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The change in science language as a result of transition from primary to secondary school

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The linguistic challenges of the transition from primary school to secondary school

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Background: the project

- Many students in England find the transition from primary to secondary school difficult (Brooks, 2016; DfE, 2011; Evangelou et al., 2008; Howe and Richards, 2011; Braund and Driver, 2005)

  - social reasons, larger school, tougher academic demands, …

  - **tougher linguistic demands?**

Academic school language

- “A set of registers through which schooling activities are accomplished” (Schleppegrell, 2012, p.413).
- Comprises overlapping subject-specific registers (Christie, 2002; Christie and Derewianka, 2008)

academic activities are associated with a kind of language that is different from that used in everyday activities

(Leung, 2014, p.137)

Project research questions

- How does the academic language of Key Stage 3 (KS3) differ from that of Key Stage 2 (KS2)?
- How does the language of both KS2 and KS3 differ from everyday language?
- How do teachers and students perceive the linguistic challenges of the transition from primary to secondary school?

Subjects: English, maths, science, history, geography

Features of language in science

School science inherits essential properties of professional science discourse, such as informational density, technicality, abstraction, and authoritativeness (Fang, 2006, p.493)

- Technical words that rarely appear in everyday language: *deciduous, Australopithecus*
- Ordinary words with non-vernacular meanings: *school, fault, "A mammal is a warm-blooded vertebrate that feeds its young milk." (p.495)*
- Prepositions, conjunctions and pronouns: "*An animal in hibernation survives <u>on</u> stored body fat." (p.495)*
- Subordinate clauses; lengthy sentence constructions; passive voice
- Abstract nouns/nominalisation: *to evaporate* becomes *evaporation*

Language of School Science (LSS)

Students have to learn to move between the "discourse communities" (Yore and Treagust, 2006, p.310) of home, school and science (Mercer et al., 2004; Lemke, 1990).

The change in science language as a result of transition from primary to secondary school

- How the science language demands faced by students in England change as a result of transition
- Exemplify challenge for students to understand polysemous words in a science context
- Implications for follow-up research on students' learning of science language and implications for teacher development, and how corpus analysis can contribute to these

Project data

13 schools contributed data, across the North of England: 5 secondary schools, 8 primary schools (5 of the primary schools ‘feed’ 3 of the secondary schools)

1. Written data (Key Stage 2 and Key Stage 3)
   - Worksheets
   - Textbooks
   - Exams and assessment tasks
   - Lesson presentations
   - Vocabulary/glossary booklets

2. Spoken data (Key Stage 2 and Key Stage 3)
   - Audio recordings of lessons: teacher utterances only

3. Interviews with students and teachers for qualitative analysis
   - students: 5 focus groups of 6 Students; twice in Y6 and again in Y7
   - Teachers: individual interviews with 7 teachers

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Corpora

Main divisions
Key Stage 2/ Key Stage 3
Written/ Spoken

Written corpus: 1.9 million tokens
Key Stage 2: approx. 800,000 tokens;
Key Stage 3: approx. 1,100,000 tokens

Spoken corpus: 600,000 tokens
split roughly equally between Key Stage 2 and Key Stage 3

