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ABSTRACT

Black Americans in the US not only suffered from disproportionately high hospitalization and death rates throughout the pandemic but also from the consequences of low COVID-19 vaccination rates. This pattern of disparity is linked to distrust of public health systems that originates from a history of medical atrocities committed against Black people. For that reason, mitigation of race-based inequity in COVID-19 impacts might find more success in grassroots information contagion than official public health campaigns. While Black Twitter is well-positioned as a conduit for such information contagion, little is known about message characteristics that would afford it. Here, we tested the impact of four different message frames (personalization, interactive, fear appeal, neutral) on the social contagion potential of bi-modal social media messages promoting COVID-19 vaccinations and finding personalized messages to be the most shareable. Wary of recommending personalization as the blueprint for setting a social contagion health campaign in motion, we probed further to understand the influence of individual-level variables on the communicability of personalized messages. Subsequently, regression models and focus group data were consulted, revealing that thinking styles, vaccine confidence levels, and attitudes toward social media were significant factors of influence on the contagion potential of personalized messages. We discussed the implications of these results for health campaigns.

Repeated surges of SARS-CoV-2 strains prolonged unnecessary suffering and exacerbated racial, ethnic, and socioeconomic health disparities. In the United States, Black people, in particular, were disproportionately affected, especially during the first years of the pandemic. By February of 2022, roughly three months after this study's main experiment was conducted, Black people had around 2.5 times more hospitalizations and 1.7 times more deaths than White people (Hill & Artiga, 2022). An important part of these disparities is likely due to differences in vaccination rates.[1] By April 2022, 57% of Black Americans had received at least one vaccine dose, compared to 63%, 65%, and 85% of White, Hispanic, and Asian Americans (Adeagbo et al., 2022),[2] which aligns with survey results of vaccine hesitancy among US adults (Khubchandani & Macias, 2021; Willis et al., 2023).

A confluence of factors influences COVID-19 vaccination hesitancy among African Americans. Medical mistrust is widespread due to historical injustices committed against this group (Nuriddin et al., 2020) and inequitable contemporary health practices. Cumulative inequality theory posits that when discrimination is systemic in a society, its corrosive effects accumulate over time, driving individual-level attitudes such as institutional distrust that fuel vaccine hesitancy (Kail & Taylor, 2014; Williams & Mohammed, 2009).

These patterns of disadvantage call for inquiries focused on Black communities to assess the viability of grassroots information sharing among community members rather than top-down campaigns from government authorities. Grassroots sharing depends on how engaging and shareable information are, appealing to researchers to identify the particular message characteristics that could promote pro-vaccination information spread through social media networks. Indeed, grassroots campaigns are not possible without spreadability, or what we call the *social contagion potential* of messages.

Here, we report on the contagion potential of messages by combining two approaches. First, we used a controlled experiment to assess the viability of four different message frames for social contagion. Second, we turned to focus group data from *The New Georgia Project* to provide context for understanding the findings of the experiment. Using regression and moderated mediation modeling we also focalized individual centered variables such as thinking styles and reliability estimates of social media to understand the communicability of pro-vaccine information among Black Americans.

The legacy of medical mistrust among Black Americans

Public health crises have historically affected Black people disproportionately. For example, in the early 2000s, the Centers for Disease Control and Prevention (2004) reported that Black people contracted HIV at a rate about nine times higher than white people. During the 2009–2010 H1N1 global influenza pandemic there were glaring disparities among those

affected by the flu and low vaccination rates among Black people (Burger et al., 2021). The same is true for the early years of the COVID-19 pandemic when Black Americans were most susceptible to contract, be hospitalized, and die from COVID-19. These and other failures of healthcare systems to address racial disparities cultivated widespread medical mistrust among Black Americans (Wells & Gowda, 2020).

The medical mistrust among Black people is connected to the dark history of medicine. Torturous exploitation of Black people for experimentation is well documented. For example, enslaved women suffered unanesthetized procedures that developed the foundations of gynecology (Christmas, 2021; Washington, 2006). The racialized medical abuse of the Tuskegee experiments was formally acknowledged in 1997 by then-president Bill Clinton. Conducted by the US Public Health Service from 1932 to 1972, poor rural Black men were recruited to participate in research that used deception and inactive treatment protocols to observe the natural progression of untreated syphilis. When the study ended, 28 patients had died from syphilis, 100 died from syphilis-related conditions, 40 participant wives contracted syphilis, and 19 children were born with congenital syphilis (Magner & Kim, 2018). These and other incidents still reverberate through the collective consciousness of Black Americans (Washington, 2006). This past remains present and critical to understanding vaccine attitudes and behavior.

Information warfare has also contributed to medical mistrust among Black Americans. In 1983, the K.G.B. propagated the idea that the HIV virus was a bioweapon developed by the American military to kill African Americans. By 1987, news about this HIV conspiracy ran in 25 languages across 80 countries, undermining American diplomacy abroad and fueling domestic race-based conflict (Broad, 2020). Decades later, survey data show Black Americans continue to believe the HIV conspiracy, adding resistance to condom use (Brooks et al., 2018), HIV testing (Bohnert & Latkin, 2009), and antiretroviral treatment (Bogart et al., 2010). The lingering presence of this disinformation campaign is unknown. Yet, other misinformation circulating through social media have raised concern among scholars and policy makers – with good reason. No media outlet in history matches the velocity and transmissive capacity of contemporary social media for spreading falsehoods. The conditions of the pandemic magnified this throughput.

