

Wenn der Funke überspringt – Word Embeddings im Dienst der Wissenschaftsgeschichte

Johannes Hellrich, Alexander Stöger & Udo Hahn

DHd 2018



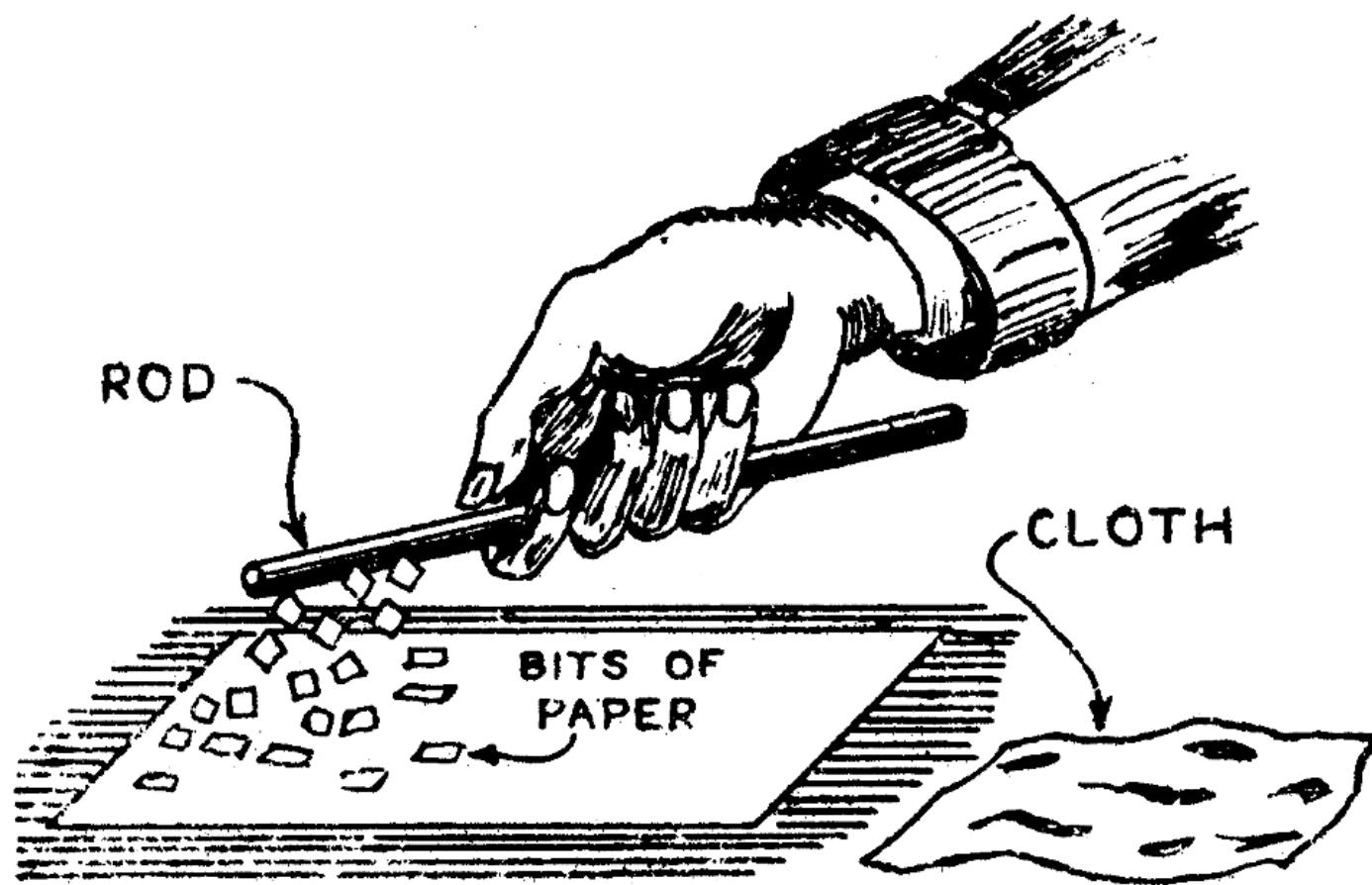
FRIEDRICH-SCHILLER-
UNIVERSITÄT
JENA

Bis zum 17. Jhd.: Elektrizität nur als natürliches Phänomen



Blitz. Wikimedia (Fir0002). 2007.

Anfang 18. Jhd.: Frühe Experimente mit statischer Elektrizität als anziehende Kraft



Experiment von Newton

Mitte 18. Jhd.: Elektrischer Funke in Natur und Labor



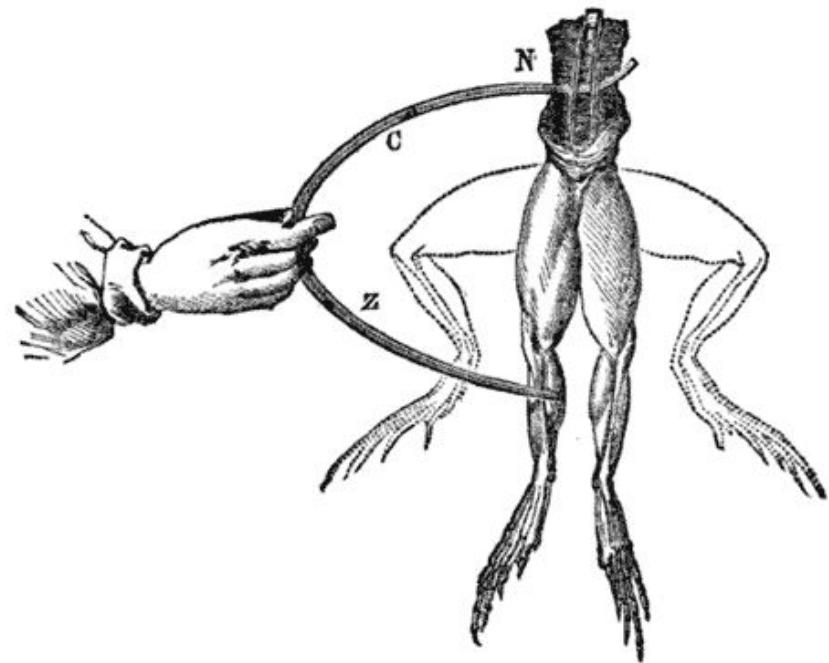
Benjamin West: Benjamin Franklin drawing electricity from the sky. Um 1816.



Große Reibungselektrisiermaschine nach Georg Winter. Nachbau 1870. iCollector.com 2004.



Charles Amédée van Loo: Allegorie auf das
Leidener Experiment. 1777



Galvanisches Experiment mit
Froschschenkel. Galvani: *De viribus
electricitatis*. 1791.

Luigi Galvani. Um 1800.

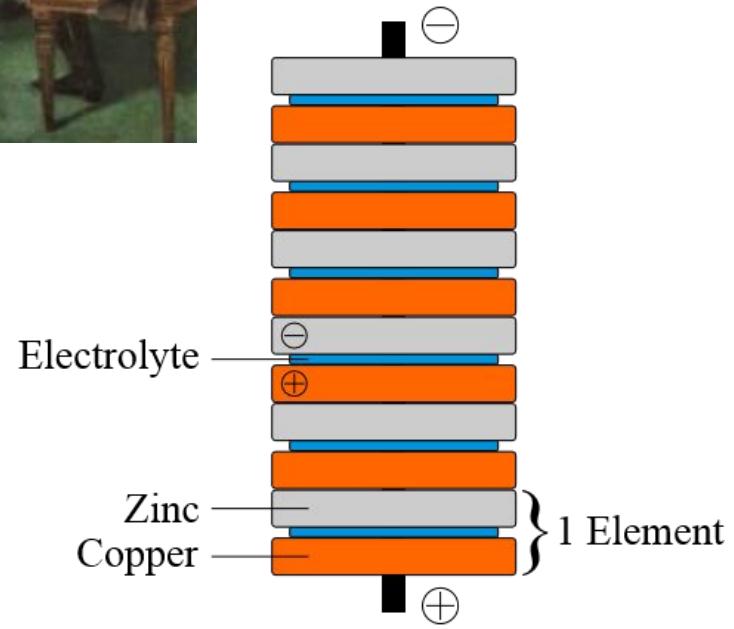


Promotional photo of [Boris Karloff](#) from [*The Bride of Frankenstein*](#) as [Frankenstein's monster](#).
Universal Studios/Wikimedia. 1935.



