



Robotic Psychology

Alexander V. Libin

Georgetown University, Washington, DC, USA

Elena V. Libin

*Institute of Robotic Psychology and Robototherapy,
Cyber-Anthropology Research Incorporated,
Chevy Chase, Maryland, USA*

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needs. Artificial creatures have their own distinct individuality, which manifests itself in the robot's design and behavioral configuration, in the same way that people and other living beings differ from each other in various parameters, such as weight and height, behavioral reactions and character, emotions and cognition, abilities, and coping strategies. Analyses of person–robot interactions account for the essentials of both humans' behavior and that of their artificial partners.

GLOSSARY

robo-IQ The complexity of the software-based artificial intelligence related to an adequate performance of an uncertain or multiple-choice task.

robot An automat with programmed behavior designed for the purposes of substituting for certain human activity or to satisfy a person's physical, psychological, or social needs.

robotic psychology A study of compatibility between people and artificial creatures on different levels: sensorimotor, emotional, cognitive, and social.

Robotic psychology is defined as an interdisciplinary field of research and practice that focuses on the compatibility between people and artificial creatures on different levels: sensorimotor, emotional, cognitive, and social. Robotic psychology studies the psychological significance of robots' behavior and its intertwining with elements of physical and social environments. Different classes of robots are aimed at fulfilling different human

1. ROBOTIC PSYCHOLOGY: ON THE COEXISTENCE OF HUMANS AND ROBOTS

Interactions with robotic creatures of different kinds are rapidly becoming part of people's daily lives. Satisfying various human needs, robots with artificial intelligence and sensitive feedback perform industrial and military functions, research and medical procedures, and assist in educational and therapeutic tasks. A study on human–robot coexistence based on innovative robotic psychology concept now encompasses cybernetics and humanities, engineering and biology, and information sciences and aesthetics. An analysis of robotic beings and their behavior from the psychological standpoint opens new perspectives for theoretical and practical applications in both technological and social sciences. Robotic psychology as a new

research area employs a systematic approach in studying psychophysiological, psychological, and social aspects of person–robot communication.

The search for an artificial being as a human companion dates back to ancient mythology and creatures such as Golem in medieval literature. However, the contemporary understanding of an automatic creature began when Czech writer Karel Capek coined the term “robot” (meaning a worker or a servant) in 1921 and Russian-born U.S. author Isaac Asimov developed the concept of robotics in the 1940s to describe the field of designing and using automats for human purposes. The term robot can be defined nowadays as an automat with programmed behavior aimed at substituting for certain human activities or to satisfy a person’s physical, psychological, or social needs.

1.1. Classification of Artificial Creatures in Robotic Psychology

Due to the diversity of human activities, a variety of robotic creatures are required to help in the performance of these activities. From the perspective of human needs, all kinds of interactions between people and robots deserve psychological attention. Contemporary primary classification of artificial creatures is based on a robot’s relation to human activity, a robot’s behavioral configuration defined by degrees of freedom, robo-IQ (complexity of software-based artificial intelligence related to an adequate performance of an uncertain or multiple-choice task), and the robot’s physical properties manifested in the hardware architecture and appearance (Table I).

Robotic psychology emphasizes three major modes of a robot’s relation to human needs: substitute for human activity (e.g., rescue robots), extension of human activity (e.g., medical robots), and stimulation of human activity (e.g., social robots and therapeutic robots).

2. PSYCHOLOGY OF PERSON–ROBOT INTERACTIONS

Rodney Brooks, a scientist from the Massachusetts Institute of Technology (MIT), developed a concept of robotic beings. He argued that robots’ behavior must be based on the principle of dynamic interactions with changing physical and social environments. A robotic being is perceived as an embedded part of human relations with the world, as one of the components of the interactive process but not the separate system. To

be relevant to the unpredictable psychological reality of its human partner, the organization of a robotic creature’s behavior needs to be built with the motor and sensory loops running in parallel rather than employ hierarchically structured functioning.

2.1. Modeling the Human Mind

Robots’ capacity to adjust to the requirements of the human world stems from the concept of artificial intelligence, or a set of programs that control the automatic actions of machines. John McCarthy, who coined the term artificial intelligence (AI) in 1956, was an enthusiast of the psychologization of computers. This position reflects an idea that there is no difference between human reasoning and computer programming. A different approach expressed by philosopher John Searl states that although the human mind has the ability to compute, it is completely different in its nature from AI. Whereas robotic actions result from embedded programs, human behavior is determined by subjective needs and preferences, likes and dislikes, and intentionality. That is why it is such a challenge to build an artificial creature capable of interactions relevant to the complexity of human relationships. It is of no coincidence that the competence of a robot’s AI is tested by the human expert implementing the Turing test, based on the robot’s ability to answer random questions in the same manner as people do.

On the other hand, it is considered an honor to challenge an artificial partner in fair competition, such as in a game of chess. Grossmeister Gary Kasparov, along with the rest of the world, regarded IBM’s Big Blue robot as a serious gaming partner in a person–robot chess competition. Sophisticated artificial intellect requires an adequate vehicle. In 2003, Hugo de Garis developed an artificial brain with 37.7 million artificial neurons that will allow a robo-kitten designed by Michael Korkein to perform an animal-like intelligent behavior based on retrieving sensory experience from the different parts of the environment.

