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Use of sources by science news writers: An exploration of information credibility

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Use of sources by science news writers: An exploration of information credibility

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Dissertation

Presented to the Faculty of the Graduate School of
The University of Texas at Austin
in Partial Fulfillment
of the Requirements
for the Degree of

Doctor of Philosophy

The University of Texas at Austin
August 2016

Dedication

To Nora and John

Acknowledgements

I am grateful for the support of an outstanding committee – James Howison, Lynn Westbrook, Lecia Barker, Randolph Bias, and Homero Gil de Zúñiga. They are wise scholars, skilled teachers, and good souls I'd be glad to have in my village in any kind of circumstance. Lynn provided much encouragement along the first part of my journey, and I am deeply grateful for James' guidance in these final stages. I also owe many thanks to Diane Bailey for her support and wisdom. The funding of the Institute of Museum and Library Services through the Cultivating Digital Librarianship Fellowship program was also invaluable.

I was, and am, astounded by the generosity of my participants in sharing their thoughts and writing lives with me. Time is a valuable commodity for a freelance writer, and I received gifts I hope to pay forward in whatever ways I can in the future.

My fellow students at the UT iSchool are amazing in most every way. I want especially thank Lorrie Dong, Ramona Broussard, Julia Bullard, and Jane Gruning for reading and responding to so many lousy first drafts and being smart and steady friends.

A great number of medical professionals kept me more or less together over this past year. I don't yet have the words to say how grateful I am for their care, but I'm working on it.

I am grateful to my (mostly) patient children, Nora and John, for keeping me aware and tuned in to real life going on outside. Sorry this took so long, you guys. Their father, Mike, is the best co-parent and supportive friend I could ever hope to have.

Use of sources by science news writers:
An exploration of information credibility

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The University of Texas at Austin, 2016

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In this dissertation I examine the work of freelance science news writers in order to understand their information practices related to credibility. This study emerges from a socially constructed view of credibility that is informed by ethnographic studies of knowledge sharing, sociological study of news work, and foundational theories of persuasion and trust based in Aristotelian rhetoric. In making judgments about what constitutes "science news," science writers enact complex decisions about who is a credible source for describing science, and how that credibility is best communicated to wider audiences. They do this while inhabiting a nexus of two very different epistemological traditions – that of science and that of journalism. Scientific norms place a high value on specialized expertise and restricted communication; journalism is profoundly identified with broad democratic participation and transparency. Furthermore, contemporary news media is adapting to a variety of new social, technological, and economic pressures. These adaptations are shifting established paradigms for understanding information trust and credibility judgments. For these reasons, science news writing is a rich site for exploring how information credibility functions in multi-disciplinary spaces.

My participants are active freelance science writers, recruited through their affiliation with the National Association of Science Writers. I applied an ethnographically informed research design to explore how the writers chose story topics, identified and interacted with expert sources, structured their writing, and worked with publishing outlets. I gathered data from interviews and from examinations of the participants' published work,

grounding my protocol in details of process and using prompts from stories authored by the participants. My analysis is ordered around two thematic axes: professional identity and specific practices. For freelance writers without consistent organizational support, judging credibility (and being judged as credible) hinges on continued demonstrations of professional identity and a reliance on normative processes. Contrary to some current scholarship, which suggests contemporary journalism is a profoundly disordered practice space, I found adherence to normative traditions of newswriting useful to my participants in unexpected ways. My findings are organized to inform the development of interdisciplinary collaborative research information spaces and contribute to ongoing conversations related to public understanding of science.

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Information trust in a digital culture

In the networked 21st century, evolving digital technologies combine with changing information and communication practices to significantly reshape the environment in which the public engages with complex information. Reaching large audiences was, until relatively recently, possible only for professional broadcasters or publishers. Knowledge and information from specialized government, corporate, or scientific spheres was confined within its own area of practice. Now public communication of information with billions of potential participants happens across boundaries online with little to no institutional mediation. In this environment, visible markers of institutional authority have become less central to ideas of information trust (Lankes, 2008; Lowrey & Anderson, 2005). Social contexts are now seen as part of aggregative and flexible information trustworthiness judgments in increasingly collaborative online knowledge work (Jessen & Jørgensen, 2011; Lankes, 2008).

Questions of information credibility often emerge tethered to certain domains, such as health information, and may imply certain types of risk related to the sharing of incorrect information or deliberate misinformation. Vaccination information, for example, engages potential risks at both personal and social levels and is a subject of intense study (*e.g,* Baker, 2008; Betsch, Renkewitz, Betsch, & Ulshofer, 2010; Hilton, Hunt, Langan, Bedford, & Petticrew, 2010). The realm of science news, where communication is traditionally mediated by experts, foregrounds questions of credibility judgment and its attendant risks to scholars and practitioners in a variety of domains. Social scientists, researchers, public policy experts, and private industry have vested interests in these conversations that may overlap or be entirely at odds.

Climate science, like vaccine policy, is an arena in which expert information from a number of disciplines collides with public conversations. The 2009 Climategate scandal illustrates how a lack of consensus over what constitutes "credible information" in a boundary-crossing space is debated over the course of a breaking news story. On November 19th, 2009, several thousand personal emails from international climate researchers were illegally removed from servers at the Climatic Research Unit (CRU) at the University of East Anglia and made public online (Leiserowitz, Maibach, Roser-Renouf, Smith, & Dawson, 2010). The events that followed illustrate key points related to information credibility, and how news writers negotiate information credibility in a digital environment, which underlie my proposed study. The leaked emails were first published on climate skeptic blogs where their contents were presented as proof of dishonest practices on the part of the scientists (Jonsson, 2010; Leiserowitz *et al*., 2010; Nerlich, 2010). Skeptics of climate science, and other institutional forms of science, question the social and cultural authority of institutions like the CUR. They reject conclusions not because of religious dogma or opposition to the norms of science, but because they believe the institutionally-approved knowledge is not scientific *enough* (Harambam & Aupers, 2014). In this skeptic/conspiracy-theorist worldview, relevant facts were hidden by politically powerful forces.

The informal conversations among scientists about how to present climate data fueled suspicion among these skeptics. These "hidden" conversations were proof of a behind-the-scenes conspiracy that had well-established social support. Meanwhile, established climate scientists assured the public that there was nothing unusual in the email exchanges. Regardless of assurances, the media quickly dubbed the story of the leaked emails "Climategate," contributing to the emerging sense of scandal and political cover-up even among those outside of the skeptic community (Holliman, 2011a; Nerlich, 2010). Whose interpretation of the leaked emails was the most credible became a highly polarized topic in public discourse (Holliman, 2011a).

In the midst of the ongoing public controversy, several independent review panels launched investigations into both the source of the email leaks and the work practices of

the scientists affiliated with the CRU (Boulton, Clarke, Eyton, & Norton, 2010; Grundmann, 2012). All of the reviews found the data handling generally appropriate and that the scientists' research and data analysis overall had met relevant standards (Grundmann, 2012). However, a lack of clarity in labeling data and a failure to "display the proper degree of openness" by the researchers risked the credibility of their science (Boulton *et al.*, 2010, p. 10).

Regardless of the assurances from scientific review panels, the climate science skeptic community embraced the emails as proof of a government-science conspiracy to advance a bogus notion of anthropogenic climate change (Holliman, 2011a; Jonsson, 2010; Nerlich, 2010). This community, enacted through blogs and online public comment forums, was poised to attack the credibility of climate scientists with communication strategies articulated throughout larger political networks (Holliman, 2011a). Within this networked media environment, the Climategate emails were incorporated by this community into their existing polarized understanding of climate science. Critiques of climate science were common in these politically conservative skeptic forums, but the Climategate emails were a unique news item on their pages, in that they offered access to unmediated scientific discourse for lay audiences.

Rather than reading a polished version of a completed scientific study and its findings, non-scientist publics were able to witness informal exchanges among scientists about their data and their work practices before their authors formally presented the research findings. The "issues of scientific data and nature of scientific enquiry" were foregrounded in online public discussion after Climategate in a way they had not been previously (Koteyko, Jaspal, & Nerlich, 2013, p. 84); details of scientific methods and data were mostly invisible to the general public before. Within the corpus of emails, expressions of uncertainty among scientists about particular elements of data representation were interpreted as a lack of overall scientific consensus about climate science by the skeptic blogs (Koteyko *et al*., 2013; Ryghaug & Skjølsvold, 2010). Scientists collaborating on CRU research communicated among themselves using known terms and jargon familiar to them (Ryghaug & Skjølsvold, 2010); they knew the limits of

what was being negotiated in their exchanges in a way public readers of their email messages did not. To the general public, it seemed that nearly all of the science was up for debate. The decision by the scientists to continue to advance a theory of climate change in spite of a perceived lack of consensus, then, was interpreted as proof of a global conspiracy (Grundmann, 2012; Holliman, 2011a) or a delusional dogma (Nerlich, 2010) by the online skeptic community.

With this conspiracy framing already in place from Internet communities, the Climategate story was taken up by the mass media. Traditional mass media outlets, despite the proliferation of online channels of information and the rise of "citizen journalism," remain a key vehicle for public understanding of science (Boykoff, 2008; Brossard & Nisbet, 2007; Holliman, 2011a; Nisbet & Scheufele, 2009; Tøsse, 2013; Treise & Weigold, 2002). The Climategate story was no exception. Yet, unlike the linearity of science journalism in traditional media, which tends to report scientific study directly from experts to the public (Fahy & Nisbet, 2011; Holliman, 2011a), Climategate came to the media channels having already encountered skeptical publics in online media. The "news" reported by the traditional media outlets was not only the scientific climate study and the data theft, but also the suggestion of scandal that framed it – a much more compelling narrative in journalistic terms (Fahy & Nisbet, 2011; Holliman, 2011a; Koteyko et al., 2013).

Climategate incorporated information from established authorities such as academic institutions, governmental entities, and inter-governmental entities such as the IPCC. Online sources with little formal authority (but broad public interest and support) were framing the institutional science with their own conspiracy-oriented perspective before the story came to traditional media outlets. Many individuals were informed about the events of the Climategate story through some combination of traditional media sources and more public blogs and social media. But fundamentally, institutional science lost its epistemic authority to frame its findings as "facts" via a cooperative media as skeptic blogs inserted a contradictory framing before the formal media processes got to work.

The repeated assertions of "this is how science is done" by high-ranking scientific officials only assured the skeptics that a wide-ranging conspiracy was at work.

Neither source-based credibility and relevance studies from information science, nor journalistic models offer much help in explaining the events of Climategate. News writers were likely paying attention to the established media space as a source for story framings, not the "off-grid" skeptic communities. Information science scholars may have questioned how a batch of leaked emails served as an authoritative source of science information. Neither disciplinary lens explains how Climategate became the phenomenon it did – or suggests how to predict and navigate through these events in the future. In order to understand how people communicate their perspectives persuasively in public discussions of science, contemporary scholarship requires an approach that accounts for the roles of social and professional practices and identity management in networked information spaces. The interactive digital environment has radically blurred the lines between "producers" and "users" of information and an ongoing of synthesis is at the heart of nearly every online interaction. Particularly in spaces such as science and science communication, where news and information is translated across communities with different agendas and bases of knowledge, the role of existing epistemic cultures is essential to consider. When skeptics challenged the practices of climate scientists, scientific authorities asserted their special status in knowing "how science is done" through established media voices. Rather than persuading the skeptics and conspiracy theorists, this approach only reaffirmed their existing worldview of powerful forces in collusion. How, then, do professional communicators operate in such an environment? How do we share knowledge across populations when fundamentals of epistemic authority are up for debate?

This study uses a social constructivist approach to examine the practices of professional science writers as knowledge workers at the heart of public science conversations such as Climategate. Using discursive understandings of identity and with a focus on the details of science news writing, I describe how multiple and ongoing social connections define "credibility" for science news writers. As both consumers and producers of science

information, they became a singularly reflective source of ethnographic data supporting conclusions that will inform knowledge-sharing in other interdisciplinary domains. In the networked 21st century, more people are writing to convince others than ever before with larger potential audiences. Meanwhile, the traditional structures that used to mediate persuasive communications are sidelined, forcing every individual into the position of a solo entrepreneur in the information marketplace. Insightful scholarship based in the observation of specific practices in their social contexts will support new and much-needed theoretical development.

Digital culture and news reporting

Broad participation in digital knowledge sharing and creation requires a re-evaluation of information credibility models built on the use of clearly-defined "published" sources (Metzger, 2007; Self, 2009). While traditional organizational and institutional affiliations continue to influence individual readers' trust in online information to some degree, the potential for reader/author interactions mediate that influence substantially (*e.g.*, Heikkilä, Kunelius, & Ahva, 2010; Kaye & Johnson, 2011; Robins, Holmes, & Stansbury, 2010). In the journalism space, factors such as broadcast outlet consolidations, rapidly shifting modes of news distribution, and citizen participation in news "reporting" via Twitter and Wikipedia have forever altered that work (Edstrom & Ladendorf, 2012; Keegan, 2013; Mitchelstein & Boczkowski, 2009; Netzley & Hemmer, 2012).

According to media scholar Deuze (2006), the information changes spurred by digital media are truly cultural ones, and not merely a shift from one working technology to another. Deuze identifies three principal components that make up a full digital culture: participation, remediation, and bricolage (p. 66). That is, broader participation in communication, the ability to modify existing knowledge structures to suit new purposes, and the assembly of wholly new forms of expression define 21st-century digital culture. In Deuze's view, more individuals are publicly communicating information in modified forms and as part of cultural assemblages that are truly new. Accordingly, people are increasingly making decisions about the "trustworthiness" of information via social and participatory activities (such as upvotes and shares on social media), rather than the

information's specific provenance from a known authority *(e.g.*, Jessen & Jørgensen, 2011; Lankes, 2008; Metzger, Flanagin, & Medders, 2010; Rowe, 2010).

As a common site of human encounters with novel information, news writing offers a theoretically rich arena for examining the understanding, maintenance, and construction of credible communications within and outside of a community of practice. Although traditional media organizations are clearly struggling, "news" is still abundant in a variety of emerging forms (*e.g.*, Netzley & Hemmer, 2012). Society is still engaged in turning "mere happenings into publicly discussable events" through news (Tuchman, 1978, p. 3). For decades, interactions with news media have provided a setting for the empirical study of credibility judgments and for the development of theories of human information evaluation (Kang, Bae, Zhang, & Shyam Sundar, 2011; Thorson, Vraga, & Ekdale, 2010). Early credibility scholars used printed news media in their experiments (Hovland & Weiss, 1951); contemporary scholars often use news websites and journalist Twitter feeds (Hermida, 2010; Johnson & Kaye, 2004). Regardless of media format, the concept of "news" underpins notions of a Habermasian public sphere for knowledge sharing and political engagement by lay persons across areas of practice and knowledge (D. S. Allen, 2008; Craig, 2010; Habermas, 1991). In even more abstract phenomenological terms, news is a mediator between the external world of systems and structures and individual understandings (Heikkilä *et al*., 2010). Human beings integrate events that they did not experience first-hand into personal understandings of reality through the reportage of the events by others.

In traditional news environments, journalists serve as specialized agents who articulate knowledge from an authoritative source into published news. In the online environment, news media and journalism are "dismantling…carefully cultivated hierarchical relationships between (mass) media consumers and producers" (Deuze, 2006, p. 65). Shifts in journalistic identity articulate Deuze's participation, remediation, and bricolage elements thereby calling the journalistic specialization into question. Readers consult citizen journalists, Twitter feeds, and other ad hoc fora alongside of more traditional outlets (Hermida, 2010; Kaye & Johnson, 2011). This multi-modal space, upending

traditional ideas of information authorities, exemplifies Deuze's proposition of a digital culture and redefines the notion of news. Distinctions between writers and readers are blurred. "News has become a transportive, transactional object of professional, social and civic work for both journalists and audience members" (Robinson, 2011, p. 138). The ongoing transactions between journalists and audience members imply new routines for establishing epistemic authority and credibility that are tied to practices and identity, rather than to formal markers of authority (Deuze, 2005).

Science news writing and credibility

While daily news reporting may require news writers to interact with ordinary citizens and describe public events, science reporting is at an epistemic and literal remove. Science writers are often dependent on the source to explain the meaning of a story, and increasingly narrow areas of scientific specialization limit the number of potential expert sources available to writer (Fahy & Nisbet, 2011; Hansen, 2009; Nelkin, 1995). Scientific journals and other forms of online scientific information can overwhelm news writers on tight deadlines (Granado, 2011). As news writers confront these pressures while writing science stories for a non-scientific audience, the reporters perform a type of boundary work, "defining what does (and does not) count as reliable and valid knowledge; whether a scientific consensus exists; what is controversial; who is a credible expert (and who is not); and, to some extent at least, when and why readers should be concerned about a science-based issue" (Holliman, 2011a, p. 839).

Science news writers themselves have traditionally embraced their responsibility for policing the boundary of scientific expertise, deliberately identifying themselves as specialists with unique qualifications to convey science information (Fahy & Nisbet, 2011; Rensberger, 2009; Trench, 2007). The emergence of modern science journalism in the 20th century is closely tied to a belief in the virtues of science as public good; the science writer role, therefore, enacts a civic duty of public education (Fahy & Nisbet, 2011; Rensberger, 2009). Those writers relied on their specialized professional status to prove their credibility to both their scientist sources and their public audience. The 1955

National Association of Science Writers (NASW) charter established their mission to "foster the dissemination of accurate information regarding science through all media normally devoted to informing the public" (NASW Website). In 2016, NASW is still an active organization with over 2,200 members including employees of major newspapers, magazines, and broadcasting companies and hosts a number of conferences and educational events (NASW Website).

Despite the relatively long tradition of science writers asserting themselves as a unique form of journalist, scholars of the public understanding of science currently describe "a disruptive period of continuity and change in the ways that scientific information (and other forms of knowledge) circulate in the public sphere" (Holliman, 2011a, p. 834). Mainstream print and broadcast media still provide science information to the general public on the largest scale (Boykoff, 2008; Brossard & Nisbet, 2007; Holliman, 2011a; Nisbet & Scheufele, 2009; Tøsse, 2013), but online communication and changes in scientific and journalistic practices provide additional opportunities for the public to encounter science information. Citizen science, special interest blogs, broadly shared scientific datasets, and other forms of interaction all contribute to a daily information environment permeated by scientific data, and science information that is increasingly less mediated (Borgman, Abelson, & Dirks, 2008; Schäfer, 2009). The science work itself is also increasingly visible to the public, through changes in both information technology and science practice (Boykoff & Boykoff, 2004; Jung, 2012; Peters, 2012; Schäfer, 2009; Tøsse, 2013). These changes in public visibility can include planned collaborative projects, such as the recruitment of "citizen scientists" to collect and share environmental data (Cohn, 2008; Van House, 2004).

Just as the emergent digital culture reshapes the science news landscape, it also has shaped the work of science itself. Historically, scientists themselves have disdained mass media exposure, considering public visibility at odds with "inner-scientific norms" (Peters, 2012, p. 219). Concerns about journalistic inaccuracy in reporting their scientific findings appear prominently in surveys of scientists (Dunwoody, 2012; Trench, 2007). However, a number of recent studies also suggest that scientists are not as antagonistic

towards media as previously thought (*e.g.*, Dunwoody, Brossard, & Dudo, 2009). Regardless, public visibility though mass media exposure offers a tangible form of legitimization for scientific work, manifested in terms of research funding or prestigious appointments (Dunwoody *et al.*, 2009; Jung, 2012; Peters, 2008, 2012). Scientists and scientific institutions are increasingly attentive to how their work is presented to outside audiences and may author their own communications (such as blogs or Twitter feeds) to speak directly to the public and circumvent traditional science reportage (Bonetta, 2007; Fahy & Nisbet, 2011; Trench, 2007).

As scientists and non-scientists engage in science communication activities formerly reserved for formally-identified science journalists, Deuze's element of *participation* is foregrounded. *Remediation* and *bricolage* develop as existing forms of communication are adapted, and entirely new forms of communication are spun out of scientist-authored Twitter feeds and collaborative crowd-sourced data gathering. This study builds on the core philosophical concepts of credibility and trust to further develop a body of literature that moves well beyond traditional notions of journalism and publishing to examine how science news work functions as an exemplar for many types of informative writing that crosses boundaries or knowledge and practice. Ongoing studies of participation in online news and other types of collaborative sites, such as Wikipedia and question-and-answer sites, share a central concern with balancing broad participation with information quality and credibility *(e.g.*, Ahn, Butler, Weng, & Webster, 2013; Lucassen & Schraagen, 2010). My work will contribute to that discourse as well.

Conceptual and disciplinary scope of this study

My examination of contemporary science news writing illuminates the social dimensions of information credibility decisions. My work is informed by credibility theory as well as prior ethnographic study of journalism work and collaborative knowledge sharing online. I intend to advance the understanding of how information credibility functions in networked spaces by articulating the features of the work of science news writers and how concepts of identity serve to support or undermine credibility decisions in a complex information environment. Science journalists make credibility judgments when they

select sources, and infer how their own credibility will be judged when writing for future audiences. "Doing credibility" is part of an ongoing synthetic process.

I have investigated how science writers manage credibility evaluations during science news authoring through the selection, use, and incorporation of information sources in their stories. A key element of journalistic practices (and one that involves significant social identity work) is the news writers' interaction with their sources. Journalists' source credibility judgments are commonly viewed as assumptions based on working notions of trustworthiness and social connections, without reference to any detailed framework (Dunwoody & Ryan, 1987; Ekström, 2002; Fishman, 1980). Even in the contemporary environment, scholars of journalism struggle with defining particular news writing routines that are central to the epistemological authority journalists assert; findings from social studies of news writing are often ambiguous and contradictory when examining how news writers use their sources (Dickinson, Matthews, & Saltzis, 2013; Godler & Reich, 2013; Meyer, 2010; Reich, 2006).

Within science news writing, subject matter may be uncertain or contested in ways not accessible to the public. The information's value often lies in its relationship to public conversation, public policy, values, and funding. Meanwhile, the expansion of online information and a less-mediated information environment contribute to a "perceived diminished role for science reporters as chief disseminators of scientific content" (Fahy & Nisbet, 2011, p. 783). While significant scholarship reflects on these concerns, overall there is "little regard for how a science journalist would situate themselves [sic] in an alternative framework of production. Theory abounds, practice is neglected" (Amend, Capurro, & Secko, 2014, p. 15).

My study focuses on news writing practices in order to illuminate the specific problem space of science communication, and to contribute to broader ongoing investigations into social epistemologies and credibility within 21st century digital culture. In beginning this examination, I draw on a wide body of multi-disciplinary literatures offering theoretical and methodological guidance concentrated mainly within the disciplines of information

studies and communication. These literatures emphasize the role of social connections, social practices, and professional identity on credibility judgments. The role of trust, as a psychological and social construct, underpins this idea of credibility in practice. However, a coherent theoretical framing of credibility and its relation to trust has remained elusive in prior empirical studies of credibility, as literature reviewed more thoroughly in Chapter 2 will demonstrate.

In current information credibility study, the role of social contexts emerges at the forefront in the 21st century (Jessen & Jørgensen, 2011; Luyt & Tan, 2010; Metzger *et al.*, 2010; Rowe, 2010; Self, 2009). Repeatedly, researchers have specifically identified an understanding of social interactions as a means to address shortcomings in existing credibility theory. For example, in their examination of credibility in Wikipedia articles, Luyt and Tan (2010) found that many articles did not adhere to the site's policy of "verifiability;" many entries featured a number of un-cited or poorly-cited claims. While traditional information credibility scholarship depends on a model of authoritative citation, Luyt and Tan conclude that a broader consideration of the social context of the material's production and use is necessary for understanding the trust placed in sites like Wikipedia. Similarly, after exploring everyday online information-seeking behavior among a variety of individuals in focus group discussion, Metzger *et al.* (2010) demonstrated how "social arbitration" is used to deal with the abundance of information available in many different settings. Informal conversations between friends or colleagues, often mediated by online group tools, helped participants decide between competing information sources. These authors conclude by encouraging additional credibility research to examine how social context is used to support credibility judgments (Luyt & Tan, 2010; Metzger *et al*., 2010).

Most recent science communication studies center on tension between an information deficit model of public attitudes towards science, and suggest a more social dialogic model of communication of science knowledge (Bauer, 2008; Besley & Tanner, 2011; Davies, 2009; Schäfer, 2009). That is, how the public comes to understand science is a question that scholars of public understanding of science typically approach from one of

two models. The deficit model is a normative approach that correlates negative attitudes towards science with a lack of information. The newer dialogic approach gives greater attention to the role of social interaction in knowledge development. Emerging studies of scientific communication include models of presenting science news that go beyond a didactic approach, and suggest including contextual "everyday" details relevant to the intended audience (Amend *et al*., 2014; Secko, Amend, & Friday, 2013). These newer models are implicit in working with interactive digital culture and are foregrounded in the literature review and methodology of this study. In addition, this model sheds additional light on credibility concerns and negotiations the highly social work environment of news writing (Dunwoody & Ryan, 1987; Fahy & Nisbet, 2011; Geller, Bernhardt, Gardner, Rodgers, & Holtzman, 2005; Hansen, 2009; Ten Eyck, 1999; Trench, 2008a, 2009).

The next chapter's literature review offers a theoretical justification this study's research questions and methodology by summarizing the streams of research that illustrate the influence of social practices on credibility judgments in the communication of science information. The work of contemporary science writers exemplifies knowledge work in our digital culture, offering insights beyond the immediate setting of science news writing. The following research questions have emerged from the literature review focused on the practice space of science journalism, but are aimed at informing ongoing scholarly conversations related to a number of forms of online and interactive knowledge-sharing. The research questions related to credibility will be addressed via thematic axes of social identity and processes as the "tools" with which a science news writer engages with boundary-crossing information.

Research questions

1. How do science writers understand information credibility? How does this affect their sourcing decisions?

2. How does this understanding interact with other factors writers consider when creating persuasive communications from expert source information?

3. How can understanding the experience of professional science writers inform theory related to the communication of credible expert information within collaborative online environments?

Potential impact

By focusing on social processes and identity as the themes along which to develop my analysis, I am aiming to engage with the broadest scope of disciplinary approaches, while using the sociological and analytical tools with proven explanatory power. In asking my research participants to tell me, in their own words, about who they are when they do their work, I am allowing for a wide range of responses that enable me to consider science news writing within its larger information environment. I hope to enable three potential impacts from that approach.

First, I hope to contribute to the study of science communication and public understanding of science from an outside perspective. Most of the research related to scientific communication currently comes from either specialized journalism programs, or from scientific literacy efforts working to assist researchers in communicating directly with the public. These disciplinary areas come from two quite different normative traditions, and have had difficulties finding common ground. A perspective from library and information science, with our traditions of collaboration and inclusiveness, enables a "third force" in that space.

Second, many of the concerns of freelance writers, particularly as related to their professional credibility and perceived value as profession are not limited to writers. The global workforce is seen as becoming more distributed and more working arrangements are now contingent and flexible in a "gig economy." Insights related to the social and political economy of freelance work can contribute to scholarship in organizational science and policy studies.

Third, as I will describe in Chapter 5, I anticipate this study speaking to broader studies on online collaborative information spaces. The affordances of online technologies have allowed for the sharing of expertise and skills in a variety of distributed formats with little mediation. Many areas of scholarship and professional practice are concerned with optimizing the benefits of those interactions, while maintaining a sense of trust in the quality of the shared information. How does information become social knowledge, when shared across social networks and unmoored from traditional understandings of shared culture? I will suggest that well-established theoretical underpinnings of communities of practice and social capital can support a more synthetic understanding of credibility judgments.

2 LITERATURE REVIEW: INFORMATION TRUST AND JOURNALISM PRACTICE

Overview

Theoretical understandings and empirical approaches to the study of information credibility vary widely depending on the social and intellectual context of the research space, as well as the disciplinary stance of the researchers. Questions of credibility have historically engaged classical concepts related to Platonic knowledge, Aristotelian rhetoric, and problematic definitions of social trust (Self, 2009). Even within a single discipline, the concept of "information trust" or "credibility" may be operationalized in a number of different ways and supported by a variety of theories and modeled understandings (Rieh & Danielson, 2007). For example, recent research has used descriptors such as "fair/unfair" (Thorson et al., 2010) or "reliable" (Kang et al., 2011) on Likert-scale response items as an empirical credibility measure in their studies. Across studies, however, consistent dimensions of a credibility variable continually elude researchers.

Therefore, I have chosen in this study to engage a wide interdisciplinary space that can accommodate a number of different approaches to defining credibility and information trust. My literature review focuses on scholarship that supports a socially-constructed and iterative understanding of credibility bound by practices in a digital culture, and leaves rigid metrics aside. This view embraces the particular discursive work of science reporting, a rich site for exploring knowledge-sharing among professional writers, other public communicators, and scientists. Professional news writers work to create credible and accurate communications for public consumption, but credibility is just one of their concerns, as dramatic changes in technology and economics of the mass media have reshaped the news landscape. Information trust, or credibility, cannot be considered independent of these pressures. The management of credibility in the evolving news media space, where it is essential to professional identity and authority, can shed light on concerns relating to information sharing across boundaries in many areas of practice.

Although a coherent cross-disciplinary (or even within-discipline) definition of credibility is essentially out of reach, this study is informed by a literature review and synthesis that identifies two streams of credibility scholarship that serve as a frame of reference. Within information science, study of credibility focuses on user-source interactions, including relevance judgments, source attributes, and social context. This stream of research informs my examination of science writers' sourcing and citation patterns. From scholarship of mass communication and journalism, sociological examinations of credibility and the role of economic and political power contribute to my research on the writer's editorial relationships, attitudes towards their audience, and financial environment.

I begin the review of the literature with an examination of the shared roots for these streams of scholarship. Rhetorical theory from ancient Greece is one of the few areas of shared foundations among divergent approaches to credibility study (Self, 2009). Ancient traditions of exposition and narration underpin theory and modeling in both the information science and mass communication space. This review of theoretical literature will then move to address social trust and epistemology in broad terms, as well as applied to the domains of news writing and science writing.

Within information science, credibility study has focused on the features of information sources as related to credibility judgments, suggesting "that there is a generally valid perception or standard of credibility that is equally applicable by all users to all documents, or at least to all documents associated with a particular task situation" (Feinberg, 2012, p. 330). In reaching for universality in this way, information science has often struggled to incorporate emerging forms of online communication and their varying visual features and capacities for interaction. This credibility literature still offers important insight, but requires additional depth from more specific ethnographic research related to particular cases.

In examining prior study of journalists generally, and science news writers in particular, my review of literature concentrates on central themes of professional identity and

emerging practices related to news writing. This framing aligns itself with classical notions of persuasion and communication, while avoiding some potential conflicts encountered in information credibility study in recent years. Sociological study of news writing, and application of discourse analysis approaches are used to further an understanding how writers both judge sources to be credibility, and in, turn, try and be credibility sources themselves.

This study chooses the case of science journalism and its unique positioning as an interdisciplinary knowledge-sharing endeavor. By organizing this literature review around broadly applicable themes of identity and process, the research space (and its knowledge gaps) become much more clear and the findings from this study more salient for a number of potential information situations.

Shared foundations

The role of ethos

Scholarly treatments of communication, persuasion, and credibility often find their earliest conceptual foundations in ancient Greece. Aristotle's idea of *ethos* arises from discussions of persuasion and moral character of public speakers in his *Rhetoric*. All communication, in Aristotle's view, is persuasive communication (MacDougall, 2005). *Ethos* is one of three elements of Aristotle's theoretical concept of *pisteis* (proof). Aristotle also included *pathos* (emotions) and *logos* (the actual subject matter under discussion) as elements of persuasive communication (Aristotle, 2012; Reynolds, 1993). The *ethos* is directly tied to a speaker of a message (unlike *logos* and *pathos*) and is made up of three parts: wisdom, virtue, and goodwill toward the listener (Delia, 1976; McCroskey & Young, 1981; Reynolds, 1993). Later credibility scholarship frequently condenses these three elements down to two: the competence or expertise of a source, and his or her trustworthiness or character (Fogg *et al.*, 2003; McCroskey & Young, 1981).

Scholars from a number of disciplines continue to engage with interpretations of Aristotle's *ethos* and its components in order to examine how written or spoken communication is understood as trustworthy and/or persuasive to its receivers (*e.g.*, Burbules, 2001; MacDougall, 2005; Warnick, 2004). Within mass communication study, the *ethos*-based research is best represented by a line of psychometric approaches to credibility theory developed by Yale psychology researchers Hovland and Weiss in 1951 (Hovland & Weiss, 1951; Severin & Tankard Jr., 2001). Hovland and Weiss's key contribution to this scholarship is generally referred to as source credibility theory within communication study. These approaches are treated in more detail in the following section, but mentioned here as the most substantial body of research reflective of the Aristotelian *ethos* foundations.

Other scholarship suggests more nuanced roles for the *ethos* concept and a reopening of the philosophical assumptions that source credibility theory may have taken for granted or ignored, such as an individual's affective disposition towards a source (Simons, Berkowitz, & Moyer, 1970). These context-focused critiques are especially salient in a research space that engages questions of public deliberation of complex topics across communities. Within science writing, freelance writers, scientific experts, and publishing venues may be motivated by a number of divergent, if not truly contradictory concerns (Fahy & Nisbet, 2011; Fjæstad, 2007; Nelkin, 1995). Reynolds (1993), in writing about the rhetorical uses of *ethos,* suggests a broader definition of *ethos* that includes consideration of location of the speaker and his or her accompanying values. That is, a speaker's "location" in a given social context (*e.g.,* teacher, student, judge) and should be a factor in considering the credibility of a communication. Writers "earn their rhetorical authority by being responsible - by stating explicitly their identities, positions or locations, and political goals" (Reynolds, 1993, p. 330). Part of the *ethos* construction in this view happens at the "betweens" – sites of negotiation between specific communities. Source credibility theory largely ignores such features (1993, p. 327).

The power of shared values between author and audience underlies more detailed studies of rhetoric and persuasion, such the twentieth-century treatise on rhetoric by Perelman

and Olbrechts-Tyteca (1969). Again invoking Aristotlean principles, the authors suggest that in making a persuasive argument, "the important thing is not knowing what the speaker regards as true as important, but knowing the views of those he is addressing" (Perelman & Olbrechts-Tyteca, 1969, pp. 23–24). In constructing persuasive communication, an author needs to secure her audience's "mental cooperation" – a willingness to go along with the writer on a narrative journey starting from an opening premise. In traditional publishing spaces, this "premise" could be the form of publication or shared affiliation of the audience members. For example, readers of the journal of the American Physical Society share similar disciplinary orientations and bases of knowledge. Writers for that publication will be able to assume some shared perspectives and backgrounds, and can start off with a premise of argumentation that may be further ahead than what could be assumed when writing for the same subject for a daily mass market newspaper.

These theories of *ethos* describe rhetorical stances in philosophical terms in support of a critical analysis. Scholars of human behavior in online environments, meanwhile, see a more practical rationale behind being explicit about locations and identities for *ethos*. Warnick (2004) points out that Aristotle's *pisteis* relied on a public deliberative space, where many attributes of the speaker (including his or her appearance, manner, and dress) were open for public scrutiny. Later theories developed around *ethos* – such as source credibility theory – assumed a mediated information environment where authorities such as publishers, libraries, and scientific institutions would provide visible indicators of credibility, while at the same time, hide some original source attributes from view. The online environment, some scholars suggest, may come closer to re-approximating the broad public *fora* of Aristotle's original theory (Burbules, 2001; MacDougall, 2005; Warnick, 2004). Forms of online engagement, such as blogs and citizen journalism, encourage un-mediated public discussion in ways nearly impossible in earlier eras (*e.g.*, Goode, 2009; MacDougall, 2005). Everyone online has the potential to speak before a limitless audience, deeply complicating the role of shared values with an imagined audience in traditional rhetorical analysis.

This multiplicity of authorial voices creates and supports a multitude of available information sources. Scholarship of online trust and communication currently wrestles with the problem of how *ethos* functions in this environment – or sets aside *ethos* theory in favor of examining "likes" and "re-Tweets" as evidence of persuasive communication (*e.g*., Jessen & Jørgensen, 2011; Morris, Counts, Roseway, Hoff, & Schwarz, 2012). However, a compelling solution is suggested by the notion of "synthetic ethos" put forward by Feinberg (2012). According to a model of synthetic ethos, credibility may be established in the relationships between sources and in the formal and informal organizational structures that surround them – similar to the "betweens" proposed by Reynolds (1993). In Feinberg's presentation, the manner of organizing a collection of materials demonstrates values and epistemologies. Synthetic ethos addresses the intertextuality of hyperlinked online communication, but also responds to the question of multiple or unexpected audiences in the long tail of Internet publication. As Feinberg points out, "a document that effectively cultivates ethos with one group may sacrifice believability for another audience" (2012, p. 332). In a group of documents, whether purposefully organized by some authorities, or related by emerging social networks or links, *ethos* is generated by "choices accrued toward the market," not by any formal organization (2012, p. 333).

As reasonable as a "synthetic ethos" may sound in the networked 21st century, this approach pushes back against decades of scholarship endeavoring to closely focus on the characteristics of individual information sources for clues to anticipated credibility judgments. This source-based focus persist in studies, that, for example focus on the color used in web site design as provoking judgments of trustworthiness (Alberts & van der Geest, 2011). The synthetic approach, however, is supported when looking at larger social phenomena such as trust and social epistemology. The details of an information artifact are only one small set of variables with a ongoing social interaction.

Trust and social epistemology

A view of credibility decisions that moves beyond the characteristics of the source of the message necessarily becomes more of a sociological concern as it attempts to account for

the context of a communication. This contextual approach offers substantial explanatory power, requiring careful attention to the site and characteristics of particular information encounters. Focused attention to social context is also less likely to result in an all-purpose model or theory of credibility. The question of "how we know what we know" in a social setting can be addressed with theories of trust and social epistemology. These interconnected theoretical areas concern themselves with how humans choose what to know in an environment with abundant information sources. Trust is the most foundational of these areas (Govier, 1997; Hardin, 2000; Hardwig, 1991).

Focusing deeply within the general social trust literature, this section specifically examines work on trust as a functional information filter. At the individual level, trust in information enables people to reduce complex inputs about the world and provides opportunities for rational action (Burbules, 2001; Luhmann, 1979; Möllering, 2001). Within groups, interpersonal trust enables individuals to exchange information and engage in knowledge work without having to re-establish each other's *bona fides* prior to each communicative act. "We need to […] get the information we were originally looking for. This means that, at some point, judgments rely on attributions of trust -- trust in individuals, trust in communities and collective (if largely invisible) processes of vetting information" (Burbules, 2001, p. 451). This view of trust – as a means to simplify and filter information in a complex environment – is also well-established in studies of journalism practices and epistemologies, particularly in positioning those practices in a digital world (Craig, 2010; Heinrich, 2011; Trench, 2007).

Trust relationships underpin theoretical understandings of knowledge structures – both as social phenomena (epistemologies) and as ontologies (Davenport & Cronin, 2000; Hardwig, 1991). As Wilson explains in his conception of cognitive authority –authorities both tell us who and what in particular is credible and trustworthy (epistemological questions), but also what are the appropriate boundaries of knowledge within our domain (an ontological understanding) (Wilson, 1983). While information science scholars have been perhaps the most explicit in modern scholarship in articulating the role of trust in the development of knowledge and information structures (*e.g.*, Egan & Shera, 1952;

Fallis, 2006), sociology of science scholars such as Hardwig (1991) are also very clear about trust's primacy. "In an important sense, then, trust is often epistemologically even more basic than empirical data or logical arguments: the data and the argument are available only through trust" (p. 694).

