ShotSpotter and the Misfires of Gunshot Detection Technology

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STOP
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EXECUTIVE SUMMARY

- U.S. cities are squandering money on ShotSpotter's unproven gunshot surveillance technology.
- ShotSpotter surveillance increases police activity, but it wastes officers' time. One major study of the technology showed that ShotSpotter fails as an investigative tool, providing no evidence of a gun-related crime more than 90% of the time and producing exceedingly few arrests (less than 1 per 200 stops) and recovered guns (less than 1 per 300 stops).[1]
- ShotSpotter fails the Black and Latinx communities where it appears to be disproportionately deployed.[2] The tool increases police activity and the risk of police violence without producing any significant effect on firearm offenses[3] or on shooting victims' medical outcomes.[4]

[1] Joseph M Ferguson and Deborah Witzburg, "The Chicago Police Department's Use of ShotSpotter Technology," City of Chicago Office of Inspector General, OIG File #21-0707, August 24, 2021. https://igchicago.org/wp-content/uploads/2021/08/Chicago-Police-Departments-Use-of-ShotSpotter-Technology.pdf. The study documented 244 arrests and 152 recovered guns for 50,176 ShotSpotter alerts.

[2] This paper argues that ShotSpotter focused on Black and Latinx communities in New York City as of 2018. For other cities, *see* "ShotSpotter Creates Thousands of Dead-End Police Deployments That Find No Evidence of Actual Gunfire," MacArthur Justice Center, April 2021, https://endpolicesurveillance.com/. *See also* Todd Feathers, "Gunshot-Detecting Tech Is Summoning Armed Police to Black Neighborhoods." *Vice*, 19 July 2021, https://www.vice.com/en/article/88nd3z/gunshot-detecting-tech-is-summoning-armed-police-to-black-neighborhoods.

[3] Mitchell L. Doucette et al., "Impact of ShotSpotter Technology on Firearm Homicides and Arrests Among Large Metropolitan Counties: A Longitudinal Analysis, 1999–2016," *Journal of Urban Health* 98 (2021): 609–21, https://doi.org/10.1007/s11524-021-00515-4.

[4] Anna Goldenberg et al., "Use of ShotSpotter Detection Technology Decreases Prehospital Time for Patients Sustaining Gunshot Wounds," *Journal of Trauma and Acute Care Surgery* 87, no. 6 (December 2019): 1253–59, https://doi.org/10.1097/TA.0000000000002483. *See also* Brendan R. Gontraz et al., "Firearm Acoustic Detection in Hartford, Connecticut: Outcomes of a Trauma Center – Law Enforcement Collaboration," *Cureus* 13, no. 10 (October 14, 2021), https://doi.org/10.7759/cureus.18789.

I. Introduction

U.S. cities are turning in increasing numbers to gun detection technology, a combination of microphones and audio analytics software that claims to identify the sound of gunshots, but which frequently also reports other loud noises as shots. ShotSpotter sells its leading gunshot detection software to over 130 cities and towns.[5] Its discriminatory placement in Black and Latinx communities increases police dispatches to those communities and the risk of police violence. But while ShotSpotter increases responses to supposed gunshots (and fireworks, and car backfires), it fails as an investigative tool, providing no evidence of a gun-related crime in more than 90% of activations in one major study of the tool.[6] ShotSpotter also fails the communities where it is deployed, where it has had no significant effect on firearm offenses in the two years following installation[7] and no effect on shooting victims' medical outcomes.[8] ShotSpotter succeeds in three outcomes: exhausting police budgets, consuming officers' time, and overpolicing Black and Latinx neighborhoods. What ShotSpotter doesn't do is work.

II. ShotSpotter's Growing Footprint

ShotSpotter is expanding across the country. As of March 2022, ShotSpotter reports that at least 130 U.S. cities and towns have installed its technology,[9] up over 50% from about 85 cities in 2018.[10] Federal funding—especially the American Rescue Plan Act (ARPA)—has aided this expansion, with $10 billion committed to law enforcement projects as of May 2022[11] of a total of $350 billion of

[5] ShotSpotter, Inc., Form 10-Q (United States Securities and Exchange Commission, March 31, 2022), https://www.sec.gov/ix?doc=/Archives/edgar/data/1351636/000095017022010133/ssti-20220331.htm.
[6] Ferguson and Witzburg, "Chicago Use of ShotSpotter."
[7] Doucette, et al., "Impact of ShotSpotter."
[8] Goldenberg et al., "Use of ShotSpotter Detection." *See also* Gontarz et al., Firearm Acoustic Detection."
[9] ShotSpotter, Form 10-Q.
[10] ShotSpotter, "Frequently Asked Questions," January 2018. Last accessed March 16, 2022. https://www.shotspotter.com/system/content-uploads/SST_FAQ_January_2018.pdf
[11] "FACT SHEET: President Biden Issues Call for State and Local Leaders to Dedicate More American Rescue Plan Funding to Make Our Communities Safer – And Deploy These Dollars Quickly" (The White House, May 13, 2022), https://www.whitehouse.gov/briefing-room/statements-releases/2022/05/13/fact-sheet-president-biden-issues-call-for-state-and-local-leaders-to-dedicate-more-american-rescue-plan-funding-to-make-our-communities-safer-and-deploy-these-dollars-quickly/.

