

Alley Cats & Sex Kittens

Cats transmit one of the most common human parasite infections in the world, affecting our sexual attractiveness, IQ, and the likelihood of developing schizophrenia or being in a car accident. Nicky Boulter reports.

Have you or a close friend been acting unusually lately? Has your teenage daughter suddenly become more outgoing or your son become insular and withdrawn?

Don't assume that drugs are to blame – it may be the unconscious effect of a mind-altering parasite. This may sound like something from *The X-Files*, but recent research is providing growing evidence that *Toxoplasma gondii*, a relative of the malaria parasite, is affecting the way we think and behave.

Approximately 40% of the world's human population is infected with *Toxoplasma*, which translates to about 2.5 billion people, eight million of which live in Australia. The majority of infected people are completely unaware of the parasite's presence, which makes this a very successful, but potentially dangerous, beast.

Infection generally happens by accidentally eating oocysts (the parasite's equivalent of eggs) excreted in the faeces of an infected cat (see *Parasite Precautions*) or, most commonly, by ingesting cysts containing the parasites in raw or undercooked meat.

Toxoplasma infection, or toxoplasmosis, has long been known to be

serious if acquired during pregnancy, where it can cause abortion, stillbirth or severe disabilities in the unborn and newborn child, such as hydrocephalus (enlarged head), mental retardation and blindness. More recently, with diseases such as AIDS becoming more prevalent, toxoplasmosis has also been shown to cause very severe disease in immunocompromised people. In these individuals, whose own immune system is weakened, the parasite is able to replicate uncontrollably and can result in pneumonia or encephalitis (swelling of the brain), which may be fatal.

In people with adequate immune responses, the parasite is controlled and is forced to live in cysts, predominantly in the brain and muscle, where it is protected from being killed. Occasionally, healthy people get mild flu-like symptoms or eye damage when they become infected, but more often than not there are no symptoms at all: the parasite simply goes to ground in its cysts and stays there for the rest of your life. There is no cure for this parasite and no safe, effective treatments for the cyst stage.

Toxoplasmosis was traditionally thought of as an insignificant disease in

Parasite Precautions

You may come into contact with oocysts while cleaning out litter trays, eating unwashed vegetables or gardening in areas where cats have defecated. What can you do to reduce exposure to *Toxoplasma*?

You do not need to get rid of your cat! Although cats are the only animals known to excrete oocysts of *Toxoplasma* into the environment, they can only become infected once in their lives and will shed oocysts in their faeces for approximately 2 weeks only.

The oocysts, however, can survive in the environment for long periods of time, but there are some sensible precautions you can take. It is very important to establish good hygiene practices such as washing your hands thoroughly after gardening or cleaning the litter tray or, better still, wearing disposable gloves.

Be particularly careful if you are immunosuppressed, pregnant or planning to become pregnant. Cats love sandpits too, and are more than happy to use them as toilets, so cover sandpits when they are not in use. Thoroughly wash vegetables destined to be eaten raw, especially if home-grown.

Finally, but probably most importantly, always cook meat thoroughly to avoid ingesting live parasites.

