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Navigating intersectional expectations: a computational multimodal analysis of the effects of identities and communication styles on public engagement with science on TikTok

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ABSTRACT

Communication research has long established the impact of the communicator's social identity on persuasion. However, few communication studies have applied an intersectional lens to examine identities or systematically examined how the effectiveness of communication styles has been evaluated through identity-based expectations. Focusing on digital science communication, we used a unique multimodal dataset of 10,800 videos and 448,002 comments to explore how people's engagement and commenting behaviors were influenced by a communicator's gender, race, and their interaction with communication styles. Our results show that women of color, particularly Latina/Hispanic women, often faced *dual role incongruity* when communicating science online, receiving significantly lower engagement than those with a single marginalized identity. Audiences showed more engagement with online communicators who adopted *role-congruent communication styles* to communicate science (i.e., favoring affective tone from women and aggressiveness from men). This study sheds light on how identity-related heuristics increasingly shape engagement behaviors in visual-oriented platforms.

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Joanne Manaster, a science educator and communicator, aptly observed, 'If young ladies don't see other women articulating science, the impression will be that women don't do science, and a vicious cycle ensues' (Manaster, 2013). Her statement underscores the critical role of representation in science communication. Representation shapes societal perceptions of science and scientists, influencing how people answer fundamental questions: Who can become a scientist? Who is deemed qualified to impart knowledge and earn respect in the public sphere? And who is afforded greater visibility and recognition

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as a science communicator? The answers to these questions are deeply intertwined with systemic inequities.

Science communication, like the fields of Science, Technology, Engineering, and Mathematics (STEM), has long grappled with issues of diversity and inclusion. While prior research has substantiated the challenges faced by women and people of color in engaging the public with science (Amarasekara & Grant, 2019; K. Chen et al., 2024), much of this work is primarily descriptive and has two key limitations. First, it often treats identity in a mono-categorical way, analyzing gender or race separately. However, women of color face unique intersectional challenges in communicating science online (Phillips et al., 2022). Second, prior studies typically focus on identity alone, without adequately considering how communication styles interact with identities to influence audience engagement. In video-based communication, communication styles are not judged in a vacuum but evaluated through the lens of the communicator's social identity.

These gaps are particularly consequential in understanding short-video science communication on TikTok, where the unique audio-visual presentation culture and platform algorithms jointly shape audience engagement dynamics. First, unlike traditional voice-only science documentaries in which the communicator's identity is often backgrounded, TikTok influencers typically place themselves at the center of the video, making their identities highly salient (Divon & Eriksson Krutrök, 2024). Second, TikTok algorithms are becoming 'infomediaries' that are involved in framing the interactions between science communicators and audiences, curating the visibility of different science communicators, and shaping people's beliefs in 'who can be science communicators' (Morris, 2015). By examining the science engagement dynamics on TikTok, our study probes into which groups are more likely to be amplified and surfaced, and which may be disadvantaged in the algorithmically driven environment.

Drawing on the Role Congruity Theory of Prejudice (Eagly & Karau, 2002) and the Communication Style Inventory (CSI; de Vries et al., 2013), our study aims to examine how visible identity cues and communication styles jointly shape public engagement with science in the algorithmically driven environment. We conducted this study on TikTok for three reasons. First, TikTok is one of the most popular social media platforms in the U.S. and is broadly used for science communication (Zeng et al., 2021). Second, it breaks down traditional barriers to science by involving multiple actors to communicate science (Huber & Baena, 2023). Last, its unique multimodal, interactive, and algorithmic environment allows communicators to showcase their identities, while interactive features such as likes, shares, and comments provide measurable metrics for audience behaviors (Zeng et al., 2021). We performed a computational multimodal analysis of 10,800 science-related videos and 448,002 post-video comments on TikTok. We revealed the intersectional visibility in science communication and highlighted how communication role-style (in)congruence influences public engagement behaviors.

Literature review

Science communication on short-video social media platforms

Short-video social media platforms, such as TikTok, Instagram Reels, and YouTube Shorts, have revolutionized science communication, enabling the rapid dissemination

of science-related content to broad publics (Rein, 2023). Prior research highlights both its promise and challenges: While short-video platforms like TikTok can lower barriers to scientific knowledge and facilitate engagement with scientific content, emerging work points to systematic disparities in engagement with science videos produced by different social groups (S. Chen & Brewer, 2025; Huber & Baena, 2023). Unlike traditional science TV shows or documentaries, where communicators' credibility is pre-legitimized by professional settings and editorial gatekeeping, science communicators on TikTok need to continuously negotiate and construct their authority through audiovisual presentation, interactions with audiences, and algorithms (Phillips et al., 2022). In computer-mediated environments where contextual information is limited, creators' visible identity cues, such as race- and gender-coded appearance, might function as powerful heuristics for assessing authority and shaping public engagement (K. Chen et al., 2024).

Social identity, as one's self-concept derived from perceived membership in social groups, can profoundly shape communication outcomes (Fleming & Petty, 1999). We argue that the role of the communicator's perceived identity is particularly pronounced in short-form videos. First, unlike traditional television or documentaries, where science communicators usually occur through voiceovers, TikTok promotes an influencer-centered culture in which creators often speak directly to the camera and film from a first-person perspective (Divon & Eriksson Krutrök, 2024). As a result, communicators' identity cues become more salient than ever and influence perceptions of communicator authority. Second, compared to long-form content that heightens the message itself and facilitates thorough evaluation, short-videos are designed for rapid and low-effort consumption. In these contexts, audiences may rely more on visible identity cues to form initial reactions, leading to group-based biases (Fleming & Petty, 1999).

Moreover, the prevalence of video-format messages prompts scholars to adopt a 'multimodal framework' that considers the combined effects of visuals, text, and audio (K. Chen et al., 2024). As more science communicators turn to short-video platforms to share scientific knowledge (Zeng et al., 2021), it becomes increasingly important to analyze how identity-based stereotypes are activated and reinforced by different modes. Role Congruity Theory (RCT) offers a valuable framework for understanding this dynamic. Originally developed to explain gender bias in leadership (Eagly & Karau, 2002), RCT posits that people hold biased expectations regarding social identities, and individuals are evaluated less favorably when their behavior deviates from social expectations linked to their identity. We argue that these expectations extend to science communication, where certain identities are perceived as more competent or '*fit*' for the role.

