Social Network Analysis of Covid-19 Vaccine YouTube Videos in Odisha, India: Mapping the comment network and analyzing comment sentiment

Presenting author
Neil Alperstein

Co-authors
Jamison, A. Bhaktaram, A., Burleson, J., Kluegel, E., Barnett, D., Ganjoo, R., Satyanarayan, S. Nanda, A., Orton, P., Parida, M., Pascual-Ferrá, P., Rimal, R., Rath, S.

Introduction

While face-to-face approaches to enhancing vaccine acceptance and confidence may be ideal, they are not always practical or effective. Social media, because of its widespread use in India, can play a vital role in enhancing vaccine acceptance. Social media platforms like YouTube and Facebook because they have deep penetration among the target population (18-35) and secondarily their family and peers, may be useful where other approaches have failed or found to be inadequate. Approximately 45 percent of the population of India use the internet and users spend almost 2.5 hours daily on social media, making it a routine part of daily internet usage. The most popular platform is YouTube (85%), followed by Facebook (76%) (theglobalstatistics.com, n.d.). The question addressed in this research regards the impact of message design on the ability of YouTube videos to affect young adults' attitudes, beliefs, and intentions towards COVID-19 vaccination through appeals (collectivistic/individualistic), tone (humor/straightforward), and protagonist (male/female).

Covid and Vaccinations in India

As the COVID-19 pandemic enters its third year, more than 315 million cases have been recorded and more than 5.5 million people have died worldwide (Center for Systems Science and Engineering (CSSE), 2022). India has experienced the second-largest burden of COVID-19 disease, with more than 35 million confirmed cases and nearly half a million cumulative deaths

(World Health Organization, 2022). Although the country was largely spared during the initial outbreak, a deadly "Second Wave " of virus swept the country in Spring 2021 (Singh, 2021). With this deadly surge, experts believe official statistics may be a gross undercount of the true burden of disease; preliminary analysis of mortality rates suggests as many as 3.97 million excess deaths have occurred since the start of the pandemic (Anand et al., 2021). The threat of a "Third Wave" looms large, particularly as new disease variants emerge.

India's COVID-19 vaccination campaign was launched in January 2021 with an ambitious goal of fully immunizing all 1.3 billion Indian citizens against COVID-19 by the end of the year (Menon, 2021). The sheer size of the population makes this campaign the world's largest vaccination program (Chowdhury et al., 2021). Initially, two vaccine products were authorized for use: "Covishield" produced by AstraZeneca and locally produced "Covaxin". Both vaccines require two doses administered 4 weeks (Covaxin) and 12-16 weeks (Covishield) apart (Reuters, 2021). Although additional vaccines have recently been approved, upwards of 90% of vaccines administered to-date have been "Covishield" (BBC News, 2021). By the end of 2021, more than 1.5 billion doses of COVID vaccine had been administered, with an estimated 90% of the adult population having received one dose (Menon, 2021). However, among the vaccinated, roughly 1 in 3 have not received a second shot and are not fully protected (Indian Council of Medical Research, 2021). This gap between 1st and 2nd dose is the largest in the world and undermines the overall success of the vaccination campaign. This problem is amplified as the demand for vaccines declines. As the number of daily doses administered has tapered off officials underscore that decreased public demand and *not* supply issues are driving the slowdown (Menon, 2021).

Vaccination in Odisha

As a large and diverse country, each Indian state has experienced the pandemic differently. In the East Indian state of Odisha, the burden of disease has been comparatively low, with 1 million confirmed cases and 8,400 deaths reported since the start of the pandemic (Government of Odisha, 2021). Vaccine distribution is also decentralized, with each state responsible for local administration and vaccination rates vary widely by state (Pandey et al., 2021). Data regarding COVID-19 vaccine confidence in Odisha is limited. Panda et al. (2021) whose study was based on a small sample (less than 400 respondents) did find support for mandatory vaccination, but this finding was countered with the belief that natural immunity would be more effective than a vaccine. Chowdhury et al. (2021) found that vaccine hesitancy, at least at the early stages of the rollout, was lower in Odisha than in many other Indian states, with less than 25 percent of the respondents unwilling to get vaccinated against COVID-19. In Odisha, more than 53 million doses of vaccine have been administered; however, of those who are vaccinated, 72% have received both doses (Government of Odisha, 2021). The combination of high COVID vaccine initiation, but low COVID vaccine completion -- when coupled with the low burden of disease in the state -- makes Odisha an ideal environment to explore possible vaccine complacency and hesitancy around 2nd dose completion.

Panda, et al. (2021), who studied vaccine acceptance in Odisha, found that the majority of their sample believed the vaccine to be safe for both adults and children, but they also found variations in attitudes regarding immunity that follows infection as opposed to vaccination. Additionally, the researchers found two major barriers to vaccination: safety and awareness. For young adults, who may have a greater sense of invulnerability than their elders and a life view that is focused more on the here and now, as well as an accompanying distrust of authorities, makes reaching them through traditional communication channels difficult. While vaccination

rates are reasonably high in Odisha, there is the issue of moving residents of all ages through the vaccine funnel from one to two doses of vaccine and as they become available, a booster jab. Because of their low-risk perception, along with other factors like misinformation, there is a lack of motivation to become fully vaccinated and a corresponding lack of interest in motivating others—friends, co-workers, and family members—to get fully vaccinated. Because of distrust of authority among young adults, who delivers the message is of paramount importance regarding acceptance of messaging instilling confidence in COVID-19 vaccines. Additionally, the context of the message is important for vaccine acceptance as well; the typical government official directly addressing an audience simply does not work with this population.

YouTube as Public Health Delivery System

Enhancing vaccine confidence and acceptance is beyond the control of public officials, otherwise a link between education and vaccination would be linear. Social media because it is a more democratized form of communication may include influencers, like celebrities and ordinary people (micro-celebrities) who are active on social media to supplant experts and government officials. It is in this way that social media messaging operates on a lateral plane with opportunities to communicate and spread information (and misinformation) through weak ties (Granovetter, 1973). The open structures of social media allow for influence to flow across networks in a scale-free manner in which actants, identified as nodes in the social network, have the potential to influence attitudes and normative behavior. YouTube as a dynamic visual medium has unique qualities to create an environment of indirect learning when it comes to public health messaging. There is no shortage of public health or more specifically vaccine awareness information on various social media platforms, but research to date suggests that while changes in attitudes may be accomplished, there has been no evidence of vaccine uptake

(Yun-Ju Song & Gruzd, 2017). The present study represents an opportunity to evaluate YouTube videos in an effort to enhance vaccine confidence based on message design.