Hardwig (1991) instantiates his epistemological argument in the literal details of managing data in modern research environments – suggesting that the need for teams to thoroughly gather and analyze large amounts of data illuminates the importance of trust in knowledge-building work. The role of teams in complex research and the accompanying trust elements are highlighted by other scholars in a variety of applied settings (*e.g.*, Aral & Van Alstyne, 2007; Knorr-Cetina, 2010; Mizruchi & Stearns, 2001; Wuchty, Jones, & Uzzi, 2007). Building on theoretical models such as actor-network theory and communities of practice, this work emphasizes the affordances of shared tools and objects for social cohesion and collaborative knowledge building (Knorr-Cetina, 1999; Star & Griesemer, 1989). Trust is co-constructed through these shared practices.

Beyond its role in coordinating the work of research teams, and more central to the questions of this study, trust also serves to reduce complexity as expert information moves between and among communities. As digital interactions lower boundaries between different areas and levels of expertise, the role of trust becomes more salient because shared practices and common understandings cannot be assumed (Kelton, Fleischmann, & Wallace, 2008; Trench, 2007; Van House, 2002). In digital information spaces, where an authorial source may be ambiguous, design elements, interactivity, and hyperlinks can all inform judgments of trustworthiness (*e.g.*, Fogg *et al.*, 2003; Robins & Holmes, 2008). Trust is posited as a key mediator between encountering a piece of information and using it, even if the origins of that trust are unclear (Burbules, 2001; Kelton *et al*., 2008; Warnick, 2004; Wathen & Burkell, 2002).

Scholars of information and communication have concerned themselves with the problem of online trust for decades (*e.g.*, Fritch & Cromwell, 2001; Hernon, 1995; Viehland, 1993). The ease and speed with which documents could be altered and shared prompted

substantial concern (but few solutions) about how "even knowledgeable individuals might be duped" by misinformation on the Internet (Hernon, 1995, p. 138). Current approaches to understanding online trust in information range from design studies examining visual and interactive features of web sites (e.g., Robins et al., 2010) to algorithmic big data approaches (*e.g.*, Tanaka *et al*., 2010). The nature of how people come to trust information online, and accordingly, how best to design and support trustworthy systems, remains a complex research space (Kelton et al., 2008; Lucassen, Muilwijk, Noordzij, & Schraagen, 2013). Lack of a single robust set of theories suggests the need to engage more closely with specific environments or practices (Heinrich, 2011; Metzger et al., 2010; Self, 2009). This study examines the news media space, and particularly, the practice of science news, as an instantiation of digital culture in an environment where expert and non-expert voices intersect.

Information science: finding credibility

> "In the field of information science, credibility research has been conducted in the context of information seeking and retrieval. Therefore, credibility is often considered a core criterion for people to rely on when they try to reduce the amount of information they consume by selecting more useful, accurate, current, objective, complete, and reliable" (Rieh, Jeon, Yang, & Lampe, 2014, p. 437)

Contemporary information science scholarship grows out of the professional roots of librarianship and computer science. These fields share a focus on helping individuals find, use, evaluate, and manipulate information. Information science aims to support the tasks of individual in managing an increasingly complex information environment. Its norms tend to be less prescriptive and more responsive than those of journalism. Information science tends to focus on the attributes of a source of information to determine its trustworthiness and relevance for the question at hand – trusting that the individual is the best judge of the relevance for the question. (Journalism, in contrast, tends to more directly shape the questions of a culture and its publics (Gans, 1979; Mindich, 2004).) This section briefly outlines the theoretical and model-building stream

of credibility literature within information science, in order to explore the contrast and with journalism and mass media theory later.

Source credibility theory

Among 20th and 21st century information and communications researchers, Hovland and Weiss's source credibility theory has long been a point of reference (and more recently, departure) when discussing information credibility (Rieh & Danielson, 2007; Severin & Tankard Jr., 2001). Source credibility theory, applied to both interpersonal and mass communication interactions, places the source of the information at the center of the credibility judgment. *Ethos* is understood as "essentially similar" (Giffin, 1967, p. 106) to source credibility theory by many scholars, however, source credibility theory offers more empirical guidance. This theory emerged from a series of experiments at Yale University wherein researchers Hovland and Weiss investigated whether the source of information (operationalized as news sources *Pravda* and *Life Magazine*) would influence the credibility judgments of student participants. One of the experiments involved scientific information related to nuclear submarines; another provided commentary about the movie industry. Yale University students found the information presented from known U.S. experts in *Life Magazine* more credible than those students reading the identical information from Soviet sources in *Pravda* (Hovland & Weiss, 1951; Rogers, 1994).

Hovland and Weiss operationalized their variables within mass media sources embedded into the specific political and scientific context of the mid-20th century, yet provided little reflection on the social implications of those contextual choices. They were concerned largely with developing psychometric measurements of credibility -- operationalizing how trustworthy students found the articles by measuring information retention over time, and through scaled responses to directed questionnaires about trustworthiness. Continuing research in this stream refined measures and scales for information trust, again ignoring the many other socially-related theoretical dimensions of credibility as a concept (Delia, 1976).

Source credibility theory continues to serve as a foundational construct for empirical research of credibility judgments within mass communications (Chung, Nam, & Stefanone, 2012; Kaye & Johnson, 2011; Thorson *et al.*, 2010), as well as for similar work within information studies (Del Giudice, 2010; Hilligoss & Rieh, 2008; Robins et al., 2010). However, literature within communications and psychology scholarship has been identifying hidden complexities within this model for decades (Delia, 1976; Giffin, 1967; McCroskey & Young, 1981; Reynolds, 1993; Self, 2009; Simons *et al.*, 1970). Some of these scholars argue that the theoretical construct for the "source" understanding of credibility serves only as an initial exploration of an understanding of credible communication (Delia, 1976). Other critiques of the Hovland and Weiss work are even more pointed, arguing that the Yale program was based on inconsistent and, "in certain cases, invalid premises" (Earle & Cvetkovich, 1995, p. 15). Primarily, critics have argued that the Hovland and Weiss work created isolated experimental conditions and formulated "all purpose" theory that attached credibility concerns to source characteristics, rather than considering social context, and potentially relevant characteristics of the participants (for example, did the participant have any predispositions or previous exposure to certain types of news sources?) Source credibility theory remains firmly anchored in the "source" end of information interactions.

Communications scholar Delia challenged the source credibility concept by emphasizing the emergent and social character of credibility decisions, via reiterative "perceptual and judgmental processes" (1976, p. 366). Delia urged credibility researchers to focus on ongoing social interactions and on how those encounters influence trust and credibility decisions, rather than on how to further parse a specific credibility measurement. McCroskey and Young (1981) were even more forceful in urging a halt to continued refinement of a source credibility measure, and reminded researchers of the broad range of social and affective features that influence communication outside of an established scale of source credibility dimensions. More recent scholarship, informed by critical theory, illuminates the political and economic motivations related to a continuing focus on source credibility theory (Flanagin & Metzger, 2008; Self, 2009). "Credibility" is a commodity for mass media outlets; being able to measure its presence can allow media

producers to assign relative values to their products in an increasingly competitive marketplace (Self, 2009). However, these measurements may be of little use in fully understanding the complex phenomena of credibility judgments in a digital culture.

Shifting models and algorithms

Recent empirical work in credibility begins to address criticisms of an excessive focus on a universal measure, and is "shifting the theoretical center of the concept away from source credibility toward a new grounding in community, collaboration, and interactivity by active recipients assumed to be judging credibility within personal or communal contexts of motivations, goals, and projects" (Self, 2009, p. 435). In methodological terms, some current empirical research approximates a focus on ongoing social situations through analysis of participant-generated free text data from more ethnographic approaches (*e.g.*, Lucassen et al., 2013; Metzger *et al*., 2010; Rieh & Hilligoss, 2008; Rieh *et al*., 2014). Based on such research, scholars Hillgoss and Rieh developed a heuristic model of information credibility judgment (Figure 1 below), which proposes three levels of engagement between an individual and an information object: construct, heuristics, and interaction. The construct level represents the individual's internal "compass" for evaluating credibility and trust, heuristics are "rules of thumb" used in making those evaluations, and the interaction level describes the specific features of the information object that enable or hinder the information encounter.

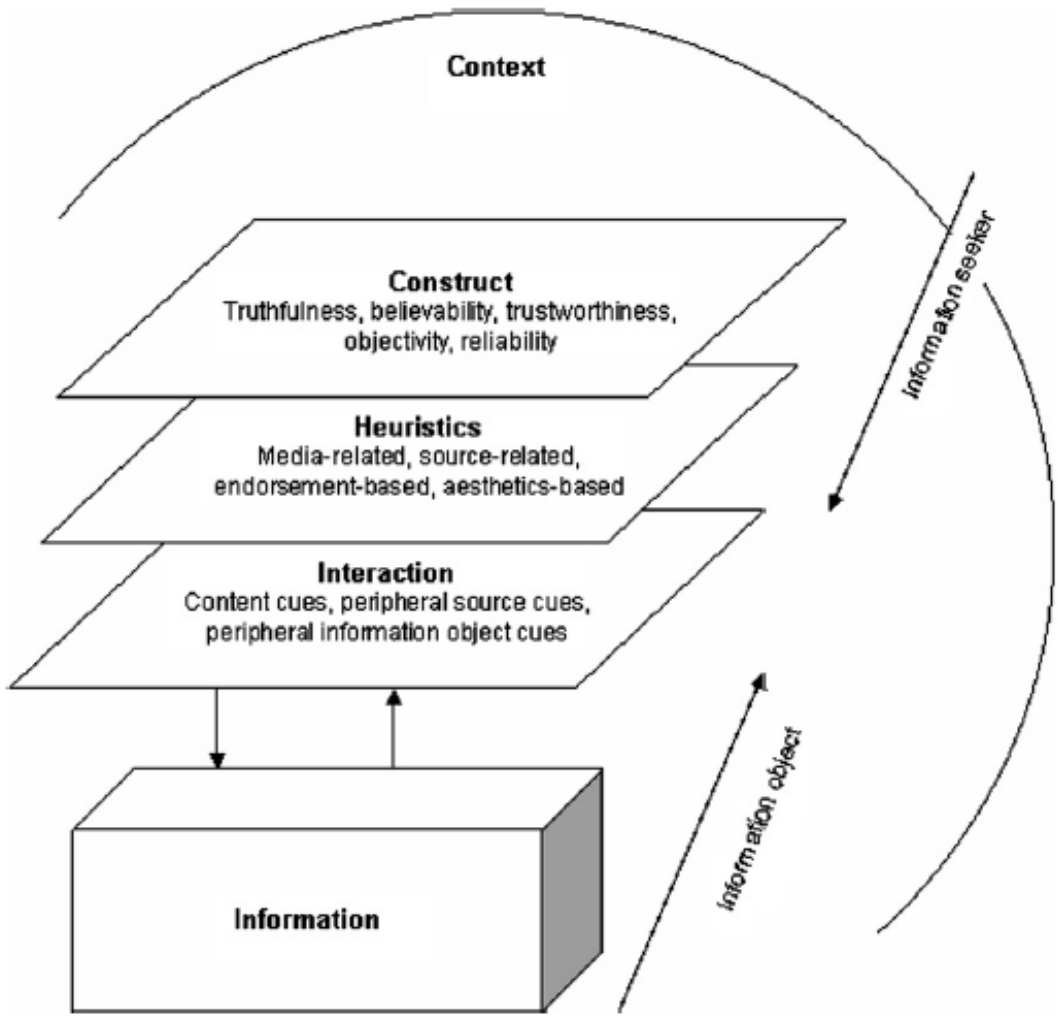

Figure 1

A unifying framework of credibility assessment (Hilligoss & Rieh, 2008, p. 1474)

This model also illustrates the overarching importance of the context of the encounter with information. Social variables are instantiated at the heuristics level (through endorsements from others) and suggested at the construct level via reliability (*i.e*. several pieces of information from different places offer confirmation) and peripheral source cues. Social context may also be instantiated by features of interaction and design. Other recent models of information trust also incorporate shared social evaluations and emphasize to a greater degree the influence of repeated interactions (*e.g*., Kelton et al., 2008; Sundar, 2008).

Some current human-computer interaction scholarship relies more explicitly on the affordances of technological tools when exploring cumulate effects and the role of repeated interactions on credibility judgments. For example, question and answer (Q&A) sites, whether general-purpose (such as Yahoo answers) or specialized (such as Stack Overflow) follow fairly standard patterns of interaction that researchers have been exploring with more algorithmic approaches. (Ahn et al., 2013; Savolainen, 2012; Tan, Niculae, Danescu-Niculescu-Mizil, & Lee, 2016). Research questions are examining the structure of argument patterns and how persuasion may be achieved in a back-an-forth exchange on these types of message boards. Quantitative measures (such as length of a response, number of exchanges, or number of prior posts from a particular poster) are readily accessible in these environments. Credibility judgments are operationalized in affordance elements such as the ability to "upvote" a particular response. So far, there is little in terms of coherent findings in terms of finding a way to describe, with numbers, which answer will be trusted or best received, but social features (such the extent of a poster's social network within a site) are a central focus.

The concepts of ongoing social interaction and community are critical to my study of the work of science writers in managing credibility concerns over the course of their careers. Science writers engage with ideas of credibility and information trust as they research articles using scientific sources, and also when they communicate the information from those sources in their own written works. Information credibility is one of several concerns writers must negotiate, along with more practical features of the writing process such as publication deadlines. Concerns related to the credibility of expert sources, and in how to most accurately communicate that credibility in writing science news, may shift depending on topics, publication constraints, and the particular point in a writer's career. The specifics of the practice of journalism are central to how to understand credibility judgments for my study.

Journalism: being credible

Journalistic processes and practices turn human experts and human witnesses into credible textual information. Journalism theorists suggest epistemological concerns are foundational in journalism, even though "journalism has not received much attention within the sociology of knowledge" (Ekström, 2002, pp. 260–61; Habermas, 2006; Matheson, 2004). Applied research in the area of news epistemology tends to focus on the role of trust in known news organizations and official affiliations in making a complicated environment more navigable for ordinary readers (Brossard & Nisbet, 2007; Hayes, Singer, & Ceppos, 2007). However, the epistemological questions are much broader and evolving rapidly and the digital environment has forced a re-opening of theoretical conversations (Steensen & Ahva, 2015).

Media scholar Mats Ekström outlines three areas for study in the epistemology of journalism generally: the form of knowledge, the production of knowledge, and public acceptance of knowledge claims (2002). These three areas are interconnected – form and production for certain modes (*e.g.*, print, television, online media) suggest implications for how knowledge is accepted. Television news, as an example, may be considered less serious or informative by critics (Ekström, 2002), but nonetheless holds powerful potential to shape public conversation (Habermas, 1991). While digital technologies are provoking a radical shift, form and process of the particular news communication have always been bound up in its ability to make claims to the truth. Media scholar Marshall McLuhan's explication of "the medium is the message" (1964) has been central to mass communication scholarship for decades (Ekström, 2002).

Within a given mode of communication, news typologies and story frames enable working understandings for news production, or rather, a way to declare certain epistemological questions settled and removed from contention (Ekström, 2002; Entman, 1993; Tuchman, 1978). For example, "crime stories" may follow a straightforward model of reporting a witness's account of events and an official police response without discussing the legitimacy of the laws related to the alleged crime. (The use of "news frames" in journalism is specifically described in more detail in a later section.)

Additionally, some knowledge that news writers encounter is considered "pre-justified" – from news bureaus, government sources, and well-known experts (Ekström, 2002; Fishman, 1980; Godler & Reich, 2013). The use of news frames and pre-justified experts serves to obscure epistemological and credibility questions from much direct scrutiny, at least in traditional (pre-Internet) journalism. "If somebody else draws the inferences — and usually this someone else is an official empowered to do so — then the journalist can treat these inferences as hard facts" (Fishman, 1980, p. 88).

Discursive techniques in news work instantiate this epistemological relationship, situating reported knowledge outside of the reporter's own opinions in order to legitimate it and prove it credible. These techniques include avoiding the use of the first person in news writing (or any reference to the author's identity), and attributing quotes that give someone else the job of identifying the "truth" (Carvalho, 2008; Clayman, 1992; Ekström, 2002; Fishman, 1980; Potter, 1996; Shapiro, Brin, Bédard-Brûlé, & Mychajlowycz, 2013). These discursive moves draw attention away from the reporter and make the verification of truth claims the job of the expert sources. Another approach used by news writers is to present the sources in a way that shows consensus and corroboration (Conrad, 1999; Reese, 1990). However, such moves have a sociological foundation beyond journalism; they are seen in science study and epistemology generally. Science and technology studies (STS) scholar Woolgar calls these techniques "externalizing devices" (Potter, 1996; Woolgar, 1988) and they are related to the "inscription" process for science knowledge described by foundational STS scholarship such as *Laboratory Life* (Latour & Woolgar, 1986). "Inscription" is defined as the means by which laboratory-discovered knowledge makes its way out into a broader world, through the publication of formal articles, but also through informal notes and conversations (Latour & Woolgar, 1986).

While the link between journalism and epistemology, broadly construed, has not been well studied, journalism's role in providing trustworthy information for an informed civil discourse is consistently a part of journalism scholarship, which often refers to Habermas' notion of a public sphere of discourse (*e.g.*, Allen, 2008; Craig, 2010; Curran,

2005; Nah & Chung, 2012). Habermas defines the public sphere as a civic space that is neither controlled by the government nor part of private home life; it is where citizens engage with each other to exchange information and exercise control over the state (Curran, 2005; Habermas, 1991). In Habermas' view, early printed newspapers were authentic *fora* for the public sphere. News items were delivered to printers by citizens and reproduced with little editorial change (Habermas, 1991). However, as journalism matured into a business enterprise in the 19th century, literary journalism with ideologies and editorial motivations of its own emerged. A "new element – political in the broader sense – was joined to the economic one" of producing news (Habermas, 1991, p. 182). Editorial opinion became a political commodity of value, one that could legitimate or challenge the laws and activities of state actors. Official agencies of government relied on the press and engaged in conflict with it.

Overall, professionalization of the press weakened its ties to the authentic public sphere and a lack of transparency about key concerns (such as financial means) was seen as preventing the modern press from effectively functioning as a true public forum (Allen, 2008; Habermas, 1991). Yet this conclusion becomes less certain in the era of digital culture. As news writers operate increasingly in a number of settings beyond traditional journalism forms, several typologies of news writers have been suggested. These typologies go beyond early 20th century sociological descriptions of news writers as more or less homogeneous actors in a political sphere to illustrate the importance of different identities and motivations. Different writers may manifest differing motivations and respond to different contexts. Building on work from Donsbach (2004) and Deuze (2005), journalism scholar McIntosh White proposes "two opposing ideal types:" the communicative and the strategic types of news writers (McIntosh White, 2012, p. 563). The communicative type writer more fully recognizes his or her role in supporting public accountability for powerful governmental and corporate forces and places a high priority on presenting all possible information to the public. The strategic type, in contrast, privileges the private sphere and may be more responsive to the goals of his or her institutional sponsor (McIntosh White, 2012). Consideration of typologies has

implications for the trust embedded between the writer and his or her audience, and the writer and his or her scientific sources (McIntosh White, 2012).

Scholars of science news as a particular journalistic form articulate a nuanced relationship between the press and their audience, as the media play a role in legitimating this expert activity in the public sphere (Jung, 2012; Peters, Heinrichs, Jung, Kallfass, & Petersen, 2008; Peters, 2008; Schäfer, 2009). When science writers communicate science news with non-scientific references, they establish relevant links between science study and public life and make science news credible for members of the public. In doing so, science journalists both legitimize science and hold it accountable (Fahy & Nisbet, 2011), demonstrating the conflict between the epistemological paradigms and practices of science news writers and journalists (Dunwoody & Ryan, 1987; Fjæstad, 2007; McIntosh White, 2012; Nelkin, 1995; Trench, 2007). Science work is performed in a privileged space where qualifications determine who is allowed to speak on specific topics. Journalism, in contrast, derives its legitimacy from a multiplicity of perspectives and consensus-building. When news writers cover a complex scientific topic by citing a multiplicity of sources to describe all views of a possible controversy, it is "very often a source of irritation to the scientists involved" (Nelkin, 1995).

Journalists develop trust as they build news stories through interactions with many individuals, as well through repeated interactions with those sources. Relationships between journalists and sources are best understood as an ongoing relationship within a larger network (Conrad, 1999; Reich, 2006; Singer, 2007). Trust develops over time and over the course of several interactions. In the course of writing a story, sources are used to define the initial outlines, but the reporter will direct the development of a story principally thereafter (Reich, 2006). However, the abundance of complex information for some science topics and science's influence on issues of public concern may make writers more beholden or deferential to their sources to manage that complexity (Brossard & Nisbet, 2007; Dunwoody & Ryan, 1987; Granado, 2011; Hansen, 2009; Trumbo, Sprecker, Dumlao, Yun, & Duke, 2001), in a way reporters working as public advocates or "watchdogs" on a political beat may not be. However, increasing numbers of science

writers have an academic background in science themselves and professional paradigms are becoming more fluid (Dunwoody, 2012).

Public opinion polls generally show high levels of trust for scientists, especially when the science information the media provide does not conflict with existing social or political goals (Nisbet & Scheufele, 2009). Yet, scientists struggle with communicating uncertain science into public policy spaces, as public deliberations often seem to ask for clear guidance and definitive answers from "science" (Amend et al., 2014; Jasanoff, 2007). Additionally, public trust can be damaged when the individuals feel that they are being talked down to or manipulated by industry interests in media representations (Bubela *et al*., 2009; Nisbet & Scheufele, 2009). In dialogic exchange between scientists and the public, transparency (particularly in regards to funding), is seen as supporting positive credibility judgments from audiences. However, this approach can be difficult for both scientists and journalists to incorporate as science work occurs in a hierarchical environment (Dunwoody, 2012). Journalists are trained and socialized to respect those credentials (Fishman, 1980; Holliman, 2011a; Nelkin, 1995; Tuchman, 1978), even as emerging study identifies new patterns of how journalists work with sources to establish credibility and frame their identities as professionals within the public sphere *(e.g*., Hermida, 2010).

Sociological study of newswork

> "The emphasis upon stories suggests that, at least in part, reporters may speak of stories among themselves rather than about events. They may see the everyday world and its supporting documents in terms of the product they are to manufacture -- a news story" (Tuchman, 1976, p. 95).

The sociological study of news reporting emerged in the 1970s and 1980s and is best represented by the work of foundational scholars Tuchman (1973, 1978) and Fishman (1980). Also Gans, writing in 1979, contributed to this discourse with a specific examination of the work of national news reporters in *Deciding What's News*. The work of these three scholars foregrounded explicit study of how "reporters 'decide' what is news and the occupational routines they employ to 'construct' the news" (Viswanath,

Blake, Meissner, & Saiontz, 2008, p. 761). Building on the early ethnographic work of Breed (1955), this scholarship examines the work of journalists as enforcers of particular norms and as legitimators of social and political power structures. The role of professional practice in building credibility is central to this view of journalism.

The study of news work by Fishman (1980), builds on the analysis of Warren Breed through a focus on the broader dynamics of power and control that surround the work of news reporters. In 1955 Breed highlighted the tensions between the individual autonomy of the reporters and the need for social conformity for the news organization. The news organization is both a broker of information to the public, and an actor in political and economic exchanges among other corporate and governmental organizations (as detailed by Habermas). Publishers and editors may need to preserve relations with holders of power and not produce news reports that challenge the status quo – but "ethical taboos" (Breed, 1955, p. 326) prevent direct editorial interference in the work of reporters. Socialization and a high degree of in-group professional identification have traditionally helped organize reporter behavior along normative lines.

Fishman builds upon a similar understanding of power structures to show how information from powerful bureaucratic sources is granted fact status in a more straightforward matter than information from other sources. Journalists are participating "in a normative order of authorized knowers in the society" (1980, p. 96). Reporters will allow for multiple perspectives on an event by citing multiple incongruous sources – if an empowered source draws inferences from these multiple perspectives, the journalist is free to treat those inferences as facts without personally assessing the evidence. Journalists seem to continue to appreciate the usefulness of official sources by their preference for institutional-affiliated sources over non-affiliated ones (Conrad, 1999; Moriarty, Jensen, & Stryker, 2010; Weaver & Wilhoit, 1996). Journalists, for the most part, are willing to participate in this power structure partially as a strategy to simplify the complex information environment – reporters need competent knowers to select and mobilize facts under deadlines (Gans, 1979; Granado, 2011; Trumbo *et al*., 2001).

In his ethnographic examination of national news reporting (*CBS Evening News*, *NBC Nightly News*, *Newsweek*, and *Time*) Herbert Gans expressed many of the same themes as Tuchman and Fishman in a study situated in elite national newsrooms (1979). While reiterating the importance of authorized sources and seeking of multiple perspectives, Gans specifically addressed issues of daily practice among news workers. The availability of sources to answer a news writer's questions, and their willingness to respond to them in ways that are accessible and useful to the writer, help define the sources' utility as a source for an immediate news article. Furthermore, a successful response to a first request may go on to define the source's future usefulness in related work for the particular journalist (Gans, 1979). In these prestigious newsrooms, the presentation of objectivity is understood as a valuable commodity that ensures audiences, and thereby, income. However, interviews with journalists demonstrated that they recognized an ethical value of objectivity apart from these commercial considerations (1979, p. 186). Informed by the then-recent Watergate scandal, Gans' participants expressed varying levels of awareness of the tensions between their role as neutral communicators of official narratives, and their own opinions of what constituted the "truth."

Once the sources are in place the journalist relies on established framings and story forms to turn the source information into a "publishable" piece of writing (Tuchman, 1973). The *de facto* standard for news writing is the inverted pyramid form as illustrated below (Mindich, 2004; Pöttker, 2003).

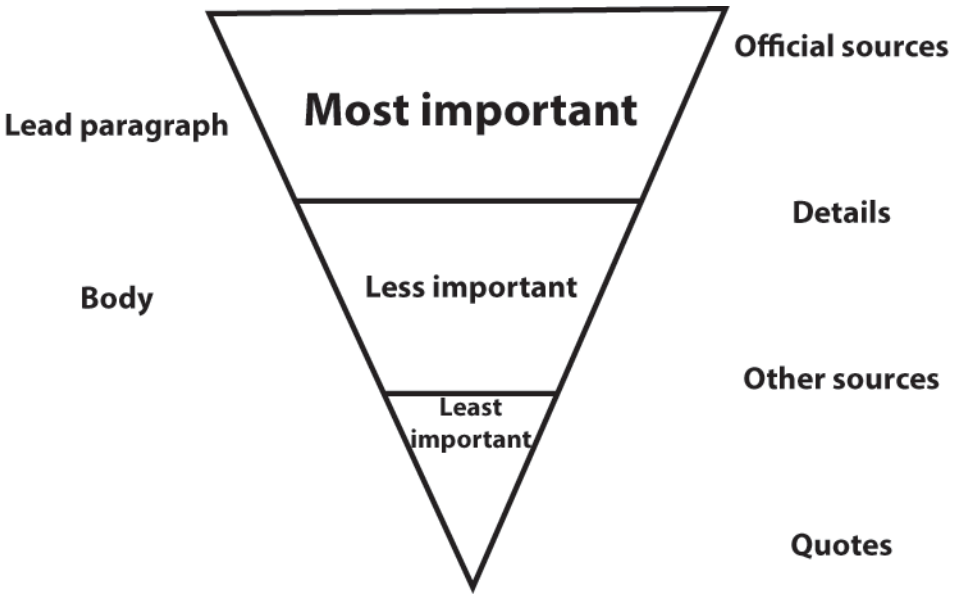

Figure 2

Inverted pyramid structure for news stories

The inverted pyramid places the "most important" pieces of information in the lead paragraph of the story, and organizes supporting information and quotes in the remaining paragraphs. This model emerged as a practical approach during industrial revolution of the late 19th century. During this time, the role of "official science" had begun to permeate news reporting, especially in areas of public health and public policy. The cholera outbreak in the US in the later 1800s were an instance in which "doctors serving as designated sources of authority" were prominent in news reporting (Mindich, 2004). The official reports were featured early in news story where they were be more likely to be read – a decision with implications for public health and safety. News reporting also became a profitable business during this time – and stories would sometimes need to abbreviated for space and economic concerns. This particular structure of a story, and the authorial and editorial judgment of the most relevant (and credible) details, remains a persistent form (Pöttker, 2003).

Foundational analyses of journalism cohere around two salient themes for the understanding of credibility in contemporary science news writing. First, journalists engage in specific social practices to present themselves as recognizable truth-tellers.

Journalists' professional identity is defined by a sense of individual autonomy as discoverers of the truth. The news profession has historically been "a permeable occupation" with frequent overlap between individuals primarily occupied with publicity goals or employed as writers of other kinds; this permeability is not an entirely new feature of the digital age (Abbott, 1988, p. 225). Professional news writers define the boundaries of their professional identity in opposition to this real and perceived competition. They do this not by serving as authorities in their own right, but by triangulating views from multiple sources in the public sphere. This triangulation is primarily discursive and ritualized; journalists may publicly perform the routine of questions-and-answers to show audiences that they are working at getting to the truth (Godler & Reich, 2013; Shapiro *et al*., 2013).

Second, understanding the practice of journalism, with its own particular norms and professional identity, requires a larger consideration of social epistemology. This consideration must take into account the economics and politics of the surrounding environment in which encounters with news information occur, and, in the case of science journalism, public understanding of science. Knowledge work and formal patterns of communication in fields such as government and science may be in conflict with journalistic identity and norms; how these conflicts are resolved shapes narrative framings of contentious issues in news writing, and thereby, public understandings.

Discursive practices and identity in journalism

Journalism scholar Gay Tuchman was one of the first to apply Goffman's conversational frames theory to reporting work in her social studies of news writing (Tuchman, 1976). The concept of framing allows for the organization of events in everyday life to be incorporated into existing social structure and routines. By surrounding an event or casual talk with well-defined contextual information it becomes part of social reality. Tuchman specifically applied this concept to the work news writers do when they witness an event and covert it into broadly-accessible "objective" social reality for readers of newspaper by writing about in the standard inverted pyramid format in the newspaper (Tuchman, 1976). The inverted pyramid model places the most important information in the opening

paragraph, and less-relevant (and more numerous) details later in the story (Pöttker, 2003).The news writers are framing the story by putting it into the editorial context of the paper, the larger social and political context that helps decide what the most important facts are for that first paragraph (Scheufele, 1999; Tuchman, 1978). These decisions are supported by news frames.

The current understanding of media frames (or news frames) is defined by Gitlin as "persistent patterns of cognition, interpretation, and presentation, of selection, emphasis, and exclusion, by which symbol-handlers routinely organize discourse" (1980, p. 7). Framing, although its application is often confused (Entman, 1993), continues to be an important in path for interpreting identity and credibility management in ethnographic journalism studies *(e.g.*, Antilla, 2005). Goffman's related theory of conversational footings (1981) has more direct relevance for examining the discursive work of journalists as they construct credible information for readers out of many different narrative sources. Footing theory is a way to describe the speaker's relationship (and the relationship's changes over the course of a communication) to the information being expressed. Contextual cues surrounding the communication, both linguistic and non-verbal, illustrate the relationship between the speaker and the information being expressed. Specifically, the speaker may be the animator, author, or principal of what is being said (Clayman, 1992, p. 165). All three footings may be in place at once, for example, if a single speaker is telling a story about himself or herself. The footing shifts if speaker A is reporting the activities of B, and shifts again if speaker A is reporting second-hand about what C saw B do. Changes in footing suggest changes in frame, and are closely linked to the notion of code-switching (Goffman, 1981, p. 145). For example, a political reporter may use a "conflict" frame in reporting what candidate A said about incumbent B, using discursive shifts in footing to clarify that the contentious information were the words of A, not the reporter's own.

Gaye Tuchman first adapted the theory of news framing from Erving Goffman's theory of conversational frames (1976, 1978) and this theoretical support continues to be central in studies of journalistic epistemology (*e.g.*, Druckman, 2001; Jung, 2012; Nisbet,

Brossard, & Kroepsch, 2003; Reese, 2007). In journalism terms, a frame is "a central organizing idea or story line for a controversy" (Nisbet *et al*., 2003, p. 38). Reporters are socialized to cover stories according to established frames and conventions of the newspaper medium (*e.g*., front page story, back page story). Events are given their character by existing social structure. Frames are chosen by the journalist for specific reasons related to ongoing concerns in the larger social world (*e.g*., Antilla, 2005; Callaghan & Schnell, 2009; Nisbet *et al*., 2003). Climate science stories, for example, are frequently reported on in the context of existing conflicts between political interests, or as a question of controversial science. The Climategate story shows the persistence of the "Watergate" frame (and suffix) as way to present perceived conspiracies (Holliman, 2011a; Nerlich, 2010). The choices for established points of reference are not inconsequential, as the particular news frames used by reporters have been shown to alter how readers think about political issues (Antilla, 2005; Callaghan & Schnell, 2009), for example.

Scheufele advances Tuchman's approach to framing theory by suggesting even further meta-theoretical applications (1999). While Tuchman (1976, 1978) articulates how frames make happenings news, Scheufele's approach goes beyond this to suggest that frames turn happenings into social reality. This approach allows for consideration of the audience's own internal frames and a broader social constructionist understanding of the role of news reporting in communicating information and shared public understandings. News framing is posited as a bridge between macro-level socially constructed understandings and micro-level individual beliefs. Other work suggests implications for cognitive processing of information related to the use and choice of frames in a news story (Callaghan & Schnell, 2009). The choice of sources and their perceived credibility is central to the framing perspective:

Thus, the real value of sources lies in their ability to enhance framing effects (Callaghan & Schnell, 2009). While frames matter, sources, especially credible ones, matter even more. Encountering a credible source likely generates an increased interest in the frame that shifts the attitudinal judgment in the direction of the frame. Encountering a biased

source (for example, from a lobbying group or a political party) tends to mitigate the impact of the frame. Presumably, the unbiased source caused respondents to internalize the frame, integrating it into his or her own value and belief systems (Callaghan & Schnell, 2009, p. 22).

Footing and frame have epistemological relevance for journalism, and science journalism in particular, as they are often used to support journalistic norms of objectivity and neutrality (Clayman, 1992; Ekström, 2002; Nisbet *et al*., 2003; Ryghaug & Skjølsvold, 2010). Journalists traditionally ground their identity as credible communicators by discursively framing news narratives outside of themselves with expert sources. "News journalism seeks legitimacy by diverting attention away from journalism as a producing, interpreting and arguing activity. The anchor, the reporter, and interviewers in any newscast all generally use a footing of 'animators', *i.e*. they communicate what others have said" (Ekström, 2002, p. 279). Newsworthy events "become known through the already coded and interpreted discourse of others " (Van Dijk, 1988, pp. 96–97). In this way, traditional journalism functions as a way to amplify the conversations within a society, mapping out specific regions of argument and their participants, without charging the news writing itself with identifying a particular truth (Clayman, 1992; Craig, 2010; Deuze, 2005; Ekström, 2002; Van Dijk, 1988)

However, the distancing of authority away from the reporter himself carries with it the risk of journalism being seen as reproducing "poor copies of science and literature" (Ekström, 2002, p. 264) in its efforts to make specialized communication widely accessible. Additionally, as journalism has moved online, the notion of what constitutes public discourse become increasingly difficult to define. As the public has fractured, and fewer single media outlets dominate, the idea of a single shared public space or deliberative decision-making in the public sphere becomes less central than a notion of "agonistic pluralism" (Mouffe, 1999; Papacharissi, 2009). The discursive implications are that subtle shifts in frame and footing may be difficult to manage in these less-mediated agonistic digital communications. "Back stage" and "front stage" distinctions, key to

traditional journalistic shifts in footing, may often be made in public (Karlsson, Clerwall, & Nord, 2014; Karlsson, 2011; Singer, 2014).

The shifting role of professional journalistic practices

The professional communities of both scientists and journalists have expressed concern over shifting boundaries between specialized spheres of knowledge and engagement when nearly anyone can make "news" (*e.g*., Allen, 2008; Domingo *et al*., 2008; Hayes *et al.*, 2007; Netzley & Hemmer, 2012; Singer, 2003, 2007). These evolving epistemological boundaries are demonstrated by changing journalistic practices. News writers may or may not have specialized science knowledge themselves, but they know where to obtain it in a way ordinary citizens do not (Hermida, 2010). "One of the fundamental assumptions of news work is that when journalists lack the knowledge necessary to cover a particular story, they can obtain it by interviewing knowledgeable people" (Smith, 1996, p. 207). What now defines these "knowledgeable people" and how a journalist works with them in a digital culture is a question underlying my study.

Rather than constructing authority via access to expert sources behind metaphorical closed doors, news writers use different approaches of authority. With an abundance of potential sources and more types of mediation, verification of the details of a story is part of a networked process, which includes audiences, rather than centered on access to a knowledgeable person (Heinrich, 2011). Knowledge is a process rather than a product, and journalistic claims to authority are "implying discernment, an ability to locate needles in the haystack of the internet and therefore a claim to breadth of knowledge, even comprehensiveness" (Matheson, 2004, p. 456). This process is best described by two primary features: new participants in the process of information gatekeeping and repeated interactions over time.

First, increasing participation in news media spaces by non-journalistic professionals demonstrates a form "secondary gatekeeping" of information in digital culture (Singer, 2014, p. 55). An abundance of news, and ample opportunities to select and interact with that news through personalized portals, comment sections, and blogs allow many more

types of people to make quasi-editorial decisions in media spaces (Heinrich, 2011; Holliman, 2011b; Singer, 2003, 2014). Professionally-identified journalists work alongside (digitally speaking) individuals who would likely never have been in a traditional newsroom (Hayes *et al*., 2007; Heinrich, 2011; Singer, 2007, 2014). These participants in comment forums and in blogs may have never been formally exposed to the norm of the "inverted pyramid" style of reporting, but are likely still enacting to its pervasive utility (Pöttker, 2003).

Second, in creating credible news knowledge, writers engage in repeated interactions with their sources. These interactions are characterized by a two-part sequence: contacts with sources for "news discovery" purposes, and interactions for "news gathering" (Godler & Reich, 2013; Reich, 2006). The initial discovery area of news work is described as a "systematically unapproachable, and hardly visible social arena in which reporters and sources exchange information, which later becomes the news fed to the public" (Reich, 2006, p. 504). In discovering news, writers are more dependent on their sources for the definitions and identification of what constitutes news. The second news-gathering stage is where the reporters contact multiple sources with different perspectives to craft a narrative. Story frames, or media frames, may play a central role here, as do editorial concerns (Carpenter, 2007; Reich, 2006). Prior studies, in news journalism and science journalism, have found correlations between number and type of sources cited and characteristics of the publication venue (Carpenter, 2007; Holliman, 2004). For example, elite newspapers tended to cite more sources per story in a study of Iraq war coverage (Carpenter, 2007)

It is in the repeated interactions that may describe boundaries between participants in the news media space. Journalists, who identify professionally as such, demonstrate a "methodological commitment to accuracy" (Shapiro *et al*., 2013, p. 669). Verification of facts occurs alongside the news-gathering and framing portions of news writing in an ongoing loop. It is central to how journalists understand their work (Hayes *et al*., 2007; Hermans, Vergeer, & D'Haenens, 2009; Shapiro *et al*., 2013), and may be ritualized when performed in public (Shapiro *et al.*, 2013). These boundaries become complicated

when the news under question is a shared public concern. News reporters are traditionally crafting narratives for collective memory; citizen journalists may object to "official journalism's" version of events to give their version of the truth (Robinson, 2009). In reportage of Hurricane Katrina, for example reporters invoked their identities as also citizens suffering from the effects of the storm and flooding to be able to tell the story credibly to their audiences (Robinson, 2009). This strategy, within the science news space, can conflict with science journalists' self-proclaimed status especially empowered to talk about science.

