

Science as Experience:
A Deweyan Model of Science Communication

Megan K. Halpern
Michigan State University

mhalpern@msu.edu

Kevin C. Elliott
Michigan State University

kce@msu.edu

Abstract

The field of science communication is plagued by challenges. Communicators face the difficulty of responding to unjustified public skepticism over issues like climate change and COVID-19 while also acknowledging the fallibility and limitations of scientific knowledge. Our goal in this paper is to suggest a new model for science communication that can help foster more productive, respectful relationships among all those involved in science communication. Inspired by the pragmatist philosophy of John Dewey, we develop an experience model, according to which science communication consists in people's experiences with science and the meanings they develop from those experiences. Three principles are central to the model: experience is cumulative, context matters, and audiences have agency. We argue that this model has significant implications both for communication research and practice, which we illustrate by applying it to the phenomenon of vaccine hesitancy. We show how science communicators can help to identify and alleviate structural factors that contribute to skepticism as well as fostering opportunities for meaning making around shared experiences.

1 Introduction

The COVID-19 pandemic of 2020 has highlighted challenges that have plagued the field of science communication for several decades. In numerous cases, including genetically modified foods, climate change, vaccines, and finally the pandemic, commentators have lamented the ways that lay people have seemingly disregarded the input of scientific experts (Augustine, 1998; Duncan, 2007; Letzter, 2017; Mooney, 2015). At the same time, others have contended that it is unwise to frame this situation too pessimistically or dismissively. Rather than focusing on the apparent scientific ignorance of many lay people, science communicators have increasingly highlighted the distinctive values and expertise that those outside the scientific community can bring to the table (Epstein, 1996; Goldenberg, 2016; Hicks, 2017; Wynne, 1992). Building on these insights, the literature in science communication over the last decade has abounded with efforts to promote dialogue, engagement, and participation between scientists and publics (Bauer et al., 2007). Nevertheless, there has still been a lingering sense that many of these efforts fail to fulfill their potential because of the tendency to revert to a dismissive mindset that focuses primarily on convincing members of the public to change their attitudes or behaviors (Suldovsky, 2016).

Our goal in this paper is to suggest a new model for science communication that can help foster more productive, respectful relationships among all those involved in science communication. Central to our model is a shift away from viewing science communication as an exercise in transferring information and toward viewing science communication in terms of experience and meaning-making. To develop this model, we draw on John Dewey's account of experience, grounded in his pragmatist philosophical worldview. By utilizing a model for science

communication that focuses on experience rather than information transfer, we argue that both communication scholars and practitioners can develop new insights for grappling with seemingly intractable science communication challenges.

In the next section, we contextualize the paper by describing previous models of science communication and the struggles to move beyond the view that the public primarily needs to be given more information. In Section 3, we introduce Dewey's philosophy and his conception of experience. Building on Dewey's account of experience, we present our new model of science communication and its distinctive characteristics in Section 4. Finally, in Section 5 we examine debates about vaccines through the lens of this model in order to illustrate its power to reframe science communication research and practice.

2 Beyond Information Transmission

In our view, the most important virtue of the experience model that we develop here is the way it recenters attention away from information transfer and toward meaning-making. To highlight the importance of this shift, we begin the paper with a brief review of previous work in science communication and its relationship to our new model. We view science communication as a set of activities, practices, interventions, scholarship, and ideas that structure the relationship between the sciences and various publics. It encompasses several sub-disciplines, including public policy for science and technology, science journalism, informal science learning, and research into behaviors and attitudes about science. Much science communication research in the United States has focused on quantitative studies of public attitudes and understanding about science as well as trust in science (e.g. Besley, 2013; Newman et al., 2018). Some science communication research also flows from scholarship in the field of STS, including work on lay

expertise (e.g. Collins and Evans, 2008; Irwin, 1995; Wynne, 1992) and on public responses to scientific controversies (e.g. de Melo-Martin and Intemann, 2018; Goldenberg, 2016; Hicks, 2017).

But science communication includes more than research; it also includes practice. Science communication practitioners range from scientists who are involved in outreach and engagement (a sometimes fraught area) to museum educators. Some have noted a sharp divide between research and practice, wherein researchers seem to be writing in peer reviewed journals to each other without understanding the challenges practitioners face, and practitioners are not drawing on the latest research when they design interventions and create messages (Maynard and Scheufele, n.d.; National Academies of Sciences Engineering, and Medicine, 2017). In order to bridge this divide, it is important to keep both research and practice in mind when evaluating and developing models for science communication.

Central to both these aspects of science communication over the past forty years has been the demise of what is typically called the “deficit model” (Miller, 2010). This model may be best exemplified by the influential Bodmer Report released by the British Royal Society in the mid-1980s (Bodmer, 1985). The Bodmer Report asserted a greater need for public understanding of science. According to the report, this meant the public writ large should comprehend “not just the facts of science, but also the method and its limitations as well as an appreciation of the practical and social implications” (p. 6). Although this report was central to generating a new focus on promoting “public understanding of science,” it was really the culmination of a longstanding focus on promoting science literacy and public interest in science that was prevalent throughout the Western, English-speaking world (Bauer et al., 2007). Throughout the

Cold War, the space race, and the drive to promote nuclear power and weaponry, the US had also been focusing on big government-funded scientific projects and the urgency of fostering a public that was knowledgeable and supportive of such endeavors.

This focus on public understanding of science ultimately came under withering criticism, however, as scholars labeled it the “deficit model” and challenged its presuppositions (Miller, 2010; Suldovsky, 2016; Trench, 2008). One of the most important criticisms is that it fails to take account of the “local knowledge” that many actors outside the professional scientific community bring to science policy issues (see e.g. Corburn, 2005; Irwin, 1995; Wynne, 1992). Another problem is that it presumes that public opposition to science-related initiatives stems from a lack of understanding rather than differences in goals, values, or perspectives (Douglas, 2009; Elliott, 2017; Goldenberg, 2016; Hicks, 2017). In general, the deficit model has come to be regarded as patronizing, simplistic, and ultimately ineffective, even on its own terms (Nisbet and Mooney, 2007; Priest, 2001; Sturgis and Allum, 2004).

In response to the weaknesses of the deficit model, science communication researchers and practitioners have launched numerous efforts at public engagement, which we will subsume under the label of a “dialogue” model (Bauer et al., 2007; Trench, 2008). The dialogue model suggests that rather than focusing on educating people about science, communicators and policy makers need to enter into a dialogue with members of the public. As then AAAS CEO, Alan Leshner wrote in a 2003 editorial for *Science*:

We need to move beyond what too often has been seen as a paternalistic stance. We need to engage the public in a more open and honest bidirectional dialogue about science and technology and their products, including not only their benefits but also

their limits, perils, and pitfalls. We need to respect the public's perspective and concerns even when we do not fully share them, and we need to develop a partnership that can respond to them. (Leshner, 2003)

While the intent behind this call for engagement is positive, however, the practice has not turned out to be so simple. After a couple decades of work with the dialogue model, some of its major strengths and weaknesses are becoming clear (see e.g. Trench, 2008). At its best, the dialogue model has the potential to bring scientists and policy makers together with other stakeholders and community members to share their varied perspectives and forge mutual understanding (see e.g. O'Rourke and Robinson, 2020). When it works well, it has much in common with the experience model that we propose here, insofar as it provides an opportunity for sharing the experiences and meanings that different groups bring to scientific controversies. However, even when practitioners or facilitators are committed to authentic, two-way dialogue, the existing power structures within which these efforts exist do not melt away. Audiences and members of the public are not always comfortable with the kinds of discursive practices in which scientists and policy makers are well-versed. Opportunities for dialogue also tend to attract and uplift the most passionate, and often most extreme, perspectives. And finally, the dialogue model has the potential to downplay the agency of members of the public who are not engaged in dialogue.

