



## Progress and push-back: How the killings of Ahmaud Arbery, Breonna Taylor, and George Floyd impacted public discourse on race and racism on Twitter

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### ABSTRACT

This study examined whether killings of George Floyd, Ahmaud Arbery, and Breonna Taylor by current or former law enforcement officers in 2020 were followed by shifts in public sentiment toward Black people. **Methods:** Google searches for the names “Ahmaud Arbery,” “Breonna Taylor,” and “George Floyd” were obtained from the Google Health Application Programming Interface (API). Using the Twitter API, we collected a 1% random sample of publicly available U.S. race-related tweets from November 2019–September 2020 (N = 3,380,616). Sentiment analysis was performed using Support Vector Machines, a supervised machine learning model. A qualitative content analysis was conducted on a random sample of 3,000 tweets to understand themes in discussions of race and racism and inform interpretation of the quantitative trends. **Results:** The highest rate of Google searches for any of the three names was for George Floyd during the week of May 31 to June 6, the week after his murder. The percent of tweets referencing Black people that were negative decreased by 32% (from 49.33% in November 4–9 to 33.66% in June 1–7) (p < 0.001), but this decline was temporary, lasting just a few weeks. Themes that emerged during the content analysis included discussion of race or racism in positive (14%) or negative (38%) tones, call for action related to racism (18%), and counter movement/arguments against racism-related changes (6%). **Conclusion:** Although there was a sharp decline in negative Black sentiment and increased public awareness of structural racism and desire for long-lasting social change, these shifts were transitory and returned to baseline after several weeks. Findings suggest that negative attitudes towards Black people remain deeply entrenched.

The killings of Ahmaud Arbery, Breonna Taylor, George Floyd, and other Black Americans by law enforcement resulted in national outrage. According to polls from the Kaiser Family Foundation, NORC, and Pew Research Center, 15–26 million people in the U.S. participated in Black Lives Matter protests in 2020 (Buchanan et al., 2020). These protests

occurred in the midst of social-distancing recommendations during the COVID-19 pandemic, making their magnitude even more remarkable. The enormity of these protests was likely driven in part by activism on Twitter and other social media platforms, most famously signified by the #BLM or #blacklivesmatter hashtags.

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To what extent did these killings, and the protests that followed, result in changes in racial sentiment on a broader scale? Scholars have long noted that social events shift racial attitudes (L. Bobo & Steeh, 1985). Studies using the Bogardus social distance measures (E. S. Bogardus, 1926) showed that Americans' perceptions of warmth towards social groups have changed alongside large-scale events. For example, in 1946, during World War II, the group least favored became the Japanese. In 2011, in the aftermath of the 9/11 attacks, Muslims became the least favored group (Emory S. Bogardus, 1967; Parrillo & Donoghue, 2013).

One prediction is that there would be an increase in negative sentiment toward Black people following the killings and protests. According to realistic group conflict theory, prejudice and discrimination are the result of perceived conflicts of interest between groups (L. Bobo, 1983). The general proposition is that when White people feel threatened by racial minorities, they develop negative racial attitudes and may respond with discriminatory behaviors. Policies that disrupt the racial status quo and threaten Whites' position in society may be met with opposition. For example, calls to protest and defund the police emerged after the killings. The theory predicts that such calls may increase negative sentiment toward Black Americans because these protests may be seen as threatening White interests. Policing may be seen as a resource for Whites, and calls to defund the police may be viewed as leading to the depletion of a resource Whites value.

Yet, broad support for BLM protests suggests the opposite pattern—that positive racial sentiment for Black people may have actually increased. Theories related to racial empathy suggest that attitudes improve when members of the ingroup are able to empathize (e.g. understand the experiences and share the feelings) with outgroups (Burgess et al., 2007; Finlay & Stephan, 2000; Stephan & Finlay, 1999). For example, prior research has found that reading acts of racial discrimination (i.e., unjust treatment of marginalized racial groups) can elicit feelings of empathy (Finlay & Stephan, 2000). Given this evidence, videos capturing shootings and instances of police brutality may have garnered empathy and resulted in more positive sentiment toward Black people. For example, the video of the murder of George Floyd showed an instance of unyielding violence against an unarmed person. In the video, Floyd is seen pleading and asking for his mother with a response of grim indifference by the officers. The video represented a visual example of unwarranted violence that may arouse feelings of injustice and elicit empathy.

As the BLM movement gained national recognition, Black lives became part of the daily conversation and news, with organizations and media networks featuring stories about Black Americans (Neighmond, 2020). The BLM movement increased widespread awareness of issues related to the fight for social justice (Reuters, 2020). Taken together, the increased media coverage of the killings and protests that followed may have increased empathy during this time, resulting in lasting positive sentiment toward Black people.

A third theory that may help explain shifts in racial sentiment following these killings is Critical Race Theory (CRT). CRT stems from the field of law and seeks to understand and transform the relationship between race, racism, and power (Delgado & Stefancic, 2017). Within CRT, two related constructs—racial realism and interest convergence—would predict transitory, or short-lived, changes in racial attitudes. Racial realism, first described by Derrick Bell, is the thesis that racism is permanent in the U.S. (Bell, 1991). That even efforts to quell racial inequality through laws will ultimately “slide into irrelevance as racial patterns adapt to maintain” the racial status quo (Bell, 1991). Relatedly, the concept of interest convergence suggests that instances of racial progress only occur to the extent that they also benefit White people (Bell, 1980). With regard to BLM protests, CRT would predict that so long as there are expectations of benefits for supporting Black people and speaking up about police killings, we can expect people to do so. But when those expectations cease, public support for BLM protests specifically, and Black people in general, will return to normal levels.