Recent investigations show that Black Americans turned to social media as the dominant source for information about COVID-19 during lockdowns (Adekoya & Fasae, 2021; Kemei et al., 2022) where they were exposed to falsehoods about prevention and treatment. Moreover, discussions about medical mistrust among Black social media users were leveraged by some anti-vaccination groups to dissuade Black people from getting vaccinated (Dexter-Colllins, 2020). Thus, while serving as destinations for fulfilling information needs, social media hosted falsehoods with potentially deadly consequences and exposed vulnerable populations to disinformation campaigns.

Among social media platforms, Twitter offered a relatively safe community network for Black people during the pandemic. Described as a counterpublic, researchers noted that Black Twitter is "held together by varying degrees of a sense of community" (Freelon et al., 2018, p. 44). Engaged members recognize and conform to the distinct discursive cultural characteristics of this group (Brock, 2012; Graham & Smith, 2016; Jackson et al., 2020). If the primary user requirement is understanding and using culturally competent discourse, misinformation aligning with this culture could gain considerable potency. Thus, the sense of community that holds this network together also leaves its users vulnerable to misinformation that could perpetuate disparities. At the same time, Black Twitter is also positioned to diffuse reliable health information with great efficiency and credibility, a potentiality of central interest to this study.

The social contagion potential of social media messages

Measures that track message diffusion patterns on social media provide a robust account of the dynamics of virality or social contagion as some researchers refer to it. As valuable as this network level perspective is, it tells us little about the internal cognitive and evaluative properties that actuate content sharing at the individual agent level. Yet, as Falk et al. (2012) point out, assessing cognitive processes of individual human beings is methodologically challenging. Even if media users are cooperative and motivated to tell researchers why they share information, they might not be able to do so. Humans lack conscious awareness of the underlying factors that motivate their behavior and struggle to reflect on it. To bypass this challenge, a few functional magnetic resonance imaging (fMRI) studies have identified brain-related precursors to message propagation (Falk et al., 2012, 2016). Based on that literature, we developed self-report items for measuring message propagation probabilities or *contagion potential* as we call it.

First, information that resonates with a media user upon initial receipt (neural activity in the Brodmann's area 10 and the precuneus/posterior cingulate cortex) advances the likelihood of advocacy for the information to others. We employed the *feeling thermometer* to assess agreeability and affect toward messages. Second, perceptions of how information might be received by others (neural activity in dorsomedial prefrontal cortex and temporal-parietal junction) affect enthusiasm about the information. We employed an item measuring the perceived efficacy[3] of messages to assess this dimension of mentalizing information reception among others. We also directly assessed perceived shareability, asking participants how willing they are to share a series of messages. As we report later, these three items were statistically reliable as a self-report index for the contagion potential of a message – the main dependent variable for this study. Future studies that test this index in conjunction with message virality and fMRI procedures could add substantial pragmatic value to building effective health campaigns in the future.

Virality and emotional message content

Research on factors that influence the virality or shareability of messages has identified at least two major dimensions. First is *social reinforcement*: individual contributions to social contagion increases with exposure to multiple other

people sharing the message (Centola, 2010; Liu et al., 2017; Ugander et al., 2012). Second is the *characteristics of content* (Cheng et al., 2014; Tsur & Rappoport, 2012) which we address here with specific focus on the emotional charge of messages.

While emotional content consistently emerges as a predictor of content virality (Berger & Milkman, 2012; Lwin et al., 2020; Saquete et al., 2022; Stieglitz & Dang-Xuan, 2013; Tellis et al., 2019), there are striking incompatibility across findings. This is likely due to mismatches in conceptual and operational definitions of virality. Moreover, studies span across content genres that vary in diffusion mechanics – from mainstream news to user generated novelty content to meme campaigns about smoking cessation, to name a few. Finally, while most of these studies are grounded in a dimensional view (Russell, 1980) of emotion (valence and arousal mostly) a discrete treatment of emotion (Plutchik, 1980) might add nuance to measures of affective responses. For example, in a state of arousal (dimensional approach) subjects reported experiencing multiple discrete emotions concurrently, leading to calls for integrating dimensional and discrete approaches (Harmon-Jones, 2019; Harmon-Jones et al., 2017).

Despite the levels of incompatibility across existing studies, there is growing certainty that emotionally charged messages are more likely to spread than neutral ones. Some studies report that negative sentiment has more viral potential than positive sentiment (Berger & Milkman, 2012; McLaughlin et al., 2016; Meng et al., 2018; Saquete et al., 2022). Others have shown that positive messages that excite and inspire have shareability potential on social media across content genres and topics such as news, personal tweets, advertisements, and health news (Al-Rawi, 2019; Berger & Milkman, 2012; Kim, 2015; Liu et al., 2017; Tellis et al., 2019).

