

Collaborative Dissent: Noses as Shared Instruments in the Nineteenth-Century Fight for Public Health

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Abstract

In the decades after the United States' Civil War, city and state governments began to institutionalize organized public health, a process that gave physicians and chemists limited political power as officials. The emergence of boards of health as scientific-political institutions fostered but also undermined productive collaborations between chemists, physicians, and urban residents—collaborations of the sort that our contemporary citizen science hope to create, wherein experts and local lay persons shared authority. This paper interrogates the first phases of organized public health in Boston, Chicago, and New York City to reveal the forces that enabled productive collaborations between chemists and citizens, and to pinpoint how the demands of government and the law shifted the balance of power from local, embodied knowledge to quantitative measurement. For modern movements, these historic moments raise the question of how bodies can be mobilized as dissent—and of where scientists need to be physically located in urban environments and communities. Identifying and understanding the social and cultural factors that enabled collaborative dissent holds promise for contemporary urban environmental and health crises.

Keywords

olfaction; public health; noses; embodied knowledge; chemistry

Introduction

On the final night of November in 1880, New York City chemist Samuel Goldschmidt answered his door at 10:30 p.m. to find lawyer Herbert Turner standing on the stoop. Turner had come out, despite the late hour, to enlist Goldschmidt's help in determining the source of a foul odor that permeated Turner's home. Because of miasma theory—the medical and vernacular belief that bad airs caused disease—Turner feared this stench would sicken his family. Goldschmidt went out into the streets of New York City to help Turner identify the stench and determine its origin, but the two men failed. As Goldschmidt reported to the Board of Health, the odor “had died away by the time Mr. Turner reached my residence” ([Grace Administration 1881](#)).

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Turner and Goldschmidt's foray into the night is one of many collaborations between citizens and scientists that regularly occurred between the 1860s and 1880s in United States' cities. During this period, scientists such as Goldschmidt were gaining political positions and power through the organization of permanent public health boards in city and state governments. The creation of standing boards of public health with regulatory powers marked a change in the locus of power and authority. These boards, still in existence as departments of health, were the first effort in the United States to institutionalize disease prevention as government policy, a few decades behind French and British initiatives ([Coleman 1982](#); [La Berge 1982](#); [Hamlin 1998](#)). In the United States, boards of health supplanted the common law tradition of nuisance complaints, under which aggrieved citizens petitioned the city government to abate "nuisances detrimental to health" such as stench-producing industries. Nuisance law had given aggrieved citizens power over industries ([Morag-Levine 2003](#); [Novak 1996](#); [Hurley 1997](#)), but this power waned as industries grew in number, size, and economic importance during the nineteenth century. Boards of health staffed by scientists and physicians hold an important place in the history of scientific professionalization, the process that separated scientists from and gave them authority over lay citizens ([Daniels 1967](#); [Reingold 1976](#); [Lucier 2009](#)). However, governments created these boards not to privilege scientists but in order to check the growing power of large industries and to respond to complaints ([Cumbler 2001](#); [Rosenkrantz 1972](#)). As in Europe, the activities of board of health during their first years, both in terms of actions taken and working methods adopted, negotiated many conflicting priorities in an increasingly industrial society and set the standard for subsequent interventions in—or laxity towards—polluting industries ([Le Roux 2016a](#); [ibid., 2016b](#)).

During the transition from common law to boards of health, the regulatory apparatus included and enabled collaboration between residents who complained and board-employed chemists. While boards of health brought citizens and chemists into contact with one another, collaborations resulted from two cultural factors: a continuum of knowledge and shared sensory perceptions. First, both scientists and citizens recognized a continuum of knowledge in which scientific (often quantitative) reports were supporting evidence rather than privileged, objective, or definitive measures on which governments based their decisions. In the early years of boards of health, the culture of nuisance complaint gave citizens like Turner the power to direct the attention and efforts of chemists such as Goldschmidt. Health boards actively sought citizens' knowledge when they placed complaint books in local police stations or collected testimony. Unlike lay observer networks, in which scientists reached out to and coordinated amateurs ([Vetter 2011](#); [Benson 2017](#)), citizens directed the analytical attention of chemists and physicians. As health boards became established in local governments, the continuum of knowledge narrowed to focus on scientific analysis and quantitative reports, effectively reducing the power of complaining citizens in health governance and industrial regulation.