Nach Bertini. Volta demonstriert seine Ladungssäule Napoleon Bonaparte. 1801.

Voltaische Säule. Wikimedia (borbrav). 2008.



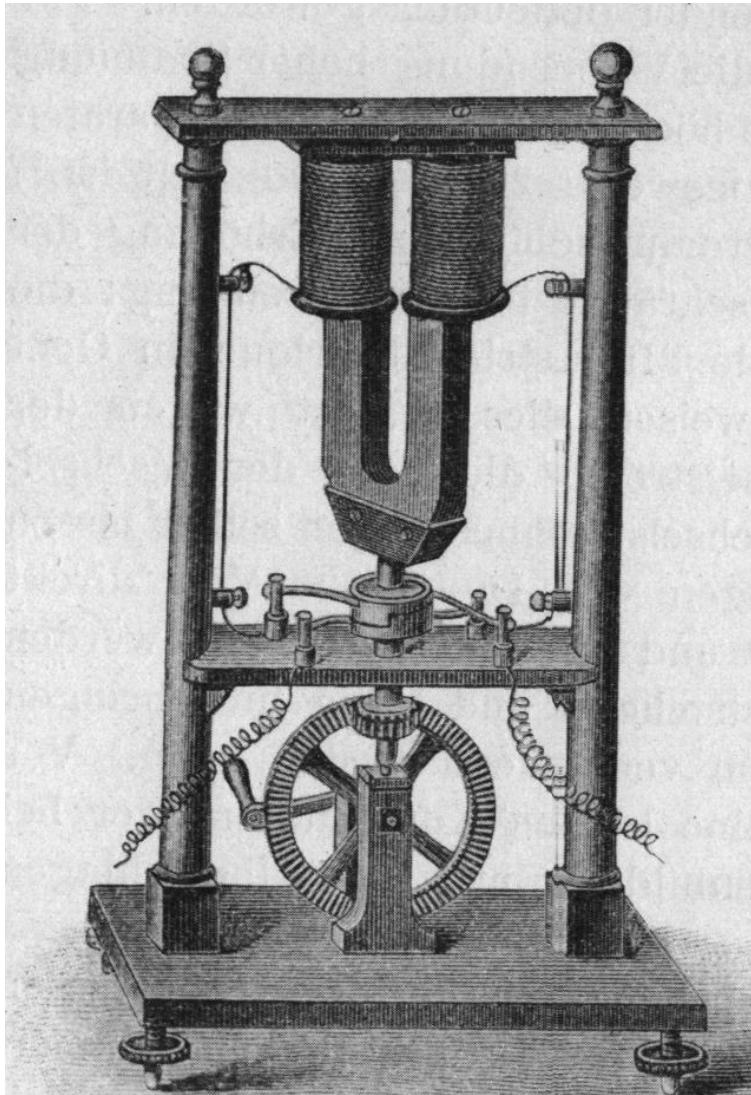


Fig. 33.

Erster Generator, gebaut 1832
von Pixii

PHILOSOPHICAL

TRANSACTIONS.

I. On the Influence of Temperature on
By AUGUSTUS MATTHIESSEN

Received December 5, 1806.

THE results obtained by different observers on the electric conducting power of metals, and partly to their not having tested the wire of a pure metal is heated for the purpose of determining the conducting power of the wire is observed on to keep the wire for several days at 100° cooled, becomes constant.

In the experiments we are about to describe, pure metals, as well as a method and a method of accuracy could be obtained.

The method employed for the determination of the 'Philosophical Magazine' for February apparatus. B is the trough in which the two thick copper wires F (4–5 millims. thick), bent as shown in the figure, and ending in the mercury-cups E, which were connected with the apparatus by two other copper wires, F', of the same thickness. C is a piece of board placed in such a manner as to prevent the heat of the trough from radiating on the apparatus. The mercury-cups O are made of small blocks of wood, through which holes are bored just large enough to take the thick wires, and to the bottoms of which blocks amalgamated copper plates are fastened. Now it is clear that if the ends of the thick copper wires are filed flat, and well amalgamated, and the mercury-cups are filled with mercury, this method of connexion may be looked upon as a soldering of the copper plates to the wires, or, in other words, as a perfect connexion; for the wires may be removed as often as required, and on replacing them the same resistance is always observed. The wires F'',

I. The Bakerian Lecture, on some chemical Agencies of Electricity.
By Humphry Davy, Esq. F. R. S. M. R. I. A.

Read November 20, 1806.

1. Introduction.

THE chemical effects produced by electricity have been for some time objects of philosophical attention; but the novelty of the phenomena, their want of analogy to known facts, and the apparent discordance of some of the results, have involved the enquiry in much obscurity.

An attempt to elucidate the subject will not, I hope, be considered by the Society as unfitted to the design of the Bakerian Lecture. I shall have to detail some minute (and I fear tedious) experiments; but they were absolutely essential to the investigation. I shall likewise, however, be able to offer some illustrations of appearances which hitherto have not been fully explained, and to point out some new properties of one of the most powerful and general of material agents.

MDCCLVII.

B

On the specific Inductive Capacities of certain Electrical Substances.

By W. SNOW HARRIS, Esq., F.R.S., &c.

Received May 21.—Read June 9, 1842.

unrivalled series of Researches in Electricity with which Dr. FARADAY has enriched the pages of the Royal Society's Transactions, have greatly extended my view in this wonderful department of natural knowledge.

doctrine of specific inductive capacity advanced in these profound researches, has a considerable claim to attention, being both a novel and important feature in the action. I have been hence led to some further examination of it, and the results obtained, I am not without hope that a brief account of them may be acceptable to the notice of the Royal Society.

Given a measured quantity of electricity be deposited on different insulators of the same thickness, and having metallic coatings of the same extent and density of charge, as shown by an electrometer, will greatly vary. I found differences in some cases to be so great as twenty-five to one. Thus, in one case, the intensity of the charge sustained by induction through air being 25^o, that of the same charge sustained by induction through lac only amounted to 1. Experimental examination of this question, however, demands very considerable care, since a small degree of conducting power, or dissipation of the charge, or absorption of electricity by the superficial particles of a given substance would diminish the apparent intensity; and a small loss of the quantity absorbed would tend to increase it. It is hence essential to find measurement of specific inductive capacity in the least possible time under favourable circumstances. In the processes I have endeavoured to

[10]

VI. Observations upon the Effects of Electricity applied to a Tetanus, or Muscular Rigidity, of four Months Continuance. In a Letter to the Royal Society. By William Watson, M. D. F. R. S. Member of the Royal Colleges of Physicians of London and Madrid, and Physician to the Foundling Hospital.

To the Royal Society.

Gentlemen,

Ever since your establishment, the 1763, communicating the history of uncommon diseases has seldom failed of a favourable reception by you, and has been frequently thought to merit a place in your journals and register-books. This has emboldened me to lay before you the following history.