We conducted a mixed-methods study leveraging data from Google and Twitter to describe temporal and regional trends in sentiment toward Black people during the 2020 Black Lives Matter movement promulgated by the killings of George Floyd, Ahmaud Arbery and Breonna Taylor. Previous research has found U.S. regional differences in reports of racial discrimination (Kim et al., 2017). Because of the key role that Twitter has played in public discourse on race and racism in recent years, we focus our analyses on this platform. Twitter offers several advantages for measuring public racial sentiment. Millions of tweets are sent daily by users across the globe, and 90% of Twitter users make their profile public (Mislove et al., 2011). Studies have found that people feel less inhibited in expressing their views and beliefs online compared to in-person interactions (Mondal et al., 2017; Pinsonneault & Heppel, 1997; Suler, 2004). Perceived anonymity, especially for Twitter users who use the platform without connection to their true identities, may decrease self-censorship of socially unacceptable views (Chae et al., 2018; Suler, 2004).

Drawing from media sociology, Community Structure Theory explores how community characteristics and dominant ideologies among groups shape the framing of news and media (Pollock, 2007). A rich discussion of media sociology and current research directions have been published (Waisbord, 2014). Similarly, we view social media platforms, such as Twitter, as a reflection of society at large. The focus is not on individual Twitter users. Rather the tweets, as a collection, represent prevailing cultural attitudes and social structures including the nature of intergroup relations as an aspect of societal organization. To complement our Twitter analysis, Google search concentration, in part, reflects public awareness and interest in certain topics, including those which individuals may be reluctant to disclose due to social desirability bias (Chae et al., 2015; McKetta et al., 2017; Stephens-Davidowitz, 2014). Using both platforms may facilitate a more robust analysis of trends in sentiment towards Black people. Data from social media can capture attitudes about sensitive topics such as racial prejudice and bias in real time following social shocks (Chae et al., 2015). Expressions on social media may partially capture the climate of racial sentiment in an area, which provides one way to explore the hypotheses noted above. In addition, qualitative methods provide in-depth understanding of the topics and themes emerging in discussions of race and racism before and after the killings and to help inform interpretation of the quantitative trends.

## 1. Methods

### 1.1. Overview

A random 1% sample of publicly available tweets was collected from November 2019 to September 2020 using Twitter's Streaming Application Programming Interface (API). Details of the data collection process including the full keyword list have been previously published (Nguyen et al., 2019). We restricted our analyses to English language tweets from the U.S. with latitude and longitude coordinates or other “place” attributes that permitted identification of the region from which the tweet was sent. Tweets for the sentiment analysis used one or more of 518 race-related keywords compiled from racial and ethnic categories used by prior studies examining race-related online conversations (Bartlett et al., 2014, pp. 1–51; Pew Research Center, 2016) and an online database of racial slurs (“TheRacial Slur Database, 2018). Tweets were classified into four main racial/ethnic categories: Asian, Black, Latinx, and White according to the keywords used. For this paper, we focus on tweets referencing Black people. The analytic sample included 3,380,616 tweets from 430,189 Twitter users. The qualitative content analysis included a subset of 3,000 tweets using race-related terms from two time periods: 1) November 1 through February 22—before any of the 3 killings, and 2) May 26 through June 30—after all three killings. The killings of Ahmaud Arbery, Breonna Taylor, and George Floyd occurred within a three-month period (Feb–May). Due to the close

succession of the killings, sustained media coverage of the killings over this time period, and our a priori desire to examine the potential impact of all three killings on public discourse, we analyzed the tweets before any of the three killings compared to the tweets after all three killings. Google Health Trends data were used to capture Google searches for each individual's name from February 15 to September 30.

### 1.2. Sentiment analysis

Twitter data were cleaned and processed for the sentiment analysis. We dropped duplicate tweets according to their "tweet\_id" and pre-processed the tweets to remove stop words, emojis, urls, punctuations, and hashtag signs. We removed job postings according to the hashtags "#job" and "#hiring." We also removed tweets that had the terms, "Black's beach" (beach in Southern California) and "black smoke." We developed a sentiment model using Support Vector Machine (SVM) to label the sentiment of each tweet. Support Vector Machine (SVM) is a supervised machine learning model that is used for text classification in natural language processing tasks. Since SVM is a supervised machine learning model, training data that are labeled by humans is needed to "learn" what people consider a negative or positive tweet. We obtained training data from manually labeled Sentiment140 (n = 498) (Sentiment140, 2011), Kaggle (n = 7,086) (Kaggle in Class, 2011), Sanders (n = 5,113) (Sanders Analytics, 2011), and 6,481 tweets labeled by our research group. Sentiment140, Sanders, and Kaggle datasets are all publicly available training datasets specifically labeled for sentiment analysis. First, we labeled negative tweets (assigned a value of 1) versus all other tweets—positive or neutral tweets (assigned value of 0). We used 5-fold cross validation to assess the model performance and reached a high level of accuracy for the negative classification (91%) and a high F1 score (84%). In a separate model, tweets were also labeled as positive or not positive. We similarly used 5-fold cross validation and achieved an accuracy of 89% and a F1 score of 81%. Accuracy is measured as the number of tweets with the correct prediction divided by the total number of tweets in the testing data set. The F1 score is a measure that balances precision ((positive predicted value and recall (sensitivity)); a high F1 score suggests a model is robust in predicting tweets that are labeled as 1. Once the SVM models were trained for negative and positive sentiment classification, we applied the SVM negative and positive sentiment model to label tweets collected from November 2019 through September 2020.