The continuum of knowledge narrowed, in part, because of questions about the other cultural factor that enabled collaborations between citizens and chemists: the shared instrumentation of the human nose. Odors, like other sensory phenomena, are fruitful for probing the intersection between scientific and vernacular knowledge because all people use the nose as an analytical instrument to apprehend and analyze odors ([Shapin 2012](#); [Howes 2015](#)). However, approaches to the senses have divided between attempts to train and standardize supposedly subjective sensory perception in order to create purportedly objective data ([Besky 2017](#); [Berenstein 2018](#); [Burlingame et al. 2017](#); [Dietrich and Burlingame 2020](#); [Lahne 2018](#)) and the

recognition that sensory perception is “bodily reasoning” and environmental attunement, a form of experiential and local knowledge that has accurately pointed to significant health harms in such cases as state mega-projects, modern housing, and polluted water ([Parr 2010](#); [Shapiro 2015](#); [Spackman 2020](#)). In response to the call to “invite apprehension” by recognizing and integrating “multiple strata of apprehending the environment” rather than relying on numerical data ([Shapiro et al. 2017](#)), I offer examples of how governments invited apprehension—and then stopped doing so—in the nineteenth century. Due to their concern about disease-causing miasmas, nineteenth-century Americans’ environmental attunement included the belief that olfaction reliably warned of health threats. Because both urban residents like Turner and chemists like Goldschmidt used their noses to evaluate the air, their shared bodily experiences were the basis for their collaboration and dissent against prevailing industrial practices. But as chemists and citizens testified to their olfactory knowledge before the state, disagreements about smells raised questions of whose noses were trustworthy instruments for evaluating the environment.

This essay draws on a series of environmental and health debates in American cities in the 1870s and 1880s to explore moments of collaborative dissent in which citizens and scientists worked together to change industrial and economic practices. These debates reveal that local politics and power relations shaped both collaborations and their effect on industrial practices. The evidence is drawn from three different cases that inaugurated and challenged standing boards of health: an 1873 hearing before the Massachusetts Board of Health, a series of nuisance suits brought by Chicago’s Board of Health in 1877 and 1878, and an 1878 indictment of New York City’s Board of Health and its aftermath. All three of these cases concerned stench nuisances, which were a particular concern in these decades because the industrialization of slaughtering and related businesses concentrated and intensified the foul odors that were understood to harm health. The bases for and limits on productive collaboration, including the methods employed and the relative power of citizens to chemists, can be instructive to those engaged in citizen science today.

Before Boards of Health: Shared Knowledge *without* Political Power

Before the creation of permanent boards of health, shared instrumentation did not necessarily lead to collaboration. The events in Chicago during 1862 offer a prime example. As the slaughtering industry expanded production to supply Civil War demand, citizens from all neighborhoods and classes complained vociferously about the corresponding increase in stench. City aldermen ignored numerous petitions about odors until they received one from the Board of Trade. Chicago’s businessmen feared that the strong stench would drive laborers from the Chicago River, thereby halting commerce. Thus an economic imperative, not widely shared citizen concern, spurred aldermen to many public health actions, including hiring chemist Frederick Mahla to conduct a “scientific chemical analysis of the river” ([Chicago City Council Proceedings Files 1862](#)). Mahla’s research took months, during which the odors continued to build and citizens grew impatient. As the Chicago Tribune opined, “We have had smelling committees enough, chemists enough, and theories enough . . . The public nose is just as sure an index” ([Chicago Tribune 1862](#)).