CATHERINE FIELD, a girl in the Foundling Hospital, aged about seven Years, and otherwise a healthy child, having been disordered a few days with what were considered as complaints arising from worms, was observed, on Thursday, July 8, 1762, to open her mouth with great difficulty. This particular circumstance increased so much, that by the Sunday following, when I first saw her, her teeth were so much confined, it was with difficulty that even liquids could be admitted into her mouth. She had two days before parted with two worms, and had

attention to this interesting subject; they of the given substance to be examined being diameter and four-tenths of an inch thick. pieces of polished marble, and an interval of six inches in diameter were applied to each insulating edge of three inches wide. Plate prepared, in which a b is the plate, and c the cover of air was required, the opposed coatings by an inch in thickness, covered with tin foil and fit

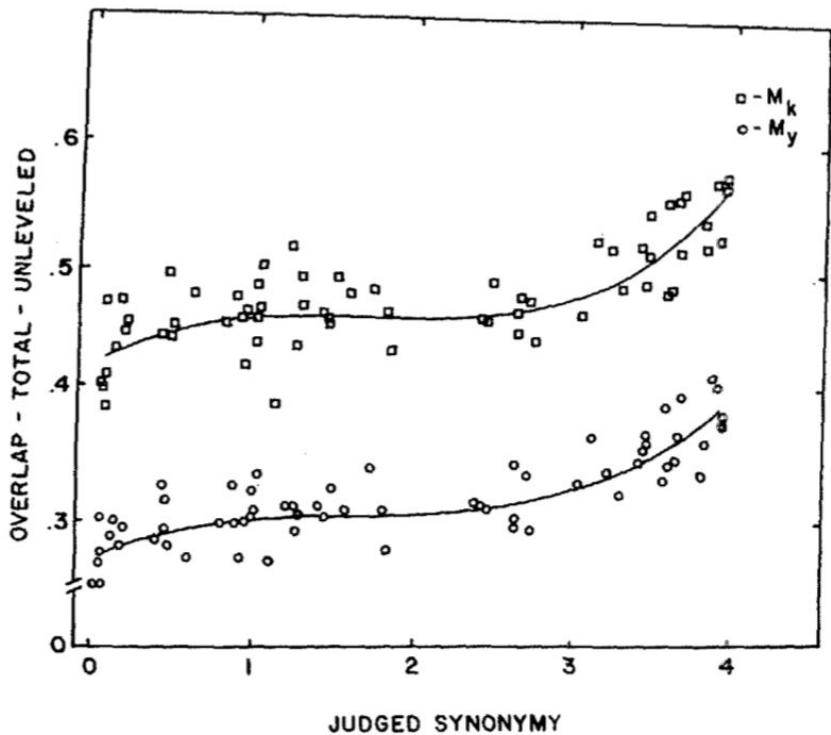
and which I have lately had an occasion more perfect manner, through the kindi

Distributionelle Hypothese

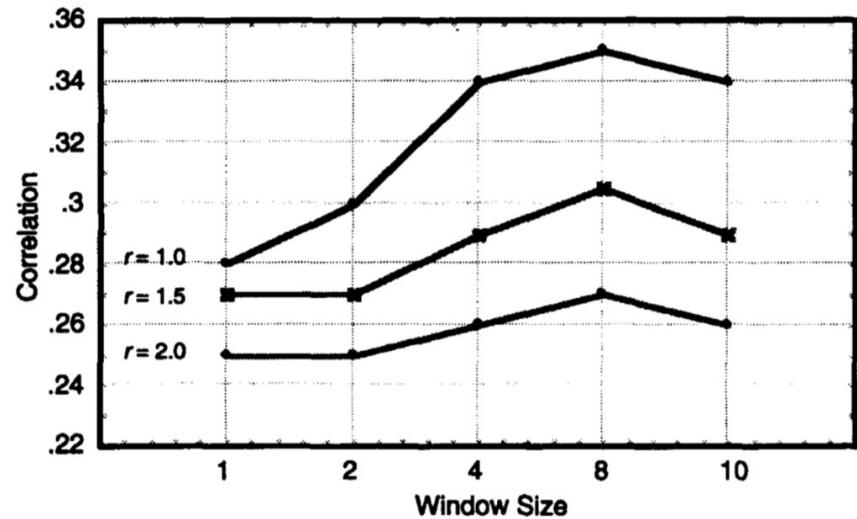
“If A and B have some environments in common and some not (e.g. oculist and lawyer) we say that they have different meanings, the amount of meaning difference corresponding roughly to the amount of difference in their environments.”

Harris, Distributional Structure, 1954

Experimentelle Belege



Rubenstein & Goodenough,
Com. ACM 8(10), 1965



Lund & Burgess,
Behavior Research
Methods 28(2), 1996

Word Embeddings mit SVD_{PPMI}

Verfahren: Levy et al., TACL 3, 2015

Beispiele: DTA 1871–1900

Wörter und Häufigkeit ihres Umfelds

	negativ	Funken	
elektrisch	81	43	...
Elektrizität	104	0	...
Feuer	0	3	
...			

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...			

PPMI

Wörter und Spezifität ihres Umfelds

	negativ	Funken	...
elektrisch	0,06	0,07	...
Elektrizität	0,09	0	...
Feuer	0	0,03	...
...			

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elektrisch	0,06	0,07	...
Elektrizität	0,09	0	...
Feuer	0	0,03	
...			

SVD

	1	...	500
elektrisch	0.0448	...	0.0358
Elektrizität	0.0382	...	-0.0336
Feuer	0.0534	...	-0.0388
...			

Wörter im Vektorraum

Word Embeddings mit SVD_{PPMI}

Verfahren: Levy et al., TACL 3, 2015

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Wörter und Häufigkeit ihres Umfelds

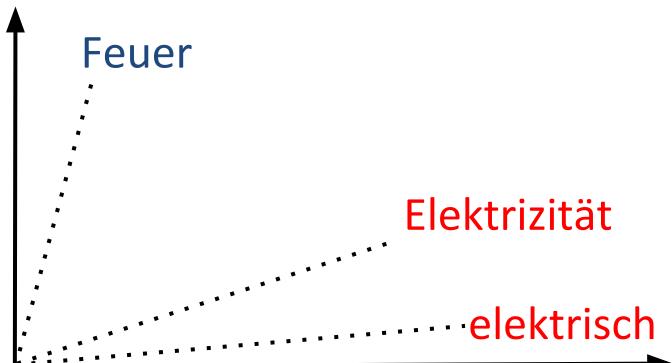
	negativ	Funken	
elektrisch	81	43	...
Elektrizität	104	0	...
Feuer	0	3	
...			

PPMI

Wörter und Spezifität ihres Umfelds

	negativ	Funken	
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...			

SVD



=

	1	...	500
elektrisch	0.0448	...	0.0358
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...			

Wortähnlichkeit und Position im Vektorraum

Wörter im Vektorraum

Welcome to JeSemE

The Jena Semantic Explorer

enter a word

Search

COHA DTA GB Fiction GB German RSC

JeSemE allows you to explore the semantic development of words over time. An interesting example is searching "heart" in the COHA corpus.