Those seeking to work with the dialogue model can also easily fall back into deficit thinking, such that they regard dialogue primarily as a strategy for persuading people to accept scientific information (Wilsdon et al., 2005; Wynne, 2006). As Brianne Suldoovsky puts it in a recent article on the persistence of the deficit model, "...diffusion is the most ubiquitous conception of communication in science communication scholarship. As long as communication

is viewed as the diffusion of scientific information, the deficit model will continue to be predominantly (and inappropriately) utilized” (2016, p. 423). One has only to consider the well-trod metaphor of upstream and downstream communication to appreciate the persistence of this focus on diffusing information. While its intention may be to promote the importance of two-way communication, the metaphor hinges on information flowing up- and down-stream. It also provides a telling vision of how power structures and infrastructures shape dialogue.

We have the same intuition as Suldozsky: as long as science communication is focused on transmitting information, it will continue to fall into problematic patterns that are reminiscent of the deficit model. We use the term “information” broadly to refer to propositional content; this content could involve a wide assortment of things, including facts, descriptions, explanations, or questions. We contrast this concept of *information* with the concept of *meaning* (see e.g., Wynne 2003), which we describe further below. This is not to say that information plays no role in science communication (Suldozsky, 2016; Trench, 2008). Information is always part of any communicative interaction, but the ways it is incorporated, interpreted, and made meaningful vary depending on the context. Focusing on information alone provides, at best, an incomplete view of science communication that yields very limited insight into how people engage with science and how controversies arise. Moreover, focusing primarily on information leads to practices that disenfranchise people who do not have what appears to be relevant information. At its worst, focusing science communication on information transmission leads to encounters that inflame tensions rather than helping to resolve problems.

Despite the dialogue model’s efforts to move beyond these problems, it still tends to focus on bidirectional or multidirectional transmission of information. As a result, it continues to

miss features of science communication that transcend information, it still disenfranchises people when they are not providing information, and it provides limited resources for addressing scientific controversies. This is not to say that there are not rich and compelling examples of science communication that were developed within the model. It suggests, rather, that the model itself does not provide a complete understanding of what happens in these cases; it does not place enough attention on the historical and contextual factors that shape how audiences engage with scientific information. We contend that the field of science communication would benefit from having a model that moves decisively away from a focus on information in order to provide a clear alternative to the deficit and dialogue models. Our experience model is designed to provide this alternative. To flesh it out, we turn to John Dewey's exploration of the nature of experience.

3 Pragmatism and the Experience Model

We believe that Dewey's pragmatist account of experience provides a compelling basis for our proposed model of science communication. He begins with a pragmatist account of human knowers who are situated in the world. For Dewey, our conceptions of reality are rooted in our experiences, which are meaningful interactions between ourselves and that which we experience. Dewey wrote extensively about experience throughout his career, most notably in three works: *Experience and Nature* (1925), *Art as Experience* (1934), and *Experience and Education* (1938). The experience model that we develop here relies primarily on Dewey's conception of aesthetic experience as explained in *Art as Experience*, though it is informed by his other discussions of experience in education and nature.

An aesthetic experience, which Dewey also calls a vital experience, an integral experience, and simply *an* experience (as opposed to experience in general, which Dewey

defined as a constant state of interaction with the world) occurs when “the material experienced runs its course to fulfillment” (Dewey, 1934, p. 36). In other words, it feels somehow complete. For Dewey, experiences are at the heart of human endeavors and interactions, and the cumulation of these experiences shape lived experience--the sum total of an individual’s experiences. An experience can be long or short, positive or negative, inconsequential or transformational, but the unifying feature of all experiences is their sense of fulfillment or completeness. This culmination of an experience allows it to become meaningful and distinct from the constant state of experiencing the world. As Dewey says, “then and only then is it integrated within and demarcated in the general stream of experience from other experiences” (p. 37). Experiences invite reflection and meaning-making. For science communication, this account of experience suggests that researchers and science communicators should be interested not in what publics understand about science, but in what meanings they make of their experiences with science.

To flesh out the implications of Dewey’s account of experience for science communication, we suggest three principles that emerge from his work. The first is that experience is cumulative. By this we mean that each experience is shaped by previous experiences and, in turn, shapes subsequent experiences (Dewey, 1916). The second is that context is central to experience. While Dewey suggests that an aesthetic experience consists in an interaction between an object and an individual, he maintains that the interaction is shaped both by prior experiences and the current context. Mood, location, relationships with others, and even the weather can all be part of an experience (Dewey, 1934). Finally, Dewey’s account of experience shows that audiences have agency (Dewey, 1934). The object of an audience’s attention does not provide an experience on its own, but rather the experiences happen through the interaction between the person and the object (Dewey, 1934). Humans engage with and

interpret the world through their own lived experience, so they have agency in choosing what they attend to and how they interpret the object or event, thereby making meaning from the interaction. It is therefore not possible to “give” someone an experience without their involvement. Instead, encounters provide opportunities for people to have experiences.

One of the strengths of this account of experience is that it is guided by democratic principles. According to Dewey, nobody has direct knowledge of objective reality, but everyone has meaningful experiences of the world. His pragmatism encourages a vision of all human experience as being more or less equal. This does not imply a rejection of scientific expertise, but it does require scientific expertise to be regarded as one form of experience among others. Because pragmatists like Dewey rejected a strong distinction between the theoretical and the practical, they insisted that philosophers and scientists ultimately make sense of the world in the same experiential ways as everyone else (Brown, 2020).

Admittedly, the notion that all human experience is more or less equal might seem too idealistic and optimistic for our current moment in history. Dewey did not consider the difference in the quality and nature of experiences for marginalized and vulnerable people and classes, and he did not articulate the ways that his experiential view of the universe could lead to fractured realities. When scientists and publics attempt to communicate, they sometimes do so within and across deep divides caused by lack of common experiences coupled with the false and misleading claims of bad actors (Nguyen, 2020; Oreskes and Conway, 2010). Dewey did not account for meanings made in the midst of repeated and prolonged experiences with misinformation and disinformation. Nevertheless, we can use Dewey’s framework as a helpful lens for explaining and exploring our current social conditions, particularly the sense that we are

living in an increasingly fragmented society. By paying attention to people's differing experiences and meanings, we can better understand the basis for our misunderstandings and disagreements, and by seeking to form experiences together we can potentially develop shared meanings that enable us to create a more successful democracy (O'Rourke and Robinson 2020).

4 Experience and Science Communication

Although we do not claim to follow all the details of Dewey's account, we draw on Dewey's ideas about experience as a source of inspiration for developing a model that helps to reframe contemporary conversations about science communication. According to this model, science communication consists in people's experiences with science and the meanings associated with those experiences. Our three principles inspired by Dewey's account of experience then provide a roadmap for working within the experience model.

