Discovering Psychology: Updated Edition

07 Sensation and Perception

1	01:00:20:03	>> ZIMBARDO: How is our brain tricked by visual illusions?
2	01:00:26:17	What makes a star quarterback misjudge an easy pass?
3	01:00:33:18	Why does this rotating square appear to expand and contract?
4	01:00:42:18	"Sensation and Perception," this time on *Discovering Psychology* .
5	01:01:19:03	Lights, camera, perception!
6	01:01:23:11	When you were little and some big kids pushed you around, did you ever fantasize about becoming bigger all of sudden?
7	01:01:31:12	Well, I did, and now I can at the Exploratorium, San Francisco's Science Museum.
8	01:01:39:02	How did I do it?
9	01:01:39:24	The easy way -- by manipulating your perception.
10	01:01:44:22	When you first saw me, I appeared to be normal size because you couldn't see the rest of the room.
11	01:01:51:00	But as lights came up and the camera pulled back, your brain performed a new, instantaneous analysis.
12	01:01:57:14	It now saw me as small.
13	01:01:59:26	It added up all the visual information it had about my size and the size and shape of the room, and then it added in everything it knew from experience about the usual shape of rooms: that they're rectangular and have right angles.
14	01:02:16:06	So when I walked over here, your brain was convinced I was growing incredibly large because there was no other perceptual explanation, even though it wasn't logical.
15	01:02:26:14	Let's look at it again, only this time from a different perspective.
16	01:02:30:22	The room is not rectangular at all; it's totally distorted.

17 01:02:34:00 There are no right angles anywhere.

18 01:02:36:14 So that makes this clock, which is large and oval, look the same as that clock, which is small and circular, from your other perspective.

19 01:02:43:25 The floor slopes upward, and as you can see, the ceiling slopes downward.

20 01:02:51:16 So, I'm not getting larger at all.

21 01:02:54:06 You're just misperceiving my size because you think that you're the same distance from me when I'm over here as you are from me when I'm over there.

22 01:03:03:24 But in fact, I'm twice as far away.

23 01:03:08:06 It's always more fun to have a vivid example of misperception, but the truth is our perception is usually very accurate.

24 01:03:16:22 It has to be.

25 01:03:17:29 We couldn't survive if it weren't.

26 01:03:19:26 Perception is our way of making contact with our environment, of discovering what's happening outside our body and our brain.

27 01:03:29:08 All species have developed special sensory apparatus to gather information essential for survival.

28 01:03:37:12 Eagles and other birds of prey have astonishingly accurate vision.

29 01:03:45:21 Dogs can smell things in concentrations 100 times lower than we can.

30 01:03:55:21 (*wings flapping*) And bats can use sonar to track and capture tiny, fast-moving insects.

31 01:04:07:21 Psychologists study all sensory processes -- hearing, smell, taste, and so on -- but their major focus, and ours, is on visual perception.

32 01:04:18:15 Our sensory abilities are usually measured by the absolute threshold, the weakest level of a stimulus that can be accurately detected at least half the time.

33 01:04:30:22 For humans, that includes a candle flame seen at 30 miles on a dark, clear night; the tick of a watch, under quiet conditions, at 20 feet; (*watch ticking*) one teaspoon of sugar in two gallons of water; one drop of perfume diffused in the space of a three-room apartment; the wing of a bee falling on your cheek from a distance of one centimeter.

34 01:05:06:25 Our sensory knowledge of these stimuli comes from the many millions of specialized receptors spread throughout our bodies, in our eyes, ears, nose, tongue, skin, muscles, our joints and tendons, our inner ear, and even certain parts of our digestive tract.

35 01:05:30:29 Each receptor is designed to detect certain types of physical energy, such as light waves or sound waves.

36 01:05:38:12 This stimulation is then converted into a special code, electrochemical signals called neural impulses, which the nervous system transmits to the brain's cortex.

37 01:05:50:19 The cortex has the job of putting all the sensory information together and acting upon it.