In Chicago before the creation of a permanent board of health, citizens and scientists were powerless to create change, as neither commanded the attention of the city’s government. Citizens filed private nuisance suits in court, sent petitions to city politicians, and published angry letters in newspapers, but none of these efforts materially changed the city’s atmosphere. When the city government finally acted on the stench, citizens saw chemical analysis as a delaying tactic, and Mahla could not convince the city

council to act upon his recommendations. This moment before organized public health was a lose-lose moment for citizens and scientists, as the government responded to neither group.

The creation of permanent boards of health staffed by physicians and scientists with regulatory powers brought citizens and scientists into direct contact and collaboration. In the nineteenth-century United States, many governmental powers were reserved for city and state governments; thus, the creation and powers of permanent boards of health varied significantly by location and local politics ([Duffy 1990](#)). In 1866, in the midst of a cholera epidemic, New York State's legislature created and appointed physicians and chemists to the Metropolitan Board of Health, the nation's first permanent health department to have regulatory powers for protecting health. Citizens redirected their complaints from local politicians to the chemists and physicians had been appointed as health officials with regulatory powers. Complaining citizens and government scientists collaborated as nearly equal partners; both used their noses to parse odorous breezes and follow stench to their sources, though government scientists decided on actions that would improve the local smellscape and, by extension, public health. Early actions restricted the location of industries away from populated areas, as had been common under nuisance law. Strong opposition from business owners and the rapid growth of urban populations were hurdles to such spatial regulation, hurdles that boards evaded by turning to less disruptive regulations that relied on emerging technologies and enabled industries to continue polluting ([Le Roux 2016a](#); [ibid., 2016b](#); [Cumbler 2001](#)).

As they collaborated, chemists and citizens did not exchange practices, but they adopted one another's language and references. Their shared vocabulary was evidence of a shared understanding and enabled further communication. For example, sulphuretted hydrogen was a frequent and shared topic of conversation in the 1860s and 1870s. Chemists tested for the presence of hydrogen sulfide using strips of paper moistened with acetate of lead, looking for the precipitation of black lead sulfide. Newspapers reported this chemical test as visual confirmation of the presence of sulphuretted hydrogen. Furthermore, reporters promoted the notion that sulphuretted hydrogen was "the essential element of all stench" ([Chicago Tribune 1862](#)). Citizens who had read about sulphuretted hydrogen recognized the same chemical reaction in foul-smelling environs. When lead paint darkened overnight in July 1873, the inhabitants of East Cambridge, Massachusetts immediately understood their walls as visual evidence of excessive sulphuretted hydrogen.

Massachusetts: Physicians *with* Authority

When the stench got so strong that houses changed color, citizens and chemists jointly petitioned the newly created Massachusetts Board of Health to regulate the local slaughtering industry. The Board, which had existed for four years but had regulatory powers for only two, convened a hearing to determine if the largest local slaughterer, John P. Squire & Company, produced the stench. This hearing brought local citizens and chemists together as smell detectives who, through a variety of methods, consistently traced the stench to the Squire's property. Citizens followed their noses in a process that they referred to as "tracing the odors": when they perceived a foul scent, citizens used their noses to pursue the odor to its source. Chemists also traced odors with their noses. In addition, chemists used papers soaked in acetate of lead and photographic plates cleaned with nitric acid to test for odorous gases emitted by the local waterway and by local businesses. Such analysis generated visual evidence and numerical data through which chemists compared the intensity and gaseous components of odors released by sewer outfalls, industrial dumping, and different parts of the slaughtering process. Squire's lawyers preferred the creation of numerical data

cross-referenced with dates and locations, a process which they named “fixing the odors” and portrayed as more precise than olfactory experiences ([Burpee and Robson 1874](#)). Despite attempts to claim greater precision for numerical data, both sides used their noses and relied on olfaction to explain changes in the neighborhood that residents and slaughterhouses shared.

