

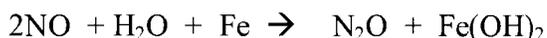
## Guest Writer Article

# Joseph Priestley and Nitrous Oxide

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A significant number of older adults in the UK will have experienced nitrous oxide (N<sub>2</sub>O) anaesthesia first hand, usually in connection with the extraction of a tooth. It can also diminish the experience of pain and is sometimes used as an N<sub>2</sub>O-oxygen analgesic mixture in childbirth. Most writers attribute the discovery of this gas to Joseph Priestley, attaching the date 1772.

Stephen Hales (1677-1761) is generally considered to be the first person to describe gas manipulations in detail, such as their collection over water. But his concept of what constituted a gas was quite different from that we have today. His gases, no matter from what sources, were all forms of "ordinary" air. If they wouldn't support life, then this air was contaminated with toxic particles. If, like marsh gas, they were flammable, then the air was loaded by invisible, flammable particles. That they might be discrete substances with individualities of their own was assumed by Joseph Black (1728-1799) in his classic investigations into the nature of magnesium oxide, carbonate and their connection with carbon dioxide. Joseph Priestley used forms of Hales's apparatus and Black's concept of a gas (though he described them as "airs" until his dying day) to discover or report on a significant number of gases among them NO, NO<sub>2</sub>, N<sub>2</sub>, HCl and N<sub>2</sub>O (all 1772), O<sub>2</sub> (1774) and SO<sub>2</sub> (1775). Naturally, he didn't use these formulae, and indeed his names for them have not survived the passage of time. Today's nitric oxide (NO) was to him "*nitrous air*" and our nitrous oxide he originally named as "*nitrous air, diminished*", on account of his preparative method of allowing NO to stand in contact with moist iron filings (initially mixed with sulfur, but this was later found not to be essential). Today's equation is:



in which two volumes of nitric oxide reduce to one volume of N<sub>2</sub>O as the reaction proceeds.

Was Priestley the first person to make it? Probably not. It may have been prepared, unwittingly, by Joseph Black. He published little of his own work, but accounts of his lectures and demonstrations survive and one from 1768 records the "*Ammonium nitrate: is the most fusible of the common salts; when the heat is increased it copiously converted into a vapour; the degree of heat sufficient for its fusion is that of boiling water; if exposed to sudden heat (it) undergoes a deflagration...*" Today we would write:



the well-known college preparation of the gas. However it is unclear whether Black was recounting the fruits of his research, or simply reporting someone else's work.

So, who should get the accolade for having discovered nitrous oxide, Black (who arguably made it as a demonstration) or Priestley, who prepared it, undisputedly, by means of an alternative method? I contend that three criteria should be fulfilled by a "discoverer". (S)He must

- Isolate the substance
- Tell the world about it, establishing precedence
- Show an understanding of the "discovery" in the context to the contemporary science.

Black *may* have met the first criterion, but Priestley fulfilled all three, so if there are prizes for the discovery to be awarded, they should go to him.

Priestley was clearly perplexed as to the nature of his diminished nitrous air. A candle burnt with an increased

brightness in the gas. When mice were placed in a bell-jar of N<sub>2</sub>O their liveliness was reduced and they soon died. In contrast they seemed livelier if they respired oxygen, which Priestley subsequently discovered (1774). Priestley spotted this paradox but did not have the time to account for it with any satisfaction. Other gas-based discoveries were pressing and he moved on.

By the time he was 20, Humphry Davy was well-versed in chemistry, and had been appointed Laboratory Superintendent of the Pneumatic Institute in Bristol (1798). This establishment was founded on the belief that the gases, so recently discovered by Priestley and others, might have medical applications. Shortly before taking up his appointment, Davy decided to test an idea, prevalent at the time, that nitrous oxide was highly toxic, responsible for many diseases (as a “principle of contagion” according to American Samuel Latham Mitchell<sup>1</sup>) and had a remarkably deleterious effect on animal tissue. Davy, however, found that it could be safely breathed for short periods and it had no effect on tissue. Undoubtedly these initial observations set him to explore this gas in greater depth than any scientist hitherto. His studies gave rise to his monumental text on the history, chemistry, physiology and recreational use of nitrous oxide. Curiously, given the primary purpose of the Pneumatic Institute in healing the sick, its use in therapy is barely mentioned. Instead he concentrates more on its recreational use, with several of his friends recounting their experiences (akin to a transient drunkenness, mainly). It is at the end of this book, on page 556, that he makes his famous statement about the possible use of nitrous oxide in surgery:

*“As nitrous oxide ...appears capable of destroying physical pain, it may probably be used with advantage during surgical operations in which no great effusion of blood takes place...”*<sup>2</sup>

Sadly his suggestion, admittedly rather a “throwaway” remark: almost an afterthought, was not exploited by the surgical profession.<sup>3</sup> For the next 40+ years operations would continue to be attended by agonising pain. Meanwhile nitrous oxide continued to delight gentlemen and ladies as a recreational drug.

Horace Wells, an American dentist, wished to make his fortune by marketing a new form of dentures. But for them to fit successfully, he needed to remove any remaining stumps of teeth, and to attract a goodly number of patients he needed to do this as painlessly as possible. He knew of a gaseous agent that could induce euphoria, feelings of merriment, sometimes an uncontrollable laughter and which, if breathed longer and deeper, could induce a brief insensibility. Used hitherto as a “substance of abuse” he decided to try out this gas on his patients. They went to sleep. Their teeth were extracted. And they woke up.... safely. The era of anaesthesia was born in this year of 1844.<sup>4</sup> And what was this “laughing gas”? None other than Joseph Priestley’s “*nitrous air, diminished*”: our nitrous oxide.

## References

1. H. Davy, *Nicholson’s Journal* 3 (1799), pp, 55, 93. Mitchell’s work probably came to Davy’s attention as an appendix to Thomas Beddoes and James Watt, *Considerations on the medicinal use, and on the production of factitious airs* Bristol: J. Johnson, 1796.
2. H. Davy, *Researches chemical and philosophical; chiefly concerning nitrous oxide, or dephlogisticated nitrous air, and its respiration*. London: J. Johnson, 1800. Downloadable (free) from Google Books.
3. A. Dronsfield, P. Ellis and D. Zuck “*Nitrous oxide – past, present and future*”. In press, *Education in Chemistry*.
4. B. M. Duncum, *The development of inhalation anaesthesia*. London: Royal Society of Medicine Press Ltd., 1994.