Young adults in Odisha are generally tech savvy having access to mobile phones and are users of popular social media platforms like Facebook and YouTube and messaging platforms like WhatsApp. In a study of social media strategies regarding vaccine acceptance, Limaye, et al. (2021) found two key values regarding decisions related to vaccine acceptance were framing of the message and who delivers the message. Li, et al. (2020) maintain that YouTube has not been utilized as an effective tool in health crises like Zika, H1N1, or Ebola but it has great potential depending on the reputations of the sources delivering the message as well as the ability to work against the virality of misinformation. Social media, because of its widespread use in India, can play a vital role in enhancing vaccine confidence. Social media platforms like YouTube and Facebook have deep penetration among the target population (18-35 years of age) and secondarily their family and peers. YouTube, for example, accounts for the largest penetration at 89 percent as of January 2021, followed by Facebook at 76 percent.

Effective Message Design

While direct appeals from authority figures may fall short, there is evidence that young adults do desire to protect the wellbeing of others, in particular older family members who they see as particularly vulnerable to COVID-19. Therefore, while young adults may be less motivated to get fully vaccinated themselves, there is indication they may be driven by their desire to protect and act on behalf of others around them to encourage vaccination. The goal of this applied project is to enhance vaccine confidence among young adults (defined as those between 18 and 35 years of age). The approach to messaging is indirect encouraging young adults to serve as vaccine ambassadors, encouraging them to promote vaccination among friends

and family, among others. As a result, we anticipate their own confidence towards becoming fully vaccinated will be enhanced.

Methodology

Standard social science methods for eliciting opinions include questionnaires, in-depth interviews, and focus groups. On the other hand, social media mining based on the use of social network analytics for analyzing opinions expressed in public on social media platforms is becoming more widely used in the social sciences. Interest focuses on counting web activities including YouTube comments to analyze the levels of interest in a topic, as is the case with this applied project, interest in Covid-19 vaccine acceptance. In addition to sentiment polarities – negative, neutral, or positive, algorithms are utilized to generate insights through community detection between users. The following applied research is based on both the analysis of YouTube comments and the networks that form around communities of users. The approach is meant to complement standard social science approaches.

YouTube's popularity in India makes it a logical source of social web data. The multiple purposes for YouTube and its international and inter-generational audiences make it a potentially valuable source of information about the act of watching videos, the issues depicted in them and the meanings that viewers make of their messaging. The methods utilized in this research analyzed two Covid-19 vaccination acceptance videos, viewer sentiment, various metrics, network detection, and categorization of comments. These methods were combined to produce an evidence-based evaluation of the approach taken in this applied research project.

Phase 1 – Eight videos were produced based on a four x four matrix: straightforward/humorous and collectivistic/individualistic. For each there was a male figure or female protagonist delivering the key messaging. The length of each video is in the 1–2-minute range. Scripts were

focus group tested and produced in the Odia language. Two videos were selected for the present study.

Phase 2 – Individuals were recruited to participate in an online survey that addressed attitudes towards vaccination, vaccine behaviors and intentions, as well the 2,349 respondents were randomly served one of the eight videos to assess their reactions. Demographics (age, gender, caste, education) were included. Participants were provided with an incentive of free airtime for their mobile device for completing the survey (see Rimal, et al., 2022).

Phase 3 – Two videos from the eight that represent diametric approaches were uploaded to the Swasthya Plus Network on YouTube (https://www.youtube.com/c/SwasthyaPlus). The videos chosen were based on the following criteria: male/individualistic/humorous, and, female/collectivistic/serious. A social media campaign to promote the videos was based on organic search engine optimization (SEO) and pushed through WhatsApp messaging, important for enhancing discovery and engagement with the videos (For additional information about the videos and links see Appendix I). In addition to standard metrics, we are interested in how viewers use these videos for sense making purposes considering the following questions: 1) what dramatic qualities in the videos generate engagement; 2) when viewers comment on the videos, what comes up for them, what are they thinking about as expressed in their comments; and 3) how are viewers "talking" to one another in the form of comments and replies?

Phase 4 – Assessment of the videos is based on the following metrics: watch time, average percentage viewed, average view duration, engagement, unique viewers, and who is watching (gender).

Phase 5 – Social network analysis of YouTube channel and comment networks. First, we utilized YouTube Data Tools to extract the comments from the videos (Rieder, 2015). The software

provides a CSV file of the comments and a second graph file (GDF) for visualizing the network. The CSV file includes the comments, which were uploaded to software that analyzes those comments for sentiment. As necessary the team in India translated the comments from Odia to English. Their translation considered culturally unique language. After the comment network was translated, a sentiment analysis was conducted using machine learning (ML) that identifies comments as either negative, neutral, or positive. The graph file was uploaded to Gephi (Gephi.org), an open-source data visualization software that creates a map of the comment network allowing the researchers to see how the messaging in the videos is directed within the network of comments, how clusters are organized within the viewer community, with particular interest in who is influencing the network, what in network analysis are referred to as "hubs" and "bridges" that serve as community connections. Data based on the network of channels associated with our two seed videos provided additional visualizations.

Results

This section describes the result of applying our methods to the two Covid-19 vaccination acceptance videos, as described above. See Appendix I for additional information regarding the videos. We begin the analysis by comparing the metrics for the two videos. This is preliminary data as the videos are still "live" and research is in progress.

Table 1. Metrics of 2 YouTube videos (February 2 – February 11, 2022)

YouTube Metrics	Video #1 – Male/Ind./Comic - Somanath	Video #2 – Female/Coll./Serious - Mini
# of Views	1,510	5,700
# of Likes	93	81
Watch time (in seconds)	20.3	68.4
Average Percentage Viewed	42.2	37.9
Average View Duration	0:48	0:43
Engagement	27,452	27,452
Impression	27.5K	78.6
Who is watching (gender)	31.3 Fem. / 68.8 Male	40.3 Fem. / 59.7 Male
Comments	25	11

These standard YouTube metrics are based on a short period of time in which the two videos gained some momentum. As mentioned above, we used SEO practices to organically boost the views, which was successful in "seeding" the videos in the channel network. As the two videos were placed on a health channel with over 400 thousand subscribers, we expected reach would be significant. The analysis of the channel network below speaks to the how our videos are served to subscribers and how they become part of the YouTube recommender system.