Our investigation of emotional content and message virality focused on four message frames grounded in research that show their prevalence in social media content (Zhu et al., 2020), their capacity to provoke emotion, and their effectiveness in health campaigns across a number of dependent variables including memory, attitudes, health-related behavior, and virality (Borah et al., 2021; Gao & Feng, 2016; Penţa & Băban, 2018).

Personalization (aka exemplification) in messages refers to the inclusion of emotional testimony from ordinary citizens about their personal experiences of social issues (Bas & Grabe, 2016; Zillmann, 2006). Personalization has been shown to put a human face on social issues, provoking empathy and identification with other people's experiences, increasing perceptions of issue importance (Grabe et al., 2017), enhancing memory formation (Mujica & Bachmann, 2016), and reinforcing political participation (Bas & Grabe, 2016; Marcus & MacKuen, 2004). Health communication studies have documented the persuasiveness of personalization (Hinnant et al., 2013; Zillmann, 2006), its impact on advancing pro-vaccine attitudes (Fitzpatrick-Lewis et al., 2010) and social media retransmissions (Kim et al., 2016).

Interactivity refers to provocative content that encourages media users to respond with comments or images to a seed exchange. Studies have shown that interactivity promotes participation and emotional engagement

(Collins, 2014; Hallett, 2003; Qiao, 2019) and influence attitudes (Agarwal & Karahanna, 2000; Sundar, 2007), even in health messages (Bellur & Sundar, 2017). Bail (2016) demonstrated that messages featuring visuals and positive textual interactions have higher viral probability than text-only messages and messages without interactivity. They recommend that social media campaigns employ images that strategically invite positive emotional reactions and prompt interaction through exchange and content creation and transformation. Memes are an example of how media users creatively transform content into social media interactions (Shifman, 2013).

Fear frames highlight the cost of failing to engage in a recommended behavior (Hong & Hashimoto, 2021) and have the potential to induce anxiety by emphasizing the escalation of a crisis (Hameleers, 2021). There are mixed results about the effectiveness of fear-eliciting frames in health messages (Kim et al., 2019; Lawes-Wickwar et al., 2021). Some studies report that fear appeals, emphasizing danger and loss, negatively impact health attitudes and behavioral intentions (Lawes-Wickwar et al., 2021). Yet, the fear frame was found to be persuasive in high efficacy contexts (Peters et al., 2013; Tannenbaum et al., 2015). The inconsistency in findings about the fear frame also extends to the realm of contagion. Wang et al. (2021) found that Twitter users were most likely to share positive content about preventative measures with low uncertainty (i.e., mask-wearing) and negative content (including fear appeals) about preventative measures with high uncertainty (i.e., vaccination).

Emotionally neutral messages are often used as a baseline comparison condition in experimental studies that test the effectiveness of emotional content. Messages void of emotional appeals tend to be less persuasive and memorable and have lower contagion potential in online environments (Falk et al., 2016; Lench & Levine, 2005; Stieglitz & Dang-Xuan, 2013). For that reason, we included emotionally neutral message frames as a point of comparison for personalized, interactive, and fear appeal frames.

Given the lack of consistent findings about the comparative impact of emotional content on virality, we formulated a research question to guide the experimental investigation of the four frames we are investigating:

RQ1: Are there significant differences in the contagion potential of COVID-19 vaccine messages presented in personalized, interactive, fear-appeal, and neutral frames?

Social contagion potential and individual differences among media users

Scattered evidence suggests that cognitive and media use factors might offer a productive entry point into understanding individual differences in social contagion. Specifically, Actively Open-minded Thinking about Evidence (AOT-E) has been associated with sharing behavior in online environments. Moreover, the credibility of social media is linked to the believability and shareability of messages. We developed

three research questions to explore the intersection of message frames and these two media user factors.

Thinking styles

AOT-E is a cognitive disposition independent of cognitive ability, measured on a continuum from principled to open-minded styles of integrating new information into attitudes (Haran et al., 2013; Janssen et al., 2020). Principled thinking is marked by cognitive rigidity and resistance to belief change in line with confirmation bias tendencies (Stanovich & West, 2007). Conversely, high levels of AOT-E indicate a mind habit receptive to varied points of view and a tendency to evaluate evidence independent of prior beliefs – something Stanovich et al. (2016) argue is central to rational behavior. People high in AOT-E avoid the impulsiveness of online posting behavior that spreads disinformation (Carpenter et al., 2018). Whether high AOT-E is linked to spreading reliable health information remains unknown. In fact, AOT-E has received relatively little attention in the health realm. A few exceptions are Scherer et al. (2018) linking AOT-E to higher HPV vaccination rates, Cohen et al. (2021) reporting an association with trust in COVID-19 experts, and Erceg et al. (2020) connecting higher knowledge of COVID-19 to open-mindedness. A comparison of US adolescents showed no statistically significant effect of ethnicity on self-reported thinking styles (Emlen Metz et al., 2020). To date, AOT-E is untested in the context of social contagion, prompting our second research question:

RQ2: Is Active Open-minded Thinking about Evidence a significant factor in accounting for the contagion potential of COVID-19 vaccine messages?