BNC2014 Baby+: 5 million tokens

Data analysis

- A sequential mixed-methods research design

- Analysis of interviews with students

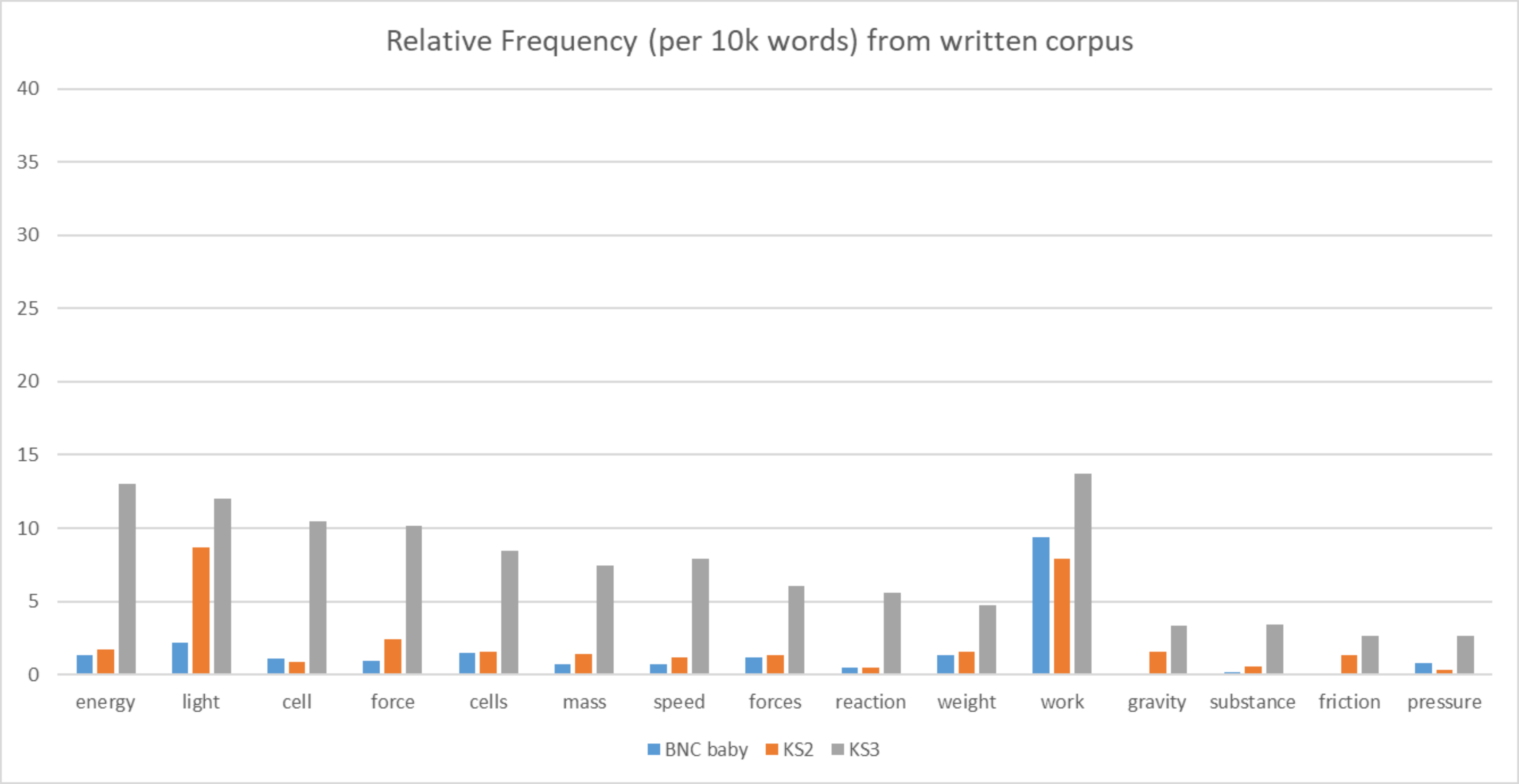
- Analysis of classroom data, using free text analysis toolkit LancsBox (Brezina, Timperley and McEnery, 2018)

“Table 2.3 One way of grouping science words” (Wellington and Osborne, 2001, p.18)

Scientific words		Semi-technical words		Non-technical words but widely used in science	
Words unique to science	Those with everyday meanings too	With one meaning only	With dual meanings	One meaning	Dual meaning
Cathode Anode Electrolysis Refraction Diffraction Ion Electron Atom Neutron velocity	energy power work efficient conduct reflection law contact theory field circuit charge cycle filament substance impulse weight mass massive beam pitch friction potential producer consumer	emit excess exert immerse repel optimum component displace probability impact continuous definition diverge converge gain random flow deflect principle principal particle	naked reverse positive average negative excite incident characteristic static fair material light valid reproduce key property neutral relative contract	crucial linear maximum omit minimum modify source alter relevant factor sufficient supply appropriate estimate external internal limit adjacent	standard contrast effect volume application crude transfer complex initial substitute dependent tendency agent rate