Credibility and selection of sources

Historically, sociological study of journalism has found that news writers make assumptions about the credibility of their sources based on established networks and in deference to institutional authorities (Dunwoody & Ryan, 1987; Ekström, 2002; Fishman, 1980; Gans, 1979). As described in the pre-digital work of news scholars Gaye Tuchman (1978) and Mark Fishman (1980), trustworthiness within journalism is grounded in the application of particular newsgathering practices when working with sources. While not perhaps the "elaborate rules" (France, 1999, p. 122) described by some defenders of journalism, the practices related to ensuring objectivity in reporting work are seen as foundational to the profession (*e.g.,* Tuchman, 1978). For example, news that is seen as contentious requires sources from a number of perspectives (Gans, 1979). News writer interactions with expert sources are a reiterative and networked process (Conrad, 1999; Reich, 2006). Journalists may have difficulty judging the trustworthiness of their sources at the first interaction; those they continue to talk with over time and over the course of several stories are treated as increasingly trustworthy (echoing the role of ongoing social process described by recent credibility scholarship). "Specialist" reporters who cover particular beats (such as science) develop "symbiotic relationships with their most regular sources" (Gans, 1979, p. 137), as the reporter depends upon the sources for expert information about the topic, the sources may need the reporter's access to an audience to publicize their science.

In the contemporary information environment, with ample opportunity of audiences to encounter multiple competing sources that may appear authoritative, "… it becomes apparent that the theoretical basis for an analysis of trust in news media is the term *selectivity*. Trust in news media means trust in their specific selectivity rather than in objectivity or truth" (Kohring & Matthes, 2007 [emphasis added]). Journalists prove themselves to be credible communicators for their audiences by citing expert and "objective" sources and citing them in the appropriate ways (Callaghan & Schnell, 2009; Gans, 1979; Page, Shapiro, & Dempsey, 1987; Shin & Cameron, 2003). While traditionally, the gathering and selection of sources was performed "behind the scenes" as described by Gans (1979) and others, online publishing affordances and changing norms have pushed the sourcing process into public view creating a more transparent process (Allen, 2008; Deuze, 2005; Lowrey & Anderson, 2005). The push for transparency comes as the journalists themselves struggle to navigate this diversity of sources, causing increased tensions (Heinrich, 2011; Singer, 2014; Trumbo *et al*., 2001).

Some journalism advocates, however, argue that demonstrating professional practices in a public space (which is not socialized into the norms of journalism) is potentially fraught with risks both to journalistic authority and to the understood goals of disseminating facts to a democratic public (D. S. Allen, 2008; Lowrey & Anderson, 2005; Smolkin, 2006). As Allen argues, a commitment to transparency can also limit "the ability of a person to freely express himself or herself" (2008, p. 326) in a search for truth. A stated commitment to complete transparency also may hide the notion that "truth" is, in fact, bound to its context in a "socially and politically constructed world" (p. 328). Ostensibly "transparent" interactions between reporters and official spokespeople (at a press conference, for example) are driven by strategic aims and professional rituals more than a desire to reveal all possible facts related to a story (Godler & Reich, 2013; Shapiro et al., 2013)

The news work that is now being made transparent consists primarily of tasks of selectivity and gatekeeping. Journalists act as "intermediaries reverberating cultural trends within audiences and bringing them to the forefront of debate" (Fürsich, 2009, p.

245). These journalists consult with sources out in the world providing factual information that they must literally sell to laypeople as true narratives (Tuchman, 1976, 1978). In the process of gathering information from sources, journalists mutually co-construct the newsworthiness of these facts with their sources (Nisbet *et al*., 2003; Viswanath *et al.*, 2008), emphasizing some features over others, and deciding how to place the story within larger social and cultural narratives (Fishman, 1980; Palmerini, 2007). Within science communication, scientific and institutional sources may have competing concerns (such as a scientist wanting to wait for the final findings of a research study, whereas a journalist may want to immediately publish exciting partial results) that have to be negotiated (Palmerini, 2007). Citing sources with visible authority and credentials gives the journalist's narrative an affiliation with a recognized expert community – particularly relating to scientific or technical matters (Brossard & Nisbet, 2007; Holliman, 2011a) that may influence credibility judgments, both of the source (Conrad, 1999; Fahy & Nisbet, 2011; Hinnant & Len-Ríos, 2009) and of the writer (Conrad, 1999).

In contrast, credibility can also be established in certain situations outside of an authoritative sphere, especially in contentious political contexts, as the Climategate example shows. Some members of the public found skeptic blogs more credible than "official" sources of climate information as the story of the leaked emails developed. Followers of skeptic blogs may question the knowledge of authoritative experts not merely in an abstract way, but tied to specific epistemological understandings supported by they own first-hand experience (Harambam & Aupers, 2014). The conspiracy framing emerges for individuals over a series of social interactions in their lives and their skepticism of forma authority is continually reinforced.

Similarly, but less dramatically, Iraq war news bloggers in 2003 were seen as most credible when they presented as unaffiliated individuals, a key narrative at the time being that official sources from within the Iraqi establishment were compromised and/or corrupt (Singer, 2007; Wall, 2005). The "autonomous professional power" (Singer, 2007) of journalists to present multiple perspectives is central to their professional identity

(Deuze, 2005). This autonomy can be demonstrated via particular conversational moves in broadcast interviews (Clayman, 1992; Craig, 2010) and discursive formations (Ekström, 2002, 2007; Fürsich, 2009; Reed, 2001; Van Dijk, 1988) attributing sometimes contradictory points of view to multiple experts. This serves to keep politically contestable issues "open" rather than necessarily achieving consensus (Antilla, 2005; Craig, 2010; Jensen & Hurley, 2012). The individual non-expert journalist serves as a proxy for the individual non-expert audience member.

In the course of presenting themselves as autonomous non-experts, journalists are dependent upon established power structures and institutional authorities during the news-gathering process to varying degrees. Scientists at institutions and governmental officials often serve as authorized knowers (Conrad, 1999; Fishman, 1980; Reich, 2006). In particular, during the early parts of news gathering for a story, journalists are vulnerable to these authorities, since they may lack the knowledge to access to contradictory information (Godler & Reich, 2013). Reich (2006) describes this news-authoring process as consisting of two main parts – first, contact with sources that provide the "discovery" of the news event (wherein the journalist is lacking some power) and, second, contact with other sources who provide the details that are gathered to write the story in full detail. As journalists move through this process, more sources become available and/or known to them, and they have greater opportunity to negotiate with the sources and shape the story's presentation (Gans, 1979; Palmerini, 2007; Reich, 2006).

Examination of the written products of journalists allows for "non-obtrusive observation of the final product of the agenda/frame-building processes and the narrative negotiations between journalists and sources" (Nisbet *et al.*, 2003, p. 65). Communication scholars describe news texts as occupying a mediated location between a "real" event that only a few individuals have first-hand experience of, and the "social reality" of the news event that can be widely shared and understood (Carvalho, 2008; Fürsich, 2009). Media content "is a site in which current societal debates and representations are played out" (Fürsich, 2009, pp. 244–245). Scholars working within the paradigms of critical discourse analysis argue that this text can support the identification of shifts over time in the presentation of

complex social values that interviews with journalists or readers would have failed to identify (Carvalho, 2008; Fürsich, 2009). Specific examination of source choices in media content describing science news illustrates the persistent central role of institutions and official organizations as trusted information sources (Conrad, 1999; Moriarty et al., 2010; Ramsey, 1999).

Journalistic activity is thoroughly discursive. Conversation, interviews, and other forms of informative discourse are central to the processes and practice of journalism as a profession (Craig, 2010; Ekström, 2002, 2007). It is the "processing of this input text and talk which lies at the heart of news discourse production" (Van Dijk, 1988, pp. 96–97). It follows, then, that journalistic identity is considered throughout the media scholarship literature and in this review as a construction built by discourse (Clayman, 1992; Ekström, 2007; Ibarra & Barbulescu, 2010; Van Dijk, 1988). Other discussions of identity in journalism scholarship center on more specific ideas of professional membership accompanying economic and political implications (*e.g.*, Singer, 2003). This section of this review primarily relates to how identity is enacted through discourse and underpinned by shared motivations. The study of discursive identity in journalism is rooted in sociocultural linguistics.

The study of sociocultural linguistics (related to sociolinguistics and drawing from linguistic anthropology and social psychology) concerns itself with how identity is performed and modified through speech while one interacts with others (Bucholtz & Hall, 2005). Identity is thereby seen as socially constructed and emergent over time (as opposed to a cognitive or psychological approach that may define identity as fixed and resident in a human mind) (Bucholtz & Hall, 2005). In addition to describing the specific identity of a person or group under study, linguistic anthropologists note that "by rooting social identity in the interactional production of acts and stances, the social constructivist approach allows us to further understand some of the existential conditions of life in society" (Ochs, 1993, p. 298). Within this framework, Bucholtz and Hall define identity as the "social positioning of self and other" (2005, p. 587).

This understanding of identity has been widely developed across several related social science disciplines since the 1990s (Bucholtz & Hall, 2005; Ochs, 1993; Tracy & Robles, 2013). In recent years, the scholarship of Tracy (2013) and others has incorporated the work of sociologist Goffman into sociocultural linguistics to elaborate the more nuanced deployment of specific features of identity to accomplish certain context-specific tasks. Particularly important in understanding the identity work of professionals, the Goffman notion of face and face-work can underpin how shifting roles, objectives, and status are negotiated in social interaction (Goffman, 1955; Ho, 1976). Goffman defines face as "the positive social value a person effectively claims for himself by the line others assume he has taken during a particular contact. Face is an image of self delineated in terms of approved social attributes" (Goffman, 1955, p. 213). Depending on the situational obligations, a person may be required to defend the face of others (for example, one's boss) as well as one's self. Individuals may use face in personal interactions to be liked by others, receive attention, or in professional interactions to be seen as competent in a task or profession (Tracy & Robles, 2013). News writers must defend the face of their sources in order to ensure full cooperation from those sources, and also to appear neutral (and credible) to their audience (Antilla, 2005; Tracy & Robles, 2013). These maneuvers to protect face are effective when the news writer is seen as autonomous, and not beholden to his or her sources.

Journalist identity

Being seen as competent as autonomous individuals is key to journalistic self-conception (Bull, Elliott, Palmer, & Walker, 1996; Deuze, 2005; Fjæstad, 2007; Russo, 1998) as more journalists identify with their profession than with their employer (Russo, 1998). However, "while journalists tend to see themselves as skilled, ethical, autonomous and estimable professionals, the public is not convinced. Nor are sociologists, who are more likely to categorize journalism as an emergent profession" (Singer, 2003, p. 146). The journalist's preservation of his/her own professional identity and face, and his or her obligation to protect the face of others are both implicated here. Prior study suggests that the isolation of news work complicates a well-established identity (Slay & Smith, 2011).

In studying televised political interviews, for example, Bull, *et al* (1996) suggest that the preservation of face may be as much a ritual and even a "condition for interaction to take place" at all as much as an emergent strategy (p. 271). Politicians are unlikely to agree to appear on an interview program if they fear they will be embarrassed or lose status. The rituals related to preserving face (for example, the polite exchange of turns to talk) are an understood condition for participation. The Goffman concept of footing is a similar linguistic or para-linguistic strategy used to show one's relationship to other individuals or sources of information (Clayman, 1992; Goffman, 1981). Footing is used to signal a stance towards another person or source of information. For example, the "air quotes" when repeating the words of an absent individual to others indicates a specific footing towards that piece of information (*i.e.,* it's not to be taken seriously). Careful deployment of footings demonstrate neutrality when reporting information from multiple sources (Bull *et al.*, 1996; Clayman, 1992; Ekström, 2007).

Footings are deployed in the process of writing news stories – and the process *itself* of writing underpins the news writers' sense of their own professional identity and reputation (Cassidy, 2007; Weaver & Wilhoit, 1996). Routines of behavior in the course of gathering and writing news, and determining which events make it through the gatekeeping process to become news, are central to a journalist's "professional role conception" (Cassidy, 2007, p. 480). The conception of a professional role, however, is problematized as the workforce for news reporting becomes increasingly dominated by freelancers rather than staff writers (Wahl-Jorgensen & Hanitzsch, 2009). Recent research suggest that writers' whose assignment are varied and contingent rely more on a personal sense of ethics and responsibly rather than sense of professional norms (Ladendorf, 2013).

Special concerns of science communication

Journalists identify with a gatekeeping role, and present their work as accurate interpretations of complexity for a lay audience (Hudson & Temple, 2010; Nah & Chung, 2012). Journalists may also embrace a role as an activist or public watchdog, policing elite institutions such as science (Cassidy, 2007; Fahy & Nisbet, 2011; Nelkin, 1995).

Practicing scientists, however, frequently resent the misinterpretation of their work in news publications, and may have trouble relinquishing control of their messages once they enter the public sphere of discussion (Nisbet & Scheufele, 2009; Tøsse, 2013; Treise & Weigold, 2002). Interactive spaces in online news sites allow ordinary citizens to contribute in public to "unfinished science stories" (Amend *et al*., 2014; Secko, Tlalka, Dunlop, Kingdon, & Amend, 2011).

In addition to boundaries between science news writers and science news audiences receding, the boundaries between "science" and "news" are fading through "developments on both sides" (Trench, 2007, p. 133). Scientific institutions rely on networked technologies to communicate among communities of different expertise and increasingly produce their own information for the media. Traditionally, scientific epistemology rests on the specialized knowledge of experts -- a restricted community that mobilizes its own body of specialized and knowledge to demonstrate special access to the truth (Fahnestock, 2004; Mikulak, 2011). Journalism, with its democratic ideals and Habermasian view of an engaged public sphere of debate, is at odds with this vision (Fuller & Collier, 2004; Hinnant & Len-Ríos, 2009; Mikulak, 2011; Taylor & Condit, 1988). In questions of public understanding of science, scientists blame journalists for public shortcomings in science knowledge; journalists contend that scientists lack the communication skills for speaking to the general public (Besley & Tanner, 2011; Geller et al., 2005). Most recent science communication scholarship emphasizes the role of trust and cooperation between scientists and science journalists in improving public understanding of science (*e.g*., Bubela *et al*., 2009). Trust and cooperation develops in repeated one-on-one interactions between journalists and scientific sources (Conrad, 1999; Nelkin, 1995).

Secko, Amend and Friday illustrate a recent instantiation of this cooperation in their elaboration of four models of science communication (Secko et al., 2013). At its core, the model centers around "producing good science stories that matter." Two models are involved with more active engagement and audience participation, two are somewhat more traditional and focus on the transmission of accurate science information. Secko, *et*

al. theorize that the most effective forms of science communication are hybrids, using one or more of these models at a time (2013). It is a utilitarian perspective focused on the ultimate goal of sharing specialized knowledge widely and improving scientific literacy.

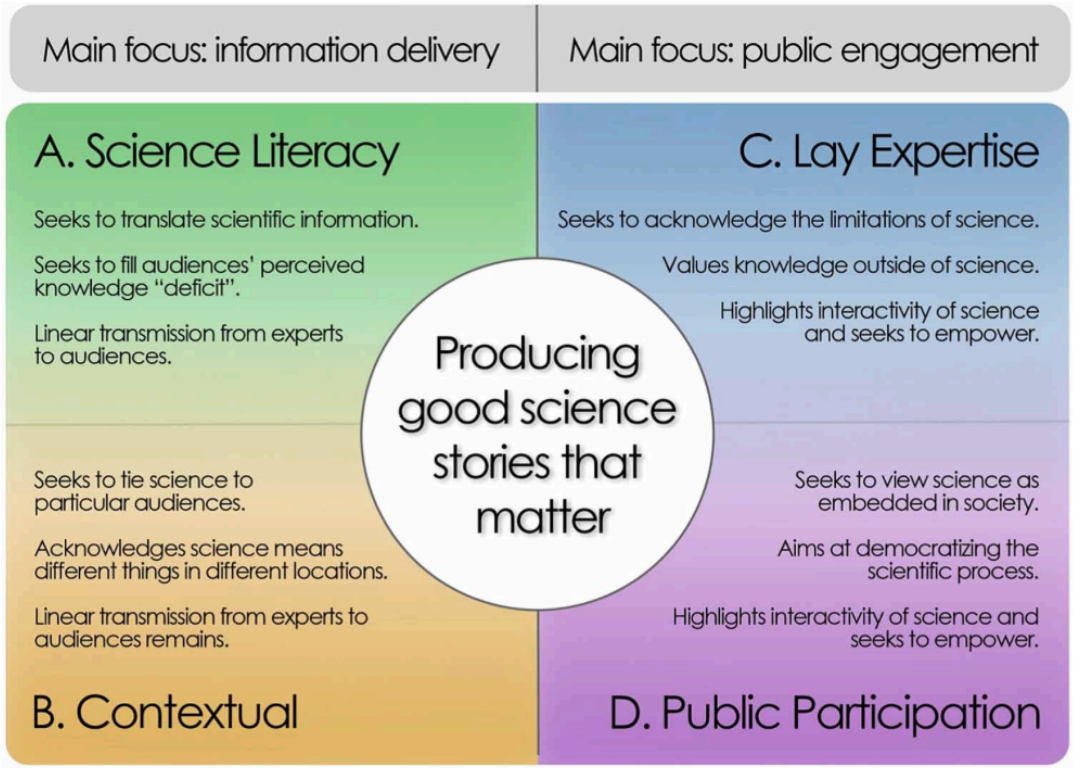

Figure 3

Four models of science communication (Secko et al., 2013, p. 67)

Identity in science journalism

Science journalism, as a form of news reporting, articulates many of the general themes related to professional identity, but also presents additional complications. Prior studies and surveys show that science writers are deeply concerned about scientific literacy – their own, and that of their fellow practitioners and readers (Treise & Weigold, 2002). They often work a science beat for most of their careers, and are more likely to be freelancers than employees of a particular publication (Dumlao & Duke, 2003; Dunwoody, 2012; Trumbo *et al.*, 2001). They may describe themselves as science

reporters, science writers, or science journalists – these distinctions may be merely semantic, or may reveal a meaningful choice about professional identity. As a group, they blur understandings of boundaries. Increasingly, science writers are former scientists who have become science communicators (Dunwoody, 2012). Science communication scholar Trench draws certain distinctions in an analysis of science journalism in the Internet era:

> "We distinguish 'science reporting' and 'science news', as representing various forms of journalist activity around science, from 'science journalism' as a specialist practice within professional journalism. We are not here entering a long-running debate about whether special qualifications, for example, a university education in science, are necessary in order to report science adequately. We are merely underlining that there are many more people producing science news than there are people who can justifiably define themselves as science journalists. This may be a source of disappointment, even an object of complaint, for some. But, in the context of Internet publishing in particular, it is an inescapable reality, and it has clear implications for the practice of science journalism (Trench, 2007, p. 133)".

Notions of professional identity have been central in the practice of science reporting since its earliest emergence as a profession. The largest professional organization of science writers, the National Association of Science Writers (NASW), created in 1934, was established in the U.S. with a membership of 12 people. From this early point onward, professional science news writers viewed themselves as somewhat apart from regular journalists, more closely aligned with the scientists rather than other journalists, and with special status to communicate and interpret science information for the public (Palmerini, 2007; Trench, 2007). The early NASW, in fact, encouraged scientists to speak only to writers who were members of their organization, signifying their "elite" status (Rensberger, 2009). The membership called themselves "'writers' rather than 'journalists' or 'reporters' because they felt it sounded more professional" (Rensberger, 2009, p. 1055).

Science journalists also work within the particular ideologies that are part of "modern" news reporting as a whole-- such as the need to communicate both sides of a contentious topic and the economic benefits of promoting controversy and negative news (Deuze,

2005). Some features of this ideology specifically conflict with the practices of science. A number of these conflicts are listed in Table 1, below.

Scientists	Journalists
Aim: dissemination of research results, teaching, PR for science	**Aim:** news, enlightenment, exposure, large audience
Slow information dissemination	Fast dissemination
Factual orientation	Personal orientation
Rational appeal	Emotional appeal
Consensus gives best picture	Diverging voices give best picture
Theoretical relevance important	Practical relevance important
Comprehensive	Selective coverage
Details important	Details unimportant
Results are qualified	Results are overstated
Work judged by colleagues, thus reinforced and reproduced	Work judged by colleagues, thus reinforced and reproduced

Table 1

Professional practice typologies highlighting similarities and differences between scientists and journalists

(Fjæstad, 2007, pp. 127–128)

Fjaestad's table reflects traditional paradigms in these professions, but overlooks recent points of convergence between scientists and science news writers examined by others *(e.g.*, Besley & Tanner, 2011; Trench, 2007). The conflict between these orientations and goals are further complicated by emergent technological change. Online life has made science information more widely available than ever to the general public (Holliman, 2011a; Trench, 2007) and journalists struggle with problems of information overload and information evaluations (Garrison, 2000; Granado, 2011). However, the adoption of Internet tools such as email and the Web was likely more rapid among science reporters

than other types of journalists (Granado, 2011; Trumbo *et al*., 2001). Online access to governmental reports, scientific journals, and email access to the scientists themselves (who may have been previously difficult or impossible to reach by telephone or in-person) have all been cited as changed characteristics of the work of 21st-century science reporters *(e.g*., Kiernan, 2014).

This rapid evolution produced multiple effects, however, as the speed of online commercial publishing, often occurring in parallel with the lengthy academic peer review process, means that layperson response and critique of science findings may occur ahead of "official" publication and peer response (Fahy & Nisbet, 2011; Holliman, 2011a; Trench, 2007, 2008b). Scientific institutions themselves have since become niche publishers of their own research, often as an effort to control their own message, ahead of the glacial pace of academic publishing (Liang, *et al*., 2014; Lowrey & Anderson, 2005; Shin & Cameron, 2003; Trench, 2007).

There is abundant prior research demonstrating the declining presence of a formalized "science news" space in the 21st century (*e.g*., Fahy & Nisbet, 2011). Current economic pressures on scientific news production are substantial. According to Liang, *et al*. (2014) "In 1989, there were ninety-five weekly science sections in newspapers in the United States. However, by 2005, fewer than a third of these remained, and that number plunged to nineteen in 2012." Meanwhile non-traditional science news venues are abundant – such as on specialized blogs - but the diminished prestige (and lack of paying opportunities) for newswriting work creates a challenging environment for the freelance science journalist (*e.g.,* Trench, 2007). The epistemological implications of lightly-mediated science blogs are not well understood (Shanahan, 2011).

Science writers occupy a deeply complicated information space. They may be, as individual professionals, as likely to work for private institutions writing public relations copy as they are to do investigative work for traditional news media. They may emerge from educational and professional backgrounds that may more closely ally them to the subjects of their news coverage rather than the lay audiences they are speaking to (Fahy

& Nisbet, 2011; Trench, 2009). They may see their role differently depending on whether they primarily write for a magazine or a newspaper (Hinnant & Len-Ríos, 2009). They could identity with journalistic traditions of advocating and informing the public sphere, or more profoundly with their educational background in science (Treise & Weigold, 2002; Viswanath *et al.*, 2008). The institutions and individuals in the science news space embody goals and power relationships that can affect information communications and the production processes that surround them in ways that are not yet well understood.

Public understanding of science

While current social epistemological theories make plain the role of social context in knowledge claims, it is worth noting that for some time, epistemologists and philosophy of science scholars saw "no role for trust in knowledge" (Hardwig, 1991, p. 693). In the 19th and early 20th century, social elements, such as trust, and local practices were seen as irrelevant by those who embraced the notion that the "truths of science are independent of any local context" (Durkheim, 1972, p. 88; Shapin, 1995). The theories and logic of science practice were thought to be plainly visible and globally accessible; science did not need to be met with any kind of understanding of the sociological or the cultural world that surrounded it (Fuller & Collier, 2004).

This view began to change in the mid 20th century. In the face of grave political threats to science knowledge from Nazi Germany's science program, Robert Merton described an *ethos* of scientific practice that was particularly cultural. In Merton's view, members of the scientific community defined their practices in their norms, and expressed antipathy towards those who refuse to operate by its rules (1938). Like Aristotle's inclusion of virtue and goodwill in the original *ethos* definition, Merton was explicit about the virtuous features of science in the face of challenges to practicing scientists from political fascism in Germany. While the scientists supported by the Nazi regime were ostensibly engaging in the same processes of science as the rest of the world, Merton argued that the scientific *ethos* had been corrupted by the influence of nationalistic desires and notions of "racial purity." The specificity of this historical background highlights arguments of

those who propose an ethical culture of science, and the role of trust in building in the formation of knowledge (Shapin, 1995).

This epistemological background and history underpins contemporary scholarship into how science is communicated to the public by media actors. In Dorothy Nelkin's germinal examination of science in the media, she theorizes that science knowledge comes to the public via the media as reflection of current social and political concerns (1995). For example, a "gee-whiz" style of press coverage of the technological developments of the mid-20th century reflected an optimism and faith in technology following World War II (Fahy & Nisbet, 2011; Reed, 2001; Rensberger, 2009). This view eventually gave way to a more critical stance, co-incident with larger social critiques of political, social, and environmental policies (Nelkin, 1995). The co-constructed nature of scientific discoveries and how these discoveries are published by the media are the foci of much of the most recent scholarship emerging from STS and the public understanding of science. This co-construction can be perceived as a "tension between science and democracy" (Fuller & Collier, 2004, p. 194), and is foregrounded in situations such as vaccine-related controversies and many types of conspiracy theories (Harambam & Aupers, 2014). Democracies expect specific, certain, and actionable information in public deliberations. Scientific discovery, by its nature, is contingent and partial (Jasanoff, 2007; Maxim & Mansier, 2014). This epistemic tension becomes more more salient as media-consuming publics have access to previously inaccessible types of information about science (Boykoff & Boykoff, 2004; Schäfer, 2009; Tøsse, 2013), and as different types of participation emerge in 21st-century digital culture. In particular, "strategic" communicators, such as public information officers may increasingly engage in writing science news stories as paid staff of research centers, complicating traditional understandings of the science writer/science expert relationship (Len-Ríos *et al.*, 2009; McIntosh White & Wingenbach, 2013; McIntosh White, 2012). If not actually writing science news for public consumption, public relations staff may insert themselves between the researcher and the writer as a representative of a company or institution. Figure 2 below illustrates the potential for increasing mediation between the science writer and science expert.

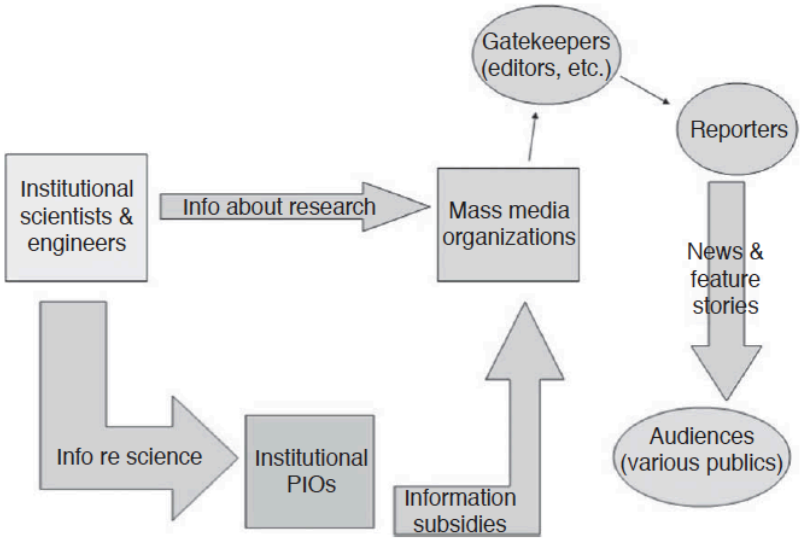

Figure 4

Conceptual model of knowledge transfer from institutional researchers to the public through institutional public information officers (PIOs) and mass media journalists (McIntosh White, 2012, p. 565)

Public information officers and scientists themselves may both communicate science information to news writers in this model. Disconnects between mediated "information subsidies" and "information about research" affect information trust and trust's persuasive power, such as in case of information about public health crises (Avery & Kim, 2009; McIntosh White, 2012). Public information officers and science journalists "think differently about information sourcing and journalist bias" (McIntosh White, 2012, p. 572). Organizational culture and professional motivations, rather than educational background or scientific knowledge, are at the root of those distinctions.

For working news writers, clarity and deadlines are motivators -- science writers will value and confer with sources who respond promptly and in language that the writer and a lay audience can understand (Conrad, 1999; Hinnant & Len-Ríos, 2009; Reed, 2001). Although novelty in news stories has long been a journalistic imperative (Gans, 1979; Geller et al., 2005; Van Dijk, 1988), and can still drive reporting in some types of

rapidly-emerging science such as genetics (Geller *et al*., 2005), science writers demonstrate the influence of other considerations. Writers invested in a "watchdog" professional identity, for example, may concentrate on research and discoveries that they perceive as important to illuminate for public scrutiny (Fahy & Nisbet, 2011). The complexity of the writers' judgments and the multiple influences on source decisions is reflected in research that demonstrates the increasing sophistication of readers' evaluations of the credibility of science news. For example, the public may consider issues of data management (as the Climategate example shows) and funding source when determining credibility of science information in the press (Bubela *et al.*, 2009). Supported by pervasive social and technological networks in the 21st century, science writers may demonstrate the credibility of their communications by providing a more comprehensive view. Knowing more, knowing better, and being able to establish connections and follow a story over time are becoming increasingly relevant to how science writers establish their identities as credible communicators (Fahy & Nisbet, 2011).

Summary and implications

This review has analyzed a wide body of literature in order to describe the range of theories and methodological approaches to the study of science news and information credibility. One of the ultimate goals of this study is to bridge the intellectual gaps between the two streams of literature -- information studies and scholars of mass communication and media -- in understanding credibility judgments. While these disciplines share a number of concerns, their intellectual traditions and methodological settings have often prevented useful collaborations. Information studies has largely concerned itself with interactions between users and texts at the individual and organizational level, incorporating scholarship from cognitive science to understand motivations and outcomes of particular encounters with information. Mass communication study focuses on the creation of these communications and the social and economic forces behind them. In this way, mass communication study seeks to understand information encounters in order to support the process of creating informative and persuasive texts. This study asserts that under Deuze's proposition of a digital

culture, the distinctions between types of information encounters, and between readers and creators of texts, are becoming increasingly fluid. Digital texts may all potentially be "mass communications." Digital information is individualized and socialized simultaneously.

Science news resides at a nexus of two communities of practice with traditionally distinct epistemological structures: science and journalism. However these distinctions are fading. Working scientists may author their own media content. Science news consumers may also participate in citizen science projects. Publication of science information may happen in a traditional journal, via Twitter, or an institutional blog (or all three at once) – often exposing in-process research to immediate public scrutiny. This public scrutiny can, in turn, shape public policy to profound effect in areas such as technology, climate and health care. In order to fully describe this space, this study has looked backward in order to assess shared theories of trust and epistemology between disciplines. These shared theories, in particular Artistotle's *ethos*, highlight the role of social interactions over time that have re-emerged from the public *fora* of Ancient Greece into a very public digital culture.

This study focuses on science news writers not simply as actors in a mass communication space and authors of institutionally-sanctioned credible news stories (though they are that at times). Rather this study focuses on the notion of credibility throughout the work process of science writers. Information credibility as a particular element influencing sourcing and story topic decisions has been minimally explored in prior work. These decisions are crucial in an area were expert information must be negotiated and interpreted by writers for lay people.

3 RESEARCH QUESTIONS AND METHODS

As the literature review demonstrates, freelance science news writing is practiced in a complex and evolving digital publication space. Writers incorporate expert information into science news articles using digitally-mediated networks and as part of loosely-structured professional relationships. Formal arrangements and affiliations are increasingly less a part of this work, as well as in many other practice environments, as a more individual sense of professional identity becomes central. Credibility constitutes one of many motivations that drive information source decisions for science news writers. Concerns related to credibility are also at the core of the central research question of our field: how do we better support collaborative knowledge work and improve the exchange of information across a variety of social and technological boundaries that may have limited organizational supports? There is no one disciplinary approach that addresses these questions sufficiently to explore this question in its full depth, as the literature has demonstrated, so my approach to methodology has been similarly informed by prior research from several related fields.

This study's findings related to contemporary science writing suggest implications for the development of information structures and practices supportive of an improved public understanding of science. Going beyond the field of science information, this research supports new approaches to information credibility and collaborative knowledge-sharing in online environments. In addition, I demonstrate here a qualitative case-based approach to understanding knowledge work that focuses on the individual as a unit of analysis. With a commitment to an ethnographically-informed methodology, I developed a theoretical and thematic framework for understanding how writers "do credibility" supported by interview and article data gathered from each case.

Before detailing my research questions and methodology, I will clarify some points related to terminology. While the reviewed literature has variously used the words "science journalism," "science news," and "science reporting," I am primarily choosing to primarily employ the term "science writers" to describe the participants. I make this

decision for two reasons. First, the use of "writer" allows room for the complexity of the "journalist" professional identity expressed by Trench (2007) and others. Individuals writing about science may choose to identify as "journalists" or not or to varying degrees depending upon a number of factors. I have included the identification with journalism, as a specific form of profession, as a component of my analytical theoretical axis related to identity. Science writers may also produce written works, such as opinion pieces, that are not "reported" as such, but still communicate science information. The individual (the writer), not the institution (journalism), is my unit of analysis. Second, and more simply, my choice reflects the organization providing my sampling frame, the National Association of Science Writers. The selection of the term "writers" in their name was deliberate for this organization (Rensberger, 2009), as was noted in the literature review.

The concept of "publication" is also somewhat problematized. For my purposes I operationalized the idea of "publications" to include a variety of written, but not broadcast, communications authored by each participant. Analyzed articles were written for conventional publications fitting under the traditional notion of "mass media" (*e.g., The New York Times, Newsday, or Scientific American* magazine), as well as publicly-accessible writings in specialized blogs (*e.g., InsideClimateNews.org*), online publications affiliated with larger news or advocacy organizations *(e.g., NPR.org, The Nature Conservancy*), or professional or academic publications (*e.g. Chemical Society News*). Each article was considered as part of each writer's "textual population" by either its inclusion in the Ebsco Masterfile database under his or her name, or its inclusion among the list of sample clips featured on the participant's professional website. Additional detail about definitions and sampling is discussed in Section 3.4 below. Some of these venues are clearly more "mass media" or "public" than others; discussion of the differences between publication venues and editorial practices was addressed in the interviews and provides a focal point for the research question related to processes.

Finally, the term "sourcing" is used in the journalistic sense: sources are individuals who provide information to a news writer. The Reuters organization specifies industry-typical practices: "You must source every statement in every story unless it is an established fact

or is information clearly in the public domain, such as court documents or in instances when the reporter, photographer or camera operator was on the scene" (Reuters, n.d.). Sources are typically knowledgeable people who provide information to a news writer in an interview or other one-on-one interaction. For example, a research scientist may provide a phone interview describing his or her work, or a corporate spokesperson could answer a query about a new product with an email. A source could also be a scientific journal article or organizational website. Interactions with these sources become more of an "information studies" concern when work practices increasingly involve a variety of technological modalities (*e.g.*, Artwick, 2013; Holliman, 2004).

Research questions

I am investigating the following research questions:

1. How do science writers understand information credibility? How does this affect their sourcing decisions?

2. How does this understanding interact with other factors writers consider when creating persuasive communications from expert source information?

3. How can understanding the experience of professional science writers inform theory related to the communication of credible expert information within collaborative online environments?

I note here that I am using the phrase "understand information credibility" to support investigation of a full range of behaviors and attitudes related to the writers' relationship to credibility. The writers interact with expert sources and make judgments about that source information's credibility as users. Simultaneously, they are creators of their own communications and ultimately intend to be seen as credible themselves by colleagues and readers. In using a constructive and synthetic theory of credibility, I am seeking to describe credibility judgments holistically throughout all of a writer's work activities –

from story choices, to sourcing, to publishing a finished piece. By focusing on individual writers as cases and units of analysis, I am able to bridge a theoretical gap between studies of individual user judgments of information credibility, and theories of persuasive communication. These theories are all relevant to the work of science news journalism, and in deeply examining the full context, I can instantiate and resolve theoretical tensions that may have been somewhat artificially separated in prior work.

Methodology

The reviewed literature demonstrates the complexity of theories underlying credibility research, and illustrates the number of overlapping, and often competing, concerns related to trust and information within science communication. This interdisciplinary theoretical review of credibility, as well as the more focused study of science news writing, support the development of my research questions and accompanying methodology. Credibility judgments are explicit and/or implied throughout the decisions science news writers make in selecting and authoring stories (e.g., Dunwoody & Ryan, 1987; Geller et al., 2005; Ten Eyck, 1999). Credibility and trustworthiness of their sources are not the only concerns facing science writers (Conrad, 1999; Gans, 1979; Ten Eyck, 1999; Tuchman, 1978), but taking as a given the writers' desire to communicate "true" information about the world to their readers, they are central concerns.

The triangulation of methods is particularly relevant in investigating questions of journalistic epistemology, given its situation in context-sensitive and discourse-based knowledge work (Dickinson et al., 2013; Godler & Reich, 2013; Lewis, Zamith, & Hermida, 2013). This study follows in the model of journalism scholars Godler and Reich, who sought to "juxtapose journalistic practices, self-descriptions and work products, without relying exclusively on any single source of data" in their approach to an ethnographic examination reporters' epistemological decisions (2013, p. 679).

To choose either an analysis of published texts alone, or interviews alone, would require missing key elements of the phenomenon of credibility judgments in context. As Yin

points out, "Except for studies of preliterate societies, documentary information is likely to be relevant to every case study topic" (Yin, 2014, p. 105). Diversity of data sources in a qualitative study allows the researcher to corroborate or contradict emergent observations from ethnographic studies (Brady & Collier, 2010; Yin, 2014). In a more abstract sense, using documentary texts alongside of interview data provides practical access to the theoretical "meso-level" concept of trust and credibility explored in the literature review. Credibility provides a bridge that allows external events to become internalized knowledge; the citing of specific sources in written texts instantiates the "macro" trust decisions of the journalists as were discussed in interviews. The analysis of interviews offers a "micro" view to explain, in-depth, how those decisions are reached, and, illuminates hidden complexities and implicit criteria.

In addition to the work of Godler and Reich (2013), other prior research of work practices of journalists offer models of similar mixed-methods approaches. In a study of internet research among news writers Machill and Beiler (2009) argued for "deep qualitative insight" (p. 179) in a field frequently dominated by survey reports. In order to support their initial quantitative survey findings, these authors performed an ethnographic observation of journalists in editorial offices. The specific study of science news writing offers examples of similar mixed-methods approaches. In a study of media coverage of cloning, Holliman (2004) performed a content analysis of news articles and broadcast programming, then conducted interviews and focus groups with writers. Conrad (1999) employed a similar approach for examining the use of sources in the reporting of genetics in the news. In order to capture the full extent of the collaborative activity involved in news authoring, he coded a sample of articles and then interviewed science wirters, coding the resultant interview texts for emergent concepts in the tradition of grounded theory.

Process overview

Following the guidance of recent mass communications scholarship that similarly deals with networked epistemological questions (*e.g.*, Dickinson *et al.*, 2013; Heinrich, 2011) I used a qualitative and ethnographic approach to studying working writers *in situ*.

Employing a purposive sampling frame (*e.g.*, Babbie, 2011a) with a randomized element I gathered two types of data from my participants: what science writers *say about what they do* in interviews, and what I can observe about what science writers *have done* in published texts. The following sections describe the study population and participant recruitment, and the gathering and analysis of the interview and published textual data.

