

## ONLY ONE CHANCE: HOW ENVIRONMENTAL POLLUTION IMPAIRS BRAIN DEVELOPMENT—AND HOW TO PROTECT THE BRAINS OF THE NEXT GENERATION

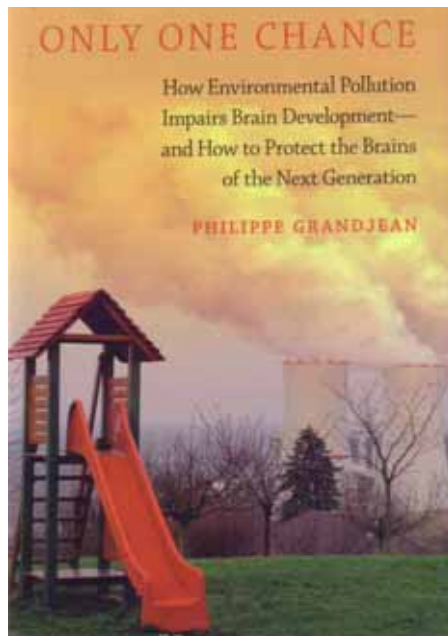
By Philippe Grandjean<sup>a</sup>

Reviewed by Bruce Spittle

**SUMMARY:** In *Only one chance: how environmental pollution impairs brain development—and how to protect the brains of the next generation*, Philippe Grandjean highlights the silent pandemic that is occurring as industrial chemicals disrupt brain development. He notes that we get only one chance to develop a brain and that damage to the developing brain of a fetus or child is likely to have lifelong effects. Along with listing 213 industrial chemicals, including fluoride, that are known to be able to reach the brain and cause brain toxicity, which he calls brain drainers, detailed examples are given of the effects of lead, mercury, arsenic, polychlorinated biphenyls (PCBs), and pesticides. The limitations of the placenta in protecting the fetus are discussed with examples including thalidomide, rubella (German measles), and alcohol. He notes similarities in the responses of vested interests to the descriptions of brain toxicity from lead, mercury, and fluoride. Grandjean concludes his book with a ten-point strategy to counter brain drain with the list being headed by optimal brain functioning being the key focus of health promotion. To promote ongoing discussion of the issues he has also set up a website: [www.braindrain.dk](http://www.braindrain.dk).

Keywords: Alcohol; Arsenic; Brain development; Brain drainers; Fluoride and the brain; Lead; Mercury; Neurotoxicity; Polychlorinated biphenyls (PCBs); Prevention of brain drain; Rubella.

Published by Oxford University Press, New York, this 212-page book, whose cover shows a children's playground adjacent to a smoke-belching powerstation, is the eighth in the *Environmental ethics and science policy series*, edited by Kristin Shrader-Frechette, following the earlier titles of *Environmental Justice; creating equality, reclaiming democracy; In nature's interests?: interests, animal rights, and environmental ethics; Across the boundaries; extrapolation in biology and social science; Taking action, saving lives: our duties to protect environmental and public health; Is a little pollution good for you?: incorporating societal values in environmental research; A perfect moral*



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*storm: the ethical tragedy of climate change; and What will work: fighting climate change with renewable energy; not nuclear power.*

For 30 years Philippe Grandjean has pursued research on the toxicity of environmental chemicals on the brain development of children, effects he calls chemical brain drain.

He notes that neurodevelopmental delay or neurological disease are thought to occur in about one of six children in the United States with the adverse conditions ranging from serious diagnosed disease, such as mental retardation, cerebral palsy, and autism, to less clearly defined disorders like attention deficit hyperactivity disorder (ADHD) and more subtle deviations like learning disabilities and sensory



Professor Philippe Grandjean, MD, DMSc (Copenhagen)

deficits. Because some of these conditions seem to be increasing in prevalence, he felt they were probably not of genetic origin, and, although the causation in most cases is unknown, environmental factors are the most likely culprits.