Engaging audiences on social media requires more than charisma; it also demands the demonstration of intellectual credibility and authority to capture public attention and convey professional information (Phillips et al., 2022). However, agentic qualities like assertiveness and expertise are more commonly attributed to men, creating a mismatch for female science communicators that may result in prejudice and biased evaluations. Research shows that men are traditionally viewed as authoritative and technically skilled, while women are associated with communal traits such as emotional and sympathetic (Eagly & Karau, 2002). Racial stereotypes also play a role. According to the stereotype content model, social groups are perceived along two dimensions: warmth and competence (Cuddy et al., 2008). In STEM-related fields, White individuals were found to disproportionately occupy key network positions among science content creators on social

media (K. Chen et al., 2023), and Black and Latino/Hispanic individuals are stereotyped as warmer but less competent than White and Asian individuals (Cuddy et al., 2008). Although Asians may be viewed as more competent, they are often seen as lacking authority and leadership in the United States (J. G. Lu et al., 2020).

These gendered and racialized perceptions might intertwine with platform affordances to ‘penalize’ women and communicators of color, making them less visible and eliciting backlash through toxic commentary. On one hand, TikTok’s algorithmic recommendation system may increase the invisibility caused by perceived role incongruity, making female communicators and communicators of color receive less engagement than their male and White counterparts. Since TikTok’s algorithms are partly driven by users’ prior engagement activities (Kang & Lou, 2022), such algorithms can create self-reinforcing feedback loops in which content aligned with dominant preferences is repeatedly surfaced. Meanwhile, visibility on TikTok is not evenly distributed across one unified public, but across multiple ‘sides’ of TikTok with their own norms and audiences (Maddox & Gill, 2023). As a result, creators may gain visibility with one niche side of TikTok while remaining less visible in broader dominant segments, which may further reinforce exclusion and suppression of marginalized groups.

On the other hand, TikTok’s online commentary provides another important showcase of audience reactions linked to role incongruity. Toxic comments toward female creators reflect broader misogyny in society (Gardiner, 2018). When the evaluated object does not match stereotypical expectations for competent social roles, such perceived deviance can trigger toxic comments aimed at policing boundaries of existing power hierarchies. For instance, Gardiner (2018) found that news articles written by women and ethnic minorities attracted disproportionate levels of hostile comments. We argue that such identity-based backlash could be intensified in science short-videos, where identity cues are highly visible and role expectations for ‘science communicators’ can be strongly gendered and racialized. Consistent with this view, Amarasekara and Grant (2019) found that female science communicators received significantly more hostile comments than males. We therefore examine audience reactions using two complementary indicators: engagement metrics (i.e., views, likes, shares, and comments) and comment toxicity. Accordingly, we propose:

H1: Compared to male hosts of science videos, female hosts will receive (a) lower engagement and (b) more toxic comments.

H2: Compared to White hosts of science videos, hosts of color will receive (a) lower engagement and (b) more toxic comments.

Penalizing role deviations through intersectional identities

While RCT has been widely applied to gender and race separately, the intersection of these identities remains underexplored. As Crenshaw (1991) emphasized, the experiences of women of color are frequently the product of intersecting patterns of racism and sexism. Current media effects scholarship, however, often uses a mono-categorical lens to describe and explain how gender-only or race-only identities shape experiences. Intersectional oppressions are not considered in understanding media outcomes (Ramasubramanian & Banjo, 2020).

Intersectionality may lead to both harsher judgments and intersectional invisibility. Purdie-Vaughns and Eibach (2008) describe *intersectional invisibility* as the tendency for individuals with multiple marginalized identities to be overlooked or devalued. To extend RCT through an intersectional lens, we propose that individuals are penalized more harshly for role deviations when their compounded identities diverge further from dominant prototypes. In science communication, the prototypical communicator is often imagined as a White man (Phillips et al., 2022). Black women, for instance, may be perceived as lacking both the technical competence stereotypically attributed to White individuals and the authority typically associated with men. Similar role incongruity may apply to Asian women and Latina/Hispanic women, who also fall outside the White male prototype in science. Thus, we propose:

H3: Compared to White men, women of color (i.e., Black women, Asian women, and Latina/Hispanic women) will receive (a) lower engagement and (b) more toxic comments.

Extending RCT to role-congruent communication styles

RCT suggests that individuals are penalized when their behavior deviates from socially prescribed expectations tied to their gender or racial identity. However, these identity-based expectations do not operate in isolation. In video-based communication, audiences interpret visual and textual cues in an integrated, multimodal process. While prior research has examined identity-based disparities in science communication, it has often overlooked the moderating role of communication styles within this process.

Communication styles refer to ‘the characteristic way a person sends verbal, para-verbal, and nonverbal signals in social interactions’ (de Vries et al., 2013, p. 507). The interpretation of communication styles is deeply embedded in sociocultural contexts and shaped by individual social identities. Although many studies have documented identity-based differences in communication styles (Tenenboim-Weinblatt & Baden, 2021), few have systematically theorized the link between RCT and communication styles. To address this gap, we introduce the concept of *role-congruent communication styles*, arguing that the effectiveness of communication styles depends on their (in)congruence with identity-based expectations: communicators are more favorably evaluated when their communication style aligns with expectations associated with their social identity, and face penalties when it does not.

To empirically test this concept, we focus on three styles within the CSI: *verbal aggressiveness*, *overall affective tone*, and *informality* (de Vries et al., 2013). These styles are selected not only for their significance in science communication, but also because they reflect deeply ingrained gendered and racialized expectations in society. Characterized by anger, authoritative, and derogatory language, *verbal aggressiveness* is critical for establishing scientific authority, building trust, and enhancing visibility of scientific content on social media (Yuan et al., 2024). However, aggressive language can also undermine credibility and provoke backlash (König & Jucks, 2019). Importantly, audiences interpret verbal aggressiveness through a gendered lens. M. Burgoon et al. (1983) found that when women adopted more verbally aggressive styles, deviating from the normative expectation of prosocial communication, they were penalized with lower perceived persuasiveness.

A message's overall affective tone has been shown to increase audience engagement with science (H. Lu, 2023). Importantly, affective tone is interpreted through gendered expectations. Since emotional expressiveness is stereotypically associated with women (Adams et al., 2015), audiences may evaluate affective cues differently depending on the communicator's gender. Accordingly, our goal is not to isolate any single emotional state (e.g., fear, joy, or anxiety), but to examine how a communicator's overall sentiment valence shapes engagement and evaluations in gendered ways. For alignment with this focus and parsimony, we adopt a dimensional emotion view that captures overall sentiment valence (positive/negative) rather than treating emotion as categorical states (Nabi, 2010).

