Ashley Donnelly

Professor Reynolds

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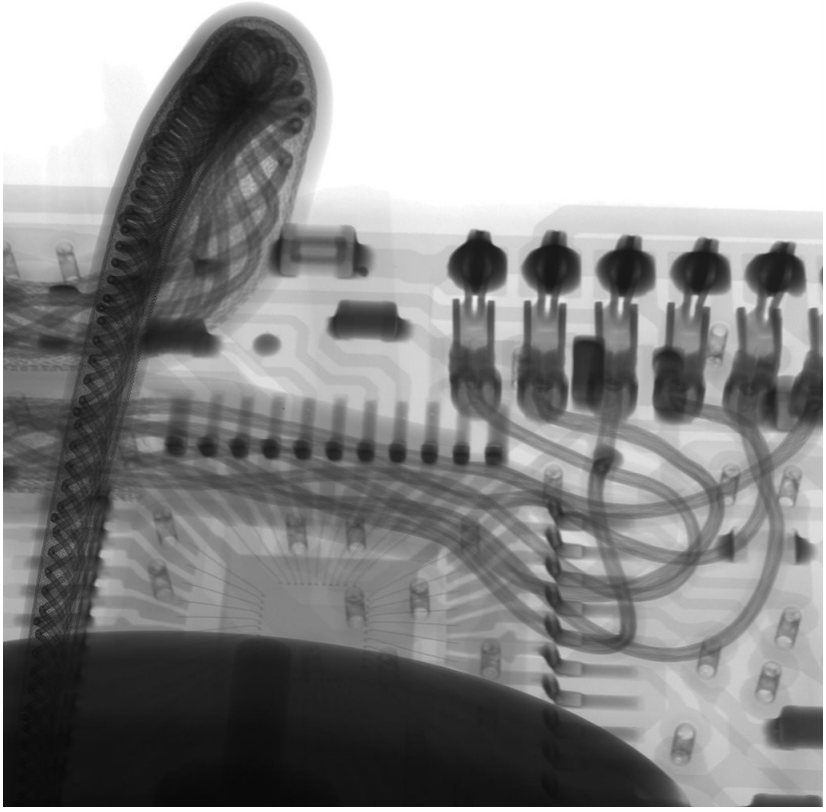
Sensorimotor Experience and Artificial Intelligence



While human consciousness develops, a child creates memories through sensorimotor experience. All memories are sensory experiences which guide our physical reflexes and emotional reactions (Rockets). Emotion is felt through physical changes in the body, either through external stimuli or neural pathways, which also leads to self-awareness (Damasio and Lenzen). Researchers are in the midst of creating a robot which can develop knowledge the way a human does- through the compilation of first-hand experiences (Rockets). Through the use of highly sensitive skin-like materials, as well as sensors which imitate vision and hearing, a robot may be able to sense the world

almost as humans do (Bergeron). When an artificial intelligence entity or robot “feels” physical and emotional sensations, could these sensations lead to self-awareness and consciousness?

Steve Grand, a forerunner in experience-based AI research, believes that most AI has been developed incorrectly and that the correct model should be based on human development rather than the input of data-based “knowledge” (Rockets). When a person is born they can physically feel their limbs moving about. They can also see their arms moving and hear their own cries. This helps them begin to feel a sense of presence and awareness of the self. The child then begins to understand that the world is separate from themselves and that others have the same individuality. Physical awareness of the body is necessary in order to reach these conclusions is the key to developing consciousness. Grand believes that “everything we do as an adult is built upon those sensorimotor foundations and it seems to me that you can't shortcut the process” (Rockets).

According to neurobiologist Antonio R. Damasio, “feelings arise as the brain interprets emotions, which are themselves purely physical signals of the body reacting to external stimuli” (Damasio and Lenzen). Damasio differentiates feelings from emotions. For example, when we are afraid it automatically causes physical changes in the body, such as increased heart rate. This automatic reaction is a physically manifested emotion and cannot be controlled. After the automatic emotion of fear is felt, the mind has time to become aware of and fully experience the emotion as feeling (Damasio and Lenzen).

Of course, not all feelings come from external stimuli; the feeling of sympathy, for example, happens when the brain recreates some of the pain of another. Damasio argues that feelings such as sympathy, guilt and pride are the foundations of human intelligence and morality; these feelings guide our actions and define our sense of self. Damasio also states that the body and mind, though related, are actually two distinct aspects of biological processes with their own purpose and expression; “feelings are not just the shady side of reason but that they helps us to reach decisions as well” (Damasio and

Lenzen). Every action we complete has its roots (as well as its consequential expression) in the physical feeling of an emotion or the memory of the physical feeling of an emotion. Once created in AI, however, could these feelings be controlled or would they have to develop independently?