The Channel Network

We used YouTube Data Tools Channel Network Module to investigate the relationship between videos based on the two video IDs. The software generates a network of channels in which a video from one channel points to the video of another channel, creating an edge; the more times that appears, the more weight the connection gets. This network is a product of the YouTube recommender system, which is a common form of machine learning that operates behind the scenes of Facebook, Twitter, and YouTube's "suggested videos." Algorithmic bias has sometimes been charged with steering users toward mis- or dis-information regarding COVID-19 vaccines, among other topics and issues that may garner controversy. Our two videos operate within the larger YouTube system and as such they are linked to other videos based on the YouTube algorithm.

We utilized YouTube Data Tools Channel Network Module (https://tools.digitalmethods.net/netvizz/youtube/mod_channels_net.php) to crawl channels that are connected to our two videos via subscriptions. **Figure 1** represents a visualization of related videos. Crawl depth is used in the search to see how far the two videos, referred to as "seeds" extend. For this analysis we selected a crawl depth of 2, which yielded 2,517 video connections. The GDF file was uploaded to Gephi open-source data visualization software for analysis.

Depicted in the visualization are 878 nodes representing the seed channels and 6,816 edges, which represent the connections between the nodes. The visualization in **Figure 1** is based on a measure of modularity, which in this case is 0.638. Modularity represents the fragmentation of the network as it develops into distinct communities or clusters. Those communities or clusters are represented by the different colors in the visualization. Clusters in this case represent groups of nodes that share a commonality, a connection or tie with the two seeded videos. Modularity measures vary between 0 (lowest) to 1 (highest). For example, a modularity measure closer to 1 indicates clear divisions between communities, whereas values less than 0.5 suggest that the communities overlap more; the network consisting of a core group of nodes. The modularity measure for this network is in the middle range, 0.625, indicating a well-connected network. Additionally, the visualization demonstrates what may be called a homophily effect in which like-minded individuals (or in this case channels) that share beliefs and perhaps behaviors come together as the different colors represent those interests. While we cannot determine exactly what brings these nodes together, we can assume that channel subscriptions may partially explain the connections, as this is a function of YouTube's recommender algorithm.

  Figure 1 shows the resulting network where each node represents a single channel with connections to our two videos that are seeds that propagate the network. Following the principle of homophily, we expect similar content would cluster around interest in vaccine acceptance. The larger the circle, the greater the strength of the node, meaning that node is a central figure in the network and based on power law, is likely to be a driver of communication, calculated as high degree, within the network. As indicated in the color legend above, approximately 42 percent of the nodes represented by the fuchsia color are connected to the Swasthya Plus Odia, the home YouTube channel where the two videos are located. The central node in the green

cluster is the Sidarrth TV network, a general entertainment TV channel in Odisha. In the blue

cluster Odisha Digital, a youth-oriented Odia channel is central, and the central node in the black

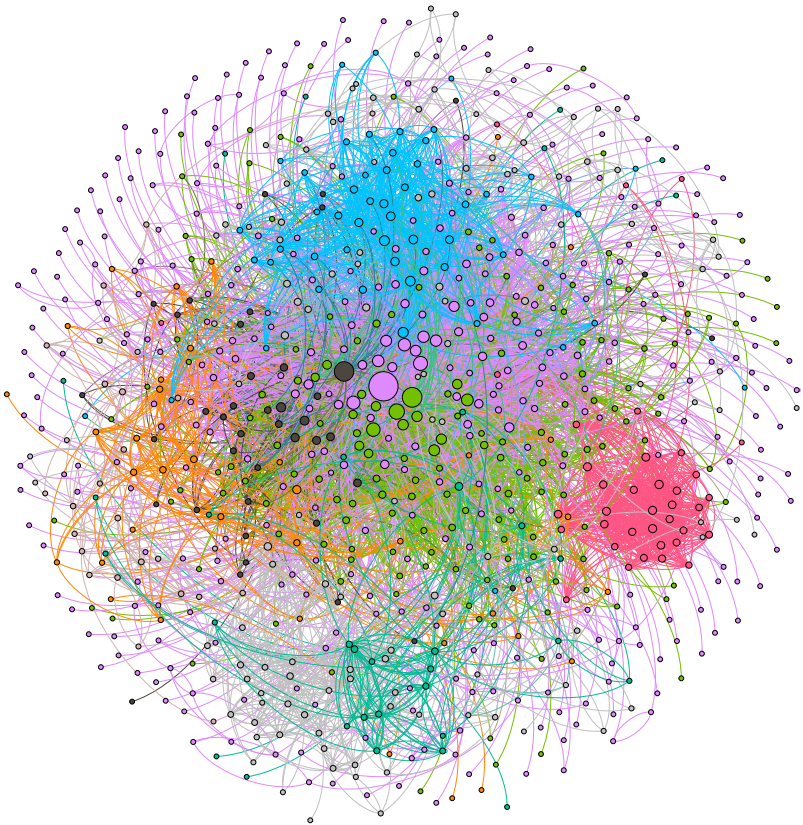network is Nandighosha TV, a multi-platform channel on television, the internet and mobile.