From the science writer participants, I gathered data from semi-structured interviews, published work as available in subscription databases, and their professional web sites. I applied content analysis methods (Krippendorf, 1980; Neuendorf, 2002) and textual analysis methods (Altheide & Schneider, 2013; Schreier, 2012; Zhang & Wildemuth, 2009) to the published work by the writers in my study, and analysis methods to the interview data informed by discourse analytic traditions (Borer & Fontana, 2012; Jørgensen & Phillips, 2002; Wooffitt & Widdicombe, 2006). The writer's professional websites (featuring some form of a *curriculum vitae* and links to selected writings) were examined for graphical and technological elements related to the themes of my research questions.

My choice to include textual analysis of the articles allowed me to gather data from the intermediate site (between scientific events and their construction in social discourse) of news production described by journalistic epistemologists Fürisch (2009) and Carvalho (2008). Content analysis is supported as an empirical method by the use of an *a priori* coding scheme (Neuendorf, 2002) and a concentration on manifest elements. Findings from the analysis of textual materials provided intersubjective (Babbie, 2011b; Neuendorf, 2002) support to underpin more thematic and qualitative findings from the interviews.

In examining the interview data, I used a simplified discourse analytic approach informed by both critical discourse analysis (CDA) (Jørgensen & Phillips, 2002; Wodak & Meyer, 2009) and conversation analysis traditions (Wooffitt & Widdicombe, 2006). For the purposes of my study, discourse analysis contributes an interdisciplinary perspective, a consideration of the relationship of discourse to ideological and power arrangements in

the larger social world (Jørgensen & Phillips, 2002), and an embedded reminder to consider of the role of the researcher/interviewer in the collection of data (Wodak & Meyer, 2009; Wooffitt & Widdicombe, 2006). Conversation analysis has been well-used in examinations of news interviews, the foundational format of journalism (Craig, 2010), to explore questions of epistemology and their articulation through credibility and objectivity practices in news work (Clayman, 1992; Ekström, 2002, 2007).

However, considering a strict application of either of these approaches (CDA or conversation analysis) was problematic. In particular, as a social science researcher interviewing journalists, my interview discourse was underpinned by more nuanced power relationship than may benefit from a strict CDA perspective. Additionally, the research interview setting, as a structured discursive engagement, presents complications for an application of conversation analysis that typically looks at naturally occurring task-oriented talk. I have found guidance in Plesner's suggestion to researchers interviewing journalists to "study sideways" (Plesner, 2011). That is, as a scholar of journalists and technologists, she encourages researchers to acknowledge their role in co-constructing meaning with their interview participants, but also to displace some (CDA-based) concerns about clear power differentials since these differentials may be extremely nuanced. Interviewers, rather, should engage in more directly explicit discussions and possibly confrontational questions about meaning, task, and processes. Plesner borrows from the work of Latour and actor network theory to suggest that this strategy gives "reflexivity back to the actors" and supports the collection of richer data (Plesner, 2011, p. 472). Wooffitt and Widdicombe's (2006) methodological discussion of the application of conversation analysis to research interviews provided more explicit guidance related to interview protocols and thematic analysis.

My research process allowed for mostly parallel collection and analysis of both bodies of data: the published materials and the interview text (see Figure 3 below). This process made efficient use of researcher time, and allowed the two analysis processes to inform each other. Repeatedly engaging with the research participants (in some cases emailing articles of interest back and forth) during the interview and analysis process created a

detail-rich “site” of study and allowed individual characteristics of this varied group to emerge. Participants were engaged and complicit in the data-gathering about them, and managing the technological “tools of the trade” (particularly Skype and email) while making them also topics of discussion led to insights that might have been difficult to discover in other contexts. Figure 3 below provides an overview of the methodological steps showing the sequences of data gathering and analysis.

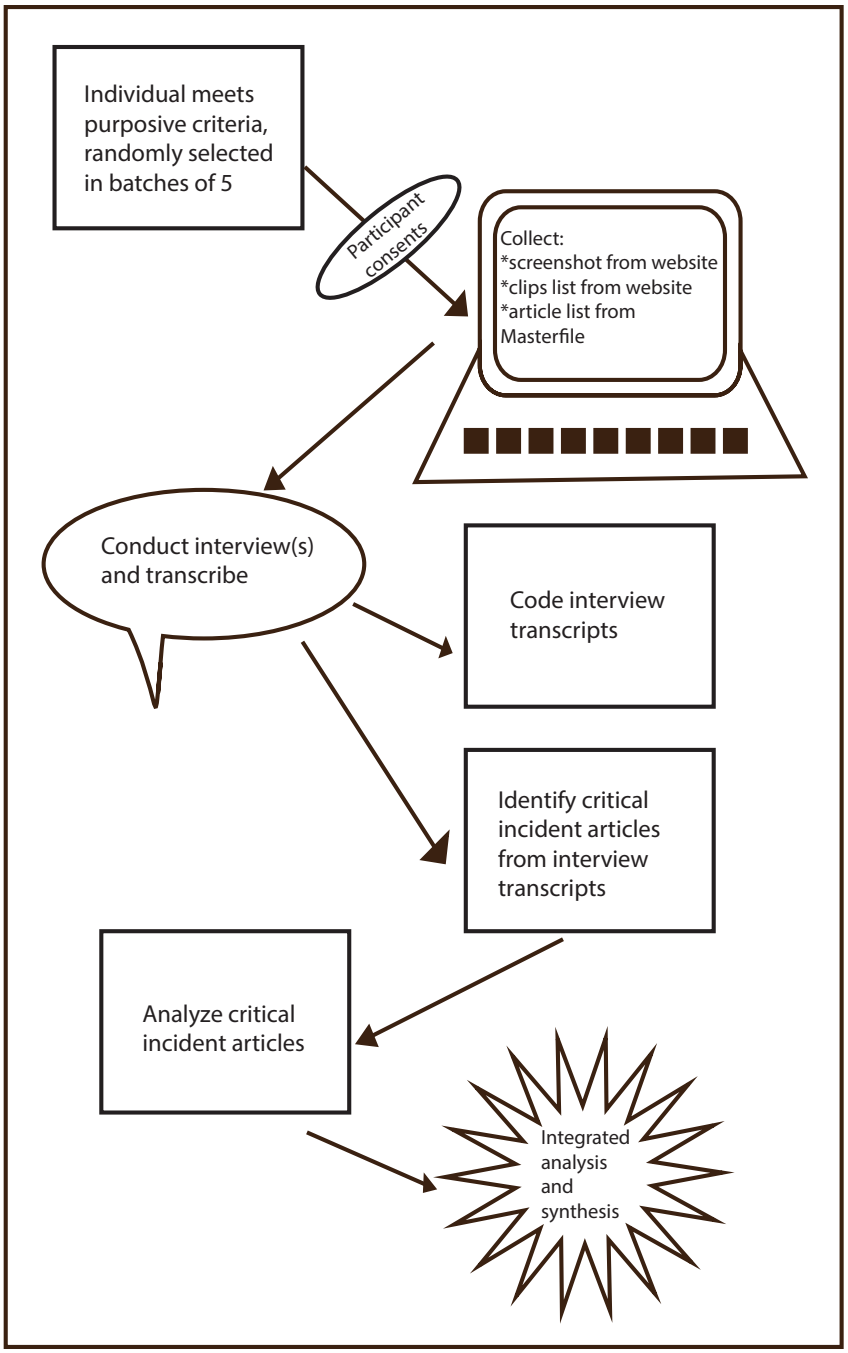

Figure 5

Methodological process

Note that the interviews provided the data themselves for the thematic discourse analysis, as well as supported the identification of critical incident articles subjected to analysis. Recruitment criteria and analysis processes are explained in additional detail in the following sections.

Study population

My study population is freelance environmental science writers. There are few areas of science writing specialization that engage public concerns as much as environmental writing, and expert source information is frequently complex and multi-disciplinary. Environmental reporting is a well-established site for scholarly study of this type, as it fully engages issues of credibility, public trust, and expert/non-expert communications (e.g., W. Allen, 2001; Antilla, 2005; Sprecker, 2002). Therefore, I purposefully selected participants who write about environmental issues, and used theoretical sampling to determine the final limits of my sample size (Babbie, 2011a, pp. 207–208). Phenomena related to my research questions on credibility judgments, writing processes, and identity were captured and recorded to measure theoretical saturation. Table 2 in the following section describes the participant sampling process.

Study sampling

In using a primarily purposive sampling method, I am following models employed by the most recent and relevant research in the area of journalistic source selection. Scholars looking to examine news authoring processes have realized the importance of purposively sampling across different publications (and over a range of years) to obtain substantial variability in a complex and dynamic problem space (Carpenter, 2007; Fahy & Nisbet, 2011; Matusitz & Breen, 2012; Reich, 2006; Trench, 2007). Chief sampling considerations in studies of science writing have often centered on the need to include experienced science writers as paradigmatic representatives of the population, and the importance of capturing a variety of publication types, such as “legacy” newspaper media and newer online publications, to fully observe the variability in the population of science writers (Conrad, 1999; Fahy & Nisbet, 2011). My sampling methods addressed these concerns of prior research and enabled the recruitment of participants of varied levels of experience who publish work in nearly every media environment (digital and otherwise).

Selection of participants

To address my research questions related to identity and process, I wanted to purposefully sample professionally-identified science writers who had successfully published work in the "mainstream press" space. Yet, my criteria needed to be flexible enough to allow for the recruitment of participants along a range of experience and productivity levels in order to support theoretical saturation. I began by identifying the National Association of Science Writers' (NASW) list of freelance science writers as a sampling pool. NASW is frequently used as a source for the recruitment of study participants for science journalism study (Dumlao & Duke, 2003; Fahy & Nisbet, 2011; Granado, 2011; Rensberger, 2009; Treise & Weigold, 2002; Trumbo, *et al*., 2001)

On its website (http://www.nasw.org) NASW describes itself as:

> The largest organization devoted to the professional interests of science writers, the National Association of Science Writers fosters the dissemination of accurate information regarding science through all media normally devoted to informing the public. Its 2,525 members include science writers and editors, and science-writing educators and students (NASW site).

In 2016, NASW remains the "umbrella organization" for the science communication profession and organizes annual conference in the US as well as meetings of regional and special interest groups (Irion, 2015, p. 593). Its members report on general and specialized scientific topics including health and medicine, technology, and governmental science policy. As noted above, this study focuses on environmental science writers as these topics are by nature interdisciplinary and are of broad public concern. Given this sampling approach, Table 2 below outlines the subsequent purposive and random sampling steps resulting in my final pool of 16 study participants.

1. Purposive Sampling

National Association of Science Writers: “Find a Writer” Page

Freelancer members with a specialty of “writer” and an expertise of “environment”

=303 Individuals in sampling frame

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2. Random sampling from the list with random-number generator

3. Evaluation of randomly-selected individuals against purposive criteria:

- Individual website with contact information
- At least one article indexed by Ebsco MasterFile Premier

4. In batches of five, individuals meeting criteria were contacted

=59 individuals meeting criteria and contacted

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5. “Yes” responses and interviews conducted until theoretical saturation

= 16 participants in study (response rate of 27%)

Table 2

Hybrid purposive and random sampling process

After selecting NASW as a sampling frame, I identified the 303 members who listed a specialty of “writer” and an expertise of “environment” on the organization’s “Find a writer” section (http://www.nasw.org/find-writer) in October of 2013. These individuals demonstrated some degree of professional self-concept, as they have chosen to affiliate themselves with this professional organization, a view supported by research findings on professional and social notions of identity. I then used a random number generator to select individual writers in groups of five.

Once I had randomly-selected groups of five, I verified that each potential participant had published at least one article indexed by the Ebsco Masterfile Premier database. The

database indexes multiple types of publications that address environmental topics from a comprehensive array of perspectives. Masterfile is described by its publisher as a "digital collection of full-text magazines for public libraries" (MasterFILE Premier, http://www.ebscohost.com/public/masterfile-premier). It includes over 1,700 full-text periodical publications dating back to 1975. Bibliographic databases are well-established tools for identifying sampling frames in research using published bodies of work as source data (*e.g.*, Enrione, Mazza, & Zerboni, 2006; McBride *et al.*, 2007). The potential participants also had to meet a second purposeful criterion this point: a functioning website with contact information.

This sampling approach was developed after an initial pilot and refined following recruitment of the initial group of five participants in consultation with my committee. I modified the approach to fully capture the dimensions of the research question and provide adequate variation to ensure theoretical saturation along the dimensions under study: 1) the range of influences on credibility and source selection decisions over the course of technological changes to the news writing process; and 2) perceptions of identity among science journalists and their relationship to credibility judgments.

Limitations to sampling method

The primary limitation to this approach to sampling was the potential for response bias. In choosing to examine the work of freelancers, I am recruiting participants in a profession that is experiencing significant employment pressures and financial strain (Fahy & Nisbet, 2011); that is, freelancing is challenging profession and freelancers' time is very valuable. Several "no" response emails to my interview requests were accompanied by some version of "I just don't have time." This may have skewed my sample towards those individuals who may be somewhat more successful in their careers and feel under less time pressure, or those who are particularly motivated to share their experiences despite the time pressures. I incorporate an awareness of this limitation throughout the discussion and findings sections of this study. The following section explains the motivations for a mixed-methods approach, building on the conclusions from the reviewed literature.

Recruitment

Between June 2014 and December 2014, a total of 59 participants were contacted via email or web contact forms as listed on the NASW site and asked to participate (participant recruitment email text is in Appendix B). A total of 20 participants agreed to be interviewed; three ultimately were unavailable, and one participant's interview had to be discarded because of confusion with a same-named author (the contacted individual did not actually meet the criteria; the same-named one did). Second interviews were conducted in two cases where needed to address additional elements of the interview protocol. Interviews were coded as they were transcribed and code distributions and frequencies were employed to determine final sample size via theoretical saturation.

"Theoretical saturation," has been difficult, if not impossible, to operationalize in prior study. Explicit guides to methods are frequently little help, as Guest, Bunce, and Johnson (2006) found in their review of theory-based qualitative interview practices. Many methodological guides offer no specific suggestions; those that do offer suggestions ranging from six interviews for theoretical saturation (for a homogeneous population) to as many as 200 for qualitative ethology. Guest, *et al*. note "none of these works present evidence for their recommendations" (2006, p. 61). For the purposes of my study, I have found guidance in the final recommendations of Guest, *et al*., and a similar operationalization strategy described by Francis, *et al*., (2010) who endeavored to operationalize theoretical saturation in their field work related to public health in Sub-Saharan Africa. Both authors suggest deciding a priori on a sample size to begin the initial analysis and code counts, then carefully recorded code frequencies before adding additional interview data.

Following these guidelines I exported code frequencies from the HyperResearch software while interviews were progressing to monitor frequencies and distributions. (Full details regarding the codebook development and coding process are addressed in Section 3.6.3 below). I focused primarily on distributions between the two thematic axes, process codes and identity codes, as means to monitor the distribution of codes across participants.

The codebook stabilized (no new codes were needed) after the fourth participant (Participant D). Participant D's interview analysis introduced two new concepts that needed to be added and suggested clarification of the existing codes to accommodate this change. Interviews from Participants A-C were then re-coded with the revised codebook.

Code distributions became stable in the identity and process axes (determined as percentage relative to the total codes applied to each individual interview) after the 11th participant (Participant K), as shown in Figure 4 below.

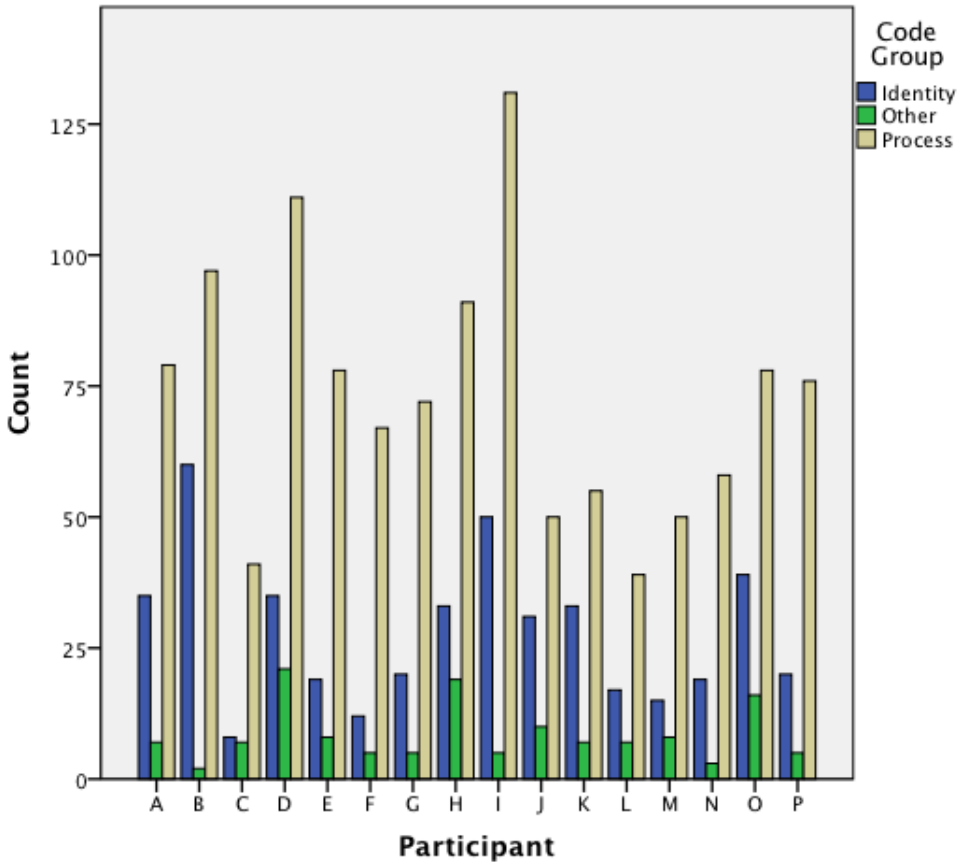


Figure 6

Code distributions by thematic axis

The final response rate (resulting in usable interviews) was 27% with 16 participants and 18 total interviews. Further details and tables describing the application of codes and distributions appear in Sections 3.6.2 and 3.6.3 covering interview analysis.

Interview data

I conducted at least one phone or Skype interview with all 16 participants. The interviews ranged in length from 35 to 70 minutes. Two participants required follow-up interviews to clarify and elaborate on points of the interview protocol. The initial interview used a semi-structured interview protocol (below) and centered on questions of general writing process and relationships to sources, editors, and other perceived audiences. Participants were also asked about their education and experience in the realms of both science generally and in news writing and/or journalism. In addition, I used a modified critical incident technique (Flanagan, 1954) prompted by the initial analysis of the participant's body of work. The incidents were used to guide discussion of writing processes and decision-making. Additional details about the identification of critical incident articles (addressed by question 4 in the interview protocol) is described in section 3.3.2 below.

Semi-structured interview protocol

The interview protocol used was as follows:

---

1. Can you tell me a little about your background and education?

    Follow-up prompts: Do you have a degree in science? A degree in journalism?

2. Tell me about the kind of writing you do.

    Follow-up prompts: Do you get assignments or freelance? Do you pitch story ideas?

3. Describe your process for researching a story.

Follow-up prompts: Do editors give you contacts? Do you use Google or academic databases? Do you have frequent sources?

4. Looking at story X – what sources did you consult with and when? How did you find them?

5. Why did you choose to talk with them? Did you get information from them from in-person conversations, phone calls, email, or some other type of communication?

Follow-up prompts: Do you fact check after you speak with your sources? Do you let them read your writing, or do you call to check certain facts?

6. Did you feel you had the knowledge/experience to know these were good sources or good information?

Follow up prompts: Do you try and find sources to agree or disagree to construct a narrative? Do you know how you want to shape your story with your sources? How does your journalism background/science background inform your choices?

7. Did consideration of your audience affect your choice of sources?

Follow up prompts: Did you write differently for X publication than Y publication? Do you write differently for online outlets versus print publications?

8. Do your initial source contacts refer you to other sources?

9. What are some of the effects you've experienced (if any) of new technological developments in your work – for example: new online resources, social network sites, or communication services like Skype?

Follow up prompts: Do you have a website? Use social media?

10. Do your editors or web staff insert links into your story when (if) they are published online? Do you have any control over those links?

Follow up prompts: What kind of sources do you link to? How do you feel about reader comments?

11. Is there any advice you would give to a colleague who is new to this field?

This protocol reflects the research questions' central concerns of information credibility embedded in process of science news writing. I developed these questions with a focus on the socially-constructed nature of credibility I had chosen to engage with. The writer participants were "performing credibility" in their writing work, but they we are also performing credibility in their interactions with me as an interviewer.

For guidance in the interview process and the following analysis, I relied on Yin's approach to case study research (2014). In particular, his suggestion to focus on "how" questions rather than "why" questions in the course of interviewing informed my decision to focus on process details of news writing. While I was aiming for (and did, in fact, encounter) significant self-aware reflection related to credibility decisions, these reflections emerged when the participants were describing to me literal details of their writing activities. Plesner's methodological direction to "study sideways" in interviews (as I interviewed individuals who do a lot of interviewing themselves) gave me some flexibility to pursue follow-up prompts and negotiations of meanings from my participants (2011).

Critical incident identification

Psychology researcher John Flanagan developed the critical incident technique (CIT) protocol to collect "direct observations of human behavior in such a way as to facilitate their potential usefulness in solving practical problems and developing broad psychological principles" (Flanagan, 1954, p. 327). In general terms, CIT provides a way for the researcher to encourage the participant to focus on a specific instance of the behavior under study and discuss choices, motivations, and outcomes as a way of grounding general observations in the particular. CIT or similar techniques (reconstruction interviews) have been applied in recent studies of journalism practices to

support the collection of rich data during participant interviews (Matusitz & Breen, 2012; Reich, 2006).

Critical incidents, within this study, were operationalized as articles written by the participants that elicited substantial reflection within the interviews. They offered detail-rich examples of particulars related to the writing process, career turning points, or illustrated complex interactions between editors and/or sources. Critical incident were identified in one of two ways:

- Suggested by the interviewer as part of the protocol. Interviewer suggestions were based on:
    - Most recent 2 articles on participant's web site
    - At least 500 words in length
    - Were reported pieces using sources, not, for example an opinion piece

  OR

- Suggested by the participant as an illustrative example in response to an interview question

All critical incident articles were included for analysis unless they could not be identified (*e.g.*, the writer referred to a piece of writing too vaguely or inaccurately to definitively track down a source). At the conclusion of the interviews, all participants had between two and 11 critical incident articles (N=16, mean=5.29, SD=3.27, median = 3.5, mode=3).

Thematic coding

HyperResearch software was used for analyzing these interviews, using an emergent coding scheme in the tradition of grounded theory (Charmaz, 2008; Corbin & Strauss, 2008). I coded the interview transcripts along themes of "identity" and "process,",and included a category of "other" codes to capture the overarching theme of credibility, as

well as reflective thoughts about the field that went beyond personal experiences and career trajectories.

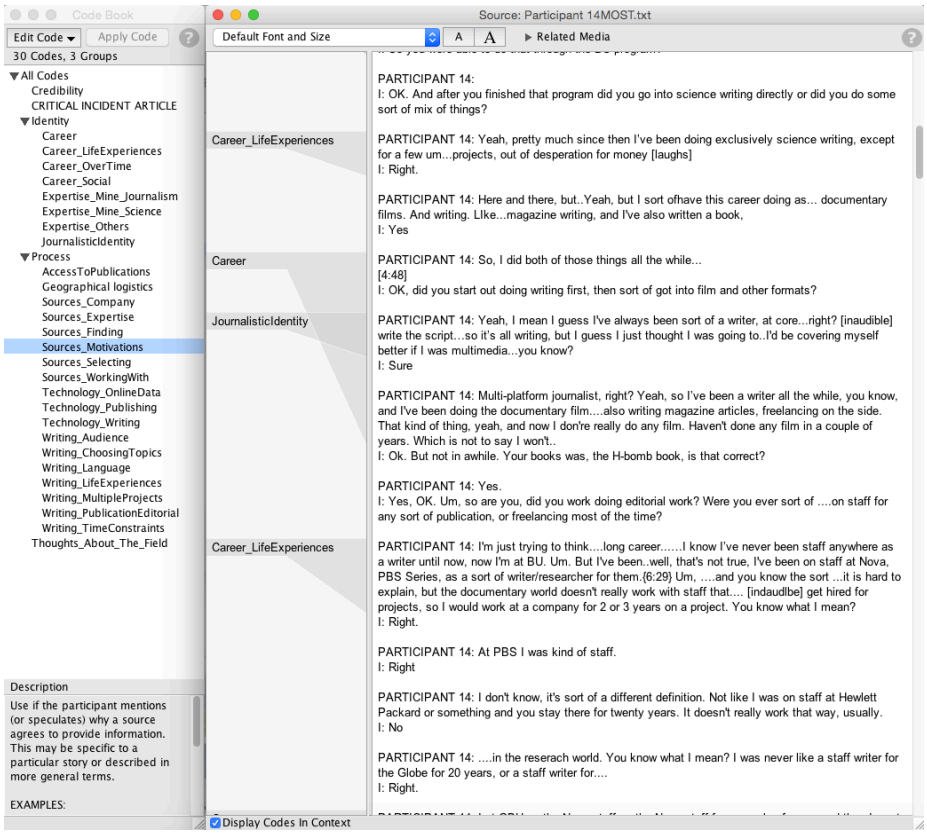


Figure 7

HyperResearch coding of themes from interview transcripts

Critical incident articles were also identified within the interview transcripts (see Table 4 below; full codebook with definitions and examples appears in Appendix C). This coding scheme highlighted areas for the application of discourse analytic techniques.

Identity	Other	Process
Career	Credibility	Access to Publications
Career_LifeExperiences	CRITICAL INCIDENT ARTICLE	Geographical logistics
Career_OverTime	Thoughts_About_The_Field	Sources_Company
Career_Social		Sources_Expertise
Expertise_Mine_Journalism		Sources_Finding
Expertise_Mine_Science		Sources_Motivations
Expertise_Others		Sources_Selecting
JournalisticIdentity		Sources_WorkingWith
		Technology_OnlineData
		Technology_Publishing
		Technology_Writing
		Writing_Audience
		Writing_ChoosingTopics
		Writing_Language
		Writing_LifeExperiences
		Writing_MultipleProjects
		Writing_PublicationEditorial
		Writing_TimeConstraints

Table 3

Interview thematic axes and individual codes

This codebook emerged from the first version following from the pilot study conducted in 2013. This codebook was used *a priori* for the first group of five participants. Annotations and the addition of six additional codes resulted in a reworking of the codebook in consultation with my advisor after the coding of the first three participants. The revised book was then used to re-code the first four participants. One additional code was added following the analysis of Participant D's interview transcript. The codebook remained stable thereafter. Coding frequencies (determined as percentage relative to the total codes applied to each individual interview) stabilized at the 11th participant (Participant 15). Five additional participant interviews were conducted, as these individuals had already contacted and interviews arranged.

Textual data

I inspected potential participants' publication history prior to initial email contacts to verify that they conformed to my selection criteria. Once an individual writer agreed to participate, I gathered their publication data prior to the interview, as described in Table 6 below. From a link on their NASW listing, I verified their website and contact information, and collected a list of clippings featured on their site and saved a screenshot image of the site (collected in Appendix F).

From this bibliographic data I had standard citation information, including publication dates, titles, and journal names. I also captured the Ebsco-applied subject codes as available. The database list was combined with the clippings list from the website (which typically included blog posts and smaller periodical publications not covered by MasterFile Premier) to create a master list of publications. Duplicates were eliminated as possible.

1. Collect screenshot of index page of writer's web site
2. Collect screenshot of clips page/s
3. Gather comprehensive list of publications
    a. Searching under writer's name as author in Ebsco Masterfile
    b. From writer's list on personal website clips page
    c. Eliminate duplicates as needed
4. Identify at least 2 articles as "critical" for inclusion in interview protocol (number 4)
5. Conduct interview
6. Transcribe interview (if recorded)
7. Identify and collect critical articles (ones I selected, ones that emerged during interview)
8. Arrange follow-up interview if needed

Table 4

Publication data-gathering process

Descriptive data was gathered from these complete lists, and analyzed alongside details and themes from the interviews. I used the complete publication history of each participant to inform my approach to the interview. In addition, this overall understanding of publication history supported my textual analysis of individual articles as included in the findings Chapter 4.

Web sites

Screenshots were saved from each participant's individual (non-organizational) website and analyzed for primarily manifest content items. Figure 6 is a representative example of these screenshots.

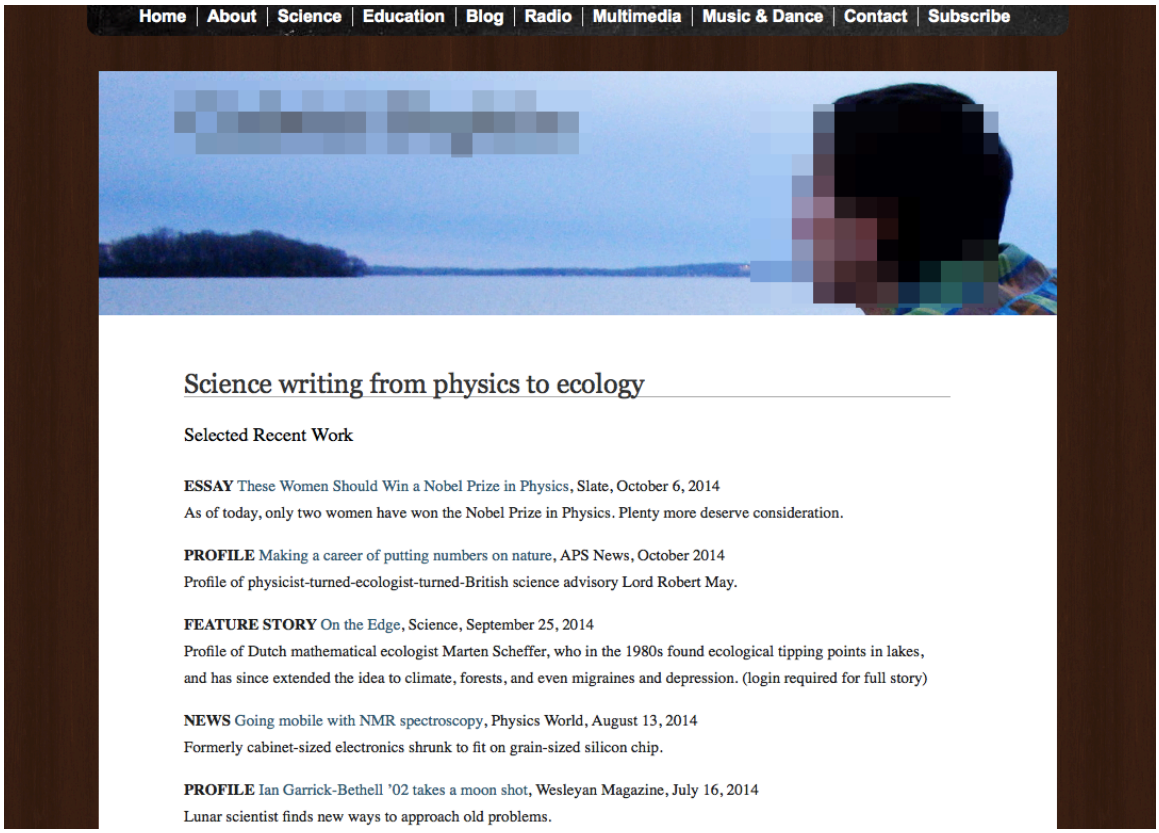


Figure 8

Sample screenshot from website of Participant L

A coding schema for the examination of the websites was developed after completion of the pilot study, and was informed by the Web Content Analysis (WebCA) paradigm proposed by Herring (2010) This methodological approach integrates the flexibility and

contextual sensitivity of traditional discourse analysis and the procedural rigor of content analysis. I examined each website for the number of presence of linked articles, integration of social media content (such as a Twitter handle or LinkedIn profile), as well as the apparent use of content management software (such as Blogger or WordPress). I used this analysis to support interview questions related to the participants' use of web sites and their attitudes to developing and maintaining their own web and social media presence.

Analysis of articles

Following the interviews, full text of the critical incident articles was collected from online databases, print and microform collections, other online sources, the writers' websites, interlibrary loan, or emailed from the writers themselves. The entire text of articles was analyzed using the codebook developed from the pilot data. Sources appearing within the articles were identified as those directly or indirectly quoted (using attribution phrases such as "according to" or "agrees that") within the text of an article, similar to the operationalization strategy used in prior study of news sources (Carpenter, 2007; Conrad, 1999). Each source was coded for source type and affiliation into pre-established categories developed from pilot study and also similar to the categories used by prior study of news source type and affiliation (Conrad, 1999; Moriarty *et al.*, 2010; Ramsey, 1999).

4 INTRODUCTION TO FINDINGS: BUILDING A CREDIBLE SCIENCE STORY

Journalists have traditionally used their institutionally supported professional identity to authoritatively position expert perspectives in news articles. That is, when they inhabit the role of "journalist," with its accompanying organizational and professional affiliations, they are able to arrange multiple source perspectives in a way that audiences (and the news establishment) believe to be truthful. Journalism scholarship has identified these normative practices in forms such as the inverted pyramid model of reporting (Mindich, 2004; Pöttker, 2003). For freelance news writers working in a muddied practice space between traditional journalism and flexible networked publication forms, assertions of professional identity and adherence to normative practices are increasingly relevant to writer's own understanding of credibility, and how they communicate their credibility to others.

Sourcing is the foundational activity of news writers, and in first tackling a story, the first-hand sources take the lead in crafting the story's shape (Godler & Reich, 2013; Reich, 2006). For example, as Participant D explained in his "boilerplate sourcing" explanation, if a reporter is writing about an oil spill, he interviews the people near the spill, the oil company executives, and the government agency in charge of cleanup – the individuals "closest to the story" in his words. The audience understands these sources as credible and relevant to conveying the truth of the oil spill because "an official journalist" is telling them that these sources matter in a familiar news story format. The journalist uses professional identity and reputation, along with sanctioned practices to organize the source information into a story that is credible and persuasive. The audience is persuaded by the details conveyed by the expert sources as well as their organization into a well-established form. Figure 4.1 below illustrates how a journalist might be understood as constructing in inverted pyramid story with the tools of identity and practice. The pyramid model is well described in prior sociological and sociotechnical studies of news work (*e.g,* Fortunati & Sarrica, 2010; Gans, 1979; Nelkin, 1995).

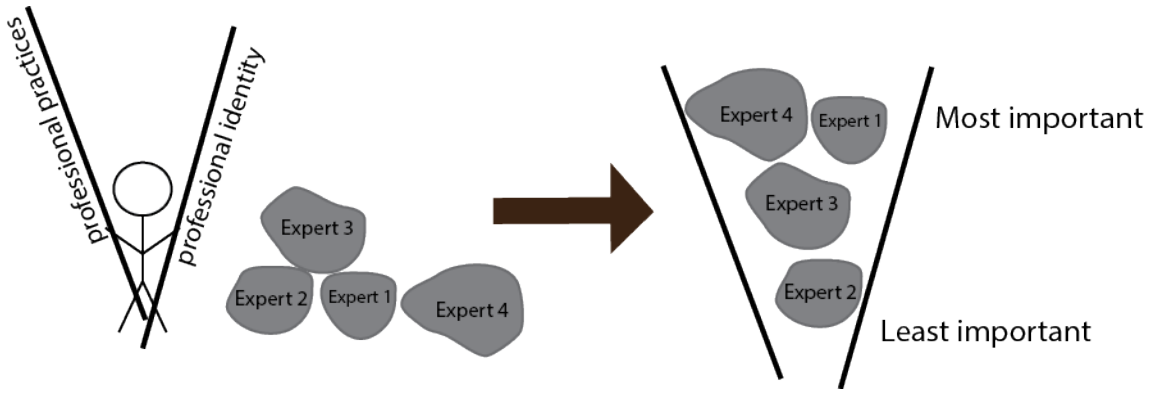


Figure 9

Traditional model of journalistic practices

The writer has typically used his or her tools of professional identity (reputation) and normative journalistic practices to arrange first-hand expert source information into an "inverted pyramid" form for a standard news article

I have added to my version of this pyramid the symbolic "boulders" of expert sources. In representing them this way, I have attempted to show how the sources exist independently of the news writer, and could, conceivable be accessed directly, but the writer has access to the tools of practice and identity to make them into the more familiar pyramid. Audiences readily recognize the pyramid structure, and that structure implies a shared understanding of how important news is communicated and what makes for "quality" reporting (Pöttker, 2003) It is important to note that the inverted pyramid structure emerged in the industrialization era of the late 19th and early 20th centuries, when news organizations and routines were becoming more structured and more financially relevant (Mindich, 2004).

Now, in some senses, the opposite is occurring. Formal news organizations are less relevant and routines within the news writing space are widely varied (Anderson, 2013). When journalists are operating as freelancers in a digital environment of multiple loose and often temporary affiliations, the traditional authority of the journalistic profession is called into question (Karlsson, 2011). The lack of institution-based authority, as well as the "increased transparency" accompanying online publication "may weaken the occupation's authority as well as its 'specialness' in the eyes of the public" (Lowrey &

Anderson, 2005, p. 2). Additionally, scientific experts in a field, rather than those doing science journalism, now have their own resources to speak directly to audiences who are likely to find them credible. Research institutions often author their own blogs and newsletters and individual scientists can write (or tweet) directly to public audiences. Is the profession of science journalism even necessary? And if so, how does one make oneself a credible and valued in the science communication space?

In setting out to examine science news work, I focused on the themes of journalist process and identity through which to explore how science news writers were managing credibility decisions. I chose to study freelancer journalists for two reasons. First, freelancers are an increasingly large part of the news workforce, and in fact, a large part of many types of work in the 21st century "gig economy." Second, substantial prior study in both information studies and journalism has been focused on organizational structures and institutional methods of coordination and control of participants. Gathering data from participants outside (at least to some degree) of those organizational structures supported critical and reflective responses that might have been difficult to obtain otherwise.

My sampling methods ensured a range of experiences and perspectives related to both themes of identity and process among the science writers. However a paradigmatic notion of what a journalist "is" and "does" remained substantially consistent throughout the interviews, even though freelancers are operating in an environment largely unconnected to formal supports for identity and process. They are not *New York Times* staff reporters following a formal *New York Times* style guide, yet they operate guided by the same type of norms. Similarly, they do not have the entire *New York Times* content in which to situate their work and ensure its credibility by association.

The freelancer must understand and negotiate his/her value as a communicator in the creation of every text. An essential part of the value they bring to that negotiation is bound up with an idea of credibility. In pitching an article to *Nature*, a freelancer needs to be able to convince the editors that she has the ability to write a *Nature*-worthy story on a scientific topic. She does this by employing a form of "synthetic ethos" (Feinberg, 2012),

in which prior publications and established relationships with scientific experts are valued.

As I analyzed and organized the data from this qualitative exploratory approach, I focused on experiences of journalists that have addressed the "added value" question proposed by Heikkilä, Kunelius, and Ahva (2010).