Building on these three principles, the experience model has the potential to be both rich in theory and useful in practice. From a theoretical perspective, the model offers a lens for characterizing all encounters with science in terms of experience. By doing so, it raises a number of new research questions and areas of focus for science communication. From a practical perspective, it offers guidance for understanding communication challenges and for developing novel approaches to communication. These practical benefits flow from analyzing the experiences and meanings of different community members, and they offer alternative approaches to developing objects for science communication. The experience model does not focus on the instrumental aims of trying to persuade or impart information; rather, it shifts the focus to sharing experience and meanings. As such, it is less straightforwardly prescriptive than

other models, and it puts a different inflection on the idea of success. Where traditional models focus on outcomes to determine success, this model focuses on the process itself.

Science communication is uniquely suited to gain from this model because science enjoys an epistemic place of privilege relative to most other fields, and this privilege translates into significant social power. This imbalance of power permeates the existing models of science communication and can contribute to conflict and mistrust of scientific experts. Thus, Dewey's idea of experience can play a particularly important role in the context of science communication because it is infused with a commitment to democratic ideals that can provide a valuable corrective to previous models.

To describe the experience model, we will first clarify its key concepts, then elaborate on the three major principles that stem from those concepts, and finally identify some of its major implications for science communication research and practice. Following this explication of the model, we will illustrate some of its implications in the next section with our case study of communication in the context of vaccine controversies.

4.1 Communication in the Experience Model

To reorient science communication so that it focuses on experience requires a deep shift in the meaning of communication. Craig (1999) outlines seven traditions of communication research and suggests that, taken together, these different traditions form the field of communication, within which we may engage in a metadiscourse. Each tradition conceptualizes communication in its own way, and each is interdisciplinary and draws on other fields, such as philosophy, sociology, or psychology, which help provide it with its own set of preferred

theories and methods. These traditions form a field rife with overlaps and tensions but rich in possibilities.

While science communication theory tends not to engage deeply with the roots of these traditions, its existing models arguably draw most heavily on the rhetorical tradition, which focuses on the art of persuasion, and the sociopsychological tradition (the basis for the majority of mass communication research today), which draws on social scientific research to uncover the ways social interactions produce cognitive, emotional, and behavioral effects.

Conceptualizing science communication in terms of experience means invoking traditions not often at the heart of science communication research, such as the phenomenological and, importantly, the sociocultural tradition. The phenomenological tradition focuses on in-person communication as experience rooted in a shared, socially constituted lifeworld. The sociocultural tradition, which finds some of its origins in Dewey's pragmatism, focuses on the existing social structures and cultures within which communication happens. Craig characterizes the sociocultural tradition as one heavily influenced by sociology and anthropology, in which methods like ethnographic studies provide empirical grounding (as opposed to survey or experimental research, which permeate the sociopsychological tradition). The sociocultural tradition takes communication as "a symbolic process whereby reality is produced, maintained, repaired, and transformed" (Carey, 1989, p. 23). Craig notes the ways interactions are deeply contextual:

Our everyday interactions with others depend heavily on preexisting, shared cultural patterns and social structures. From this point of view, our everyday interactions largely "reproduce" the existing sociocultural order. (Craig, 1999, p. 144)

At the same time, the sociocultural tradition recognizes the production, not just reproduction, of culture as a process that occurs over time. As Craig notes:

A central problem of sociocultural theory is thus to find the right balance, that is, to sort out the complex relations between production and reproduction, micro and macro, agency and structure, particular local culture and universal natural law, in social life. (145)

Thus, in the experience model, we include in our conception of science communication any interaction with messages or objects that contain or invoke meanings associated with the sciences (including medicine and technology), even when they do not involve the more direct person-to-person interaction often associated with other communication traditions. These interactions could include labels on medications and foods, advertisements and commercials, doctor's visits, conversations with IT professionals, news that tangentially involves science, television shows and films that represent science and scientists. They might also include what would be considered purposeful science communication, such as science journalism, popular science books, science museums, and popular media about science, like National Geographic Television. This broad definition allows us to focus not only on purposeful communication by scientists or science communication practitioners, but also the myriad encounters we have on a daily basis that draw on or connect to meanings we've made about science.

4.2 Meaning in the Experience Model

The experience model is predicated on the idea that experiences (as opposed to simply experiencing) involve interpretation and meaning making. The focus on meaning is the key distinction between information transfer models and an experience model. Rather than building

research or practice around propositional content that people know or believe about a scientific concept or issue, the experience model suggests building research and practice around what the concept or issue means to people (see e.g. Wynne, 2003). In our view, meaning consists in the broad significance that an experience holds for someone. Although much of this significance could, in principle, be described in propositional terms, the meaning itself involves non-propositional phenomena such as the felt connections between an experience and other aspects of a person's life; the affective nature of the experience; the range of people and places that an experience calls to mind; the previous experiences that affect how someone interprets a current experience; and the ways an experience affects one's future goals, attitudes, and aspirations. The process of generating these meanings is an active one (although not always fully intentional); as in Dewey's treatment of aesthetic experience, people interpret their experiences with science through the lens of their prior experiences. Thus, interpretation and meaning making are indicators of having had an experience.

When we take these phenomena to be the core of science communication instead of propositional content involving beliefs or knowledge claims, we shift the focus of science communication research to understanding the meanings associated with people's experiences with science. For example, as we show in the next section, the question is no longer why someone believes or disbelieves scientific information about vaccinations, but rather, what does vaccination mean to them? To be clear, the question is not what information about vaccination means, but rather what vaccination itself means. Information is part, but not the whole, of experience and meaning-making.

In terms of practice, the most cutting-edge trainings about how best to communicate science generally suggest strategies that draw on the use of narrative, imagery, and other traditionally affective forms of expression as ways to maximize opportunities for understanding. We agree that these non-discursive aspects of communication are deeply important to science communication, but the experience model characterizes them as much more than mere tools or tactics to help fulfill information-centric goals. Narrative, song, visual images, and the like do far more than deliver scientific information. When viewed through the lens of an experience model, the richness of these activities become clearer because they can be appreciated as integral to experience and meaning making rather than as tools for conveying information.

4.3 Shared Experience and Shared Meaning

Although the experience model of science communication is compatible with individual and singular experiences and meanings, the sociocultural tradition emphasizes that communication typically involves shared experiences and meanings. In this tradition, meanings are woven into the cultural patterns and shared structures that are produced and reproduced through communication. Since so much of culture is produced to share en masse, it is safe to say that many people have similar experiences with the same objects. That is to say, people with similar lived experiences encounter the same expressive object and find similar meanings. Similarly, much of science communication goes beyond individual experiences or one-on-one conversations. Experiences of science communication often involve mass media, in which individuals have their own experiences with texts or objects available in multiple formats across vast distances. Many are public experiences, like museum exhibitions that happen with other

people. Still others are conversations and engagements that involve direct communication among a group of people.

Certainly there are experiences that are singular, that happen alone, for example, in nature. But these experiences still become part of lived experience and still provide context for all other experiences. And these experiences can still be shared, insofar as they are experiences with the same text, object, or event in some way, even if they are not identical. Each person's experience of an event will be unique because no two people share identical prior experience, and no two people will interpret an event identically. But many aspects of different people's experiences with the event will still be shared because of the similarities in their past experiences and the meanings they have developed from them. This potential for communities to share experience and meaning is important because it facilitates efforts at collaboration and shared decision making. One of the experience model's valuable contributions is to help science communicators diagnose and address situations where experiences and meanings are not shared and thus where it is much more complicated for different groups to work together.