Informality, defined as an accessible and conversational tone, is effective for engaging non-technical audiences and diminishing the professional barriers to scientific knowledge. However, expectations around appropriate communication styles are often racialized in mediated contexts, such that race functions as a salient social cue for inferring communicative norms (Yum, 1988). Prior research suggests that Asian communicators are frequently associated with expectations for greater formality and respect (Y. B. Zhang, 2008), whereas White and Black communicators are more commonly associated with norms of directness, informality, and individual expressions (Yum, 1988). Such stereotypes reflect broader cultural norms and function in digital media as heuristics tied to race, particularly in short-video platforms where contextual information is limited. This dynamic is particularly pronounced on TikTok, where recommendation systems are hyper-localized and align content with users' locations (Wagner, 2023). Because all videos analyzed in this study were produced and mainly circulated within the United States, creators with Asian observable traits may be evaluated through racialized expectations formed in U.S. media environments. When such creators adopt an informal communication style, the resulting misalignment between racialized expectations and communicative behavior may lead to harsher audience evaluations.

Given the above, we propose a research question examining the associations between communication styles and audience reactions, and hypothesize that their effects are contingent upon the communicator's gender and racial identity:

RQ1: How do the communication styles (i.e., verbal aggressiveness, overall affective tone, and informality) of the video host influence public engagement and comment toxicity?

H4: Women using an aggressive communication style in science communication will receive (a) lower engagement and (b) more toxic comments than men using the same style.

H5: Women using an emotional communication style in science communication will receive (a) greater engagement and (b) fewer toxic comments than men using the same style.

H6: Asians using an informal communication style in science communication will receive (a) lower engagement and (b) more toxic comments than White, Black, and Latino/Hispanic communicators using the same style.

Data and method

Data collection

The workflow of this study is outlined in Figure 1. We collected TikTok videos that (1) contained the hashtag #science, (2) were published in the U.S., (3) were published

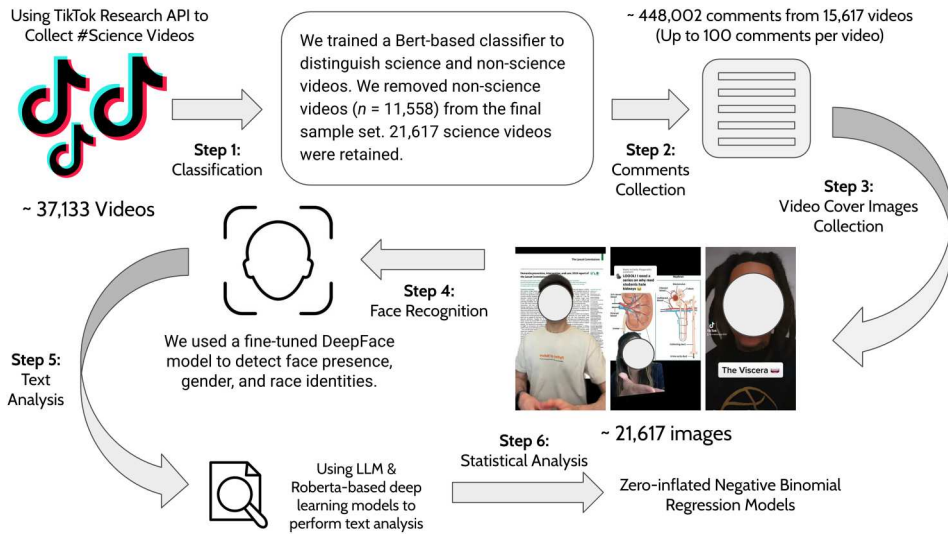


Figure 1. The workflow of this study.

between January 1st, 2023, and December 31st, 2023, and (4) had audio transcripts. This resulted in 37,133 videos. We then used the TikTok Research API to retrieve account-level information for these videos (e.g., number of followers, number of followings, verification status). Since some accounts were not publicly available, 33,788 videos were successfully linked to 12,255 unique accounts.

Training a BERT model to identify science videos

Since videos using the hashtag #science do not necessarily talk about science, we further filtered the dataset using a pre-trained BERT-based machine learning model (Precision = 0.83, Recall = 0.82, F1 = 0.83) to distinguish science-related videos from non-science content (see Supplementary Materials for model training details). BERT has been widely applied in communication research because of its accuracy to capture the contextual meaning of social media content (Viehmman et al., 2023). Video descriptions and transcripts were fed to the BERT model for categorization tasks, yielding 21,617 science-related videos; 11,558 non-scientific videos were excluded from further analysis. To validate this approach, an expert independently coded a random sample of 200 videos, yielding a Krippendorff's alpha of 0.75.

Collecting the cover images and comments

We developed a Python-based web scraping script to download the cover images of the 21,617 science videos. We focused on the cover images to identify the presence and identity of the video host, because they are intentionally selected by video creators to attract attention and often highlight the host, especially when identity presentation is central to the content.

We then used the TikTok Research API to retrieve post-video comments. Due to API limits, we were able to download up to 100 comments per video, resulting in 638,468 comments across 23,518 videos ($M = 27.15$). Through systematic manual inspection of

our dataset, we consistently observed that the comments were ranked primarily by the number of likes they received, meaning that our sample captured the most popular comments. After removing videos without comments or those that were unavailable, our final comment dataset included 448,002 comments from 15,617 science-related videos. [Figure 2](#) displays the structure of the dataset.

Measurements

Gender and racial classification using facial recognition

We used DeepFace (Serengil & Ozpinar, 2020), a fine-tuned facial recognition tool, to estimate the perceived gender and race identity from visual cues in video cover images, rather than the creator's self-identified gender or ethnicity. Based on DeepFace's classifications, 12,566 images (58.13%) contained identifiable faces. Among them, 9,074 were identified as male (72.21%) and 3,492 as female (27.79%). Racial classifications were predominantly White (67.96%), with the remaining identified as Asian (7.16%), Black (6.61%), Indian (1.36%), Latino/Hispanic (2.86%), and Middle Eastern (14.04%) (see Appendix B for details). Since our analyses focus on racialized perceptions inferred from visual phenotypes, we excluded Middle Eastern creators due to their high heterogeneity in visual phenotypes and lack of clear theoretical grounding in RCT. Following U.S. Census guidelines (U.S. Bureau, 2022), we grouped Indian with Asian and recoded race into four categories: White, Black, Asian, and Latino/Hispanic. A total of 10,800 videos with visible identity cues, created by 4,311 unique users, were included in the main analyses.

