

# **Analysing Vaccine Sentiment on Social Media**

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# Aim

To infer **public sentiment** towards **vaccination** from social media posts.  
This thesis is an **application of NLP**.

## Main Outcomes

1. Comparison **contemporary NLP techniques** for sentiment analysis in **vaccination**.
2. Applying the best method to **real-world social media data** and observing the sentiment.

# Comparison of Models

## For Public Health Domain

- Transformers models outperform lexicon-based and rule-based tools.
- GPT (decoder only model) with zero-shot, achieves superior performance over fine-tuned BERT models (encoder only models) with accuracy and F1 improvements of around 6-7%.

# Prompt Engineering Methods

## RBIC a Unique Method of parsing Social Media Posts

Role Based Incremental Coaching (RBIC) is used to obtain **gists** from reddit posts.  
Gist: essential meaning or summary.

Two Phases:

1. Role-Based Knowledge Generation
2. Incremental Coaching

Xiaohan Ding, Buse Carik, Uma Sushmitha Gunturi, Valerie Reyna, and Eugenia Ha Rim Rho. 2024. Leveraging Prompt-Based Large Language Models: Predicting Pandemic Health Decisions and Outcomes Through Social Media Language. In Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems (CHI '24). Association for Computing Machinery, New York, NY, USA, Article 443, 1–20. <https://doi.org/10.1145/3613904.3642117>

# Data Curation

**Collection:** 3063 posts from January 2021 to June 2025

**Source:** Reddit (PRAW API)

**Final List of Key Words:** vaccine, vaccination, immunization, booster, vaxx, vax, vaxxed, vaxxer, unvaxxed, vaccine safety, vaccine efficacy, vaccine hesitancy, pro-vax, anti-vax, COVID vaccine, Moderna, Pfizer, AstraZeneca, Johnson & Johnson, mRNA vaccine, vaccine passport, vaccine mandate, vaccine rollout, vaccine equity, MMR, HPV vaccine, flu shot, polio vaccine, DTaP, Tdap.

## Subreddits (Communities within Reddit):

Positive (Communities that support vaccination)	r/vaxxhappened, r/CovIdiots, r/NoNewNormalBan
Negative 1 (Communities that reject vaccination)	r/antivax, r/antivaccine
Negative 2 (Non-vaccine communities prone to have negative posts)	r/conspiracy, r/skeptic, r/conspiracytheories, r/conspiracy_commons
Neutral (General vaccine communities without a specific stance)	r/DebateVaccines, r/COVID19, r/CovidVaccinated, r/VACCINES, r/Vaccine , r/coronavirus, r/CovidVaccine

# Topic Modelling

## Methods

- 1- Keyword based classification.
- 2- TF-IDF & K-means clustering
- 3- LDA
- 4- BERTopic Modelling

**BERTopic** and **keyword-based** clusters were selected based on manual evaluation.

# BERTopic Clusters

## Effects after Vaccination

Arm after Vaccination: arm, pain, shot, tetanus, got, injection, sore, normal, site

Example: i got the pfizer vaccine on may 13. its may 21 and i have a bump on my muscle where i got it. it itches when i touch it. is this normal?

Posts: 158

## Correlations

Vaccine Causing Autism: autism, vaccines, cause, studies, study, cases, autistic, children, people, connection

Example: I was inspired by a discord chat to make this. Former Doctor Andrew Wakefield wrote a paper that said one type of vaccination could lead to autism. It was such a bad study that he lost his medical license.

Posts: 45

## Vaccine Influencers being discussed

Vaccine Influencers: jr, kennedy, rfk, zuckerberg, administration, biden, said, committee, meta, mark

Example: Great. JD Vance has ties to vaxx companies that make mRNA That's it I'm voting for RFK Jr. Tired of politicians forcing us to take this and getting financially compensated. JD Vance also has a Twitter post stating "Hospitals are overrun. Time to fire the nurses who declined to take the covid vax". I don't like this guy at all.

Posts: 38

# Keyword-Based Clusters

## Types of Vaccination:

**Covid:** covid, covid-19, sars-cov-2, coronavirus, corona

**MMR:** measles, rubeola, mmr

**Flu:** flu, influenza

**Chickenpox:** chickenpox

**Rabies:** rabies

## Discussion on Different Vaccine Makers:

**Pfizer:** pfizer, biontech

**Moderna:** moderna

**Astrazeneca:** astrazeneca, astra zeneca

**Janssen:** janssen, johnson & johnson

**Novavax:** novavax

**Sinovac:** sinovac

**Sinopharm:** sinopharm

**Sputnik:** sputnik v

**Covaxin:** bharat biotech, covaxin



# Training Data Collection

## Raw Collection of Reddit Posts

<https://www.kaggle.com/datasets/pavellexyr/the-reddit-covid-dataset?resource=download>

**Same List of Key Words:** vaccine, vaccination, immunization, booster, vaxx, vax, vaxxed, vaxxer, unvaxxed, vaccine safety, vaccine efficacy, vaccine hesitancy, pro-vax, anti-vax, COVID vaccine, Moderna, Pfizer, AstraZeneca, Johnson & Johnson, mRNA vaccine, vaccine passport, vaccine mandate, vaccine rollout, vaccine equity, MMR, HPV vaccine, flu shot, polio vaccine, DTaP, Tdap.

