

Exploring the Structure of AI-Induced Language Change in Scientific English

Abstract

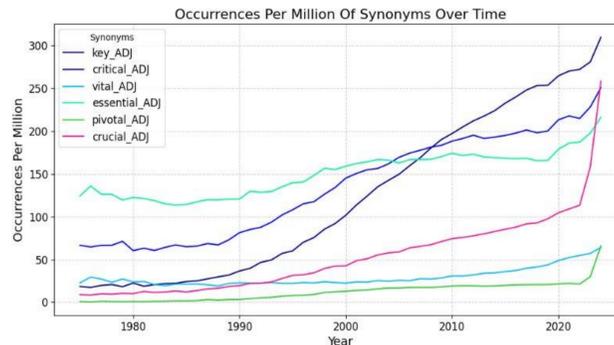
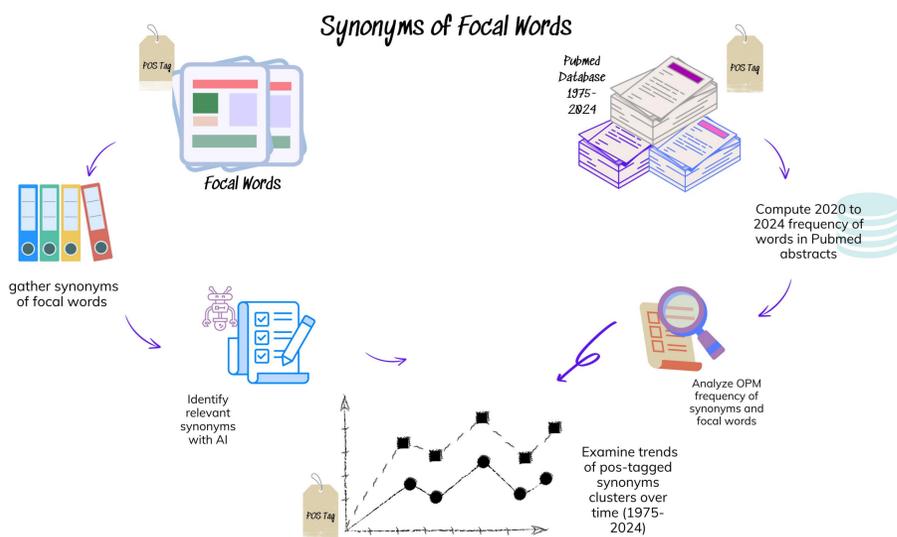
- **Recent Shifts in Scientific English:** Words like “delve,” “intricate,” and “crucial” have seen large spikes in frequency since 2022, likely influenced by Large Language Models.
- **Investigating Structural Changes:** This research examines whether spiking words replace synonyms (e.g., “crucial” replacing “essential”) or reflect broader semantic and pragmatic shifts.
- **Methodology:** We analyze PubMed abstracts using part-of-speech (POS) tagging to track shifts across grammatical categories, synonym groups, and words showing unexplained decreases in frequency.
- **Findings:** Entire semantic clusters tend to shift together rather than individual words replacing synonyms.
- **Implications:** LLM-induced language change appears to be semantic and pragmatic rather than purely lexical, aligning with patterns of organic language evolution.

Introduction

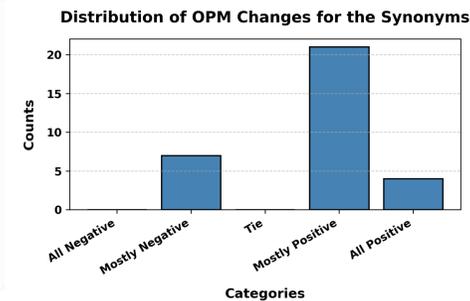
- Scientific English is undergoing rapid and unprecedented linguistic changes.
- Certain words (e.g., “delve,” “intricate,” “crucial”) have spiked in frequency since around 2022, likely influenced by Large Language Models (LLMs).
- This study investigates whether spiking words replace synonyms or introduce broader semantic and pragmatic shifts.

Methods: Synonyms

- **Data:** Abstracts from the PubMed database (years 1975–2024), applied part-of-speech tagging.
 - Years 2020 - 2024 were used to inspect recent frequency trends, likely due to influence of Large Language Models.
- **Hypothesis:** We begin with the “replacement hypothesis” as the null hypothesis, where the rapid increase of one word may be accompanied by a corresponding decrease in its semantic neighbors.
- **Methods:**
 - Compiled a list of “focal words,” widely discussed in the literature as seeing recent spikes in usage due to AI and systematically identified synonyms through the method shown below.
 - Measured change in frequency, occurrences per million, and significance (chi-square contingency test) of the synonyms and focal words from 2020 - 2024.
 - Graphed the frequency of synonyms and focal words over time (1975-2024) to analyze long-term usage trends and semantic shifts.