When working together, whether that was against or in support of slaughterer John P. Squire, chemists and citizens reinforced one another’s conclusions through different ways of evaluating local environs. Citizens opened the hearing by providing testimony about the stench and health effects they had endured. Local chemists then produced samples for show-and-smell moments in which citizens sniffed and identified the samples. Such moments demonstrated citizens’ olfactory knowledge and accuracy in identifying odors, thereby giving odor tracing the same precision as odor fixing. Chemists then explained the contents of the samples, the chemical analysis they had conducted, and the chemical combinations these gases formed. These practices, deliberately performed before city politicians, health boards, and lawyers, are evidence of collaboration and of a recognized continuum of knowledge. East Cambridge’s residents and chemists had developed a clear codependence through which they upheld one another’s methods and conclusions.

Even against such tightly orchestrated collaborations, local industries were a formidable opponent because they had the resources to adapt to changing political structures. By the mid-nineteenth century, nuisance cases often favored industries because of their size; courts using social-cost balancing often determined that closing a factory would do greater harm to the local economy, in monetary terms, than the value of the harm to health ([Rosen 1993](#); [Hurley 1997](#); [Cumbler 2001](#)). When the Massachusetts Board of Health supplanted nuisance litigation, it refused to hear arguments about the importance of the slaughterhouse to the local economy, so industries shifted the terms of the debate. In response to the Board’s claim that pure air was necessary for health, Squire’s lawyers argued that cheap food and employment ministered to life itself and thus were more important than pure air ([Burpee and Robson 1874, 194](#)). This argument meant that the Board of Health was deciding not between healthful and insalubrious environs, but between the health of all East Cambridge residents and the lives of Squire’s employees. Furthermore, Squire hired chemists whose analysis supported different conclusions and noted that the “contrasts in the honest convictions of two careful gentlemen” were evidence of “the difficulties that surround this subject” ([ibid.](#), 235). Just as scientists disagreed, so too did area residents. Squire testified that when he traced the odors, his nose led him to the smaller establishments owned by his competitors. Presumably these businesses should be closed to protect public health—and eliminate Squire’s competition. By changing the terms of the debate and offering contradictory olfactory experiences, local power brokers like Squire outmaneuvered collaborative dissent.

Chicago: Power in the Courts

Citizens and scientists also performed collaborative dissent against the industries of Chicago, where power was dispersed differently than in Massachusetts. Although Chicagoans had been complaining since the early 1860s about ill health and industrial stench, especially those from the concentrated slaughtering operations in the city’s southwest, public health was low on local politicians’ agendas. As was standard practice in nineteenth-century cities, the government enforced health regulations only when threatened by an epidemic outbreak of disease such as cholera, effectively ignoring the unsanitary conditions that

contributed to typhoid and respiratory illnesses. Chicagoans tried to change this lax approach to public health when they restructured their government after the destructive fires of 1871 and 1874. The 1876 government reorganization established a permanent Department of Health led by physicians as health commissioners ([Bonner 1991, 184](#)).

The position of health Commissioner admitted scientists and physicians into Chicago's government, but did not give these new civic employees regulatory power. Thus when physician Oscar C. DeWolf moved from Massachusetts to Chicago in order to become one of the city's first Health Commissioners, he had to build political support for his initiatives. This was especially true after DeWolf blundered in an early interview about the source of the city's stench, alleging that neither slaughterhouses nor fat renderers produced late-night stench. This assertion contradicted widespread opinion and earned DeWolf negative publicity as an "ass" and "ignoramus" ([Chicago Tribune 1877](#)), who did not understand Chicago's atmosphere, industries, and environs. To salvage his reputation and address concerns about stench, DeWolf reached out to the Citizens' Association, a group of prominent citizens who were reforming city government and whose involvement lent credence to DeWolf's efforts. In an exchange of knowledge, DeWolf explained available odor control technologies and asked members of the Citizens' Association to systematically smell and record foul odors ([Citizens' Association of Chicago Records](#)). When DeWolf and the district attorney started indicting fat renderers for creating stench nuisances, members of the Citizens' Association testified about what they had smelled and where.