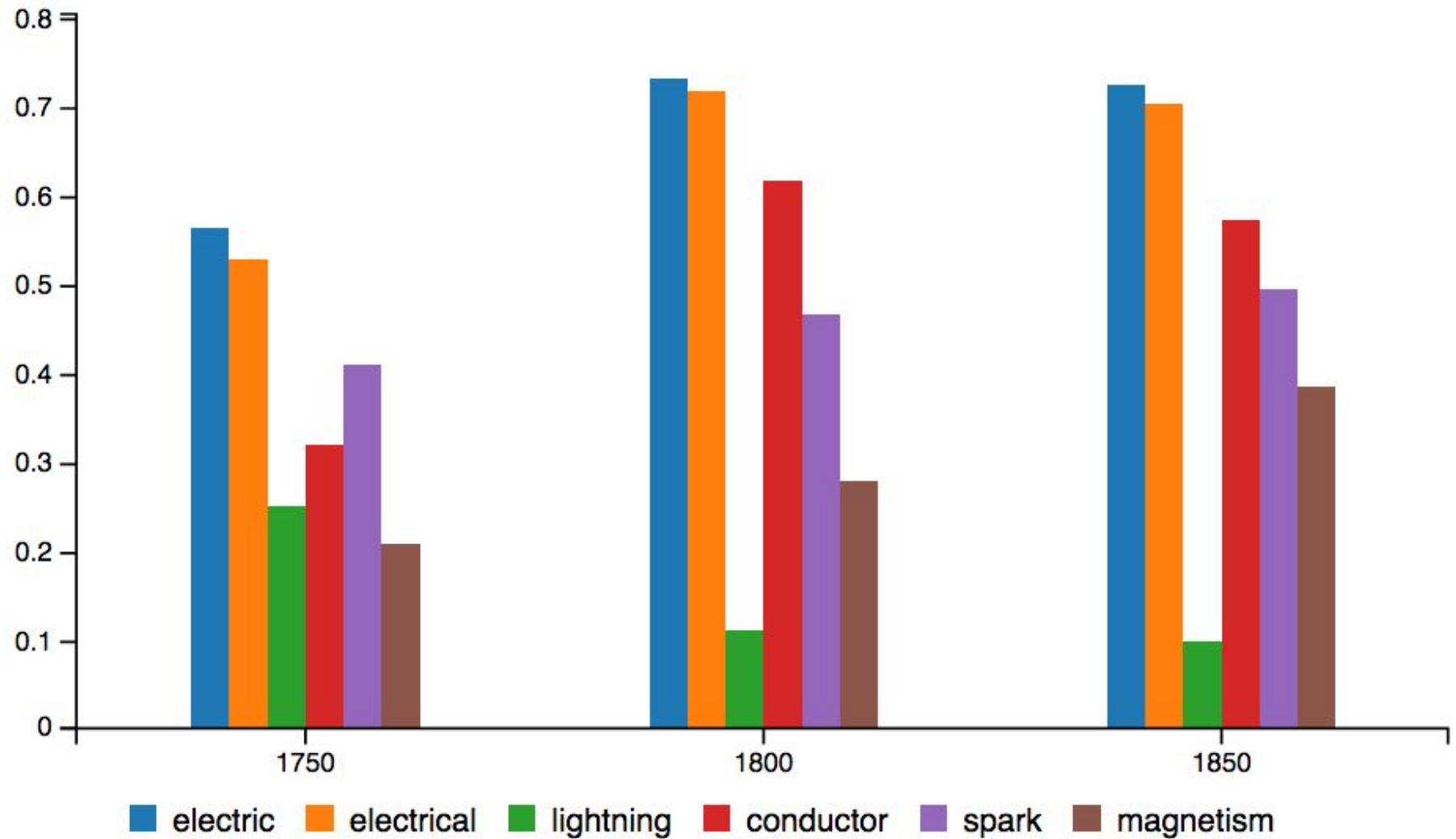
<http://jeseme.org/>

Johannes Hellrich & Udo Hahn: [Exploring Diachronic Lexical Semantics with JeSemE](#).
In: [ACL 2017](#), System Demonstrations. pp. 31-36.

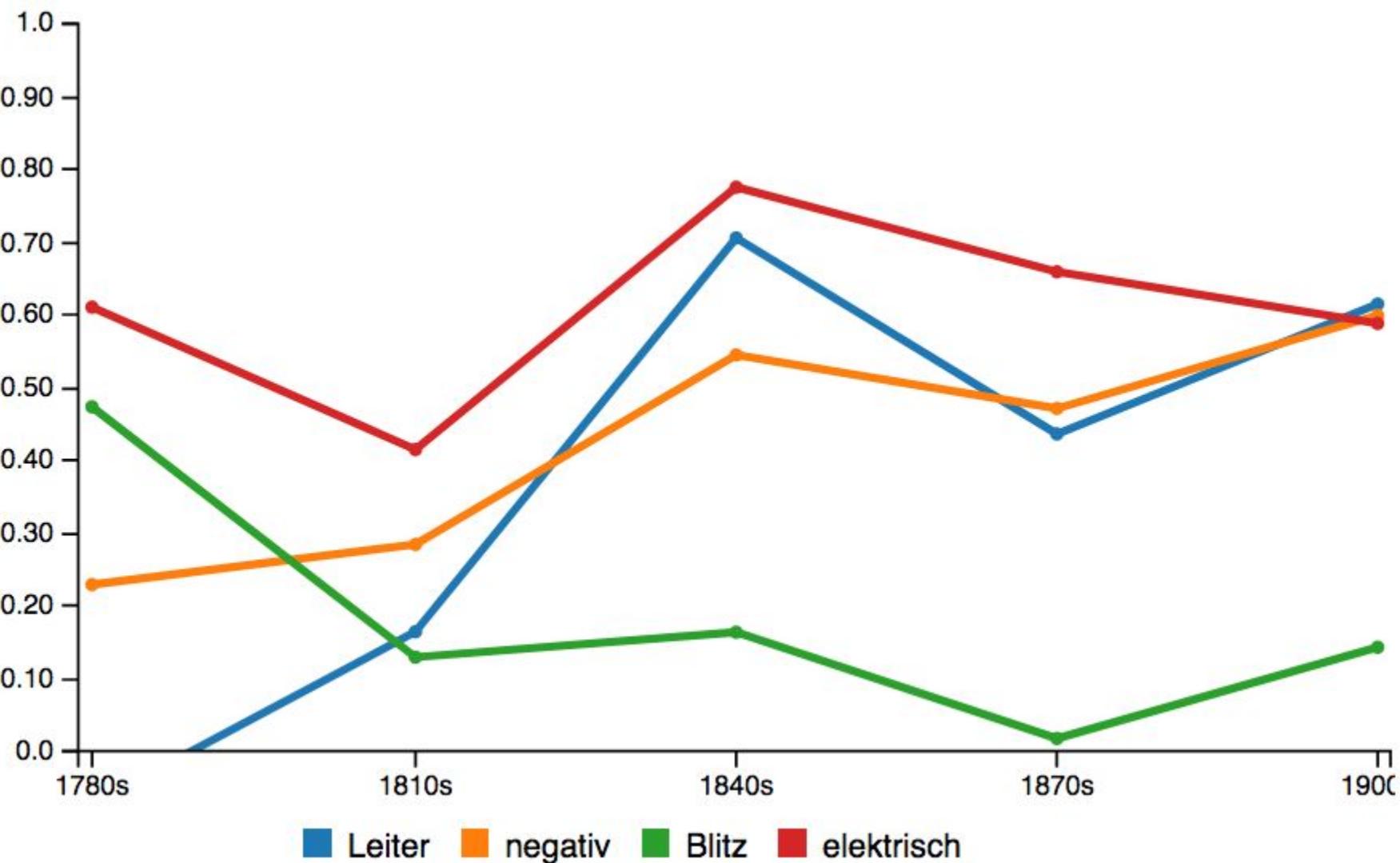
Verwendete Korpora

Korpus	Zeitraum	Wörter	Modellierte Wörter
Corpus of Historical American English	1830–2009	10^8	5.101
Deutsches Text Archiv (Geyken, 2013)	1751–1900	10^7	5.338
Google Books Fiction	1820–2009	10^{10}	6.492
Google Books German	1830–2009	10^9	4.449
Royal Society Corpus (Kermes u.a., 2016)	1750–1869	10^7	3.080