Findings 1

- More polysemous words with science-specific meanings at Key Stage 3 (11-14)



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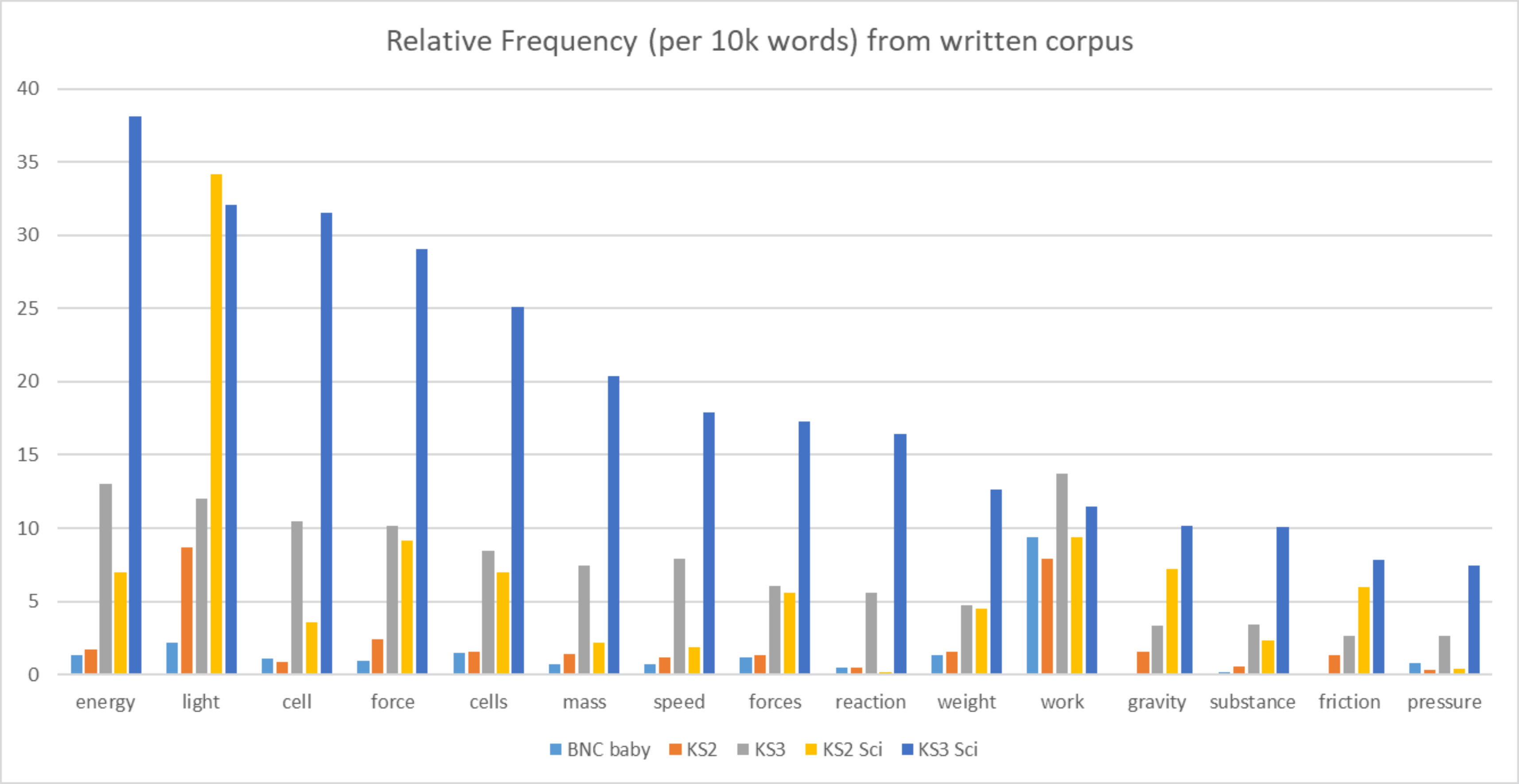