James Carey, who drew heavily on Dewey's pragmatism, especially the contingency of "reality" on interpretation and meaning, offers insight into the role that shared experiences can play in the experience model of science communication. He says that while the transmission view of communication has been ever present in our minds, an older *ritual view* is just as important to how we understand communication. He describes the ritual view as "directed not toward the extension of messages in space but toward the maintenance of society in time; not the act of imparting information but the representation of shared beliefs" (15). Similarly, he states:

If the archetypal case of communication under a transmission view is the extension of messages across geography for the purpose of control, the archetypal case under a ritual view is the sacred ceremony that draws persons together in fellowship and commonality. (15)

Carey used the example of reading a newspaper to illustrate how a ritual view would conceptualize communication, though scrolling through social media might perhaps be a more apt example in the 21st century:

[The ritual view] will, for example, view reading a newspaper less as sending or gaining information and more as attending a mass, a situation in which nothing new is learned but in which a particular view of the world is portrayed and confirmed. News reading, and writing, is a ritual act and moreover a dramatic one. (16)

Carey goes on to suggest that though knowledge acquisition occurs, the fundamental meaning of reading the news is ritual, habitual, and historical. The news changes little yet it is satisfying (like an experience) to read the news (or feed) each day. Like so many other rituals that are part of our daily routine, the news is “a presentation of reality that gives life an overall form, order, and tone” (17). Further, the ritual view emphasizes the communal nature of communication. Here Carey draws on Dewey himself to explore the communicative nature of the ritual view:¹

¹ In this passage, Carey is pointing toward the ways scholars contradict themselves as they move between transmission and ritual views of communication.

There is more than a verbal tie between the words common, community, and communication. Men live in a community in virtue of the things which they have in common; and communication is the way in which they come to possess things in common. What they must have in common... are aims, beliefs, aspirations, knowledge—a common understanding—likemindedness as sociologists say. (quoted in Carey, 1989 ellipses in original; Dewey, 1916, pp. 5–6).

Finally, Carey stresses that the ritual view is situated historically. The newspaper arose in a particular time for a particular social group. “Like any invented cultural form, news both forms and reflects a particular ‘hunger for experience’...it exists solely in historical time; and it invites our participation on the basis of our assuming, often vicariously, social roles within it” (17).

To stress the consistency with which the experience model aligns with Carey’s views and the prescience Carey demonstrated when he introduced it thirty years ago, consider that Carey ends his discussion of the ritual view with a warning that though the transmission view “led to solid achievement, it could no longer go forward without disastrous intellectual and social consequences” (18). This is an apt diagnosis of the challenges that science communicators are now facing in our polarized political context. They cannot engage successfully with diverse social groups if they place their focus on transmitting information (even in the form of a two-way dialogue) and fail to appreciate the fragmentation of experience and the lack of shared meanings that different groups bring to science.

4.4 Three Principles of the Experience Model

The experience model for science communication, in short, suggests that humans make sense of science not through the transfer of information but rather through their experiences with

science and scientists and the meanings that emerge from those experiences. In some cases this conceptual shift may lead to large shifts in practice, but in other cases it may lead to seemingly small changes. This model doesn't suggest we throw away all of the work science communicators have done for decades, but it does call for reimagining and reframing it in order to think about how it relates to experiences and meanings. To facilitate this reimagining, it is helpful to focus on the three key principles that emerge from Dewey's account of experience and the concepts we have discussed so far in this section: (1) experience is cumulative; (2) context matters; and (3) audiences have agency.

4.4.1 Experience is cumulative.

Each experience has its own meanings, but it is also situated within lived experience, and thus its meanings are shaped by prior experiences and meanings. In turn, the experience also inflects future experiences. The lasting impact of the experience is the way in which it adds to meanings already made. Experiences from different parts of our lives come together to form broader meanings. For example, an author of this paper has memories of an experience with a dead houseplant when she was 19. These memories may not be directly related to current experiences in her current garden, but the cumulative nature of experience is such that for her, what it means to care for plants will incorporate both. Similarly, an encounter with a medical professional that is not explicitly about vaccination will be part of meaning making around vaccination.

4.4.2 Context matters

While lived experience, or the cumulative experiences that inform each new experience, provide one kind of context, the situatedness of each experience is also deeply contextual. Every

aspect of the experience provides context that helps shape its meaning. Just as seeing a movie in a theater differs from watching it in your living room (something we are painfully aware of as we write this article during our seventh month of social distancing from the COVID-19 pandemic), the surroundings, relationships with others present, state of mind, mood, and any number of other aspects of an encounter impact how we experience it. Empirical studies (e.g. Bolsen et al., 2019) suggest that it matters who delivers a science communication message. The experience model explains and expands these findings. A preacher speaking to her or his congregation about the climate crisis makes for a thoroughly different kind of experience than a scientist or politician doing so. Prior experiences have likely built trust between the church leader and the parishioners; familiarity and comfort in the space is also likely a factor, as is relationships between and among the parishioners. The context in which an experience happens does not merely make one more or less receptive; it deeply shapes the contours of the experience.

4.4.3 Audiences have agency

An experience is something that occurs when an individual interacts with an object (i.e., a text, an exhibition, etc.). These objects are typically generated through acts of expression (although they could be natural objects as well), but the experiences associated with them are not provided entirely by the object, nor do they happen entirely in an individual's mind. In this sense, meaning is co-created by the person who experiences an object and the person or people who created it; it is co-created through the expressive object. No one passively receives an experience; it always involves interpretation and meaning making based on previous lived experience and current circumstances. Nevertheless, this interpretation need not always be fully intentional or deliberate. Neither can the meaning made of the experience be predetermined by the object or its creator. Context and past experience shape the willingness to engage as well as

the nature of the engagement. Additionally, audiences are not bound to reveal the meanings they make of their experiences. These meanings are sometimes deeply personal and often not fully conscious or easily articulated. Further, the challenge of ascertaining what audiences make of a particular intervention or program creates new opportunities for experience and the possibility of new or refined interpretations and meanings.

4.5 The Significance of an Experience Model

We think that the adoption of this model could have profound ramifications for communication research and practice. It provides a new theoretical framework that drastically changes the interpretation of empirical evidence. Viewing science communication through the lens of experience changes its focus, alters its research questions and metrics for success, transforms its practice, and reframes the role of science and science communication in a democracy.

First, as we have emphasized throughout this paper, the experience model shifts the focus of science communication from information transfer to experience and meaning making. An experience model explicitly acknowledges that information is only one aspect of a meaningful interaction. While information can be part of the experience and can shape the texture of the experience, it is not necessarily central to the process of making meaning. For science communication practitioners, this means that rather than drawing on the affective or narrative aspects of communication to help transmit the information, they may consider what information is vital for them to engage in an act of expression. This is a shift in their conceptualization of what they are doing. Instead of finding tools for the transmission of information, they are drawing on information as a tool to create an object of expression. Such an act, which involves

its own experiences, may draw on information, but will ultimately provide opportunities for interpretation and meaning-making.