Statistical analyses were implemented with Stata MP16 (StataCorp LP, College Station, TX, USA). We tested whether national changes in the proportion of tweets referencing Blacks that were negative between the two time periods were statistically significant using a paired *t*-test with states as the unit of analysis. Regional differences in sentiment were evaluated using an ANOVA test. We evaluated statistical significance at  $P < .05$ . Prevalence of negative sentiment against time (time series) at the regional level figures were generated using R (R Foundation for Statistical Computing, Vienna, Austria) (The R Foundation, 2021).

### 1.3. Google trends analysis

Google searches for the names "Ahmaud Arbery," "Breonna Taylor," and "George Floyd" were obtained from the Google Health Application Programming Interface (API) using the "Search Sampler" Python module developed by the Pew Research Center (Stocking & Matsa, 2017). This methodology is summarized in the online supplementary materials and described in detail elsewhere (Stocking & Matsa, 2017). Briefly, Search Sampler took 50 random samples of all Google searches in each state every week from February 15th to September 30, 2020, and calculated the scaled proportion of those searches that contained each individual's name (i.e., separate queries for "Ahmaud Arbery" "Breonna Taylor," and "George Floyd").

### 1.4. Content analysis

A qualitative content analysis was used to provide complementary information about the temporal trends on topics and themes to understand the national discussion of these events. Two members of the research team (SC and TN) developed a codebook (i.e., a list of codes and definitions representing the emerging themes) based on a literature review and coding and discussing 200 tweets from the above sample. This consensus building process enhanced the codebook by clarifying operational definitions, thereby increasing internal validity. The final coding categories or emergent themes included: positive tone related to race or racism, negative tone related to race or racism, call for action, counter movement/arguments against racism-related changes, and everyday life. Using this coding scheme, each of the two research members coded 100 tweets with two research assistants (400 tweets total) to test inter-rater agreement. Any disagreements in coding were discussed until consensus was met. Once Cohen's kappa reached 80% or higher for each coder pair, indicating substantial agreement (Landis & Koch, 1977), all team members independently coded tweets. To compare discussions and themes occurring before and after the killings, a random sample of 1,500 tweets were coded in each of the two time periods: November 1 to February 22 and May 26 to June 30, 2020.