Polysemy - Energy

- we've seen exactly why the Government need to put more energy into tackling problems in our schools. (BNC baby)
- …hit the trigger. A pulse of blue energy crossed the room in a clean, straight line (BNC baby)
- It takes more energy to separate water molecules (Sci Y7)
- The mechanical energy of motion, e, of a car is proportional to the square of its velocity (Maths Y7)
- Breakfast is known as the most important meal of the day; it gives you energy and fuel and therefore powers you for the morning. (Eng Y6)
- The anti-slavery campaign continued but lost direction and energy (Hist Y8)
- So, this is poverty. Coping with it takes all my energy. (Geog Y8)

Polysemy - Light

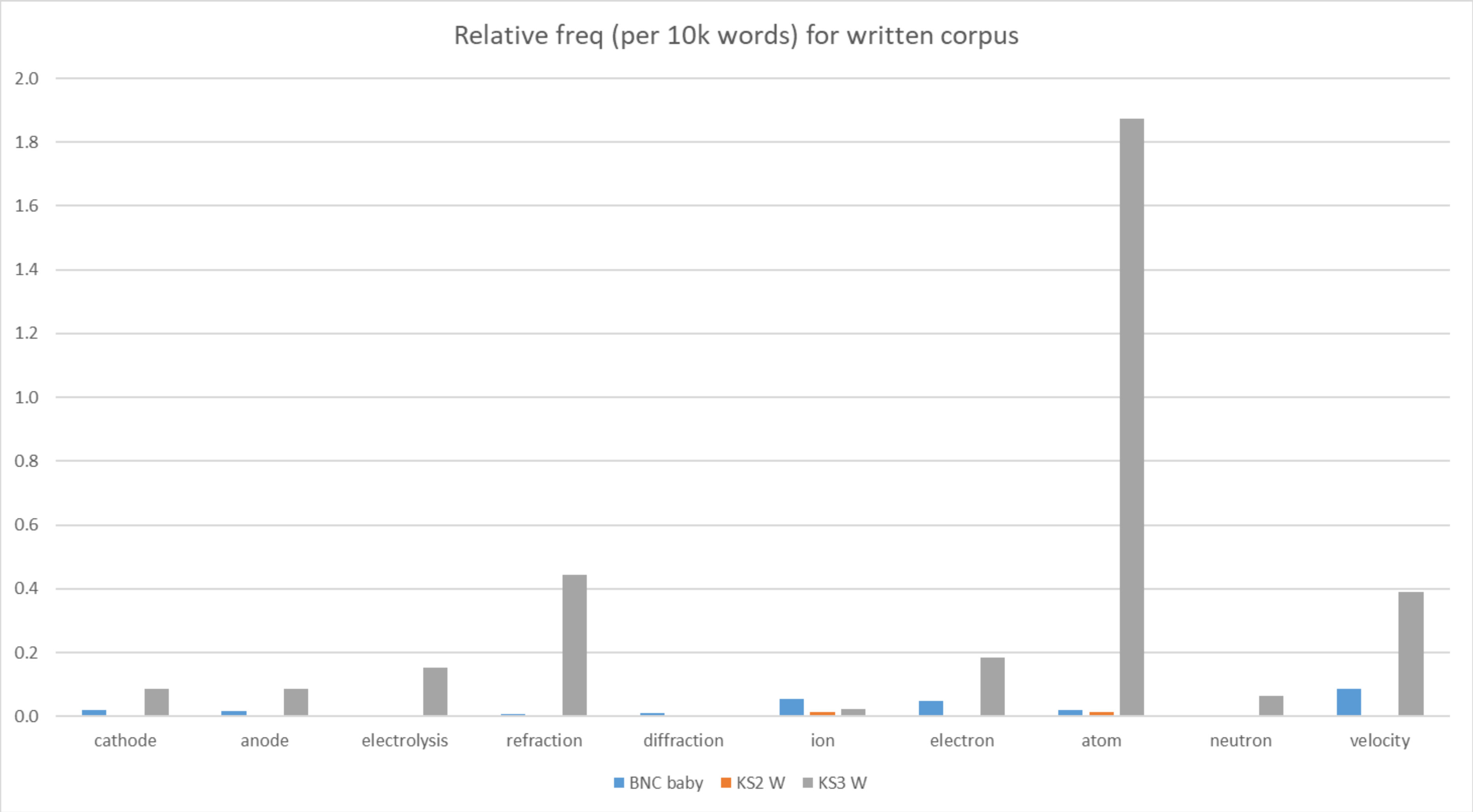
- If only school teachers could engage pupils with such a light touch and amusing voice. (BNC baby)
- Good light reading, written to entertain and inform. (BNC baby)
- In the absence of demerara, light or dark brown sugar will also do the trick. (BNC news)
- Shiny surfaces reflect light better than dull surfaces. (Sci Y6)
- Water lily Palm tree seeds are very light which helps them float. (Sci Y5)

