Conceptual Change during the Chemical Revolution: Air, Acid and Water in the Royal Society Corpus

Full paper

Cultural and scientific changes are often reflected in language (Degaetano-Ortlieb & Teich, 2022; Hoijer, 1948; Witherspoon, 1980), and semantic change literature often highlights how conceptual changes are encoded in lexical behaviour (Geeraerts, 1997). Focusing on English scientific prose, we trace the linguistic evidence of the conceptual reorganisation of *air*, *acid*, and *water* in late-eighteenth to early-nineteenth-century chemistry. As high-frequency, topic-bearing lexemes, their co-occurrence profiles reflect the timeline over which oxygen displaced phlogiston and the corresponding changes in practice. Period-by-period patterns in the Royal Society Corpus reveal the chronology of the phlogiston-oxygen paradigm shift and the linguistic imprint it left in English scientific writing.

The research question is: During the phlogiston-oxygen paradigm shift, how did core terms like *air, water* and *acid* shift in their conceptual elaboration?

We use SynFlow (Phan-Tất, 2025), a method based on syntactic co-occurrence and Jensen-Shannon Divergence (JSD) to model the diachronic distributional shifts of two *syntactic slot-fillers of air, acid and water* across successive 5-year periods (technical details and package descriptions are covered in the accompanying software demonstration). The data is drawn from a subset (1750 – 1819, filtered by the topics of Chemistry 1, 2, Biochemistry (Menzel et al., 2021)) of the Royal Society Corpus 6.0 Open (Fischer et al., 2020). Inspired by Davies (2025), we adopted an AI-assisted interpretation workflow in which ChatGPT generated candidate qualitative interpretations of the quantitative output which were then independently verified with established narrative literature from the history and philosophy of science (e.g., Blumenthal & Ladyman, 2017; Boantza, 2013; Cavendish, 1766; Chang, 2011; Conant, 1950; Dalton, 1805; Henry, 1803; Kuhn & Hacking, 2012; McEvoy, 2015; Stewart, 2012). Although ChatGPT sometimes produced unsupported claims, it was often useful, especially with its recent ‘Thinking’ mode.

For *air*, in the 1750s-60s, high JSD reflects an exploratory period with the rise of a new set of descriptors (fixed, inflammable), consistent with phlogiston theory’s consolidation-before-crisis stage. JSD drops in the 1770s–80s as the vocabulary usage temporarily stabilized during a period of debate between the main rival theories. JSD rises again in the 1790s as phlogiston terms recede yet persist as an epistemic object into the 1810s. Verbs in the oblique construction (e.g., expose to the air) move from passive exposure (tarnish, expose) to reagent-style operations (combine, unite, convert) to measurement and control (weigh, confine, exhaust). *Water* shows a parallel shift from gas washing and eudiometric practice by volume to gravimetry and precise composition, then to roles as reactant and oxidant. *Acid* moves from

source/salt/strength labels to oxygen-based composition and the -ic/-ous scheme. Together these trajectories show how distributional profiles trace both chronology and practice as chemistry reoriented from phlogiston theory to oxygen theory.

The contribution of this study is two-fold:

First, we analyse three central chemical concepts during the phlogiston-oxygen paradigm shift and show how the shift is reflected in scientific language using SynFlow, a linguistically-grounded, bottom-up method with a user-friendly package.

Second, we evaluate an AI-assisted interpretation workflow, noting its benefits and limitations (i.e., hallucination) for non-specialists in the history of science.

References:

Blumenthal, G., & Ladyman, J. (2017). The development of problems within the phlogiston theories, 1766–1791. *Foundations of Chemistry*, *19*(3), 241–280. https://doi.org/10.1007/s10698-017-9289-0

Boantza, V. D. (2013). The Rise and Fall of Nitrous Air Eudiometry: Enlightenment Ideals, Embodied Skills, and the Conflicts of Experimental Philosophy. *History of Science*, *51*(4), 377–412. https://doi.org/10.1177/007327531305100401

Cavendish, H. (1766). XIX. Three papers, containing experiments on factitious air. *Philosophical Transactions of the Royal Society of London*, *56*, 141–184. https://doi.org/10.1098/rstl.1766.0019

Chang, H. (2011). The Persistence of Epistemic Objects Through Scientific Change. *Erkenntnis*, *75*(3), 413–429. https://doi.org/10.1007/s10670-011-9340-9

Conant, J. B. (1950). *The Overthrow of the Phlogiston Theory: The Chemical Revolution of 1775-1789*.

Dalton, J. (1805). *On the Absorption of Gases by Water and other Liquids*.

Davies, M. (2025). *AI/LLM integration with the corpora from English-Corpora.org*. https://www.english-corpora.org/ai-llms/

Degaetano-Ortlieb, S., & Teich, E. (2022). Toward an optimal code for communication: The case of scientific English. *Corpus Linguistics and Linguistic Theory*, *18*(1), 175–207. https://doi.org/10.1515/cllt-2018-0088

Fischer, S., Knappen, J., Menzel, K., & Teich, E. (2020). *The Royal Society Corpus 6.0: Providing 300+ Years of Scientific Writing for Humanistic Study*.

Geeraerts, D. (1997). *Diachronic Prototype Semantics: A Contribution Historical Lexicology* (D. Geeraerts, Ed.). Oxford University Press. https://doi.org/10.1093/oso/9780198236528.003.0001

Henry, W. (1803). III. Experiments on the quantity of gases absorbed by water, at different temperatures, and under different pressures. *Philosophical Transactions of the Royal Society of London*, *93*, 29–274. https://doi.org/10.1098/rstl.1803.0004

Hoijer, H. (1948). Linguistic and Cultural Change. *Language*.

Kuhn, T. S., & Hacking, I. (2012). *The structure of scientific revolutions* (Fourth edition). The University of Chicago Press.

McEvoy, J. G. (2015). *Gases, God and the balance of nature: A commentary on Priestley (1772) 'Observations on different kinds of air'*.

Phan-Tất, B. (2025). *SynFlow* [Computer software]. Zenodo. https://doi.org/10.5281/zenodo.17414457

Stewart, J. (2012). The Reality of Phlogiston in Great Britain. *HYLE--International Journal for Philosophy of Chemistry*, *18*.

Witherspoon, G. (1980). Language in Culture and Culture in Language. *International Journal of American Linguistics*, *46*(1), 1–13. https://doi.org/10.1086/465623