38 01:05:57:06 Different regions of the cortex translate different neural impulses into different psychological experiences, such as melody or touch.

39 01:06:05:16 (*band playing*) Visual information is first processed in the occipital-lobe area in the rear of the brain, hearing and smell in the temporal lobe, speech perception in the frontal lobe, and body senses in the parietal lobe.

40 01:06:23:28 These primary-sensory centers then project the results of their activity to a relay station, the thalamus, which in turn sends the information to a succession of areas in the cortex.

41 01:06:36:02 It's believed that this is where more abstract information processing takes place, and where we connect new information with old information stored in our memory.

42 01:06:48:16 Visual perception, for instance, takes place in three areas: in the retina -- or the back surface of the eye -- in the pathways through the brain, and in the part of the cortex at the back of the brain responsible for visual processing, the visual cortex.

43 01:07:06:12 This is the way an image, or rather a pattern of stimulation, is formed on the retina.

44	01:07:11:19	It's upside-down, flat, distorted, full of holes, out of focus, and obscured by blood vessels.
45	01:07:19:24	In fact, it's amazing that we see as well as we do.
46	01:07:24:09	Now, remember that the task of all perception is to determine what the real object in the environment is.
47	01:07:31:14	Another term for this object is the distal stimulus, the thing out there.
48	01:07:36:03	But the only way to find out what that is, is by using information derived from the object's stimulation of a sensory receptor in the body.
49	01:07:45:28	This stimulation is called the proximal stimulus; in this case, an image formed on the retina.
50	01:07:52:17	The brain knows only the image, but what it must discover is the true nature of the actual object, the distal stimulus.
51	01:08:04:06	So, here's where the brain earns its keep.
52	01:08:07:06	It must eliminate confusing signals, fill in the blanks, give it three dimensions, and straighten out the upside-down image to put it all in perspective.
53	01:08:21:06	These transformations occur instantly and continually.
54	01:08:27:17	David Hubel of Harvard won a Nobel Prize with his colleague, Torsten Wiesel, for mapping the reaction of receptor cells along the visual path of a primate from the retina to the cortex.
55	01:08:40:18	>> Receptor cells usually, in the visual pathway, mean the cells that take in the energy and turn them... it into electrical signals.
56	01:08:49:09	And in the retina, those are the rods and cones.
57	01:08:51:26	There are 125 million rods and cones in each retina.
58	01:08:56:06	So in the case of the visual pathway, you start with the retina.
59	01:09:00:06	The output is the optic nerve, which contains a million fibers.
60	01:09:03:22	They end up in a certain region in the brain.

61 01:09:07:08 That region, or there are really two or three regions that they end up in, each of those sends a cable of fibers of the order of, maybe, a million to other regions, and they connect to other regions.

62 01:09:20:13 And in the case of the cortex, you have separate areas of cortex, each one connected to one or more other areas.

63 01:09:27:00 And this whole thing is a pathway.

64 01:09:29:29 In the cortex, for example, the primary visual cortex, which is about seven stages beyond the receptors and the retina, those cells react to visual stimuli only if the... if a line falls on the retina, and the line has to be a particular orientation.

65 01:09:48:14 It can be a bright line or a dark line or an edge between bright and light; any kind of line, really, generally works.

66 01:09:54:19 But the position of the line and the orientation are terribly important, and if they're not just right, any individual cell doesn't respond.

67 01:10:03:09 (*crackling*) >> ZIMBARDO: In this experimental footage, a bright vertical line stimulates a small number of neurons in the visual cortex of a cat.

68 01:10:15:09 The crackling sound is the electrical activity of these neurons as they respond to this retinal image.

69 01:10:21:19 By listening to the intensity of this electrical activity, the researchers can determine the correct orientation of the line.

70 01:10:34:29 But when the line is moved to a diagonal or horizontal position, the amount of stimulation decreases dramatically.

71 01:10:45:02 >> We're only at a very elementary stage when it comes to understanding something like how you recognize a face or something like that.