Because this model shifts its focus onto experience, it also broadens science communication research and practice to include all interactions with science, not just purposeful efforts for scientists and practitioners to communicate information about science. This shift pushes science communicators and scholars to better understand how brief encounters with pharmacists, commercials for cleaning products, and even reminders to wash your hands in public restrooms are part of lived experience with science and science communication. This broadening opens up space for new research agendas about these unexamined events in science communication as well as research about their cumulative nature and its relationship to purposeful science communication. It also provides access to new ways for practitioners to “know their audiences.”

Another consequence of shifting to focus on experience is that this model problematizes an overly simplistic binary that can arise in science communication discourse between the concepts of deficit and dialogue. The experience model highlights the fact that “one way” modes of communication can be meaningful and need not presuppose the deficit model even when they are not part of a dialogue. Scientists are often called upon to give lectures. Those that are meaningful to audiences generally arise from acts of expression, in which these scientists have used the knowledge products of their research to generate rich, dynamic lectures, which are expressive objects. The problem with many communication efforts is not that they are “one way” but that they focus solely on information transfer and presuppose that the sole goal of communication is to correct deficiencies in knowledge. The dialogue model can swing too far in

the opposite direction by assuming that if audiences are not actively contributing to a conversation, they do not have agency or a voice. The experience model emphasizes that audiences can be actively making meaning even when they are not part of a dialogue.

Further, if meaning, rather than information, is at the heart of communication, then the work of developing measures of success must be radically rethought, not just from a practical perspective, but also from an ethical one. Although the experience model is primarily designed to be descriptive, it does have normative ramifications. Nevertheless, those normative implications are very different from what one might expect in the science communication context. Normativity in the experience model stems not from the idea that some experiences or meanings are “better” than others but from precisely the opposite insight—the realization that all experiences and meanings are valid. This is not to say that all experiences draw on correct information. Certainly experiences with propaganda or disinformation are problematic, but the experiences themselves are still valid in the sense that they are part of someone’s lived experience and form part of the lens through which they interpret and make meaning from all subsequent experiences. This provides the basis for a decisive break with the deficit model; the experience model problematizes the notion that there is a single or straightforward “successful” outcome that audiences ought to achieve. Rather, it calls for science communicators to acknowledge the agency of their audiences and to respect the validity of their experiences and the meanings associated with them.

Much remains to be said, however, about how to navigate the normative implications of the experience model. One can affirm that all experiences and meanings are valid while also acknowledging that some experiences are deeply influenced by misinformation, disinformation,

or misunderstanding and that some meanings have ethically problematic aspects. One can also acknowledge that scientists and science communicators have their own rich experiences that are often shaped by scientific information, and it is entirely legitimate for them to want to share their own experiences and meanings with others. Thus, the fact that all experiences and meanings are valid does not imply that we must resign ourselves to leaving others' experiences as they are and living in incommensurable worlds. On the contrary, the experience model provides resources for moving forward to cultivate new experiences and meanings that can potentially foster engagement across different communities. Thus, one of the challenges for the experience model is to navigate the tension between respecting the experiences and meanings that everyone brings to science while also acknowledging that for some, especially scientists and science communication practitioners, lived experiences has instilled a drive to create change. Our discussion of the vaccine controversy in Section 5 illustrates this tension and some of the possibilities for addressing it.

The experience model also suggests that the power dynamics within which science operates in society are often flawed because the experiences of professional scientists are privileged relative to the experiences of others. This can occur, for example, when problems are framed as technical ones to be addressed through a method like risk assessment rather than being framed in ways that are amenable to other kinds of experience (see e.g. Wynne, 2005). Mary O'Brien (1999) vividly illustrates this point by telling the fictional story of four risk assessors who criticize a woman for refusing to wade through an icy river even though they calculate the risks of doing so as being minimal. The woman objects that there is a bridge nearby that she can use to cross the river, so there is no point in taking the risk, even if it is negligible. The general point of this story is that there are often multiple ways to approach a problem, and it can be

problematic to focus primarily on the approach preferred by the scientific community or by particular scientific disciplines (Lacey, 2017; Wynne, 2003). By focusing on the different experiences and meanings that various groups bring to an issue, the experience model can highlight alternatives to the dominant scientific way of framing the situation.

Related to this point that the experiences of professional scientists should not be privileged relative to those of others, the experience model also shifts the way we understand and value expertise. In this model, expertise is at least partly a function of having particular kinds of experience, not simply more propositional knowledge. The democratization of art was a rather significant implication of Dewey's work on aesthetic experience. He was clear that human experience is not hierarchical, and therefore "my" experience is equal to "your" experience (Dewey, 1934). We take this democratization to be a central aspect of conceptualizing science communication as experience as well. This insight accords with a great deal of recent STS scholarship, which has drawn attention to the "local" knowledge often held by those who are not professional scientists (Collins and Evans, 2008; Irwin, 2014; Wynne, 1992).

The experience model goes even farther by showing that one can have relevant expertise even when it is not readily characterized as a form of "knowledge." Namely, one can have experiences that are relevant and important for decision making; moreover, whether we like it or not, decisions are always made within the context of our experiences and are never based on "science alone," divorced from its context. Thus, the experience model helps to clarify why it is important to incorporate a range of community members in decision making and communicating about science even if they might not immediately appear to have significant knowledge to bring to the table. This implication is also fraught, as we have noted, for some lived experience may be

deeply laced with misinformation and disinformation. Lived experience can also be composed of multiple experiences with lies and bad actors, and because communication reproduces as much as it produces culture, shared experiences are built around these malicious expressive objects. Such objects can fester and build deeply rooted cultural meanings that reject scientists' experiences as false. Although there are no simple solutions to these difficulties, the experience model provides the conceptual resources to examine and understand these experiences and meanings.

5 The Experience Model in Action: Vaccine Hesitancy

To illustrate how this model can make a contribution to science communication research and practice, let us consider how it can illuminate recent controversies over vaccines. This is an apt case to consider because so-called “anti-vaxxers” have become a primary focus for science communication hand-wringing, especially in the United States. This group of people has also been called the vaccine anxious (Largent, 2012) or the vaccine hesitant (Goldenberg, 2016). Opposition to vaccination has been identified as a very serious public health threat by most major health organizations, including the WHO and the NIH (National Institutes of Health, 2019; World Health Organization, 2019). Although debates about vaccines have been present ever since their initial development, the contemporary anti-vaccine movement stems largely from the scandal surrounding Andrew Wakefield's paper that explored alleged links between the MMR vaccine and childhood autism (Eggertson, 2010). It subsequently expanded to include concerns about thimerosal (a mercury additive) in vaccines and worries that the current vaccine regimen could overwhelm children's developing immune systems (Goldenberg, 2016). STS scholars have responded to this challenge by emphasizing the importance of moving beyond the deficit model

(which would attribute vaccine hesitancy primarily to ignorance) and exploring deeper reasons why many people are suspicious of vaccinating their children (e.g. Goldenberg, 2016; Hicks, 2017; Largent, 2012). This scholarship's emphasis on understanding different perspectives and values accords well with the experience model that we have described in this paper. However, the experience model moves beyond this previous work by calling for a comprehensive understanding of the cumulative experiences and meanings that have shaped the responses of the vaccine hesitant. Moreover, it aims to use that understanding to critically examine science communication goals and shape future research and practice.

