Did Our Brains Fall Out?

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James Oberg, NASA engineer and science writer, is famously quoted as observing "You must keep an open mind, but not so open that your brains fall out." This is a fundamental dilemma faced by scientists and the journals that publish their work. As scientists, we hold a world view that nothing is known with certainty. Every scientific belief, no matter how entrenched, is open to reanalysis based on data. One need only consider the influence of relativity on Newtonian mechanics, and quantum electrodynamics on Maxwell's field theory, to appreciate the importance of keeping an open mind in science.

However, we can't let our brains fall out. We are surrounded by crackpot theories and junk science, often advanced in support of financial, political, or religious agendas. The Internet provides every whacko an opportunity to advance a pet psychotic theory to a global audience for a nominal monthly charge. What distinguishes novel theories that are meritorious of rigorous scientific analysis and publication in a peer-reviewed journal from junk science?

Reverend Thomas Bayes (1701–1761) was a German Presbyterian minister. His passion was mathematics. Upon his death, his family discovered among his possessions a set of workbooks with equations. These equations, published posthumously, describe a formal method for establishing whether an assertion is true based on new observations. In brief, the probability depends on how likely it was that the assertion was true in the absence of the new observations, and the quality of the new observations. Bayes' theorem is the "gold standard" for statistical inference. It is rarely used in statistics because the probabilities are nearly impossible to compute.

A consequence of Bayes' theorem is that extraordinary claims demand extraordinary proof. If a company develops another 5HT3 antagonist, and claims it is effective for nausea and vomiting, this is a fairly ordinary claim. A well-conducted, randomized, controlled trial is adequate evidence that the claim is true. However, if a company develops another fentanyl cogener, and claims it does not cause ventilatory depression, this is an extraordinary claim. The evidentiary standard must be much, much higher than the evidentiary standard for the new 5HT3 antagonist. Scientists and journals typically use Fisherian statistics to evaluate claims: $P < 0.05$. We do that because it is easy to calculate. However, it is incorrect. Fisherian statistics to not distinguish ordinary claims from extraordinary claims. As Reverend Bayes taught us, the prior probability of truth has a huge influence on whether an assertion is true given supporting data.

This issue of *Anesthesia & Analgesia* contains several articles about alternative medicine (1–5). The claims of alternative medicine are extraordinary. The physics of static magnets suggests they should have almost no biological activity (2) (except, perhaps, confusing migratory animals which have internal ferromagnetic receptors). Acupuncturists put needles in your hand to treat migraines, and needles in your ear to treat nausea. How weird is that?

Bayesian inference implies we should hold the extraordinary claims of alternative medicine to an exceptionally high standard. This is because the mechanisms are unknown. It is the standard to which we hold alternative medicine submissions to *Anesthesia & Analgesia*. We look very carefully at the scientific rigor of all studies, but particularly at those involving

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alternative medicine. We also look at studies examining mechanisms of alternative medicine with guarded enthusiasm.

At this point in time, the weight of the evidence appears to support the clinical efficacy of acustimulation for some indications. As Dr. White points out in his accompanying editorial (3), we need clinical studies of increased rigor to precisely define the risks and benefits of acustimulation. We also need basic science studies to determine the mechanism of action. Once the mechanism of action is understood, claims of clinical efficacy for acustimulation will no longer be extraordinary.

We also have a responsibility to our patients. Therapy with static magnets is an extraordinary claim supported by the most paltry of evidence (4). Most studies are negative, and those very few studies that suggest efficacy cannot be repeated. Bayesian inference suggests that static magnets are ineffective and claims of effectiveness are false. If we follow Bayes rigorously, we would not even consider a manuscript such as that submitted by Cepeda et al. (5). To paraphrase a reviewer of this paper: "Magnets shouldn't work, and this paper says they don't. Why publish it?"

Anesthesia & Analgesia exists for patients (5). Patients may not have access to *Anesthesia & Analgesia*, NIH consensus documents, or Bayes' theorem. However, they do have access to the Internet. They are wasting huge sums of money on quack therapies. We have a responsibility to publish rigorous manuscripts that can help patients understand their therapeutic options and spend their money wisely.

Bayesian inference is the answer to Oberg's paradox. Extraordinary claims demand extraordinary evidence. We are very interested in papers that make extraordinary claims, but authors need to know that the evidentiary bar is high. We are also interested in papers that explore the mechanism underlying extraordinary claims, as such papers will, over time, make the extraordinary ordinary. Lastly, we will occasionally let our brains fall out, and publish papers that Reverend Bayes would find ridiculous, when it best serves the interests of our patients.

REFERENCES

1. Karst M, Winterhalter M, Münte S, et al. Auricular acupuncture for dental anxiety: a randomized controlled trial. Anesth Analg 2007;104:295–300.
2. Fassoulaki A, Paraskeva A, Kostopanagiotou G, et al. Acupressure on the extra 1 acupoint: effect on BIS, serum melatonin, plasma β-endorphin and stress. Anesth Analg 2007;104:312–7.
3. Tsuchiya M, Sato EF, Inoue M, Asada A. Acupuncture enhances generation of nitric oxide and increases local circulation. Anesth Analg 2007;104:301–7.
4. Schlunzen L, Vafaee MS, Cold GE. Acupuncture of LI-4 in anesthetized healthy humans decreases cerebral blood flow in putamen measured with PET. Anesth Analg 2007;104:308–11.
5. Cepeda MS, Carr DB, Sarquis T, et al. Static magnetic therapy does not decrease pain or opioid requirements: a randomized double blind trial. Anesth Analg 2007;104:290–4.
6. Flamm BL. Magnet Therapy: Healing or Hogwash? Anesth Analg 2007;104:249–50.
7. White PF. Use of alternative medical therapies in the perioperative period: is it time to get on board? Anesth Analg 2007;104:251–4.
8. National Center for Complementary and Alternative Med. National Institutes of Health Research Report. Questions and answers about using magnets to treat pain. Available at http://nccam.nih.gov/health/magnet/magnet.htm. Last accessed 9/28/06.
9. Shafer SL. Thank you, Ron Miller. Anesth Analg 2006;102:982–3.