Figure 1- Channel Network based on 2 Video Seeds

9		(42.6%)
0		(17.88%)
8		(5.81%)
10		(4.78%)
4		(4.21%)
13		(4.21%)

Next, we wanted to visualize betweenness centrality in this network. Simply put, a node

with high betweenness centrality has a large influence on the transfer of information following

the shortest path through the network. Betweenness represents the degree to which nodes stand

between each other. In **Figure 2**, we have filtered the network to identify those nodes with high

betweenness centrality. As noted above, the Swasthya Plus Odia network, the Nadndighosha TV

network, and the Sidarrth TV network provide the greatest connections across the shortest paths

in the network map. The value of this approach is that we can visualize the path from channel to

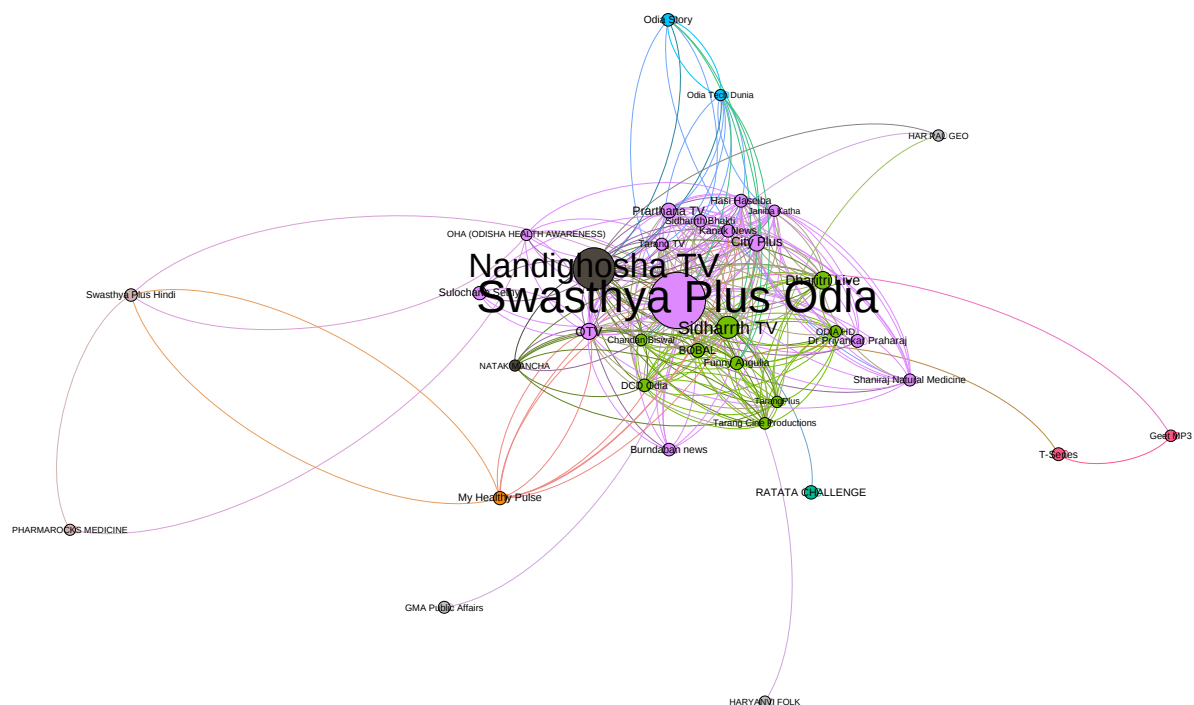video that viewers are served based on YouTube recommendations.

Figure 2 - Video Network based on Betweenness Centrality

These visualizations hold implications for this social network made up of connections to our two

seeded videos. The higher betweenness centrality depicted in the larger colored circles in the

visualization reflects power because those nodes exercise control over the dissemination of these

videos and reflect stronger ties within the network and may serve as bridges to other clusters

within the network, recalling that the network is made up of different clusters representing

different interests or routes to the videos. It is important to point out that the titles to the seed

videos did not contain references to COVID-19 or vaccines, thus avoiding the potential for YouTube to block the videos, as the platform has been removing anti-vaccine videos and it is possible that pro-vaccine informative videos can be also blocked through that process by the platform.

The Channel and Comment Network

Our study also investigated the channel network related only to the two videos. We utilized YouTube Data Tools Video Network Module to retrieve information regarding the relationship between the two videos and the connected network of channels (https://tools.digitalmethods.net/netvizz/youtube/mod_videos_net.php). In addition to the comments, we were able to identify the key genres, like news channels or comedy channels operating in the network. **Figure 3** is a visualization of the related YouTube channels based only on our two seeded videos. The two dominant circles in fuchsia and green represent the Swasthya Plus Odia network where our two videos are located.
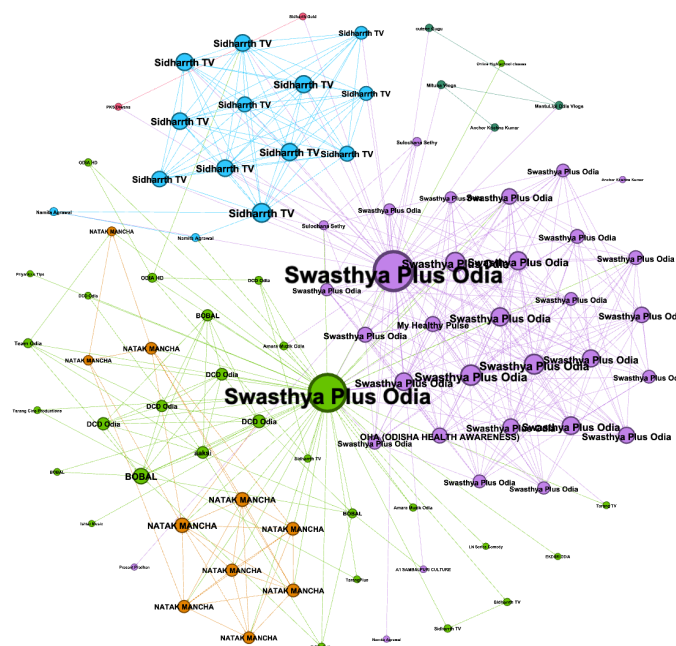

Figure 3 - Visualization of the Network of Relations between the two Videos

This is a network with 88 nodes with 521 edges. The network diameter is 5 nodes. The density measure is 0.068 and the average degree is 5.92. The modularity measure is low at 0.491, which suggests this is a highly connected network. **Table 2** is a list of channel genres to which our two seeds are connected. The channel genres fall into five categories with one-third of the nodes being entertainment channels, followed by education channels at 26 percent. Fourteen percent of the nodes are comedy channels, people and blog channels at 11 percent and music channels nodes at 7 percent.

