

Conceptual changes in HIV and AIDS: Distributional semantics meets history

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Introduction

This study combines historical and computational linguistic methods to study American public discourse during the HIV/AIDS pandemic between 1980 and 2010. Through this interdisciplinary approach, we, a group of historians and computational linguists, critically evaluate what computational methods can provide against a well-researched historical background. Specifically, we use historical literature and archival sources to develop a conceptual model of the HIV/AIDS crisis and use this to verify the results of diachronic word embedding models. We focus on associations in public discourse between HIV/AIDS and the social groups that have been affected by it the most: the queer community, African Americans, and the people of Sub-Saharan Africa. **The main research question is: Can computational models capture semantic shifts in the concept of the HIV/AIDS pandemic and its associations with race, gender, and sexuality?**

Methods

We developed a conceptual model of HIV/AIDS based on historical literature, following Sommerauer and Fokkens (2019) and Betti and Van den Berg (2014). These historical developments will be briefly summarized here. During the early '80s, HIV/AIDS was stigmatized and strongly associated with gay men and intravenous drug users (Snowden, 2019) (Catlin, 2021). During the '90s, HIV/AIDS came to be seen as a more general public health problem. However, there was still a strong association between HIV/AIDS and African Americans (Snowden, 2019 p. 442). In 1997 the HIV/AIDS crisis in the USA was widely considered to be over (Snowden, 2020, p. 414; Catlin, 2021, p. 1459). Since then, HIV/AIDS has become more strongly associated with Sub-Saharan Africa where the disease has remained a major public health problem (Piot and Bartos, 2002). Based on these developments we formulated hypotheses about expected conceptual changes regarding HIV/AIDS and race, gender and sexuality.

We test the conceptual change hypotheses using experimental computational techniques with distributional semantic models, visualized in Figure 1. We use static neural embeddings trained on the Corpus of Historical American English (COHA) per decade, provided by Hamilton et al. (2016). These neural embeddings, or distributional semantic models, represent words according to words they frequently co-occur with (Hamilton et al, 2016). We compare three model types, Positive Pointwise Mutual Information (PPMI), Singular Value Decomposition (SVD), which uses manipulated versions of the PPMI embeddings, and Skip-Gram with Negative Sampling (SGNS), which uses 'word2vec' embeddings.

First, we measure the cosine similarity between 23 pre-determined word pairs such as *HIV/homosexual*, and *aids/Africa* over time, and observe whether there is a shift in similarity. Based on historical literature we identified words used in HIV/AIDS discourse during the 1980s, 1990s, and 2000s. Second, we measure the top 20 nearest neighbors of our main concepts *HIV*, *AIDS*, and *gay* per time frame, to determine whether their closest

associations change throughout time. We use the time frames 1980's, 1990's, and 2000's. We compare our results to 6 control word pairs (such as *Asian/HIV* and *flu/homosexual*), which we hypothesize to show no significant conceptual change, in line with Sommerauer & Fokkens (2019).