> We are now witnessing an increasingly intensified struggle over the value of journalism. This debate is played out at various levels. In newsrooms and professional discourses within them, the institutional and the market value are being converged into a quest for "added value." What it actually comprises, and how is it pursued, has become a key point for strategic decisions in media organisations.
>
> This paper sketches out a third option for added value: How does journalism foster a public connection between the readership and the public world? Following our argument in this paper, such an approach has two objectives. Firstly, it needs to detach the notion of public from its earlier, dominantly institutional frameworks, in which being a member of a public is an abstraction that rests upon institutionally defined practices of citizens and voters. Secondly, it needs to resist, or at least balance out, the market-driven discourse that understands audiences as individual consumers.
>
> In order to pursue this we argue that it is important to situate audience research at the level of the social fabric of everyday life and focus systematically on how the relevance of journalism is negotiated in social networks […] (Heikkilä *et al.*, 2010, p. 282)

The sociological work of Heikkilä, *et al*., points towards a philosophical approach to answering the question of added value, borrowing from philosopher John Dewey to suggest a more through engagement with the habits and educational contexts of a democratic public. My study builds on this foundation, but finds support from the disciplinary traditions of library and information science that focus on the public as seekers, judges, and users of information. Synthetic credibility is understood as part and product of informational exchanges within social contexts and everyday experiences. The "social fabric of everyday life" (Heikkilä *et al*., 2010, p. 282) is operationalized within this study as the work of freelance science news writers.

The vignettes included here represent the most salient responses from my participants to questions about "doing credibility." I have identified and analyzed these vignettes with an eye toward bringing to bear relevant information scholarship, its usefulness and its gaps, on an information credibility space that has suffered from deep disciplinary divisions in the streams of research. As outlined in the methods section of Chapter 3, I have relied on an iterative explanation building form of analysis as described by Yin (2014) to organize the findings from my interview and article text cases. Below, I briefly review the criteria I used in deciding on explanatory vignettes.

Analysis and criteria

As described previously, I developed my interview protocol following a review of prior work and a pilot study with a small number of participants. I created questions (Appendix A) that related to the writer's professional experiences, and including specific details related to recently authored articles. Those recent articles (or critical incidents) were used to ground discussion of abstract practices and attitudes towards work in specifics – specifics that the writer could describe to me and that I could examine in the final published work. In many cases the critical incident prompt led to rich discussions related to credibility. In other cases, thoughts related to writing credible news stories emerged more organically from questions about career trajectories or the use of technology.

Following coding of the interview transcripts (full codebook is in Appendix B), and analysis of the articles as described in Chapter 3, I began testing explanatory propositions against the emergent themes of my data. While typically this approach looks for ways in which the prior theoretical explanations fall short (Yin, 2014), more often I found the failures to be ones of bridging two distinct disciplinary streams of literature. Information science scholarship on credibility examines user interaction with information artifacts, while media and journalism scholarship looks at organizational structures to promote trust. Both of these elements were in play, but needed to be considered together coherently.

The primary signal I used to identify an explanatory vignette were those cases or critical incidents where the participant was able to reflect on their activities as both some discerning about their sourcing choices (*e.g.*, "Does this scientist know what he's talking about?) at the same time they were conscious of themselves as producing some information that had to have value to others (*i.e.,* the editors or the audience) as credible. In this way I was able to bring together the two streams of theoretical literature (from journalism and information science) in an organic way, well-grounded in lived social experiences.

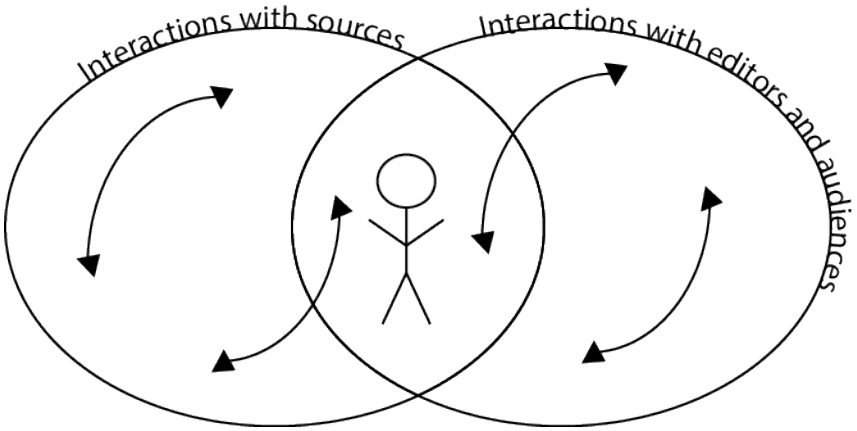


Figure 10

The science news writer participant, occupying the space between the enacted worlds of the journalism production and their information-seeking with sources

As illustrated in the above figure, the science writer occupies a liminal space between two worlds of information interactions. The sphere of journalistic production consists of interactions with editors, publication venues, and the notion of an audience. This space, though evolving and remaking itself with social and technical changes, remains fairly well-described by sociological study focused on organizational structures. Meanwhile, the science writer (and in particular, the *freelance* science writer) engages with expert sources in ways that are addressed by information science study: as individuals seeking to meet an information need. Prior models of information credibility focus almost

exclusively on the user's interaction with the information object, and treat social context as peripheral. I intent, with this model, to show a more thorough integration of the "information seeking" and "information producing" spaces in terms of credibility judgments. The reflective participant working in the intersection of these spaces provides the material for the following cases.

4.1 The "journalist" Identification

Overview: Freelancers and professional identity

Prior study has identified the professional identity of journalists, and science journalists in particular, as relevant to questions about their writing process and the social conversations in which science news reporting occurs (*e.g*, Fjæstad, 2007; Trench, 2007). Specialized science writers have traditionally asserted their particular expertise to talk about science topics in the mass media. While there is abundant scholarship on news work showing how the norms of journalism are taught and re-affirmed through the processes and structures of traditional media, how freelance writers learn (or do not learn) these practices on their own is less well-understood.

Again, the term "journalist" is used in this study to refer to a professionalized practice of news reporting; for the most part, relevant prior research has used this term. In describing the participants in my current study, however I am using the term "writers" for the reasons outlined earlier, including the fact each individual identified with the journalistic profession to varying degrees. The distinction, then, is not merely a semantic one. The features of professional identity -- whether as a journalist, a writer, a scientist, or an activist – were a central theme of my analysis.

Examinations of the profession show that writer identity may suffer from a "high degree of isolation," in fact (Slay & Smith, 2011). What identifies a journalist a "journalist," if she lacks a regular byline at a known media outlet? The professional label of "journalist" is inextricably bound to the perception of being a credible communicator and the ability to make believable claims to truth-telling (Abbott, 1988; Ekström, 2002; Heikkilä et al., 2010). Professional identity, therefore, is not a minor concern when studying credibility.

Emerging research is showing that freelance journalists develop an "entrepreneurial" approach to their work, taking more responsibility for their qualifications and education, and relying less on formal affiliations on job titles (Edstrom & Ladendorf, 2012; Ladendorf, 2013). The particular effect on journalists' understanding of credibility in this

environment is little-studied, though most often approached through the context of exploring the contemporary blurring of the distinction between authoring public relations material and journalism (Ladendorf, 2013). "PR work" is normatively seen as less authoritative and more compromised than "straight" journalism that presumes to report unbiased facts for public discourse (Abbott, 1988; McIntosh White, 2012). This normative difference persists in prior study and among my participants, although there is little doubt that this distinction is in no way clear-cut (McIntosh White & Wingenbach, 2013; McIntosh White, 2012). The financial pressures of a freelance environment and the entrepreneurial mindset described above necessitates, for many writers, regular shifting between "straight reporting" and public relations writing assignments, This context problematizes a relationship between professional identity and credibility.

Journalists' professional identity is reinforced in response to training and experience that can be widely varied. At its core, however, the identity centers on a sense of being accountable at a personal level to the public (Cassidy, 2007; Singer, 2003). A writer's byline on his or her story demonstrates an investment and measure of commitment to honest public information. The internet, with its capacity for multiple hyperlinks many times removed from a source and potential for anonymity, complicates the notion of a byline as a mark of integrity (D. S. Allen, 2008; Cassidy, 2007; Hermans et al., 2009; Walsh, 2015). However, recent work and reports from my participants suggest the affordances of the internet can continue to support traditional forces supporting professional identity and accountability.

Vignette: Traditional journalism affiliation as a warrant

Participant D was a rich source for uncovering the current complexity surround the "journalist" label among freelancers. Among all the participants, he had the greatest number of bylines for fairly high-profile traditional media sources (such as NPR and *The New York Times*) and a career of over 25 years in reporting. Our conversation related to how the journalistic identity is negotiated was, itself, a negotiation between the two of us.

Following a comment he made regarding the state of journalism generally, I followed up with a more focused prompt related to professional identity.

> **Interviewer:** Yes. One of the things I'm wrestling with is this notion of a journalist, this professional identity. A lot of the things that you've said and other people have said, for me, seemed to cohere in a theme, like, "I don't let sources review my writing," or, "I try and get multiple perspectives," or, "I work with an editor." […] It seems like you might have gotten that just from working in these environments with lots of other journalists, and seeing what that format it and what those practices are.
>
> **Participant D:** Yeah. I would say particularly, my first job, which was on a weekly newspaper, working closely with a very good editor who ... I learned a lot really by osmosis, or diffusion, whatever it would be, on the job. I guess at all the staff jobs I've had, I've learned a lot. Then also when I worked as a daily reporter for public radio, for Maine Public Radio, I learned an awful lot from my colleagues there. Yeah. A lot of it has to do with what are standards of the industry. I think this is why people identify as journalists rather than writers, in many cases, because there are some certain standards and procedures that you go through and you make assumptions about them. It's part of being a journalist.
>
> **Interviewer:** Right. That semantic thing is actually interesting. I was just researching the history of the NASW, and they actually chose "science writers" over "science journalists," thinking it sounded more scholarly or more professional, back in the '30s, which is interesting.
>
> **Participant D:** Yeah, and maybe it is. I'm sure you, having talked to as many people as you have, there are people who self-identify as journalists, and even, "I'm a freelancer." I could say, "I'm a freelance writer" or "I'm a freelance journalist." I identify as a journalist, and I think I know what that means. I think editors understand what that means.
>
> Early in my career, I took an evening course in magazine writing. The guy who was teaching it, a famous Maine writer who's now dead named John Cole, he said,
>
> "Journalism experience puts editors at ease." I asked him more questions about that. I think what he meant was, if you're working with an editor, and they know you're a journalist, they can make assumptions about how you've approached the story, whereas if you ... a writer, *per se*, I don't think that they necessarily know that that's the case.
>
> This has to do with sourcing, quotations, everything, all the stuff that we assume journalists do. Does that make sense to you?

Interviewer: Yes, it does. It seems like there's a couple different ways where you could come. To identify as a journalist to an editor, you could have a journalism degree, or you could have enough bylines from enough regular news outlets that legitimate you in that way.

Participant D: Right. It's interesting in that perspective, because it's different than being a journeyman electrician, because we're not certified by anyone. You're right, it's a leap. You're saying, "I'm a journalist," and who's to say otherwise. Yeah, I think it really does have to ... For me, it's all about building up your clips and having clips, again, in newspapers and places where it's straight journalism, and not opinion pieces but news.

Interviewer: I know journalism has changed radically in the last 10, 20 years. Do you feel like that's changed how journalists identify themselves? Is there still that professional sense of identity and "These are the things we do that make us journalists?"

Participant D: I think it's blurring. I think it's definitely blurring. Gosh, I saw a ...

Interviewer: Oh.

Participant D: A unique kind of journalism that's a blend of ... I don't remember what it was. I was thinking, "Well, it's unique, because it's not journalism." This is probably good, that things are not as rigidly structured as they used to be. I think there's a lot of what people might consider journalism that doesn't meet the stricter standards that I would hold out for what I construe as journalism.

Interviewer: Right. Right. Yeah, I've heard that again and again. Some people come at it from a really optimistic view, and some are just terribly worried.

Participant D: Yeah. I think with more news outlets like that we have now, I think maybe the onus is on the reader to know where they get their news that they trust. In many cases, it is straight journalism. I think it is getting harder, because you have so many blog-y type pieces that are not only somewhat opinionated, but they're also accretions of previously reported information. Sometimes people put a bunch of links in a story. It makes it look like they've done some homework or something or they're bolstering a case, but it can be random, and it can be selective.

In this exchange over several minutes, Participant D repeatedly established his bona fides with me as someone who knows journalism. He referenced where he has published, courses in journalism he has taken, and they years of experience he has in the field. He shifted his discursive footing deftly in our conversation – bringing in what editors think

of journalists and even making suppositions about the kinds of findings I was gathering. Participant D's experience and skill controlling our interview discourse (from years as an on-air news interviewer, presumably) was unique among my study participants.

His views on what constituted "professional journalism" were fairly representative of traditional norms of print and broadcast news (Gans, 1979). Checking in with me about "the stuff we assume journalists do" affirmed that we were operating from the same definitional understanding of journalism or news – it was this type of engagement that was stood out among the data. This kind of interaction did not occur with every participant, and suggests Participant D's view of himself as an expert, or ambassador for his field. Participant D was willing to engage with me about his own story, but was especially interested in making sure I understood some things about journalism generally. For example, interview questions about process and sourcing of his own articles led Participant D to respond in terms of journalistic norms, or what reporters and their sources "should" do. A conversation about difficulties in reaching expert sources for his stories led him to conclude, "I feel like people should open their doors to journalists." Questions about individual experiences led to generalizations about the profession and its function.

This participant was also comfortable in asserting what editors expect from someone who identifies as a journalist – and how editors know to trust the writers as credible sources of information who understand the larger media ecosystem. He was able to generalize about "editors" as a group – not something other participants did, or something I would feel comfortable doing as a scholar of journalism. The variety of types of articles and venues of publication were extraordinarily diverse in this science news space – yet Participant D remained certain that bylines from "regular news outlets" were a warrant for credibility. The trust placed in regular news brands (*e.g.*, Robins, Holmes, & Stansbury, 2010) confers some level trust then upon the journalist. Trust that persists as they move as an entrepreneur through a flexible freelance information space.

Conclusion: Identity norms reaffirmed through individual experiences

Participant D's confident explication of the relationship between journalist identity and credibility is illuminated by a contrast with Participant O. Participant O is an early-career writer very much conflicted about her current work (at a pharmaceutical industry journal). She had very little social "newsroom" history of Participant D, and had never had the support from a community of practice (Wenger, 1998) and activities such as peripheral participation to support her professional identity formation.

She engaged in much less back-and forth about how journalism identity confers credibility on a news writer with me, but was a unique example in the intensity of her identifications with the traditional ideals of journalism. Participant D wanted to make sure I understood this relationship between journalism and trustworthy writing as a concept; Participant O wanted to make sure I understood *her* particular struggles with this relationship.

She described over the course of the interview her close relationship with her uncle, a "newspaper man." Writing about science came along later in her career, but the notion of the role of a reporter as a sort of public crusader and source of true information for everyday citizens was described as a key part of her personal identity since childhood.

> **Participant O:** I have my own kind of narrative. My uncle who was a newspaper man and he wrote me at my high school graduation, he said, "A newspaper writer is one of the few ways to make an honest living," and that's all part of the whole idealism but I totally believe that.
> … If I were to write a story of my journalism career, I guess, it would just follow this arc of there was that promise of *All the President's Men* that was my ideal. I was going to work at the *Marietta Daily Journal*. I was going to get to the *Atlanta Journal Constitution* and then I was going to go to out west, to the *Sacramento Bee* and then I was going to go to the *New York Times* and it was just … I was willing to do anything to get to that and it's so interesting now.

Participant O, at the time of the interview, had, in fact, had become so conflicted about the ethics of her employment she had decided to quit her job the day before our

interview. Her science writing was being delivered to an audience of subscribers who could afford to pay for this pricey trade journal. The general public, who might benefit directly from her coverage of new drug trials, had access to her writing. Her sense of being a credible communicator was threatened by the fact she was not performing the essential journalistic of being transparent and accountable to the public. This suggests a locus for the identity-credibility relationship between social practices and personally held norms.

This finding relating identity to credibility addresses my first and second research questions about how science writers understand information credibility. As earlier theories back to Aristotle demonstrates, identity is a central piece of rhetorical ethos and being seen as a credibility communicator. My participants demonstrated their reliance on the persistent existence of a journalistic profession and an associated set of ethics. Phrases like "an honest living" and "straight journalism" (versus PR or activism) demonstrate a belief in community of practice dedicated to a public good. While they recognize the limitations to this definition, they assert this professional identity in service of credible communications by leveraging experience and affiliations (bylines) and making established practices of sourcing transparent.

Participant D said "I identify as a journalist, and I think I know what that means. I think editors understand what that means" and referred to "stricter standards that I would hold out for what I construe as journalism." The reference to editors is important as editors are the route to publication to larger audiences, and editors need to demonstrate the credibility of their publication in order to ensure its success in the information market. At the same time, Participant D did not express reliance on the editors or publication venues to enforce or teach him those ethics "I know what this means" he said and "standards that I would hold out." While the ethics and standards were surely constructed socially, they were resident in a sense of individual identity, and may be strengthened by the growing influence of competing sets of standards from professions like public relations (Abbott, 1988; McIntosh White & Wingenbach, 2013).

In contrast to literature suggesting a deep crisis in the profession of journalism and lack of a cohesive journalist identity (Barnhurst, 2013; Siles & Boczkowski, 2012; Singer, 2003), my findings suggest that the sense of professional identity remains strong, even with organizational and financial structures of journalism in transition. This identity construction is central to how writers understand credibility, and as demonstrated by Participant D, personal experiences can lead to generalized norms about the profession. This professional label does a lot of work in managing credibility – both in terms of the writers' selection of credible sources and in terms of the writers' efforts to present themselves as credible; when thinking of these aspects of credibility my participants asked themselves what a journalist would do, or what was expected of a journalist. While each had slightly different relationships to the journalist identity, each drew on the identity as they performed credibility. As journalism becomes an increasingly freelance and contingent professional practice, understanding the many ways identity is leveraged in news writing becomes more and more salient. Professional identity is a feature in all of the following illustrative vignettes, and it is inseparable from the writers' understanding of credibility.

4.2 Source mediation/disintermediation

Overview: Getting to the source

Identifying first-hand sources and obtaining useful information from them is the foundational activity of news reporting. News writers serve as proxies for the information-seeking public when they ask questions of an expert source or eyewitness. Specialized reporters "popularize technical knowledge and publicize experts, they become ambassadors to the lay world for the specialties they cover" (Gans, 1979, p. 137). Prior research has shown that a good source has relevant credentials and affiliations (Conrad, 1999). These sources are available through the social network of the journalist. Journalistic practices and writing then establishes those facts as part of the public discourse (Godler & Reich, 2013; Tuchman, 1978,).

Obtaining information to build a news story is not a one-time act, but rather a "relatively structured process extending over long minutes, often hours and (less frequently) days" (Reich, 2006, p. 498). The process model suggests that over the course of work, the informational dynamic between the source and writer will shift. Sources will "lead" early in the discovery of a news item, while the writer's perspective asserts itself with the process in order to fit the story within existing frames and organize other views. (Ekström, 2007; Reich, 2006). Information science, while looking at sources as information objects retrieved by a user, also reflects a view wherein where source context matters more than specific source attributes (Metzger et al., 2010; Warnick, 2004).

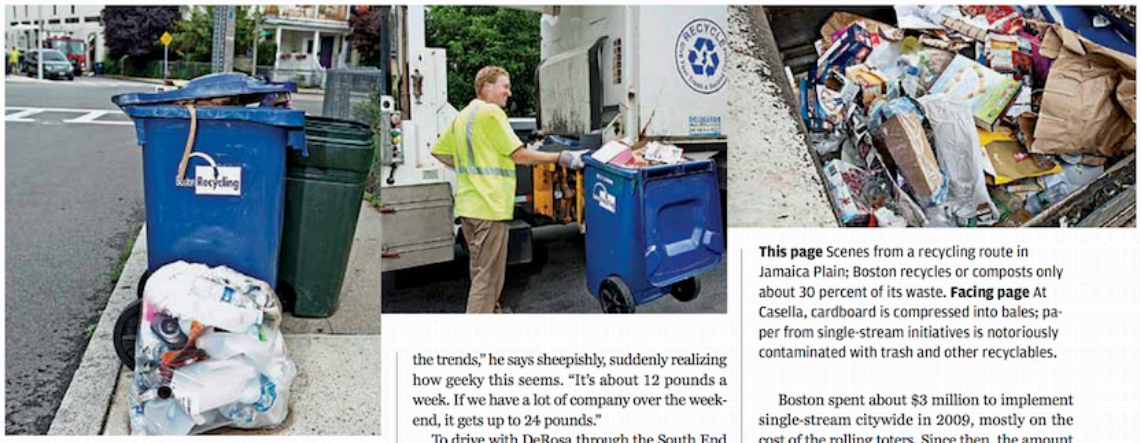
While a "structured process" is a fairly straightforward way to describe the interaction – it doesn't offer much explanatory power. Interactions with sources can be problematic – how do problems and barriers affect the pattern of source-finding for writers? And how does this ultimately influence the creation of a credible narrative by the writer? This chapter describes writers' encounters with sources that are stymied by some sort of mediation and is intended to respond most directly to my second research question about the forces that may intersect with and confound a writer's focus on credibility. Many participants reported difficulty with getting responses to email, or having to speak to an

industry group of public information office rather than the scientist. The writers, in these cases, came to question the credibility of the information they were getting – since the encounter with the source was limited in some way. There is little prior research exploring the adaptions writers make when their interactions with sources are challenged, and how those challenges and adaptations influence credibility judgments.

Vignette: Follow the garbage

Participant J is an experienced writer who spent many years as a longer-term contract writer and documentary producer (for television shows such as PBS's *Nova*). She relied heavily on freelancing work after the birth of her first child and has continued to freelance as the publication of investigative science news declines. She described the economics of freelancing remained challenging. The logistics required for contacting multiple sources for a long-form article were a cost in time and money for her. Participant J described her latest long-form investigative piece for the Sunday magazine section of a major daily paper on the city's recycling program (Figure X below). She consulted dozens of sources over the course of several weeks for an article that netted her a $3500 payment – a figure she volunteered to me.

While describing this as a "good story" that she felt proud of, the interactions with sources were stymied by economic limitations. These sorts of limitations are much more of a concern for freelancers for obvious reasons, as are logistical and political concerns in many cases.



This page Scenes from a recycling route in Jamaica Plain; Boston recycles or composts only about 30 percent of its waste. **Facing page** At Casella, cardboard is compressed into bales; paper from single-stream initiatives is notoriously contaminated with trash and other recyclables.

many officials and activists in Boston see San Francisco as the gold standard.

"Why is San Francisco a national leader and Boston at the tail end?" asks Lynne Pledger, the solid waste director for Clean Water Action Massachusetts. "It is a matter of political will."

To be sure, Boston is getting greener. Bike lanes and Hubway docks are springing up like wildflowers, the city recently launched a sustainability initiative called Greenovate Boston, and Mayor Tom Menino has established efforts to reduce the city's greenhouse gas emissions by 25 percent and plant 100,000 trees here by 2020. Boston now recycles waste in all its public schools and is putting recycling bins into public parks.

The state, too, seems energized. In May, the Massachusetts Department of Environmental Protection released an ambitious 10-year Solid Waste Master Plan, which calls for raising the state's diversion rate to 64 percent by 2020 and 90 percent by 2050. State legislators interested in keeping plastics out of rapidly filling landfills are discussing an expanded bottle bill and a ban on some bags. And in June 2014, the state's commercial food-waste ban, the first in the country, will go into effect. Any facility generating more than a ton of food waste a week—universities, hospitals, hotels, some high schools—will have to compost it, rather than dump it as garbage.

Change is afoot. But can Boston catch up with San Francisco or even Seattle? Maybe.

ROB DEROSA, Boston's superintendent of waste reduction, may be the only man in the city who weighs his family's recycling—every week, holding the bag, on the bathroom scale. "Just to check the trends," he says sheepishly, suddenly realizing how geeky this seems. "It's about 12 pounds a week. If we have a lot of company over the weekend, it gets up to 24 pounds."

To drive with DeRosa through the South End is to see the city through garbage-colored glasses. Instead of leafy parks and immaculate brownstones, you're faced with a warren of apartment buildings and narrow alleys conspiring against proper waste collection.

He points out a well-dressed young woman scurrying past with an armload of cardboard. "People want to do the right thing," DeRosa says, sighing as he watches her disappear around the corner. "But sometimes they have nowhere to put the stuff."

To increase recycling overall by easing the process for residents, Boston, San Francisco, and a growing number of communities nationwide have adopted what's called single-stream recycling. Instead of separating glass, plastics, paper, and cans, residents dump them together into one bin.

"Why is San Francisco a national leader and Boston at the tail end?" asks environmentalist Lynne Pledger. "It is a matter of political will."

Neal Klinman, a kindergarten teacher who lives in Brighton with his wife and three kids, loves it. Klinman was a diehard recycler anyway—he made his kids' sandbox out of a discarded car-top cargo carrier—but says that single-stream has, well, streamlined the process. "It's way easier," he says. One evening after dinner, he lugs the recycling outside and tips it into a big blue cart on wheels with a satisfying crash. His 96-gallon "toter" is almost full. Then he holds up his trash for the week, which fits into two small Target bags. "That's pretty cool, huh?" he says, smiling.

Boston spent about $3 million to implement single-stream citywide in 2009, mostly on the cost of the rolling toters. Since then, the amount of recycling collected has shot up from 19,000 tons in fiscal 2008 to 32,000 tons in 2012. Over the same period, garbage collection dropped 11 percent, from 221,215 tons to 196,205. The introduction of single-stream has both decreased what we put in landfills and saved the city about $1.3 million each year. Boston currently pays $82 for every ton of garbage disposal, and in 2012 was paid an average of $1 for every ton of recycling. (The city has five contracts with collectors and brokers that use three facilities, depending on the district.) Recycling income or costs slide up or down each month depending on commodity prices—in the last few years, the city has either received or paid up to $40 per ton.

But before we give ourselves a big green hug, it's important to examine the other side of single-stream. This is where things get tricky, because increased collection of recyclables does not necessarily mean increased *recycling*. About 10 percent of what enters a US waste management facility from single-stream recycling winds up getting thrown away as trash. In Casella's plant in Charlestown, the rate is better, but it's still 8 percent.

At the plant, six people using hands and hooks pull non-recyclables off the line before the machines take over. Broken umbrellas, Styrofoam containers, wire hangers, plastic bags: all trash. Workers also pull off some recyclables at this point. Rigid plastics—kiddie pools, that red sled I saw—go into one pit, and big pieces of metal—weight-lifting bars, cooking pots—into another.

Screens filter out cardboard, magnets grab other metals, optical sorters separate different types of plastics—air jets shoot milk jugs onto one belt and colored plastic onto another. The results are huge bales of paper, aluminum, and plas-

PHOTOGRAPHS BY WEBB CHAPPELL

Figure 11

Participant J's recycling article for a major daily paper's Sunday magazine section

Interviewer: Um, there is [story about] about recycling. The green initiative…

Participant J: Oh God, yeah. Jesus, that was a ton of work.

Interviewer: That was a ton of sources. How did you get started on that?

Participant J: Oh my gosh….so they call me up and say 'We really want you to do a piece on recycling. Whether or not recycling works.' And I'm like 'OK' so that was that, right? [laughs]

Interviewer: Got it.

Participant J: No clue. I've got not clue about recycling. Except I always wondered, like, if they just chuck the stuff in the dump once I put it in the bin? Does this actually work? So anyway I was kind of curious. Um… so I thought, I thought here's what I'm going to do, I'm going to follow…I'm going to go and ride around in recycling trucks all day and see what they do. So I called like the city office of something and then, they said "No, you can't do that" because it was a safety hazard

Interviewer: Uh-hmm.

Participant J: So then I said, OK, I'm going to change that idea and I'll just sort of track garbage, you know what I mean? And see where it goes? And that kind of worked, but it doesn't exactly work. So, I don't know. Well, I just…

Interviewer: How did you try and track garbage?

Participant J: Well, I thought, I'll just follow… I'll see where they pick it up and then figure out where does that truck bring it? And OK, it goes from here and then it goes to the MRF [materials recycling facility] and from the MRF it gets packed up and it goes on a boat to China or wherever the hell it goes …but it gets all mixed up and goes to all these different places…so I felt that that would be fake, you know? Like I would be making up a story that wasn't real. You know?

Interviewer: Right.

Participant J: Cause I couldn't…the MRFs are those places, they're sort of like super-secretive and I [laughs] I don't know, they don't want to tell you anything and….I don't know. I don't know – it was weird. So, I don't know, right the story kept getting bigger and bigger. So I interviewed the city guys because that seemed obvious, the city garbage guys, and then I interviewed the guys at the sorting place, and then, yeah, I've gotta figure out where all this stuff goes. It's like different for every thing. So then I started trying to figure out who to talk to about the glass, and the plastic, and then there was this whole… I interviewed all these people at the incinerator…the story, yeah, I don't know. I guess it just kept going and going and going. I guess I just kept going, um, until I kind of felt like I knew what I was talking about. [laughs]

Interviewer: Right

Participant J: Yeah, yeah, but it was like a ton of work, right? And you know, this is why freelancing doesn't work. I think I got like, you know, 3500 bucks for that piece, and it was like, probably, 3 to 4 weeks of work, full-time, and that was a lot of work – a lot of site visits, driving around, and I don't know. You're just like …exhausted. And it was cool, a good story, and everything, and um, but I mean economically, it just doesn't….

Interviewer: Right

Participant J: ….pay. You know, I can't just keep doing that. [Laughs] All the time, that sort of depth of interview as a freelancer, you know what I mean?

Interviewer: Would you do that again? If they asked…knowing then what you know now ?

Participant J: You know, no. I'm not doing that…that's why I came to work for [university]. Cause I'm like… I cannot…no. It's killing me.

Interviewer: So you had to…if you wanted to find …so you talked to this PET plastics guy …or no it was it a woman, Raisa…

Participant J: I talking to every freaking….yeah…

Interviewer: So were just kind of on your own Googling who was this trade group or who's in charge of this environmental group?

Participant J: I think there's a bit of that, but also sort of once you get into it, you ask people, like, once you get into it, you figure out that this person seems straight-up, you know this person seems knowledgeable and straight-up, and you can ask them, "who would I talk to about X, Y, and Z?" I also ask my friend, I have a friend [NAME], who's an environmental reporter at [Daily Paper], you know, I asked her for some good people to talk to. And sort of once you get the first couple people to talk to, that kind of leads you down other paths.

Interviewer: Right

Participant J: And some of the other paths are …bad ideas [laughs]. You know, especially in these kinds of stories where people have these really strong feelings about recycling, and then you, like, I don't know, end up talking to these crackpots on the phone and then you realize like 10 minutes in…crackpot….oh my God. Anyway…

Participant J was repeated stymied in her efforts to engage with sources in the course of reporting this story. First, the safety concerns of the city authorities kept her from doing the story the way she had originally planned. She also bumped up against her financial

limitations – especially as a freelancer. She was able to start her research with sources on the ground, even if she wasn't able to ride on a garbage truck. She then used her collegial networks – people she knew to be "straight-up" on prior interactions were able to inform her about some of the scientific and technical aspects.

This particular story was complicated in that it contains a notable political and policy element. There are many actors invested in what is being told to the public about recycling – including city officials, private waste or resource recovery companies, environmental groups, and scientists. Some, as Participant J noted, could be "crackpots." Additionally, it is noteworthy that this story was originally assigned to her by editors at a big-city daily. The politics of that assignment within the larger socio-political context are also at play. While she did not describe meeting any editorial resistance to her story or its framing, it's likely the editorial oversight was substantial.

Conclusion: Writers articulate credibility by overcoming obstacles

Prior research concludes that working with sources is a repeated, self-referencing process for news writers (Ramsey, 1999; Reich, 2006). However these prior studies do not offer substantial explanation of how problematic interactions and limitations are handled. After having identified credible expert sources for their reporting, how do writers recover when interactions with those sources are blocked or challenged? The contingent nature of freelance reporting and ongoing pressures in the economics and organizational structures of publishing suggest that difficulties in getting information with sources How can research from information science serve to support

For example, several participants noted that they are limited in which journals they use as sources by subscription paywalls. Without an institutional affiliation, freelance writers cannot afford to get access to certain kinds of expert communications. This privileges certain kinds of writers over others, and forces choices on the part of the writer. Participant J, for example, noted that she had chosen articles to cite in her writing based

on the fact they were accessible via Google Scholar when she could not get another article that was limited to Web of Science subscribers.

Researchers need a broader sociotechnical lens (*e.g.*, Fortunati & Sarrica, 2010) to locate the motivations – political, economic, and otherwise – that might present barriers to journalist-source interaction and limit credible science communication. In particular, a sociotechnical lens allows us to move away from technologically-deterministic approach that looks at the tools themselves as forces of disruption, rather than looking at how those tools are employed within systems so serve particular ends.

This finding addresses my second research question about how credibility interacts with other factors influencing writing sources decisions. While other vignettes illustrate how external pressures can effect source selection earlier in the process, this vignette addresses the point of overcoming obstacles and may suggest how a chain of "good enough" information decisions might present in a networked publication space. Much journalism research in recent years has described news organizations in reactionary ways, adapting to real and perceived threats from internet technologies as publishers. My study illustrates the broader context in which freelance journalism encounters all kinds of obstacles to its work. Experts may not readily provide the hoped-for information, or subscription academic journals may be difficult or impossible to access for a freelancers. Adherence to a normative process for "finding good sources" and persisting in the face of these obstacles are key to how journalists understand their work in being credible. In response to the first research question, overcoming obstacles to act as competent mediators and provide information unavailable to the "public" is key to journalists' understanding of themselves of credible. This normative persistence to overcoming obstacles to "truthful" reporting also addresses my second research question. While economic, social, and political pressures limit writers' access to some source materials, they are motivated to persist in spite of them, to some degree. Even if they are stymied in in getting the information they sought, having struggled to do so reinforces their idea of themselves as credible.

4.3 Working with publications and editors

Overview: Editorial relationships and institutional boundaries for the freelancer

Despite widespread dire assessments of journalism, and science journalism in particular, as a profession, current study shows relationships between editors/publishers and freelance news writers remain fairly solid (Ladendorf, 2013). While editors in formal publications must maintain their role as institutional gatekeepers, and often say "no" to journalists, journalists seem to trust their editors as allies acting in good faith in the process of constructing a credible news narrative (*e.g.*, Treise & Weigold, 2002). What holds freelance writers and their editors together, in terms of a collegial relationship and shared credibility goals, is not entirely clear. Editors often have both the power to see that a writer gets paid, and to demand certain story topics or the use of certain sources (credibility and relevance judgments) from the writer. However, it seems that what could be an inherently conflict-riddled relationship is rarely described as such, either in prior study (*e.g.*, Edstrom & Ladendorf, 2012) nor among the participants in my current research.

Historically, political and editorial motivations supporting particular framings of news events were primarily instantiated at institutional and organizational levels (Habermas, 1991; Scheufele, 1999), less so at the level of the individual reporter. These motivations include political pressures from authoritative knowers, such as policy officials and elite researchers and institutes, who may want to control the narrative of scientific discovery in a way that ensures public support and funding for their scientific work. In traditional publishing, news organizations may use various forms of editorial control and socialization among their staff to ensure suitable framings for sources of authoritative information. Framing choices, such as the selection of certain sources of scientific information as more relevant than others, or including quotes from particular government agencies to explain the relationship of a scientific discovery to public policy, are examples of this kind of activity. Media organizations need access to elite sources and could be pressured to frame their stories more favorably to the elite sources to maintain that access (*e.g.*, Godler & Reich, 2013).

Older theoretical explorations of framing and credibility in journalism have emerged from studying traditional news-gathering activities in the context of established media forms and organizational structures. However, in an environment dominated by freelancers and loosely-affiliated digital networks, those explanations offer limited explanatory power. Freelance science journalists are entrepreneurs, usually working with several publication outlets at a time. Each form of publication has its own editorial perspective, audience, and approach to sourcing and story topic selection. Contracts and writing agreements with each venue are managed by a personal relationship with a particular editor or editors (Edstrom & Ladendorf, 2012). These relationships have been described as fundamentally altered by the emergence of digital publication in the 1990s and early 2000s as freelancers lost certain copyright protections in digital formats (Boczkowski, 2004). While this transition period has largely passed, the implications of that relationship change, and the fundamental instability of the freelance news reporting market continues to complicate understandings (Dickinson et al., 2013).

The relationship between editorial forces and freelance journalists is further complicated in the particular space of science journalism. Researchers and scientific institutions express concern about scientific literacy among members the public and are increasingly relying on forms of direct publication through their own public information officers, blogs and newsletters (Bauer, 2008; Peters, 2008, 2012; Trench, 2008a). There are a number of efforts within the scientific community to encourage scientists to embrace a role as communicators and take up responsibility for describing their own science themselves (Besley & Tanner, 2011; Irion, 2015). Digital publication allows these scientists to communicate to interested publics without a third-party professional media presence at all. Current scholarship both encourages this development as a tool to encourage public engagement with science, and problematizes the potential for misunderstanding when research findings go “out into the world” without thorough mediation (Peters, 2012).

I was interested in exploring how editorial relationships between freelance news writers and editors influenced with the credibility decisions of the news writers about sources of scientific information. Discussion related to this topic emerged in the interviews from initial questions in the protocol about choosing story topics, and from later questions relating to editorial handling of online publication and hyperlinks. I have selected a vignette from a participant writer covering health research for *Nature* magazine in an effort to examine work by a freelancer with a well-established publication outlet. Current research of news practices is still struggling to describe how information credibility is understood when older and highly-structured institutional forms of publication engage with freelancers in contingent arrangements.

Vignette: Adaptation and re-negotiation

Participant E is a freelance news writer with approximately 10 years of experience in science journalism. She has a number of bylines in well-known national publications, and maintains an active media and social media presence sharing recent science news stories. She also participates in professional conversations online about the profession of science journalism. She also holds a master's degree in science journalism. In the course of our interview, Participant E described her experience of becoming established as a science writer, and the relationships with various publishing outlets that have developed over the course of career. These relationships have changed as she has accumulated bylines and credibility. For example, she will now often have editors from established publications approach her with story topics that they know fall within her area of expertise. In contrast, many early-career writers described constantly having to pitch story topics, and being frequently turned down. Editors seemed to know Participant E would deliver a well-researched story within the necessary time frame, and she was reflective about this change, and other elements related to her relationships with her publication venues. Her thoughts about editorial relationships emerged as I engaged her with follow-up prompts related to finding credible expert sources for her stories.

> **Interviewer:** I see. That's really interesting. You write across so many different kinds of publications. Does your venue affect who you want to talk to source wise or is it really more driven by the subject that you're talking about?

Participant E: The venue very much drives who I'm looking for as sources. That is to say that some of the stories don't require an outside source. Like when I write for [website], they only require one source. You can get into a discussion of whether that's good or bad for journalism not to have that outside voice. It certainly makes writing the stories a lot faster and in a short turnaround cycle that is a lot easier. When you're looking for one or two outside sources that like I said can be the biggest time suck of them all.

Interviewer: It looks like you've got a lot of material that's published in more or less traditional or legacy media sites and then you've got sort of the newer blogs and some blogs affiliated with legacy media sites. I notice there's a lot of hyperlinking to other stories. Is that something that you do or is that something the editors will do? Like if you're putting something online for Wired, will they decide we need to link to this original study or we need to link to this research center or whatever?

Participant E: I always link to the original study that I'm talking about and maybe the researchers, the other project or whatever. Sometimes, the publications go back and add links to other stories within their publications or if it's a *Popular Science* story, they'll add little hyperlinks to other *Popular Science* stories.

I don't do those, but I do the outside links that refers so that a reader could then go and find the original source, at least the abstract of that paper and see what it actually said.

Interviewer: Do you work pretty closely with editorial then for those kinds of things or you just kind of send it off and they do what they do and then you can go back and see it? Is there much back and forth?