Table 2. Video Channel Genres
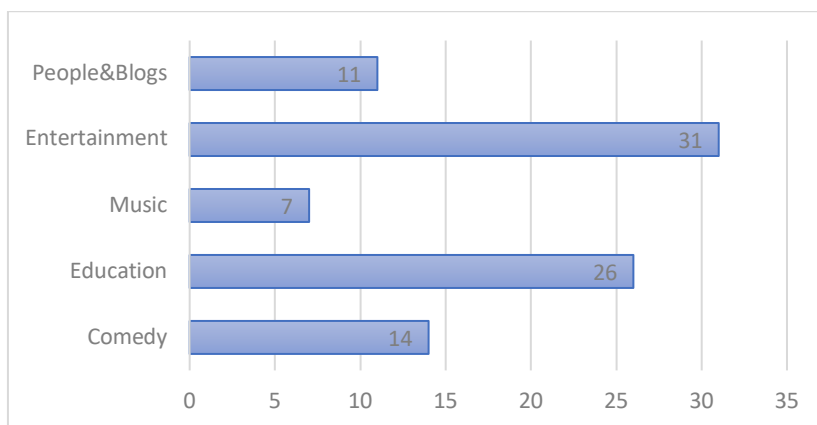
Comment Network on YouTube

One way of looking at YouTube discourse and user interaction is through network analysis, that allows researchers to visualize data to look at the relationships that form within and around our data set. We have used this network analysis to look at the recommender network above, and now we turn to the comment network of our two Covid-19 vaccine acceptance videos. The comment threads allow the researcher to look at influence within the conversations based on graph diameter, node degree and graph density. These statistics tell us about the

shortest paths between two nodes, how close those nodes are to one another and who are the influencers, in which case those nodes may be serving as "hubs" in the network. Hubs in this sense foster communication, and it is possible to identify those posters who are serving as hubs to better understand who they are and the role they are playing within the network. The following is based on preliminary data, as the videos were posted to YouTube on February 2. The videos initially elicited a small number of comments upon launch (see Table 1), and on February 12, 2022, a contest was launched to boost the level of comments on the second video, which is what this analysis is based upon (see Appendix II).
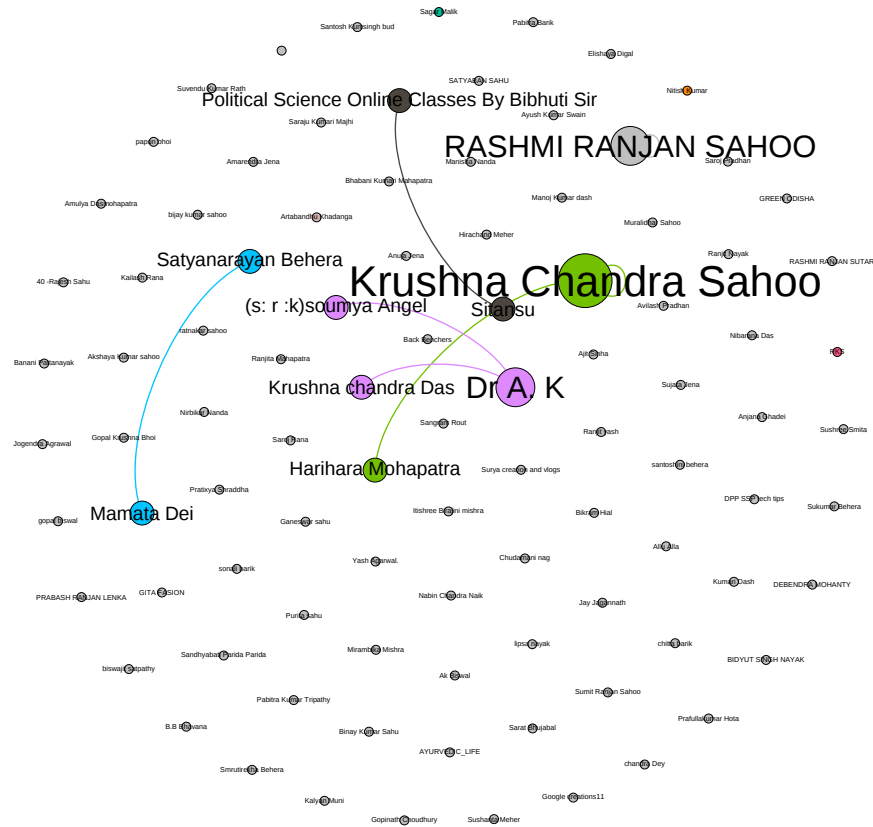

Figure 4 – "What is Mini's Gift" Video Comment Network

The video titled "What is Mini's Gift?" comment network is comprised of 95 nodes representing comments and 7 edges. Modularity is 0.72; the average degree is 0.074 and the network diameter is 1. The few edges in this network reflect comments but very few replies, meaning there is little

interaction among the commenters. This is not unusual but is merely a product of the lack of interaction among those viewers who choose to post comments to the video.

Sentiment Analysis of YouTube Comments

The goal of sentiment analysis, also known as opinion mining, is to classify comments into three types strong positive, negative, or neutral. As with opinions regarding Covid-19 vaccines we would anticipate that viewers of the two videos would elicit strong responses. Generally, comments reflect people's thoughts, feelings, and intention to behave. YouTube, a widely used social media platform attracts views every day, making crawling users' comments a potentially ongoing activity since the videos were posted February 2 and monitored until February 14, 2022. In this study, those comments taken together represent the virtual collective consciousness, that is the direction of thought around Covid-19 vaccines in relation to the posted videos. This approach to social media research provides real-time monitoring of commenters' attitudes and serves to supplement more traditional approaches to research. We used the Sentiment Analysis Module of Communalytic for the sentiment analysis of YouTube comments. This software detects polarity of posts in the dataset of comments (Gruzd, 2022). It categorizes comments as negative, neutral, or positive sentiments. To calculate the scores, the module uses two type of analysis VADER (Valence Aware Dictionary for Sentiment Reasoning) and TextBlob. The comments were translated from Odia to English for processing; comments in other languages were skipped. **Table 3** is a sentiment analysis of 62 of the 104 posts. Based on the VADER results 80 percent of the comments were positive, whereas TextBlob determined that 62 percent were positive. The differences are also presented in the Distribution of Polarity Values in **Figure 5**. There was little to no negative sentiment expressed in the comments;

VADER determined that almost 18% of the comments were neutral, and TextBlob categorized

37% as neutral.