Polysemy - Cell

- I have in my bag the cell phone that… (BNC baby)
- to be the leader of the IRA's cell in Birmingham. (BNC baby)
- Later that night, she appeared outside his cell. (Eng Y5)
- the bees then cover the cell with a wax cap (Sci Y5)
- the black cross in the bottom right corner of the cell. Side= C2/A2 Perimeter= (A2+B2)*2 (Maths Y6)
- A battery is a type of cell (Sci Y6)
- Plant cells have a cell wall. Animal cells don't. (Sci Y7)
- a cell is anything that produces a potential difference […] solar cell: chemical cell: fruit cell: (Sci Y7)
- the use of […] hydrogen in fuel cell vehicles. (Sci Y8)

Findings 2

- More science technical words at Key Stage 3



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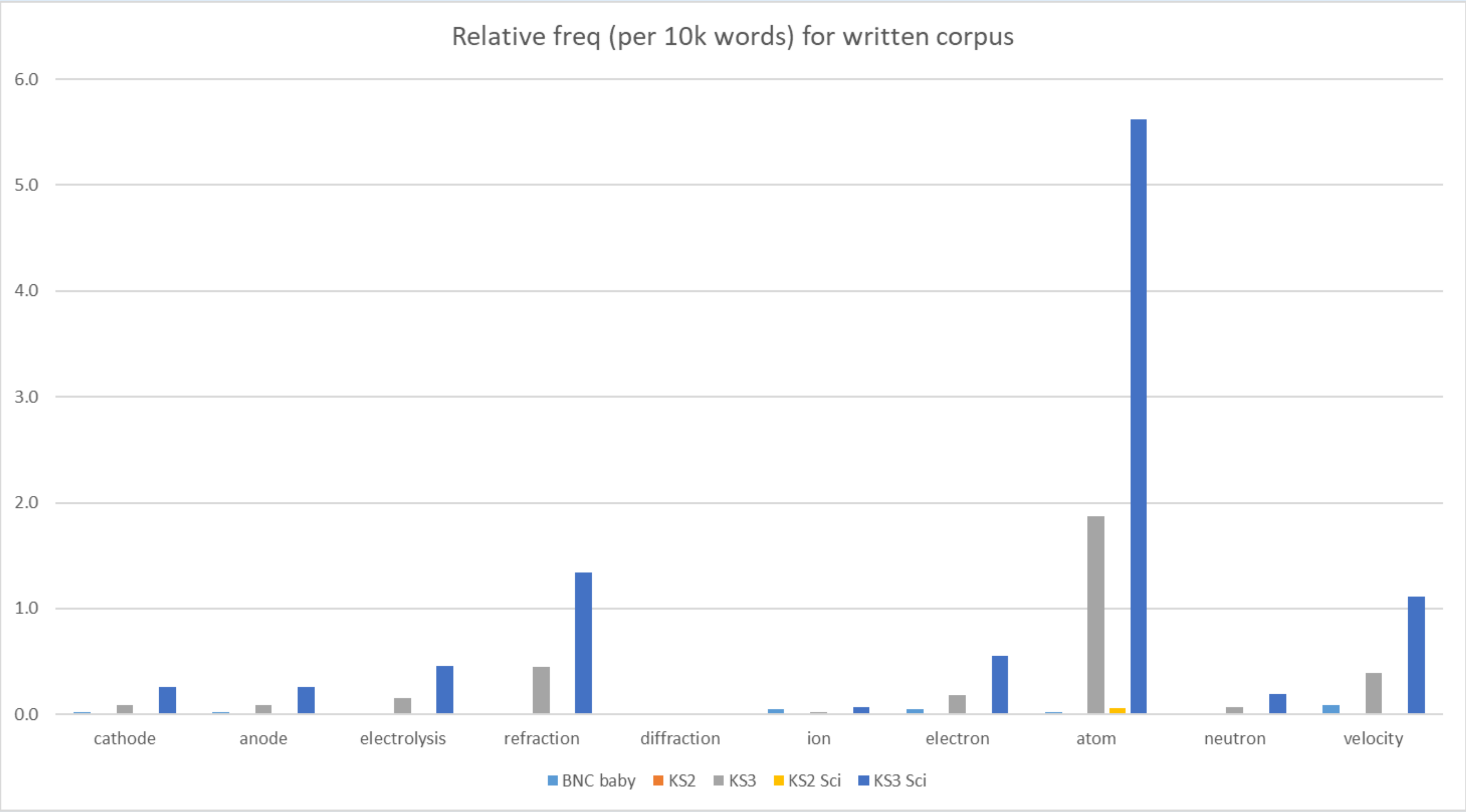