Participant E: It really depends on the publication and whether it's print or online. A lot of the online stuff, there's not a ton of back and forth, but for the print, I find that there really is. There is a discussion of every word and the word count when it comes to print media that is not true in the online world.

Interviewer: That's interesting. I found that across a few interviews.
[…]

I wondered if that was something that you'd experience like between ... If it's more or less the same "article" in two different formats, does editorial sort of have more of a hand in reshaping it in that way?

Participant E: Yes. I think that they have a stronger hand in just going in and generally changing things on the online version and they tend to do far less of that in the print version.

Participant E was one of several participants to comment on the distinction between writing for online publications versus writing for "print" publications. Even under the same corporate title, such as in the case of *Nature* or *Popular Science*, writers were aware of different in-house editorial structures and processes. The fact of this distinction, and the writer's response to it, is little covered in either the journalism stream of research or the information-science stream of research focused on information-seeking and credibility. The one exception is Boczkowki's early-21st-century study of digital innovations (2004).

Participant E's statement that "you can get into a discussion of whether that's good or bad for journalism" (related to fewer sources being required by some online outlets) places editorial sourcing practices squarely within the topics under discussion related to credibility. We also spent some time in the interview discussing Participant E's recent work for *Nature* magazine on sickle-cell disease (see Figure X below). Her sourcing approach for this article (assigned to her by editors who knew she had some experience with similar topics) followed a fairly standard pattern for legacy media science news writing. She used academic sources to identify researchers in the field to speak to, got additional referrals from those initial contacts, and then checked in with well-known (to her) sources in science who could explain more complicated elements of the story to her. This pattern was explained in the context of standard writing for print and the finished article close adheres to the "inverted pyramid" model. Essential facts are described in the opening paragraph, and additional details and future projections related to the research are at the end of the story. Participant E described knowing she had close editorial oversight, and would have fact-checkers at *Nature* reviewing her work.

> **Participant E:** […] Recently, I was writing a story on sickle cell disease and gene editing techniques and I'm not an expert in genetic manipulation and technology, so I was trying to figure out who to talk to for what topic and it took a little bit of time to untangle the right people for the right topic.
>
> **Interviewer:** When you're talking to somebody, do you ask them to refer you to other people if ….

Participant E: Absolutely. That's one of my final questions in any interview is, "Who else should I be talking to in this field?"

Interviewer: Is that usually ... Do you ever have ... I wonder sometimes if there's like you're trying to get maybe another perspective, but at the same time it may be very small field […]. Do you ever feel like you have to maybe step back a little bit from that original contact and say, "Who's maybe working in another angle from this?"

Participant E: Absolutely. In that case, in the sickle cell case, I've sort of looked at someone who had mentioned a sister diseased called beta thalassemia disease which is also a rare genetic disease but very related to sickle cell and had some clinical trials right now. We're looking at people doing similar work in beta thalassemia and so I could talk to them more generally about the gene editing techniques and not getting dialed down so much into the specific outcome of the technique.

cells, and then turns them into induced pluripotent stem (iPS) cells, which can be converted into any cell type. The researchers correct the haemoglobin gene defect *in vitro* using gene editing, then differentiate the repaired iPS cells into blood stem cells. From there, the researchers have a couple of choices. The repaired cells could simply be infused into a patient's bloodstream, where they would make their way into the bone marrow and start to make healthy haematopoietic cells.

But Izpisua Belmonte is also working on a cure that could work inside the bone marrow itself. His team is combining TALENs with a different viral vector, HDAdVs, to boost the success rate of gene editing, and the researchers are working on a plan to administer their hybrid vector directly into the bone marrow, so the genetic fix would take place inside the patient's body. Although each infusion into the marrow might correct only 1% of the cells, ten such procedures over the course of several months — something Izpisua Belmonte and his research associate Mo Li think is feasible in terms of time and cost — could alleviate the symptoms of sickle-cell disease. "Little by little, you are correcting the disease *in vivo*," says Izpisua Belmonte. So far, this 'hybrid vector' technique has shown promising efficacy in umbilical-cord blood stem cells.

Sickle-cell disease results when both copies of the haemoglobin gene are faulty, and fixing just one of the genes is sufficient to make a big health improvement. As Li points out, people who carry one copy of the mutated gene, a genetic condition referred to as 'sickle-cell trait', do not show symptoms. "In fact, many of the world's best sprinters have the sickle-cell trait, he says. "Our approaches will most likely restore one mutated copy to its wild-type sequence, leaving the other copy untouched."

CRISPRs (clustered regularly interspaced short palindromic repeats) are the most recent addition to the gene-editing toolbox. Whereas ZFNs and TALENs use a protein to lock on to a specific section of DNA, CRISPRs use a 'guide RNA'. These guide RNAs are much easier to program than the proteins in TALENs and ZFNs, as well as being cheaper and more efficient. CRISPRs also make it possible to perform multiple genetic manipulations in one go. CRISPRs work in combination with the Cas9 (CRISPR-associated 9) nuclease: after the CRISPR locks on to the target gene, Cas9 snips both strands of the DNA, disabling the gene. The approach is less than two years old, yet many researchers are now working with CRISPRs in parallel with other *in vitro* techniques.

There are safety hurdles to be overcome before gene editing is used in humans, especially because it involves a permanent change in the genome. The thorniest issue is 'off-target activity' — unintended changes to the genome away from the target gene.

CHRIS CALLER/GEORGIA INSTITUTE OF TECHNOLOGY

A researcher corrects a mutation in the β-globin gene that causes sickle-cell disease.

Gang Bao, a biomedical engineer at the Georgia Institute of Technology in Atlanta, is developing gene-editing strategies for sickle-cell disease and is paying particular attention to the challenge of limiting off-target effects. He notes that if erroneous cuts happen in a cancer-causing gene, they could potentially trigger tumour growth. Even a rate of off-target activity lower than 1% could still pose serious health risks. So that the technology can move forward, researchers need to have a better understanding of off-target effects. There are two main issues: determining exactly where the off-target cuts occur and at what rate.

Bao's group has created software to predict where the off-target effects might occur for the different gene-editing techniques. In a paper published in May, his team reported that their software predicted 114 potential off-target sites across the whole genome for the CRISPR/Cas9 system, and experiments confirmed 15 of them by sequencing the cleaved DNA[2].

Izpisua Belmonte's team is also looking at the rate of unwanted mutations caused by gene-editing techniques. The group created iPS cell lines and then edited half of the cells using HDAdVs and TALENs[3], but left the other half unedited. The edited cells had no more mutations than the unedited ones, indicating that — in contrast to Bao's findings for CRISPRs — the use of TALENs does not seem to make cells any less safe. Although human testing is still a few years off, they say that these results give them optimism about the potential for gene editing to work.

The other major challenge for gene-therapy researchers is ensuring that the edited stem cells survive and generate healthy red blood cells after they are reinserted into the bone marrow. Edited cells often die because of the amount of stress they undergo during therapy. Researchers might be able to improve the cell-survival rate by delivering other types of cells at the same time, and the speed of gene editing also seems to be important: the longer the cells are cultured *in vitro*, the less likely they are to survive. "Let's see if we can perform the whole procedure in four hours instead of four days," says Bao.

FUTURE REPAIR TOOLBOXES

Based on his research so far, Bao thinks that CRISPRs are the best method for generating DNA breaks, but they are also more likely to cause off-target activity. TALENs are less efficient than CRISPRs, but they seem to have fewer off-target effects. The rate of on-target activity for CRISPRs is between 40% and 80%, whereas the on-target rate for TALENs is between 20% and 50%, Bao says. The rate of off-target activity varies depending on the type of cells and the nuclease used. "If we have a way to overcome the off-target and [cell-survival] problems, CRISPR is a very promising technology," he says.

Kohn has compared ZFNs, TALENs and CRISPRs, and thinks all three have therapeutic potential for patients with sickle-cell disease. The techniques are all good at slicing DNA; now the remaining challenges are delivering them to the target cell and accurately repairing the gene after the break.

Ultimately, for sickle-cell gene therapy to become reality, the details must be sorted out on a large scale. Tinkering with human genes can yield both devastating and remarkable results, and the difference between the two often lies in a single nucleic acid of a single gene. This places a heavy responsibility on the shoulders of every researcher in the field, but the vast potential of gene therapy makes that burden worthwhile. ■

is a freelance writer in

1. Romero, Z. *et al. J. Clin. Invest.* **123**, 3317–3330 (2013).
2. Fine, E. J. *et al. Nucleic Acids Res.* **42**, e42 (2014).
3. Suzuki, K. *et al. Cell Stem Cell* **15**, 31–36 (2014).

Figure 12

Participant E's story on sickle-cell disease from Nature

Conclusion: A sociotechnical lens for understanding hybrid news writing

Participant E's experience with the sickle cell disease story described a fairly traditional model of print journalism. She was assigned a topic by her editor, researched sources using authoritative medical journals, and relied on editorial control and fact-checking to help ensure the credibility of the finished article. She was experienced and reflective about the difference between writing for print versus online venues, but her article's conformity to a fairly traditional model of editorial relationships ran somewhat counter to more resent research that suggest those forms of relationships have been upended (*e.g.*, Boczkowski, 2004).

I found additional clarity when considering this vignette alongside of an exchange I had with Participant H. She has a very similar background to Participant E (holding a master's degree in science journalism and having approximately 15 years of science news reporting) and has published in many of the same venues. However, Participant H had lived outside the US for several years, putting her at a literal remove from many of her most regular publication outlets, and is currently taking some time off from freelancing to teach at a university science journalism program. These differences may have contributed to the slightly more nuanced perspective she offered when talking about credible writing and established publication venues.

> **Participant H:** The guy running the [science writing] program here sees all of these opportunities to get rid of ... He sees opportunity within getting rid of these boundaries. He thinks this is a good thing and I'm still didn't brainwashed by Columbia where public information is the dark side. PR is not to be trusted which is to some extent true, but neither is journalism because we have our biases too. I don't know, that sounded really cynical, sorry.
> […]
> Right now, I think there is a shift with all of these new things that I was talking about. With ProPublica and the ... all of these different journals and news groups and whatever, these online things, they do want to tell people something. They want to get information in front of the right people so that something changes and that seems like advocacy journalism to me but that doesn't ... It's not advocacy journal in the traditional sense of the word, I think, or what would have been the sense of those words 20 years ago, so it's interesting to see what's coming.

Interviewer: Do you see more of that coming up like ... Especially environmental issues where it intersects sort of public concerns and public ... Public understanding of science, I think, really hits the environmental journalism more than any other maybe. …

Participant H: I assume so. I don't know. Yeah, there's a consumer driven journalism. What am I thinking of? *Consumer Reports*, right? If you had something like that for the environment, I can't think of any journal that does that or any magazine that does that.

Mother Jones did a little thing about the sort of blew BPA out of the water -- like when the replacements started coming in, the replacements are even less safe than BPA.

Interviewer: Right and all the baby bottles and the children's products and all the other water bottles.

Participant H: Yeah, all that good plastic stuff. *Mother Jones* wrote that piece of consumer reporting journalism in a way. That's environmental science to me.

Interviewer: Yes, very much. I agree.

Participant H: I guess that would be the advocacy journalism. Let me think about this for a minute. I can't wrap my head around it. I don't think I know enough about what's being published where and how for whom.

Interviewer: Do you think the online aspect has changed it, has it sort of blurred the lines between advocacy and just more ...

Participant H: I assume so. I just assume so. I have nothing to back that up.

Participant H engaged with me in a conversation related to science news publication and credibility (and the role of advocacy) in a way that considered her full identity as a writer and reader of news. I didn't know if she had written for either *Mother Jones* or *Consumer Reports*, but she was willing and able to comment of stories they've done and how their editorial decisions contribute to her understanding of journalism as part of a synthetic definition of what it means to do credible science writing. She did not see advocacy journalism as necessarily a separate form of journalism, and was willing to express that "we all have biases." The form of the work – digital or online – seemed to matter little in her view, and the socially-defined nature of credible journalism was foregrounded.

There is no universal "freelancer-editor" relationship that can capture the differences in dynamics expressed in these experiences. My central conclusion is that relationships between editors and freelancers are less changed by digital modes and freelancing contracts than some recent scholarship might suggest. Traditional journalist norms related to choosing credible sources are still motivators. Participant E described a back and forth sourcing process reflective of the inverted paradigm model of journalism for the prestigious print journal *Nature*. Participant H, removed from the details of a particular story, offered less of this specificity, but still identified certain publications by name and acknowledged distinctions between publication venues in their approach to sourcing. Given the entrepreneurial identity of the freelance journalist, and their lack of a consistent institutional tether, the variable ethos of publication sites and their editors exists as separate forces acting upon credibility perceptions of journalists when choosing their expert sources.

I am incorporating this vignette as a response to my second research question, asking how the writers' understanding of credibility interacts with other factors influencing sourcing and writing decisions during the production of scientific news articles. The freelance writers claim a set of journalistic ethics and enact them through professional practices as individuals, but they intersect with a shared understanding of what counts as "credibility" and "expertise" from any given editorial venue. While the specifics of each publication's standards may change, the writers and editors share a definition of what it means to "do science," and what it means to do credible science that is worth reporting to the larger public. This finding suggests the usefulness of a sociotechnical approach for further understanding how journalism practice is evolving in a networked environment. Foundational concepts to sociotechnical study, such as boundary objects (Star & Griesemer, 1989), can illustrate how the work of news writing can maintain its ethical and functional integrity despite disruptions in the organizational structure (Shanahan, 2011).

In the example of this vignette, Participant E sought out expert sources who had published research in peer reviewed medical journals to inform her story for the print

version of *Nature*. The contracted article she was writing for served as a boundary object allowing for a shared understanding of credibility. For the editor, credibility was needed to ensure that the final article published under their masthead would withstand public scrutiny. For the writer, this credential made her feel confident she was getting expert information to educate herself about a complex topic, inform her writing, and contribute to her ongoing identity formation as a knowledgeable communicator.

4.4 Audiences

As outlined in the literature review, Goffman's theories of conversational frames and footings (1981) underpin this study's analysis of identity. Journalists use the tools of discourse when they write and when they interact with sources and editorial colleagues to show their relationship to sources of information in their news writing. A frame can show how a news event fits into current political and cultural points of reference, providing indicators of relevance and credibility (Tuchman, 1978). The use of footings, particularly in news interviews or in the use of direct quotes from sources, can position the writer in the role of the "honest broker" of information from others (Craig, 2010). Science writers follow decades of journalistic norms to maintain their appearance as objective communicators of information from expert sources (Mindich, 2004). The paradigm of "objectivity" also emerges in broader study of information credibility generally (e.g., Kelton *et al*., 2008).

By invoking well-known story frames, participants contextualized their work in ways that revealed their understanding of their professional identity. For example, several participants mentioned the editorial pressures to produce articles about striking applications of new technology – invoking the "gee-whiz" model of science reporting (Fahy & Nisbet, 2011; Rensberger, 2009) – and included me (as a fellow scholar) in thinking about how this approach was problematic. For example, a participant with a long history of reporting environmental news described difficulty in selling her work to more general interest science publications; environmental and nature stories, for a time, were seen as less engaging than stories featuring technology. Participants made shifts in conversational footings often, particularly when discussing serial interactions with expert sources that informed a news story. The writers shifted their footings to a more of an "animator" stance when talking about particularly complex topics in the interviews, for example, when explaining genetic modification or the chemical makeup of petroleum products. They wanted to be clear that they were articulating information from other sources, and not representing themselves as first-hand experts.

These shifts in frame and footing were all done with an audience in mind – whether real readers from online interactions or simply imagined ones based on the publication venue. Long-established rhetoric and persuasion theory focuses on the role of shared values and knowledge between author and audience as a force underpinning credibility judgments *(e.g*., Perelman & Olbrechts-Tyteca, 1969). Current scholarship in information science and journalism, however, gives varying levels of attention to the role of the audience. Information science scholarship focuses on credibility in the context of information seeking behaviors, and study of producers of information consciously trying to be credible is only just emerging (Rieh et al., 2014). Traditional journalistic norms suggest that journalists ignore audiences as a "functional imperative" – so they may make their own choices about what constitutes an important story (Dunwoody, 2007, p. 242).

The description of this imperative is somewhat contradictory, as journalistic ethos suggests also a commitment to informing the public about matters of concern – how are those concerns known if the audience is to be ignored? In answering this, prior theoretical work isolates the broader public good as separate from audience demands, which may have been seen as easily manipulated by advertising and commercial concerns. However, this distinction may not be entirely satisfactory. As Heikkilä, *et al*. (2010) point out, it is increasingly difficult to separate out theoretical concerns about an informed public sphere from economic concerns. They propose an integrated understanding of journalism's value, looking at how the information it provides is judged credible and relevant within social networks. As the boundaries of established news organizations fall away, negotiated interactions with news reporting (across social media platforms, for example) are increasingly relevant. My research is intended to further develop this view.

Additionally, older theory falls short in considering what happens when the audience talks back. There are well-established paradigms for understanding imagined audiences in formal paradigms of journalism production. There are emerging paradigms for the noisy multi-audience conversations of online interaction and social media. There is little to explain what happens when these spaces intersect. My findings address these

theoretical gaps. This chapter examines, in detail, how a preconception of the audience shapes a writer's decisions throughout the story-writing process.

Vignette: Imagined audience instantiated in the comments section

One of Participant N's primary freelance contracts is writing for a research institute dedicated to the study of autism. A question about publication venues showed how closely linked the imagined audience and its concerns were for her in writing articles for this site.

> **Participant N:** I think it's all sorts of things. There is the scientific content, and I will say that in most cases, as writers, we are responsible for fact checking, but I think the editors do o through very closely and pay attention to is this the right way to describe the science, does this make sense, is this science correct? That sort of thing, and they obviously ... The editors who are working there because the autism beat is pretty much what they do, they have a very deep well of knowledge of the way the research has unfolded. On the one hand it's being very rigorous about the science, and describing things precisely. Then on the other hand, it's also being very clear about structure, and leading a reader through the piece. Then there is also, definitely ... I notice especially with this publication, there is a sense of ... This publication is actually ... On one level it's aimed at other scientists in the autism research field. But, we also have a lot of parents of people with autism, and also a lot of people with autism, people in the autism spectrum themselves. There is definitely attention to wording and whether a metaphor might come off not quite right to some of our readers. Trying to avoid alienating people, and being really careful and inclusive, and non-judgmental in our language.

A conversation related to audiences emerged from follow-up prompts related an article Participant N had written about autism and the Latino community. The writer made a post in the comments section of her article in order to clarify a point in her writing she felt had been misinterpreted.

> **Interviewer:** Are you ever writing for sites ... One thing I ask people when they write online is if they every write for sites that have comments, and what their experience with that has been?

Participant N: I think my experience is don't read the comments. I don't pay a lot of attention to comment sections. You can drive yourself crazy and usually by the time something is published I'm deep in the middle of some other deadline. I don't engage a lot with comment section, unless they are ... Unless I'm specifically asked to. Basically, usually, if there is some specific comment that has arisen that an editor wants me to respond to, then I might do that every once in a while. For the most part I don't pay a lot of attention to comment sections.

Interviewer: That's happened, that an editor has said can you pop into this thread and say something?

Participant N: Sure, yeah.

Interviewer: Was that on a health site? Do you remember any specific time that happening?

Participant N: The one that I remember was most recent was actually not one where the editor asked me to pop in, but where I decided to pop in. There was a short piece that I wrote for the same publication about a month of so ago. It was about perceptions of autism in the Latino community. There were some comments that made it sound like the readers were reading it as though there was a belief in the refrigerator mother theory of autism in the Latino community. That was something that ... That was an interpretation that I knew was a risk, but was something that I didn't feel like the data supported. I tried to write it in a way that would be very nuanced, but it was clear that there were some readers that were missing that nuance. I felt like I want to jump into the comments section and clarify that a little bit. That's the most recent example that I can think of.

A Concerned Grad Student · a year ago

Jenny, I agree that parents should educate themselves about their children's health. It is so important to be fully informed and involved in these important decisions. However, if you're concerned about autism, please see resources at Autism Speaks and from similar Autism resource organizations, or even better, directly read some of the empirical research yourself!

There's so much we have left to learn about autism, but there's one thing that researchers agree on - vaccines and autism are not related. The one study that claimed that autism was caused by vaccines has been completely discredited, not only because the man who conducted it would have earned a lot of money from a company which was struggling to compete in the vaccine market, but also because his findings have been rejected by countless researchers who replicated his study and controlled for other reasons why kids were being diagnosed with autism around the time that they were getting vaccines, like people paying more attention to how their babies develop at that time, especially after the doctor asks the parents all kinds of questions about their child walking and talking and all those good things :)

For instance, if ice cream sales go up and so do rates of violent crime, can we say for sure that ice cream makes people violent? Or are both of those increases caused by something else, a third thing, like really hot weather? That's why it's really important that they're looking into reasons why Latino kids are getting diagnosed with autism later - because of one of those third factors.

The idea of a cold "refrigerator mother" causing autistic kids' behavior was an idea proved to be wrong a long time ago, but it looks like some Latino parents still blame their parenting styles and home situations for their children's autistic-like behavior. So let's focus on getting information about autism to Latino parents, rather than on questioning the legitimacy of a disorder that affects 1 in 68 kids in the US.

Reply · Share ›

Ganondox → A Concerned Grad Student · a year ago

Please do not recommend Autism Speaks, they are not a good source for information on autism.

Reply · Share ›

a concerned scientist · a year ago

Hi, "A Concerned Grad Student". I agree with your statements, but, separately, I do not think that this particular work can make any claims about the specificity of Latino culture or Mexican, for that matter, even if the study was conducted on Mexican women. What is important is that these women were undereducated, they have not finished high school. In any culture, not enough education would lead to similar assumptions by the parents. In my opinion, the importance of this study lies in the fact that the research was conducted on subjects that were not culturally American (non-USA) or European. This brings a new dimension to this work by demonstrating how family and society values based on other, non-American or non-Western European, cultures can influence parenting of autistic kids and their acceptance in their cultures. Most of parents from any society that is not "Westernized" would behave similarly. Also, note this quote from the text above: "They [parents] also had difficulty getting healthcare providers to listen their concerns." -- so, it goes both ways - cultural differences make the understanding of these parents hard by the healthcare workers. It is perhaps more than just the language barrier.

Reply · Share ›

Participant N · a year ago

Thanks, Concerned Grad Student and concerned scientist, for your very interesting comments on this piece and for carefully thinking about the issues of cause and effect that may be at play here. I just wanted to briefly address the "refrigerator mother" issue.

It's true that in this study many Latino parents thought that the child's behavior problems might be a sign of problems within the family or needing more attention from his mother (or father!). But, crucially, they didn't see these behavior problems as autism -- they didn't see them as signs of a developmental problem that needed to be discussed with a doctor, but as behavioral challenges that needed to be addressed within the family. So, the authors aren't arguing that Latino parents subscribe to the "refrigerator mother" theory of autism. In fact I think the idea that a child's challenging behaviors can sometimes be a result of parenting and family dynamics is pretty widespread in many cultures, including Western/Anglo-American culture.

Reply · Share ›

Figure 13

Participant N's response to online article comments

Participant N's experience here demonstrates her attachment to the imperative described by Gans (1979) to ignore the audience (instantiated in comments sections), but how it was problematic to ignore under those particular conditions. She expressed that some readers were "missing that nuance" in her original article, and the affordances of online communication allowed her to clarify the point. Participant N's writing and follow up comment shows her imagining her audience at some remove. They missed a nuance (some knowledge to understanding the truth of the story) in the scientific data. Despite the immediacy of online publishing and comments, she was still placing herself in the role as an ambassador for the science to the audience. She is still in a superior role as an "expert knower."

Participant N states she needs to lead a reader through the piece. This is an activity she tries to refine a bit in her comment – explicitly identifying herself as the author of the article to come in and clarify mistaken conclusions from her reporting. However the earlier part of our interview conversation made it fairly clear she prefers to not engage with comments. This view was echoed by most other participants. For example, Participant D noted "it sounds…egocentric, but I often think it cheapens the article […] Where you have the comments sections directly appended. It seems to give as much weight to just anyone, even an anonymous commenter with access to a computer and a keyboard, as whoever wrote the article. That really bothers me." The writer is the writer, and the audience is the audience. In most cases, better imagined than heard from.

Conclusion: Science writers rely on separation from audience

Science news writers remain attached to their normative role as objective reporters, separate from the audience when they are interacting in comments sections or when the audience is only imagined. They are careful representatives of the voices of experts and cautious about the conclusions that non-expert audiences will draw from them. They are reluctant to engage in a back-and-forth the public, and are reluctant to let reader comments be the last word on an article they have written.

Scholars don't know quite what to make of these hybrid spaces that include formally-sourced and written news articles and interactive comments section. Journalism scholarship may focus on professional norms and organizational patterns, when considering credible discourse in front of an audience, but the relevance of that approach for freelance writers remains. However, these findings reflect media use scholarship that shows that readers respect trusted news brands. Audiences and writers alike are looking for reassurance and informational gate-keeping. Science news writing is effective and trusted when an audience as imagined at some distance from the news writer.

This example addresses my first and second research questions, and further relates to the central role of journalist identity and central to credibility judgments. The first research question asks how writers understand credibility, while the second asks how that understanding interacts with other pressures on writers when they work with expert sources to create persuasive communication. This finding in this vignette shows that the instantiation of an audience can serve as a vehicle through which to integrate those concerns holistically and address both research questions. In the vignette above, my writer believed her sources to be credible and cited information she trusted from them in her initial article. But being a direct repeater of that information was insufficient.

Editorial pressures – to not confuse or upset/disturb an audience were also part of the credibility equation. The writer's ability to step into the comments, at her editor's request, and mediate the conversation was part of how credibility was negotiated and enacted among competing concerns. This contradicts some Gans' notion of the need for journalists to ignore audiences as a "functional imperative," to enable an objective assessment of a story's validity and importance (Dunwoody, 2007; Gans, 1979) Audiences are now impossible to ignore. This vignette also instantiates Heikkilä *et al.*'s suggestion to examine news-audience interactions "at the level of the social fabric of everyday life" (Heikkilä *et al.*, 2010, p. 282).

Writers choose (or are assigned) a role of mediator when communicating information from their expert sources. The expert source may be many removes from a public audience working in his or her particular field; the science writer has special status to speak for the expert findings. How this status is established and functions, particularly in networked and interactive publishing spaces, shows the influence of interpersonal trust on decisions related to information credibility. The first research question asks how writers understand information credibility. This vignette, and the first vignette related to credibility, have demonstrated that a science news writer uses features of their identity to ensure they are both obtaining credible information and communicating credibility. A feature of this identity is their special status as a mediator for expert information before the audience. The second research question asks how this understanding interacts with other pressures the writers face. This vignette suggests that concerns about an audience become a vehicle to manage multiple pressures at once. While a writer may value credibility, he or she may also face time pressures from the editorial authority. What the audiences' needs might be, whether real or imagined, may help the writer prioritize some pressures over others.

4.5 Markets, relevance, and "added value"

Overview: Defining a market

The move away from full-time staff to freelance and contingent employees throughout commercial media has dramatically reshaped news reporting in recent years and suggests shifts in ethical and boundary concerns of the profession as a whole (Edstrom & Ladendorf, 2012; Heikkilä, Kunelius, & Ahva, 2010; Ladendorf, 2013). The economics of contemporary journalism influence the larger public information landscape, as there are increasingly limited paying outlets for science news, simultaneous with "a dramatic expansion online in the availability of science-related information and a perceived diminished role for science reporters as chief disseminators of scientific content" (Fahy & Nisbet, 2011, p. 781). Science news content is available from a multitude of sources, often for free, and frequently untethered from institutional markers of authority. Questions of professional boundaries and economics converge in this space, as journalists are forced to prove their worth as credible communicators more often in terms of markets, and in defining trusting readers as potential consumers (Heikkilä *et al.*, 2010).

Journalism scholarship devotes considerable time to analyzing the economics of 21st century journalism at an institutional level. However the implications of larger trends on the work of the individual freelancer are not well explored. For example, lines between different media formats and types of publishing operations are blurring under economic pressures, yet the stigma of "doing PR" or "pay for play" publishing is still profound. Particularly in areas of high stakes research and substantial financial interests, such as in medical news, writers struggle to both identify trustworthy sources and produce credible reporting. Under traditional norms the value of a credible news story was understood via its role in promoting public understanding and discourse (*e.g.*, Habermas, 1991). More recently, a credible news story is valued as a means to deliver paying audience members; this tension is not resolved. (Heikkilä, *et al*., 2010).

Heikkilä, *et al.* offers a "third way" between goals motivated my economic pressures and a commitment to an informed public, regardless of financial incentives (2010). These

authors suggest the need for understanding the "public" outside of its usual abstraction of the role "citizens," but rather for a closer examination of the social context in which individuals engage with (and create) news. Making news stories relevant to individuals is where the added value of a credible journalist can be instantiated – particularly in cases of remote or complex science topics. In order to further develop this theoretical proposition, I have examined a vignette describing the experiences of a later-career writer and editor of a non-profit science blog. His particular choice of framings for a high-profile and complex science news story demonstrates his implicit understanding of how to add value in this space.

Vignette: Ebola outbreak

Participant M described his work on a science news website where he is the primary author and editor. He is a later-career news writer with a bachelor's degree in philosophy and a master's in science. He has been working on a non-profit science news site affiliated with a large state university for over 20 years. Participant M writes the bulk of the stories himself, and is the main editorial control. The site, in his words, features science stories "behind the news."

During the 2014 Ebola outbreak in West Africa, he described trying to "get another angle" on the story of the Ebola virus. The framing he chose was motivated both by a desire to go beyond the "straight news" reporting on other media outlets, and by not wanting to bother the doctors and researchers fighting the Ebola virus. He stated that he felt it would be an imposition to ask doctors and researchers in the field fighting the virus to serve as a source for his writing. When discussing several of the stories Participant M authored or edited on his blog, he mentioned several times his desire to do a story that is currently in the news in a slightly different way. His unusual position, as having wide control over a media outlet that was largely grant-funded and well-connected with university researchers, afforded him special opportunities to frame his stories as relevant and credible that few other science writers described.

The science news website Participant M edits follows a weekly publication schedule, so editorial meetings are held to quickly decide which science news stories getting mass media attention are going to be covered in the following few days. During the 2014 Ebola outbreak, the website staff was angling for a story frame that would stand out, and fit their site's ethos of communicating "the story behind the story."

> **Participant M:** Instead of saying "What's going to happen with Ebola" – I say what's happened with other pathogens? Like Black Plague. What are the possible lessons that can come from that?

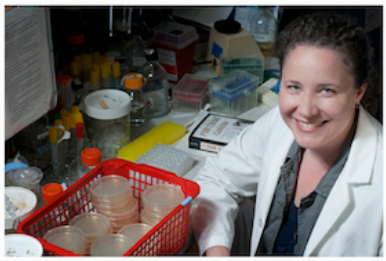
Participant M described this approach to me as one he came up with himself. He felt sufficiently knowledgeable that the additional historical context he wanted to put into the story would be both credible and relevant. The resultant story for the site wound up as a discussion of the current Ebola outbreak, contextualized within a larger scientific history of outbreaks – including smallpox and cholera – illustrating public and medical authorities responded at the time. Participant M consulted several expert sources on the story – but none were currently involved in Ebola research. They were biologists studying other diseases or historical sources describing events from the time of the Plague (see Figure X, below).

Ebola on the march!

UNITED NATIONS — Schools have shut down, elections have been postponed, mining and logging companies have withdrawn, farmers have abandoned their fields. The Ebola virus ravaging West Africa has renewed the risk of political instability in a region barely recovering from civil war, United Nations officials said Tuesday, hours after the World Health Organization reported that new cases could reach 10,000 a week by December — 10 times the current rate. New York Times, Oct. 14, 2014

Ebola has spread to a second Texas health care worker, and the World Health Organization has predicted a frightening climb in new infections. Health authorities are scrambling to contain a highly infectious disease that kills through massive bleeding.

In the absence of a prompt and effective response, the director of the UN's Ebola Emergency Response Mission, Anthony Banbury warned that the world faces "an entirely unprecedented situation."



Caitlin Pepperell, an assistant professor of medical microbiology at UW-Madison, investigates evolution in the tuberculosis bacterium. "People tend to conflate fitness and virulence," she says. Virulence measures the ability to cause severe disease or death. Fitness is the ability to infect new hosts.
Credit Terri Watters

As the global response lumbers onward and thousands die, we started wondering about the "classic dogma" of infectious disease: Pathogens become less virulent — less deadly — over time since live hosts spread infections better than dead ones. The rapid and mysterious disappearance of the Black Death (bubonic plague) from Europe in the middle ages helped raise the question: After killing as many as 200 million in Europe between 1346 and 1353, did the Yersinia pestis bacterium lose its "will to kill," in the interests of its own survival?

The comforting dogma is backed by some evidence — and rebutted by plenty of counter-examples, as we'll see.

Evolution is a numbers game, and this comforting dogma could allow us to think that deadly Ebola will lose its grip over time, as evolutionary pressures "persuade" the virus to sheath its claws. As many as 70 percent of West African Ebola patients are dying, far more than previously reported. The original source of infection is likely a virus-infected bat butchered and eaten by some unlucky African.

It's a nice notion that pathogens "always evolve towards less virulence," Lone Simonsen, a research professor in global health at George Washington University wrote to us. "But this is in fact not necessarily what will happen, as it depends on how the changes affect its transmissibility in the human host."

Plague, and its Middle Ages outbreak Black Death, were caused by the bacterium Yersinia pestis, spread by fleas on rats. Several outbreaks occurred between the 6th and early 19th centuries, including one in the Middle East. Here, French emperor Napoleon Bonaparte visits hospitalized troops in Jaffa (present-day Israel) in 1799, during his Egyptian campaign.
Image: Antoine-Jean Gros – Bonaparte visitant les pestiférés de Jaffa Public Domain

Figure 14

Story on science news site on Ebloa from Participant M

Participant M enacted a particular (and unique) framing of the contemporary Ebola story informed by his years of experience as a reporter of science and news and supported by with thick bonds of affiliation with his sponsoring institution. He is comfortable asserting the relevance of historical narratives in his framing; we believe how medieval Europe

responded to the Plague is relevant to a 21st century story about Ebola because he tells us it is so. His added value is an elaborating a larger framework he understands as relevant to the blog's audience. Participant M knows the readers of the university's non-profit science news blog from years of engagement with them. He appreciated the rarity of that venue, and acknowledged his role as part of news ecosystem with particular affordances that a purely profit-driven system would not. Participant M was also aware of the tenuous state of that publication's funding, and in fact the blog ceased publication after 20 years online in January 2016.

Several of Participant M's stories embedded some substantial editorial framing as well, as in the Ebola story referring to some scientific theories as "comforting dogma" or "a nice idea." This participant was even more outspoken in the interview about the validity of some approaches to science as being more worthwhile than others, responding to one follow-up prompt by saying "I don't want any of that creationism crap here."

Conclusion: Credibility is being able to assert framings for the audience

Participant M uses his particular expertise (and unique role as the primary editor of his site of publication) to demonstrate his ability to define "what exactly audiences consider to be science stories" (Weigold, 2001, p. 165). In his writing, Participant M deploys footings and framings to animate or background certain parts of the science narrative he wants to convey. He makes this decisions based on a deep understanding of his particular audience and the social context of the publication that is his primary venue.

In comparison to other participants, his confidence in his decisions related to framing a story stands out. This singularity makes sense when considered in the context of Participant M as his own editor, and publishing in a grant-funded venue affiliated with a state university (with a particular mission in its charter for educating the public). Over his 20 years in his position, he has developed his identity and perspective on science news writing in relation to this connection, and his reflections on his (somewhat limited) work as a freelancer were the least entrepreneurial, in many senses, of all the participants. Participant M's story suggests the need for a closer analysis of hybrid interactions, where

writers are also publishers, untethered from strictly for-profit markets. The "third way" proposed by Heikkilä, *et al.* (2010) suggests a useful theoretical underpinning for understanding the relationship between credibility and social relevance in current environments. Their suggestion counters other frameworks of news production positioning the value of journalism as either a force for educating the public, or as a revenue stream for publishers and other content producers. Heikkilä *et al.* suggest an analytical lens that removes the notion of "the public" from an institutional framework and pushes back against market-driven views that understand readers mostly as consumers of a product. These authors suggest examining audience engagement with the news as interwoven with the context of daily life of social networks.

Understanding how writers use credibility then in those terms points to writers' credibility as bound to their ability to frame news stories in a unique way that is relevant and integrated in the daily lives of their audience. The findings in this vignette directly address my first second research question. Writers make judgments about credible sources with an understanding that they must demonstrate their unique qualifications to speak about this topic in the way that they have. Credibility, and the "other factors" – such as financial pressures and political motivations – are a part of the daily life for both the writer and the readers of news. Participant M was singularly well-embedded into the social network of both the news production and its audience's concerns and larger financial imperatives. That uniqueness was the value he brought to the news market.

4.6 Hyper-local and hyper-specialized networks of trust

Overview: Location in networks made visible

How does a writer communicate credibly? Reynolds's view on *ethos* (1993) suggests that writers earn their credibility by being specific about their rhetorical location. An author must acknowledge his or her social position explicitly. Articulating the social and intellectual differences that exist in between themselves and their audiences is central for communicators trying to earn rhetorical authority. Prior study within both streams of literature – information studies and journalism – confirms the theoretical importance of rhetorical location.

Information science or HCI studies generally focus on the observable specifics of a communication that earn a credibility "vote" from a user. For example, are Reddit members more likely to be persuaded by responses which repeat words and phrasing from the original question (Tan et al., 2016)? This approach supports a socially-constructed view of credibility, but within a context fairly limited by the technology involved (and within a limited population). Conversely, journalism and mass communication study tends to examine the overall social and economic environment in which news writers and their organizations exist within existing power structures for clues related to rhetorical authority. These examinations are currently working towards new theory to support the activities of news reporting in a digital environment where the role of formal news organizations is shifting (Steensen & Ahva, 2015). Yet, the fundamental role of a writer's location, and that location in a "discovery" process for the audience remains central, regardless of media involved (Godler & Reich, 2013; Reich, 2006).

My data supported the ongoing findings within both of these streams of research. The pervasiveness of networked digital communication – always inter-connected, hyper-visible – made the notion or "location" both quite flexible and profoundly important to writers as they judged the credibility of their sources and worked to earn the credibility for their own writing. Details of how they came to a story – physically, for on the ground

reporting as well as intellectually – were understood as important parts of a discovery process. Where the writer was, and how he or she came to be there, were understood as intrinsic parts of creating a credible story. In recent research examining the credibility and utility of freelance writers, the writer's geographic location in a remote area was seen as useful for certain story types (Ladendorf, 2013).

For freelance writers, whose position within existing traditional journalism environments is tenuous, being specific about their "location" – is not just a means for getting a story written, it is essential to their professional identity and ability to be hired for future work. Earning trust for their writing was not just a matter of creating one well-researched article, but a constructive activity that also supported their own professional identity as linked to their location. This "location" could be their intellectual expertise, but also their literal geographic location, as in the case of Participant B. Credibility was process and a product – an ongoing loop that was supported by specificity in the location-specific details of writing and images and an accumulation of trust between the writer and her editor.

Vignette: Location-based networks for a science writer in South America

Participant B is an environmental writer who has lived in and written about Peru and South America for almost 30 years. After earning her bachelor's in journalism in the late 1970s, she moved to South America to work with an environmental group and gradually wound up carving out a niche for herself as an "on the ground" writer for a variety of publications, ranging for small non-profit newsletters to, most recently, high-profile publications such as *Nature* and *Lancet*. This professional development was gradual, and dependent on her local social networks.

