dug up in different phases of the £430 million project to extract ilmenite, a mineral which can be used to produce titanium dioxide pigment. Around 750,000 tonnes of the ore will be extracted each year at the start of the operation, which could last 40 years.

The huge economic growth of China has led to an enormous demand for the white pigment, which is used in paper, paint and plastics, at a time when other ilmenite mines in Australia and South Africa are being exhausted.

Tony Juniper, head of Friends of the Earth in the UK said: "This is a very sad day and very bad news for the people of Madagascar. Rio Tinto is exploiting natural resources in the developing world and, once again, it is the local people who will pay the price."

Rio Tinto, highly sensitive to conservation criticisms, set up an independent biodiversity committee in order to assess any likely damage and to see how much could be avoided or minimised. As a result, the company decided to set aside a conservation area on land that it was previously going to mine, so that some of the plants and other species could be protected. It also worked with experts from Kew Gardens in London to preserve the seeds from threatened plants.

Amongst the gloom surrounding mining and other developments, there is some hope that new projects will help people process food products grown on the island into quality products for the world market. A British company has helped set up Malagasy, a company that sells and markets finished chocolate bars and, in due course, coffee, herbal teas, honey, nuts and spices under a system known as Equitrade. Neil Kinsall, Malagasy's marketing director says: "All it would take to end poverty in Madagascar is £750 million a year."

New trading arrangements are seen as a major opportunity to meet this goal and many believe the alleviation of local human poverty is one of the best chances for the future survival of the island's extraordinary biodiversity.

Quick guide

Theory of mind

Chris Frith and Uta Frith

What is 'theory of mind'? Maxi eats half his chocolate bar and puts the rest away in the kitchen cupboard. Then he goes out to play in the sun. Meanwhile Maxi's mother comes into the kitchen, opens the cupboard and sees the chocolate bar. She puts it in the fridge. When Maxi comes back into the kitchen, where will he look for his chocolate bar? The answer to this question will seem obvious. First, Maxi doesn't know that his mother has moved the chocolate. Second, Maxi still believes, falsely, that his chocolate is in the cupboard. That is why he looks in the cupboard. If this is how you answered the question then you have a 'theory of mind'. We naturally explain people's behavior on the basis of their minds: their knowledge, their beliefs and their desires, and we know that when there is a conflict between belief and reality it is the persons' belief, not the reality that will determine their behavior. Explaining behavior in this way is called 'having a theory of mind' or 'having an intentional stance.'

What is the advantage of having a theory of mind? Through having a theory of mind we can recognize that another person's knowledge is different from our own. I know what's behind the rock, but he doesn't, because, from where he is, he cannot see that there is a scorpion. Having a theory of mind allows us to manipulate other people's behavior by manipulating their beliefs. If he is my friend I can warn him about the scorpion. If he is my enemy I can tell him it is safe. This latter is called tactical deception or Machiavellianism. Human interactions predominantly involve the dissemination of true or false knowledge for good or for ill.

Who has a theory of mind? Up to the age of about five years, a

Where will Maxi look for his chocolate? (From the collection of Uta Frith.)

child told the story of Maxi and his mother will say confidently that Maxi will look for his chocolate in the fridge. It is as if they assumed that what they know to be true everyone else knows too. Nevertheless, even three-year-olds look first at the cupboard when the question is asked, and even 15-month-olds can be shown to have an inkling of what is going on; their eye gaze pattern shows that they are surprised if Maxi looks in the fridge. But only from age five or so do children show full understanding of the situation and become able to explain exactly why Maxi has a false belief.

Children with autism have a specific problem with theory of mind tasks. They expect Maxi to look for his chocolate in the fridge. They reach a mental age of about 10 years before they achieve an understanding of the Maxi task. More complex problems that involve white lies or double bluff take them even longer to learn, and they may never grasp them fully. Theory of mind difficulties can also be acquired through brain damage in frontal cortex or in the region of the temporo-parietal junction.

From field studies there are accounts of a range of animals using tactical deception. But there is still argument over whether even chimpanzees show evidence of this in controlled experiments. The current view is that chimpanzees may have a rudimentary theory of mind, but monkeys (and other animals) probably do not.

What is so important about deception and false belief in the study of theory of mind? Having a theory of mind enables many important human interactions other than deception, in particular teaching. But deception is important in the study of theory of mind because of its association with false beliefs. If Maxi's belief about his chocolate were true — it was still in the cupboard — then you can correctly report where Maxi will look either by basing this prediction on what Maxi believes (because you have a theory of mind) or by basing this prediction on where the chocolate really is (not requiring having a theory of mind). Thus, when successfully solving false belief tasks, where there is a conflict between the false belief and the true state of affairs, we can deduce that theory of mind is engaged.

How is theory of mind possible? In order to explain people's behavior on the basis of their minds, we need to have some idea of what is in their minds. The ability to acquire knowledge about other peoples' beliefs and desires is called 'mentalizing' or 'mind reading'. Our understanding of the mechanisms underlying this ability remains rudimentary. In everyday speech we frequently explain behavior in terms of mental states. Maxi will look in the cupboard because that's where he *believes* his chocolate is and because he *wants* to eat it. Maxi *doesn't know* the chocolate is in the fridge. These everyday explanations of behavior in terms of mental states are referred to as folk psychology. Perhaps our ability to mentalize depends upon representations within the brain of the propositions that make up this theory of behavior (referred to as theory theory). On the other hand, perhaps the ability to mentalize is related to our capacity to empathize with other people: to put ourselves into their shoes (this is referred to as simulation theory).

An influential view is that mentalizing crucially depends on the ability to form meta-representations, that is, representations that are decoupled from reality. Thus the truth of the statement, 'Maxi believes his chocolate is in the cupboard' does not depend upon where the chocolate is in reality. A possible starting point for developing a mechanistic account of mentalizing comes from the problem of perspective taking. The computation of what another person sees from a different point of view than yours involves translation between egocentric and allocentric spatial co-ordinates. This translation is also fundamental in spatial navigation. It is perhaps no coincidence that in young children the ability to solve spatial viewpoint problems emerges at about the same age as the ability to solve false belief tasks.

What is the neural basis of mind reading? There is currently much interest in identifying a social brain: a circumscribed network of brain regions specialized for the social domain. Mentalizing is one of a number of problems confronting this social brain. When brain activity is measured during the performance of a wide range of tasks engaging theory of mind, two regions have been consistently identified: a medial prefrontal region (paracingulate cortex) and the temporo-parietal junction in the superior temporal sulcus.

The medial frontal region is also engaged when subjects reflect upon their own mental states, as well as those of others with the more inferior orbital region responding especially to emotional states. The temporo-parietal junction, on the other hand, seems to have a special role in using perceptual cues to recognize the actions and intentions of biological agents. Identification of the precise role of these regions awaits the development of a mechanistic account of our remarkable ability to make inferences about the minds of others.

Where can I find out more?

Frith, C.D., and Wolpert, D.M. (Eds). The Neuroscience of Social Interaction: Decoding, imitating and influencing the actions of others. Oxford: Oxford University Press.

Nichols, S., and Stich, S. (2003). *Mindreading*. Oxford: Oxford University Press.

Flavell, J.H. (1999). Cognitive development: children's knowledge about the mind. Annu. Rev. Psychol. *50*, 21–45.

Tomasello, M., Call, J., and Hare, B. (2003). Chimpanzees understand psychological states - the question is which ones and to what extent. Trends Cogn. Sci. *7*, 153–156.

Functional Imaging Laboratory and Institute of Cognitive Neuroscience, University College London, London, UK.