**Included Data from Banned Subreddit:** r/NoNewNormal.

# Training Data Annotation

## Manually Labelled:

More than **1500** Posts to get at least **500** each from **positive, negative and neutral**.

## Training Data

**1350** posts, **450** from each of the positive, negative and neutral.

## Test Data

**152** posts, **50** from each of the positive and negative labels, and **52** from the neutral label.

# Annotation Strategy

## Annotation Strategy

**Positive-** Posts that support vaccination or discourage anti-vaccine views.

Example– Sad to see that a significant portion of the Western population is distrustful of vaccines.

**Negative-** Posts that oppose vaccination or mock those who support it.

Example- Honestly, I feel like certain vaccinated people want everyone else to get it as well, just so they if they end up finding out the vaccine had a bad side effect down the road or kills a lot of people, they want you to be dead too.

**Neutral-** Posts without a clear stance for or against vaccination.

Example– I got the flu shot yesterday and my arm is still paining.

**Sentiment refers to the post author's views towards vaccination, not the content of the post.**

# Language Models

## Decoder only

Model	Approach
GPT 3.5 Turbo	Finetuned & RBIC
GPT 4.1	Finetuned & RBIC
GPT 4.1 Nano	Finetuned & RBIC
GPT 4.1 Mini	Finetuned & RBIC
GPT 4 Omni	Finetuned & RBIC
GPT 4 Turbo	RBIC alone

## Encoder only

Model	Approach
BERT-base	Finetuned
BERT-large	Finetuned
RoBERTa-large	Finetuned
cardiffnlp/twitter-roberta-base-sentiment-latest	Finetuned for Vaccine Sentiment

# Finetuning Details

## Decoder Only

### Supervised Fine-tuning with OpenAI API

#### Hyperparameters

Batch size: 2

Learning rate :  $2.0 \times \text{base learning rate}$

Epochs: 3

OpenAI uses some PEFT and base learning rate (not publicly disclosed).

# Finetuning Details

## Encoder Only

### LoRA Configurations

Low Rank Dimension = 8

Lora Alpha = 16

Target Modules = ["query", "value"]

Lora Dropout = 0.1 (regularization)

### Hyperparameters

Learning Rate =  $3 \times 10^{-5}$

Per Device Train Batch Size = 16

Weight Decay = 0.01

# RBIC Prompt Structure

## Role-Based Knowledge Generation

**System:** You are a domain expert in analysing and inferring public sentiment towards vaccination.

**User:** Sentiment is of 3 types:

**positive** - supports vaccination or shows genuine interest in taking it, or encourages others to take it, or discourages negative sentiment towards vaccination or negative sentiment towards anti-vaccine people or sharing positive information on vaccine safety.

**negative** - against vaccination, or not interested in taking vaccination, or discourages others from taking vaccination by sharing painful experiences.

**neutral** - not clearly positive or negative, sharing experience (can be painful) but the intention is not to discourage vaccination.

List some common linguistic cues present in textual Reddit posts that contain vaccine sentiment that can help infer the sentiment of the post.

# RBIC Prompt Structure

## Incremental Coaching

### [Input the Post]

**User:** Does the following post contain a vaccine sentiment mention (yes/no)?

### [Model Output]

**User:** If yes, generate a gist of the post highlighting the key phrases that convey the post author's sentiment.

If no, return no sentiment.

### [Model Output]

**User:** Infer the author's sentiment towards vaccination with all the information. (Return only the sentiment (Positive/Negative/Neutral)).



# Performance on the Test Data

LLM	Method	Type	Accuracy	Macro-Avg-F1
<b>gpt-4.1</b>	Finetuned	Decoder	94.7%	94.69%
<b>gpt-4.1-mini</b>	Finetuned	Decoder	94.08%	94.09%
<b>gpt-3.5-turbo</b>	Finetuned	Decoder	94.08%	93.98%
<b>gpt-4o</b>	Finetuned	Decoder	92.11%	92.07%
<b>gpt-4.1</b>	RBIC	Decoder	89.47%	89.33%
<b>gpt-4.1-nano</b>	Finetuned	Decoder	88.82%	88.67%
<b>gpt-4o</b>	RBIC	Decoder	88.16%	88.33%
<b>gpt-4-turbo</b>	RBIC	Decoder	87.5%	87.33%
<b>cardiffnlp/twitter-roberta-base-sentiment</b>	Finetuned	Encoder	86.18%	85.90%
<b>roberta-large</b>	Finetuned	Encoder	85.53%	85.24%
<b>gpt-4.1-mini</b>	RBIC	Decoder	84.87%	84.33%
<b>bert-base-uncased</b>	Finetuned	Encoder	80.26%	80.68%
<b>bert-large-uncased</b>	Finetuned	Encoder	79.61%	79.02%
<b>gpt-3.5-turbo</b>	RBIC	Decoder	69.08%	68.33%
<b>gpt-4.1-nano</b>	RBIC	Decoder	63.82%	62.67%

**Models ranked from highest to lowest performance.**

**152-sample test set  
(50 positive, 50 negative, 52 neutral)**

# Temporal Distribution of Sentiment

Ran **finetuned GPT 4.1** (best performing model) sentiment pipeline on the observation data (3063 posts).

## Statistics

1. 45.77% Neutral, 36.43% positive, 17.79% negative.

## Observations

Negative shows a steady increase in 2025 and are mostly from infant Vaccine Cluster and MMR Vaccine Cluster.