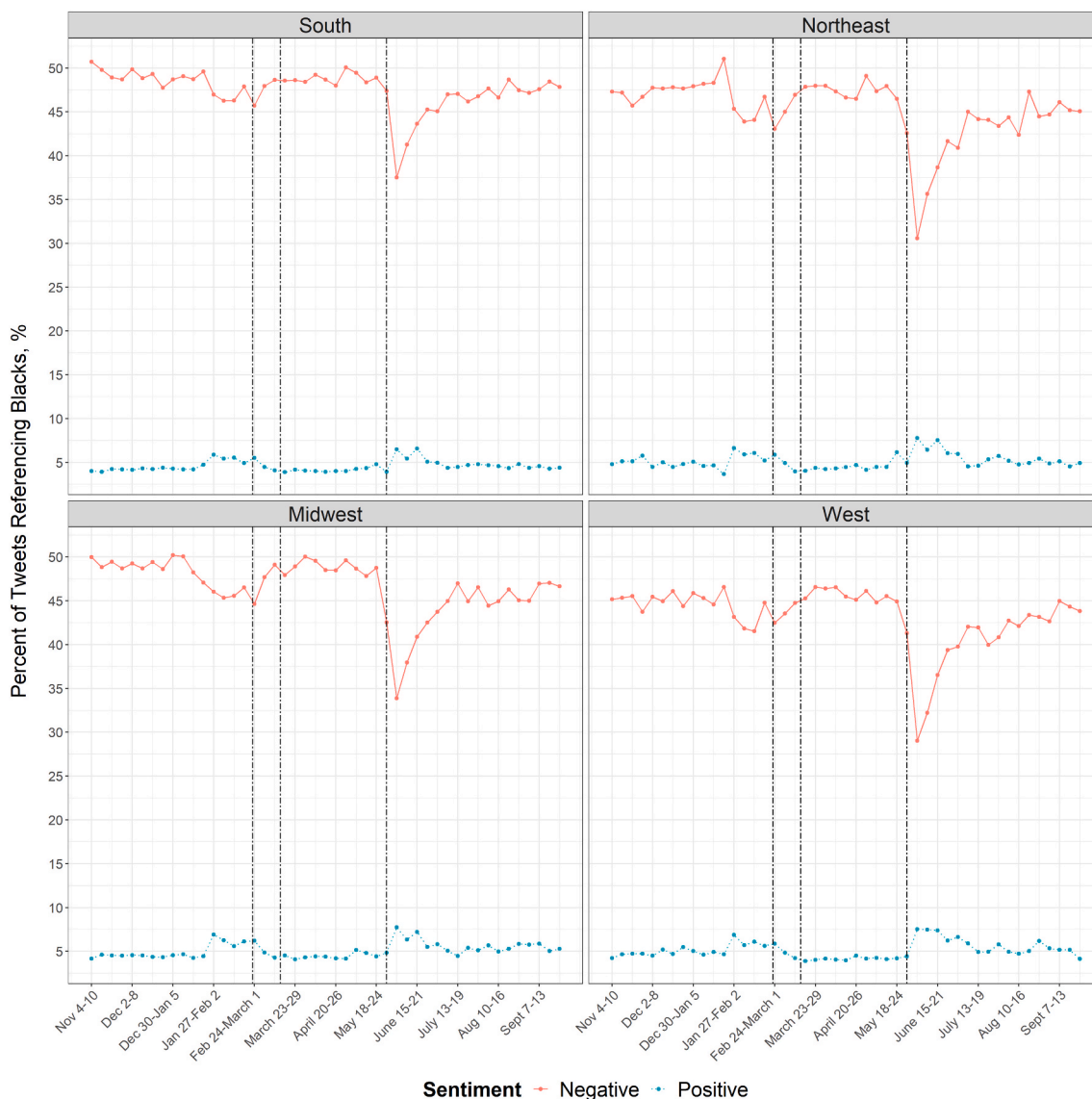
## 2. Results

Google search interest over the study period was highest for George Floyd, followed by Breonna Taylor, and finally, Ahmaud Arbery (eTable 1). The killings generated considerable, albeit short-lived public attention about the individuals killed. For example, search interest for George Floyd peaked from May 31-June 6, the week after his murder and video release, but showed a substantial decline over the next several weeks and remained stable for the duration of the study period. Google search trends are illustrated graphically in online supplementary eFigs. 1 and 2. A timeline of events surrounding the killings of Ahmaud Arbery, Breonna Taylor, and George Floyd are presented in online supplementary eTable 2.

Nationwide, the percent of tweets referencing Black people that were negative decreased by 32% (from 49.33% in November 4–9 to 33.66% in June 1–7) ( $P < 0.001$ ) following the murder of George Floyd. The decline was temporary and began to rebound a few weeks after George Floyd's murder, although it did not return to the levels seen at the beginning of the time period. There was also a short-lived, though much smaller, rise in percent of tweets referencing Black people that were positive, lasting a few weeks from late May to early June.

Across all U.S. regions, there were declines in the percent of negative tweets referencing Black people following the murder of George Floyd (Fig. 1). For example, in the Northeast, negative Black sentiment declined from 45.09% in November 4–9 to 29.01% in June 1–7, and in the South, negative Black sentiment declined from 51.19% to 36.60%. While there were not statistically significant regional differences in the change in negative sentiment ( $P = 0.90$ ), there were statistically significant regional differences in negative Black sentiment the week after the murder of George Floyd (June 1–7) (South; 36.60; Northeast: 29.01%; Midwest: 31.74%; West: 29.70%;  $P < 0.001$ ). eFigs. 3 and 4 presents state level temporal trends in negative and positive Black sentiment. Many states showed a transitory decline in percent of tweets referencing Black people that were negative immediately after the murder of George Floyd. For other states, there were fluctuations throughout the data collection period without a clear pattern around the killings. eTables 3–4 present national temporal trends.

The percentage of negative and positive sentiment tweets along with the total number of tweets referencing Black people by month are presented in the online supplementary eTables 3–4. They show that for the month of June, there was an increase in volume of total, negative, and positive tweets referencing Black people, corresponding to the timing of the BLM protests and increased awareness and public interest in

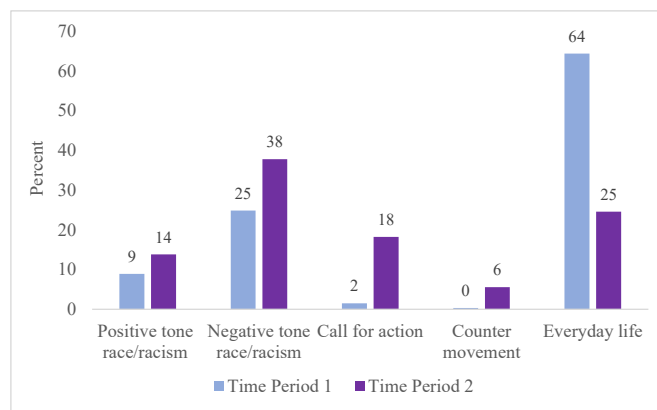


**Fig. 1.** Weekly trend in percent of tweets referencing Black people that are negative and positive by U.S. region, November 2019–September 2020. Vertical lines represent dates of the killings of Ahmaud Arbery (Feb 23), Breonna Taylor (March 13), and George Floyd (May 25), respectively.

discussions around the killings, police brutality, and structural racism. It is also important to note that while 30–50% of tweets referencing Black people were negative, 5–7% of tweets referencing Black people were positive. (Fig. 1). In previous work, we found that proportion of positive tweets are lowest for tweets referencing Blacks compared to other racial/ethnic groups (Nguyen et al., 2019).

**2.1. Content analysis**

There were substantial differences in the themes during the two time periods. For example, there were very few tweets in time period 1 (November 1 – February 22), explicitly calling for change related to racism in the U.S. However, in time period 2 (May 26 – June 30), nearly 1 in 5 tweets fell into the category of call to action (Fig. 2). In the first time period, the most common themes were related to tweets about everyday life and negative-toned tweets about race or racism. In the second time period, tweets about race or racism using a negative tone, everyday life, and call to action were the most common themes. Illustrative tweets are presented in Table 1.



