

Will Small Step for Robots Lead to Giant Leap for Robotkind?

How close are we to being replaced by robots? *NewsHour Science* Correspondent Miles O'Brien reports on efforts to engineer robots that are eerily similar to humans and animals.

Video Interview Transcript

By Miles O'Brien

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- 1 **Judy Woodruff:** Finally tonight: a change of pace. Just how close are we to being replaced by robots? *NewsHour* science correspondent Miles O'Brien examines the efforts under way to develop robots that are just like us.
- 2 **Miles O'Brien:** Who says you need to be human to have the right stuff?
- 3 **Man:** I am going to show you some demonstrations as to the capabilities of the robot. One of the most important features of the robot are its hands. It has, obviously, five fingers.
- 4 **Miles O'Brien:** They call it Robonaut. And it is headed to the International Space Station on the last mission for the shuttle Discovery. It's the first humanoid robot to fly in space.
- 5 **Steve Lindsey,** commander, Discovery: We are going to figure out exactly how you would use this technology to assist astronauts, as well as how you would use this technology to assist humans on the ground, because it has spinoffs everywhere.
- 6 **Miles O'Brien:** The idea, eventually, astronauts will use Robonaut as an assistant on space walks, and, who knows, maybe, one day, to clean the space station toilet.
So, the astronauts are getting a robot butler. Are you jealous? I sure am.
- 7 **Actor:** Danger, danger. Force level building to fatal intensity.
- 8 **Miles O'Brien:** I have always wanted what Will Robinson, George Jetson, and Luke Skywalker have.
- 9 **Anthony Daniels,** actor: That's how we came to be in your service, if you take my meaning, sir.
- 10 **Miles O'Brien:** You know, a robot servant to do my bidding, my dirty work. It seems like that idea is languishing in around-the-corner purgatory, with the flying car, fusion power, and the jet pack.

A lot has changed over the years. Robotic devices are everywhere, on assembly lines, disarming bombs, helping the disabled, even sucking up dust bunnies. They are smarter than ever, but, unlike Hollywood's robots, they only excel when the task is very narrow and clearly defined.
- 11 **Pieter Abbeel,** University of California, Berkeley: And, for robots, it's really easy these days to do repeated motions very precisely. It's very hard to deal with variation like this, where, every time, it is looking at the towel and seeing something different.

- 12 **Miles O'Brien:** This really hit home for me when I saw this robot in Pieter Abbeel's lab at U.C. Berkeley.
- I'm going to unfold this robot, darn it.
- He has taught the device to fold clothing. In the world of robots, that's a big deal. It takes about 20 minutes to fold one measly towel. Why? Computers are smart enough to beat the world's greatest chess master. Why are robots flummoxed by a dirty rag? Well, it's complicated.
- 13 **Marvin Minsky,** Massachusetts Institute of Technology: There's still no machine that can solve everyday commonsensical problems.
- 14 **Miles O'Brien:** Marvin Minsky helped create the field we call artificial intelligence, you know, making computers think like us. Over the years, he has stumbled on a surprising paradox: What's hard for us is simple for robots, and vice versa.
- 15 **Marvin Minsky:** If somebody is very good at some skill, it's because they know about 20,000 fragments of knowledge or process or whatever.
- 16 **Miles O'Brien:** But to have common sense, the mundane skills you need to get through the day and fold the clothes, you need a few million fragments of skill, knowledge and insight.
- 17 **Marvin Minsky:** So, this advanced mathematics came easily, and then the high school-type mathematics was a little later, and we are still not at the age of the 4- or 5-year-old.
- 18 **Miles O'Brien:** Humanoid robots are also having a hard time learning to walk.
- How difficult a problem is it?
- 19 **Robert Playter,** Boston Dynamics: It's—it's difficult, because we don't know what we don't know.
- 20 **Miles O'Brien:** Rob Playter is with a company called Boston Dynamics. This is the home of BigDog. BigDog was built at the behest of the Pentagon's Defense Advanced Research Projects Agency. They're seeking a mechanical mule for foot soldiers in the next four years or so.
- Powered by a two-stroke engine, hydraulic actuators, a gyroscope, and some breakthrough software, this prototype can slog through some pretty rugged terrain. It has a remarkable sense of balance and the ability and agility to break a fall.
- So, what do you do? What is the way to—how do you—how do you teach a machine to walk?
- 21 **Robert Playter:** You have to build them. You have to experiment with them. You have to push them. You have to kick them and see how they respond. Rather than try to build a response to stepping on a rock or stepping on ice, what [we] try to build is a fundamental sort of core concept of balance and how to behave in—in the gravitational field.
- 22 **Miles O'Brien:** Boston Dynamics is now developing a two-legged robot called PETMAN for the Army.