72 01:10:53:14 The general region of the brain is known where things like that go on, but we don't have the slightest idea of what's happening at the level of single cells, for that particular problem.

73 01:11:05:13 But for more elementary problems, for the very first processes of vision, we do have a very good understanding of what happens at the very beginning.

74 01:11:14:00 So, it's just a start.

75 01:11:16:18 >> ZIMBARDO: Misha Pavel of Stanford University is studying the successive stages of information processing that take place continually as we perceive the world.

76 01:11:25:24 Using computer graphics, he has demonstrated how the visual system breaks down visual stimulation into millions of bits of information and recombines them into a coherent image that we recognize.

77 01:11:38:14 >> Seeing something is... seems such an effortless activity that it's hard to imagine for us the complexities and difficulties that are involved.

78 01:11:48:02 Only when you try to build a robot that can actually see and recognize objects do you realize how complicated task this is.

79 01:11:56:16 People can... must do awful lot of processing in order to see images and interpret them.

80 01:12:02:15 Here's an image of a cat as our eye and brain sees it.

81 01:12:06:21 Now, let's look at what the visual system goes through to enable us to see this image.

82 01:12:12:12 When the light first reaches the retina, the image is slightly defocused by the optics of the eye.

83 01:12:18:09 Then, it is broken up into millions of little pieces.

84 01:12:21:28 Each receptor sees just a minuscule portion of the original image and measures its brightness.

85 01:12:27:13 Different receptors in the retina are sensitive to different colors of light and respond to the amount of that color that they see.

86 01:12:35:29 To discover objects, the visual system tries to find important boundaries.

87 01:12:40:05 It uses edge- and line-detecting neurons, whose characteristics have been investigated by Hubel and Wiesel.

88 01:12:47:09 Here you can see the results of the red, green, and blue edge detectors.

89 01:12:56:02 Look at the blue edges.

90 01:12:57:07 It is hard to believe that there is a cat in there.

91 01:13:02:17 What I'd like to show you now is the kind of information that the brain uses in order to make sense out of these messy images.

92 01:13:11:00 The things that the brain seems to look for are constancies and simplicity.

93 01:13:15:16 Imagine that you are in your visual system looking at this pattern of active neurons, but you can't recognize the pattern.

94 01:13:27:09 We can see it now because all the points in the cat picture move together.

95 01:13:32:03 This is an example of the brain using rigidity to recognize moving objects.

96 01:13:41:15 Ambiguous perception of motion can actually destroy the rigiditic percept.

97 01:13:46:17 In this case, we have a rotating rigid object -- a square -- but when its corners disappear from view, the square appears to get smaller.

98 01:13:57:08 When the corners reappear, it gets larger.

99 01:14:02:29 Another example: we thought that the square loses its rigidity because the visual neurons at each location can see only a small proportion of the entire picture and therefore can't accurately perceive the direction of the moving parts of the object.

100 01:14:19:11 If we rotate the cross, then the stationary square appears to be rigid.

101 01:14:27:04 We can simultaneously compare these two situations.

102 01:14:32:06 The conclusion is that the motion of the square is necessary to lose rigidity.

103 01:14:37:20 The failure of rigidity, in this case, helps scientist to study how information from different retinal locations is combined to form a single percept.

104 01:14:47:18 This is one of many examples that perceptual phenomena can reveal how our brain works.

105 01:14:59:07 >> ZIMBARDO: Every moment, the brain must make an endless number of perceptual decisions.

106 01:15:04:24 It has to compute size and distance relationships, determine where boundaries and edges exist, identify figures within backgrounds, move us towards objects we want and away from objects we need to avoid.

107 01:15:21:29 Many of these perceptual decisions are made without any conscious awareness of the processes involved.

108 01:15:28:08 The brain is automatically computing the sensory feedback and guiding the body to perform the necessary tasks.

109 01:15:37:26 When a quarterback sees a receiver, for instance, he automatically, unconsciously calculates distance, angle, and velocity; and the muscles in his hand, arm, and shoulder adjust accordingly.