Social media use and credibility

There are clear indicators that social media is a credible source of health information for young non-White people, even preferred over direct contact with medical professionals (Basch et al., 2018; Lariscy et al., 2010). Most recently, Stewart (2022) reported that Black college students identified social media as their main resource for information about how COVID-19 affects the African American community. Pew Research Center (2020) confirmed this for older adults. Of Black respondents, 37% (compared to 34% of whites) reported using social media to share or post COVID-19 related content. The perceived reliability of media platforms has been shown to serve as a navigational tool for media use (Chock & Kim, 2020; Kim & Grabe, 2022) and sharing behavior (Ali et al., 2022; Stefanone et al., 2019). Our study builds on this foundation, testing how perceived reliability of social media, in general, might impact social contagion.

RQ3: Are perceptions of social media reliability a significant factor in accounting for the contagion potential of COVID-19 vaccine messages?

Among the major social web platforms, Twitter has developed a reputation for housing a collective of Black users, commonly referred to as Black Twitter (Clark, 2014). In 2019, the Pew Research Center reported that Black people accounted for about 11% of the site's user base (Wojcik & Hughes, 2019). Research on Black Twitter suggests that Black users treat the site as a space for community building, inspiration, and belonging (Hill, 2018; Jackson et al., 2020; Williams & Gonlin, 2017). The circulation of *Blacktags* – viral, racialized hashtags widely shared among Black Twitter users – points to the agency that this site affords its users (Brock, 2012; Florini, 2014; Sharma, 2013). This makes Twitter uniquely positioned for social contagion among Black Americans (Sharma, 2013), prompting a fourth research question to direct such inquiry.

RQ4: Do attitudes toward Twitter, specifically, have a moderating effect on the contagion potential of COVID-19 vaccine messages?

Methods

Experiment

COVID-19 vaccine messages were tested using a 3 (message repetition) × 4 (message frame) within-subjects experimental design. The four message frames were each represented by three messages and rated for contagion potential, in random order, by all participants in this study. A Qualtrics panel of 701 young (18–40 years), urban, Black people with a Twitter account participated in this study over the course of 3 weeks in November 2021 during the height of the COVID-19 pandemic. Among social media platforms, Twitter stands out as one most used among urbanites. In fact, only 18% of the residents in rural areas report ever-using Twitter, compared to 74% using YouTube and 67% using Facebook. More than 50% of the urban and suburban dwellers report using Twitter (Pew Research Center, 2021).

Stimuli

A research team member with professional background in graphic design built bimodal (still image with text) messages that featured personalization, interactivity, fear appeals, and emotional neutrality (for baseline comparison). The stimuli (Figure A1) and the results of a manipulation check (Tables A1 and A2) are represented in the online appendix. Personalization was introduced through identifying ordinary people (non-experts) offering testimonials (quoting them) about their lived experiences with the vaccine. The interactivity condition presented an unnamed person inviting media users to comment or share photos about their vaccine experiences. The fear appeal condition was operationalized as the combination of visual and verbal modalities to present vaccination as a countermeasure to life threatening or debilitating outcomes. Finally, neutrally framed messages were visually and verbally unemotional, showing vaccine vials with a brief, simple message encouraging vaccination.

Measures

The wording of measures and reliability assessments of indices are reported in the online appendix. Experimental participation started with screening questions (age between 18 and 40 years, Black, urban, Twitter account holders) and potential

predictor demographics (gender, education level, and income) to make the sample of participants nationally (US) proportionate. The average age was 28 and 49.6% self-identified as women, while .8% either responded "other" or preferred not to answer. About 58% of participants earned less than $50,000 - per year and 69% had post-high-school training.

A key dependent variable of the study was a three-item (5-point scale responses) index that assessed what we call the contagion potential of messages based on the conceptual work of Falk et al. (2012) and Falk et al. (2016). For each message, we asked respondents to assess resonance (feelings toward messages), perceived efficacy, and the shareability potential. The reliability of this index was assessed for each of the frames separately, with Cronbach's alphas all above .90. A contagion potential index was constructed for each frame by aggregating three items across three messages that represented each frame.

Vaccine confidence was tested using a validated seven-item index (Hadjipanayis et al., 2020) that was also reliable in our dataset. We adapted the Adongo et al. (2021) index to measure vaccine access. Vaccine status was measured through a question with six options (Siegler et al., 2021).

The Bronstein et al. (2019) eight-item version of Actively Open-minded Thinking about Evidence (AOT-E) was not reliable as an index and therefore subjected to a confirmatory factor analysis. Two dimensions of which one was strong with clean factor loadings on five items (see Table A3 in the online appendix) emerged and was reliable. It was used as an open-mindedness index in subsequent analyses.

Perceptions of reliability for social media, legacy media (radio, TV, and newspapers), web searches, and friends and family were measured using five-point semantic differential items. Attitudes about Twitter were assessed with a ten-point Feeling Thermometer (FT) slider (Nelson, 2008). An open-ended question about COVID-19 was used to determine the quality of participation which resulted in the exclusion of a hundred participants who provided nonsensical written responses to this question.