Our analysis in this section demonstrates both the descriptive and the normative potential of the experience model. From a descriptive perspective, it can enrich the understanding that public health practitioners and physicians bring to the case by helping them to appreciate the cumulative past experiences that have helped to generate skepticism about vaccines. It would be contrary to the spirit of the experience model to use this description to generate simple principles for counteracting vaccine skepticism, but the model can still generate normative guidance in several ways. First, it invites science communicators to reflect on the experiences and meanings of others as well as themselves and to consider altering their questions, their framing of the situation, and their goals in response. This openness to rethinking goals reflects the experience model's emphasis on respecting the validity of others' experiences and meanings. Building on this attentiveness to others' experiences and meanings, this model encourages science communicators to engage with their audiences by building opportunities for shared experiences. Recognizing that they are part of, rather than outside, the experiences of others, and that they are themselves also making meaning based on their own experiences can potentially provide a shift in their perceptions that alters the power dynamics at play and creates opportunities for shared

experiences, which are first steps toward building trust. Finally, learning about how others interpret and make meaning about their experiences can reveal potential areas of concern within institutions and infrastructures. Addressing these large, structural problems could be key to lasting transformation of systems that created the conditions in which hesitancy was born.

5.1 Understanding Past Experiences

Commentators on the vaccine case have highlighted a number of cumulative experiences that have contributed to contemporary vaccine hesitancy (see e.g. Goldenberg, 2016; Hicks, 2017; Largent, 2012). Here we focus on three types of experiences that we take to be particularly significant and illustrative of the kinds of experiences that merit discussion in the context of science communication about vaccines: (1) an individual-centered risk focus during pregnancy and infancy; (2) a consumer paradigm in medicine; and (3) a lack of trust in the pharmaceutical industry. We focus on these because they are common experiences in contemporary society that might not immediately seem relevant to vaccine hesitancy. By focusing on these experiences, we show how the experience model draws attention to a broad range of historical and contextual factors that can affect how audiences engage with scientific information.

As we discuss these experiences of pregnant women and expectant parents, we acknowledge that we are abstracting from a wide variety of experiences with pregnancy and motherhood that often vary based on country, socioeconomic status, race, and ethnicity. Some of the experiences we discuss and the hesitancy they engender belong largely to middle class women and families. For example, there are vast disparities between the ways White women and Black women in the U.S. are treated by the medical system, which contributes to a higher

mortality rate among Black mothers (see e.g. Tucker et al., 2007). Although we are focusing on the importance of some common experiences here, the experience model also emphasizes the importance of considering differences in lived experience.

Consider first the individual-centered focus that many women experience toward their child during and after pregnancy, which provides a cumulative set of experiences that influence how they approach childhood vaccines. By an “individual-centered focus,” we mean that women are encouraged to scrutinize all their activities through the lens of considering how it could affect their child (Goldenberg, 2016, 2021), whereas they are less likely to receive messages focused on the broader public health of their communities. This resonates with the general cultural emphasis in the US on individual as opposed to community welfare (Morling and Lamoreaux, 2008). These experiences play out not only through interactions with doctors and other medical professionals but also in popular cultural products like television shows and commercials. They are also woven into social interactions around pregnancy and permeate popular literature about pregnancy and childbirth. During pregnancy, women in the US are routinely told not to consume alcohol and to limit or eliminate all caffeine. Additionally, they are told not to eat unpasteurized, soft cheeses and sushi to reduce the risk of foodborne illnesses, and to limit how much fish they consume to reduce exposure to mercury. Additionally, many women are told not to drink herbal teas, not because they have been found dangerous, but because no research has been done on whether or not they may have an impact on the fetus (see e.g. Murkoff, 2019; Petre, 2020).

Once the child is born, women are encouraged to breastfeed, and as long as they do so, they are often told not to drink alcohol or to “pump and dump,” meaning that if they do ingest alcohol, they use a breast pump to extract and discard any milk that may contain traces of

whatever they've imbibed (Ho et al., 2001). Increasingly, answers to questions about infants' digestive problems are sought by investigating what nursing mothers consume (Martín-Muñoz et al., 2016). This is not to say that there is no good evidence supporting such links, nor is it to suggest that these links don't matter. Eliminating soy or dairy, for example, has improved the lives of many nursing mothers and infants. Nevertheless, this focus expands a medical and risk-based experience of pregnancy and motherhood. These moments of motherhood-as-medical-condition can be valuable for some mothers and infants (and have even been life saving for an author of this paper), but the expansion can become indiscriminate, so that every moment of every pregnancy becomes scrutinized to the point that the medical ramifications supersede all other aspects of women's lives (Barker, 1998; Rúdólfsdóttir, 2000).

In addition to being conditioned to develop a laser-like focus on the health of their children, parents also experience a medical landscape in which they are both patients with medical conditions and consumers shopping for products. They are encouraged to make their own choices from among specific, well marketed options that may or may not contain false advertising (Goldstein and Bowers, 2015; Tritter et al., 2009). They are also responsible for making these decisions based on conflicting and rapidly changing expert advice, which is given based on conflicting and rapidly changing research (Hämeen-Anttila et al., 2014; Hauck et al., 2007). Depending on who they ask, they can either refrain from drinking alcohol altogether or they can indulge specifically in one glass of wine per day (why only wine, and not beer or liquor?). And their doctor, who is the expert, will dictate the terms of their medical treatment, unless they heard about another option on television, in which case they could suggest that treatment to their doctor, who may or may not have also been approached by a pharmaceutical representative working for a competing company (Elliott, 2010; Sismondo, 2018). Building on

this general consumer paradigm in medicine, Goldenberg (2016) reports that parents are also influenced by a “new public health” framework in which they are encouraged to take an active role in making personalized decisions that seem best for them and their loved ones.

A third set of cumulative experiences that affect how people approach childhood vaccinations is a lack of trust in pharmaceutical companies. Many, if not most, of the prominent news stories about pharmaceutical companies have focused on the unethical behavior of their leadership. Martin Shkreli (also known as “pharmabro”) leapt into infamy in 2015, when his company, Turing Pharmaceuticals, purchased Daraprim, a live-saving drug used primarily to treat complications related to AIDS, and dramatically increased the price (Chandler, 2015). Shortly after, another scandal erupted over the EpiPen, which a pharmaceutical company called Mylan had purchased in 2007. Just as Shkreli had done with Daraprim, Mylan increased the price of EpiPens to the point at which those who needed them could not afford them (Rapaport, 2017). At the same time, Purdue Pharma was under public scrutiny (and has since plead guilty) for downplaying the risk of addiction to opiate pain relievers like OxyContin and launching the nation’s opioid epidemic (Benner, 2020; Keefe, 2017). People are exposed to a constant stream of high-profile cases of greed and disregard for patient health and safety on the part of medical researchers and pharmaceutical companies, which fosters a lack of public trust (see e.g. de Melo-Martin and Intemann, 2018; Holman and Elliott, 2018; Sismondo, 2018).

These three examples, along with many other relevant shared experiences, may not seem directly relevant to questions about vaccinations, but they shape what vaccination means. So by the time a healthcare professional is in a room with new parents to discuss vaccinations for their infant, the experiences have already accumulated, and meanings are already well established.

