

*Op-Ed*

# ***How Electromagnetically-Induced Cell Leakage May Cause Autism***

**- Andrew Goldsworthy, PhD**

**“There has been a 60-fold increase in ASD in recent years.”**

## **What is autism?**

Autism is in fact a group of life-long disorders (autistic spectrum disorders or ASD) caused by brain malfunctions and is associated with subtle changes in brain anatomy (see Amaral *et al.* 2008 for a review). The core symptoms are an inability to communicate adequately with others and include abnormal social behavior, poor verbal and non-verbal communication, unusual and restricted interests, and persistent repetitive behavior. There are also non-core symptoms, such as an increased risk of epileptic seizures, anxiety and mood disorders. ASD has a strong genetic component, occurs predominantly in males and tends to run in families.

## **Genetic ASD may be caused by calcium entering neurons**

It has been hypothesized that some genetic forms of ASD can be accounted for by known mutations in the genes for ion channels that result in an increased background concentration of calcium in neurons. This would be expected to lead to neuronal hyperactivity, the formation of sometimes unnecessary and inappropriate synapses, which in turn can lead to ASD (Krey and Dolmetsch 2007).

## **Electromagnetic fields let calcium into neurons too**

There has been a 60-fold increase in ASD in recent years, which cannot be accounted for by improvements in diagnostic methods and can only be explained by changes in the environment. This increase corresponds in time to the proliferation of mobile telecommunications, WiFi, and microwave ovens as well as extremely low frequency fields (ELF) from mains wiring and domestic appliances. We can now explain this in terms of electromagnetically-induced membrane leakage leading to brain hyperactivity and abnormal brain development.



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### **Non-ionizing radiation makes cell membranes leak**

The first effect of non-ionizing electromagnetic radiation is to generate small alternating voltages across the cell membranes, which destabilize them and make them leak. This can have all sorts of consequences as unwanted substances diffuse into and out of cells unhindered, and materials in different parts of the cell that are normally kept separate, become mixed.

### **Why weak fields are more damaging than strong ones**

We have known since the work of Suzanne Bawin and her co-workers (Bawin *et al.* 1975) that modulated radio-frequency electromagnetic radiation that is far too weak to cause significant heating can nevertheless remove calcium ions (positively charged calcium atoms) from cell membranes in the brain. Later, Carl Blackman showed that this also occurs with extremely low frequency electromagnetic radiation (ELF) but only within one or more “*amplitude windows*”, above and below which there is little or no effect (Blackman *et al.* 1982; Blackman 1990). A proposed molecular mechanism for this can be found in Goldsworthy (2010). In particular, it explains why weak electromagnetic fields can have a greater effect than strong ones and why prolonged exposure to weak fields (where cells are maintained in the unstable condition for longer) is potentially more damaging than relatively brief exposure to much stronger ones.

### **How calcium ions stabilize cell membranes**

This loss of calcium is important because calcium ions bind to and stabilize the negatively charged membranes of living cells. They sit between the negatively charged components of the cell membrane and bind them together rather like mortar binds together the bricks in a wall. Loss of just some of these calcium ions destabilize the membrane and make it more inclined to leak, which can have serious metabolic consequences. Among these are the effects of membrane leakage on the neurons of the brain.

### **How membrane leakage affects neurons**

Neurons transmit information between one another in the form of chemical neurotransmitters that pass across the synapses where they make contact. However, the release of these is normally triggered by a brief pulse of calcium entering the cell. If the membrane is leaky due to electromagnetic exposure, it will already have a high internal calcium concentration as calcium leaks in from the much higher concentration outside. The effect of this is to put the cells into hair-trigger mode so that they are more likely to release neurotransmitters and the brain as a whole may become hyperactive (Beason and Semm 2002; Krey and Dolmetsch 2007, Volkow *et al.* 2011). This may not be a good thing since the brain may become overloaded leading to a loss of concentration and what we now call attention deficit hyperactive disorder (ADHD).

### How does this impact on autism?

Before and just after its birth, a child's brain is essentially a blank canvas, and it goes through an intense period of learning to become aware of the significance of all of its new sensory inputs, e.g. to recognize its mother's face, her expressions and eventually other people and their relationship to him/her (Hawley & Gunner 2000). During this process, the neurons in the brain make countless new connections, the patterns of which store what the child has learnt. However, after a matter of months, connections that are rarely used are pruned automatically (Huttenlocher & Dabholkar 1997) so that those that remain are hard-wired into the child's psyche. The production of too many and often spurious signals due to electromagnetic exposure during this period will generate frequent random connections, which will also not be pruned, even though they may not make sense. It may be significant that autistic children tend to have slightly larger heads, possibly to accommodate unpruned neurons (Hill & Frith 2003).

Because the pruning process in electromagnetically-exposed children may be more random, it could leave the child with a defective hard-wired mind-set for social interactions, which may then contribute to the various autistic spectrum disorders. These children are not necessarily unintelligent; they may even have more brain cells than the rest of us and some may actually be savants. They may just be held back from having a normal life by a deficiency in the dedicated hard-wired neural networks needed for efficient communication with others.

A useful homology might be in the socialization of dogs. If puppies do not meet and interact with other dogs within the first four months of their life (equivalent to about two human years), they too develop autistic behavior. They become withdrawn, afraid of other dogs and strangers, and are incapable of normal "pack" behavior. Once this four-month window has passed, the effect seems to be irreversible (just like autism). If this homology is correct, it suggests that experiments on dogs could hold the key to the investigation of autism and its possible links with electromagnetic exposure.

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Andrew Goldsworthy was born in 1939. After a conventional Grammar School education he obtained a First Class Honors Degree in Botany followed by a PhD for research into plant physiology and biochemistry at the University of Wales. He went on to lecture at Imperial College London, where he spent the rest of his career. He has had many teaching and research interests, ranging from the biochemistry of photorespiration to the biology of space flight. He retired in 2004 but remains as an honorary lecturer. He was also a scientific advisor to the European Space Agency and is currently a scientific advisor to several European charities concerned with the environment and electromagnetic fields, including the Bio Electromagnetic Research Initiative, the Radiation Research Trust, and Electrosensitivity-UK. He has always had a strong interest in how living organisms use internally-generated electric currents to control their growth and metabolism, and in their disruption by externally-applied currents and fields. In his retirement, he pieced together nuggets of information from a wide range of scientific journals and created simple layperson's explanations of how weak electromagnetic fields affect us all. The first of these can be found at <http://tinyurl.com/2nfujj>.

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