Table 3. Sentiment Analysis of 62 out of 104 Comments

	# of Posts	Negative Sentiment	Neutral Sentiment	Positive Sentiment
VADER (English/EN)	62	1 (161%)	11 (17.74%)	50 (80.65%)
TextBlob (English/EN)	62	0 (0.00%)	23 (37%)	39 (62%)

Figure 5 - Polarity Values for VADER and TextBlog Analysis

Word clouds are another way of visualizing lexicon utilized in the YouTube comments. **Figure 6**

represents a word cloud of the most often used words in the comments. The larger the depiction

of a particular word indicates that the word was used more often than others.

Figure 6 - Word Cloud of most often used words

In addition to analyzing sentiment, five broad categories emerged from the content analysis of the comments: sharing beliefs, sharing knowledge/information, safeguarding self and community, personal experience, and reactions to the video. **Table 4** presents a sampling of YouTube comments that provides evidence of the effectiveness of the message design, and they add qualitative evidence of the positive sentiment described above.

Table 4. Four Categories of YouTube Comments

Category	Comment Example
Sharing Beliefs	*Corona virus is not going to go away from this world. So we have to be prepared for the virus in such way, that the virus can't affect us. So right now the only cure for it we have is vaccine and masks.* *We all should get completely vaccinated. Mini is conveying the right message.* *Health is wealth* *The person who is healthy and safe both physically and mentally, only they can help create a healthy society. My best wishes to them.*
Sharing Information	*Covid vaccine hesitancy is addressed in this video very deliberately. While developing the covid vaccine we take 100% precautions and safety checks before opening for human use. We all need to understand the seriousness of the situation and take 2 nd dose of vaccine. It is also advisable for the exposed groups to take the third dose which is booster dose after consulting with physician. Very dynamic initiative from Swasthya plus team. Kudos 👍* *Sanitizer mask and hand 🖐* *"Our government is not our enemy. It has been raising awareness about the epidemic. For this reason, they have been spending billions of rupees from the exchequer to get back to normal." Follow the Covid guidelines (government) for your benefit and your community.* *Everyone needs to have a sense of responsibility as citizens. We must have a strong faith and belief in the science of medicine. According to the rules of the government, vaccines need to be taken at the right time. As a result this whole society will stay safe.*

Safeguarding self and community	*We all should get vaccinanted (sic) completely, we will stay safe and there will be less infection in our country. We have to make people understand.* *Mini has given a lesson to the family, stay healthy and safe, keep others healthy and safe and it can protect the world from the covid pandemic. Because, every live and every human is valuable.* *Take vaccine, stay safe and make other safe.* *We all should get vaccinanted(sic) completely, we will stay safe and there will be less infection in our country. We have to make people understand.* *The only way to get rid of corona is vaccine. It is really important to take both the doses of the vaccine. Because if we stay healthy and safe, we can keep our family healthy and safe and then our state, country and the then we can get rid of this virus from the whole world. Let's get vaccinated and get rid of corona and create a society as it was earlier. We need to spread awareness about corona. I am saying it again get vaccinated and remove corona.*
Personal Experience	*Vaccination is the biggest gift. I have got vaccinated, you guys should get vaccinated too.*
Reactions to Video	*This is incredible!* *Thank u so much for share this video*🙏 *Nice video* 👍👍

This qualitative approach provides additional insights into how viewers are thinking in response to or reaction to the video. The following comment stood out as it exemplified the impact that the messaging in the video was designed to elicit among viewers.

Who knew Covid19 would spread all over the world in days and take on such a terrible form. It took lives one after another for no reason at all, the pain of losing a loved one could only be explained by the person who went through this. This pandemic became so terrifying that the government had to take the decision of stopping the trade, commerce, transportation and educational institutions. Which affected the common society a lot and nothing like what it used to be. The knowledge of Indian and the scientists from overseas helped create the vaccine for the prevention of the spread of the COVID infection. It was made available to the civilians for free and an order was issued by the World Health Organisation that instructed the general public to abide by the enacted law which was effective in each state accordingly. Those were wearing the mask while stepping out, maintain social distancing, go out only if needed and keep washing hands regularly. The public also followed it and though the COVID cases were starting to reduce everyone started to go out withought(sic) any reason. As a result of which the world is now suffering. Taking both the doses of the vaccine doesn't mean haat we are safe, the virus and the

infection hasn't yet gone. The world needs proper awareness of how to prevent themselves from this pandemic. After taking the second dose one should get the booster dose as well. Follow the government's rules and help eliminate the epidemic from the world. As a medical student, my hope is that the epidemic will not last long. Only awareness can save our precious lives. Hopefully sensitive people will accept it.

Discussion

COVID-19 vaccine acceptance continues to be a challenge for the world, and of particular interest to this research project, Odisha, India. Communication based on appeals to which young adults can relate, appeals that inform and encourage them to serve as ambassadors to their friends, family, and community was the goal of this applied research project. Message design was of paramount interest, as research suggested that top-down messaging that might be heavy handed in its approach may not work with this target population. Rather, we develop a more indirect approach, one based on ordinary people in relatable situations to deliver the key message in under 2-minutes. The visualizations of the channel network in which our videos reside indicates that YouTube videos do not exist in a vacuum; rather, they are part of a subscriber and recommender network, which is important to disseminating the messages contained in the videos. Additionally, we were able to extract 104 comments from one of the videos for sentiment analysis and found those comments to be mostly positive. While there were some neutral comments, the research found no negative comments. Finally, we did a content analysis of those comments in which five categories emerged. Examples of those comments provide additional insight into the reception of the messaging. While YouTube and other social media platforms are attempting to weed-out COVID-19 misinformation, there remains a need to promote vaccine acceptance in ways that are most palatable to those who are in most need of that information

Conclusions and Limitations

In this applied research project, we were interested in effective message design regarding COVID-19 vaccine acceptance and the impact messaging would have on the attitudes of young adults in Odisha, India. We selected two videos to upload to the YouTube platform, each representing a diametric approach, but both offered pro-vaccine messaging. The videos varied in appeal, tone, and protagonist. This is an organic approach in that is there was no paid advertising to influence viewership, the measures of views, likes and comments are reflective of the popularity of each video. Initially, the video with the collective appeal, and serious tone, "What was Mini's Gift?", with a female protagonist garnered more attention, that is views, than the alternative video that was based on a comedic tone, individualistic appeal, and male protagonist. In the interest of boosting comments, we used WhatsApp to promote an incentive to generate additional comments.