Focus groups

A potential weakness of experimental research is the distance it places between researchers and the study group (Steckler et al., 1992). This outsider perspective often misses key aspects of participant experiences, leading to blind spots in study design and interpretation. To address this limitation, we turned to focus group data from *The New Georgia Project* to interpret the first round of experimental findings and guide subsequent data analyses. Focus group data were collected among unvaccinated Black participants in October 2021 and designed to explore reasons for vaccine hesitancy and how health campaign messages could promote confidence levels. Each focus group comprised eight to nine participants and lasted an average of 120 minutes. Participants were selected from *The New Georgia Project*'s voter file by location/urbanicity, age, gender, and listed telephone numbers. Participants were prescreened via phone for vaccination status, parental or guardianship of children, gender, and age. Conversations were conducted using online video conferencing. Upon completion, participants

received $150 in compensation. Transcripts from interviews were analyzed using an immersive and re-iterative process to identify relationships within and between groups (Strauss & Corbin, 1998) about media messages.

Experimental findings: Interpretation aided by focus group data

Vaccine attitudes

More than half (52.2%) of participants were unvaccinated, whereas 14.8% were fully vaccinated, 15.7% scheduled or had at least one shot, 6.3% were contemplating it, and 11% did not answer the question. *The New Georgia Project's* focus groups offered three entangled qualitative explanations for relatively low vaccination rates among Black people: (1) concern about safety and efficacy of the shot; (2) distrust of the public health system, coupled with; (3) fatigue from exposure to its campaigns. Focus group participants doubted the science behind the vaccine. One Georgian noted, "I feel like 10 years from now, we're going to have a commercial saying, "If you took the COVID vaccine in 2021, you may be eligible for compensation." Another said, "Hey, you got a bad history with these experiments and vaccines. It's very questionable how fast they made it." Underlying the pessimism about jab safety was distrust of government and health industries, two systems known to oppress Black communities: "It's just pandering . . . them trying to pander to Black people. So, it really just be counterproductive, really." Participants felt strained by public health campaign pressure which added to their hesitancy about vaccines: "I get more pressure from the media, television, radio and just everything surrounding me. That seems like where all the pressure's coming from in my area." This picture of distrust in authorities and their health campaigns confirmed our primary study goal to test messages that have potential to spread at the grass-roots level. These qualitative data also guided subsequent interpretations of results related to our research questions.

RQ1: Testing the contagion potential of four message frames

In pursuit of identifying message characteristics (see RQ1) that might be conducive to contagion, a single-factor ANOVA was used to compare the contagion indices of four frames. It yielded a statistically significant result, $F(1, 2800) = 50.53$, $p < .001$. The personalized frame had the highest score ($M = 3.55$; SE = .04), followed by the interactive frame ($M = 3.35$; SE = .05), the neutral frame ($M = 3.14$; SE = .04), and the fear frame ($M = 2.75$; SE = .05). Post hoc *t*-tests showed that the personalized frame had statistically more contagion potential than any of the others.[4] By contrast, the fear frame's social contagion potential was strikingly low – even lower than the baseline neutral frame.

The New Georgia Project's focus group data offered corroboration and explanation for the relative ineffectiveness of the fear frame. It is likely that fear appeals do not effectively move concerns about contracting COVID-19 to a point of outweighing deeply ingrained fears. One participant noted, "And also,

as far as being Black, we have too many experiments that have happened from Tuskegee…it's just too many things that have [sic] happened that you want me to put something in me." Another said, "I don't trust the pharmaceutical companies. It's too many incentives to get it. When has the government ever paid us to do something?" Another focus group participant offered, "They're literally not telling us the side effects. If you take Celebrex, you could get eye spasms and stuff like that. If you take this vaccine, what are some of the true side effects?" When asked how information about disproportionate Black mortality rates affected their perceptions, one participant lamented, "… it's trying to instill some level of fear in Blacks so we get that vaccine. And honestly, it's not going to work." Another participant referred to campaign messages about race disparities in vaccination rates as "fear mongering."

These negative responses to fear appeals are contrasted by comparably high contagion potential of personalized messages. The grassroots sensibility inherent to personalization is a likely explanation. Giving voice to the personal vaccine experiences of ordinary citizens is an empowering alternative to the top-down messaging from public health institutions. In fact, resistance to experts and potentates, even celebrities, was clear from focus group discussions. For example, participants were uninspired by a pro-vaccine video testimonial from NBA player LeBron James: "That's my favorite basketball player of all time, and I'm still not clicking."

RQs2 and 3: Predicting the contagion potential of personalized messages

To answer RQ2 and RQ3 we tested for individual-level mechanisms that might underlie the communicability of the most effective frame (personalization) through an exploratory linear regression analysis. Fourteen variables were entered into the model. These include demographics (age, gender, income, and education), vaccine confidence and access indices, the AOT-E index, reliability measures of a number of information sources, and the Feeling Thermometer (FT) measure of Twitter. The analysis produced a significant model, $F(14, 686) = 30.97$, $p = .001$, that accounted for 38% of the variance associated with the contagion potential of personalized messages.

Table 1. Standardized Beta Coefficients of independent variables predicting the contagion potential of personalized messages.