**Fig. 2.** Percent of tweets in each content analysis category by time period. Time period 1: November 1, 2019 – February 22, 2020; Time period 2: May 26, 2020 – June 30, 2020.

**Table 1**  
Content analysis of themes with illustrative examples by time period.

Themes	Examples Tweets from Time Period 1: Nov 1 - Feb 22	Examples Tweets from Time Period 2: May 26 – June 30
<b>Positive or neutral tone for tweets expressing or addressing race/racism</b>	<p><b>Affirmations</b> BLACK MEN ... I LOVE YOU ALL</p> <p><b>Cultural Pride</b> Happy Lunar New Year! Asian American communities reach new milestones every year - for 2020, our communities know the best is yet to come LunarNewYear LeadRight</p> <p><b>Empowerment</b> Can we just talk about how all of Lizzo's performances are about empowering black women. She not only has an all black female stage, but she also has diversity in hair texture, skins tones, and body sizes! RepresentationMatters Queenthing</p>	<p><b>Hope and Optimism about Racial Equality</b> Im seriously emotional. Im so grateful for all the protesters all over the world. This is the first time I feel valuable and needed in society. I am not black. I'm a POC. I finally don't feel alone in this fight. I have an abundance of HOPE we can evolve and heal united</p> <p><b>Cultural Pride</b> Celebrating all of the black influence that I've been blessed with in my life. From my brothers; sisters, music, fashion, vernacular, sports, photography, cinematography ... just to name a few. Happy Juneteenth! BlackLivesMatter</p> <p><b>Self-Reflection and Introspection about Racism</b> While I often view social media as mainly divisive, lately it spurred a lot of self-reflection. It's made me recognize many of my own character flaws that I need to improve on moving forward. I hope it helped others too and thank yall using your voices for good BlackLivesMatter</p> <p><b>History of Racism in the United States</b> There is absolutely nothing wrong with asking for forgiveness from oppression and racism that's been going on for 400 years and til this day.</p>
<b>Negative tone for tweets expressing or addressing race/racism</b>	<p><b>Racist Labeling</b> You are such a racist. You believe blacks are stupid; can't think for themselves. You are disgusting.</p> <p><b>Negative attitudes towards White people</b> White people creepy</p> <p><b>Negative attitudes towards racial/ethnic minorities</b> Aiiight I'm tryna see less Iranians in my notifications. No offense but I'm putting all ya n*ggas in suicide bomber category till sh*t cools off</p> <p><b>Critiques about President Trump</b> trump's wall, i.e. the Racist Monument, is the least effective and most expensive solution to securing the border. In addition to being corrupt, crooked, a racist, and a liar, he's really dumb. But you already knew that.</p>	<p><b>Racist Labeling</b> if that's what you focus on then you are a sad individual. If you are more angry at looters than angry at a cop who should have been fired years before murdering a man in cold blood ... You are one sad, f*cking racist.</p> <p><b>Racial Bias in Systems</b> When I think about racism in healthcare (especially in OB) it sickens me dude. Racism is really deeply rooted in a profession that can control whether or not a life will be brought into this world successfully.</p> <p><b>Frustration towards White People's Attitudes about Race</b> White people believe it's their right to feel safe and protected but believe black people just need to stop acting like that they have the same rights too</p> <p><b>Critiques about President Trump</b> How do we expect change when we have a racist in office ?? POTUS</p> <p><b>Action Against Police Brutality</b> This police brutality has to stop. DefundPolice we will not stop until police departments get defunded and punished for their brutality. We will not put up with it anymore!</p> <p><b>Protests</b> i wasn't there today but i watched on the news; i'm proud of my city and my friends who went and used their voices and continue to use their voices peacefully! riverside is my home and I'm forever proud of us! stay safe! BlackLivesMatter</p> <p><b>Petitions</b> I've donated what I could, signed petitions and more. Do what is necessary or what you can. Don't be pressured to do everything. Your voice can still be heard in many ways. justice blacklivesmatter blackout standup justiceforgeorgefloyd justiceforahmaud love</p> <p><b>Vote</b> Vote. Vote. Vote. These federal lifetime judges will impact most of our lives even after Trump is gone. blacklivesmatter allvotesmatter</p> <p><b>Solidarity</b> BlackLivesMatter! The Latinos in solidarity with the Black community for all the injustice, violence, deaths suffered because of the racism that's gone on for too long.</p> <p><b>Critical of BLM</b> So? Not everyone is a r*tarded cuck like you, [Name] ... AllLivesMatter. .... Unless you're an ANTIFA/BLM/SOROS r*tard ... Then you're pretty much superfluous ...</p> <p><b>Focused on Violence</b> The GeorgeFloydProtests do not justify the Riots caused by Leftist extremists encouraged by FakeNews The DNC using Their Antifa BrownShirts are directing the violence to start a Race War in SanctuaryCities. That's the Dems Plan. I'm sorry buddy that sh*ts going to happen in your town it just needs to f*cking stop that's ridiculous AllLivesMatter</p> <p><b>Black on Black Crime</b> Imagine if liberals protected the unborn. And if they cared enough about black lives to stop the senseless black on black crime in liberal run cities like Baltimore and Chicago. It would be a much better world.</p> <p><b>Everything Racialized</b> Real estate people won't be saying Master bedroom or Master bathroom any longer because it sounds racist. So, can Astronomers still say Black Hole?</p>
<b>Call to action</b>	<p><b>Limited Racism-Related Call to Action Tweets</b> In a letter to Homeland Security, SAA protests destruction of archaeological and Native American cultural sites at the border wall, calling for construction to cease immediately.</p>	
<b>Counter movement/ argument against racism-related change</b>	None Noted	

Some tweets were edited or shortened to remove identifying information. Hashtags, urls, and tags were removed.