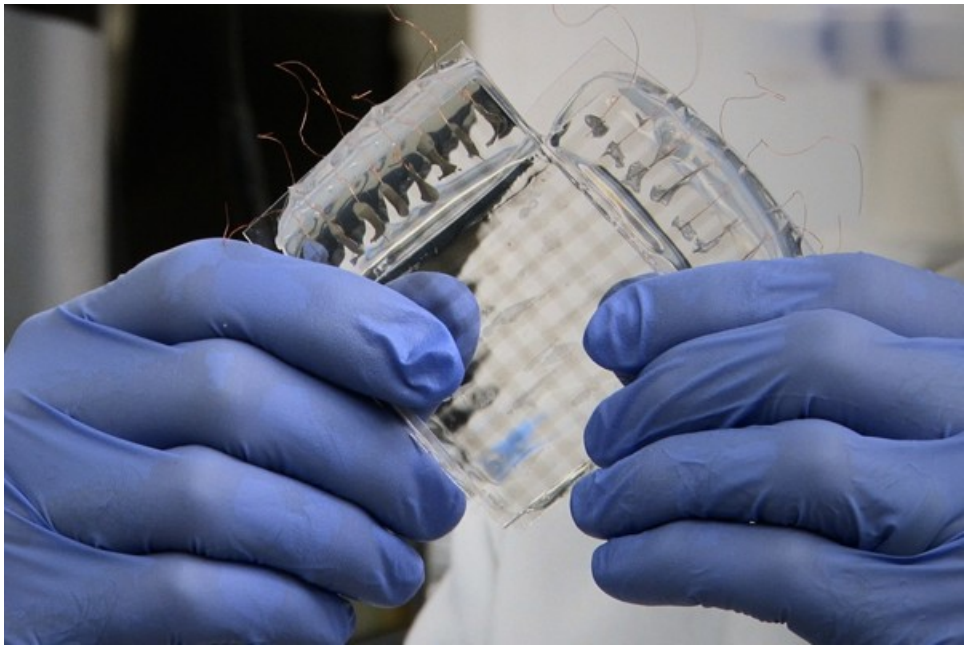
In 2006, researchers at the Laboratory for Integrated Advanced Robotics at Italy's Genoa University (LIRA) created BabyBot. This small toddler-sized robot was designed to develop AI from the experience-based model. The researchers began by studying child development, including how

LIRA's BabyBot uses many senses to experience and learn (Rockets)

young children perceive and interact with their environment and other people. They discovered that an infant has no inherent knowledge and therefore learns through action, cognition and *then* perception. The LIRA team developed a process model of consciousness based on this discovery: “objects in the environment are not considered real until they have been perceived via the newly developed system” (Rockets). This is similar to when a child is burned for the first time. The child learned from experience and will store this memory as permanent caution towards whatever burned it. There mind will have an automatic reaction to such stimuli and their body will automatically react by pulling away to avoid the

physical pain. In the end, emotions are reflexes much as muscle movement is an automatic reaction to physical pain; reactions based on memories and previous experience (Rockets).

In 2011 Zhenan Bao, associate professor of chemical engineering at Stanford, and her team of researchers (including graduate students in both chemical and electrical engineering) built a thin stretchy material which, according to Bao, "can register pressure ranging from a pinch between your thumb and forefinger to twice the pressure exerted by an elephant standing on one foot" (Bergeron). This material is made up of three layers. The outer layers (positioned face-to-face) consist of nanotube-coated silicone and the inner layer is a slightly less stretchy type of silicone which stores electrical charge. Any pressure exerted on the material causes the inner layer to compress and alter the amount of electrical charge which it holds. The change in electrical charge is detected by the outer nanotube layers. These outer layers "act like the positive and negative terminals on a typical automobile or flashlight battery" (Bergeron).



Stanford engineers' stretchy nanotube-filled material (Bergeron)

The patterns of deformation differ when the material is stretched versus when pressure is applied. Stretching will create a pattern of pressure which goes in a straight line from stretching point to stretching point. If pressure is applied directly, the pattern resembles a circle which gradually decreases in pressure as you go from the center. This material is very durable and neither stretching nor pressure creates any permanent deformation. Bao also reports the creation of a less stretchy but much more sensitive sensor which can detect pressures “well below the pressure exerted by a 20 milligram bottlefly carcass” (Bergeron). The more sensitive type of sensor would be very useful on the fingertips and possibly face of a robot while the stretchier material would work well as the other areas of skin or even as muscle because this is similar to how a human senses its environment. The feeling of positive or negative physical feelings would be hard to instill in a robot, and pain could only be understood if the robot was aware that it was damaging itself and needed to stop the damage.

Why would these researchers choose to develop such innovative materials and concepts? Most are trying to assist the human race understand and helps itself. Steve Grand and the researchers at LIRA believe that creating AI at this stage in its development will mainly only help us understand human consciousness, which of course furthers the understanding of AI in the long run. Antonio Damasio believes that studying how consciousness develops will help those with brain injuries which cause abnormal reactions to external stimuli and neural systems. The researchers at Stanford believe that their material can be used in a variety of applications, including computer touch screens, touch-sensitive prosthetic limbs, human-like robots and pressure-sensitive bandages or other medical devices. In the end, any developments in AI ultimately end up helping our current understanding of human senses and consciousness.

Although the connection between artificial intelligence, consciousness and physical perception hasn't been proven, it has very strong believers from many fields including engineering, developmental psychology and neurobiology. The researchers involved with artificial intelligence are still working on

simple AI, such as getting AI robots to recognize objects quickly and also to differentiate them from complex backgrounds. This technology still hasn't passed out of the first stages of controlled environments into uncontrolled real-life environments. It may be a long time until both the software and hardware of AI robots can be effectively sent into the world and and can successfully function alone. However, the understanding of human development and consciousness is increasing only slightly faster than the technology which could help cultivate it. Having this understanding will lead to build-able and testable concepts. I do believe that someday all of these fields of science, including neurobiology, robotics and chemical engineering, will merge in a way that can successfully imitate practical intelligence and, possibly eventually, emotions.

Bibliography

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Rockets, R. (2006). "Bringing Up BabyBot." <http://www.scienceagogo.com/news/babybot.shtml>

1. This assignment gave me insight on the importance of senses and perception to consciousness, be it human or AI. It also showed me that while our hypotheses and ideas about consciousness may be very advanced, it is difficult to even study it, let alone to recreate it.
2. This assignment challenged my assumptions that creating sensitive and thin skin-like materials was even possible. The technology that is being created constantly is quite impressive. Although, such technology is one thing when compared to the technology we would need in order to create an imitation of human consciousness and intelligence.