> I fell into a little niche. Because of some of the experience I'd had at Latin American Press with environmental issues, I knew a fair amount about them. There was a woman who had been working for a little publication out of the States called [publication]. She left Peru and she basically turned her string over to me. That was the beginning my really freelancing on environmental issues here.

Over many years, as an on-the-ground-in-South-America, English-speaking writer well-connected in the region, she has set herself apart from other writers covering this topic, as environmental topics.

> At the time, the environment wasn't really much of an issue yet. People weren't really interested in it. I was looked down on by my Anglophone colleagues as the resident tree hugger. That has changed. Now people email me and ask me if I know something about polycyclic aromatic hydrocarbons.
> […]
> It's funny how these things change. A few years ago, environmental issues became cool, and there I was.

"There" she was – in terms of both expertise and geography. Participant B's professional website (below) foregrounds her location as both a subject specialist and as a resident of a particular region.

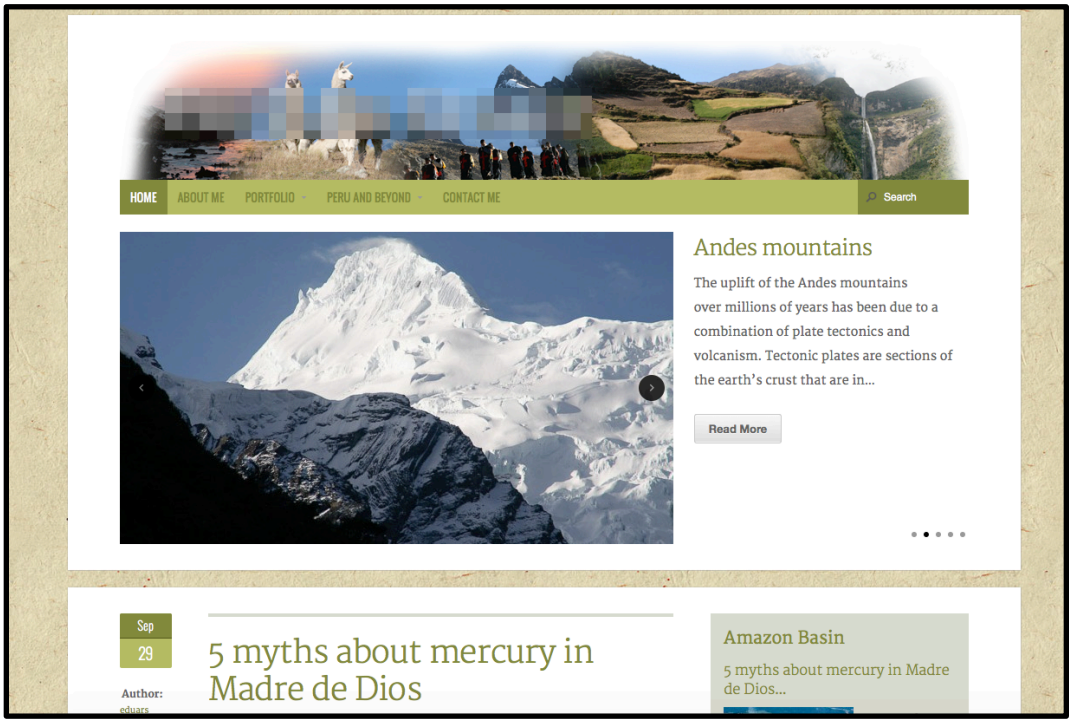


Figure 15

Participant B's website with writing and photography samples

Through this website and her linked portfolio of work, Participant B has become known to both potential venues and scientific sources with relevant specializations as a

knowledgeable news writer on South American environmental topics. Geography has mentioned by other writers as crucial to supporting the credibility for writing on certain environmental topics. Participant I, for example, writes about ecological issues in New England, although she began her career as a technology writer. "I remember the tipping point" Participant I noted, "being a couple of things that happened right in a row. I moved to Vermont, which maybe gave me some credibility for writing about the environment and wildlife stuff."

Throughout Participant B's engagement with different topics and different publication venues her embeddeness in networks of scientists and public officials in Peru have both provided her with credible sources and helped establish her own credibility as a professional journalist However, the initial process of gathering enough freelance work was hard. As she explained, there was already a "stable of English-speaking press corps here in Lima, and we tended to be very polite to each other. People wouldn't step on each other's strings, so if you were working with a particular magazine, I wouldn't try and horn in on your relationship with that magazine." But by respecting these (and other) norms over time, her social network in Peru has continued as a significant source of support.

Throughout our interview, Participant B also mentioned how her larger professional networks (profoundly supported by internet technologies) were essential to her ongoing work. She noted that The Society of Environmental Journalists has been a useful resource-- they have an active email list and people are very generous with their contacts. She pointed out "You can put up a message saying 'I need somebody who knows something about polycyclic aromatic hydrocarbons and how fast they evaporate,' and four people will send you names." These descriptions of her interactions reflected decades of prior research illustrating how journalists will mobilize networks of competent "knowers" to ground the information in their writing (Gans, 1979; Granado, 2011; Trumbo et al., 2001).

There is no one route to finding an authoritative informative source for a story, and there is no single mode through which an author conveys credible information. Participant B provided a rich recent example in describing her work covering an oil spill in Northern Peru.

> If I can go to the place, I'll go to the place, obviously. If it's a story about something like that. This one that just ran yesterday in [PUBLICATION] about the oil spill in Northern Peru is a good example. I happened to be in the neighborhood of where the oil spill was. I went to do something else, and I'd hired a local journalist to help me with the interviews I needed to do. He said, "Let's go up and see the oil spill first."
>
> We did. We went in with people from local communities. We spent three or four days up there. Talked to people in the local communities, so I had a lot of local color. Then called people from the relevant Peruvian government agencies to get comments.
>
> I needed more about environmental health. That required tracking down some people who knew something about oil and the environment and health. That actually did not prove as easy as I thought it was going to be because all of the Deepwater Horizon stuff happened in an ocean, and this is happening in an Amazonian wetland. It's not all the same. I actually chased my tail a lot on Monday over that story before I finally ran down a couple of people who were just really, really helpful.
>
> I finally found the right people, mostly through internet research, although I know people in…I don't really know them. I have email relationships with people in the communications office at Columbia University's Earth Institute, at the Woods Hole Research Center, and a couple other places like that. I just sent them emails asking if any of their scientists worked on things like that. I put a note on the Society of Environmental Journalists listserv and asked if anybody could help me out with contacts.

Participant B found the appropriate contacts for the story on the oil spill for the environmental publication (screenshot below). Her "local color" appeared in the story most visibly through pictures she took herself – establishing her authority to describe this even since she was literally there on the ground. Her local journalist acquaintance helped her make those contacts – that is a detail omitted from the published piece (unsurprisingly) as the reporting norms typically keep many elements of story-building backstage (Nelkin, 1995). She includes vivid descriptions of the activities of the local people coping with the oil contamination to further establish herself as a first person witness – making this happing a "news-worthy event" a la Tuchman (1978), and using her writing to make the connection between global scientific concerns, and real-world

events that could be immediately relatable to an audience far removed from rural Peru (Fahy & Nisbet, 2011). The dangers of the petroleum industry generally and specifics of an oil spill may be hard to grasp for many readers, but the writer's vivid descriptions of contaminated pools and, especially, photos of boys soaked in oily clothing do the epistemic work of making those abstract facts real for an audience.

Municipality of Urarinas

the Marañón River. People's complaints of nausea and skin rashes are aggravated by nervousness about eating the fish, concerns about their lost income and fears that oil will spread throughout the tropical forest and lakes when seasonal flooding begins in November. Cuninico, a village of wooden, stilt-raised, palm-thatched houses, is home to about 130 families but several hundred families in other communities also fish nearby.

Three weeks after they discovered the spill, the villagers still have more questions than answers about the impacts.

"It sounds like an environmental debacle for the people and the ecosystem," said David Abramson, deputy director of the National Center of Disaster Preparedness at Columbia University's Earth Institute in New York.

"There is a need for public health and environmental monitoring at a minimum of four levels – water, fish, vegetation and the population," he said.

Photo by Participant B

Company officials at Petroperu did not return phone calls and emails seeking comment.

Government officials have not officially announced how much crude oil spilled. However, in a radio interview, Energy and Mines Minister Eleodoro Mayorga mentioned 2,000 barrels, which is 84,000 gallons.

Indigenous leaders noted that the pipeline, which began operating again July 12 after the repairs, has a history of leaks.

Leaders of at least four neighboring communities said masses of dead fish appeared in lagoons and streams in the week before the oil spill was reported, indicating that it could have been leaking for days before it was spotted.

Even fish that escaped the worst of the spill could be poisoned, experts said. Fishermen who traveled an hour or two up the Urituyacu River, a tributary of the Marañón, in search of a catch unaffected by the spill returned with fish that they said tasted of oil.

Some Amazonian fish migrate long distances, and ongoing monitoring will be important for determining how fisheries recover, said Diana Papoulias, a fish biologist with E-Tech International, a New Mexico-based engineering firm that advises indigenous Peruvian communities on oil-related issues.

Key concerns include polycyclic aromatic hydrocarbons (PAHs), which are classified as probable human carcinogens and can cause skin, liver and immune system problems, according to the U.S. Centers for Disease Control and Prevention. Exposure to PAHs in the womb has been linked to effects on children's brain development, including learning and behavioral changes.

"The rule of thumb is that during the spill it's a horrible mess, and two or three years later it's hard to find evidence." –*Edward Overton, Louisiana State University*

For pregnant women, the fish become a "double-edged sword," Abramson said. "They need that protein source to enhance the neurological development of the fetus, but at the same time, you don't want them ingesting things that have unknown impacts."

Mothers said children and adults in their families are suffering from stomachaches, nausea, vomiting and dizziness, and small children have skin rashes after bathing in the rivers.

In this part of the Marañón valley, the nearest health center is more than an hour away by boat and does not have a doctor.

The government's Environmental Evaluation and Oversight Agency (Organismo de Evaluación y Fiscalización Ambiental, OEFA) has taken no samples of fish tissue for testing, according to Delia Morales, the agency's assistant director of inspection.

Much of the oil settled in pools along the pipeline during the flood season, creating a viscous soup where dying fish flopped weakly. Government officials said damage was limited to a 700-meter stretch along the pipeline. The ground and tree trunks in the forest on both sides of the pipeline were also stained with oil, in a swath local residents estimated at up to 300 meters wide. When that area begins to flood again in November, villagers fear that contamination could spread.

SERNAN (http://www.sernanp.gob.pe/sernanp/vermapa.jsp?ID=418)

Petroperu hired men from the village of Cuninico to find the leak and raise the pipeline out of the canal to repair it. Several of the men said they were up to their necks in oily water, working in T-shirts and pants or stripped to their underwear. They said they received protective gear only when a Peruvian TV crew arrived more than two weeks later. The July 20 newscast led to a shakeup in Petroperu's leadership.

Figure 16

Article on oil spill in Peru featuring photos by Participant B

This role of details in a variety of media (such as photographs) was also highlighted in comments by Participant D, who frequently reports on science topics for NPR. He described how he much preferred getting audio recordings of scientists working in the

field for his stories, seeking out off-the-cuff remarks and ambient noises that emerge when wading through a swamp looking for a particular breed of salamander.

But Participant B also leveraged outside scientific expertise in her oil spill article – both as sources of explicitly cited scientific information, and to support her own narrative framing of the story.

> I find that I'm more cautious than a lot of people, than a lot of people that might not have as much of a science background. Sometimes I'm overly cautious on things.
>
> This oil spill, for example. Everybody in the villages closest to the oil spill were having stomach problems. I was hesitant to draw a direct connection between the oil spill and the stomach problems because stomach problems can be due to so many other things. There's so much gross stuff in the water those people are drinking. After I talked to a couple of public health people, I realized I could probably be a little less cautious about that.

The oil spill story was a relatively recent one for this writer – she had been in the field for 25 years when it was published. But as she reflected on her writing career, she repeatedly returned to the idea of writing up to her limits, and when finding her limits (either in terms of knowledge or the type of venues she was publishing in), looking for ways to move beyond them. Prior study of science writers has found them to be acutely concerned about public understanding of science (including their own) and my participant group was no exception (Treise & Weigold, 2002)

Participant B is in a developing part of the world, and that may be part of her hesitancy to assert any scientific expertise. She is relatively isolated and the stakes may be higher – and she is reporting about environmental topics that directly affect peoples' health and well-being – people who are living with limited means and less likely to have access to the resources she has. She is also (not incidentally) translating between Spanish and English (and indigenous languages occasionally) as she interviews sources and writes. She works is an intermediary between several different information ecosystems in a particularly complex way.

The most potent limit she found in navigating this complexity was her lack of scientific background. She mentioned if she "had to do it over" she would have gotten a science degree initially and picked up writing courses along the way. She completed an online master's degree in environmental studies online about 10 years ago in an effort to overcome her lack of science education.

> Finally, I realized that I needed more background for what I was doing. I could talk to somebody at a mining company or talk to somebody at an oil company and I could ask questions up to a certain point. Then I could get snowed because I didn't know enough to know where to dig. At that point, I actually started looking for a master's degree.

Her choice of degree and institution was limited – as she couldn't afford to leave Lima (and her beat of topics and venues) – to institutions in the U.S. offering online programs. Participant B also described her access to scientific papers as mediated by librarians at the U.S. institution where she received her master's degree.

While some technologies (such as the email list of environmental journalists) were ready sources of support, other technologies presented more of a challenge. Our interview briefly touched on some aspects of "data journalism" – as publicly accessible datasets from satellites and other forms of remote sensing equipment are increasingly being used to report environmental news stories. Participant B knew of this and was enthusiastic about its potential. She was also hopeful that her embeddedness in that social network would help her transcend the limitations of her technical knowledge.

> There's a group of young journalists here in Peru that has just created a digital publication. They've teamed up with a bunch of young…they call themselves "The Hackers". I'm not sure they're actually hackers, but they're hotshot computer types. I'm circulating on the fringes of that group largely because I've been traveling a lot for the last few months when they've been meeting. I'm hoping that I can find some people in that group who will help me get up to speed on some of these skills that I really do need. (Participant B)

In addition to the feeling limited by certain aspects of scientific and technical knowledge, Participant B also described as lately feeling limited by publishing in small niche environmental publications. This was both an economic/career concern, but one also deeply related to credibility. She has only recently started trying to expand the topics she covers in her writing and to publish her work in more "high-profile" science publications. Participant B described her efforts at trying for many years (and finally succeeding) at getting a story into a top-tier science journal after decades of working for regional and special-interest environmental journals.

> The first pitch was a big pitch. That was the glacier story, and they went for it. I spent all of last year pitching them and striking out every single time. The editor is really sweet. He always answers my emails. He will always say, 'Not quite, but try again' basically.

While the lack of a proximal social network (living in Peru, not the United States) may have hindered Participant B's efforts to broaden her publication network in some ways, embeddeness in Peru and social contacts is helping her transcend those limits. Two years ago, Participant B was asked to write a short article about the newly-appointed health minister of Peru by an international medical journal, largely because she was an experienced English-speaking writer on the ground in Lima with local contacts. Her later pitch (of a story about contaminated blood supplies) was quickly accepted by this same journal shortly after – somewhat to her surprise.

> Without thinking about it, I pitched a story about the safety of the blood supply in Latin America. They said, yeah, great idea. Then I thought, oh my goodness, I know nothing about the safety of the blood supply in Latin America. I don't even know where to start. Which has been the story of my life with stories for [journal], but it's been fun because I've learned a lot.

Conclusion: Location is key to credibility, but within more than a single text

Rhetorical ethos as presented by Reynolds (1993) and related interpretations in information science and journalism show the importance of a writer's being specific about location as central to success as a credible communicator. My findings affirm that

importance, but find that "location" can mean multiple things, and technological affordances can reaffirm the boundaries of location in unexpected ways. Particularly for writers isolated by geography and by the contingent nature of their work as freelancers, assertions of location are even more salient than prior journalism scholarship has suggested. Participant B pointed out her editors "trust me to know what is important in Peru." They trust her because she has lived in and written about Peru for decades.

Future study of the work of freelance science writers (who will continue to make up a greater portion of science journalism production if current trends continue) would be well-supported by theories such as Feinberg's synthetic ethos (Feinberg, 2012). Credibility, or ethos, is synthesized across a number of publications, bound by the career arc of an individual journalist, or perhaps by hyperlinked network of associations and publications. Participant B's expertise as related to her location in Peru was developed after years of bylines and affiliation with various South American community groups, In contrast, Participant A, newly arrived in Central Africa with few local connections, did perceive his location to be useful to his credible communication of science news.

My finding related to location is relevant to answering the all of my research questions. The writer's location, and how that location is made visible, influences how the writers understand their own credibility and can intersect with other forces influencing credibility decisions. Developing a visible location within a location and its networks becomes a self-sustaining means to ensure continued credibility for a news writer. Location appeared in the interview text both in relation to features of identity and features of process as related to credibility choices. In response to research question one, a writer's location affects their sourcing decisions by giving them greater access to first-hand expertise. Locational specifics come into play in research question two by supporting perceptions of credibility by editorial forces and by influencing a writer's choice of story topics and larger career path. In the case of Participant B, her location in Peru was too valuable of an asset for her to give up by leaving. Staying in that location becomes a self-sustaining means to ensure continued credibility. A location-based component reflects both the "expertise" and "goodwill" elements of traditional credibility definitions.

A writer in a particular location can we seen as both an expert in that place, and personally and ethically invested in events that occur there.

As online collaborative "publishing outlets," such as Twitter and Wikipedia, are adapted for the reporting of news, my finding also addresses my third research question related to other online collaborative knowledge forms. Research of collaborative outlets such as these show conflicting findings about the role of identity and formalized processes in ensuring trust and cooperation among contributors (Jessen & Jørgensen, 2011; Keegan, 2013, 2015). My findings suggest that theoretical borrowing from studies of journalistic activity and social epistemologies can illuminate this rapidly-developing research space for information science scholarship, where relatively little attention has been paid to place-based characteristics. In journalism scholarship, a postmodern approach to contemporary news reporting as a collaborative space addresses physical location and local networks. Place-focused and collaborative locally-sourced stories reject a modern "meta-narrative" of an overarching truth (Wall, 2005). Recent empirical news study suggests that "newsworkers and journalism institutions are more entangled in local media ecosystems than ever before" (Anderson, 2013, p. 166). The potential for collaborations across geographic locations does not make location irrelevant to presentations of identity and decisions about credibility. Rather, reassertions of location through multiple modes (photographs, descriptive writing, first-hand interviews, etc.) and across multiple interactions may be foregrounded and increasingly relevant to perceptions of credible news stories.

4.7 Thematic summary

From the literature review and an initial pilot study, I had anticipated discovering that the work of freelance science news writers was a disordered space. "Dynamic stability" was missing in 21st century journalism, and the "open systems" of contemporary media production seemed to raise more questions than could possibly be answered (Fortunati & Sarrica, 2010). However, I found remarkably more consistency in the freelance science writer space than I expected, and substantial reflection on larger social implications from the participant writers. While the participants in my study were at times as dismayed as some observers of professional journalism (*e.g.*, Heinrich, 2011), they demonstrated significant optimism about science news writing as a meaningful form of public information. Frustrations were consistently directed toward of economic forces that limited the number of paying outlets for professional journalists, not toward researchers or the public interested in science.

A pervasive optimism in participant responses underpinned both a socio-behavioral flexibility and critical stance towards science news reporting. In terms of both their engagements with publishing outlets and their interactions with expert sources, the participants are leveraging traditional tools of process and professional identity in new ways. I have identified four main themes across the six vignettes reflective of this flexible stance.

Traditional structures and affiliations remain influential

Surprisingly, distinctions between print and online formats still seem to matter quite a bit to writers. Information science scholarship has largely left behind "digital versus analog" examinations, and journalism study finds the digital media space entirely upending old notions of epistemic control. The medium clearly is no longer the message. No one, even in 2016, still knows quite what to think. Even one participant asked me "it's all digital now, isn't it?"

But it's not. "Print" versus "digital" distinctions exist in both how the production is handled and how the writer interprets his/her byline. When writers have to assemble their bylines they are aware of the prestige of traditional newspaper and journal names and the status that they confer on the writer going forward. Writers are also aware of the editorial and fact-checking supports that come from working with a prestige print outlet; these are notable forms of support for freelancers working alone with limited resources. Yet "print" versus "online" seems to remain largely a conceptual distinction with more implications at the organizational level than as related to the actual technology. A writer writing for the "print side" of *Discovery News* may have a very different editorial experience (and paycheck) than writer contributing to the "online side" of *Discovery News*. Though both may wind up in exactly the (online) place ultimately.

Also science news writers still want to have special status as communicators. Writers are resistant to interacting with commenters and want to see themselves as ambassadors for science, at least within the bounds of the topics of their stories. While one participant pointed out he appreciated "being in the middle of the conversation" when comments appeared on his blog writing, the overwhelming attitude towards literal audience feedback was negative.

Accessibility and relevance remain important credibility-adjacent factors

In general, responses to questions related to the influence of venue on sourcing decisions were somewhat ambiguous. Primarily, though, news writers indicated that their choice of the "best" information source is made independent of the venue. How that source's information was incorporated into the final story was were the influence of the publication venue was instantiated.

However the competitive realities of freelance news writing consistently factored into sourcing decisions. Details were important for creating a persuasive narrative, and those details cannot be included into a finished science news article if a source does not respond fully and in a timely way. The expert source must be willing to return a phone

call, and the peer-reviewed article must not be made prohibitively expensive to be factored into a credibility assessment.

Relevancy is also aided by journalistic transparency. For example, hyperlinks to relevant web sites or journal articles cited by the news writer are assumed as a de facto part of science news writing. One participant appreciated this feature as a chance to "embed some sourcing" in his work along the way. While some voices in reflective journalism scholarship see transparency as a potential threat to professional identity (D. S. Allen, 2008), for the science writers in my sample, it was not a concern.

Distinguishing yourself in a crowded information space

A writer distinguishes him or herself both at the level of professional reputation, and at the level of individual articles. For example, Participant M took an angle on the Ebola outbreak reporting that brought a historical perspective to the story rather than retelling only the contemporary facts – he wanted to separate himself (and his publication) from an abundance of reporting on the topic. This was his approach (as an editor) to most of the science news on the blog. Over years, an audience developed around the ethic of his blog's reporting, enabling it to exist for over two decades as a credible source of unique science news.

Participant B distinguished herself as an on-the-ground reporter with decades of experience living and writing about Latin American environmental news. In contrast to Participant M, Participant B was a true freelancer, needing to renegotiate her status as a credible and knowledgeable communicator with editors and publishers repeatedly. While the theme of needing to separate oneself as a specialist was consistent, its application varied among the participants. Those participants with the experience or the arrangements in place to more or less "self-publish" understood themselves as credible to readerships, regardless of editorial mediation. Participants who were regular freelancers attended more to the "added value" of their specialized credibility at the point of negotiation with editors and publishers. This suggests that further research applying these findings to other

types of online collaborative environments needs to identify the points at which the added value of credibility is negotiated at information exchanges.

The writer's accumulation of texts and social network prove his/her credibility

In addition to a "unique" perspective contributing to value and credibility, there is a concurrent influence of the accumulation of a writer's published texts and number of social connection. News writers show their capacity for engaging in credible communications through a public presence (such as a professional web site, as in Appendix F) showing clips of their work published by recognized authorities. They also leverage social connections when they engage with their sources –for example a referral from an initial contact will provide an opening to additional experts in the field.

The two influences – of uniqueness conferring a sort of credibility while an accumulation of materials also confers credibility seem to forces in opposition to a certain extent. Audience members want to hear a unique voice than answers what they perceive to be a fairly unique information need, but there is also the reassurance of social confirmation. The information user/reader/judge wants to place their understanding of credibility and relevance in alignment with larger social structures and trends.

Conclusion

I used Figure 17 below in the opening this chapter to describe how I saw locus of the writer in the middle of overlapping information interactions in the science communication space. Exchanges in interviews where the writer was reflective about these circumstances, and could instantiate them in the details of specific article, were used to signal cases for the vignettes I explored.

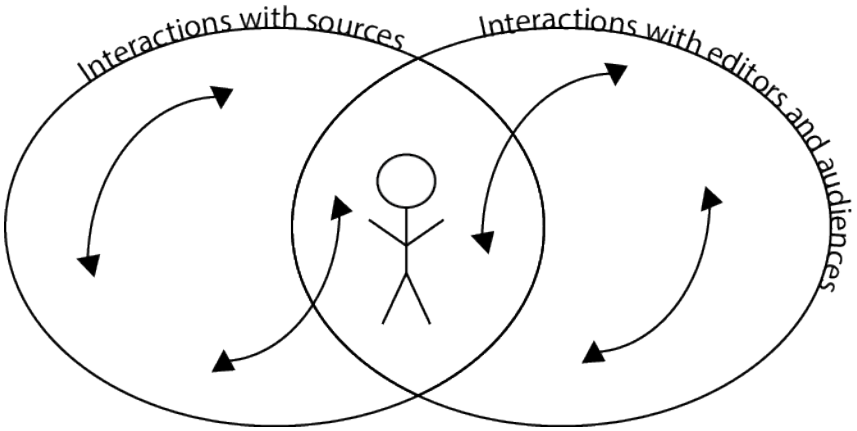


Figure 17

The journalist in the center of information interactions (Reudx)

In organizing a thematic conclusion, I return to this illustration considering the original representation of the journalist in the center as the stick figure. What become clear after my analysis is that the figure is also an instantiation of the reader as well. It is through conferring some measure of trust that we, as readers, perceive ourselves in the constructed narrative of a scientific event. We are not engaging directly with scientific sources, and typically only engaging with a publication space as a reader or commenter, but we are, regardless, inhabiting that same intersection of information worlds.

The news writer is our proxy in a sort of "journey" in describing the science. We cannot arrive at any understandings that he or she does not. And we trust them to bring us these understandings as we are taken through the story, making connections between sources and perceiving relevance as the writer does. Credibility is made in the specificity and coherence of those connections, and in the writers articulating (explicitly or not) their existence in the story as our representatives. Science writers are enacting forms of community and social networks in their story-building, and implicating the readers as co-participants.

5 CONCLUSIONS

My study of contemporary science news writing work describes professional identity and practices as socially-constructed influences on the information credibility decisions that science news writers make. From the introductory example of the Climategate media coverage in 2009, throughout the analysis of my interviews with science news writers, I have identified thematic elements in credibility understandings that are more than just reactions to changes in communications mediums. Rather than mere effects of technological determinism, work practices involving internet tools have co-constructed shifts in work routines and beliefs about credibility that call into question many earlier epistemological models.

Information science scholarship has used tools such as source credibility theory and heuristic approaches to describe an information user encountering a source and making a decision about its credibility in its epistemological models. Rieh, *et al*., describe this research as follows.

> "In the field of information science, credibility research has been conducted in the context of information seeking and retrieval. Therefore, credibility is often considered a core criterion for people to rely on when they try to reduce the amount of information they consume by selecting more useful, accurate, current, objective, complete, and reliable" (Rieh et al., 2014, p. 437).

These models have been focused on attributes of a textual source that suggest utility for answering the user's immediate concern and reducing the amount of available information to answer a single discrete question. These models often are not part of considering an individual's ongoing engagement with information activities (seeking and creating informative communications) and overlook broader social contexts (Self, 2009). However, recent inter-disciplinary studies are turning more attention to ongoing social interactions (e.g., Metzger et al., 2010; Rieh et al., 2014), and my study contributes to this stream of research.

Within journalism study, epistemological theories and sociological understandings of news writing are tightly bound up with organizational structures and tend to privilege the experiences of elite journalists working with established media outlets (Wahl-Jorgensen & Hanitzsch, 2009). The experiences of freelance writers, and how they understand the ethics and norms of their profession, are just now receiving serious scholarly attention (Edstrom & Ladendorf, 2012; Ladendorf, 2013). My study focuses on freelance writers' understandings of information credibility – both in terms of their selection of expert sources and the integration of those sources into their writing – as an especially salient aspect of this shift from formally-affiliated news writing to a freelance entrepreneurial model.

In the digitally-supported publishing ecosystem, the influences of larger (and older) social and political influences are not always as visible as the much-hyped technological changes. Yet, this digital technology has emerged alongside of and co-constructed a shift from organizations as information producers to distributed and networked ways of news communication; my findings suggest this shift is central to an understanding of information credibility decisions. Scholarship of credibility decisions has looked through the practice structures of two separately-identified professions, with similar but related professional aims related to credibility: information science and journalism. The affordances of internet communication suggest greater convergence in the way these practices are understood and can be studied, as illustrated in Figure 5.1 below. The gap – temporal and conceptual -- between finding and communicating information is shortened. The production of texts is less formalized – a publication process could now consist of a social media report from the site of a ongoing news event. The transparency of news writing work and multiple modes of communication now make identity and process more closely connected in terms of the professional and disciplinary areas of focus.

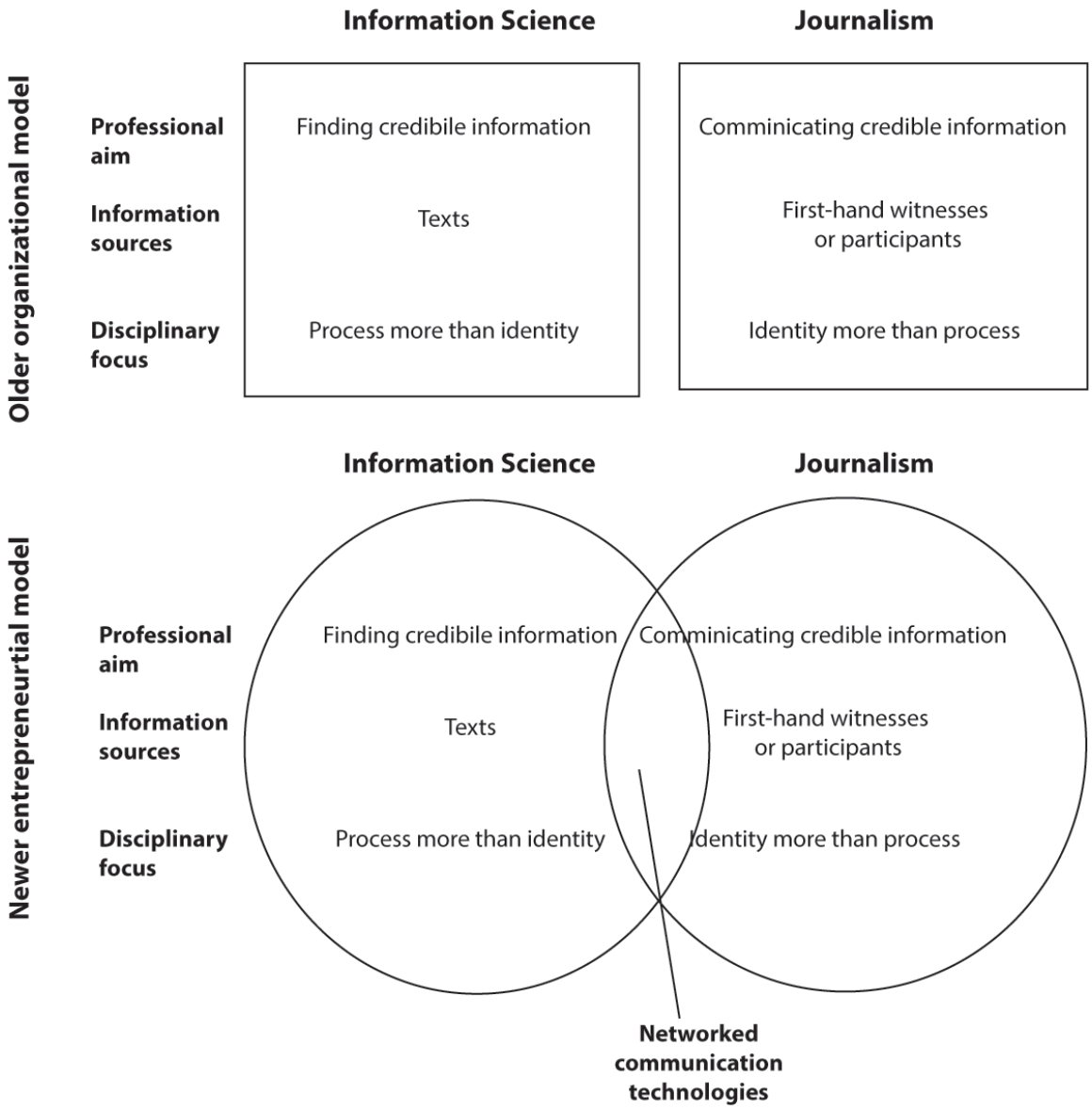


Figure 18

Shifting practices supporting blending across disciplines

But this overlap introduces unanswered questions. Across the literature of both fields, the trend of disintermediation is foregrounded, if not also problematized. Information science and journalism scholarship is adjusting to the effects of decentralized publication and innumerable outlets for news and information in the online environment. A lack of "credentialing" at the site of publication continues to be seen as cause for concern about information quality and the potential for disinformation (*e.g.*, Hernon, 1995; Pan, *et al.*,

2007). However, despite the waning influence of formal publication organizations and their credentials, well-researched motivations are still at work in the news writing space. The information credibility decisions news writers can be understood through existing sociological lenses; the spaces is not as disordered as some research might suggest. The concluding themes I found coalesced around the axes of identity and process to suggest foundational understandings of credibility judgments that can help future studies in both journalism and information science, and increasingly, the middle ground between them.

Traditional structures and affiliations remain influential

In the 21st century economy, traditional media organizations are losing power and economic influence. Full-time newspaper staffs contribute an ever-decreasing proportion of news content to the public sphere (Wahl-Jorgensen & Hanitzsch, 2009). However, even given this environment, legacy media outlets retain prestige and known media brands continue to correlate with positive and trusting reactions from readers (Hargittai, Fullerton, Menchen-Trevino, & Thomas, 2010; Johnson & Kaye, 2000). While the number of traditional media outlets with dedicated science desks has declined, those outlets may retain an outsize influence as their content is distributed through social media sites and gains greater visibility and interactions (Liang *et al*., 2014). Freelance news writers understand this environment and leverage their bylines with established high-profile journals in crafting their entrepreneurial identity.

As Participant D described in Section 4.1 related to identity, "For me, it's all about building up your clips and having clips, again, in newspapers and places where it's straight journalism, and not opinion pieces but news." Those clips in publications doing what he described as "straight journalism" were how he established his identity as a credible communicator. Similarly, Participant O described the intended arc of her career in relationship to established newspaper brands, "I was going to work at the *Marietta Daily Journal*. I was going to get to the *Atlanta Journal Constitution* and then I was going to go to out west, to the *Sacramento Bee* and then I was going to go to the *New York Times."* These established media outlets, even thought they retain less day-to-day

influence in actual news output, still serve as powerful tools of credentialing freelance writers as credible communicators within the freelance news marketplace.

Established publication venues also influence decisions of the writers as the select their sources. As reported by Participant E in Section 4.3, the publication venue (and even its format as primarily online or in-print) "very much drives" who she looks for as an expert source in her reporting. She may also have different forms of negotiation with editors at these venues – some editorial desks have a separate fact-checking process and some do not. Prior study of freelancer socialization and ethical understanding suggests that individual ethics are replacing organizational norms (Ladendorf, 2013). My data suggest the relationship between organizational and individual standards of a writer may be more complex. Freelance science news writers are working under the pressures of contingent employment and their roles and goals have to be continually renegotiated. A writer's failure to correctly incorporate his or her individual ethics with the priorities and norms of the (paying) organization may jeopardize future assignments.

Continued research in this space is complicated as each writer's career is singular. From a theoretical perspective, it becomes less easy to generalize about "what journalists do" because every career is crafted out of contingent arrangements. Sociological studies of journalism have not well addressed the changes in the news market.

> "Researchers need to reassess journalism's place in an increasingly global and mutually interconnected world with new communication technologies that profoundly challenge traditional boundaries between information production and information consumption and raise new questions about journalism's identity and positioning in a mediatized society" (Wahl-Jorgensen & Hanitzsch, 2009, p. 13).

The role of established news organizations as visible indicators of credibility is only lightly addressed in current credibility models within IS as a form of social context. Finding credible sources and writing credible texts is ongoing performative work done by writers. The model of a user in isolation performing singular and discrete credibility judgments in private does not offer much explanatory power in this space.

Accessibility and relevance remain important credibility-adjacent factors

Several participants addressed difficulties, either currently or in the past, with accessing sources of information because of the lack of organizational affiliation. These difficulties may include persuading sought-after experts in relevant fields to return a phone call from an unknown writer, to not having access to expensive academic literature database. My data found social network connections are leveraged frequently in response to these difficulties – an accommodation not well-addressed by prior research. While relevance questions are a topic under study in information science, the definitions (often related to information retrieval algorithms or machine-learning) are generally unrelated to the broader questions of accessibility and relevance I address here. Information retrieval focuses on narrowing down a crowded information environment to make the most relevant information accessible. My study has uncovered a space where overabundance of information is not the problem.

Prior journalism scholarship on sourcing behaviors of writers has addressed some of what happens when interactions with relevant expert sources is challenging for writers. For example, Reich (2006) found that reporters frequently let availability of sources drive the focus of their reporting away from what they may have originally intended in the initial phases of writing a story. Accessibility, or the willingness and availability of a source to speak to a certain topic made of that topic relevant. However, this work and similarly sourcing-focused journalism scholarship focuses heavily on traditional media arrangements and does not well address the additional complications posed by a freelance marketplace.

My findings shed light on how source availability can influence decisions about credibility and relevance when publication arrangements are flexible and contingent. For example, in Section 4.2, Participant J described her efforts to find the correct (and enough) sources for her article on recycling practices in a large city. Her freelance assignment gave her limited resources, in terms of time and money, to contact and interview a number of people related to some technical questions that were completely new to her. When some of her original attempts were complicated by city bureaucratic

rules, she had to adapt to these stymied encounters and find alternate sources. These interactions would likely have been different, as prior research suggests, if she had had more leverage with an institutional affiliation to gain access to some of the source despite the bureaucracy. She might have also had more power to renegotiate the focus of the story as a staff writer, rather than a freelancer with a single specific assignment.

Participant B also demonstrated the relationship between credibility and accessibility as described in Section 4.6. As a freelancer living and working in Peru, her local relationships were an integral part of her gaining access to relevant sources, and being seen as credible by her editorial supervisors. The assignments she received from more "prestigious" publications came about, as she described them, as having access to those local sources and being trusted as an authority in the geographic locale, even if the subject matter was not a specialty of Participant B's.

Distinguishing yourself in a crowded information space

Participant B also demonstrated the theme of crafting a singular professional identity as an underpinning for credibility. The writer's professional identity is reaffirmed through sourcing and publication practices made visible in a digital network. A writer constructs a unique identity as part of a certain social network – and bridging certain networks, as in the case of science writers communicating from expert sources – in order to both access credible sources, and be seen as credible by editors and audiences.

Within information science scholarship, identity is not considered outside of source credibility theory, which considers relevant features of the source's identity when deciding whether to trust the information provided by that sources. That is, is the author of an article credentialed? Is the author affiliated with an institution? These kinds of question frequently figure into information science heuristic models to explain user credibility decisions (*e.g.*, Hilligoss & Rieh, 2008). However, features of the identity of a user, and how they might interact with a source in an ongoing way to produce additional communications are unaddressed by information science.