Add the personal, deeply emotional, and honest stories from people who are convinced without any doubt that a vaccine has harmed their child, or repeated interactions with medical practitioners who have not listened to them or responded thoughtfully to their concerns. It becomes clear that by the time someone is speaking to a patient directly about vaccination, they already have a clear, well-formed sense of what it would mean to vaccinate their child. One more encounter makes only a small addition to this body of interactions.

5.2 Drawing on Past Experiences to Reshape Communicators' Thinking

The experience-based model invites those involved in science communication to reflect on the experiences that other people “bring to the table.” Rather than focusing on a body of information to be transmitted, it invites communicators to critically examine their questions, goals, and framings based on the experiences of others and the meanings associated with those experiences. In the case of vaccine hesitancy, it is striking how the experiences that parents bring with them are shaped by the broader landscape of the medical, public-health, and pharmaceutical systems. Parents are under significant pressure to make medical decisions that are in their children’s best interests, despite operating in a confusing system where many of the actors may not be promoting the best interests of patients. The experience model also invites communicators to consider how their own unique perspective, which is shaped by their own experiences, may differ greatly from those with whom they wish to communicate.

If communicators are to respect the experiences and meanings that others bring to their interactions, they arguably need to reframe the goals they might initially bring to their work. Rather than focusing solely on ways to convince people of the safety of vaccines, they might decide that one of their ultimate goals should be to develop a culture in which patients,

physicians, public-health experts, policy makers, and the broader society trust one another enough to decide together how to deal with the risks inherent in medical interventions. Science communicators might conclude that an important part of their goal should be to shift medical and public-health conversations to focus not only on risks to individuals but also on family and community well-being. Finally, communicators might decide that they need to work with the medical community and policy makers to create a medical system that can earn public trust (de Melo-Martin and Intemann, 2018), perhaps by shifting away from a for-profit model. This might be idealistic, but the alternative is troubling: manipulating or coercing those who do not trust the systems within which they must exist.

By focusing on the experiences that shape people's responses to childhood vaccinations, science communicators can recognize how failure to pursue the broader goal of trust is likely to threaten their more immediate goal of increasing vaccination rates. Adopting a coercive approach could generate future experiences that foster even greater distrust and opposition. In 2015, lawmakers in California passed a bill that eliminated personal belief exemptions from vaccinations for schoolchildren (Mello, 2019). In 2019, lawmakers passed additional legislation that allowed the state health department to investigate and reject medical exemptions in schools where the vaccination rate drops below 95%, or when a doctor provides more than five exemptions per year (Karlman, 2019a). Similarly, in 2019, New York State eliminated religious exemptions from vaccinations (Otterman, 2019). Both states were responding to measles outbreaks, and the result, in both states, was a rise in home-schooling. While alarm over these outbreaks is warranted, and concern over vaccine hesitancy is important, these laws have sparked outrage among apprehensive parents and led to an extreme increase in parents' homeschooling their children to avoid the shots (Bellafante, 2019; Karlman, 2019b). These

are dangerous paths that set the stage for increasing clashes in which the power of experts is wielded to force uneasy compliance from increasingly mistrustful publics.

5.3 Starting from Past Experiences When Communicating about Vaccination

One might worry, however, that even if communicators shift their goals so they incorporate more than just a narrow focus on increasing vaccination rates, physicians and public-health experts still need advice about how to communicate about vaccines with their patients. The experience model would recommend that they consider what kinds of experiences they offer patients, and how those experiences might become meaningful for patients in the context of their lived experience. This does not mean abandoning or hiding a desire for the patient to choose vaccines, but it does suggest a certain level of reflexivity about that desire. Such consideration requires an understanding of, and responsiveness to, the patient's experiences in an effort to build shared meaning. This will, by definition, mean listening to patient stories and concerns. Additionally, it will likely involve a conversation in which the health professional is willing and able to share their own meanings surrounding vaccination, risk, and safety. These meanings might be broader, but they would not supersede or overrule the patient's. This might provide opportunities to, as Goldenberg (2016) emphasizes, work with parents to assuage the concerns they might have about the unique characteristics of their children that might make the parents worry about negative reactions to the vaccine. But it isn't just the content of the conversation that matters, as the principles of the experience model suggest; the context of the conversation is important. The physical space, the manner and demeanor of the practitioner, and the other elements of the visit (such as physical examinations or medical tests) all play a role in the experience within which the visit happens. Attention to when and how these conversations

happen can convey a sense of respect for the patient that is often lacking. Ultimately, the patient may not walk out of the healthcare practitioner's office having changed their mind, but if the practitioner reconceptualizes the point of the visit from an opportunity for persuasion to an opportunity to foster a shared experience, they have begun the work of building shared experiences, better relationships, and, potentially, trust.

Consider an example of how physicians and public-health experts could engage with their patients' past experiences. Given that parents have the cumulative experience of needing to operate as consumers who watch out for potentially questionable medical interventions, experts might engage them in a meaningful way by equipping them with thoughtful questions they can ask as they try to evaluate vaccines. This simple gesture might provide a drastically different experience in which the power dynamics shift and in which these parents gain new tools with which to express themselves. For example, an online piece published at the Medium (Haelle, 2020) provided those concerned about vaccines for COVID-19 with questions they could ask themselves when assessing information about the vaccines to help evaluate whether they would feel comfortable receiving them. While conventional thinking might suggest that the central goal of this communication strategy is to equip people to obtain additional information, the experience model suggests a different interpretation: Thinking through these questions could lead to new experiences that shape meanings associated with healthcare professionals, medical experts, and vaccinations. By providing the questions, the physicians were providing an opportunity for a different kind of experience.

Thus, the experience model would place less emphasis on the ways questions could foster the flow of information and more emphasis on how the experience of exploring the approval

process could prove to be formative for skeptical parents. For example, they might develop new understandings of the experiences that shape vaccine scientists' perspectives and alter their own perspectives as a result. This approach also respects these parents as individuals who have their own agency, whether or not they are involved in an explicit dialogue with physicians or scientists. It shifts the focus of the experience from one in which people are being persuaded to change their behavior to one in which people are equipped to take an active role in their medical care.

5.4 Altering Systems

While the experience model can point communicators in the direction of better approaches for engaging with patients in the short term, it is especially powerful for developing thinking around large, structural changes that are more conducive for fostering the kinds of shared experiences and meanings that can enable different groups to understand each other better. Whereas the short-term strategies discussed in section 5.3 tend to involve granular interactions “on the ground” between providers and patients, a macro-scale focus reveals the systemic changes that strike at the heart of the troubling experiences currently engendered by larger systems and infrastructures. These kinds of shifts take time, and any subsequent shift in culture (wherein the cumulative, shared experiences slowly shift meanings and shared meanings) take even longer. As discussed earlier, careful attention to the experiences of the “vaccine hesitant” suggests that science communicators might want to reframe their overall goal from a short-term focus on getting people vaccinated to a long-term focus on developing a culture in which those involved in this issue trust each other enough to decide together how to handle the risks inherent in medical interventions. To achieve this goal, communicators and policy makers

need to create conditions that impact overall lived experiences and meanings, not just the singular experiences that involve specific vaccination decisions, which means altering the systems that create an individualist focus (not only during pregnancy and childrearing but across the healthcare system as a whole), a consumer paradigm in medicine, and a lack of trust in pharma.