ARPA funds available to law enforcement.[12] Cities like Detroit ($7 million),[13] Syracuse ($170,000), Macon-Cobb County, GA ($2 million), New Haven ($1.2 million), and Albuquerque ($3 million)[14] are opting or have opted to invest ARPA money in ShotSpotter, devoting money originally intended to ease the economic hardship of the COVID-19 pandemic to police technology. Meanwhile, big cities with longstanding ShotSpotter contracts have renewed them. In 2021, Chicago extended its $33 million contract by two years[15] and New York City added three years and $22 million to its contract,[16] nearly doubling its previous annual outlay.[17] While big city contracts often run in the millions, these are extraordinary figures: in New York City, ShotSpotter is in the top 5% of NYPD contracts by dollar amount, rivalling even the cost of leasing pricey NYC real estate.[18]

III. How ShotSpotter Works—and Doesn't Work

ShotSpotter uses audio sensors, computer software and human analysts to try to identify gunshots.

1. Determining coverage and installing sensors

[12] Zolan Kanno-Youngs. "Biden Aims to Bolster Police Departments as Homicides Increase." *The New York Times*, June 24, 2021, sec. U.S. https://www.nytimes.com/2021/06/23/us/politics/crime-biden.html. To fund law enforcement projects, including ShotSpotter services, members of the U.S. House of Representatives requested an additional $110.7 million in earmarks in June 2021 from the House Appropriations Commerce-Justice-Science Subcommittee. *See* Jack Fitzpatrick, "Democrats Reject Calls to Defund Police With Spending Requests," *Bloomberg Government*, June 24, 2021, https://about.bgov.com/news/democrats-reject-calls-to-defund-police-with-spending-requests/.

[13] David Leins and Bryce Huffman. "Tracked and Traced: Does ShotSpotter Prevent Violent Crime in Detroit?" WDET 101.9 FM. February 16, 2022. https://wdet.org/2022/02/16/tracked-and-traced-does-shotspotter-prevent-violent-crime-in-detroit/.

[14] Jon Shuppe and Joshua Eaton, "A Gunshot Detection Tech Company Is Facing Criticism. Police Are Investing Anyway," NBC News, February 10, 2022, https://www.msn.com/en-us/news/us/a-gunshot-detection-tech-company-is-facing-criticism-police-are-investing-anyway/ar-AATGv6j.

[15] ShotSpotter contract retrieved from the City of Chicago's Procurement Services website: https://webapps1.chicago.gov/vcsearch/city/contracts/71366. Last accessed April 19, 2022.

[16] ShotSpotter contract summaries retrieved from CheckbookNYC, the NYC Comptroller's website the city's municipal spending: https://www.checkbooknyc.com/smart_search/citywide?search_term=shotspotter*!*domain=contracts. Last accessed March 13, 2022.

[17] ShotSpotter contract summaries retrieved from CheckbookNYC, the NYC Comptroller's website the city's municipal spending: https://www.checkbooknyc.com/smart_search/citywide?search_term=shotspotter*!*domain=contracts Last accessed March 13, 2022.

[18] ShotSpotter contract summaries retrieved from CheckbookNYC, the NYC Comptroller's website the city's municipal spending: https://www.checkbooknyc.com/smart_search/citywide?search_term=%22police%20department%22*!*domain=contracts*!*facet_year_array=2021 Last accessed March 13, 2022.

ShotSpotter and its clients first identify coverage areas using municipal crime data and mapping information from Google Earth and ArcGIS.[19] ShotSpotter installs "audio sensors"—roughly comparable to microphones in cellphones[20]—throughout the targeted coverage areas on everything from buildings to utility poles to streetlights.[21] As ShotSpotter has made clear in at least a portion of its municipal contracts, coverage "cannot be verified," meaning that sensors can fail to detect a gunshot even if it occurs within the designated coverage area.[22] In fact, one Massachusetts town dropped their ShotSpotter contract after the system missed all 7 gunshots in a 2018 murder.[23] ShotSpotter's privacy policy states that only company employees will know the exact sensor locations,[24] an apparent protection against police evidence tampering, but there are other ways for police map ShotSpotter sensors: the white diamond- or rectangle-shaped microphones are often installed in highly visible, public locations.[25] Police officers even accompany ShotSpotter employees on some trips to ask for consent to place sensors.[26]

2. Recording audio

Once installed, ShotSpotter sensors record audio 24/7, storing recordings for 30 hours (down from 72 hours) until they are overwritten on a rolling basis.[27] The eavesdropping devices record anything