And, in Florida, at the Institute for Human and Machine Cognition, they're working on some legs with a keen sense of balance that may one day be connected to Robonaut.

But, to get to this point, well, let's just say it's been a long, slow, stroll.

23 **Marvin Minsky:** What most people today are doing is saying, first, let's get the robot so that it can do the simple things, and then we will make it do the harder ones. I think we should just turn it opposite.

24 **Miles O'Brien:** While others try to solve the ambulation equation, at MIT's Media Lab, Cynthia Breazeal is focused on this question:

25 **Cynthia Breazeal,** Massachusetts Institute of Technology Media Lab: Should it be a human device? How humanlike should it be? What do we even mean when we say humanlike?

26 **Robot Voice:** My name's Nexi. What's your name?

27 **Miles O'Brien:** Nexi is just the latest robot in her menagerie that Breazeal has programmed to engender trust by bridging the gap between machine and mankind with expressions, nonverbal communication, body language, if you will.

28 **Cynthia Breazeal:** So things like when I finish speaking and I look at you, that's a very implicit prompt that now I'm expecting you to respond.

29 **Miles O'Brien:** And this is when the kids go wild, right?

Breazeal is also fascinated with ways to make robots a better learning tool for children. The more expressive and empathetic and, frankly, cute the face is, the better.

Now, here is a face anybody could love. Looking at Leonardo, it is easy to forget what is behind him.

30 **Sherry Turkle,** author, *Alone Together*: Here are my—all my little robots.

31 **Miles O'Brien:** So these are robots you like?

32 **Sherry Turkle:** Yes. Well, you know, I'm obsessed with robots.

33 **Miles O'Brien:** Really?

Sherry Turkle is a colleague of Breazeal's at MIT. Her latest book is *Alone Together: Why We Expect More From Technology and Less From Each Other*. She says humanoid robot builders are leading us down a slippery slope.

34 **Sherry Turkle:** The moment you make a robot in human form, and the moment it can make eye contact, track your motion and gesture toward you, you're kind of toast, because you believe that there is somebody home, in other words, a consciousness, even potentially something with feeling and that is like you.

35 **Miles O'Brien:** But it isn't, of course. Turkle worries about another paradox: Machines that act like humans can dehumanize the real thing.

- 36 **Sherry Turkle:** And a lot of the fantasies about nanny-bots and elder-care-bots are really about being company, being companions for people who, quite frankly, we think sometimes we don't have time for. And, there, I think we get into a lot of trouble, because, you know, why are we doing this?
- 37 **Miles O'Brien:** So, this is love's labor lost?
- 38 **Sherry Turkle:** Love's labor lost. It diminishes us. It diminishes us as people.
- 39 **Cynthia Breazeal:** Now, I—I have faith that people are actually pretty savvy about relationships. And the relationship I have with various people, whether it's my children or my husband or my pets, these are all of very, very different kinds of relationships. The relationship I have with pets is a very different kind of relationship. I think people are pretty savvy.
- 40 **Miles O'Brien:** So, when am I going to get my robot butler? In Japan, they are fixated on the idea, and they have built some robots that appear to be closer to the Holy Grail than they really are.
- But the makers of BigDog say the pieces are finally coming together: intelligence, expression, dexterity, and mobility.
- So, we are in the post-novelty stage?
- 41 **Robert Playter:** I think so. Well, in fact, really in the last decade, robots have become real.
- 42 **Miles O'Brien:** The proof is in the silicon astronaut, I suppose.
- In a sense, this is nothing new for NASA. The space agency has been sending robots of another kind to other worlds for decades. The next one to launch to Mars is the size of a Mini Cooper.
- Of course, Robert Playter was quick to remind me, the wheels of one of the Martian Rovers, Spirit, had been mired in a sand trap for months.
- 43 **Robert Playter:** Now, maybe we can build a robot that can't get stuck.
- 44 **Miles O'Brien:** So, the first footprints on Mars might in fact be deposited by a bipedal robot?
- 45 **Robert Playter:** It might be.
- 46 **Miles O'Brien:** I suppose that would be one small step for robot, one giant leap for robotkind.