First, if policy makers and public-health professionals want to promote a culture of mutual trust and shared decision making, they could consider long-term thinking about how to approach health and risk as matters for communities, rather than individuals. This means fostering a culture in which varied experiences are more widely shared, a broader range of community members have opportunities to engage in acts of expression, and opportunities for experiences are framed in terms of the health of the community. Even if the information infused in these opportunities remained largely the same, it would become one part of a series of experiences in which a greater range of perspectives, lived experiences, and ethical values are considered.

In the context of pregnancy, for example, when women are expected to eliminate all risk to fetuses, even at the expense of their own health and well-being, it suggests that the fetus is of greater value than they are. This presupposition may, in turn, be influenced by a legacy of historical experiences in which women were regarded as property and their primary role was to produce children (Gordon, 2002). Thus, fully addressing communication around vaccines may require a new discourse around pregnancy that considers a broader array of risks and trade-offs, including a greater focus on the needs of mothers (Kukla, 2005). Along the same lines, policy makers might also want to consider the benefits of rethinking child care as a community effort

rather than the individual responsibility of families. If families are focused on the health and well-being of the entire community rather than just their own children, they are more likely to take the benefits of vaccination and other community health initiatives into account rather than focusing single-mindedly on the risks to their own families. In addition, when people are given greater opportunities to encounter the perspectives of others who must contend with different kinds of risks, their own lived experience may be shaped by these shared experiences, thereby generating more concern for the community. For example, this manuscript was written during the controversy over wearing masks during COVID-19, and it was striking how challenging it was for some people to consider wearing a mask for the safety of others. While this reluctance has been met with understandable frustration and anger, the experience model suggests that some people simply don't have lived experience that helps them make sense of the communal benefits or responsibilities of honoring such a request.

As we intimated in section 5.2, other ways to change the broader system surrounding vaccine communication include altering the consumer paradigm in medicine and advocating for structural change to the pharmaceutical industry. One obvious step towards changing the consumer paradigm would be to reevaluate the direct-to-consumer (DTC) advertising currently used in the United States. Patients respond to new medications in ways that are influenced by all the marketing and advertisements their paths have previously crossed. As discussed earlier, this contributes to a pick-and-choose, buyer-beware mindset. Limiting direct-to-consumer advertising (as most all other countries do; Almasi et al., 2006) would change people's experiences with medication and perhaps alter the mindsets associated with it.

Finally, as long as the pharmaceutical industry has the reputation for cutting corners and doing everything in its power to maximize profits, it is no wonder that people are skeptical of vaccine safety. As Inmaculada de Melo-Martín and Kristen Intemann (2018) have emphasized, one of the most important steps for promoting acceptance of scientific information is the creation of a scientific community that deserves trust. One potential way for the pharmaceutical industry to earn greater trust in the science it performs would be to make all the data associated with the safety studies for their products, including vaccines, publicly available. As long as those data remain private, people will continue to have legitimate concerns about the ways the companies have strategically manipulated the results to downplay side effects and promote benefits (Holman and Elliott, 2018; Sismondo, 2018). Other potential strategies for fostering trust might involve increasing the negative consequences associated with misbehavior. For example, one might advocate for altering the legal system to limit the extent to which companies are shielded from liability associated with vaccine side-effects (Bogus, 2003; Copper, 2006). In general, pharmaceutical industry executives would also probably place greater priority on public health (and thus garner greater trust) if they were more likely to be held criminally liable when their products cause negligent harms (Henning, 2015; Michaels, 2008). Creating more effective systems to compensate individuals harmed by vaccines could also prove valuable for engendering trust (Halabi et al., 2020). One might even argue that the most effective solution would be to stop structuring pharmaceutical research and development as business ventures at all (Brown, 2002). But our model suggests that these actions alone would not immediately shift meanings. Rather, prolonged and repeated experiences in which trust was earned as a result of these measures could slowly, over years and possibly decades or generations, shift the shared meanings associated with pharmaceuticals.

5.5 Comparison to Previous Approaches

Those who are familiar with previous work on science communication are likely to notice a number of similarities between the experience model we are proposing and the dialogue model that has been celebrated as a successor to the deficit model. After all, many of the insights that we have discussed in the vaccine case have come from STS scholars who have already moved beyond a deficit mindset. We agree that the experience model does indeed resonate with many of the changes that have already been occurring in science communication and STS scholarship, but it is also important to recognize the new contributions made by this model. These contributions revolve around the shift from a focus on information transmission to a focus on experiences and the meanings associated with them. At its best, the dialogue model makes a similar move. By emphasizing the importance of two-way communication, it provides opportunities for science communicators to alter their perspectives and priorities and co-create meaning by listening to the experiences of others (O'Rourke and Robinson 2020). However, because it does not place explicit emphasis on those experiences, it does not always achieve the deeper changes envisioned by the experience model.

Additionally, approaching science communication as dialogue has often proved challenging for practitioners and scientists because it doesn't provide clear methods for engaging in dialogue around thorny issues like vaccine hesitancy. Grounded in deliberative democracy, the dialogue model might suggest that the ideal result of any intervention would be consensus or compromise. Experience provides opportunities for shared meaning-making, but such work does not imply there is always a "middle ground" where a clear solution is possible; in fact, it highlights cases where different groups have such different experiences and meanings that they

are unlikely to arrive at shared solutions, at least in the short term. It lays bare perhaps the biggest trap that advocates of dialogue encounter: at the end of the day, policy makers may not be willing or able to accept a consensus solution to science policy matters, especially when they have safety implications (see e.g., the results of the UK's GMONation! Efforts in Irwin, 2014).

Finally, as discussed in section 4.4, the explicit shift to a focus on experiences generates different emphases and perspectives compared to previous approaches. The experience model sets aside efforts to convince people to accept information and instead focuses on understanding people's previous experiences in order to foster future experiences that can bring communities together in productive ways. It also respects people's agency even when they are not engaged in dialogue with the scientific community; the experience model is interested in and concerned about people's full array of current and past experiences. Even when people are not able to communicate effectively about their experiences in a dialogue format, the experience model encourages careful attention to their lived experiences. Finally, the experience model emphasizes solutions that other approaches are less likely to emphasize. It highlights the value of fostering shared experiences among people from different communities so that they can develop shared meanings that enable them to move forward more productively. One can arrive at similar solutions by working thoughtfully with other models of communication, but the experience model places explicit emphasis on them.

6 Conclusion

Building on John Dewey's pragmatist philosophy, we have developed a new model of science communication focused on experience and meaning-making. This model is valuable because it provides a decisive shift away from a focus on information transmission, thereby

mitigating the potential for other models to drift back into deficit thinking. According to this model, science communication consists in people's experiences with science and the meanings they develop from those experiences. Three key principles emerge from this way of thinking about science communication: experience is cumulative, context matters, and audiences have agency. We have argued that adopting this model not only changes the focus of science communication but also alters its research questions and metrics for success, transforms its practice, and reframes the role of science and science communication in a democracy. To illustrate these changes, we showed in the case of vaccine hesitancy how the experience model could help all those engaged in controversial science communication cases understand each other better and potentially reconsider their goals, generating more thoughtful ways of engaging with each other over both the short and long terms. In an era characterized by sharp polarization, conflict, misinformation, and distrust, the experience model has the potential to foster much-needed mutual understanding and empathy among all those involved in science communication.

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