[19] Claim based on New York City's process for placing sensors. The City of New York Police Department and ShotSpotter, "Agreement for the Provision of a Gunshot Detection and Location System for the Police Department of the City of New York." New York City, 2016.
[20] New York City Police Department, "ShotSpotter: Impact and Use Policy." Accessed March 5, 2022. https://www1.nyc.gov/assets/nypd/downloads/pdf/public_information/post-final/shotspotter-nypd-impact-and-use-policy_4.9.21_final.pdf.
[21] ShotSpotter. *How ShotSpotter Gunshot Detection Works - English (Updated Aug 2021)*, 2021. https://www.youtube.com/watch?v=Nk980tdlzFI.
[22] The City of New York Police Department and ShotSpotter, "Agreement for Gunshot Detection."
[23] Brian Fraga, "After Too Many Shots Missed, Fall River, Mass., Ends Deal with ShotSpotter," *GovTech*, April 23, 2018. https://www.govtech.com/public-safety/After-Too-Many-Shots-Missed-Fall-River-Mass-Ends-Deal-with-ShotSpotter.html.
[24] ShotSpotter. "Privacy Policy." Accessed March 5, 2022. https://www.shotspotter.com/privacy-policy/.
[25] Dave Davies, "Surveillance And Local Police: How Technology Is Evolving Faster Than Regulation." *NPR*, January 27, 2021, sec. Technology. https://www.npr.org/2021/01/27/961103187/surveillance-and-local-police-how-technology-is-evolving-faster-than-regulation.
[26] The Policing Project at NYU Law, "Privacy Audit & Assessment of ShotSpotter, Inc.'s Gunshot Detection Technology," July 2019, https://static1.squarespace.com/static/58a33e881b631bc60d4f8b31/t/6065e7d81422241f592ce0e5/1617291232883/Privacy%2BAudit%2Band%2BAssessment%2Bof%2BShotSpotter%2BFlex.pdf#page=17.
[27] Our description of step two is based on ShotSpotter's materials and on NYPD's ShotSpotter documentation. New York City Police Department, "ShotSpotter: Impact and Use Policy." Until The Policing Project at NYU Law objected to the practice, ShotSpotter sensors stored recordings for 72 hours. *See* Policing Project, "Assessment of ShotSpotter."

they hear, including conversations conducted at normal volume up to 50 feet away, according to ShotSpotter's own engineer when testifying under oath.[28] Once recorded, those conversations could be searched manually and preserved for later use.[29] There are at least two cases of ShotSpotter voice recordings being used in court. In 2007, a California court allowed a voice recording captured by ShotSpotter as evidence in a murder trial.[30] In 2012, a Massachusetts court ruled that ShotSpotter's recording of a conversation violated the Massachusetts's Wiretap Act.[31] Like many states, Massachusetts's wiretapping ban goes beyond tapping phone lines and other communication platforms, also outlawing bugging locations with secret microphones. Instead of answering concerns around sensors' eavesdropping capacities, ShotSpotter first claimed that its sensors cannot record conversations.[32] It later admitted the risk,[33] and in 2019 apparently agreed to external auditors' recommendation that it deny or challenge police demands for sensor audio.[34] Promises aside, however, nothing appears to stop ShotSpotter from searching, retrieving and sharing audio stored for 30 hours on its sensors or from sharing the audio stored longer on its servers.

3. Detecting loud sounds and calculating their locations

When three or more ShotSpotter microphones register a loud sound, ShotSpotter software calculates the location of the pop based on the angle of arrival of soundwaves (triangulation) and arrival time of soundwaves (multilateration) at different microphones.[35] Wind, street noise,

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[28] The Legal Aid Society, "Testimony to The Council of the City of New York Committee on Public Safety," June 14, 2017. https://www.brennancenter.org/sites/default/files/The%20Legal%20Aid%20Society%20Testimony%20Before%20NYC%20Council-%20June%2014%202017%20%283%29.pdf.

[29] Proposed Int. No. 1482-2017 (Public Oversight of Surveillance Technology (POST) Act), Before The Council of the City of New York Committee on Public Safety, [number of the Congress], page 6-9 (2017), (Jerome Greco, Staff Attorney Legal Aid Society's Digital Forensic Unit). https://www.brennancenter.org/sites/default/files/The%20Legal%20Aid%20Society%20Testimony%20Before%20NYC%20Council-%20June%2014%202017%20%283%29.pdf.

[30] *People v. Johnson*, no. A131317 (Cal. Ct. App. Feb. 27, 2013) *available at* https://casetext.com/case/people-v-johnson-5116.

[31] Ronald Hedges, Maverick James, and Maria Ermakova, "Electronic Evidence in Criminal Investigations and Actions: Representative Court Decisions and Supplementary Materials," December 2017, https://www.mass.gov/files/documents/2018/01/08/CRIMINAL%20ESI%20DEC%202017.pdf.

[32] ShotSpotter, "Frequently Asked Questions," January 2018.

[33] ShotSpotter's "Frequently Asked Questions" document was first acknowledged this in August 2018, when it reported that "if voices are concurrent with the gunshot, and are loud enough and close enough to a sensor, then they may be captured in the brief audio alert snippet."

[34] Policing Project, "Assessment of ShotSpotter."

[35] Ferguson and Witzburg, "Chicago Use of ShotSpotter." *See also* ShotSpotter, "Frequently Asked Questions," January 2018.

structures, foliage, and ground reflection create errors in ShotSpotter's location calculations.[36] For the best results, ShotSpotter suggests that data from six microphones is needed. [37]

ShotSpotter then translates location coordinates to street addresses using third-party data (e.g., Google or municipal data).[38] This translation can go very wrong. One court case revealed that certain ShotSpotter coordinates were translated to a street address 1.1 miles away when ShotSpotter's translational process was confused by a park.[39] The scramble to correct ShotSpotter's mistakes reportedly produced a trail of corrected and re-corrected "evidence" that prosecutors ultimately withdrew.[40]

4. *Is it a gunshot? Software analysis*

ShotSpotter uses non-open-source software to visualize loud sounds as "image mosaics."[41] The mosaic includes acoustic data and information about reporting sensors.[42] ShotSpotter describes multiple acoustic visualization techniques, but without knowing which approach the company uses, its software remains a mystery.[43]