2.2. Modeling Emotions

The idea of modeling intellectual functions of the human mind has existed throughout the history of robots. The reproduction of human emotions did not attract investors’ attention as much as the built-in cognitive component of artificial creatures. Nevertheless, the new millennium was marked by the paradigmatic shift in robot design from mechanocentric to human-oriented

TABLE 1
Classification of Artificial Creatures in Robotic Psychology

	<i>Human need</i>	<i>Behavioral configuration</i>	<i>Physical appearance</i>
Industrial robots	Perform hard labor and hazardous work		
Research robots	Provide extension of human sensorimotor capacities	Defined by a situated activity that substitutes for human behavior	Machine-like appearance with emphasis on peripheral devices
Military and rescue robots	Activity in life-threatening situations		
Medical robots	Performance of fine motor operations on the human body		
Recreational robots	Trigger positive behaviors through entertainment	Aimed at human feelings and emotions	Animated form of existing and non existing beings or objects
Interactive stimulation robots			
Social robots	Communication	Based on human facial expressions and complex gestures with social meaning	Anthropomorphized (humanoid) appearance
Robots with therapeutic potential	Therapy and treatment of negative emotional states and behaviors	Models basic emotional states and social behaviors embodied in lifelike form	Animal-like or human-like appearance

principles, which transform the very purpose of artificial creatures' existence, their architecture, and their physical appearance.

A new concept of an artificial emotional creature proposed an original lifelike design and behavioral configuration relevant for natural human communication. The robotic cats Tama, designed in 1998 by Toshihiro Tashima, and NeCoRo, created by Takanori Shibata and colleagues, employ fuzzy logic in the organization of AI, which makes the robotic creatures' behavior "unpredictably" engaging and emotionally attractive for humans. A distinct feature of emotional robot pets is the use of tactile sensors covered with "skin," a synthetic fur. The combination of lifelike behavior and tactile stimulation creates an appeal that is missing in many other robotic models. In 2002, Libin and colleagues studied the influence of past experiences with real animals and technology on a person's emotional communication with a robotic creature, the Omron Corporation's robotic cat NeCoRo. The intensity and direction of emotional responses triggered in a human partner by the robot were

associated with the human's relevant past experiences. People perceived the robots as part of their living world.

2.3. Modeling Social Behavior

Regardless of shape (human or animal), the robot's most difficult task is to model people's social behavior with such cues as eye contact, gestures, and emotional answers recognizable in the social context. Social robots model the natural process of communication and are able to learn through social interactions. Braezeal and colleagues applied a developmental psychology approach to the design of the autonomous robot Kismet, build at the MIT media lab in 1998. The learning processes of robots are similar to those of children and are described by Lev Vygotsky's concept of the proximity zone; that is, the complexity of the stimuli increases when a learning agent reaches a certain level of competency in performing the task. In the robot's process of social learning, this condition is achieved by maintaining a level of interactivity that is neither overwhelming nor understimulating.

2.4. Modeling Teaching Behavior

During the education and learning process, both the levels of robo-IQ or communicational ability and the robot's anthropomorphic characteristics are important. Children ages 3–5 years are more motivated to learn from a personified mobile robot with a smiling face and verbal positive reinforcement than from an immobile and nonverbal machine-like device.

Analysis of children's needs and preferences resulted in the creation of a realistic robotic doll called My Real Baby, which enhances a child's communication experience via 15 human-like emotions of different intensity: facial expressiveness, soft and flexible skin, and a rich vocabulary of sounds and words. This doll, which is in the class of interactive stimulation robots, allows a child to develop educational interactive play experiences triggered by his or her imagination and creativity through natural responses expressed in emotionally appropriate ways.

A variety of humanoid robots, such as Kismet and Cog, Doc Beardsley and Nursebot, and AMI and PINO, are able to provide warmth and friendliness for their human partners. Another option considers animals, especially pets, as prototypes for the robotic creature design. Among the most interesting examples are the robot seal Paro and horse Karakuri, dog AIBO and cat NeCoRo, and robo-puppy Techno and robo-kitten Robokonenko. Robotic pets' resemblance to real animals and associated human experience allowed Peter Kahn and colleagues in 2002 to study the influence of communication with robotic dog AIBO on children's cognitive, social, and moral developmental processes. Children's conceptualization of the robotic creatures' behavior was similar to their perception and reasoning based on experience with real pets.

3. COMPANIONSHIP BETWEEN PEOPLE AND ROBOTS

A core aspect of the concept of companionship between people and robots is their compatibility. Compatibility in the robotic psychology context depends on how humans perceive their robotic companions and how they feel about them emotionally. In a study conducted by the Sakamoto Laboratory of Ochanomizu University in collaboration with the NEC company, three robotic creatures—dog AIBO and humanoids ASIMO and PaPeRo—were compared with each other as well as with animals, humans, and inanimate objects. People's

perceptions of the robots differed from their perceptions of animals, other humans, and inanimate objects. The appearance and shape of the robots influenced the level of comfort people experience around technological devices, especially robotic creatures.

In 2002, Libin, Libin, and colleagues performed a cross-cultural study of the United States and Japan that investigated biological, psychological, and cultural determinants of people's communication with the robotic cat NeCoRo. A culture was defined as a system of created social meanings and artifacts that have symbolic value and reflect the logic of human mentality derived from norms shared by a given community. A specially designed scale evaluated verbal and nonverbal, emotional, and tactile-kinesthetic patterns of communication. For age and gender, preferences regarding the robot's features and interactive patterns were similar in both cultures. Older people liked the robotic pet more, whereas men enjoyed the cat's triggering behavior more than women. The influence of a person's past experiences with live pets and modern technology on the type of person-robot communication was universal. Differences between cultures were found for the participant's evaluation of the robotic creature's appearance and character and the intensity of tactile interactions.

Robotic psychology research incorporates the elements of training, education, entertainment, and therapy into the person-robot communicative process, which leads to the development of an enhanced constructive model of interactive technology.

See Also the Following Articles

Emotion ■ Learning ■ Robotherapy ■ Social Skills Training ■ Teaching Effectiveness

Further Reading

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