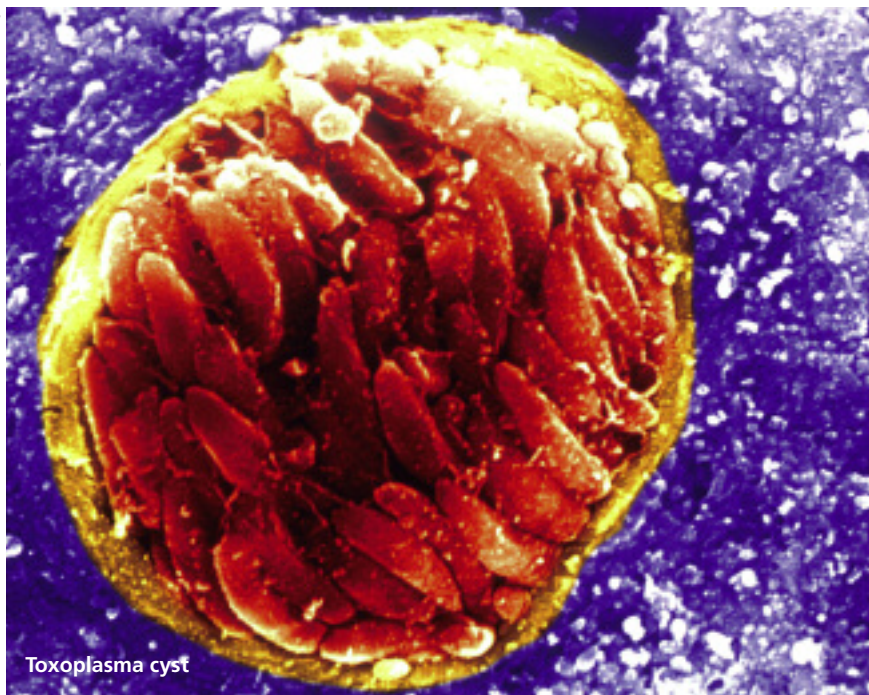


ISSUES

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NUCLEAR ENERGY

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Toxoplasma cyst

healthy people until Jaroslav Flegr and colleagues from Charles University in the Czech Republic showed that *Toxoplasma* has mind-altering capabilities.

Interestingly, the effect of infection is different between men and women. Infected men have lower IQs, achieve a lower level of education and have shorter attention spans. They are also more likely to break rules and take risks, be more independent, more anti-social, suspicious, jealous and morose, and are deemed to be less attractive to women.

On the other hand, infected women tend to be more outgoing, friendly, more promiscuous, and are considered more attractive to men compared with non-infected controls.

In short, it can make men behave like

“alley cats” and women behave like “sex kittens”! These results are intriguing but are not fully conclusive, and further studies need to be undertaken to definitively prove whether toxoplasmosis affects human behaviour.

However, there is fairly conclusive evidence that the altered behaviour of rodents infected with *Toxoplasma* makes these animals more likely to be predated upon by a cat and thus facilitates completion of the parasite’s life cycle (see *Risk-taking Rodents*).

Why the parasite should cause similar behavioural changes in humans is not known. These changes are unlikely to result in predation of a human by a cat and the completion of the life cycle. It may just be an evolutionary hang-up

carried over from the parasite’s adaptation to the rodent host, or another as-yet unknown reason.

Perhaps more frightening is the statistic that people with latent toxoplasmosis are 2.7 times more likely to be involved in a car accident, either as the driver of the vehicle or as a pedestrian, compared with uninfected controls. In a conclusive study undertaken by Flegr, 146 people involved in car crashes and 446 people living in the same neighbourhood were examined for the presence of *Toxoplasma*. It was clearly shown that infected individuals have slower reaction times and shorter attention spans than non-infected controls, and this probably contributed to the higher incidence of involvement in road traffic accidents.

The French are notorious for their bad driving and high accident rates, and it just so happens that the incidence of toxoplasmosis in France is very high (~85%) due to their habit of eating rare or raw meat – a coincidence or further proof?

Another link between the parasite’s habitation in our brains and their effect on us is the link between *Toxoplasma* and schizophrenia. Fuller Torrey from Stanley Medical Research Institute in Maryland demonstrated a very strong association between the level of *Toxoplasma* infection and the incidence of schizophrenia and other neurological diseases.

Cases of psychiatric complications such as disorientation, anxiety, depression and psychoses are well-recognised



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DISEASES

After antibiotics were introduced and smallpox eliminated, many people thought that infectious diseases would soon be a thing of the past. AIDS long ago broke that confidence, and with the threat of an avian flu pandemic hanging over us **Issues 75** explores the diseases that are becoming more common and those that are threatening. See page 7 for subscription details or order your copy of this edition at issues.com.au

among immunosuppressed people with toxoplasmosis, but until recently these symptoms had not been identified in infected immunocompetent people or not linked with *Toxoplasma* infection. Torrey analysed serum samples obtained from mothers shortly before or after birth. The results revealed that children born to mothers who acquired toxoplasmosis during pregnancy had a significantly higher chance of developing schizophrenia in later life. In addition, individuals suffering from a first episode of schizophrenia have significantly elevated levels of *Toxoplasma* antibodies compared with uninfected controls.