ShotSpotter then analyzes its image mosaics with ResNet, a third-party machine learning algorithm used to recognize images. The software compares incoming mosaics to mosaics that have already been identified as gunshots. If an incoming mosaic looks similar enough to previously identified gunshots' mosaics, the software classifies the sound as a gunshot and alerts ShotSpotter employees.[44]

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[36] Robert B. Calhoun et al., "Precision and Accuracy of Acoustic Gunshot Location in an Urban Environment," *ArXiv:2108.07377*, August 16, 2021, https://doi.org/10.48550/arXiv.2108.07377.
[37] Calhoun, et al., "Precision of Gunshot Location."
[38] ShotSpotter, "August 12, 2021 Responses." Accessed on March 5, 2022. https://s3.documentcloud.org/documents/21045566/shotspotter-responses-to-the-associated-press.pdf.
[39] ShotSpotter, "August 12, 2021 Responses."
[40] Garance Burke et al., "Police Jailed a Man for Murder; Algorithm Was Key Evidence," *AP NEWS*, August 19, 2021, https://apnews.com/article/technology-24f5e12df10879dcbdbb950128fd1707.
[41] Scott Lamkin and David Rodgers. "(71) Applicant: ShotSpotter, Inc., Newark, CA (US) (72) Inventors: Robert B. Calhoun, Newark, CA (US);," n.d., 19.
[42] Lamkin and Rodgers, "(71) Applicant: ShotSpotter, Inc."
[43] Lamkin and Rodgers, "(71) Applicant: ShotSpotter, Inc."
[44] ShotSpotter, "August 12, 2021 Responses."

ResNet is a high-level description of what an algorithm *could* look like.[45] What ShotSpotter's implementation of ResNet *actually* looks like, like so much information about ShotSpotter, is not publicly available. Serious questions remain about whether a repurposed computer vision program could ever reach the level of accuracy and reliability needed for public deployment.[46] When taking software designed to analyze images and using it to analyze sounds, a variety of factors can distort and degrade performance. Such repurposing of algorithmic systems has led police astray in the past, such as the widely-denounced use of seismic algorithms (designed to predict earthquakes) to predict the location of future crimes.[47]

5. *Is it a gunshot? Employee analysis*

ShotSpotter's call center employees receive an "audio snippet" of loud sounds flagged as possible gunshots.[48] Based on a ShotSpotter job advertisement, the criteria for this position include a year of experience in a call center or in customer service and the mysterious ability to "listen to audible notifications with a high level of accuracy."[49] ShotSpotter provides unspecified "'on the job' training," but claims to have "no official or formal training materials."[50] Still, ShotSpotter and police departments trust these employees to make the life-or-death decision about what is, or maybe isn't, a gunshot. If they do believe a sound is likely a gunshot, police get a short audio recording of the supposed gunshot and its street address. Most disturbingly of all, this entire process is rushed to completion in less than 60 seconds, forcing analysts to make decisions with potential life-or-death impact at a frenzied pace.[51]

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[45] Kaiming He et al., "Deep Residual Learning for Image Recognition," in *2016 IEEE Conference on Computer Vision and Pattern Recognition* (IEEE Conference on Computer Vision and Pattern Recognition, Las Vegas, NV, USA: Institute of Electrical and Electronics Engineers, 2016), 770–78, https://doi.org/10.1109/CVPR.2016.90.

[46] Puspita Majumdar, Richa Singh, and Mayank Vatsa, "On Learning Deep Models with Imbalanced Data Distribution," *Proceedings of the AAAI Conference on Artificial Intelligence* 35, no. 18 (May 18, 2021): 15720–21.

[47] Caroline Haskins, "Academics Confirm Major Predictive Policing Algorithm Is Fundamentally Flawed," *Vice*, February 14, 2019, https://www.vice.com/en/article/xwbag4/academics-confirm-major-predictive-policing-algorithm-is-fundamentally-flawed.

[48] New York City Police Department, "ShotSpotter: Impact and Use Policy."

[49] ShotSpotter. "Incident Review Center Specialist – Hiring All Shifts– FT/PT." Accessed March 5, 2022. https://www.shotspotter.com/career/service-operations-center-specialist-hiring-all-shifts-ft-pt/.

[50] Garance Burke et al., "How AI-Powered Tech Landed Man in Jail with Scant Evidence," *AP NEWS*, August 19, 2021, https://apnews.com/article/artificial-intelligence-algorithm-technology-police-crime-7e3345485aa668c97606d4b54f9b6220.

[51] ShotSpotter webpage, last accessed March 5, 2022. https://www.shotspotter.com/law-enforcement/gunshot-detection/

6. Was it a gunshot? Police-led adjustments

ShotSpotter is hardly perfect, a fact that even the company's CEO recognized when he admitted the company relies on police data to determine "when we miss detections or when we miss-classify."[52] However, ShotSpotter marketing data masks this reality, using a narrow reading of voluntary self-reporting from police to misleadingly claim that it is 97% accurate.[53] In contrast, Chicago's comprehensive study of tens of thousands of ShotSpotter showed that more than 90 percent of the time, ShotSpotter deployments appear to be useless. In fact, police only found evidence of any gun-related crime in 9.1% of calls.[54] Yet unless officers took the time to affirmatively tell ShotSpotter of the mistake, wasting even more policing time on a false alert, the company would still count that use as "accurate."[55] Even where a gun is recovered, it's unclear how often the gun police find is the one supposedly detected by ShotSpotter. Given the high rate of gun possession in the United States,[56] even searching residents at random would be expected to detect a significant number of guns. As the ShotSpotter bill grows for taxpayers, the amount of independent performance data remains lamentably low.[57]