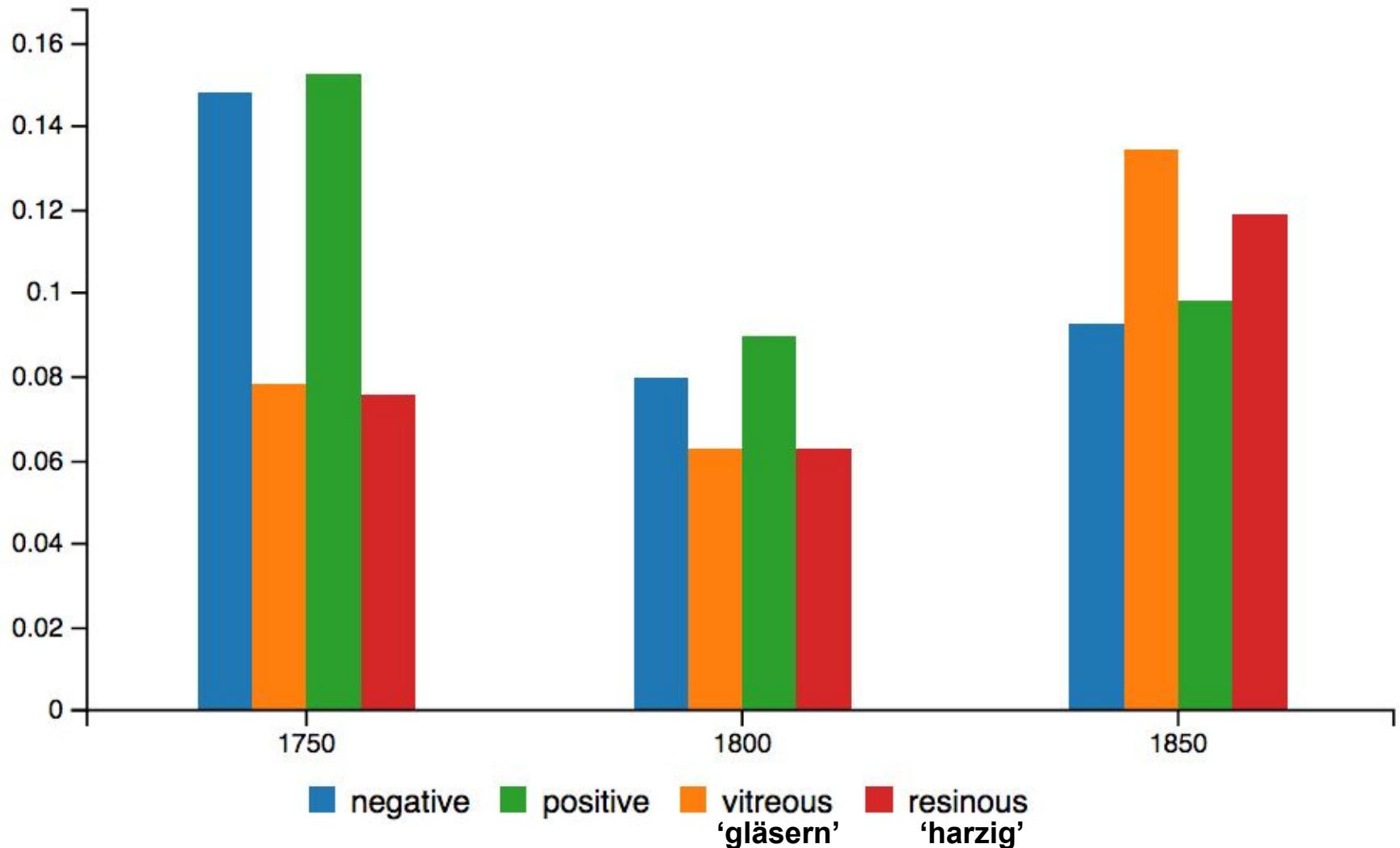
Ähnlichste Wörter für *electricity* im RSC