Chicago's "Stink Cases" played out differently than the Board of Health hearing in Massachusetts because power was arrayed differently in the two places. Massachusetts had granted the State Board of Health regulatory powers, but Chicago's nascent Board of Health had to rely on courts for enforcement of new measures. This meant that local judges and juries, rather than the health board's physicians and scientists, weighed the evidence and made decisions about businesses' effect on public health. DeWolf, as a Health Commissioner, could not decide when there was enough evidence to charge a business for harming health, as that was the district attorney's responsibility. This governmental framework contributed to DeWolf's collaboration with the Citizens' Association: after early failures, DeWolf invited apprehension of "respectable citizens" ([Chicago Department of Health 1879, 16](#)) who traced odors, collected evidence, and testified to their bodily knowledge before the Grand Jury. Without collaborators, the health commissioner could not provide enough evidence to convince the district attorney to file charges, a grand jury to issue an indictment, or a judge and jury to enforce health regulations.

Although they argued before different arbiters, lawyers pursued similar strategies in both hearings. In part, this was because they responded to similar witnesses in Chicago and Cambridge: citizens and chemists who shared different but complimentary ways of apprehending the environment. Whether witnesses complained about or defended local businesses, both sides introduced testimonies of olfactory experience and chemical analysis. In response to this united front, lawyers emphasized the subjectivity of olfaction and questioned the accuracy of conclusions based on chemical analysis in order to sow doubt.

Lawyers also tried to separate the citizens who contributed sensory evidence from the chemists' gaseous analysis, but this tactic failed differently in each place. In Massachusetts, where the State Board of Health was arbiter, witnesses contradicted each other by method of apprehension, meaning that chemists refuted chemists and residents disputed fellow residents. In Chicago, where local judges and juries weighed the evidence, the Board of Health and district attorney opposed business owners. Both sides produced and

interrogated witnesses who shared testimonies of olfactory experience and chemical analysis. In response to DeWolf's reliance on the noses of "respectable citizens" who already had the community's trust ([Shapin 1994](#)), factory owners called technicians and engineers to discuss odor-control technology, and asked why DeWolf "had not bottled some of the vapor (stink) and presented the jury with an analysis of it" ([Chicago Tribune 1878](#)). In other words, business owners asserted that the Board of Health had not been scientific enough when it invited citizens' olfactory apprehension.

Actions in both places resulted more from local power arrangements than from methods of apprehension and collaboration. Although Massachusetts' Board of Health had greater regulatory powers than Chicago's, the former did not rule in the case against Squire's slaughtering establishment because of an ongoing legal challenge to its regulatory authority. This meant that industrial activity continued as usual, as did the ongoing project of filling Miller's River in an effort to reduce stench. Looking back on this inaugural case a few years later, the Board of Health reported that the collaboration of chemists and citizens "fully proved that a very offensive odor emanated from the vicinity of the establishment of Messrs. J. P. Squire & Co." ([State of Board of Health 1875, 10](#)), but concluded that filling the basins and installing new technology had solved the issue without requiring regulation. In Chicago, where the Board of Health lacked regulatory power and relied on court rulings, the collaborations DeWolf initiated as Health Commissioner were successful at changing industrial practices. For the first time, local courts supported the Board of Health in restricting industrial practices. After forty-five minutes of deliberation, the jury sided with the collaborating citizens and chemists, and found fat renderers Mortimer Scanlon, Nicholas Conlan, Andrew Findley, and James Paxton guilty "of maintaining a public nuisance" ([Chicago Tribune 1878](#)), which resulted in a fine and a court-order to abate the stench. Business owners appealed to the state's supreme court, which also upheld the Board of Health's regulation.

