO: While some scientists seek to discover how our mind works, others are trying to apply that knowledge to everyday life, especially in education.
- 156 01:50:25:10 Robert Glaser is the director of the University of Pittsburgh's Learning Research and Development Center, or LRDC.
- 157 01:50:35:29 >> The main mission of LRDC is really the study of learning - - the study of learning in all its forms as it occurs in schools, as it occurs with people who learn in the street, people who learn in villages, people who learn in cultures... in cultures without school.
- 158 01:50:55:10 The nature of learning in all its forms.
- 159 01:50:58:03 Some people work on reading and comprehension.
- 160 01:51:01:04 They examine the relationship between basic skills and reading, and higher levels of comprehension.
- 161 01:51:09:10 They examine the relationship between obtaining automaticity -- that is, unconscious processing of words that is needed in order to be able to understand the content and the semantics of the whole paragraph.
- 162 01:51:28:11 They're very interested in the relationship between

individuals who haven't developed basic skills and individuals who have developed high levels of comprehension.

- 163 01:51:39:09 For example, in playing tennis, one has to spend a lot of time on their basic strokes.
- 164 01:51:44:25 But once these basic strokes are mastered, then these now don't require any conscious attention anymore.
- 165 01:51:53:18 It all becomes relatively unconscious or automated performance.
- 166 01:51:58:27 But what that does is free memory to be able to pay attention to sense and meaning and structure of what people are listening to and what they're reading.
- 167 01:52:08:14 So this relationship between the conscious aspects of higher- level processes and the unconscious aspects of higher- level processes are... is one kind of study that goes on here.
- 168 01:52:20:22 Some of the people at LRDC spend hours and hours and hours televising expert teachers in the elementary schools that teach arithmetic to young children, and they're trying to examine what is the experienced teacher... what is it that experienced teachers develop?
- 169 01:52:41:09 What forms of explanation do they give to students?
- 170 01:52:44:14 How do they manage their answers to students?
- 171 01:52:47:22 How do they motivate the students?
- 172 01:52:49:28 So we spend a lot of time understanding what is the nature of explanation, how they stimulate the students, and how they get the students to think.
- 173 01:53:06:07 I think that as we understand more and more about the human mind, there is no doubt that we increase the level of human intelligence.
- 174 01:53:16:18 Now, we've always considered intelligence as somewhat native... you know, native endowment of the individual.
- 175 01:53:26:12 But I tend to think of intelligence as a cognitive skill -- an ability to problem solve and the ability to learn.

- 176 01:53:35:15 And it seems to me that the more we learn about human memory, the more we learn about human problem-solving, we will be able to increase individuals' proficiency in learning to learn and learning to teach themselves and in learning higher levels of performance and other subject matters and the kind of technical knowledge that people have to acquire in doing their everyday life.
- 177 01:54:04:00 >> ZIMBARDO: The revolution in cognitive psychology is really just beginning, and yet it's already made public the most private aspect of human nature -- the working of the mind, with its enormous capacity for invention, creativity, and wisdom.
- 178 01:54:20:24 In our next program, however, we'll chronicle some of the fallacies of human intuition as we look at the process of making judgments and decisions.
- 179 01:54:28:25 And that includes your judgments and your decisions.
- 180 01:54:32:21 So be prepared to put your mind on the spot and take some risks.
- 181 01:54:36:14 Until next time, I'm Philip Zimbardo.
- 182 01:54:43:10 [Captioned by The Caption Center WGBH Educational Foundation]
- 183 01:55:48:00 >> *Funding for this program is provided by Annenberg/CPB to advance excellent teaching .*