Independent Variables	Standard Error	Standardized Beta	t	p
Age	.055	−.008	−.243	.808
Gender	.626	−.006	−.188	.851
Education	.241	−.022	−.634	.526
Income	.251	.036	1.071	.284
AOT-E	.326	.101	3.063	.002
Vaccine access	.065	.008	.259	.795
Vaccine confidence	.062	.427	12.868	.001
Reliability social media	.342	.057	1.457	.146
Reliability friends & family	.357	.054	1.470	.142
Reliability web searches	.422	.007	.189	.850
Reliability TV news	.374	.009	.205	.838
Reliability newspapers	.405	.107	2.529	.012
Reliability radio	.402	−.004	−.100	.920
Feeling Thermometer Twitter	.119	.218	6.526	.001

In answering RQ2, Table 1 shows a significant positive correlation for AOT-E. Specifically, the more open-minded the thinking style, the higher the contagion potential of personalized messages. Perceptions of the reliability of social media (RQ3) were not significantly correlated to contagion potential, but the FT measure for Twitter was. The warmer the feelings toward Twitter, the higher the contagion potential of personalized messages. It is noteworthy that vaccine confidence was significantly related to contagion potential, whereas vaccine access was not.

RQ4: Testing a moderation mediation model

To find an answer to the fourth research question, a moderated mediation model (Hayes, 2013) was tested to examine the impact of thinking styles and attitudes about social media, and Twitter specifically, on the contagion potential of personalized messages (see Figure 1). Put differently, we tested for the conditional indirect moderating effect of feelings about Twitter on the relationship between AOT-E as a predictor and contagion potential as the outcome variable, via the reliability of social media as a potential mediator. PROCESS macro, model 7, v2.16 (Hayes, 2013) in SPSS with bias-corrected 95% confidence intervals ($n = 10,000$) was chosen to assess the statistical robustness of the indirect relationships of interest.

The vaccine confidence index was entered as a covariate for two reasons. First, vaccine confidence emerged in the linear regression analysis as the strongest predictor of contagion potential. Given that our study is probing individual-level variables about thinking styles and perceptions of media, controlling for vaccine confidence will allow the other variables of interest to emerge in the model. Second, focus group data indicated that some people cannot be persuaded by any kind of media messaging. In one focus group, the moderator asked, "Is there anything that could have been in that type of message just to make you click on it to learn more? Not do anything, just to learn more?" Uniformly, participants said no. Thus, controlling for vaccine confidence enables the model to reveal variance attitudes beyond hardened vaccine resistance. The results show that higher reliability ratings for social media were associated with greater contagion potential of personalized messages ($B = 1.67$, $Bse = .28$, $t = 6.01$, $p < .001$) and accounted for 30% of the effect of AOT-E on contagion potential.

Moreover, FT scores for Twitter moderated the effect of AOT-E on contagion potential (unstandardized interaction $B = .04$, $Bse = .01$, $t = 3.33$, $p = .001$). A test for the overall model was supported by the index of moderated mediation $= .07$ (95% CI $= .02$; .12). Zero does not fall within the CI, indicating a significant moderating effect of feelings toward Twitter on the indirect effect of AOT-E via reliability of social media on the contagion potential of personalized messages (Hayes, 2013). As Figure 2 shows, the conditional indirect effect was strongest among those who held warm feelings toward Twitter (1 SD above the mean of FT; effect $= .55$, $SE = .13$, 95% CI $= .30$; .84) and weakest among those with a cold disposition (1 SD below the mean, effect $= .09$, $SE = .11$, 95% CI $= .14$; .33).
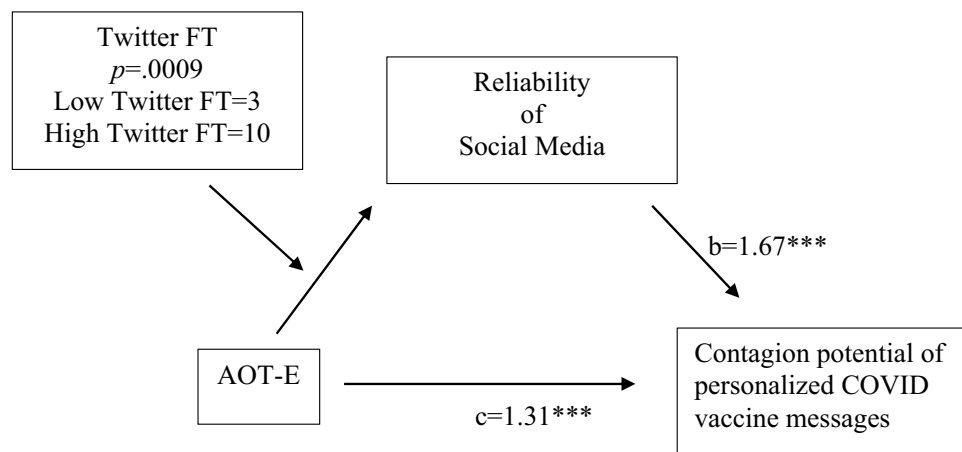
Figure 1. Conditional indirect effects of AOT-E on contagion potential via social media reliability, at high (+1 SD) and low (−1 SD) Twitter FT. ***$p < .001$.
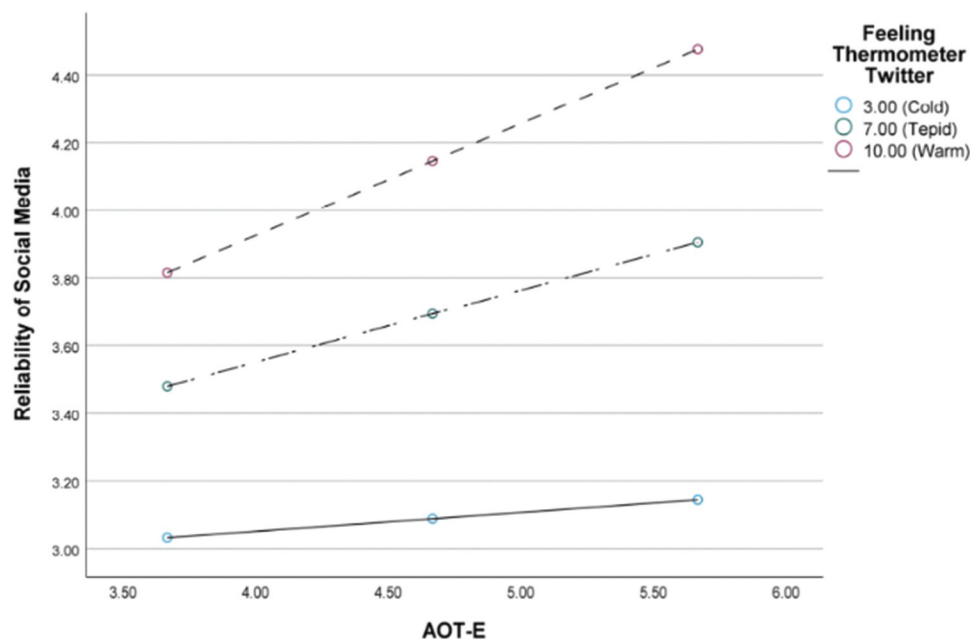