Ähnlichste Wörter für *Elektrizität* im DTA

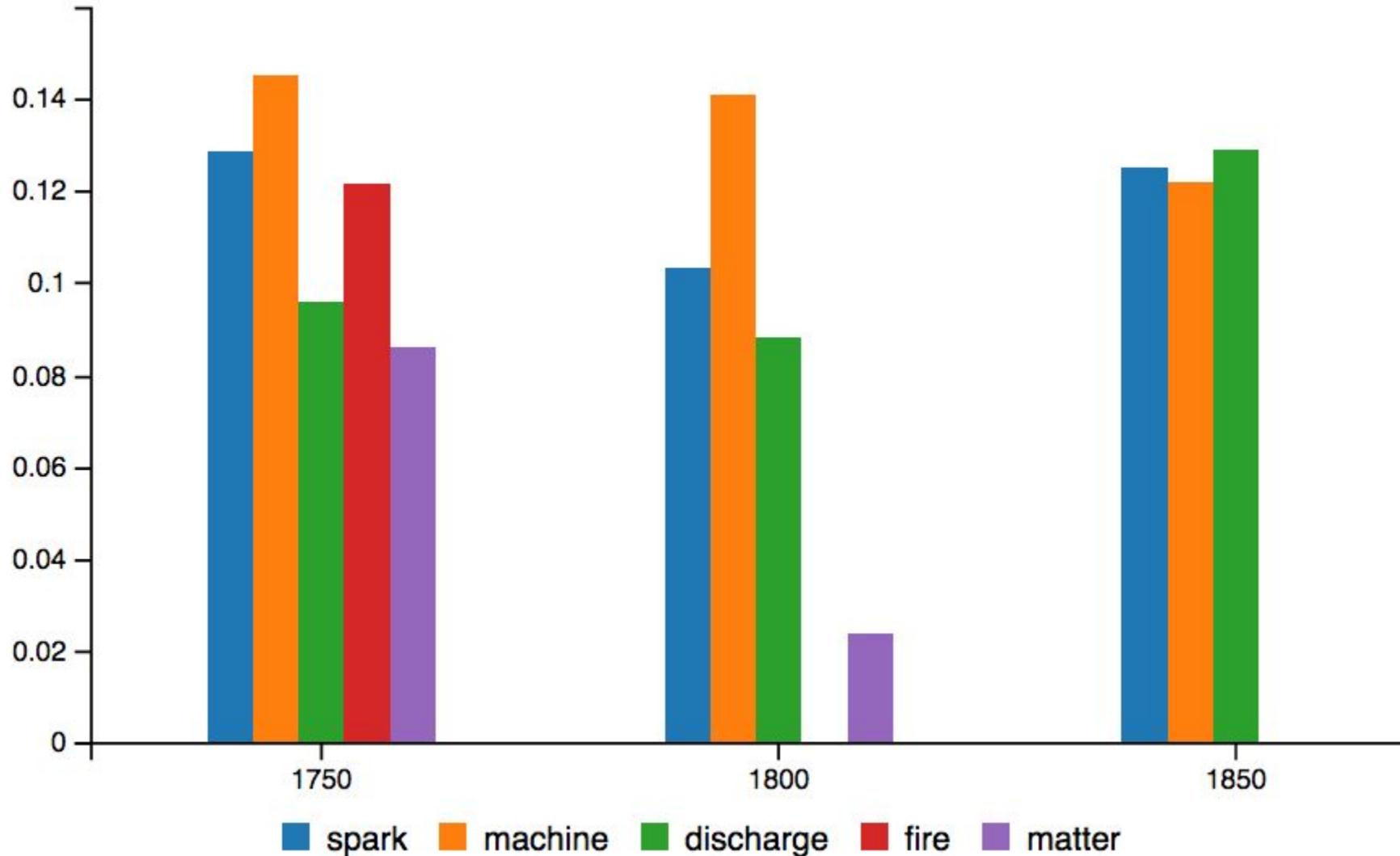


Spezifische Nachbarwörter für *electricity* im RSC

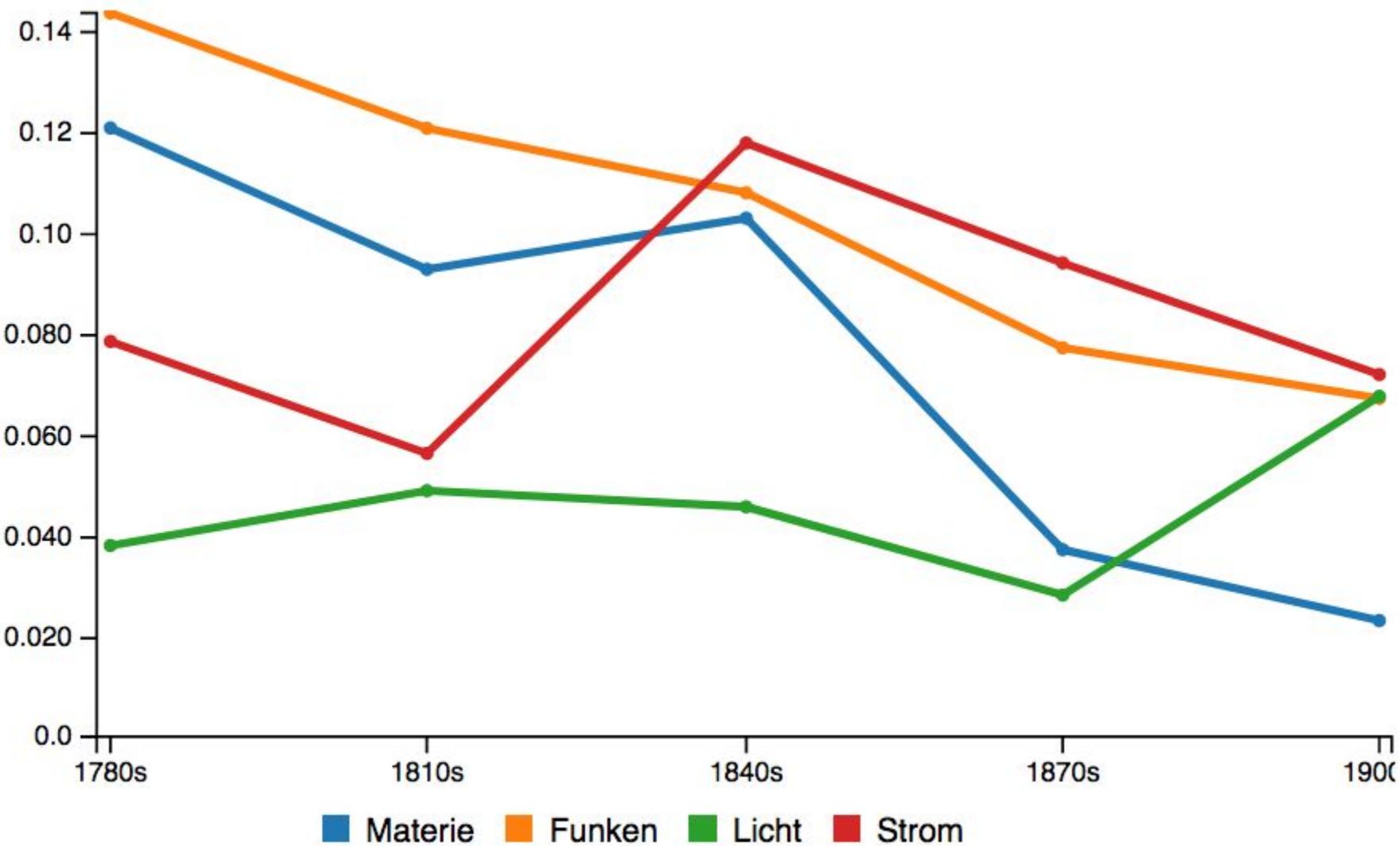




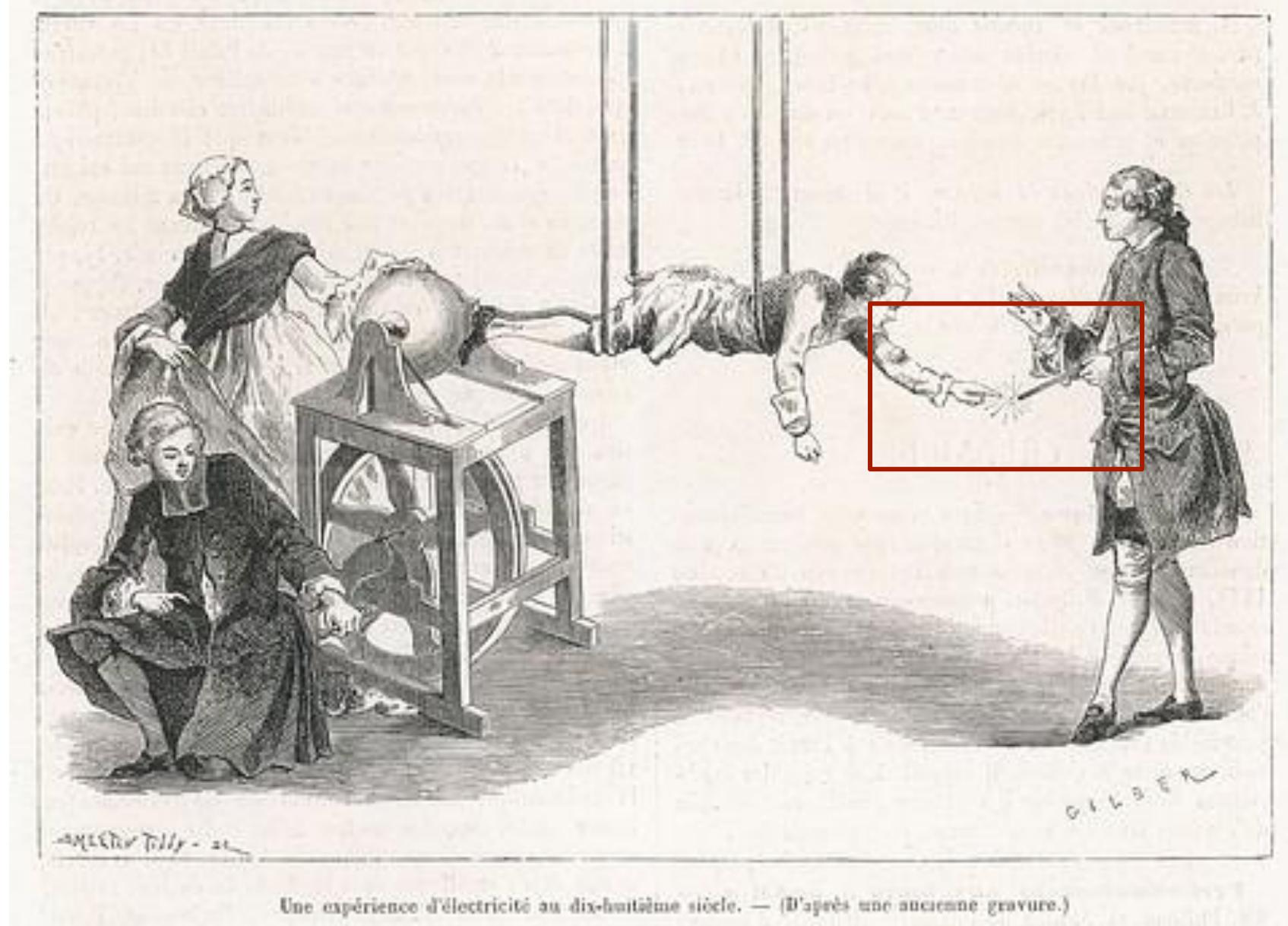
Spezifische Nachbarwörter für *electrical* im RSC