Students, Meet Your New Teacher, Mr. Robot

By Carey Benedict and John Markoff
New York Times, July 10, 2010

- 1 The boy, a dark-haired 6-year-old, is playing with a new companion.
- 2 The two hit it off quickly—unusual for the 6-year-old, who has autism—and the boy is imitating his playmate’s every move, now nodding his head, now raising his arms.
- 3 “Like Simon Says,” says the autistic boy’s mother, seated next to him on the floor.
- 4 Yet soon he begins to withdraw; in a video of the session, he covers his ears and slumps against the wall.
- 5 But the companion, a three-foot-tall robot being tested at the University of Southern California, maintains eye contact and performs another move, raising one arm up high.
- 6 Up goes the boy’s arm—and now he is smiling at the machine.
- 7 In a handful of laboratories around the world, computer scientists are developing robots like this one: highly programmed machines that can engage people and teach them simple skills, including household tasks, vocabulary or, as in the case of the boy, playing, elementary imitation and taking turns.
- 8 So far, the teaching has been very basic, delivered mostly in experimental settings, and the robots are still works in progress, a hackers’ gallery of moving parts that, like mechanical savants, each do some things well at the expense of others.
- 9 Yet the most advanced models are fully autonomous, guided by artificial intelligence software like motion tracking and speech recognition, which can make them just engaging enough to rival humans at some teaching tasks.
- 10 Researchers say the pace of innovation is such that these machines should begin to learn as they teach, becoming the sort of infinitely patient, highly informed instructors that would be effective in subjects like foreign language or in repetitive therapies used to treat developmental problems like autism.
- 11 Several countries have been testing teaching machines in classrooms. South Korea, known for its enthusiasm for technology, is “hiring” hundreds of robots as teacher aides and classroom playmates and is experimenting with robots that would teach English.
- 12 Already, these advances have stirred dystopian visions, along with the sort of ethical debate usually confined to science fiction. “I worry that if kids grow up being taught by robots and viewing technology as the instructor,” said Mitchel Resnick, head of the Lifelong Kindergarten group at the Media Laboratory at the Massachusetts Institute of Technology, “they will see it as the master.”
- 13 Most computer scientists reply that they have neither the intention, nor the ability, to replace human teachers. The great hope for robots, said Patricia Kuhl, co-director of the Institute for Learning and Brain Sciences at the University of Washington, “is that with the right kind of technology at a critical period in a child’s development, they could supplement learning in the classroom.”

Lessons From RUBI

- 14 “Kenka,” says a childlike voice. “Ken-ka.”
- 15 Standing on a polka-dot carpet at a preschool on the campus of the University of California, San Diego, a robot named RUBI is teaching Finnish to a 3-year-old boy.
- 16 RUBI looks like a desktop computer come to life: its screen-torso, mounted on a pair of shoes, sprouts mechanical arms and a lunchbox-size head, fitted with video cameras, a microphone and voice capability. RUBI wears a bandanna around its neck and a fixed happy-face smile, below a pair of large, plastic eyes.



The developers of RUBI, a social robot that currently teaches kids at the UCSD Early Childhood Education Center, are involved in the new research center.

- 17 It picks up a white sneaker and says “kenka,” the Finnish word for shoe, before returning it to the floor. “Feel it; I’m a kenka.”
- 18 In a video of this exchange, the boy picks up the sneaker, says “kenka, kenka”—and holds up the shoe for the robot to see.
- 19 In person they are not remotely human-like, as most of today’s social robots. Some speak well, others not at all. Some move on two legs, others on wheels. Many look like escapees from the Island of Misfit Toys.
- 20 They make for very curious company. The University of Southern California robot used with autistic children tracks a person throughout a room, approaching indirectly and pulling up just short of personal space, like a cautious child hoping to join a playground game.

- 21 Like any new kid in class, RUBI took some time to find a niche. Children swarmed the robot when it first joined the classroom: instant popularity. But by the end of the day, a couple of boys had yanked off its arms.
- 22 The RUBI team hit upon a solution one part mechanical and two parts psychological. The engineers programmed RUBI to cry when its arms were pulled. Its young playmates quickly backed off at the sound.
- 23 If the sobbing continued, the children usually shifted gears and came forward—to deliver a hug.
- 24 Re-armed and newly sensitive, RUBI was ready to test as a teacher. In a paper published last year, researchers from the University of California, San Diego, the Massachusetts Institute of Technology, and the University of Joensuu in Finland found that the robot significantly improved the vocabulary of nine toddlers.