Figure 2. Moderating impact of Feelings about Twitter on the indirect effect of AOT-E on contagion potential via social media reliability.

Discussion

This project fused experimental and focus group insights as a foundation for understanding the impact of message characteristics on the social contagion potential of reliable COVID-19 vaccine information among Black social media users. This work responds to well-documented racial inequalities in US health care and stunning disparities during the COVID-19 pandemic. It was an exploratory endeavor, limited to testing only four message frames and employing a social contagion potential index of three items for the first time. These limitations are starting points for future research. For example, testing more message characteristics could offer a growing compendium for health professionals working on social media campaigns at the grassroots level. Employing field experiments to examine contagion processes in the wild would add invaluable insight to arguments that message characteristics matter. More studies testing links between experimental or survey findings and the realized virality of messages are needed to validate our newly developed contagion potential index in social media environments. Moreover, the impact of online message contagion on vaccination behavior has to be assessed in a social media intervention or through mathematical models that can test causal links between online content and corresponding offline health outcomes.

Understanding the mechanisms of vaccine uptake falls outside the scope of this study. Yet, physical access to vaccines did not predict the COVID-19 immunization status of participants in our study, whereas vaccine confidence did.[5] This finding is ancillary to research pointing to individual-level variables that interact with message characteristics to drive vaccine attitudes. We found evidence that message framing is critical to health message contagion potential and that individual-level thinking styles[6] and attitudes about social media impact the willingness of social media users to share pro-COVID-19 messages.

In testing four message frames, we identified two that impact social contagion potential the most. Fear appeals inhibit contagion potential, while personalization bolsters contagion potential. Fear frames most likely alienate unvaccinated participants, which results in defensiveness and hardening of anti-vaccination positions. Fear appeals implicitly kindle a pessimistic outlook that undermines action. As focus group conversations revealed, fear appeals stir institutional distrust that originates from historic and ongoing injustices committed against Black people. Scaring people into joining pro-vaccination message contagion is far less effective than building a grassroots movement on identification with the plight of others in the community.

Indeed, personalized messages offer a subtle but promising alternative to fear appeals. Framing pro-vaccine messages around the lived experiences of ordinary people anchors the message at the grassroots level, avoids triggering distrust and animosity toward public health sources, and showcases the resilience of fellow citizens in facing the adversity of a global pandemic. In this respect, our findings align with research on other outbreaks of communicable diseases like Ebola, flu, and H1N1 (Fitzpatrick-Lewis et al., 2010) that documented the effectiveness of frames that personalize and individualize messages. Importantly, the effectiveness of personalization might hinge on the identity of the centrally featured person in the message. In line with how personalization has been defined in media research – as testimony from ordinary people about their personal experiences of social issues – we suspect that personalizing messages around experts, potentates, and celebrities would lessen the effectiveness of this frame. In fact, during focus group discussions unvaccinated Black Georgians described personalized vaccine messages from celebrities as uncompelling and ineffective.

Predictive models of both direct and indirect effects added nuanced insights about individual-level mechanisms that explain the social contagion potential of personalized messages. These exploratory steps also served two functions. First, frame comparisons provided insights into *message* level effects, but adding observations about individual differences among *media users* extended the comprehensiveness and substance of our suggestions to healthcare professionals. Second, the focus on individual differences breaks with a nocuously simplistic research tendency to treat Black people as a homogeneous group. Indeed, this dataset revealed substantial individual variances among 701 young Black urban Twitter account holders.