To validate DeepFace's accuracy, we conducted a validation study using a random sample of 200 images annotated by three trained coders. Classifications were assigned when at least two coders agreed; otherwise, images were marked as ambiguous. DeepFace

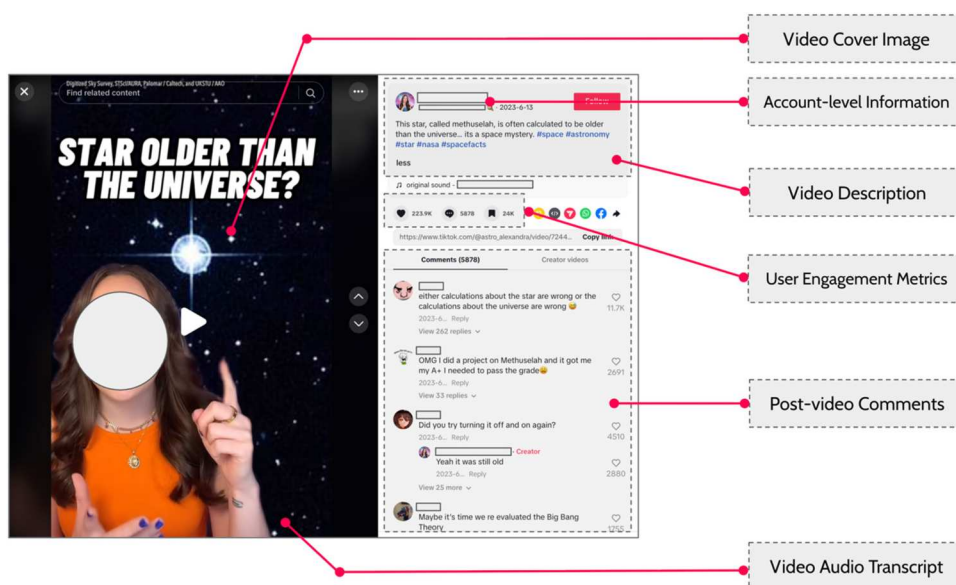


Figure 2. The structure of the dataset.

showed good performance metrics (Gender: Precision = 0.95, Recall = 0.93, F1 = 0.94; Race: Precision = 0.86, Recall = 0.95, F1 = 0.89) and strong agreement with human coders, with Krippendorff's alpha of .81 for gender and .90 for race. Additionally, a domain expert reviewed 100 randomly selected images to confirm that the majority depicted real science communicators ($n = 93$), not animations or third-party content. Full validation procedures are available in Appendix B.

Identifying communication styles

On TikTok, audience reactions are influenced not only by audio content but also by the accompanying description text. We thus combined each video's description and audio transcript into a single document for text analysis.

Prior research shows that LLMs can effectively help researchers do content analysis of text-based data (Bail, 2024). To maintain consistency and scalability, we used GPT-4o-mini with a one-shot prompt to classify verbal aggressiveness on a binary scale. A video was labeled as verbally aggressive if it included any of four facets: anger, authoritarianism, derogatory language, or non-supportiveness (de Vries et al., 2013; see Appendix C for details); otherwise, it was labeled as non-aggressive. Using this approach, GPT-4o-mini identified 766 videos as verbally aggressive and 10,034 as non-verbally aggressive. An expert independently coded a random sample of 200 videos, yielding a Krippendorff's alpha of .72.

The overall affective tone, defined as the tendency to express emotions intensely (de Vries et al., 2013), was measured using a RoBERTa-base model fine-tuned for sentiment analysis on the TweetEval benchmark. This model has demonstrated reliable performance across various social media platforms (Kauk et al., 2025). We computed overall affective tone as the sum of the positive and negative sentiment scores.¹ To validate this measure, we compared model outputs with LIWC-22 scores, resulting in a Pearson correlation of .30, suggesting moderate convergent validity.

Informality was assessed by evaluating whether the combined text reflected a casual, personal, and relaxed communication style (de Vries et al., 2013). Informality was assessed using the RoBERTa-base Formality Ranker, which assigns formality and informality probabilities (0–1). Consistent with the model's rank-based design, a video was labeled as informal if the informality score exceeded the formality score. Based on this criterion, 6547 videos were classified as informal and 4253 as formal. A trained expert independently coded a random sample of 200 videos, showing good performance metrics (F1 = 0.88, Recall = 0.84, Precision = 0.92) and a Krippendorff's alpha of .75.

Outcome variables

We operationalized public engagement using four indicators: the number of shares ($M = 150.66$, $SD = 1,954.25$), views ($M = 26,386.52$, $SD = 232,902.80$), likes ($M = 6,731.55$, $SD = 58863.30$), and comments ($M = 174.71$, $SD = 1,272.40$). Toxicity was assessed using Google's Perspective API, a widely used and well-validated machine learning tool for text analysis (Frimer et al., 2023). We specifically focused on its primary attribute, *toxicity*, which generates a score ranging from 0 to 1 to capture the extent to which a comment is rude, disrespectful, or unreasonable. The average toxicity score across all comments was 0.094 ($SD = 0.066$).

Control variables

To strengthen model validity, we controlled for three key factors. First, we accounted for account-level characteristics, including the number of followers, followings, previously posted videos, and verification status, to isolate identity effects from the communicator's existing audience base. Second, we controlled for the number of days since publication to account for differences in engagement accumulation over time.² Third, we controlled for the scientific discipline of each video, as prior research suggests that gender and racial disparities vary across disciplines. For instance, engineering and physics are typically male- and White-dominated, while life sciences and social sciences tend to be more diverse (Huang et al., 2020).

We used GPT-4o-mini to classify the scientific discipline of each video (see Appendix D for details). To validate the classification, we randomly sampled 200 videos and had an expert coder manually categorize them. Krippendorff's alpha between the model and the human coder was .65, indicating acceptable reliability.

Analysis plan

We estimated four negative binomial regression models to examine how identities and communication styles influence public engagement with science videos on TikTok, given the over-dispersed nature of these count variables (see Appendix E). We normalized the over-dispersed distribution of the number of followers, followings, and historical videos using $\log(x + 1)$. Each model included gender (woman vs. man), race (White, Asian, Black, and Latino/Hispanic), and communication styles (informality, verbal aggressiveness, and overall affective tone) as predictors, with 'man' as the reference group for gender and 'White' as the reference group for race.

We first estimated four main effects models to test the effects of gender and race on engagement (H1a, H2a, H3a) and to address RQ1 by examining how communication styles relate to each engagement metric. We then fit four interaction effects models by adding the following interactions: gender $\times$ race, gender $\times$ verbal aggressiveness, gender $\times$ overall affective tone, and race $\times$ informality, to test H3a, H4a, H5a, and H6a, respectively. Since comment toxicity is a continuous variable, we employed linear mixed-effects models for the (b) components of H1–H6 as well as RQ1 for comment toxicity. Gender, race, and communication styles (and the same interaction terms) were treated as fixed effects, while each unique communicator was included as a random effect to account for unobserved heterogeneity.