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How much current will flow around a circuit?

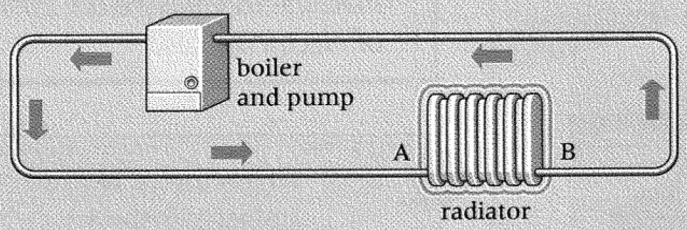
All materials are made of tiny particles called **atoms**, and all atoms have even smaller particles called **electrons** inside them. In some materials the electrons can move around easily. An **electric current** is a flow of electrons, and carries **electrical energy**.

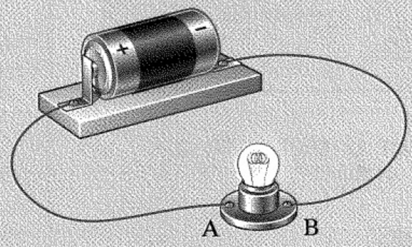
Metals are conductors because the electrons can move around easily inside them. Electrons cannot move around inside insulating materials.

It is difficult to think about electrons, because they are too small to see, even with a very powerful microscope. We can use a **model** to help us to think about electricity.

> **1** What is an electric current?

> **2** Why are metals conductors?