Born in Denmark in 1950, Grandjean graduated as MD from the University of Copenhagen at age 23, and 6 years later defended his DMSc doctoral research thesis on “Widening perspectives of lead toxicity.” In 1982, after further study as a Fulbright Senior Scholar at Mount Sinai Hospital, New York, he was appointed Professor of Environmental Medicine at the University of Southern Denmark, and in 2003 he became Adjunct Professor of Environmental Health at Harvard University. Two years later he began collaborating with Pál Weihe on the effects of methylmercury in the meat and blubber of the pilot whale, which are part of the traditional diet on the Faroe Islands, a self-governing country within the Danish Realm since 1948 lying midway between Norway and Iceland. Since that time, he has published approximately 100 articles on brain drain from mercury.

As a 22-year-old student in 1972, Grandjean saw on the TV news a teenager, Shinobu Sakamoto, with spastic paresis from methylmercury pollution in the Japanese fishing village of Minamata and became fascinated with the likely impact of such environmental pollution on human health. Later he wondered why the discoveries on disease aetiologies were only slowly being translated into

prevention, if at all, and found the medical community was failing to prevent chemical damage to children's brains. Wishing to understand why this was, he learned that narrow economic interests of industrial companies concerned for their bottom lines often hampered the new knowledge about the mechanisms of brain drain. Grandjean recalled that he had been taught by Professor Irving J Selikoff at Mount Sinai Hospital, "Never forget that the numbers in your tables are human destinies, although the tears have been washed away," and, embarrassed that the medical profession and society had not risen to the challenge, emphasized that he intended his book to be a very loud response to the serious but often silent effects of brain drain.

The book has ten chapters, each of which can be read independently of the others, although together they build towards the conclusions in the final chapter. Chapter 1, *Sensitive development: complexity creates vulnerability*, explains why the early stages of brain development are so vulnerable to toxic chemicals. Chapter 2, *Toxic invasion: the placenta is not a protective armor*, looks at the examples of thalidomide, alcohol, and rubella to show how the early view that the placenta protected the developing fetus was wrong. Several specific brain drainers are then considered with lead in chapter 3, *Invisible lead: health hazards from demanding scientific proof*, mercury in chapter 4, *Poisoned science: mercury damages the child's brain but does not harm the mother*, arsenic in chapter 5, *Substituted milk: poisoning during infancy causes permanent brain damage*, and persistent organic chemicals such as polychlorinated biphenyls (PCBs) in chapter 6, *Persistent problems: chemicals resistant to breakdown break brain cell*. In chapter 7, *Unusual suspects: chemicals that protect the lawn may damage the brain*, pesticides are considered. Grandjean notes that pesticides are often designed to interfere with the neural functions of pests, especially insects, but because brain biochemistry differs little between species, pesticides can also cause neurotoxicity in humans. The costs of brain drain, including the need for special education at school, being less successful in life, having lower incomes, delinquency, and substance abuse are considered in chapter 8, *Mindless costs: brains are indispensable to each individual and to society*.

The penultimate chapter 9, *Inconvenient truths: vested interests can endanger brain development*, notes that inertia in science, with which thousands, perhaps millions, of children may suffer adverse effects that could have been prevented while expert committees merely contemplated the evidence, is not the only hurdle. Chemical manufacturers and other companies that question the validity of the evidence and demand more documentation greatly augment this inertia. Grandjean observes that these vested interests have repeatedly manipulated brain-drain research studies and have manufactured uncertainties to raise doubt about the conclusions and the credibility of scientists. Accepting that there are uncertainties, he argues that the costs of brain drain are simply too enormous to allow their damaging effects to continue into future generations because our understanding of them is incomplete.