Results

Less engagement with science videos hosted by women and people of color

As Table 1 suggests, women and people of color received significantly less public engagement than their male and White counterparts. Videos featuring female hosts were significantly associated with lower shares, views, likes, and comments. Contrary to our hypotheses, female hosts received fewer toxic comments than male hosts.

Racial identity also plays a crucial role in shaping public engagement with science. Asian and Black communicators received significantly lower engagement than White

Table 1. Results of negative binomial regression models predicting audience engagement.

	Main Effect Models				Interaction Effects Models			
	Shares count	Views count	Likes count	Comments count	Shares count	Views count	Likes count	Comments count
(Intercept)	-4.133*** (0.200)	3.463*** (0.108)	2.694*** (0.089)	0.373*** (0.095)	-3.786*** (0.210)	3.670*** (0.114)	2.902*** (0.095)	0.360*** (0.100)
Gender								
Woman	-0.692*** (0.077)	-0.626*** (0.046)	-0.275*** (0.039)	-0.286*** (0.040)	-1.174*** (0.156)	-1.165*** (0.090)	-0.693*** (0.076)	-0.095 (0.080)
Race								
Asian	-0.136 (0.109)	-0.137* (0.065)	-0.322*** (0.057)	-0.245*** (0.058)	-0.631*** (0.184)	-0.362*** (0.106)	-0.537*** (0.098)	-0.279** (0.099)
Black	-1.003*** (0.125)	-0.523*** (0.075)	-0.465*** (0.065)	-0.148* (0.067)	-1.413*** (0.188)	-0.208 (0.116)	-0.587*** (0.101)	-0.353*** (0.103)
Latino/Hispanic	0.530** (0.180)	-0.054 (0.110)	-0.170 (0.095)	0.004 (0.097)	-0.161 (0.389)	-0.510* (0.201)	-0.322* (0.159)	-0.225 (0.161)
Communication Styles								
Verbal	0.778*** (0.127)	0.687*** (0.078)	0.630*** (0.068)	1.149*** (0.068)	0.883*** (0.150)	0.636*** (0.093)	0.688*** (0.080)	1.181*** (0.080)
aggressiveness								
Informality	0.260*** (0.071)	0.191*** (0.043)	0.349*** (0.037)	0.190*** (0.037)	0.051 (0.079)	0.160*** (0.048)	0.275*** (0.042)	0.165*** (0.042)
Overall affective tone	1.260*** (0.132)	0.382*** (0.075)	0.683*** (0.065)	0.337*** (0.066)	0.824*** (0.160)	-0.082 (0.094)	0.371*** (0.080)	0.441*** (0.081)
Woman × Asian					0.283 (0.238)	0.343* (0.144)	0.116 (0.129)	0.204 (0.130)
Woman × Black					0.589 (0.398)	0.215 (0.243)	1.045*** (0.212)	0.293 (0.215)
Woman × Latino/Hispanic					-2.136*** (0.448)	-1.448*** (0.237)	-0.562** (0.203)	-1.239*** (0.210)
Woman × verbal aggressiveness					-0.741** (0.273)	-0.156 (0.168)	-0.283 (0.148)	-0.104 (0.149)
Asian × informality					0.642** (0.225)	0.146 (0.135)	0.310** (0.119)	-0.038 (0.120)
Black × informality					0.574* (0.247)	-0.590*** (0.153)	-0.069 (0.132)	0.282* (0.133)
Latino/Hispanic × informality					1.336** (0.422)	1.065*** (0.227)	0.484* (0.195)	0.758*** (0.200)
Woman × overall affective tone					1.190*** (0.273)	1.157*** (0.160)	0.844*** (0.136)	-0.406** (0.142)
Number of followers	0.994*** (0.019)	0.758*** (0.010)	0.749*** (0.009)	0.585*** (0.009)	1.000*** (0.019)	0.766*** (0.010)	0.750*** (0.009)	0.587*** (0.009)
(log)								
Number of followings	-0.032* (0.016)	-0.152*** (0.010)	-0.043*** (0.009)	-0.028*** (0.008)	-0.061*** (0.017)	-0.167*** (0.011)	-0.052*** (0.009)	-0.025*** (0.008)
(log)								
Verified status	0.073 (0.143)	0.396*** (0.086)	0.096 (0.076)	-0.248** (0.078)	0.118 (0.146)	0.431*** (0.086)	0.122 (0.076)	-0.274*** (0.079)
Number of historical videos	-0.992*** (0.037)	-0.788*** (0.021)	-0.777*** (0.019)	-0.519*** (0.018)	-0.990*** (0.038)	-0.777*** (0.021)	-0.769*** (0.019)	-0.526*** (0.018)
Number of published days	0.010*** (0.000)	0.010*** (0.000)	0.006*** (0.000)	0.004*** (0.000)	0.010*** (0.000)	0.010*** (0.000)	0.006*** (0.000)	0.004*** (0.000)

(Continued)

Table 1. Continued.

	Main Effect Models				Interaction Effects Models			
	Shares count	Views count	Likes count	Comments count	Shares count	Views count	Likes count	Comments count
Male-/White-dominated scientific disciplines	0.586*** (0.074)	0.749*** (0.042)	0.602*** (0.037)	0.362*** (0.037)	0.521*** (0.074)	0.701*** (0.042)	0.586*** (0.037)	0.352*** (0.037)
Number of observations	10800							
AIC	54523.5	183099.0	169922.3	103663.8	54456.6	182973.8	169850.5	103619.1
BIC	54632.9	183208.3	170031.6	103773.1	54624.2	183141.5	170018.1	103786.7

Note: (1) We set man (gender), White (race), formality (informality), unverified status (verified status), more gender- and racially-diverse scientific disciplines (male-/White-dominated scientific disciplines) as the reference group. (2) The control variables have been log-transformed. (3) Standard errors are shown in parentheses. (4) * $p < .05$, ** $p < .01$, *** $p < .001$.

communicators. For Asians, engagement dropped in views, likes, and comments. Black communicators received significantly fewer shares, views, likes, and comments than White communicators. However, Latino/Hispanic communicators received significantly more shares than White communicators, though no other engagement metrics differed significantly. We found no significant increase in toxic comments toward Asian or Black communicators. However, Latino/Hispanic hosts received significantly more toxic comments. Thus, H1 and H2 were partially supported.