Central heating model	Electricity in a circuit
A central heating system can keep your house warm.	This circuit can provide light energy.
The boiler transfers heat energy to the water, and a pump pushes the water through the pipes.	The cell transfers energy to the electrons and pushes them through the wires.
The pipes let the hot water flow through them.	The wires are good conductors and let electrons flow through them.
In the radiator, heat energy is transferred from the hot water to the room.	In the bulb, electrical energy is transferred to the room as light and heat energy.
All the water stays in the pipes. If you measured the amount of water *flowing*, you would get the same reading at A and B. But the water at B would have less heat energy than the water at A.	All the electrons stay in the wires. If you measure the current (the amount of electricity *flowing*) you get the same reading at A and B. The current at B has less energy.

Model

(Rel Freqs BNC 1.8113, KS2 Sci 1.5105, KS3 Sci 4.1494)

Researcher: what is a model?

Margaret: like a picture

Jimmy: it's like a mini thing that's like it could be like it's fake but it looks real…like a model of a bike would be fake and you couldn't ride it and you'd probably crush it

Steve: like a fake version of something I don't know

Concentration

(Rel Freqs BNC 0.3702, KS2 Sci 0.0604, KS3 Sci 1.5029)

When like it’s when stuff are really high?

It means to like focus?

It means to focus and you’re not distracted

There’s concentration for focus … but there’s concentration camp

I thought concentration was where you concentrate on something or is that not the meaning in this text?

Energy

(Rel Freqs BNC 1.3256, KS2 Sci 7.0089, KS3 Sci 38.1288)

- *Mel (Y6): it’s like what you get so that you’ve got energy to do things it’s like when you can do stuff*
- *Mel (Y7): it’s like what makes you like move*

- *Andy (Y6): isn’t it the force when something is happening? so like I can’t think it’s you need energy could be used as a synonym for force*
- *Andy (Y7): can’t you measure it in volts and amps I think it’s called*

- *Bill (Y7): like sometimes like when you play football you run around a lot like you need to get a breather and then when you breathe like your energy comes back to you* rch energy **Occurrences** 1,202 (13.02) Texts 139/2,113 **▼ Corpus** KS3 written **▼ Context** 7 **▼ Disp**

File	Left	Node	Right
Geography_ye:	power station and supplies all of Svalbard's	energy	needs. Environmentalists believe the power station sho
Geography_ye:	he most likely future source being geothermal	energy,	tapping into the heat of the Earth
Geography_ye:	lectricity. Like Iceland, which uses geothermal	energy,	Svalbard is located close to the Mid-Atlantic
Geography_ye:	poverty. Coping with it takes all my	energy.	But we will survive, and I will
Geography_ye:	not produce flowers as this wastes vital	energy.	...have no roots as they collect water
Geography_ye:	not produce flowers as this wastes vital	energy.	...have no roots as they collect water
Geography_ye:	water. The fat can be metabolised for	energy.	6.Camels feetare wide so they can walk
Geography_ye:	nomadic tribes (c)Logging, mineral extraction,	energy	development, illegal wildlife trade (d)Nomadic tribes, ro
Geography_ye:	nomadic tribes (c)Logging, mineral extraction,	energy	development, illegal wildlife trade (d)Nomadic tribes, ro
History_year_8	ery campaign continued but lost direction and	energy.	It was revived after 1823 when a
Maths_year_7_	diameter of a hydrogen atom Joule- kinetic	energy	of a table tennis ball travelling at
Maths_year_7_	to its radius, r. c) The mechanical	energy	of motion, e, of a car is
Maths_year_8_	ke. What has been the percentage decrease?	Energy	bills have risen on average by 37%
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Science_year_	very weak. Your brain doesn't get enough	energy	because your blood isn't bringing it enough
Science_year_	oxygen. When your brain is short of	energy	it only does essential jobs like keeping
Science_year_	1. Which chemicals give your brain the	energy	to do its jobs? 2. Where these
Science_year_	over your body would (run out of	energy	and) die. NO--> Award level 5 and
Science_year_	leg a) supports its body b) stores	energy	c) allows movement 4 The white sticky
Science_year_	leg a) supports its body b) stores	energy	c) allows movement 4 The white sticky

ch energy **Occurrences** 666 (1.33) Texts 12/13 ▼ **Corpus** BNC2014-baby ▼ **Context** 7