New York: Collaborative Success

Collaborations effectively dissented against and changed industrial might to the degree that political power arrangements allowed, but outcomes should not be our only evaluation of inviting apprehension. As Board of Health scientists collaborated with citizens on evidence collection, this method became a regular practice of health boards across the country. These collaborations are evident not only in public hearings before health boards and legal courts, but also in the structure of annual reports. By including olfactory perception as well as chemical analyses, boards of health formally recognized a spectrum of knowledge in which chemical analysis supported citizen testimony.

When Herbert Turner knocked on Samuel Goldschmidt's door in 1878, Goldschmidt worked for the New York City Board of Health as Inspector of Offensive Trades. This position gave Goldschmidt the power to fine, suspend operations, or close businesses within New York City, which then consisted of Manhattan Island and the Bronx. Because Queens County and Brooklyn were still independent political entities, Goldschmidt and other board members lacked regulatory power over the businesses that were upwind of Turner's house. Goldschmidt likely knew that he would be unable to answer Turner's complaint to Turner's satisfaction, but the inspector joined the aggrieved citizen and the two men traced the smell together. Goldschmidt documented this moment of collaboration in his report to his superior, noting that they did not find the smell. Nonetheless, by considering Turner's description and comparing notes with other board

members, Goldschmidt concluded that industries in Brooklyn and Queens were at fault ([Grace Administration Subject Files 1881](#)).

Although Goldschmidt could not stop the stench, his actions legitimized Turner's concern and ensured that Turner and others like him would continue to complain to and collaborate with the Board of Health. Complaints and collaboration, in turn, enabled Goldschmidt and other board members to compile a record of stench that they did not have the power to abate because the stench-producer was located beyond their jurisdiction. This record had political value. Board of Health president Charles Frederick Chandler presented this record to the state legislature to argue that the limited authority of the city board made it impossible to protect air quality and health. The state legislature recognized that local boards of health were ineffective against air currents that crossed town and city borders, and created a state board of health in 1881.

Both in their approach and in their published reports, health boards reflected a spectrum of knowledge that privileged shared instrumentation and olfactory perception over chemical analysis. New York State's Board of Health continued the collaborative practices that city boards had begun by conducting public hearings, collecting citizen testimony, and hiring chemist Elwyn Waller to analyze the effluvia released by manufacturers. Board members also relied upon shared instrumentation; after gathering the olfactory evidence of locals, health board members used their own noses to investigate possible stench-producers. The state commissioners melded these methods in their official report on New York City's "effluvium nuisances." The commissioners included two physicians who worked closely with chemists, but the report opened with the commissioners' olfactory experiences closely followed by their collaboration with citizens ([State of Board of Health 1882, 338–42](#)). In drafting the report, the commissioners used Waller's chemical analysis to support the conclusions that commissioners and citizens independently made through their noses. An appendix included Waller's report as a reference ([ibid., 374–84](#)), but chemical analysis was secondary to olfactory experience in the board's conclusions and recommendations to the governor. This organization of evidence was convincing; Governor Alonzo Cornell accepted the state board's conclusions and ordered that "the causes of nuisances ... be ... removed or abated by the first day of June, 1881" ([ibid., 353](#)).

Waning Collaboration as Boards of Health Became Secure

In mid-nineteenth-century urban politics, while scientists were fighting for and obtaining positions of political and cultural authority, scientists regularly collaborated with citizens to change the problems that both groups perceived in their cities. Although it is unclear if politicians needed both citizens and scientists to decide on a course of action, the chemists and physicians on health boards needed and regularly incorporated citizens in their efforts to protect health. These collaborations made health officials more effective at identifying problems in industrial practice, even if changes did not come as quickly or as fully as many collaborators hoped.