ShotSpotter also allegedly altered determinations upon officer request. One ShotSpotter engineer testified that "[t]ypically, you know, we trust our law enforcement officers to be really upfront and honest with us when they request changes to the record."[58]

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[52] James Clayton, "Inside the Controversial US Gunshot-Detection Firm." *BBC News*, October 29, 2021, sec. Technology. https://www.bbc.com/news/technology-59072745.
[53] ShotSpotter, "ShotSpotter Privacy FAQ," December 2020. Accessed March 5, 2022. https://www.shotspotter.com/wp-content/uploads/2020/12/ShotSpotter-Respond-FAQ-Dec-2020.pdf *See also* Clayton, "Inside US Gunshot-Detection Firm."
[54] Ferguson and Witzburg, "Chicago Use of ShotSpotter."
[55] Clayton, "Inside US Gunshot-Detection Firm." ShotSpotter employees also write that the technology is trained on known false alerts, writing: "[i]n the vast majority of cases, "ground truth" (e.g. shell casings, video recordings) is not available, and it is to be expected that some training data are misidentified." *See* Calhoun et al., "Precision of Gunshot Location."
[56] 30% of U.S. adults report owning a gun. Katherine Schaeffer, "Key Facts about Americans and Guns," *Pew Research Center* (blog), accessed June 3, 2022, https://www.pewresearch.org/fact-tank/2021/09/13/key-facts-about-americans-and-guns/.
[57] Alysson Gatens and Jessica Reichert, "Police Technology: Acoustic Gunshot Detection Systems," Illinois Criminal Justice Information Authority Center for Justice Research and Evaluation, December 13, 2019, http://www.icjia.state.il.us/assets/articles/ShotSpotter-Final-191213T18420528.pdf.
[58] Burke et al., "AI-Powered Tech."

Even when these changes are requested by police, they can undermine officers in court. Prosecutors withdrew ShotSpotter evidence in a murder case after it was revealed that ShotSpotter audio was first classified by ShotSpotter software as a firework, reclassified by a ShotSpotter analyst as a gunshot, and then, months later, relocated to a new street address.[59] The defendant, Michael Williams, spent nearly a year in jail before his case was dismissed for insufficient evidence.[60,61]

This kind of "reevaluation" of evidence has reportedly happened before. On April 2, 2016, Rochester police shot Silvon Simmons three times in the back, buttock, and leg, inflicting life-altering wounds from which he will never fully recover.[62] Rather than being treated as the victim, Rochester police revictimized him, prosecuting him for firing on officers… a charge for which Simmons was later acquitted. According to the amended complaint in Simmons' federal civil rights lawsuit, ShotSpotter first missed the police officers' gunshots entirely, classifying them as helicopter noise until the Rochester police notified ShotSpotter of its mistake.[63] The police then allegedly asked ShotSpotter to provide evidence that Simmons shot at police first: an officer allegedly asked the company to "find additional shots", and as Simmons later claimed, that's exactly what ShotSpotter did.[64] When it came time for Simmons to access the supposedly incriminating recordings, ShotSpotter and the City of Rochester were unable to produce the longer audio spool(s) the allegedly incriminating recordings were clipped from.[65] Ultimately, the only charge Simmons was convicted of by the jury was set aside by the judge.[66]

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[59] Todd Feathers, "Police Are Telling ShotSpotter to Alter Evidence From Gunshot-Detecting AI," *Vice*, July 26, 2021, https://www.vice.com/en/article/qj8xbq/police-are-telling-shotspotter-to-alter-evidence-from-gunshot-detecting-ai.
[60] Feathers, "Police Are Telling ShotSpotter."
[61] ShotSpotter disputes this narrative, saying that the ShotSpotter evidence was withdrawn for different reasons and that Williams was not jailed on the basis of ShotSpotter evidence. *See* ShotSpotter, "ShotSpotter's Response to Associated Press Article," August 26, 2021. Last accessed March 16, 2022. https://www.shotspotter.com/law-enforcement/shotspotter-response-to-associated-press-article/.
[62] Donna Jackel, "He Was Shot in the Back By a Cop…Then Spent 18 Months in Jail," Narratively, July 2, 2018, https://narratively.com/he-was-shot-in-the-back-by-a-copthen-spent-18-months-in-jail/.
[63] ShotSpotter reclassified noises first flagged as helicopter noises to gunshots noting "Reason: per customer." *See Simmons v. Ferrigno*, No. 17-CV-6176 (W.D.N.Y. filed Aug. 27, 2018) (amended complaint), https://media-alliance.org/wp-content/uploads/2018/12/Simmons-v-SSTI-Amended-Complaint-27-8-18-Case-6-17-Cv-06176-MAT.pdf#page=33
[64] *Ferrigno*, No. 17-CV-6176 (W.D.N.Y. filed Aug. 27, 2018) (amended complaint).
[65] Tracy Rosenberg, "Find Us One More Shot." *Medium* (blog), December 6, 2018. https://medium.com/@tracyrosenberg/find-us-one-more-shot-22b2efd4244d.
[66] Gary Craig, "Man Once Accused of Attempting to Kill a Rochester Cop Now Cleared of All Charges," Democrat and Chronicle, May 31, 2018, https://www.democratandchronicle.com/story/news/2018/05/31/silvon-simmons-rochester-police-shotspotter-attempted-murder-officer-cleared-charges/659848002/.