After controlling for vaccine confidence, the potential for social contagion of personalized messages increased with open-mindedness among participants and was partially mediated by perceptions of social media as a reliable source of information. Thus, although there was a direct relationship between open-mindedness and contagion potential (linear regression finding), that relationship is partially explained by perceptions of social media as reliable platforms for information (mediation model). How media users feel about Twitter specifically, emerged as a corollary to these associations. In fact, Feeling Thermometer (FT) scores for Twitter moderated the relationship between open-mindedness and perceptions of social media credibility. Warm feelings toward Twitter are associated with higher reliability scores for social media, especially among the open-minded. All participants in our study reported having a Twitter account. Yet variation in their feelings about this platform was consequential to how they think about the reliability of social media more generally, which in return partially explained how open-mindedness drives the contagion potential of personalized pro-vaccine messages. It is reasonable to suggest that this moderating influence, driven by warm feelings toward Twitter, is a Black Twitter effect. The documented community building among young Black Twitter users (Jackson et al., 2020) is most likely reflected in the favorable FT scores – which influence the relationship between open mindedness and the contagion potential of personalized messages. Thus, a Black Twitter collective is likely to be well positioned for social contagion of messages that resonate with the group's sensibilities. Recent management changes at Twitter will likely affect – in unfavorable ways – the dynamics of the Black Twitter community. In December 2022 Twitter disbanded its Trust and Safety Council, composed of outside volunteer experts, who offered advice to Twitter about guarding the online safety of the platform's users. At a minimum this and a corporate approach to account verification, de-prioritizing information integrity, and tolerance for hate speech sent a chilling ripple through Black Twitter. At the same time, Black Americans have historically shown remarkable resilience to find the means to build communication channels and community (National Public Radio, 2022). The continuation of Black Twitter, in whatever form it evolves to, will remain an important ally in future efforts to level race-based inequities in public health.

It would be shortsighted to make blanket recommendations about personalization, as a means for facilitating grassroots public health campaigns via social media. Contextual information from focus groups and identifying individual differences related to cognitive style and perceptions of social media, offered a deeper understanding of underlying mechanisms of influence. That said, our data support the following conclusions and recommendations:

- Message personalization that presents testimonies from members of an endemic community.
- Giving voice to health-related experiences of ordinary citizens may hold more promise for social contagion than putting celebrities, health experts, or public health officials at the center of campaign messaging.
- Fear appeals significantly reduce prospects for success – and focus group conversations suggest this might be particularly true for government campaigns promoting new medical treatments among Black Americans.
- Twitter was and likely still is an effective launch platform for grassroots health campaigns, especially among Black adults below 45.

It is clear that a non-negligible portion of Black Americans have hardened views about government-initiated medical interventions and are unlikely to contribute to social contagion processes. Yet, among media users who score high on open-mindedness, health campaign efforts might find the impetus for social contagion to take off. The reported recommendations may be useful for future vaccination and booster campaigns as well as the inevitable next public health crisis.

Notes

1. The Kaiser Family Foundation's latest data, which was as of Dec. 28, 2022, showed Black people were 2.1 times more likely to be hospitalized and 1.6 times more likely to die from COVID-19 than White people (Hill et al., 2023).
2. The Centers for Disease Control and Prevention (2023) analyzed reports from pharmacies on vaccine administration. It showed that by May 10, 2023, 51.3% of Black Americans had received at least one vaccine dose, compared to 56.9%, 67.2%, and 73.6% of White, Hispanic, and Asian Americans.
3. PME (perceived message effectiveness) is a predictor of the actualized effectiveness of messages, especially in the context of tobacco education (Solnick et al., 2021). Moreover, perceived efficacy of health messages have been linked to diffusion size (Meng et al., 2018).
4. Personalization compared to Interactive: $t(700) = 4.27$, $p < .001$; Fear: $t(700) = 15.98$, $p < .001$. Neutral: $t(700) = 8.54$, $p < .001$.
5. $F(2,621) = 136.82$, $p = .001$; Vaccine Access Standardized $B = .015$, $t = .457$, $p = 648$; Vaccine Confidence Standardized $B = .55$, $t = 16.23$, $p = .001$
6. Surprisingly, the well documented reliability of the eight item AOT-E index was not supported in our study. The three items that lowered the reliability score varied from the other five items in at least two ways. First, it included strong language about opinions ("...should always ... ") that was not present in the other five items. In a COVID-19 lockdown with high levels of uncertainty, such unequivocal language might have elicited some restraint among respondents. Second, these three items are the ones in support of open-mindedness and are reverse coded for analyses. There might be some level of acquiescence bias involved in responding to the eight items. Nonetheless, we used the five items that emerged strongly as a factor and produced a high level of reliability.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Statement on human subjects approval

This manuscript is based on data collected with review and approval (IRB: #13062 Covid Frames) from the Indiana University Institutional review board (IRB) and the Human Subjects Office. All participants were provided appropriate informed consent as required by the IU IRB. The Study Information Sheet appeared on the very first page of the Qualtrics survey, which provided participants with an overview of the participation activities and gave them the opportunity to continue or withdraw from the study.

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