of gene–gene and gene–environment interactions, which make the prediction of genetic diseases, much less behavioural traits, extremely complex. The authors provide convincing arguments against genetic reductionism. In addition, they point out the limits of justifying prenatal diagnosis as a matter of "choice", when there are still so many constraints on choice. Certainly, women deciding whether to be tested for diseases in pregnancy, and whether to terminate, should be given objective, unbiased information about living with a disability and raising a child with a disability. Their decisions should not be determined by a failure of society to provide the required resources. Nevertheless, even in an ideal society with bountiful resources, some couples and women will want to be tested and will opt for abortion to avoid having a child with a disability.

Kerr and Shakespeare argue that prenatal testing for disability leads to prejudice against, and a decrease in services for, disabled people. However, they provide no empirical evidence for this claim, and indeed the reverse seems to be true. In the United States, disability-rights legislation, such as the Americans with Disabilities Act, has coincided with a rise in prenatal testing. There is no reason why society cannot prevent disability by a variety of means, including selective abortion, while also providing for the needs of those who are disabled. ■

Bonnie Steinbock is in the Department of Philosophy, University at Albany/State University of New York, Albany, New York 12222, USA.

Science in culture

A mechanical mind

Wolfgang von Kempelen's chess-playing automaton of 1770.

Martin Kemp

The possibility of creating a 'human machine', or more precisely a computer-driven device that exhibits independent 'consciousness', is one of the biggest remaining challenges for science. Although we tend to assume that the concept was first debated with the advent of computers — perhaps with a backward glance towards such pioneering devices as Charles Babbage's 'Analytical Engine' — automata in fact have a history spanning centuries.

The terms of the debate had been framed as early as 1637, when René Descartes speculated in his *Discourse on Method* that: "If there were such machines with the organs and shape of monkeys or of some other non-rational animal, we would have no way of discovering that they were not the same as these animals. But if there were machines that resembled our bodies and if they imitated our actions as much as is morally possible, we would always have two very certain ways for recognizing that, nonetheless, they are not genuinely human. The first is that they would never be able to use speech… The second way is that … one would discover that they did not act on the basis of knowledge, but merely as a result of the disposition of their organs."

The making of astonishingly sophisticated automata in the eighteenth century brought Descartes' model closer to realization. Most notable were Jacques de Vaucanson's renowned devices, such as a duck that actively pecked grain, digesting it in a chemical stomach before egesting the results. They found their philosophical equivalent in Julien Offroy de La Mettrie's scandalously godless tract *L'Homme-machine* in 1747, which undermined Descartes' confidence in the separateness of humankind.

A practical answer to the objection that a machine could never be flexibly responsive seemed to be provided by the famed chess-playing automaton by Wolfgang von Kempelen, immortalized by Carl Gottlieb von Windisch in his 1784 book *Inanimate Reason; or A Circumstantial Account of that Astonishing Piece of Mechanism, M. de Kempelen's Chess Player*.

A Hungarian nobleman and prominent state official in Vienna, von Kempelen's interests ranged from philosophy to large-scale engineering. In 1770 he stunned Maria Theresa's court by unveiling his life-sized chess-player. Dressed in exotic Turkish garb, the robot sat behind a cabinet of machinery, which the presenter displayed by opening its doors.

The Turk — which perished in a fire in Philadelphia in 1854 — confounded spectators, defeating accomplished players, including Benjamin Franklin, and even becoming testy when opponents cheated. When he performed in Paris, one observer claimed that the device "is to the mind and eyes what M. Vaucanson's flute player is to the ear", a reference to the musical automaton that Vaucanson presented to the French academy in 1738.

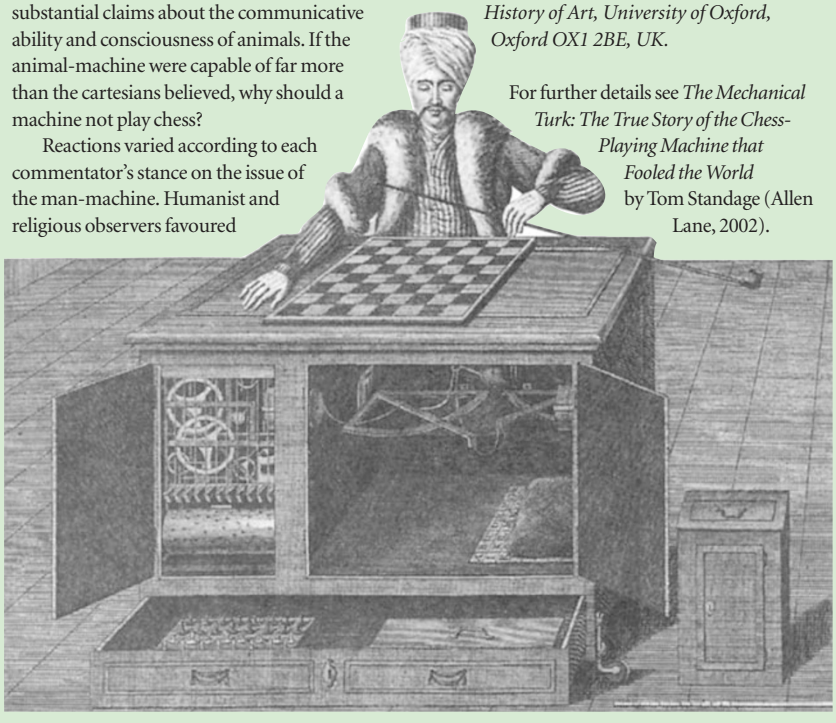
The context went far beyond mere entertainment. In *The Mechanism of Speech in the Light of the Description of a Speaking Machine* (1791), von Kempelen made substantial claims about the communicative ability and consciousness of animals. If the animal-machine were capable of far more than the cartesians believed, why should a machine not play chess?

Reactions varied according to each commentator's stance on the issue of the man-machine. Humanist and religious observers favoured theories that a living player must somehow be concealed inside the cabinet. Those disposed to believe in the potential of machines and animals for performing elaborate mental tasks were prepared to credit the chess player with intelligence. Amongst those captivated by the machine's implications were Babbage and Edgar Allan Poe.

How did it work? Johann Maelzel, who restored the Turk after von Kempelen's death in 1804 and took it on tour, openly acknowledged that the Turk relied on a magician's skills, akin to those at work in the illusion of the lady sawn in half. The secret lay in the cramped repositioning of a hidden player as the cabinet's doors were opened in strict sequence. Although mechanically ingenious, it relied upon trickery. A chess-playing machine is, of course, now a formidable reality. It remains to be seen whether the bigger trick of a human machine can be performed for real.

Martin Kemp is in the Department of the History of Art, University of Oxford, Oxford OX1 2BE, UK.

For further details see *The Mechanical Turk: The True Story of the Chess-Playing Machine that Fooled the World* by Tom Standage (Allen Lane, 2002).



'The Chess-Playing Turk' from Carl Gottlieb von Windisch's 1784 book *Inanimate Reason*.