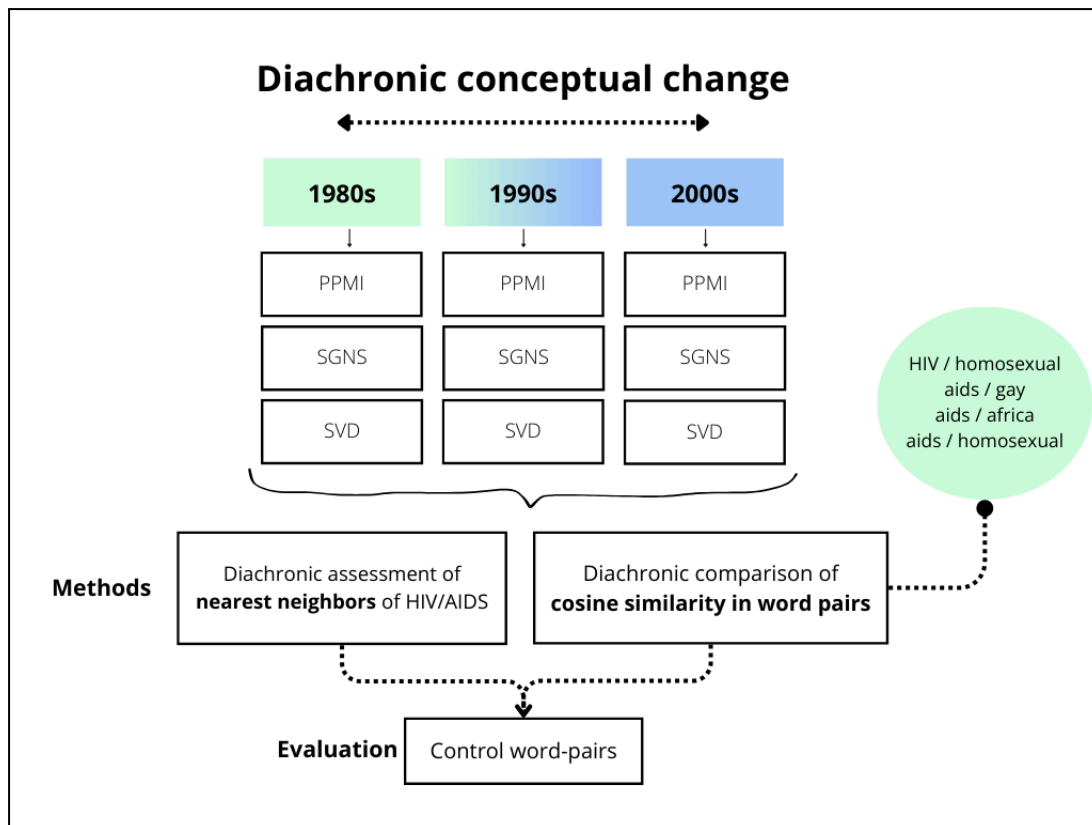


Figure 1: Visualization of the methodology used in our study, using three types of models that have been trained on time slices of the COHA. This is followed by a diachronic assessment of the nearest neighbors of our main concept HIV/AIDS, and an assessment of shifts in cosine similarity between chosen word pairs. We evaluate using the cosine similarity of control word pairs.

Results

Our results indicate that distributional semantic models showcase the expected conceptual changes, depending on the type of model. The SGNS and PPMI models showcased more inconsistent results across similar word pairs, such as *HIV/homosexual* decreasing and *aids/homosexual* increasing in similarity. In this section, we therefore focus on the results of the SVD model, similar to Hamilton et al. (2016, p. 6).

The first method, the word-pair comparison, indicates that HIV/AIDS becomes less associated with homosexuality throughout time, and more associated with Africa-related and Black-related terms, in line with our historical hypotheses. The word pairs *hiv/homosexual* and *aids/gay* peak in similarity in the 1990s and decrease in the 2000's, while word pairs

related to Africa and AIDS/HIV, such as *aids/Africa* and *HIV/Africans*, have a significantly higher similarity score in the 2000's compared to previous decades.

The second method, the nearest neighbors approach, also confirms our historical hypotheses, showing a decrease in the association between *gay* and *HIV/AIDS* in all models after the 1990s, and an increase between *Africa* and *HIV/AIDS* in the same period. The target word *gay* is strongly associated with *aids*, primarily in the 1990's, as it appears in the nearest neighbors. The association between *Africa* and *HIV/AIDS* also emerged in 2000. The target words *HIV* and *AIDS* both have *malaria* in their nearest neighbors in the 2000s, a disease that is prominent in Africa.

Our control word pairs show less conclusive results. The word pair *homosexual/flu* shows a relatively high similarity score throughout time for the SGNS model. It proved to be problematic as a control pair, as 'flu' was also used as an informal initial term to describe AIDS, as well as a derogatory association ('gay flu'). The word pair *Asian/HIV* shows differing results across models, but only a small increase in similarity throughout time, which confirms that our target word pairs capture a significant conceptual change.

Discussion and Conclusion

In this study, we investigated the ability of computational models to capture discourse around HIV/AIDS in the 1980's to 2000's using three word embedding models. This revealed an increase in the association between HIV/AIDS and Africa, supported by both the word-pairs and nearest neighbors approaches. The nearest-neighbors approach also showed a decrease in the associations between HIV/AIDS and the queer community after the 1990s, which was not found in the word-pairs approach. These results support our hypotheses based on historical sources. However, results should be interpreted with care, due to the amount of variation and numerous limitations. Future work includes experimenting with contextualized embeddings, such as Hoeken et al. (2023), who propose using masked target prediction.

Associations with African Americans could not be investigated, due to a lack of appropriate terms in the models. Our hypothesis regarding gender was not confirmed, as the models showed higher similarity scores between *HIV/AIDS* and *women* than with *men*. Future qualitative research into the corpus itself could help give insights into the reasons for these unexpected results.

Our research shows that computational methods can help explore conceptual change through time. Using computational tools in combination with historical research enables research of complex social issues.

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