The final chapter 10, *Brainy choices: how to secure optimal brain development for the next generation*, outlines how chemical brain drain can be prevented. A two-part strategy, each with five points, is suggested:

Immediate agenda:

- *Optimal brain functioning* should be a key focus of health promotion—not just the avoidance of neurological disease.
- Because brain development is *extremely vulnerable* to chemical toxicity, children and pregnant women deserve the strongest possible protection.
- The public must have access to *information on brain toxicity*, the sources of exposure, and the actual levels of exposure where they live.
- Many *pesticides, solvents, metals*, and other industrial chemicals are already known to cause brain toxicity; these exposures must be vigorously controlled without further delay.
- Because there is only one chance to develop a brain, protection against brain drainers must be promoted as a crucial and joint responsibility in society.

Supportive accompanying agenda:

- As most industrial chemicals have not been *tested for toxicity* to brain development, screening should be conducted using existing and improved test methods to identify substances that need tighter control.
- We need new *research to understand* how brain development can be optimized and how best to prevent long-term dysfunctions and deficits linked to brain toxicity.
- As exposures and toxicity do not respect national borders, a *clearinghouse* is needed to collect and evaluate documentation on brain drain and to stimulate international collaboration to prevent adverse effects.
- *Incontrovertibly definitive scientific proof should no longer be demanded* as a prerequisite to act responsibly and ethically in protecting vulnerable populations against brain-draining chemicals.
- On this basis, transparent *procedures and decision rules* need to be devised for acquisition of safety information, public information, improved control of chemicals, and monitoring while innovation in safer technology is stimulated.

Although fluoride is not given a specific chapter in the book, it receives several mentions and is included in the appendix of 213 industrial chemicals known to be brain drainers. The list is an update of the compilation Grandjean and Professor Philip Landrigan first published in *The Lancet* in 2006.<sup>1</sup> Moreover, Grandjean has a long association with fluoride research<sup>2-12</sup> including making a keynote presentation at the XIIIth Conference of the International Society for Fluoride Research in New Delhi, India, in 1983.<sup>13</sup> Since 1982, he conducted follow-up studies of the cryolite workers in Copenhagen, Denmark, who were described in a

classic 1937 monograph by Kaj Roholm (1902–1948), whose image appears on the cover of the hard copies of *Fluoride*.<sup>14</sup>

In *Only one chance*, Grandjean notes that the conclusions of expert committees depend on the make-up of the committee and that, in 2002, action on lead neurotoxicity was blocked by the appointment of new committee members with links to the lead industry. He experienced a similar situation as the author of a draft criteria document on fluoride on behalf of a WHO International Programme of Chemical Safety. Committee members associated with the use and promotion of fluoride in dentistry deleted any mention of the toxic effects of fluoride. Realizing that an attempt had been made to take him hostage, he had to disengage himself from the report.

Grandjean noted that for 40 years Robert A Kehoe at the Kettering Laboratory in Cincinnati conducted research supported by the lead industry and framed his conclusions in a manner that minimized the health risks. Kehoe also defended the interests of groups producing industrial fluoride pollution.<sup>15</sup> Grandjean considered that researchers who act as corporate consultants and give industry-friendly opinions, phrased in scientific terms and disguised under veils of uncertainty, misuse science to enhance company profits.

Grandjean comments that inconvenient scientific truths may be discredited by harassing the scientists themselves. He records that he was attacked by the tuna industry for his work on mercury and that Herbert Needleman was accused of scientific fraud and misconduct for his research findings on lead toxicity. He relates how toxicologist Phyllis Mullenix found, with a sophisticated computerized surveillance of spontaneous rat behaviour at the Forsyth Research Institute in Boston, that fluoride clearly caused pre-natal neurotoxicity. Soon after she published her results, she was fired from her position, and Grandjean links this to her inadvertently challenging the promoters of drinking water fluoridation and jeopardizing the financial support of the entire institution (the Forsyth Research Institute). He notes that even today the available evidence on any potential long-term neurotoxic harm from fluoride exposure is of limited quality and insufficient to rule out all but the most obvious effects. He sees this as an unfortunate situation as a large percentage of wells worldwide, including the USA, contain substantially elevated concentrations of fluoride. Grandjean discusses his 2012 meta-analysis study, with Guifan Sun and Ying Zhang from China and his Harvard colleague Anna Choi, of 27 studies on fluoride and IQ in school-age children, which found that in all but one of the studies a higher exposure to fluoride was associated with a poorer performance on IQ tests. He observed that Mullenix should have been praised rather than fired because she was probably right in considering that fluoride can, under certain conditions, be toxic to the brain.