## 2.2. Positive tone for tweets expressing or addressing race/racism

Time Period 1 (November 1 – February 22): Positive expressions of race or ethnicity were expressed through affirmation, cultural pride, and empowerment. Affirmations often uplifted a group by using their race and a positive comment. Cultural pride highlighted celebrations like Lunar New Year. Twitter users also expressed empowerment through representation of people of color and acknowledgment in public forums. Some tweets also highlighted the need for greater attention to Black history and issues disproportionately affecting racial/ethnic minorities.

Time Period 2 (May 26 – June 30): Positive statements expressing hope and optimism about racial equality and cultural pride were most frequent. Specifically, Twitter users expressed feelings of appreciation regarding the momentum created from the Black Lives Matter (BLM) protests promoting racial equity and how it made them feel valued. Cultural pride was shown by highlighting contributions of Black Americans and acknowledging the widespread recognition of June-teenth through individual exclamations and company/organizational support.

There was also a subset of tweets demonstrating self-reflection and introspection about racism as a result of increased awareness and education on the long-standing injustices against the Black community. These tweets were personal and involved people becoming aware of their own White privilege, the racial biases within their social networks, and the need for personal and systemic change, such as shown in this tweet: “While I often view social media as mainly divisive, lately it spurred a lot of self-reflection. It’s made me recognize many of my own character flaws that I need to improve on moving forward. I hope it helped others too and thank y’all using your voices for good Black-LivesMatter.” Some tweets acknowledged, in a more neutral tone, the history of racism in the U.S.: “There is absolutely nothing wrong with asking for forgiveness from oppression and racism that’s been going on for 400 years and til this day.”

## 2.3. Negative tone for tweets expressing or addressing race/racism

Time Period 1 (November 1 – February 22) - Some tweets used racist labeling, specifically the use of name-calling for both targets and perpetrators of racism. Tweets also expressed negative racial attitudes towards White people through generalizations or stereotypes: “White people creepy.” Other tweets expressed negative attitudes towards racial and ethnic minorities, including the use of slurs or demeaning language. Another common thread was tweets related to politics such as those that criticized former President Trump for his divisive racial views.

Time Period 2 (May 26 – June 30) – This time period also included tweets that used name-calling for both targets and perpetrators of racism: “if that’s what you focus on then you are a sad individual. If you are more angry at looters than angry at a cop who should have been fired years before murdering a man in cold blood ... You are one sad, [expletive] racist.” We also saw more discussions regarding the racial bias within systems, including the criminal justice system, police departments, and healthcare. Some tweets expressed frustration towards White people’s attitudes about race, specifically failing to acknowledge racial inequities. As seen in time period 1, some Twitter users stated President Trump promoted racism.

## 2.4. Call to action

Time Period 1 (November 1 – February 22) - Tweets explicitly calling for change related to racism in the U.S were rare in time period 1 but common in time period 2: “In a letter to Homeland Security, SAA protests destruction of archaeological and Native American cultural sites at the border wall, calling for construction to cease immediately.”

Time Period 2 (May 26 – June 30) - Calls for action in time period 2 included taking action to address police brutality and calls to participate in protests, sign petitions, and vote. Specifically, tweets referenced the

call to “Defund the Police.” Tweets expressed people being heartened by the protests and pride in the demonstrations. Tweets also called people to mobilize through donations and petitions. Some tweets focused on the importance of voting. Tweets also expressed solidarity with the BLM movement: “BlackLivesMatter! The Latinos in solidarity with the Black community for all the injustice, violence, deaths suffered because of the racism that’s gone on for too long.”

## 2.5. Counter movement/argument against racism-related change

Time Period 2 only (May 26 – June 30) - There were very few tweets falling into the category of counter movement/argument against racism-related change in time period 1. In time period 2, some Twitter users were critical of the BLM movement and used the term/hashtag #AllLivesMatter. Instead of focusing on the reason for the protests, some Twitter users focused on the violence of the protests: “The George Floyd Protests do not justify the Riots caused by Leftist extremists ...” Other tweets focused on Black-on-Black crime. Others asserted that they were not racist, and that everything is now labeled as racist: “Real estate people won’t be saying Master bedroom or Master bathroom any longer because it sounds racist. So, can Astronomers still say Black Hole?”

## 2.6. Everyday life

Tweets falling under everyday life were similar across the two time periods, but represented a larger portion of tweets in the first time period. These tweets commented on a variety of topics dealing with daily life included sports, entertainment, food, jobs, and relationships. In popular culture the term “n\*gga” is often used as an in-group term without valuation.<sup>11</sup> The colloquial use of n\*gga was common among these tweets.