110 01:15:54:26 But what if we distort his perception of the receiver?

111 01:15:58:14 These glasses will displace his visual field by 20 degrees.

112 01:16:02:11 In other words, the distal stimulus, the real object, will be 20 degrees off from where he perceives it to be.

113 01:16:11:27 If he continues to pass with the glasses on, he'll begin to adapt to the new signals by compensating for the misinformation his retina is sending to his brain; he'll start throwing what seems to him to be 20 degrees off in order to hit the receiver.

114 01:16:28:11 He has quickly learned a new arm-eye coordination.

115 01:16:35:26 But return his vision to normal, and he'll start missing again in the opposite direction.

116 01:16:42:25 Even though his retina is now passing on accurate information about the true location of the target, his brain hasn't caught up with the new input.

117 01:16:51:09 His brain is still compensating for the previous feedback from the movements in his hand and arm.

118 01:17:00:22 Getting accurate information about the world around us, and

not just the images on our retina, is the major task of our visual system.

119 01:17:09:00 But to sense, perceive, and understand our world, we utilize two very different processes.

120 01:17:14:29 First, our sensory receptors detect external stimulation and send this raw data to the brain for analysis.

121 01:17:22:01 We call this bottom-up processing.

122 01:17:24:24 Then top-down processing enters the scene.

123 01:17:27:26 It adds what we already know about such stimulation, what we remember about the context in which it usually appears, and how we label and classify it.

124 01:17:36:22 In this way, we give meaning to our perceptions.

125 01:17:44:08 When people walk toward us, we know that they're not getting larger even though the image they cast on the retina does get larger.

126 01:17:52:29 And if a shadow falls on our newspaper, we know the paper isn't turning darker.

127 01:17:58:02 That's because the hallmark of perception is our ability to impose stability on the constantly changing flow of sensations we experience.

128 01:18:08:29 Psychologists refer to this phenomenon as perceptual constancy.

129 01:18:13:18 The actual size, shape, orientation, and brightness of an object are perceived as remaining relatively constant, even when there are extreme variations in the image it projects.

130 01:18:28:14 What we perceive is not just a passive photograph of reality, but an active construction of reality.

131 01:18:35:01 We tend to see what we expect to see.

132 01:18:37:10 We see things with our minds as well as our eyes.

133 01:18:42:12 We are constantly selecting only a small part of the available sensory information to attend to and process.

134 01:18:51:11 One of the ways we perceive something actively is by taking into account its context.

135 01:18:57:00 This context can even determine the nature of the perception itself, with the same object looking very different in different contexts.

136 01:19:06:26 Take a look at this square.

137 01:19:09:20 Notice how the square appears to get darker as the background becomes lighter or, in other words, as the context changes.

138 01:19:18:29 Now, take a look at these three men.

139 01:19:21:04 We see the figure on the right as smaller than the one on the left, in back, because we unconsciously compare him with the large figure.

140 01:19:30:10 But in fact, the two small figures are exactly the same size.

141 01:19:36:27 To be effective, perception also has to work fast and extract the minimal amount of information necessary to form an impression of the entire pattern.

142 01:19:47:22 Visual perception would be far too slow if we had to wait to experience every last piece of something.

143 01:19:56:25 Edges and boundaries in particular convey lots of information about an object.

144 01:20:01:18 They provide a visual shortcut which can help the brain fill in the whole patterns from the fewest identifying parts.

145 01:20:10:16 Sometimes the brain will even register a pattern that doesn't exist.

146 01:20:15:16 These phantom patterns are called subjective contours.

147 01:20:21:14 A boundary or an edge can powerfully influence the way we see things.

148 01:20:26:04 In this example, the left half of the screen appears darker than the right half.

149 01:20:31:03 But watch what happens when we cover up the boundary.

150 01:20:35:24 What happened is this: your brain detected a slight difference in brightness in the center and then went overboard in extending that difference to the rest of the surface.