"...people with latent toxoplasmosis are 2.7 times more likely to be involved in a car accident, either as the driver of the vehicle or as a pedestrian, compared with uninfected controls".

Studies have shown that people who develop schizophrenia are much more likely to have owned a cat during childhood, and it has long been known that people born in spring had a higher probability of developing schizophrenia. One current hypothesis to explain this is that cats are more likely to spend time indoors during winter and to use their litter trays, which may then be the route of infection to the mother at a critical time during her pregnancy.

It's not all doom and gloom, however. Torrey noticed that schizophrenia patients treated with common anti-psychotic or mood-stabilising drugs have lower levels of *Toxoplasma* antibodies, indicating a lower level of infection, than untreated, infected schizophrenic patients. Subsequently, these drugs have been shown to inhibit the growth and replication of the parasite. Infected rodents treated with anti-psychotic drugs exhibit a reversal in their predator-risk behavioural traits (see box) so that the rodents behaved more like uninfected animals and were less likely to be eaten by a cat.

Interestingly, both schizophrenia and

toxoplasmosis are diseases characterised by elevated levels of the neurotransmitter dopamine in the brain. Dopamine is known to affect behaviour, and a large number of effective anti-psychotic drugs, such as Haloperidol, are dopamine antagonists that work by reducing the ability of dopamine receptors in the brain to take up dopamine.

These dopamine antagonists are also the most effective drugs in killing *Toxoplasma*. Some researchers have even postulated that these anti-psychotic drugs work as well as they do for schizophrenia because they are actually able to inhibit the growth of this parasite.

Although there appears to be an association between toxoplasmosis and the development of schizophrenia or other neurological disorders, infection with this parasite is unlikely to be the only reason that an individual will develop schizophrenia. There are known genetic, social and environmental factors involved, and infections with other microorganisms, such as cytomegalovirus and human herpes virus, have also been implicated in the onset of schizophrenia.

However, the increasing body of evidence connecting *Toxoplasma* infection with changes in personality and mental state, combined with the extremely high incidence of human infection in both developing and developed countries, warrants increased government funding and research, in particular to find safe and effective treatments or vaccines. It seems likely that this is no longer a disease of significance only in pregnant women and the immunocompromised.

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Risk-taking Rodents

Any warm-blooded animal or bird can become infected with *Toxoplasma*. Rodents may become infected with *Toxoplasma* from soil containing infected oocysts from cat faeces or from eating infected carrion.

In order to survive, rodents have an innate fear of cats. Usually, wild rats and mice are fairly shy creatures, and make themselves scarce when they catch the scent of a nearby cat. However, Joanne Webster of Oxford University has shown that rodents infected with *Toxoplasma* have altered behaviour that makes them more likely to be predated upon by a cat.

Webster compared the reactions of infected and uninfected rodents when placed in a pen with four nest boxes at the corners, each laced with a different odour: neutral, the rat's own odour, rabbit urine or cat urine. As expected, uninfected animals spent most of their time safely hidden inside the nest box, preferably in the corner with their own smell, and they stayed well away from the corner that smelt of cats.

However, infected animals had a marked preference for inhabiting the area with cat scent and would spend long periods of time there. Furthermore, the infected animals were more active and spent large amounts of time in the open grooming themselves, without showing any signs of anxiety.

All these behaviours increase the risk of predation by cats whereas other irrelevant behaviours, such as mating or social status behaviours, were not altered. The parasite is thought to directly alter the rodent's behaviour to enable it to get back to the cat and complete its life cycle. (The cat is the only animal in which the sexual stage of the life cycle can occur.)

Interestingly, rodents treated with drugs that kill the parasite reversed their behaviour, becoming more like uninfected animals and less likely to be predated upon.