Latina/Hispanic women were more marginalized in science communication

To test H3, we examined the interaction effects between gender and race. As shown in Table 1 and Figure 3, White male hosts received the highest engagement overall. Asian women experienced a significantly modest increase in views. Black women received significantly more likes than those hosted by White men, but no significant effects were found for shares, views, or comments. Notably, Latina/Hispanic women faced consistent disadvantages across all engagement metrics. Compared to videos hosted by White men, videos featuring Latina/Hispanic women received significantly fewer shares, views, likes, and comments. Latina/Hispanic women received significantly more toxic comments than White men. No other group of women of color received significantly more toxic comments. H3 was partially supported.

Preference for role-congruent communication styles

To answer RQ1, we found that verbal aggressiveness, overall affective tone, and informality each boosted public engagement (Table 1). Verbal aggressiveness was associated with significantly more shares, views, likes, and comments. The affective tone also led

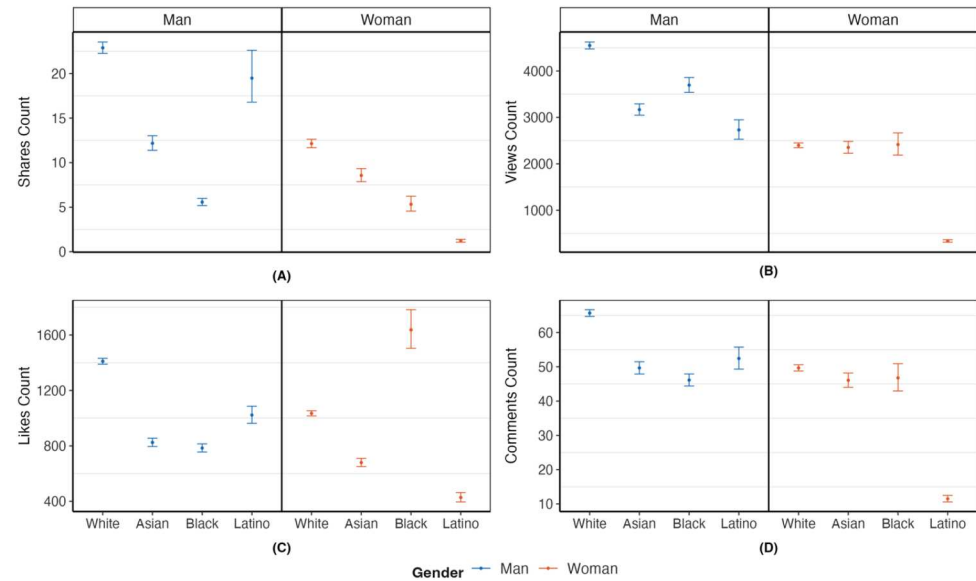


Figure 3. The interaction plots of gender and racial identities.

to significantly more shares, views, likes, and comments. Similarly, informal styles resulted in significantly more shares, views, likes, and comments. However, only verbal aggressiveness significantly increased toxic comments; the affective tone and informality did not affect toxicity significantly.

We further examined whether identity-congruent communication styles influenced public engagement (H4–H6). As Figure 4 shows, verbal aggressiveness helped male hosts boost engagement but decreased female hosts’ engagement. When female hosts became more aggressive, shares decreased significantly, while male hosts saw an increase in comments as aggressiveness rose, indicating the contrasting effects of verbal aggressiveness across genders.

Results showed that users were more likely to engage with science videos featuring women using a more affective communication style. As Figure 5 illustrates, a greater affective tone led to significant increases in shares, views, and likes, but significantly decreased comments for women-hosted videos.

Contrary to H6, informality increased public engagement across all racial groups (see Figure 6). Informality significantly increased shares and likes for Asian hosts but did not significantly influence views or comments. For Black communicators, informality significantly increased shares and comments but reduced views and had no effect on likes. Latino/Hispanic communicators experienced significant increases across all metrics, including views, likes, and comments. Toxicity was not significantly affected by role-congruent communication styles. Thus, H4 and H5 were partially supported, while H6 was rejected (Table 2).

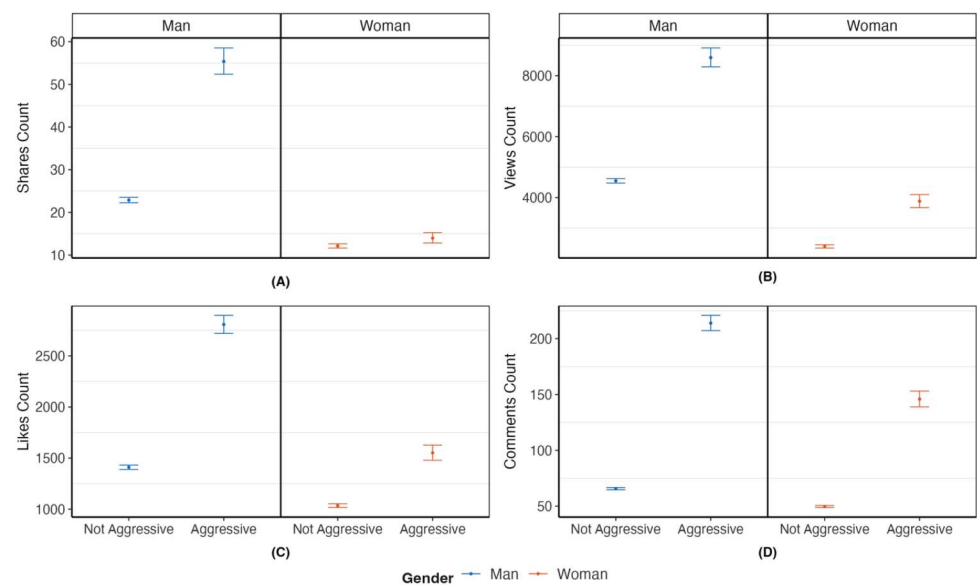


Figure 4. The interaction plots of gender and verbal aggressiveness.