## 3. Discussion

Using data from Twitter and Google, we observed decreased negative sentiment toward Black people and increased searches for the names of three unarmed Black Americans who were killed during what has been described as a “racial reckoning” in the spring of 2020 (Chang et al., 2020). Qualitative content analysis of tweets deepens our understanding of racial attitudes during this period. We found that new types of conversations began to emerge after George Floyd’s murder. There was greater discussion of structural racism, more introspection of individual biases, and more urgent calls for collective action against anti-Black racism. This finding suggests increased public awareness of structural racism and desire for long-lasting social change. However, these shifts were short-lived, characterized by steep decline in negative Black sentiment and Google searches, followed by a return to near baseline levels across all U.S. regions. There was also an expressed backlash of negative sentiment in response to the BLM protests as well as victim blaming more generally and an overall denial of racism.

It is important to consider these three killings within the broader context of the killing of unarmed Black people and the resulting public protests and discourse related to U.S. race relations. The killings of Trayvon Martin in 2012, Eric Garner, Michael Brown, and Tamir Rice in 2014 and others leading up to 2020, formed the setting where the U.S. had already experienced numerous killings of Black people. The BLM movement began in 2013 with the Twitter hashtag #BlackLivesMatter after the acquittal of George Zimmerman for the killing of Trayvon Martin (Black Lives Matter, 2021). The resurgence of BLM in 2020 occurred during a time of greater awareness of police brutality and recollection of the early beginnings of BLM.

Scholars have long-documented that public attitudes and expressions shift in response to social movements (E. S. Bogardus, 1926; Wark & Galliher, 2007). An important feature of our study is the focus on the cluster of three interrelated events that occurred in the context of a national conversation about structural racism as one of the “twin

pandemics" (in addition to COVID-19). Despite transient shifts following these highly publicized events, the sentiment levels were relatively durable. Consistent with the Critical Race Theory racial realism thesis, this finding suggests that there is some level of "homeostasis," or entrenchment, of racial attitudes within U.S. society that is difficult to change. One possibility is that these short-lived shifts reflect interest convergence, or the notion that the positive sentiment towards Black Americans only lasted as long as it was beneficial to the dominant group. In other words, it served White people's interests to be vocal about police killings in their immediate aftermath. For example, expressions of support may have been viewed as equating to "anti-racism," which carried cultural capital, accruing social, reputation, and economic benefits of virtue signaling (e.g. by acquiring more followers on Twitter or attracting more patronage to one's business), but not necessarily for an ongoing period of time (Westra, 2021).

Our findings are consistent with evidence that racial attitudes, measured using a variety of sources, are relatively stable over short periods of time. A study of racial sentiment in tweets in 2015–2016 found sentiment differed by only 3–5% over a period of 13 months (Nguyen et al., 2019). Some studies have shown an incremental decrease in racial bias over longer time periods. Between 2000 and 2016, the proportion of non-Black people who would oppose a close relative marrying a Black person has declined from 31% in 2000 to 14% in 2016 (Livingston & Brown, 2017). Research using Project Implicit data showed that negative implicit and explicit attitudes toward Black people declined steadily but incrementally from 2007 to 2016 (Charlesworth & Banaji, 2019). Taken together, these patterns suggest that racial attitudes may not change over short periods of time of a year or two but may steadily change over longer time horizons.

In June 2020, more people from various backgrounds participated in a conversation about anti-Black violence. Further, there was a rise in the depth and complexity of calls to action, including actions to defund the police, protest, sign petitions, and vote. However, there were also signs of retaliation and resistance against the BLM movement. Some tweets were critical of BLM or mentioned stereotypes of Black violence, such as "but they [Black people] commit much more crime, attracting more attention from the police." Others also talked about how everything could potentially become racialized and seen as "politically incorrect" in somewhat mocking tones (e.g. "So, can Astronomers still say Black Hole").

Taken together, our data support both racial realism and interest convergence perspectives on race relations. It is possible that the critical mass of events, made particularly salient by the videos, improved empathy towards the Black community. Additionally, corresponding discussions within the Black community, spurred by the police killings as well as the more visible preparations for Juneteenth this year compared to prior years, likely jointly contributed to the decline in negative Black sentiment. Yet the fading of conversations of BLM and calls for structural changes from general discourse may have contributed to return to "equilibrium" levels of anti-Black sentiment in the latter part of 2020 consistent with interest convergence and racial realism (Pager & Shepherd, 2008).

Our study has several limitations. Twitter data represent what people are willing to express in the online public sphere. These may differ from in-person interactions and discussions. It is possible that racial sentiment shifted in settings that would not be detected by Twitter data such as in-person interactions. It is also possible that these events drew out Twitter activity among people who are not generally active on Twitter hence not reflecting a shift but perhaps reflecting a different Twitter universe during this particular time period related to these particular events. For future studies, it would be valuable to track and compare in-person interactions, public opinion repositories or polls with Twitter data over time.

Additionally, broader media as well as social media coverage of the killings were not mutually exclusive. For example, media coverage of the killings varied (e.g., broad-scale media coverage of Ahmaud

Arbery's killing not emerging until after the video was released) and both broader media and social media coverage of the killing of Ahmaud Arbery, and Breonna Taylor increased after the murder of George Floyd. The three killings as well as the media coverage of them during a condensed period of time are inextricably linked. The detected changes in area-level racial sentiment can reflect both the killings and the coverage of the killings.