While there is no shortage of information from various sources that the jabs are clearly effective at preventing severe illness, research suggests people are not getting the second dose or a booster, as it becomes available, making the virus difficult to contain. That being the case, the benefit of vaccination is to a great extent an individual choice rather than a collective benefit, which runs contrary to the popularity of the message in the serious collectivistic approach that initially garnered twice as many views as the comedic individualistic approach. As the gender of viewers was relatively even, it is not likely that the gender of the protagonist delivering the key message confounded this finding, however additional research would have to confirm this outcome. The popularity of the video with a serious tone and collectivistic appeal suggests to us that this approach should be advanced in future vaccine acceptance campaigns. As the researchers have produced a total of 8 videos of varying combinations of appeals, tone, and protagonist, future research upon their launch on YouTube should investigate the impact of the

messaging design of those videos. What we have accomplished here is an investigation of two approaches to effective message design.

The World Health Organization (WHO) in response to the rise of anti-vaccine sentiment established a Strategic Advisory Group of Experts on Immunization (SAGE) to monitor vaccine confidence, vaccine complacency, and to consider the accessibility of vaccines on a world-wide basis. Beyond traditional approaches to deal with these issues, the time people spend on digital media, in particular social media, points to the potential of platforms like YouTube as a source for health information when it comes to COVID-19 vaccine acceptance. In this research we have developed an approach that makes algorithmic outputs visible and offers a means to describe them through visual analysis and content analysis of the comments posted by viewers of the videos. The positive sentiment expressed by those viewers in this study points to the countervailing force that the message design utilized in this applied research is an effective tool with potential to positively impact attitudes, as our online lives become ever more intertwined with our off-line decision-making when it comes to vaccines.

This study has several limitations. First, the videos went "live" on February 2, and we initially monitored them until February 12. The nature of YouTube videos varies greatly regarding how they gain acceptance among larger groups of viewers, in other words, how their audience develops over time. Some videos spike quickly regarding views, others remain at a low level of viewership and may spike at a later date. In other words, this research operated in the uncontrolled real-time world of YouTube. While the research was able to answer the question regarding sentiment of comments, the number of comments was relatively small. Similar to video views, comments may over time increase, suggesting an on-going monitoring of the video network. A limitation of the network analysis is the inability to understand the strength of

connections in the network graph as least as regards sentiment. The size of nodes in the comment network is based on the degree, which refers to viewers who are commenting (out-degree) or being replied to (in-degree). The analysis of the comments is based only on the views expressed by those who watched the videos or watched at least part of the videos and offered their commentary. The study is reflective of the comments of those who engaged with the videos, motivated by the messaging to offer their thoughts. However, everyone who watched the videos did not offer comments, and so the analysis is reflective of a subset of views of the videos.

Our study is based on the idea that vaccine acceptance depends on whether people feel the vaccines are effective, their trust in government and other authoritative sources, and access to vaccines. Furthermore, vaccine acceptance is not only an individual decision but one that may be collectivistic, that is a decision based on looking out for one's family, co-workers, and community. Unfortunately, there has been a significant amount of anti-vaccine misinformation in circulation. Our study shows that video is an effective tool for communicating in an entertaining manner, using high production values and relatable characters delivering a message in a palatable form. In this way we hope to counter-act negative thoughts about COVID-19 vaccination and in the process enhance vaccine advocacy.

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Appendix 1

Two videos posted on YouTube.com

Male, Individual, Comic

Planned Time to Post: Friday, 4 February, 6:00 PM India (7.30 AM Baltimore)

Private Video Link: https://www.youtube.com/watch?v=oSbd-RLE0Ec

Video Title: "ତମେ ତ ବଡ଼ ଡାକ୍ତର!" - କ'ଣ କରିବେ ସୋମନାଥ ଭାଇନା? | Odia Comedy Short Video | "Expert Doctor", Somanath?

Translated Title (Odia Part): "You think you're an expert doctor!?" - What will Somanath Do?

"ତମେ ତ ବଡ଼ ଡାକ୍ତର!" - କ'ଣ କରିବେ ସୋମନାଥ ଭାଇନା? | Odia Comedy Short Video | "Expert Doctor", Somanath?

#OdiaVideo #Comedyଏହି ଭିଡିଓରେ, ମୁନା ସୋମନାଥଙ୍କୁ ଠଙ୍କା କରି କହିଛି "ତୁମେ ତ ବଡ଼ ଡାକ୍ତର ଆଉ!" ଏହାର ପ୍ରତିକ୍ରିୟାରେ କ'ଣ କହୁଛନ୍ତି ସୋମାନଥ ଭାଇନା? ଶେଷରେ ସୋମନାଥ କ'ଣ କରିବେ? ...

youtu.be

Thumbnail:

Description:

#OdiaVideo #Comedy
ଏହି ଭିଡିଓରେ, ମୁନା ସୋମନାଥଙ୍କୁ ଠ�ଟା କରି କହିଛି "ତୁମେ ତ ବଡ଼ ଡାକ୍ତର ଆଉ!" ଏହାର ପ୍ରତିକ୍ରିୟାରେ କ'ଣ କହୁଛନ୍ତି ସୋମନଥ ଭାଇନା? ଶେଷରେ ସୋମନାଥ କ'ଣ କରିବେ? ଜାଣିବା ପାଇଁ ଭିଡିଓଟିକୁ ଦେଖନ୍ତୁ।
ଭିଡିଓଟିକୁ ଲାଇକ ଓ ସେୟାର କରନ୍ତୁ, ଏବଂ ଭିଡିଓକୁ ନେଇ ଆପଣ କ'ଣ ଭାବୁଛନ୍ତି ଆମକୁ କେମେଣ୍ଟ କରି ଜଣାନ୍ତୁ।
ଏହି ଭିଡିଓଟି ସ୍ୱାସ୍ଥ୍ୟ ପ୍ଲସ ନେଟୱର୍କ ଦ୍ୱାରା ନିର୍ମିତ ହୋଇଥିବା ବେଳେ ଏଥିରେ ସହଯୋଗ କରିଛନ୍ତି DCOR କନସଲ୍ଟିଂ, ଜନ୍ ହପକିନ୍ସ ବିଶ୍ୱବିଦ୍ୟାଳୟ, ଲୟୋଲା ବିଶ୍ୱବିଦ୍ୟାଳୟ, ମେରିଲ୍ୟାଣ୍ଡ। ଏହାର ପ୍ରଡକ୍ସନ୍ ପାର୍ଟନର ହେଉଛି ଓଏଲ୍ ଡିଜିଟାଲ୍। ଚଳଚ୍ଚିତ୍ର ନିର୍ମାତା କପିଲାସ ଭୂୟାଁ ଏହି ଭିଡିଓର ନିର୍ଦ୍ଦେଶନା ଦେଇଛନ୍ତି।