Spezifische Nachbarwörter für *elektrisch* im DTA



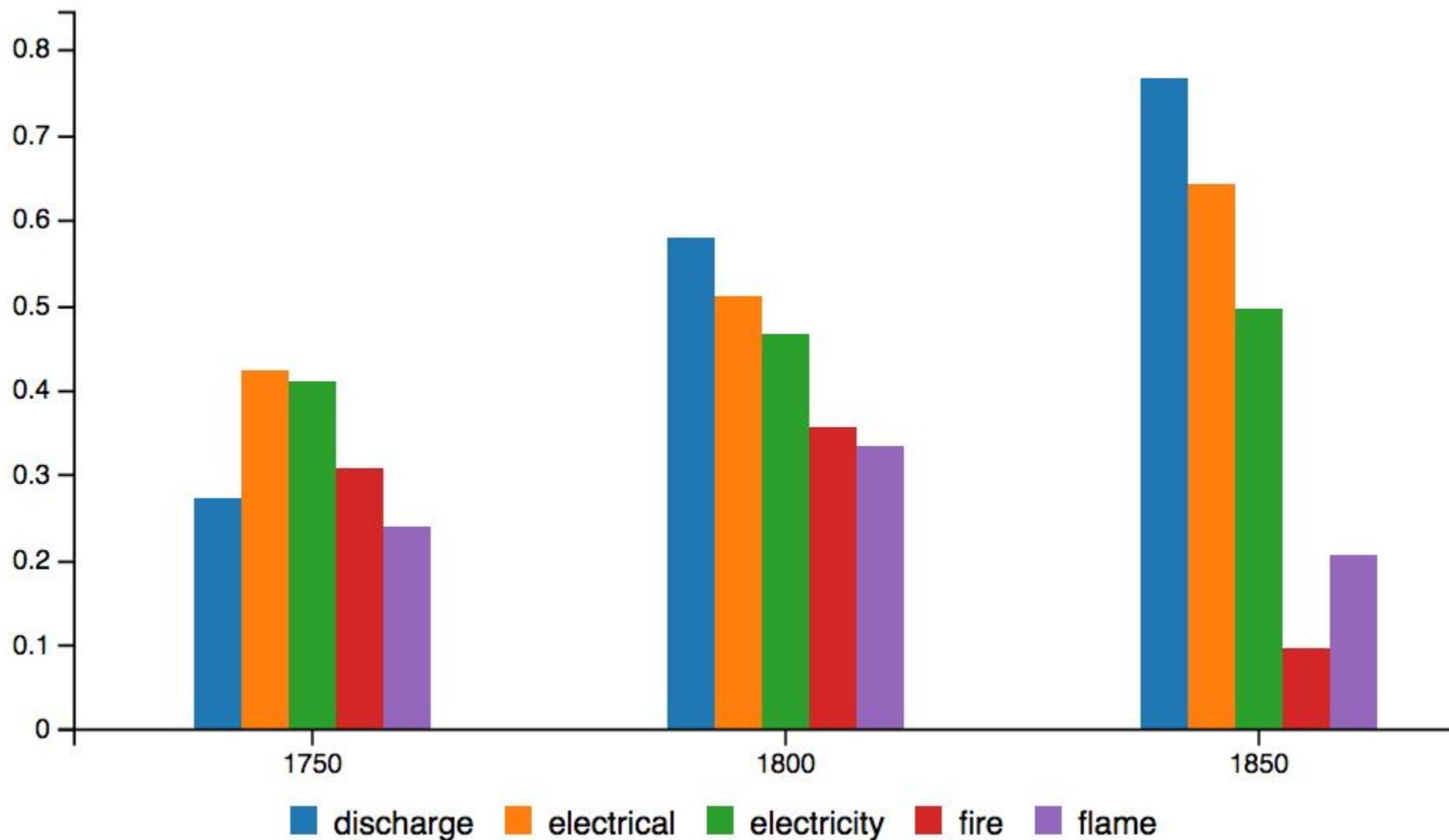




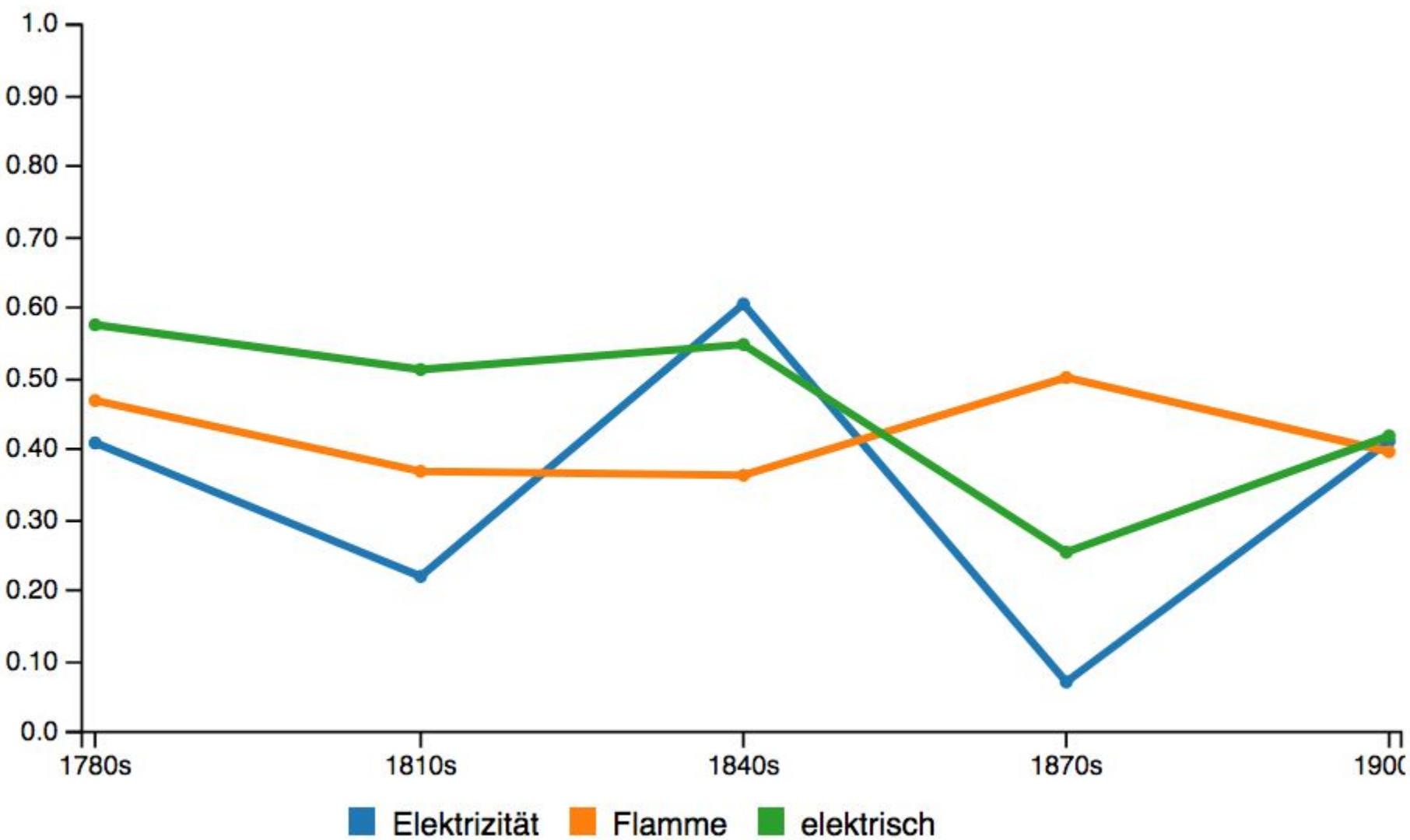
Une expérience d'électricité au dix-huitième siècle. — (D'après une ancienne gravure.)

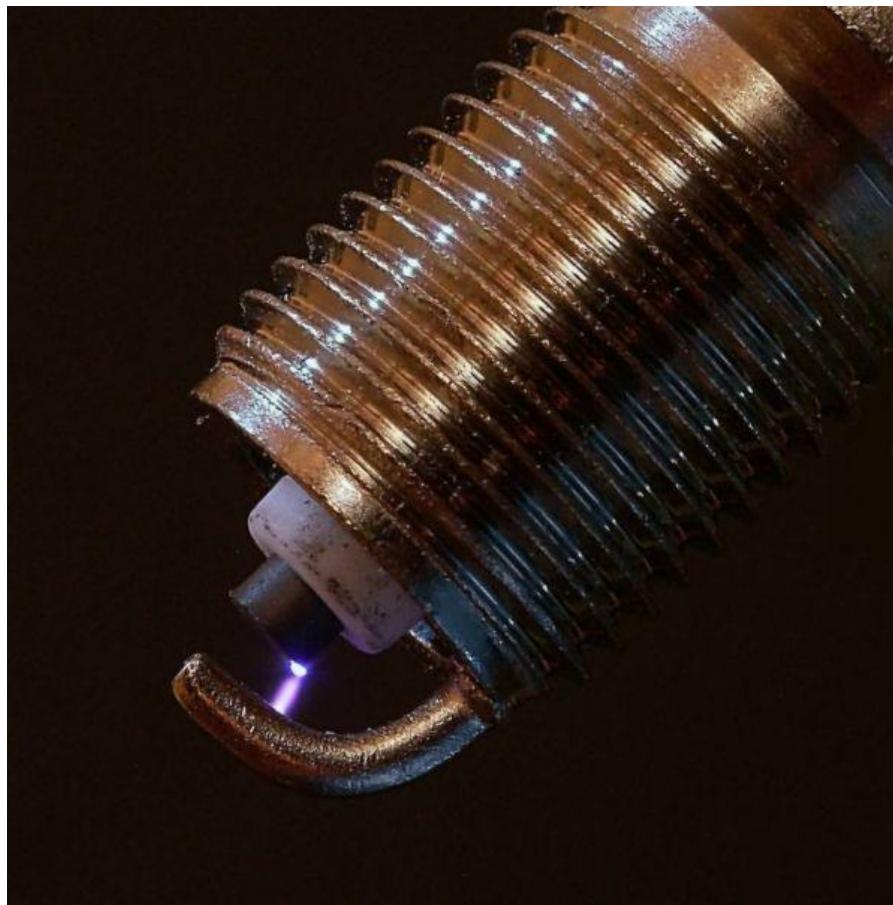
Gilber: Une expérience d'électricité au 18 siècle. 1812.