The same historical materials that record these collaborations also reveal their eclipse. While noses enabled collaborations, this shared diagnostic tool was only an asset during collaborative periods of scientific-authority building, after which it became a liability for scientists' political power. Once boards of health were established within government, the continued existence of stench enabled citizens to question health boards' efforts and efficacy. New York City's Board of Health seemed secure by the 1870s, until

citizens led by stock broker Thomas B. Musgrave traced odors from their homes to sources in Manhattan ([Musgrave 1878](#)). Based upon Musgrave's nose, New York City district attorney Benjamin K. Phelps charged the Board of Health in 1878 with the misdemeanor offense of "unlawfully, willfully and contemptuously neglect[ing] and refus[ing]... to abate and suppress" stench nuisances ([Chandler Papers 1878a](#)). In response to this threat to their political authority, the board's physicians and scientists changed the relative importance of bodily evidence. Board president Chandler complained that "citizens are very poor smell detectives" and asserted that chemists were better able to identify odors' sources because of their scientific training and experiences ([Chandler Papers 1878b](#)). According to Chandler, chemists did not possess superior technology but had, through laboratory experiences with an array of chemicals, learned to identify odors better than the average citizen ([Schaeffer 1988](#); [Roberts 1995](#)). Chandler made his rhetoric about chemists' superior noses a reality when he deputized chemists as the Inspector of Offensive Trades and when he used Goldschmidt's reports to lobby for the creation of New York State's Board of Health.

Collaborations also deteriorated because of courtroom challenges to olfaction. The same hearings and reports that included citizens' olfactory testimonies alongside chemical analyses shifted from using chemistry in support of olfactory perception to preferring chemical knowledge. As also occurred when nineteenth-century courts turned to scientists to identify bloodstains, legal questions added pressure to ongoing scientific debates over olfaction and vision. Neither courts nor scientists resolved these debates; instead, both employed human senses until new methods offered alternatives to olfaction and vision ([Golan 2000](#); [Bertomeu-Sánchez 2015](#)). In public health, lawyers' insistence on verifiable evidence privileged numerical and visual data that everyone could see and discuss ([Kiechle 2017, 198–232](#)). Chemical reports and measurements fit these criteria, as did stench maps and photographs of smoke. By the 1890s, these types of evidence supplanted olfactory experience and those who testified to it. As a result of the evidentiary change, further collaborations relied upon different methods and instrumentation rather than sharing apprehension ([Stradling 1999](#)).

Contemporary Relevance

The institutionalization of scientists as professionals, which accelerated at the end of the nineteenth century, created the gulf between scientists and lay citizens that citizen science now attempts to breach. The recognition, particularly in environmental and health sciences, of the value and validity of lay observations marks a return to an older model of science, in which the boundary and power differential between professional scientist and lay citizen was more fluid than today. Before and during the nineteenth-century professionalization of science, individuals across the social spectrum collected data and contributed observations. The shared instrumentation and understanding reduced barriers between citizens and scientists, and new political structures encouraged collaboration.

Current citizen-science efforts can learn much by examining the cultural and political forces that made these collaborations work and the power relations within which collaborating citizens and scientists dissented. As Max Liboiron has argued about intellectual property, agency is compromised by the power relations and institutional structures which ostensibly enable its exercise, so we need to make power explicit in citizen science ([Liboiron 2017](#)). The tradition of nuisance complaints, and political changes that created boards of health, fostered collaboration between citizens and chemists. Citizens held power in these early collaborations because of the tradition of nuisance complaints and because they shared instrumentation and

language with chemists. In this reciprocal relationship chemists validated citizen knowledge, and citizens validated chemists' analyses and conclusions. The recognition of a continuum of knowledge, in which both citizens' noses and chemists' tests offered valuable information, also reinforced and encouraged collaboration.

Shared instrumentation was key to collaboration, but so was shared space. Turner called at Goldschmidt's home in New York; Harvard chemist Charles E. Monroe analyzed his own town of Cambridge with and for aggrieved citizens; as a newcomer to Chicago, DeWolf created an alliance with longtime residents. In all three of these cities, chemists and complainants lived in the same neighborhoods and breathed the same air. Proximity created conversations and comparisons of knowledge, as did the attendance of chemists alongside citizens at indignation meetings, city council meetings, and before state governments. Yet in poorer neighborhoods, such as the laboring communities of Chicago's Back of the Yards and Packingtown, there were few scientists in residence and little collaboration during this period. Governments seldom if ever responded to the complaints of laboring citizens in such class- and racially-segregated neighborhoods, and the neglect of these areas created environmental injustice that continues to this day ([Washington 2005](#)). Effective collaborations occurred most readily when scientists were already in the community to share methods of apprehension with neighbors, friends, and fellow citizens. Geographic space could encourage or compromise agency.