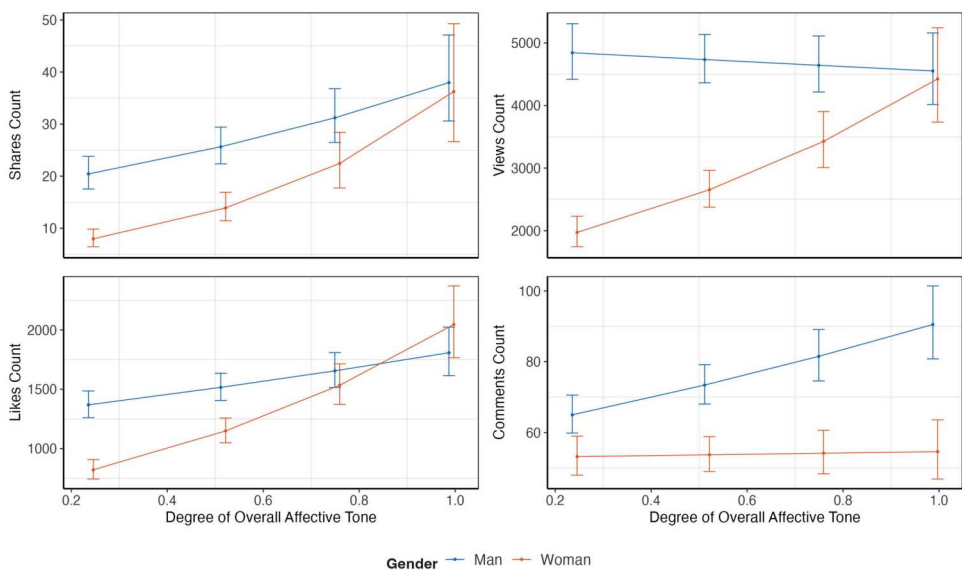


Figure 5. The interaction plots of gender and overall affective tone.

Robustness checks

We conducted several robustness checks. First, recognizing that some video cover images might feature multiple faces, we removed these cases ($N = 1372$) and re-estimated our models (Appendix F). Second, we removed videos without receiving any comments and examined the effects of identities and communication styles on engagement metrics again (see Appendix G). In both cases, the main results remained consistent. Third, we

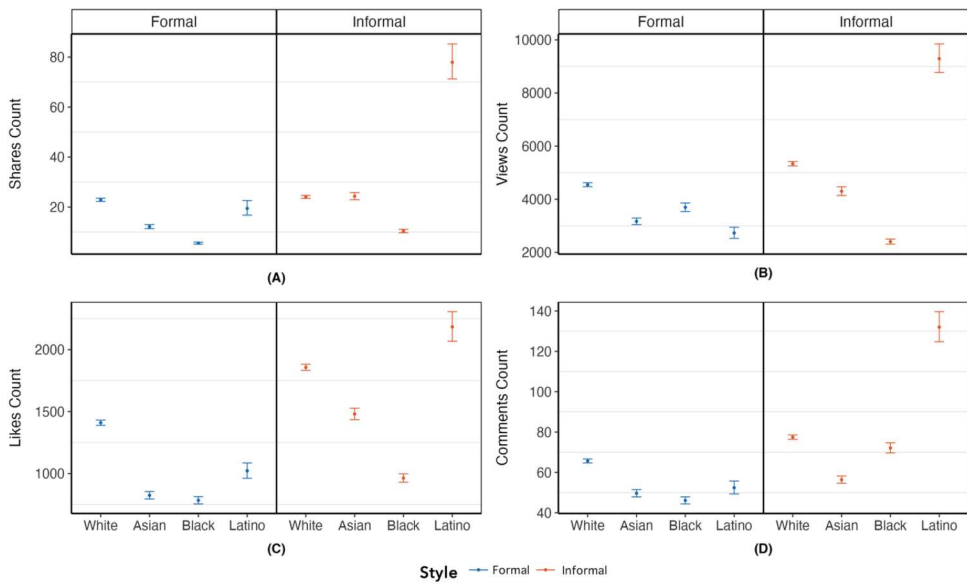


Figure 6. The interaction plots of racial identities and informality.

Table 2. Linear mixed-effects models predicting comment toxicity.

	Comment Toxicity	
	Main effects	Interaction effects
(Intercept)	0.096*** (0.002)	0.095*** (0.002)
<i>Gender</i>		
Woman	−0.007*** (0.002)	−0.006 (0.003)
<i>Race</i>		
Asian	0.002 (0.003)	0.002 (0.004)
Black	0.003 (0.003)	0.004 (0.005)
Latino/Hispanic	0.009* (0.004)	0.014 (0.007)
<i>Communication styles</i>		
Verbal aggressiveness	0.037*** (0.003)	0.035*** (0.003)
Informality	0.003 (0.002)	0.003* (0.002)
Overall affective tone	0.002 (0.003)	0.004 (0.003)
Male-/White-dominated scientific disciplines	−0.009*** (0.002)	−0.009*** (0.002)
Woman × Asian		0.000 (0.006)
Woman × Black		−0.005 (0.009)
Woman × Latino/Hispanic		0.020* (0.009)
Woman × verbal aggressiveness		0.005 (0.006)
Asian × informality		0.000 (0.005)
Black × informality		−0.002 (0.006)
Latino/Hispanic × informality		−0.018* (0.008)
Woman × overall affective tone		−0.005 (0.006)
Random effects		
σ^2	0.00	0.00
T_{00}	0.00 Username	0.00 Username
ICC	0.36	0.36
N	3251 Username	3251 Username
Observations	8114	
Marginal R^2 / conditional R^2	0.028 / 0.378	0.029 / 0.379

Note: See Table 1 for variable coding and reference groups.

used the videos that were not genuinely about science to test if our findings were unique in science communication contexts or part of the broader pattern in which women and racial minorities are marginalized in public spheres (see Appendix H). We found that women and people of color did not receive lower engagement in non-scientific videos, suggesting they faced unique challenges in communicating science online. Fourth, we tested the effect of face presence in cover images (Appendix I). While having a host generally reduced engagement, our main results further reveal a gender gap within it: science videos hosted by women received less engagement than those hosted by men. Finally, we explored disciplinary differences (Appendix J). While some interactions emerged, the core patterns held.

Discussion

This study offers a broad assessment of how visual representations of racial and gender identities serve as powerful heuristics and interact with communication styles to shape audience engagement with science. We outline a future research agenda that better addresses (1) the salience of identity cues in visual-centric social media, (2) the intersectionality of social identities, (3) the identity-based expectations of communication stylistic choices, and (4) the challenges posed by visual-oriented platforms and algorithmic infrastructures for individuals from subordinate groups.

Our findings first show that audiences were less likely to engage with science videos hosted by women and people of color than those hosted by men and White individuals.

This pattern aligns with RCT, which suggests that leadership and intellectual roles, like science communicators, are stereotypically male-coded, leading to penalties for those who deviate from these norms (Eagly & Karau, 2002). Beyond gender, racial disparities were evident: Asian and Black individuals received lower engagement than their White counterparts. As prior work suggests, Black individuals are often stereotyped as warm but technically incompetent, while Asians are stereotyped as competent but lacking authority (Cuddy et al., 2008). These stereotypical perceptions may undermine public trust in Asian and Black communicators' expertise and authority, ultimately reducing engagement.