Despite ShotSpotter's alleged willingness to alter evidence under police pressure, despite ShotSpotter's documented mistakes in identifying and locating gunshots, and despite the unknowns around ShotSpotter software and employee training, courts have admitted ShotSpotter evidence in over 200 cases to date.[67]

IV. Evidence Suggests that ShotSpotter Wastes Officers' Time

Though police departments increasingly rely on ShotSpotter, its benefits to them are at best tenuous, and potentially nonexistent. ShotSpotter may increase police *awareness* of gunfire (and fireworks, and cars backfiring) and the speed at which they know.[68,69] But that knowledge appears to offer few benefits.

Indeed, the evidence suggests that ShotSpotter wastes officers' time, leading to needless police stops. One comprehensive study of ShotSpotter analyzed over 50,000 ShotSpotter alerts in Chicago.[70] More than 9 of 10 dispatches with recorded outcomes produced no evidence of a gun-related criminal offense: not a casing, not a bullet hole, not a gun.[71] Just 2.1% of all dispatches with recorded outcomes produced an investigatory stop, and the overwhelming majority of those stops were erroneous.[72] More than three quarters of stops yielded no arrests and fewer than 15% of stops produced a gun.[73] Of over 50,000 ShotSpotter-related dispatches, there were 244 arrests (occurring

[67] "ShotSpotter Responds to False Claims," ShotSpotter, accessed April 19, 2022, https://www.shotspotter.com/shotspotter-responds-to-false-claims/.
[68] Hannah Gold, "ShotSpotter: gunshot detection system raises privacy concerns on campuses," *The Guardian*, Jul. 17, 2015, https://www.theguardian.com/law/2015/jul/17/shotspotter-gunshot-detection-schools-campuses-privacy.
[69] Jillian Carr, "Measuring the Effects of ShotSpotter on Gunfire in St. Louis County, MO." The Policing Project at New York University School of Law, January 2021, https://static1.squarespace.com/static/58a33e881b631bc60d4f8b31/t/603923e3a32c3f57d67dabec/1614357476874/Measuring+the+Effects+of+ShotSpotter+on+Gunfire+in+St.+Louis+County%2C+MO.pdf.
[70] Ferguson and Witzburg, "Chicago Use of ShotSpotter."
[71] Ferguson and Witzburg, "Chicago Use of ShotSpotter."
[72] Ferguson and Witzburg, "Chicago Use of ShotSpotter."
[73] Of 1,056 investigatory stops, 244 led to arrests and 152 led to guns being recovered. *See* Ferguson and Witzburg, "Chicago Use of ShotSpotter."

in less than 1 in 200 dispatches) and 152 recovered guns (occurring in less than 1 in 300 dispatches).[74]

Other studies have produced similarly dismal results. In Brockton, MA, ShotSpotter increased police activity, but did not "improve gun-related case resolution."[75] In Philadelphia, ShotSpotter increased police workload on gunshot investigations, but failed to "significant[ly] increase in the number of confirmed shootings."[76] Such data suggests that, in the words of former NYPD Commissioner and ShotSpotter board member Bill Bratton, communities are being "over-policed and under-protected."[77]