151 01:20:49:01 Given the complexity of the world we try to understand and the complexity of our minds, it's small wonder that what we perceive as out there is subject to a great number of influences, some of which will lead us astray.

152 01:21:02:19 We may see something that isn't there because it's what we expect to see.

153 01:21:07:19 Or conversely, we may not see something because we don't expect to see it.

154 01:21:12:23 Our previous experience, our expectations, interests, and biases are constantly giving rise to different perceptions.

155 01:21:22:16 Let's take a look at this illustration.

156 01:21:27:08 Some of you will see a young woman, and some of you will see an old woman.

157 01:21:34:21 In various studies it was found that younger people tended to see the younger face, while older people tended to see the older face, without any hints about what to look for.

158 01:21:49:21 And then, there's the rat-man illusion.

159 01:21:53:15 Try to identify each drawing as soon as you see it.

160 01:22:03:16 Now, identify this one.

161 01:22:08:05 Let's try another sequence.

162 01:22:10:17 Again, identify each drawing as soon as you see it.

163 01:22:21:02 Now, how about this one?

164 01:22:25:15 In a number of studies, it was found that the first series of drawings of animals led most subjects to identify this image as a rat.

165 01:22:35:28 But when other subjects saw the drawings of people, they tended to identity this drawing as an old man with glasses.

166 01:22:45:18 Their prior experiences created very different ways of looking at the same distal stimulus.

167 01:22:55:13 Sometimes, however, we have trouble perceiving things not because of our experiences or our expectations, but just the opposite.

168 01:23:03:25 There's just too much unfamiliar information to absorb.

169 01:23:07:17 We're taken by surprise.

170 01:23:12:05 (*gunshot*) But surprise is what often happens to eyewitnesses.

171 01:23:19:06 Watch this simulated bank robbery again and try to tell who did what.

172 01:23:26:22 (*gunshot*) Who shot whom?

173 01:23:31:24 Would you swear to it in court?

174 01:23:34:25 Let's show the film, this time in slow motion, to see if you were right.

175 01:23:39:24 The hand, the arm, even the whole body can be quicker than the eye when the brain isn't ready to do its detective work.

176 01:23:47:12 (*gunshot*) What happens when we have no trouble seeing something, but what we see just doesn't make sense; when we encounter a visual paradox?

177 01:24:00:19 At first glance, this is a solid, wooden triangle.

178 01:24:05:15 But it can't be a triangle, because from my perspective it has two right angles, and that's impossible.

179 01:24:11:05 So impossible, I want you to watch this, as I slice my arm right through without breaking it.

180 01:24:17:26 So now you know that it can't be solid either.

181 01:24:21:21 Changing the perspective enables you to see it as it really is.

182 01:24:25:20 We call this way of seeing an object in terms of its parts the analytic way of seeing, which conflicts with the holistic way of seeing the big picture.

183 01:24:34:13 Either view makes sense alone; but together, they create a paradox.

184 01:24:45:26 In this animation of a bouncing ball, the staircase appears to go up forever.

185 01:24:55:20 This paradox also works in reverse.

186 01:25:03:12 Although our senses put us in touch with the world around

us, it's our brain working from prior experiences that tells us whether something is impossible or possible, organizing our perceptions and telling us what's out there and what we should think about it.

187 01:25:22:23 And so each of us has incredibly sophisticated hardware, in the form of sensory apparatus, and software to process the information and make sense of it, both perfected over millions of years.

188 01:25:40:26 Usually, the two work together extremely well, but sometimes they don't, and so we can never take perception for granted, no matter how well we do it in the normal course of our lives.

189 01:25:55:25 In our next program, we're going to look at another ability of ours that shapes the way we look at the world, and that's our ability to learn, to profit from experience.

190 01:26:05:20 A tale of mice and men... and women, next time.

191 01:26:09:15 I'm Philip Zimbardo.

192 01:26:13:06 [Captioned by The Caption Center WGBH Educational Foundation]

193 01:27:18:11 *>> Funding for this program is provided by Annenberg/CPB to advance excellent teaching .*

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