



## Exposure science in an infectious disease pandemic: who do we want to be?

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The coronavirus pandemic has been described as a “watershed moment” for exposure science [1]. Notwithstanding the clear relevance of our techniques, perhaps this pandemic is also an opportunity to reflect thoughtfully on our contribution to the greater public health effort. From March 20 through September 2, CDC recorded 96,385 new scientific citations on Covid-19—at a dizzying rate of 17,892 papers/month [2]. Perhaps this is not a moment for just *more* science, but rather for high-quality, targeted science supportive of current public health priorities.

The challenges of this moment are political and social, even more so than scientific. As such, we need to ask not only what we bring to the table, but, humbly, whether that contribution is genuinely helpful and relevant when nerves are frayed, and attention is scant. Is it worth, for example, complicating the story on mask selection [3, 4], potentially sowing seeds of doubt, when a huge portion of Americans already refuse to wear one? Is it helpful to raise alarm about indoor air pollution [5], when we desperately need more Americans to just stay home? While we certainly don’t support opportunistic rollbacks of environmental regulation [6], can governments really curb this illness by focusing on urban air quality, rather than on the spread of the virus itself? [7]

There is no question that we have much to contribute on the benefits of exposure mitigation strategies—mask-wearing, distancing, gathering strictly outdoors—and we understand the underlying particle dynamics. But the reason exposure science has not been more prominent, I believe, is that we’ve too long ignored the “human” half of our “human–environment interface.” The current pandemic has made the “silo”-ing of our field more apparent, and

in forwarding our own agendas (or careers) without asking how our message may be received, and how it contributes to the greater cause, we risk muddying the waters while lives are at stake.

Each year, I tell my fresh-faced students that exposure science is the study of the “human–environment interface;” that we aim to understand, quite literally, how the environment gets under the skin. I then launch into 20 lectures on monitor allocation, Gaussian plumes, and depth-integrating samplers. Where is the ‘human’ in our science? Naturally, I wrap up with a week on “nonchemical stressors”—a catch-all for everything outside our traditional realm—the noise that accompanies pollution sources, the poverty that drives source allocation—paying scant attention to centuries of sociology and decades of social epidemiology that came before. Further, because the term “nonchemical stressor” is self-coined (to distinguish these factors from our traditional bread-and-butter), it doesn’t exist outside our realm; literature searches and reviews based on this terminology, or on selected commonly-studied stressors [8] paint us into a corner, identifying only that evidence which lies within our familiar domain—contained, knowable, safe.

The pandemic we face is mind-bogglingly complex, as human free agents make daily and hourly decisions about face-to-face interactions with other free agents. Do I go to the grocery store, or eke by one more day? Do I visit friends, outdoors, six feet apart? Can the kids visit grandma, now that they’re back in school? In infectious disease, humans are both vector and subject, operating in an infinite network of free agents, all acting with imperfect and unequal (mis)information. This profoundly complex social networks [9] and health behaviors problem [10] is one that we, as exposure scientists, don’t have the tools to assess. We lack the health behavior expertise to understand *why* people make the decisions they do, and the risk communications expertise to incentivize behavior change. We haven’t tended to explore the motivations behind human behaviors, but only to record them via time-activity diaries or GPS tracking, assuming

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the sampling week is representative of any other (an assumption rendered obsolete when a pandemic upends everyone's daily routine).

I'm not arguing that exposure scientists need become social scientists, but we need to find a path out of the corner we've painted ourselves into, and be cognizant of whether and how our contribution supports the greater public health goals. We do so by following the lead of infectious disease experts, accessing expertise well outside our ranks, making friends with academics who speak a very different language, and humbly asking the simple questions. We don't know how to model social networks [9]—but sociologists do. We don't know how people make decisions under constraints [11]—but this is the stuff of economics. We don't know why someone tries on a mask—but this is what health behaviorists have dedicated their careers to [10]. Even health geography—the study of how people experience and negotiate the physical world, as relates to health [12]—offers innumerable insights, but rarely are exposure scientists in attendance at geography meetings.

Finally, we must challenge ourselves, question our own motives, and ask how any given message contributes to immediate public health needs. Muddying the waters with contradictory or under-developed data, or stealing the thunder of infectious disease experts—themselves fighting to be heard amidst a cacophony of misinformation and political gridlock [13]—is counter-productive. Perhaps it is wise and responsible for exposure science not to rush forward in a “watershed” moment, but to take a half-step back, own our supporting role, catch our breath, build some new intellectual relationships—and be better prepared for the next round. It's coming.

### Compliance with ethical standards

**Conflict of interest** The author declares that she has no conflict of interest.

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