Our prior work has investigated whether an area-level measure of racial sentiment derived from Twitter data is associated with state-level hate crimes and existing measures of racial prejudice at the individual-level from the General Social Survey and Project Implicit. We found living in a state with higher negative sentiment in tweets referencing Blacks was associated with lower odds of endorsing the General Social Survey question that Black-White disparities in jobs, income, and housing were due to discrimination; and higher odds of endorsing the belief that disparities were due to lack of will. Residents living in areas with higher negative sentiment also tended to have higher explicit racial bias and higher implicit racial bias. Twitter-expressed racial sentiment was not statistically-significantly associated with incidence of state-level hate crimes (Nguyen et al., 2021). Future research can examine how area level racial attitudes can vary by racial/ethnic composition, education, employment, political affiliations of residents in the area.

In this paper, we found transient declines in negative sentiment of tweets referencing Black people. However, it is important to note that this does not necessarily mean racism declined. Racism is an organized social system that perpetuates racial inequalities via both personal interactions and institutional and structural forms of discrimination (Williams et al., 2019). This study examined one aspect of racism (i.e., racial sentiment), and should not be taken as a reflection of racism as a whole, as an interlocking system of oppression that confers benefits to some groups and disadvantages to other groups.

We do not know the demographic characteristics of the Twitter or Google users in this study. Twitter users are not representative of the U.S. population. Compared to the general adult population in the U.S., adult Twitter users are younger and more educated (Wojcik & Hughes, 2019). For example, 29% of adult Twitter users are between 18 and 29 years of age, and this age group makes up 21% of all U.S. adults. Forty-two percent of Twitter users have a college degree compared to 31% of the adult U.S. population. Twitter users also are slightly more racially/ethnically diverse than the overall adult U.S. population. Among adult Twitter users, 11% and 17% are Black and Hispanic respectively compared to 11% and 15% of U.S. adults. Twitter users are similar to U.S. adult population in terms of gender with 52% of adult Twitter identifying as women (Wojcik & Hughes, 2019).

Twitter and Google are only available to those with internet access. In addition to the rise in support for the Black Lives Matter movement, this time period also represented the emergence of COVID-19 in the U.S. and around the world with severe economic and health consequences, especially for Black communities and other communities of color. The additional strain of the pandemic and associated racial inequities may have influenced racial sentiment. However, given that the sentiment was relatively stable across the time period as a whole, it is not likely that the pandemic per se contributed greatly to the findings reported herein.

Using both quantitative and qualitative approaches, this study provides an empirical investigation of discussions of race and racism in the U.S., prior to and following the 2020 killings of Ahmaud Arbery, Breonna Taylor, and George Floyd. We use Twitter and Google data that allow for the documentation of social phenomena in real time, revealing substantial, but brief, shifts in racial attitudes in the U.S. A pessimistic interpretation is that these push, pull, and rebound forces maintain the racial status quo. A more optimistic view is that these temporary shifts in racial sentiment may represent windows of opportunity to galvanize change. Activists can seize these moments to motivate grassroots organizing, mutual aid projects, and other efforts to promote equity. In tandem, policymakers and political leaders can leverage the public's

outcry and calls for justice to write and pass legislation to create sustainable and systemic change planting further seeds to promote egalitarian societal norms and attitudes.

A year after the murder of George Floyd, 30 states have enacted police oversight and reform laws, including 16 states limiting or banning police officers' use of neck restraints and 10 states requiring or increasing funding for body camera (Eder et al., 2021). Ongoing real-time monitoring of racial attitudes can help reveal these agenda setting moments of opportunity. If actions are taken in terms of policy support or programmatic change, effects may be sustained even when public discourse on racism begins to fade.

In summary, our findings suggest that racial sentiment as indicated by the Twitter platform and Google search patterns shifts in response to social events, yet, such shifts may be relatively transient. More research is needed to understand the underlying mechanisms explaining these shifts, as well as the reasons why they do not persist. Understanding the processes driving such sentiment may inform levers for enacting more enduring social change to promote racial equity and justice.

#### Author statement

**Thu T. Nguyen:** Funding acquisition, Conceptualization, Methodology, Data Curation, Formal Analysis, Writing-Original Draft Preparation, Review, and Editing; **Shaniece Criss:** Conceptualization, Formal Analysis, Writing-Original Draft Preparation, Review, and Editing; **Eli K. Michaels:** Formal Analysis, Writing-Original Draft Preparation, Review, and Editing; **Rebekah I. Cross:** Review, and Editing; **Jackson S. Michaels:** Data Curation, Formal Analysis, Review, and Editing; **Pallavi Dwivedi:** Data Curation, Review, and Editing; **Dina Huang:** Formal Analysis, Review, and Editing; **Erica Hsu:** Formal Analysis, Review, and Editing; **Krishay Mukhija:** Formal Analysis, Review, and Editing; **Leah H. Nguyen:** Formal Analysis, Review, and Editing; **Isha Yardi:** Formal Analysis, Review, and Editing; **Amani Allen:** Conceptualization, Review, and Editing; **Quynh C. Nguyen:** Conceptualization, Review, and Editing; **Gilbert C. Gee:** Conceptualization, Review, and Editing.

#### Ethics statement

This study was determined exempt by the University of California, San Francisco Institutional Review Board (18–24255).

#### Data availability

Twitter data were collected using Twitter's Application Programming Interface (API). Twitter's API is free and open to the public. Google search data is available through Google Health Application Programming Interface (API) and is free and open to the public.

#### Declaration of competing interest

Authors declare no conflicts of interest.

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#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2021.100922>.

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