These patterns can also be interpreted through Expectancy Violation Theory (EVT; J. K. Burgoon, 2015), which posits that when communicators deviate from stereotypical expectations, they are evaluated less favorably. Given that the prototypical science communicator is often perceived as a man or a White individual, female or racially minoritized science communicators may thus violate audience expectations, resulting in lower engagement or even hostility. While our findings did not find strong associations between identity and observed comment toxicity, these results should be interpreted cautiously: creators and the platform could hide or delete comments, meaning that our study captured only comments that remained publicly visible and may underestimate the extent of hostile responses.

Second, using an intersectional lens, our study advances RCT by demonstrating that gender and race jointly contribute to disadvantage. As EVT suggests, 'the more a violation departs from the expected pattern, the larger the effect' (J. K. Burgoon, 2015). Disparities were most pronounced when both gender and racial identities deviated from the White male prototype. While Latino/Hispanic creators overall received comparable engagement with their White counterparts, Latina/Hispanic women experienced significantly lower engagement across all metrics, suggesting heightened penalties from dual role incongruity. This marginalization likely stems from both underrepresentation issues and persistent stereotypes surrounding Latinas in STEM. In our dataset, Latina science communicators ($n = 118$) constituted only 30% of all Latino/Hispanic communicators. Although the small sample size limits generalizability beyond TikTok, it shows the structural underrepresentation of Latina science communicators. Compared to White male communicators, those Latina women tended to have smaller follower bases. Since TikTok visibility is structured across multiple 'sides' and its recommendation system relies partly on audience size (Kang & Lou, 2022; Maddox & Gill, 2023), Latina creators' content may circulate primarily within smaller networks or marginalized 'sides' of TikTok rather than reaching broader dominant audiences, limiting opportunities for wider visibility on the platform.

In contrast, Black women received significantly more likes than White men, suggesting the positive outcomes of strategic self-presentation of Black creators. Undoubtedly, TikTok provides opportunities for marginalized creators who were historically excluded from STEM to challenge stereotypes and become visible (Huber & Baena, 2023). A. L. Zhang (2025) found that some Black scientists strategically increased their visibility on social media and presented themselves as role models, creating pathways for those after them. These findings suggest that while intersectional penalties persist, TikTok can also create pathways through which Black women science communicators gain visibility and recognition.

Third, by integrating RCT with the CSI, we extend RCT to consider not just *who* is seen as credible in science communication, but also *how* they are expected to communicate. We conceptualize this dynamic as *role-congruent communication styles*, the idea that the public evaluates not just identity, but whether the communicator's style fits identity-based expectations. Our findings show that while verbal aggressiveness, overall affective tone, and informality can all facilitate public engagement, their effects are filtered through social identity. Verbal aggressiveness, a style culturally associated with men, led to lower engagement for women than men. In contrast, affective communication styles aligned with feminine stereotypes resulted in higher engagement when used by women rather than men. Unexpectedly, informality boosted engagement across all racial groups, suggesting that it may serve as a cross-cutting strategy to reduce professional barriers and enhance the accessibility of scientific knowledge. These dynamics show that social identity and communication styles not only shape the disparities in public engagement but also actively *reinforce* them. When communicators are rewarded for conforming to identity-based expectations, they may internalize the need to adopt those role-congruent styles to sustain social approval and engagement, further amplifying these gendered and racialized stereotypes in digital science communication and beyond.

Finally, our findings highlight the structural challenges that marginalized groups face in increasingly visual-oriented and algorithm-driven media environments. Our study reveals the darker side of the emerging short-form video platforms like TikTok, which places communicators' identities at the forefront and center. The rise of personal branding and influencer culture has made how communicators *look*, their perceived gender and race, as central as what they say. At the same time, the rapid and algorithm-driven nature of content consumption encourages audiences to rely heavily on heuristics, often activating identity-based stereotypes through peripheral processing (Fleming & Petty, 1999). Consequently, creators who appear to be women and people of color may face heightened barriers to engagement and recognition, reinforcing existing social hierarchies.

Moreover, digital technologies may intensify and perpetuate these identity-based disparities. TikTok's algorithmic 'For You' feed curates content based on prior interactions and engagement patterns (Kang & Lou, 2022), reinforcing user preferences and reproducing social hierarchies. This feedback loop makes it more difficult for marginalized content creators to gain visibility and disrupt algorithmically reinforced biases. Addressing these challenges requires not only a shift toward greater inclusion in science communication but also platform-level interventions. Actively enhancing the visibility of diverse social groups and fostering a more inclusive space are essential steps toward creating a more equitable space for scientific knowledge production and dissemination.

Limitations and future research

This study does not come without limitations. First, our facial analysis of gender and race is based solely on video cover images, which may not always depict the creator and may lead to some misclassification of communicator identity. Future work should consider analyzing full video frames or combining user profile information to improve accuracy. Second, facial recognition tools have known biases in misidentifying women of color (Buolamwini, 2017). Although our fine-tuned DeepFace model demonstrated acceptable

accuracy, future studies should explore more bias-mitigated facial recognition tools for detecting identity cues. Third, our measurement of communication styles relies exclusively on audio and text, overlooking nonverbal modalities like facial expressions and body language. Fourth, we lack user-level demographic data, making it difficult to determine whether engagement disparities are driven by differences in audience composition. Future studies should use experimental designs to investigate how identity cues influence perceived credibility, trust, and persuasiveness. Fifth, we did not remove videos that featured third-party content or animations. While we conducted a manual validation on a subsample and found that most faces belonged to real science communicators, the inclusion of some non-original content may introduce some measurement noise. Sixth, our operationalization of racial identity may mask within-group heterogeneity in racialized stereotypes. To preserve statistical power and analytic parsimony, creators identified as Indian were grouped with other Asian creators. Future research using larger samples and richer metadata should examine within-Asian variation in stereotypical expectations and audience evaluations. Lastly, our findings are situated within the U.S. sociopolitical context and TikTok. Audience responses may differ across cultures and platforms with varying norms around identities and expertise. Future studies should explore whether and how identity-based heuristics manifest in other digital spaces.

Notes

1. LIWC defines the overall affective tone as the sum of positive and negative emotion words. Following this approach, we calculated it by summing positive and negative scores. As shown in Appendix Figure C3, the overall affective tone is positively correlated with both positive and negative emotion scores, and negatively correlated with neutral scores, supporting its validity as a valence-independent measure of emotional intensity.
2. We collected these videos on April 1, 2024. To calculate the number of days since its release, we subtracted its publication date from April 1, 2024.

Author contributions

CRedit: **Yuhan Li**: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft; **Hang Lu**: Conceptualization, Supervision, Writing – review & editing; **Chao Yu**: Formal analysis, Methodology, Supervision, Writing – review & editing.

Disclosure statement

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

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Data availability statement

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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