File	Left	Node	Right
Elan	I can't even be bothered to waste	energy	speaking to anyone. If I happen to
Elan	odd days when I have had some	energy	and have gone to the gym but
Elan	who still struggle daily with lack of	energy,	constantly catching bugs, worn out. Unfortunately there
Elan	it is it's like someone unplugs the	energy	to my brain! Weird. All in all
Elan	to get going first! I have the	energy	to do what I want, I've found,
Elan	40% of the wind wave and solar	energy	production. 60% of the fish landings. 30%
Elan	have 25% of Europe's wave and wind	energy	potential. And finally we are blessed to
Elan	Scotland. And I imagine that any wind	energy	production of an independent Scotland would be
Elan	everywhere for a week. Didn't have the	energy	to post. After five days I got
Elan	want to do but cannot summon the	energy.	Soooo frustrating! Early morning again. Great being
Elan	)t. That. Bad.? DEPRESSION Dwindling	energy	struggles to survive, While interest wanes in
Elan	that's their choice. I think it's wasted	energy	but to each their own. It is
Elan	Thank féck for Luisa She keeps the	energy	going it seems Yeh in all weathers.
Elan	be so careful nowadays). Your positive	energy	radiates. I like your 'onwards and upwards'
Elan	and lots and lots of peoples time	energy	belief and heart behind them. If you
Elan	many covered in the book such as	energy	saving for business, common agricultural policy etc.
Elan	good to go.Great value for money also	energy	efficient and it's extremley easy to use
Elan	Its so annoying I spend half my	energy	doing that and undoing it. This meme
Elan	I wish I had the momentum or	energy	to do it. Hope you're eating well
Elan	I'll promise to upload but have no	energy	to do) WERK THE CAMERA DAAAAARLING MOTHER
Elan	the North West. and I return the	energy	with equal enthusiasm Hahahaha I'm loving this

Observations

- Polysemous words that have science-specific meanings tend to be "interpreted by students with reference to their general and already known meanings" (Deignan et al., 2019, p.21).
- As a result, students are often over-confident about their understanding of these words. *(model, energy)*

- Science technical words occur far less frequently in school science than polysemous words with science-specific uses.
  - polysemous words present the greater pedagogical challenge

- Students tend to regard successful reading as being able to recall and use science words rather than having a deep understanding of them

Implications

A taxonomy of the words of science (Wellington and Osborne, 2001, p.20)

Level 1: Naming words *(trachea, vertebra, pollen, spatula, conical flask)* 1.1 Familiar objects, new names 1.2 New objects, new names 1.3 Names of chemical elements 1.4 Other nomenclature
Level 2: Process words 2.1 Capable of ostensive definition i.e. being shown *(combustion, evaporation)* 2.2. Not capable of ostensive definition *(evolution)*
Level 3: Concept words 3.1 Derived from experience (sensory concepts) *(red)* 3.2 With dual meaning, i.e. everyday and scientific *(work, energy, power, salt, heat)* 3.3 Theoretical constructs (total abstractions, idealisations and postulated entities) *(atom, frictionless body, electron, valency, mass)*
Level 4: Mathematical 'words' and symbols

Implications

- Science teachers need to know about the features of science language
- Conceptual words in science with everyday meanings need to be taught very carefully (Wellington and Osborne's 'level 3' words)
- This taxonomy could be developed to support other science language approaches (e.g. Nunes et al., 2017) to include examples of different uses of polysemous words likely to be encountered in school science and the words they are most commonly associated with

Questions

- Within the constraints of a complex and changing initial teacher education landscape in England that (over-) emphasises school-based experience, how can new science teachers and those who teach them be better prepared to teach language?
- How can corpus linguistics be used to improve practice beyond describing where we are now?

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