The regulatory apparatus was also central to collaboration, as it created avenues within which citizens and scientists could address the state. Under nuisance law, citizens directed their complaints to politicians who rarely consulted scientists. In the early years of organized public health, health boards brought scientists and citizens together in two spaces: on city streets, where chemists and citizens collected olfactory information, and in the courtrooms and official reports where chemists and citizens presented their knowledge of environment and health. The power structures of these institutions determined the successes of collaborations in changing industrial practices. The decisions made by politicians, courts, or health boards, and the ability of those arbiters to enforce their decisions, determined both changes in industrial practice and in further collaborations. Collaborative dissent was a first step in protecting public health by changing the urban environment.

We often want lessons from history that we can implement today, but that is rarely possible. The collaborations discussed here resulted from a particular confluence of political and cultural factors, all of which have changed since the mid-nineteenth century. While nuisance law still exists, the colloquial definition of nuisance has changed from 'that which harms bodies or property' to 'something irritating,' which means that nuisance complaints no longer demand a response to health threats ([Morag-Levine 2003](#)). Furthermore, at the end of the nineteenth century, the germ theory of disease changed health threats from miasma theory's airs, vapors, and fumes to microbes, bacteria, and viruses. In the twentieth century, odors were categorized as not threatening to health ([ibid., 2003](#)). The professionalization of public health has given health officials power and authority over citizens, disrupting the continuum of knowledge that enabled early collaborations. Twentieth-century zoning ordinances and suburbanization also disrupted the proximity that enabled collaboration as they further divided cities by race and class. Even the bodily practice of smelling and interpreting odors changes over time ([Elias 2000](#); [Jenner 2011](#); [Chiang 2004](#)).

Contemporary efforts to monitor air quality by crowdsourcing olfactory impressions do not invite apprehension in the same way that nineteenth-century collaborations did because they do not approach all

noses as equally capable, or olfaction as an inherently valid measure. Just as Chandler claimed that scientific training made chemists better smellers, twentieth- and twenty-first-century science insists that humans, despite being ‘the quintessential sensory analyzers,’ require training and standardization to produce useful sensory evaluations ([Burlingame et al. 2017](#)). Sensory science in the food and water industry begins not by collecting perceptions, but by training how to inhale and evaluate odors, including what descriptors to use ([Berenstein 2018](#); [Burlingame et al. 2017](#); [Dietrich and Burlingame 2020](#)). Similarly, citizen-science efforts to crowd-source olfactory perceptions, such as Smell-PGH in Pittsburgh, Pennsylvania, and D-NOSES in the European Union, calibrate the crowd’s noses to a particular set of odor descriptors rather than collecting all olfactory experiences. Other projects begin by training citizens’ noses to conduct urban smellwalks ([Quercia et al. 2015](#); [McLean 2017](#)) or to rate odor intensity by smelling through an olfactometer ([Dalton et al. 2011](#)). These practices seem to “invite apprehension” but actually attempt to convert olfactory perception into numerical data, illustrating many of the problems that scholar Gwen Ottinger has identified in crowdsourcing science for environmental justice ([Ottinger 2017](#)).

If we hope to invite apprehension and foster collaborations moving forward, we must recognize the many factors in government, scientific practice, and society that made this possible for a few decades in the nineteenth century, as well as how these factors have changed since then. Paying attention to the issues of trained noses, power imbalances, disease etiologies, and changes in governance will help those engaged in citizen science to identify possibilities for collaboration, and widen those efforts beyond their nineteenth-century antecedents, hopefully to even greater effect.

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