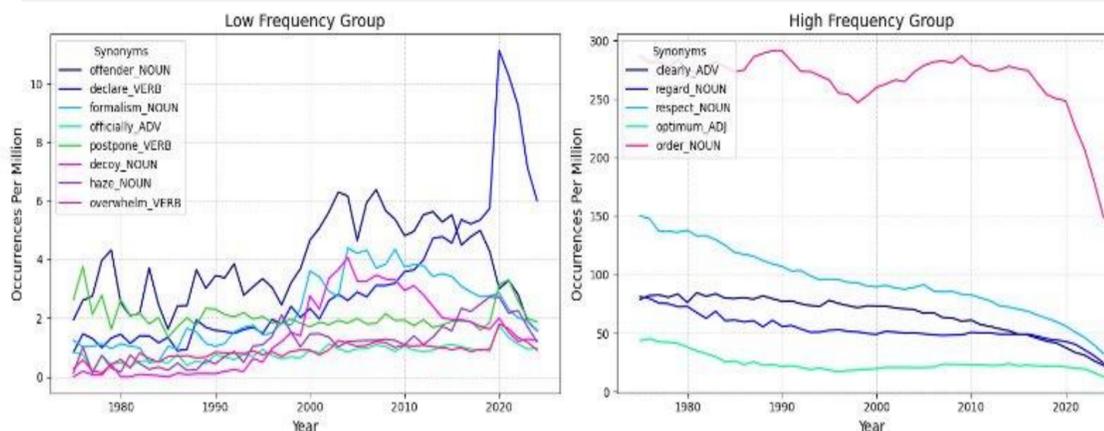
Trends in the occurrences per million words of the adjective “crucial” and five of its synonyms in PubMed abstracts over time. The large spike in frequency of “crucial,” identified in the literature as presumably due to AI, is followed by its synonyms.



The distribution of how, for any given focal word, its four to five synonyms change in frequency.

Methods: Decreases

- We hypothesize that, similar to how LLMs strongly favor certain words, they may equally disfavor others.
 - Compare frequencies of POS tagged words from 2020 - 2024 PubMed abstracts. Identify words that experience significant decreases in this time period.
 - Systematically create AI generated abstracts by querying ChatGPT 4.0 mini and compare word frequencies of the AI and the PubMed 2020 abstracts.
 - Identify words experiencing significant decreases from 2020-2024. If these words also experienced significant decreases in AI abstracts, they are “focal words.”
 - Analyze long-term trends of focal words using 1975-2024 POS tagged frequency data.



Trends in occurrences per million words for the 13 focal words in PubMed abstracts that displayed the largest decrease in usage between 2020 and 2024.

Part of Speech Tagging

- **Use:** Certain entries in the literature are grammatically ambiguous. For example, when the literature discusses “emphasizing,” this could either be the adjective form (“emphasizing ADJ”) or the verb form (“emphasize VERB”).
- **Methods:** spaCy, a POS-tagging library with Python code.
- **Importance:** We observe that for the nouns identified through the disambiguation of entries discussed in the literature, while they all show increases in usage, due to low occurrences per million, they do not contribute meaningfully.

Results

Synonyms:

- Synonyms tend to spike in clusters, for example the synonyms of “crucial_ADJ,” experienced similar spikes in frequency rather than one word causing related words to decline.
- POS tagging shows that AI-induced changes primarily affect adjectives, adverbs, and verbs rather than content-heavy nouns, however, we do not think the low information density is inherent to the words themselves: “crucial,” “meticulously,” “advancement” could, in principle, be of high information content, if their meaning was supported by specific, real-world circumstances.

Decreases:

- Decreases in words do not follow the same spiking trends as words seeing increases due to AI, rather they follow a more complex path.
- This is illustrated by the adjective “important,” a synonym for three of our focal words, “significant_ADJ,” “crucial_ADJ,” and “noteworthy_ADJ.” “Important_ADJ” is notable as it displayed a significant decrease in frequency possibly due to AI.

Conclusion

- Clusters of synonyms experiencing rapid increases in frequency may point to syntactic change due to AI which may signify larger scale changes in scientific writing.
- By analyzing the POS and synonyms of our focal words we were able to gain further insight into the structural changes of scientific language due to AI.
- It is expected that abstracts that have been processed through LLMs contain higher frequencies of AI-overused, low content words than previous literature.
- We failed to find conclusive evidence of AI induced spikes in word frequency directly causing major decreases in frequency for other lexical items, finding instead a more complex relationship.
- More research is needed to assess the implications, and exact structure of AI-driven linguistic shifts.
- As LLMs become more widespread it is essential to be aware of the broader impacts they may have on all areas of human existence, including language.

References