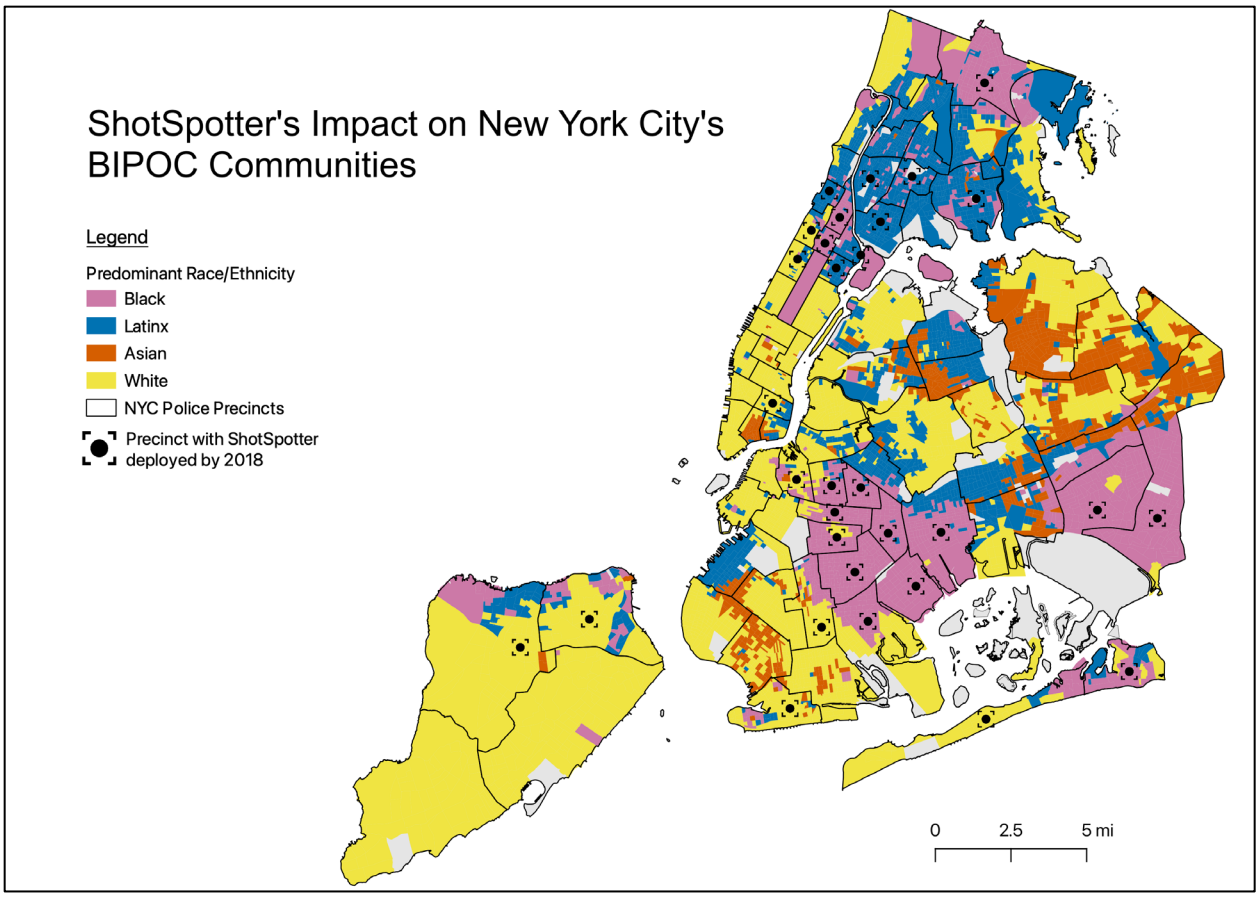
Installing ShotSpotter even appears to depress helpful community involvement. In St. Louis, citizen-initiated reports of gunshots were over seven times more useful to police than ShotSpotter alerts, while consuming less of officers' time.[78] But citizen reports decreased when ShotSpotter was in service and decreased again when St. Louis expanded its ShotSpotter installation, suggesting that St. Louis traded communities' free assistance for an expensive technological boondoggle.[79]

V. Evidence Suggests ShotSpotter Targets Black and Latinx Communities, Then Fails Them

While ShotSpotter is expanding across the nation, it is not expanding evenly. Though ShotSpotter refuses to disclose the data necessary for a comprehensive national analysis, the available evidence strongly suggests that ShotSpotter targets Black and Latinx communities for surveillance. In Chicago, ShotSpotter monitors the twelve police districts with the largest share of Black and Latinx

[74] Ferguson and Witzburg, "Chicago Use of ShotSpotter."
[75] Kyung-Shick Choi, Mitch Librett, and Taylor J. Collins, "An Empirical Evaluation: Gunshot Detection System and Its Effectiveness on Police Practices," *Police Practice and Research* 15, no. 1 (January 2, 2014): 48–61, https://doi.org/10.1080/15614263.2013.800671.
[76] Jerry H. Ratcliffe et al., "A Partially Randomized Field Experiment on the Effect of an Acoustic Gunshot Detection System on Police Incident Reports," *Journal of Experimental Criminology* 15, no. 1 (March 1, 2019): 67–76, https://doi.org/10.1007/s11292-018-9339-1.
[77] William Bratton and Jon Murad, "Precision Policing," *City Journal*, July 16, 2018, https://www.city-journal.org/html/precision-policing-16033.html.
[78] Denis Mares and Emily Blackburn, "Acoustic Gunshot Detection Systems: A Quasi-Experimental Evaluation in St. Louis, MO," *Journal of Experimental Criminology*, June 1, 2021, https://doi.org/10.1007/s11292-019-09405-x.
[79] Mares and Blackburn, "Acoustic Gunshot Detection Systems."

residents.[80] In Cleveland, Atlanta, and Kansas City, Missouri, ShotSpotter installations focus "almost exclusively" on Black and Latinx neighborhoods.[81] In New York City, our analysis shows that 70% of 31 NYPD precincts that deployed ShotSpotter in 2018 were majority Black (15) or majority Latinx precincts (7). (Due to ShotSpotter's secrecy, this is the most recent year for which data could be located.)



Data Sources:
"Political and Administrative Districts - Download and Metadata," NYC Planning, accessed June 23, 2022, https://www1.nyc.gov/site/planning/data-maps/open-data/districts-download-metadata.page.
Unpublished photo of a map of ShotSpotter deployment in New York City, by Clare Garvie, 2018, on file with the Surveillance Technology Oversight Project.
"Police Precincts," NYC Open Data, accessed June 23, 2022, https://data.cityofnewyork.us/Public-Safety/Police-Precincts/78dh-3ptz.
"Working with Census Data and Creating a Race Map of NYC," Points Unknown, November 1, 2019, https://pointsunknown.nyc//qgis/2019/11/01/06_Census_and_Joins_by_Race.html.

[80] MacArthur Justice Center, "ShotSpotter Creates Dead-End Deployments."
[81] Feathers, "Gunshot-Detecting Tech."