Ähnlichste Wörter für *spark* im RSC



Ähnlichste Wörter für *Funken* im DTA





Zündkerze. Wikimedia (Ralf Schumacher). 2005.

Fazit

- JeSemE ermöglicht es Wortwandel anhand modernster Methoden nachzuvollziehen
- Dadurch kann die Entwicklung wissenschaftlicher Begriffe in großen Textkorpora wie wissenschaftlichen Fachzeitschriften verfolgt werden
- Unsere Untersuchung spricht für die Validität des Verfahrens
- Desiderat: Exploration statt Bestätigung

Wenn der Funke überspringt – Word Embeddings im Dienst der Wissenschaftsgeschichte

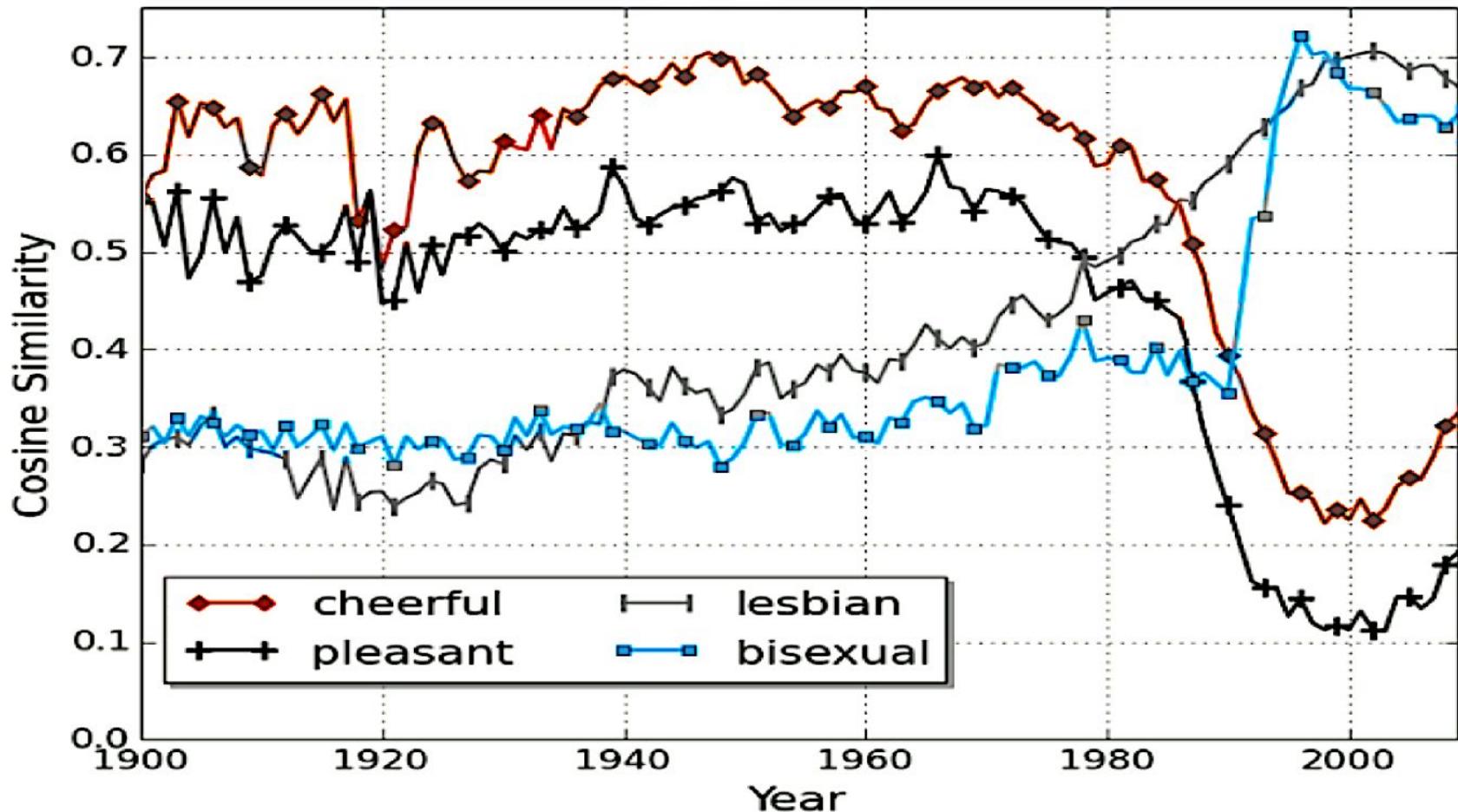
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Wortwandel und Word Embeddings

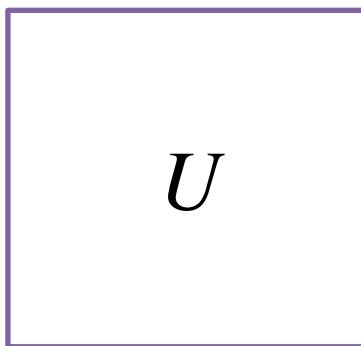
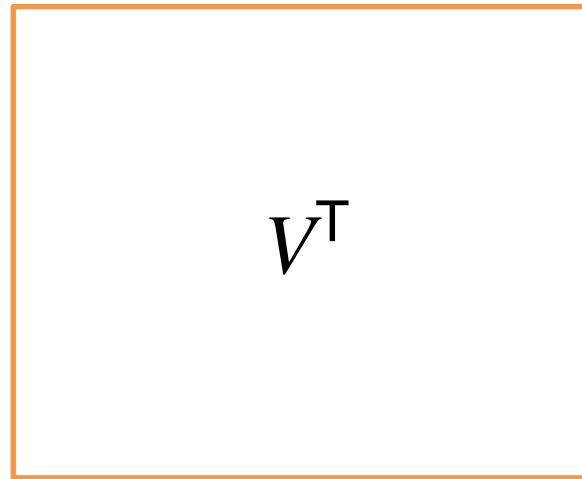
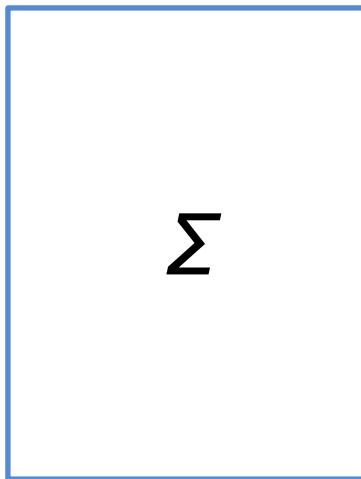


Kim et al.: Temporal analysis of language through neural language models. In: *Proceedings of the Workshop on Language Technologies and Computational Social Science @ ACL 2014*, 2014, pp. 61–65

PPMI

$$PPMI(i, j) := \max(\log\left(\frac{P(i, j)}{P(i)P(j)}\right), 0)$$

Singulärwertszerlegung



	Aachen	...
elektrisch	0	...
Elektrizität	0	...
Feuer	0	...

Ökonomische Singulärwertszerlegung