Making the Connection

- 25 In a lab at the University of Washington, Morphy, a pint-size robot, catches the eye of an infant girl and turns to look at a toy.

- 26 No luck; the girl does not follow its gaze, as she would a human's.
- 27 In a video the researchers made of the experiment, the girl next sees the robot "waving" to an adult. Now she's interested; the sight of the machine interacting registers it as a social being in the young brain. She begins to track what the robot is looking at, to the right, the left, down. The machine has elicited what scientists call gaze-following, an essential first step of social exchange.
- 28 "Before they have language, infants pay attention to what I call informational hotspots," where their mother or father is looking, said Andrew N. Meltzoff, a psychologist who is co-director of the university's Institute for Learning and Brain Sciences. This, he said, is how learning begins.
- 29 This basic finding, to be published later this year, is one of dozens from a field called "affective computing" that is helping scientists discover exactly which features of a robot make it most convincingly "real" as a social partner, a helper, a teacher.
- 30 "It turns out that making a robot more closely resemble a human doesn't get you better social interactions," said Terrence J. Sejnowski, a neuroscientist at University of California, San Diego. The more human-like machines look, the more creepy they can seem.
- 31 "The machine's behavior is what matters," Dr. Sejnowski said. And very subtle elements can make a big difference.
- 32 The timing of a robot's responses is one. The San Diego researchers found that if RUBI reacted to a child's expression or comment too fast, it threw off the interaction; the same happened if the response was too slow. But if the robot reacted within about a second and a half, child and machine were smoothly in sync.
- 33 Physical rhythm is crucial. In recent experiments at a day care center in Japan, researchers have shown that having a robot simply bob or shake at the same rhythm a child is rocking or moving can quickly engage even very fearful children with autism.
- 34 "The child begins to notice something in that synchronous behavior and open up," said Marek Michalowski of Carnegie Mellon University, who collaborated on the studies. "Once that happens," he said, "you can piggyback social behaviors onto the interaction, like eye contact, joint attention, turn taking, things these kids have trouble with."
- 35 One way to begin this process is to have a child mimic the physical movements of a robot and vice versa. In a continuing study financed by the National Institutes of Health, scientists at the University of Connecticut are conducting therapy sessions for children with autism using a French robot called Nao, a two-foot humanoid that looks like an elegant Transformer toy. The robot, remotely controlled by a therapist, demonstrates martial arts kicks and chops and urges the child to follow suit; then it encourages the child to lead.
- 36 "I just love robots, and I know this is therapy, but I don't know—I think it's just fun," said Sam, an 8-year-old from New Haven with Asperger's syndrome, who recently engaged in the therapy.

- 37 This simple mimicry seems to build a kind of trust, and increase sociability, said Anjana Bhat, an assistant professor in the department of education who is directing the experiment. “Social interactions are so dependent on whether someone is in sync with you,” Dr. Bhat said. “You walk fast, they walk fast; you go slowly, they go slowly—and soon you are interacting, and maybe you are learning.”
- 38 Personality matters, too, on both sides. In their studies with Asimo, the Honda robot, researchers have found that when the robot teacher is “cooperative” (“I am going to put the water glass here; do you think you can help me by placing the water glass on the same place on your side?”), children 4 to 6 did much better than when Asimo lectured them, or allowed them to direct themselves (“place the cup and saucer anywhere you like”). The teaching approach made less difference with students ages 7 to 10.
- 39 “The fact is that children’s reactions to a robot may vary widely, by age and by individual,” said Sandra Okita, a Columbia University researcher and co-author of the study.
- 40 If robots are to be truly effective guides, in short, they will have to do what any good teacher does: learn from students when a lesson is taking hold and when it is falling flat.
- 41 The researchers are shooting for nothing less than capturing the foundation of human learning—or, at least, its artificial intelligence equivalent. If robots can learn to learn, on their own and without instruction, they can in principle make the kind of teachers that are responsive to the needs of a class, even an individual child.
- 42 Parents and educators would certainly have questions about robots’ effectiveness as teachers, as well as ethical concerns about potential harm they might do. But if social robots take off in the way other computing technologies have, parents may have more pointed ones: Does this robot really “get” my child? Is its teaching style right for my son’s needs, my daughter’s talents?
- 43 That is, the very questions they would ask about any teacher.

Choe Sang-Hun contributed reporting from Seoul.