"When Will 120th Precinct Get ShotSpotter, the Gunfire-Tracking Tech?," ShotSpotter, November 1, 2016, https://www.shotspotter.com/news/when-will-120th-precinct-get-shotspotter-the-gunfire-tracking-tech/.
"American Community Survey B03002: Hispanic or Latino Origin by Race, 2017 ACS 5-Year Estimates Detailed Tables," United States Census Bureau, accessed June 23, 2022, https://data.census.gov/cedsci/table?q=B03002&tid=ACSDT5Y2017.B03002.

ShotSpotter appears to facilitate the same tired logic used to "justify" over-policing Black and Latinx communities to rationalize the disproportionate placement of ShotSpotter sensors in the same communities. Law enforcement's longstanding overemphasis on policing BIPOC (Black, Indigenous, and people of color) communities has produced crime data that disproportionately represents these communities and their residents.[82] Police use this geographically and demographically skewed crime data to rationalize more over-policing of BIPOC communities and individuals, perpetuating the cycle of racist over-policing.[83] ShotSpotter apparently uses this same police data to identify and rationalize the placement of sensors in supposedly "gun violent areas" of a city.[84] In turn, ShotSpotter draws more police attention to the neighborhoods where it is deployed—contributing to police misperception of these communities and falsely justifying their continued over-policing.

ShotSpotter's apparently discriminatory sensor placement could lead to discriminatory and even deadly police responses. In NYC, plainclothes officers responding to a ShotSpotter alert in Canarsie, Brooklyn, a majority-Black neighborhood, refused to identify themselves to and assaulted a 20-year-old man they found smoking marijuana.[85] In Chicago, ShotSpotter reportedly increased officers' suspiciousness toward community residents, with officers using "being in an area with frequent ShotSpotter alerts" as part of their rationale for conducting police stops.[86] In the worst cases, ShotSpotter's consequences have allegedly been deadly. Chicago police chased, shot, and killed 13-

[82] *See*, for example, American Civil Liberties Union and The Rights Working Group, "The Persistence Of Racial And Ethnic Profiling In The United States," December 10, 2007, https://www.aclu.org/report/persistence-racial-and-ethnic-profiling-united-states.
[83] *See*, for example, American Civil Liberties Union and The Rights Working Group, "Racial and Ethnic Profiling."
[84] Gabriel Sandoval and Rachel Holliday Smith, "'ShotSpotter' Tested as Shootings and Fireworks Soar, While Civil Rights Questions Linger," *The City*, 5 July 2020, https://www.thecity.nyc/2020/7/5/21312671/shotspotter-nyc-shootings-fireworks-nypd-civil-rights.
[85] Sandoval and Smith, "'ShotSpotter' Tested."
[86] Ferguson and Witzburg, "Chicago Use of ShotSpotter."

year-old Adam Toledo within five minutes of arriving in his neighborhood.[87] Toledo had his empty hands up when he was killed.[88]

In exchange for assuming the risks of increased police interactions due to ShotSpotter, communities receive little or nothing in return. A study of 68 large urban counties from 1996 to 2016 suggests that in the first two years after ShotSpotter installation, cities experienced no significant change in firearm homicides, murder arrests, or weapons arrests.[89] ShotSpotter appears to fail to deter gun violence. By contrast, permit-to-purchase laws reduced firearm homicides compared to cities in states without such laws, and right-to-carry laws increased firearm homicides compared to cities in states without them.[90] Why then are millions flowing into ShotSpotter systems? Such policy solutions are hard to implement, but cities can simply buy ShotSpotter.[91]

Even when ShotSpotter data is correct, it apparently fails to help those community members most impacted by gun violence: shooting victims. In Camden, NJ, ShotSpotter decreased the time it took for shooting victims to receive medical care, but without any improvement in patient outcomes.[92] In other jurisdictions, ShotSpotter made no difference in time to medical treatment, let alone patient outcomes.[93] ShotSpotter increases police activity and sometimes-dangerous police interactions, while failing communities it claims to serve.

VI. Conclusion

American cities rightly prioritize solving and reducing gun violence. They go wrong when they turn to ShotSpotter gunshot surveillance technology rather than programs that proactively address the

[87] Chris Mills Rodrigo, "Police Technology Under Scrutiny Following Chicago Shooting," *The Hill*, April 21, 2021, https://thehill.com/homenews/state-watch/549612-police-technology-under-scrutiny-following-chicago-shooting/.
[88] Grace Hauck, "Evolution of a City's Account of a Killing: How Chicago's Narrative Changed in the Fatal Police Shooting of Adam Toledo," USA TODAY, April 16, 2021, https://www.usatoday.com/story/news/nation/2021/04/16/adam-toledo-police-shooting-how-chicagos-narrative-changed/7260911002/.
[89] Doucette, et al., "Impact of ShotSpotter."
[90] Doucette, et al., "Impact of ShotSpotter."
[91] Doucette, et al., "Impact of ShotSpotter."
[92] Goldenberg et al., "Use of ShotSpotter Detection."
[93] Gontarz et al., Firearm Acoustic Detection."

causes of gun violence. ShotSpotter bombards officers with alerts, both mistaken and genuine, consuming hours of policing time and countless tax dollars. But it is grossly inefficient, yielding one arrest for every 200-plus deployments in one major study, with many of those arrests unrelated to guns. At the same time, ShotSpotter appears to compound the over-policing of Black and Latinx communities, putting residents of color at risk—even while evidence suggests that ShotSpotter fails the public. In short, based on publicly available data, ShotSpotter simply doesn't work.

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