Grandjean observes that regulatory agencies and industry often claim that no convincing evidence of chemical brain drain is available and comments, “When our review on fluoride neurotoxicity was published in 2012, worried fluoridation proponents and regulators rapidly responded that the toxic effects occurred only at excessive exposures, that the average effect was too small to be of any health

significance, that any such effect, if real, would have been discovered in the United States or the European Union long ago (although nobody has looked), that animal studies show no effects even at huge doses, and that any effect in the studies reviewed was likely to be due to lead and arsenic, not fluoride. When such misleading fusillade is aimed at the authors of a careful meta-analysis of 27 different studies, what would it take to convince critics like that?"

Grandjean accepts that any book on neuroscience or a public health topic may soon become outdated but describes his purpose in writing *Only one chance* as being not just to describe the frontline of such research but also to help raise consciousness about chemical brain drain. To promote discussion and exchange of information he has set up a website at [www.braindrain.dk](http://www.braindrain.dk). In a post on this site on February 11, 2013 on fluoridated water and brains, he reviewed some of the news media coverage of his 2012 paper on developmental fluoride neurotoxicity and concluded that chemical brain drain from fluoride should not be disregarded as the average IQ deficit in children exposed to increased levels of fluoride in drinking water was found to correspond to about seven points—a sizeable difference. He considered that it was uncertain to what extent the risk applied to fluoridation controversy in Wichita, KS, Portland, OR, and elsewhere but that it definitely deserved concern.<sup>16</sup>

The obstacles facing the proper recognition of brain-drain are called a triple whammy. The insufficiency of the evidence is likened to looking at only the tip of an iceberg and the uncertainties in the available evidence, which tend to hide or underestimate the possible effects of brain drainers, are equivalent to our glasses being fogged up. The third part the whammy involves scientists being soft-spoken where, in order to protect themselves against harsh critique, researchers have become particularly careful about mentioning relevant caveats and downplaying the significance of their findings. Using the example of mercury, an acknowledged brain drainer, Grandjean explains that there is insufficient evidence, even the most intensive research involves uncertainties, and the conclusions, when finally published, are expressed in the midst of scientific caveats and disclaimers. All told, such research is an easy target for overzealous critique and undue skepticism.

Grandjean calls for avoiding extremes of either skepticism or gullibility. "Skepticism has a crucial role in science but should not be exaggerated to the extent that no new ideas will be generated. Likewise, gullibility should not be so generous that it prevents the distinction between useful and worthless ideas. However, in regard to brain drainers, scientific skepticism has generally taken precedence, sometimes to the extreme, especially when absence of evidence was erroneously thought to speak against there being any risk at all. So, even if ice is spotted, it is explained away as specks on the glasses, or just a stray ice floe, certainly not an iceberg. It is safe for the *Titanic* to move on, the conclusion goes."

Philippe Grandjean's book is written in a refreshingly direct style, and the author's compassion for those afflicted by chemical brain drain is clearly evident. He makes a valid point by saying that, while chemical brain drain appears as a silent pandemic without impressive statistics on mortality or disease, it has

impacts serious enough to demand a loud response. The book places concerns about fluoride toxicity in a wider context wherein hundreds of chemical brain drainers act and interact. *Only one chance* has an important message and should be widely read and heeded.

Bruce Spittle, MB ChB, DPM (Otago)

Managing Editor, *Fluoride*

727 Brighton Road, Ocean View, Dunedin 9035, New Zealand

E-mail: spittle@es.co.nz

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