In this video, Muna challenges Somanath by remarking "You think you're an expert doctor!?", how will a surprised Somanath respond to Muna, and what will he finally do?
Like & share the video and let us know what you think in the comments below!
This video is produced by Swasthya Plus Network, with support from DCOR Consulting, Johns Hopkins University, Loyola University Maryland, and production partner OL Digital. The video is directed by Filmmaker Kapilas Bhuyan.

==Second Video:==
Female, Collective, Serious

Planned Time to Post: Sunday, 6 February, 6:00 PM India (7.30 AM Baltimore)

Private Video Link: https://www.youtube.com/watch?v=tnyg9fvlgi4

Video Title: ସୁରଜର ଜନ୍ମଦିନ - କ'ଣ ଉପହାର ଆଣିଛି ମିନି? | Odia Short Video | What is Mini's Gift?
Translated Title (Odia Part): Suraj's Birthday: What is Mini's Gift?

[ସୁରଜର ଜନ୍ମଦିନ - କ'ଣ ଉପହାର ଆଣିଛି ମିନି? | Odia Short Video | What is Mini's Gift?](youtu.be)
#OdiaVideo #Shortଏହି ଭିଡିଓରେ ମିନି ତାଙ୍କ ସମ୍ପର୍କୀୟ ସୁରଜଙ୍କ ଜନ୍ମଦିନ ପାଇଁ ଏକ ଉପହାର ଆଣିଛନ୍ତି, କିନ୍ତୁ ଏହି ଉପହାରଟି କ'ଣ? ଏହା ଏକ ଖେଳନା କି ଜୀବନ ପାଇଁ ଏକ ବାର୍ତ୍ତା? ଆସନ୍...
youtu.be

Thumbnail:

Description:

#OdiaVideo #Short

ଏହି ଭିଡିଓରେ ମିନି ତାଙ୍କ ସମ୍ପର୍କୀୟ ସୁରଜଙ୍କ ଜନ୍ମଦିନ ପାଇଁ ଏକ ଉପହାର ଆଣିଛନ୍ତି, କିନ୍ତୁ ଏହି ଉପହାରଟି କ'ଣ? ଏହା ଏକ ଖେଳନା କି ଜୀବନ ପାଇଁ ଏକ ବାର୍ତ୍ତା? ଆସନ୍ତୁ ଜାଣିବା!

ଭିଡିଓଟିକୁ ଲାଇକ୍ ଓ ସେୟାର୍ କରନ୍ତୁ, ଏବଂ ଭିଡିଓକୁ ନେଇ ଆପଣ କ'ଣ ଭାବୁଛନ୍ତି ଆମକୁ କେମେଣ୍ଟ କରି ଜଣାନ୍ତୁ।

ଏହି ଭିଡିଓଟି ସ୍ୱାସ୍ଥ୍ୟ ପ୍ଲସ୍ ନେଟୱର୍କ ଦ୍ୱାରା ନିର୍ମିତ ହୋଇଥିବା ବେଳେ ଏଥିରେ ସହଯୋଗ କରିଛନ୍ତି DCOR କନସଲ୍ଟିଂ, ଜନ୍ ହପକିନ୍ସ ବିଶ୍ୱବିଦ୍ୟାଳୟ, ଲୟୋଲା ବିଶ୍ୱବିଦ୍ୟାଳୟ, ମେରିଲ୍ୟାଣ୍ଡ। ଏହାର ପ୍ରଡକ୍ସନ୍ ପାର୍ଟନର ହେଉଛି ଓଏଲ୍ ଡିଜିଟାଲ୍। ଚଳଚ୍ଚିତ୍ର ନିର୍ମାତା କପିଳାସ ଭୂୟାଁ ଏହି ଭିଡିଓର ନିର୍ଦ୍ଦେଶନା ଦେଇଛନ୍ତି।

In this video, Mini has got a gift for her dear cousin Suraj's birthday, but what is it? Is it a shiny toy or a message for life? Let's find out!

Like & share the video and let us know what you think in the comments below!

This video is produced by Swasthya Plus Network, with support from DCOR Consulting, Johns Hopkins University, Loyola University Maryland, and production partner OL Digital. The video is directed by Filmmaker Kapilas Bhuyan.

Appendix II

Contest to boost comments on Video #2

ସୁରଜର ଜନ୍ମଦିନରେ ମିନି ଆଣିଛି ଉପହାର। ଭିଡିଓଟିକୁ ଦେଖନ୍ତୁ, ଏହାକୁ ନେଇ ଆପଣଙ୍କ ମତାମତ ୟୁଟ୍ୟୁବରେ କମେଣ୍ଟ କରି ଆମକୁ ଜଣାନ୍ତୁ। ୫ ଜଣ ଭାଗ୍ୟଶାଳୀ କମେଣ୍ଟ କରିଥିବା ବ୍ୟକ୍ତିଙ୍କୁ ସ୍ୱାସ୍ଥ୍ୟପ୍ଲସ୍ ପକ୍ଷରୁ ମିଳିବ ୧ ହଜାର ଟଙ୍କା ଲେଖାଏଁ ଉପହାର। (ଏହି କଣ୍ଟେଷ୍ଟ ୧୫ ଫେବ୍ରୁଆରି, ମଙ୍ଗଳବାର ସନ୍ଧ୍ୟା ୫ଟା ଯାଏଁ ଜାରି ରହିବ)। ଜଲଦି ଭାଗ ନିଅନ୍ତୁ। Video
Link: https://youtu.be/tnyg9fvlgi4

It's a general announcement in Odia. We'll be offering 1,000 rupees each to 5 random people. So a total budget of around $66. The contest will run until 5 PM, Tuesday 15 Feb, India.