Journalism scholarship addresses the need to distinguish one's communications primarily in terms of markets and the notion of "added value" (Heikkilä et al., 2010). As the economics of traditional journalism have fallen into disarray, making a news publication a unique (and valued) commodity is a financial imperative and a singular motivator. Yet again, studies of journalism have approached this question primarily in terms of organizational structures and institutions and not yet fully examined how the pressure to be a unique commodity in a crowded news market functions for freelancers under contingent and flexible arrangements.

In speaking specifically with science news writers, specialized science knowledge and expertise emerged frequently as a means for writers to distinguish themselves. In some cases this way tied to a specific region, as detailed by Participant B and Participant I pointed described in Section 4.6. In other cases, it was a more a diffuse kind of expertise – the ability to assert certain framing and relevance for the audience in unique ways. Participant M in Section 4.5 describes his blog writing on the Ebola outbreak story as looking for the "news behind the news." During a time when Ebola was a leading story in many publications, his writing's added value came from the way he framed that story – writing about Ebola as related to prior outbreaks of mass disease in history. Participant M was uniquely positioned as an experienced science writer who also had editorial control of his own publishing outlet (the blog). This enabled him to fully create a distinguishable science news story in ways other writers, who had to conform to outside editorial pressures, could not.

The writer's accumulation of texts and social network prove his/her credibility

One of the key difficulties in embracing a cross-disciplinary perspective between journalism studies and information science is a differing interpretation of "information source." Reporting news, as the fundamental activity of journalism, is seen as getting information from a person with special knowledge of a subject. Information science is fundamentally concerned with textual documents and their organization within systems and structures. But as Wahl-Jorgenson and Hantizsch describe, the current networked technologies "profoundly challenge traditional boundaries between information

production and information consumption" (2009, p. 13). The science news writers in my study were both producers and consumers of information. The expert source for their article may be a published journal article on a new research finding, in addition to a phone or email conversation with one of the researchers. Science news writing, as a particular form of journalism, embraces a wide multitude of sources, as academic literature informs reporting in ways no common to regular "beat" reporting, and also as forms of data journalism using existing scientific datasets become increasingly common.

Feinberg's concept of "synthetic ethos" (2012) served as a useful jumping-off point to describe how credibility functions for freelance science writers in this space using a variety of sources material across of career of contingent writing engagements. Feinberg's concept suggests that an organizational structure, describing specific relationships between objects, can convey shared values between individuals, or an individual or an organization. Credibility, or ethos, was conveyed not only in the objects (or texts) themselves, but by the implicit priorities suggested by their arrangement. My research suggests that this concept can extend beyond an organized collection of works, to a more flexible idea of a corpus of a freelance writer's texts. This text could include the formal bylines as mentioned above, but also less formal communications such as social media engagements and participation in relevant professional and social networks. A posting to an environmental science writer email list, for example, could serve to allow a writer to vet a potential source for a story, or signal their participation in this sphere of credible professionals in support of future work for hire. The line between engaging with sources to obtain information and becoming a source oneself is increasingly blurred.

Participant N's experience as described in Section 4.4 shows how this synthetic feature functions in an environment with an interactive audience element. After the publication of her original story related to autism research on a blog, readers commented with some criticism and concerns about the study. Upon a request from her editor, Participant N stepped into the comment thread as the author of the story to clarify some of the earlier points. She took on a role in a continuing conversation that would not have been available to her (or needed) in an analog environment. Her credibility in that space was linked to

both her connection to and citation of credible sources, but also her engagement in an ongoing synthetic conversation.

Contributions and future work

This study has used a social constructionist lens to understand credibility in practice. Despite dire assessments about the disordered nature of current journalism work, my data demonstrated that professional norms and understandings related to credibility persist across many different platforms for science news writing. Participant D talked about the role of "straight journalism" in doing environmental reporting in Section 4.1. In section 4.3, Participant E described her routine of "always link to the original study" when writing about new health research. In every case, writers embodied a normative role as communicators of true facts about the world to the public.

How these norms related to credibility came to exist for each writer, and how they were problematized in practice, demonstrated several variations that suggest directions for future research. For example, several participants talked about the role of the professional journalism education and membership organizations as social supports in freelancing work. Science journalism education, in particular, is limited to a few specialized graduate programs in the U.S. led by a very small number of faculty. Organizational studies of these programs could prove fruitful to demonstrating how the demanding freelance marketplace is changing what is seen as the core professional knowledge for this discipline. How does science journalism training teach people to find and work with credible source? Does this training vary depending on the institution and its larger organizational culture and disciplinary strengths?

Additional research through a socio-technical lens could also offer additional insights. For example, applying the concept of "boundary objects" to scientific authorities (either an expert person or published piece of research) could show how understandings of credible expertise could differ between writers, editors, audiences, and the scientists themselves. Peripheral participation theories from community of practice scholarship could be used to explore how practices to obtain credible expert information might be

learned by new freelance science writers. This view gives primacy to the actors in a social space, and removes the blinders of technological determinism.

In the introductory chapter of my study, I described the 2009 events surrounding the "Climategate" story as an example of science news communication that was not well-explained by existing theories of credibility. Traditional understandings of the role of authoritative publishing institutions and credible sources did not explain how the conspiracy framing of the climate science data gained substantial currency among the public. My findings show that instead of a disordered news space "disrupted" by networked digital technology, many well-known norms and social relationships persisted, but were made visible to new degrees by the affordances of new forms of communication. When institutional authorities attempted to exert control over the Climategate story though press conferences and "official" reports asserting nothing inappropriate had been done, the conspiracy narrative had already taken hold. Individual bloggers had made the Climategate a visible conspiracy, but the social relationships and motivation that created that framing had existed for years. The "climate change is conspiracy crowd" had their own social networks, trust relationships, and marketplace of ideas well-established and primed to pounce on a story such as this. Social relationships and motivations are central, and de-coupling them from the technologies and formal organizations of any given time enable us to understand credibility decisions in whatever technological environment may emerge.

APPENDICES

Appendix A: Interview protocol

1. Can you tell me a little about your background and education?

    Follow-up prompts: Do you have a degree in science? A degree in journalism?

2. Tell me about the kind of writing you do.

    Follow-up prompts: Do you get assignments or freelance? Do you pitch story ideas?

3. Describe your process for researching a story.

    Follow-up prompts: Do editors give you contacts? Do you use Google or academic databases? Do you have frequent sources?

4. Looking at story X – what sources did you consult with and when? How did you find them?

5. Why did you choose to talk with them? Did you get information from them from in-person conversations, phone calls, email, or some other type of communication?

    Follow-up prompts: Do you fact check after you speak with your sources? Do you let them read your writing, or do you call to check certain facts?

6. Did you feel you had the knowledge/experience to know these were good sources or good information?

    Follow up prompts: Do you try and find sources to agree or disagree to construct a narrative? Do you know how you want to shape your story with your sources? How does your journalism background/science background inform your choices?

7. Did consideration of your audience affect your choice of sources?

8. Do your initial source contacts refer you to other sources?

9. What are some of the effects you've experienced (if any) of new technological developments in your work – for example: new online resources, social network sites, or communication services like Skype?

Follow up prompts: Do you have a website? Use social media?

10. Do your editors or web staff insert links into your story when (if) they are published online? Do you have any control over those links?

Follow up prompts: What kind of sources do you link to? How do you feel about reader comments?

11. Is there any advice you would give to a colleague who is new to this field?

Appendix B: Recruitment email

Hello –

I am writing to ask if you would be willing to participate in a study I am conducting into the work of science journalists.

I have identified you as a potential participant via the National Association of Science Writers website.

I am a doctoral candidate at the School of Information at the University of Texas at Austin and this study is part of my dissertation research. I am hoping to examine how the practices of science journalists, including their consultation with expert sources, relate to being seen as a credible communicator of complex information.

If you are willing to take part in this study, I would be primarily interested in conducting interviews with you about your work and writing practices. These interviews would be approximately an hour each (at most) and I would hope to conduct two separate interviews if possible. These could be done in person, by phone, or via Skype. If you agree to participate, your name and other identifying details would be known only to me and not included in any published material.

This study has been approved by the University of Texas Internal Review Board and the study number is 2013-02-0012.

I know you have many demands on your time, and I thank you in advance for considering this request.

If you are interested in participating, or have additional questions you would like answered before deciding, please respond to my email address below. I am hoping to schedule interviews over this summer and early fall.

Many thanks again for your time and consideration.

Sincerely,

Jeanine Finn
Doctoral Candidate
School of Information
University of Texas at Austin
jefinn@ischool.utexas.edu

Appendix C: Interview codebook

Identity codes	
	Definition
Career	Use for general reflections on career trajectory or management of career (such as entrepreneurial or financial issues) where a more specific code doesn't apply. *EXAMPLES*: "I didn't see any way that I could take two years out from my life, just drop my freelancing for two years and expect to return to it." "…that made me deal better with the scientists themselves, and it gave me more confidence."
Career_LifeExperiences	Similar to Writing_LifeExperiences below, but use this code for broader influences on career trajectory, for example a move abroad or a major illness. *EXAMPLES*: "They had one residency a year which the told me they would waive for me if I couldn't get there. I ended up going every year because I usually go and visit my family in the States at least once a year anyhow."

Career_OverTime	For when there is a change in the manner of "I do this differently now from when I started." These are experience-driven, not education-driven. NOTE: May differentiate between science experience and writing/journalism experience *EXAMPLES:* "Actually what stood me in the best stead for my journalism training was having worked at the newspaper all through college." "For example in marine biology it just happened because through the research I'd done, I just happened to meet a lot of people who had done that. I've drawn on that for sources and that sort of thing."
Career_Social	For discussion of colleagues, peers, and social networks that have influenced career trajectory or supported writing work. DO NOT use for specific source contacts, but broader discussion of ongoing social networks. *EXAMPLES*: "….if I'm looking for something in particular, I'll email them too. They're usually really good about responding if they have something that they can help me with."

	"That has been one of the greatest resources for me -- The Society of Environmental Journalists."
Expertise_Mine_Journalism	Use for references to discussions of the participant's formal or informal journalistic expertise. This could include a college degree in journalism, or on-the-job training that the participant describes as formative. Use for cases that demonstrate self-reflection, areas where the participant is expressing confidence about skills in certain areas, as well as cases wherein the participant acknowledges limitations. *EXAMPLES*: "I'm hoping I can find some people in that group who will help me get up to speed on so me of these skills that I really do need."
Expertise_Mine_Science	For specific references to formally acquired (at college, etc.) or informally-acquired (though volunteer work, hobbies) science knowledge. This could included degrees earned, schools attended, or desires/plans to return to school for additional education as well as leisure pursuits that have provided what the participant describes as science knowledge. Use for cases that demonstrate self-reflection, areas where the participant is expressing confidence about skills in certain

	areas, as well as cases wherein the participant acknowledges limitations. DO NOT USE for story-specific details, but rather general knowledge that has influenced career choices on ongoing story seelctions. *EXAMPLES:* "I was in the second cohort for their master's in environmental studies. It turned out to be just the right thing for me."
Expertise_Others	Use to describe how limitations on science expertise are discovered and/or resolved through interactions with expert sources and influencing attitudes over time. For more specific mentions of skill gaps (related to writing or research skills) that do not involve interactions with experts, use the Expertise_Mine codes above. DO NOT use for selection of expert sources for specific writing projects that do not involve reflection on participant's own expertise (Use Process codes below). *EXAMPLES*: "I was hesitant to draw a direct connection between the oil spill and the stomach problems….After I talked to a couple of public health people I realized I could probably be a little less cautious about that."

JournalisticIdentity	Use for self-conscious reflection about the nature of journalism as a profession, and how its ethics or professional identity are articulated in everyday work. *EXAMPLES*: “To qualify that a little bit, I'm not really an investigative reporter so a lot of the things I'm talking to people about, they don't have a problem telling me about.”
Process codes	
	Definition
AccesToPublications	Use when the writer mentions (even a brief mention) having to get access to a scientific publication. It may include mentions of libraries or institutional affiliations. *EXAMPLE*: “The one publications I write for the most you may not be able to see…it’s behind a paywall.”
Geographical logistics	Use for specific mention of georgraphical location of the writer in relation to how it affects the writing process. This code will often overlap with Writing_ChoosingTopics or with Career_LifeExperiences above in Career. This may include the "geography" of attending a conference with a source, if that in-person meeting leads to a story.

	EXAMPLES: “I happened to be in the neighborhood of where the oil spill was. I went to do something else, and I'd hired a local journalist to help me with the interviews I needed to do. He said, "Let's go up and see the oil spill first.”” "I happened to run into him at a AAAS meeting a few years ago."
Sources_Company	Use for discussion of sources who work for for-profit corporations if they are presented as such
Sources_Expertise	Use when the participant specifically mentions a source’s credentials, experience, or access to a specific field site in relation to a story topic *EXAMPLES*: “I actually had a flight out of Cusco that next morning, but I changed the flight and went flying with him. Then I went flying with him again to see the spectrometry stuff in Tarapoto 2012” “He was a wealth of information in his own right because we talked about his experience in Cameroon, that sort of thing”
Sources_Finding	Use for all discussion about the participant’s process for finding sources for their stories,

	both in specific instances and in general terms *EXAMPLES*: “You asked about where I find sources of things. I subscribe to Eureka Alerts, so every morning, I wade through a bunch of abstracts of- I don't wade through all the abstracts, but I look at things that, the things in the Eureka Alerts notes, or digest, I should say, that are particularly pertinent to the things I do.”
Sources_Motivations	Use if the participant mentions (or speculates) why a source agrees to provide information. This may be specific to a particular story or described in more general terms. *EXAMPLES*: “In general, I think most of the scientists I talk to mean pretty well. They're out there trying to increase our knowledge of a certain topic or something like that” “A lot of them want to get the data out so they can protect this place.”
Sources_Selecting	Use when discussions of sources for a story address how the participant chose from among several options. This may overlap with several other codes, such as Time_Contraints and Source_Expertise below

	EXAMPLES: “What gets emphasized and who gets quoted and how much detail, how much scientific detail goes into it varies depending upon the venue and who the audience will be”
Sources_WorkingWith	Use for details of how a writer elicits information from his/her sources to build a story. This may be in terms of crafting a certain narrative arc, or in getting more engaging quotes from scientists to use in a story. *EXAMPLES:* "Yeah. I mean, if you have a cool finding, then you can get the scientist in the lab describing to you in his or her own words what's cool about it. Better yet, if you can get them afield ... That's my favorite thing to do is have some scientist who's doing field work and has made some discovery, and they're out there showing you...'Hey , these are blue-spotted salamanders.'"
Technology_OnlineData	Use for any mentions of data or datasets from online sources. Use for things like satellite maps and census data. DO NOT use for scholarly articles available or other “published” material available via library databases or Google Scholar.

	EXAMPLES: “I've used the Global Forest Watch website some, but the truth is, I have not done a lot of data journalism and I need to.”
Technology_Publishing	Use for discussion of technological tools and their use in the getting the written work out before the public. *EXAMPLES*: “I post on Facebook” “I will say one thing that's nice about the hyperlink. For example in this last story I wrote I think we're going to probably include hyperlinks to a specific case.”
Technology_Writing	Use for discussion of technological tools and their use in the writing process. This can include email, Skype, message boards, literature databases, and mobile devices. *EXAMPLES*: “That's usually where I start. Then I'll go to Science Direct, or I still have access to the library, the online collection at Green Mountain College”
Writing_Audience	Use when the participant talks about

	considering the eventual readers of the news story – both in terms of story topic and source selection, use of vocabulary, but also issues related to interactivity for online writing (*i.e.*, comments on stories) *EXAMPLES*: "What gets emphasized and who gets quoted and how much detail, how much scientific detail goes into it varies depending upon the venue and who the audience will be."
Writing_ChoosingTopics	Use when the participants talk about the motivation for choosing a particular story topic. This may overlap with Career codes such as Expertise_Mine_Sciene or Process codes such as Writing_PublicationEditorial when discussing assignments with editors. *EXAMPLES*: "I have the good fortune to be in a place where I can learn a lot about things like bush meat or the ape traders."
Writing_Language	Use for discussions of word choices in writing, either related to editorial/venue concerns, medium (e.g., online versus print), or understandability for the readers. This will frequently overlap with Audience_Concerns. *EXAMPLES*:

	“I didn't. I got paid for two versions, but the editor made the changes in the print version. I think I saw the changes. She'd told me she was going to have to condense it”
Writing_LifeExperiences	Similar to Career_LifeExperiences above, but use when related to specific details of the writing process, rather than in descriptions of overall career trajectory. *EXAMPLES*: “Exactly, yeah. It's a little bit different here because I'm ... We are out in the middle of nowhere. I don't quite work at the pace I guess that a lot of or that I used to in the States or that a lot of my colleagues do.
Writing_MultipleProjects	Use when the participant addresses issues of workflow when writing several stories at once. This may overlap with Writing_TimeConstraints and the entrepreneurial elements of the Career code above *EXAMPLES*:
Writing_PublicationEditorial	Use for discussions related to interactions and ongoing relationships with publishers. This may include stories of pitches and work with particular editors, or how the editorial process works in general or with specific publications.

	EXAMPLES: “When I started working at Latin America Press, they were just moving away from fax” “The Thomson Reuters people have a foundation that does a lot of environmental stuff. They contacted me a few months ago. They had some money from the World Bank to do writing that had to do with climate stuff. They basically said, “’Let's talk about what might be a good climate story out of Peru.’”
Writing_TimeConstraints	Use for discussions of deadlines, both in relation to editorial deadlines and time constraints related to communicating with sources. *EXAMPLES*: “I was on the clock that day for somebody else. I was working by the hour for somebody else that day, so I couldn't work on anything else that entire day” “Inevitably, I run out of time to talk to everybody I'd like to talk to”
OTHER CODES	
Credibility	*DOES NOT STAND ALONE* Use with other codes when discussion includes elements of credibility of sources or evaluations of information trustworthiness more generally

Stand-alone codes	
CRITICAL INCIDENT ARTICLE	*See separate definition*
Thoughts_About_The_Field	Use for reflection about the career of science news writing or journalism more generally that aren't specifically related to the particular participant's career. *EXAMPLES*: "Like I said, there's tons of good science journalists out there who come from the literature end of things or come from English backgrounds and that sort of thing."

Appendix D: Code frequency distributions

Code	Total	Min	Max	Mean	SD
AccessToPublications	8	0	3	0.5	0.966
Career	122	1	16	7.625	4.015
Career_LifeExperiences	41	0	6	2.562	2.128
Career_OverTime	50	0	11	3.125	3.008
Career_Social	33	0	9	2.062	2.489
Credibility	25	0	6	1.562	1.788
CRITICAL INCIDENT ARTICLE	1	0	1	0.062	0.25
Expertise_Mine_Journalism	108	1	15	6.75	2.955
Expertise_Mine_Science	122	2	23	7.625	5.737
Expertise_Others	27	0	4	1.688	1.493
Geographical logistics	23	0	9	1.438	2.279
JournalisticIdentity	54	0	17	3.375	4.66
Sources_Company	13	0	6	0.812	1.601
Sources_Expertise	47	0	9	2.938	2.435
Sources_Finding	158	3	20	9.875	4.801
Sources_Motivations	38	0	5	2.375	1.628
Sources_Selecting	65	0	9	4.062	2.72
Sources_WorkingWith	119	0	21	7.438	5.597
Technology_OnlineData	5	0	2	0.312	0.602
Technology_Publishing	76	0	11	4.75	3.235
Technology_Writing	48	0	7	3	1.932
Thoughts_About_The_Field	108	1	18	6.75	5.196
Writing_Audience	62	0	10	3.875	2.729
Writing_ChoosingTopics	126	3	20	7.875	4.674
Writing_Language	37	0	8	2.312	2.33
Writing_LifeExperiences	1	0	1	0.062	0.25
Writing_MultipleProjects	16	0	4	1	1.033
Writing_PublicationEditorial	197	5	31	12.312	6.935

Writing_TimeConstraints	24	0	4	1.5	1.033

Appendix E: Participant profiles

Participant	Education	Location	Years of Experience	Frequent Publication Venues
A	BS in biology Masters in science journalism at UC Santa Cruz	DR Congo	5	Mongabay.com (environmental organization website)
B	BA in journalism Masters in environmental studies (online)	Peru	27	*Environmental Health News, EcoAmericas*
C	BA in French literature Masters in science journalism at Boston University	Maryland (US)	30	*Washington Post*, NPR
D	Bachelors in psychology MS in environmental studies	Maine (US)	20-25	*New York Times*, NPR, *National Geographic*
E	Bachelors in environmental science and	California (US)	5-10	*Wired, Popular Science, LA Magazine, Nature*

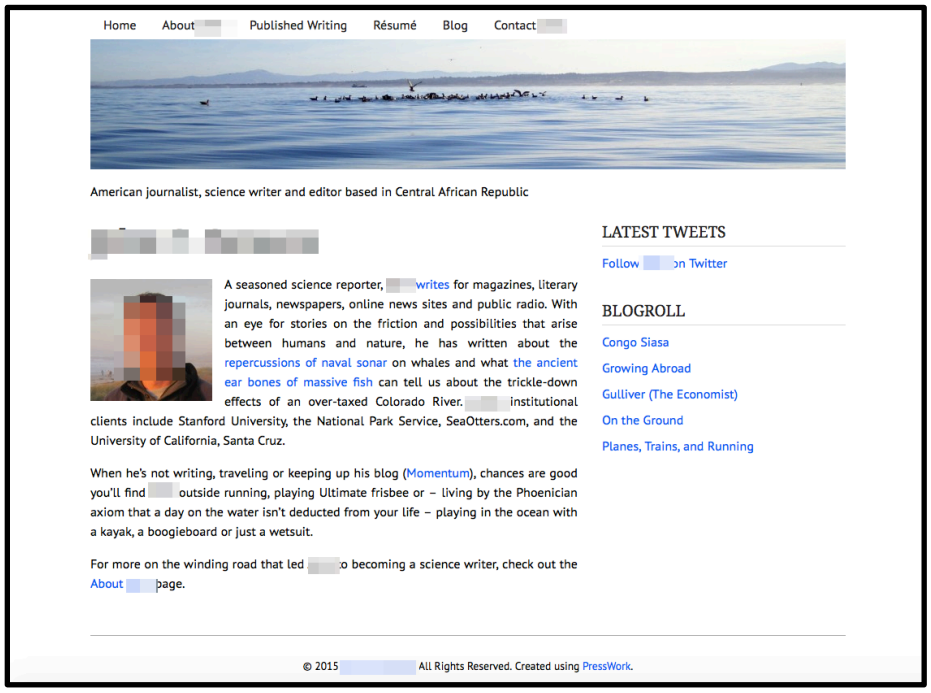
	anthropology Masters in science journalism (MIT)			
F	BA in biology Masters in science journalism (UC Santa Cruz)	Minnesota (US)	15	*Discovery News, U.S. News & World Report, Science News for Kids, LA Times*
G	Bachelors in political science and ecology Masters in watershed management	Colorado (US)	12	*High Country News*
H	BA in geology; Dual degree program – Masters in both geology and journalism (Columbia)	California (US)	14	*Nature, Chemical & Engineering News*
I	BA in English	Vermont (US)	25	*Popular Mechanics, E: The Environmental Magazine*
J	BA in American	Boston (US)	20	*Boston Globe*, ABC News

	Studies Master's in science journalism from Boston University			
K	PhD in Chemistry from Harvard University	Minnesota	30	*Chemistry* (and other American Chemical Society publications)
L	BS in Physics; Masters in science journalism from Johns Hopkins	Maryland (US)	5-10	*Science News*
M	BA in philosophy; Masters in science journalism from UW Madison	Wisconsin (US)	20	WhyFiles.org (project of UW Madison)
N	Bachelors in biology and English; Masters in science journalism from Johns	Seattle (US)	20	*Nature, New Scientist*

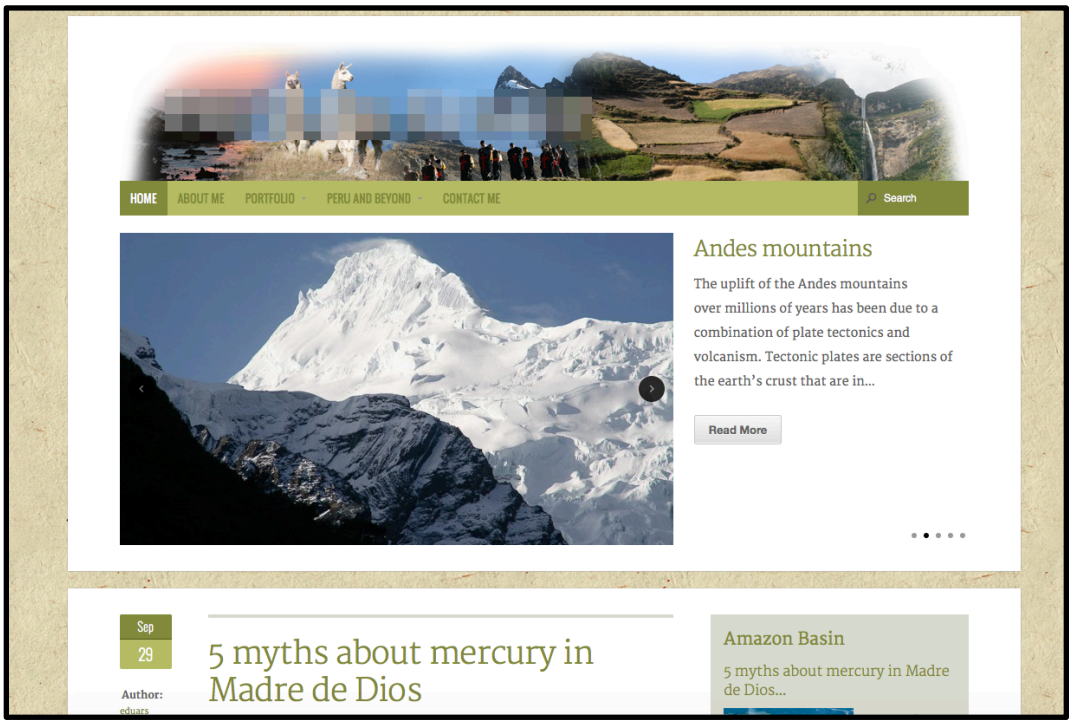
	Hopkins			
O	Bachelors in newspapers; MS in ecology; MA in health and medical journalism from MIT	NYC	5	*Nature Medicine*, Reuters
P	Bachelors in biology; Masters in science journalism from Boston University	NYC	14	*Discover, Christian Science Monitor*

Appendix F: Participant website images

Participant A



Participant B



Participant C

Freelance Journalist
and Radio Producer

HOME ABOUT VIDEO CONTACT

RADIO PRINT VIDEO WINE CYCLING

Posts Comments

Hip Replacement: Part Deux

BY ON JULY 29TH, 2014

Here's a first-person treatment of my recent hip replacement surgery in today's **Washington Post**.

4 COMMENTS PRINT, WASHINGTON POST

Can genes protect you from brain hits?

BY ON MAY 7TH, 2014

My piece in this week's **Washington Post** highlights new research about the link between certain genes and the likelihood of getting brain disease after getting hit in sports or during combat.

LEAVE A COMMENT PRINT, WASHINGTON POST

Estonian Robo-Mannequins to the Rescue

BY ON APRIL 7TH, 2014

Here's my piece in **Wired Magazine** from last summer's visit to Fits.me, a Tallin-based startup with offices in London that is making it easier to shop online for clothes.

LEAVE A COMMENT PRINT, WIRED

Finland Links Hygenie Hypothesis and Type 1 Diabetes

BY ON FEBRUARY 6TH, 2014

Here are the results of my trip to Finland and Estonia last summer, a look at the work of a Helsinki researcher linking the nation's high rate of type 1 diabetes and its clean society. Published recently in **The Washington Post.**

S WORK AT DISCOVERY

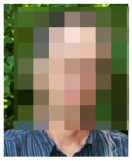
- Quake vs. Volcano: Which One's Worse?
- 3-D 'Jelly Donut' Brain Works Like Ours
- Ukraine Reviving Retro Drones to Spy on Rebels
- How to Trick the Ebola Virus
- Moving Ebola Patients to US Involves Extreme Isolation

ON TWITTER

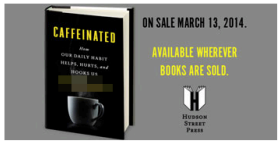
BLOGROLL

- Adventures in Climate Change
- Boing Boing
- Cycling News
- Discovery News
- Drunk Cyclist
- Knight Science Journalism Tracker
- NYC Bike Snob
- Splice Today
- The World
- VeloNews
- Wine Library TV

Participant D



Journalist and Author
Belfast, Maine
email:
Twitter:



Look for my book *Caffeinated*, an investigation of modern caffeine culture, published by Penguin's Hudson Street Press.

See this Facebook page for information about readings and other events.

For media inquiries, please contact
Courtney Nobile: Courtney.Nobile@us.penguingroup.com

Selected Clips

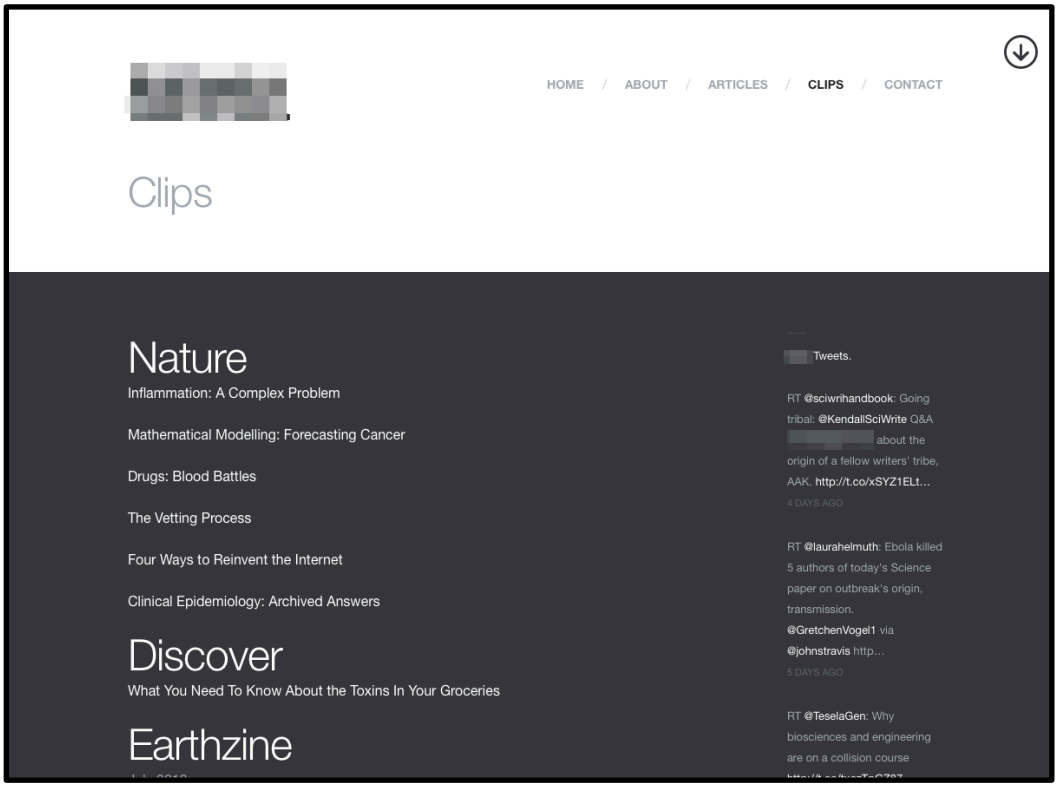
CAFFEINE

Five Myths About Caffeine
The Washington Post, May 23, 2014

Inside the Overstimulated, Underregulated Caffeine Industry
Wired Magazine, February, 2013

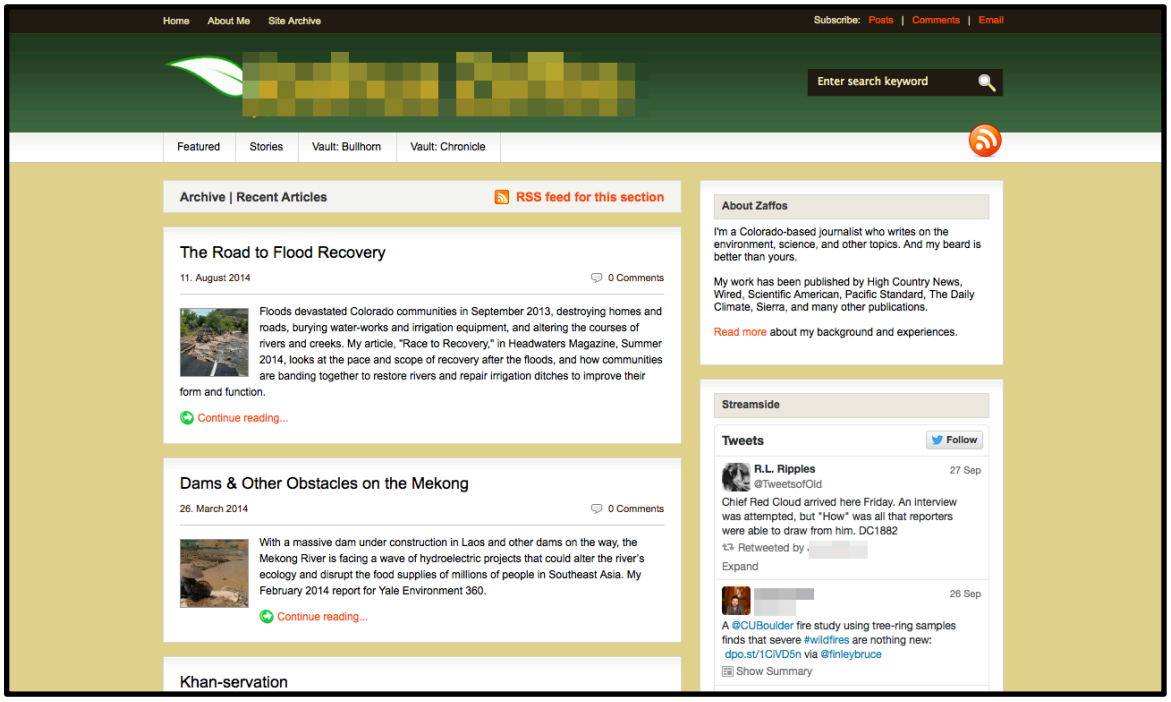
Caffeine Gives Athletes a Third and Fourth Wind
NPR's Morning Edition, November 19, 2012

Participant E



Participant F

Participant G



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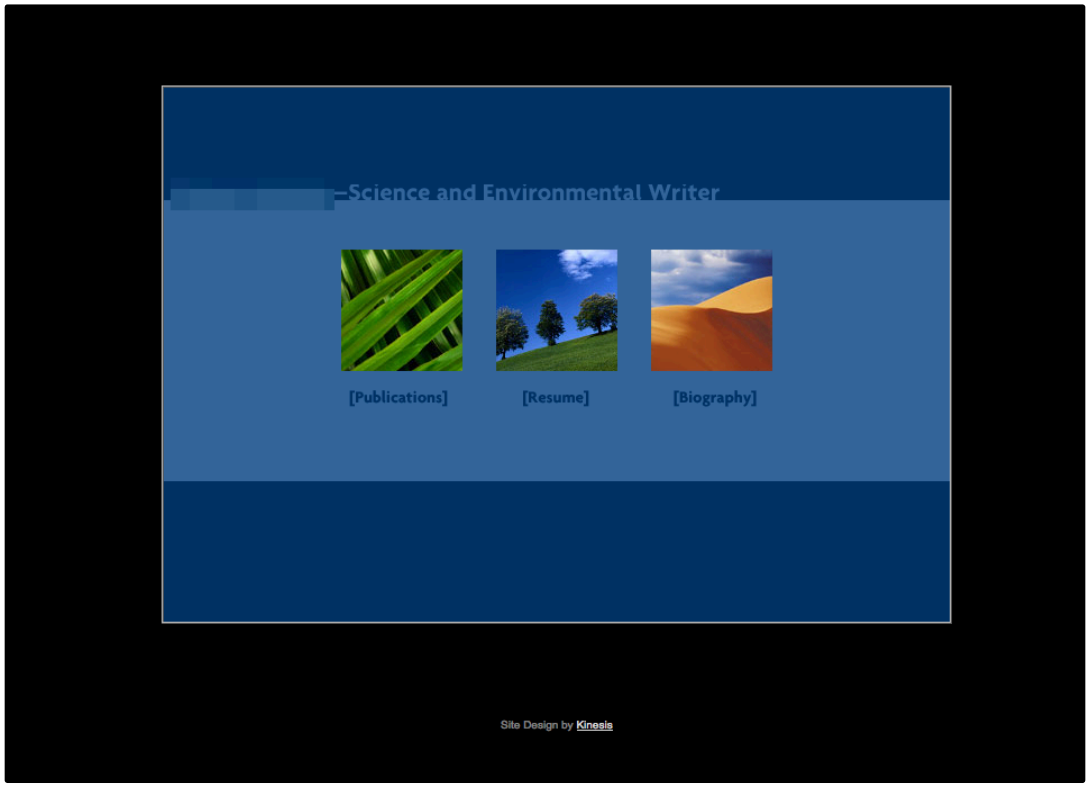
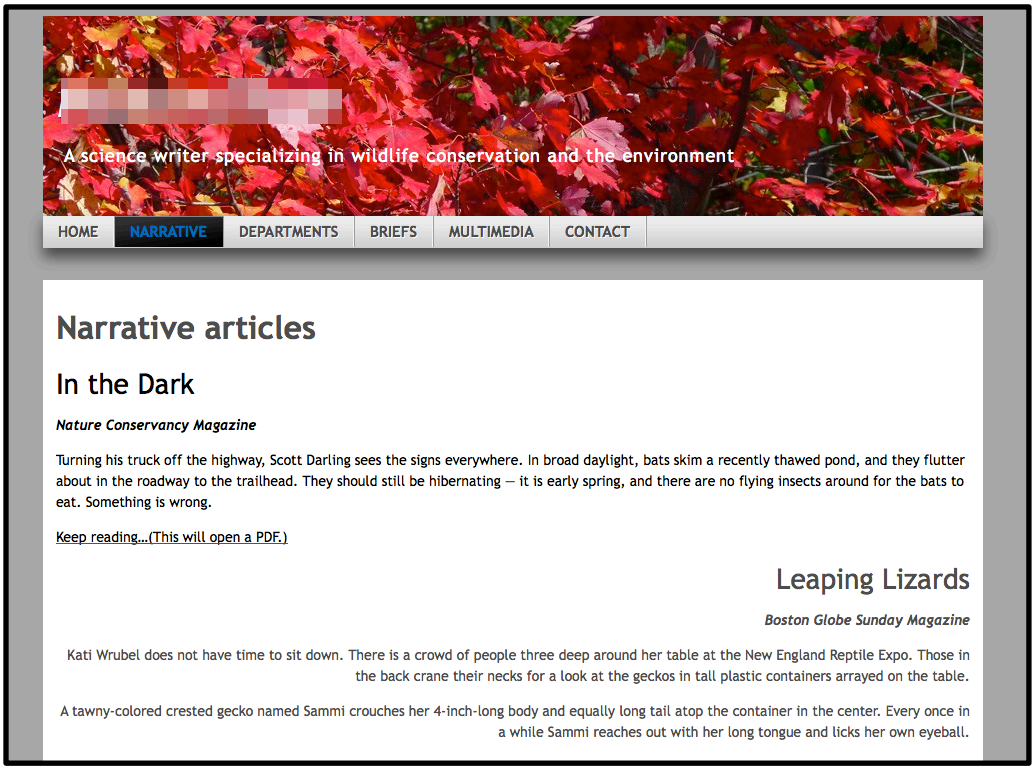
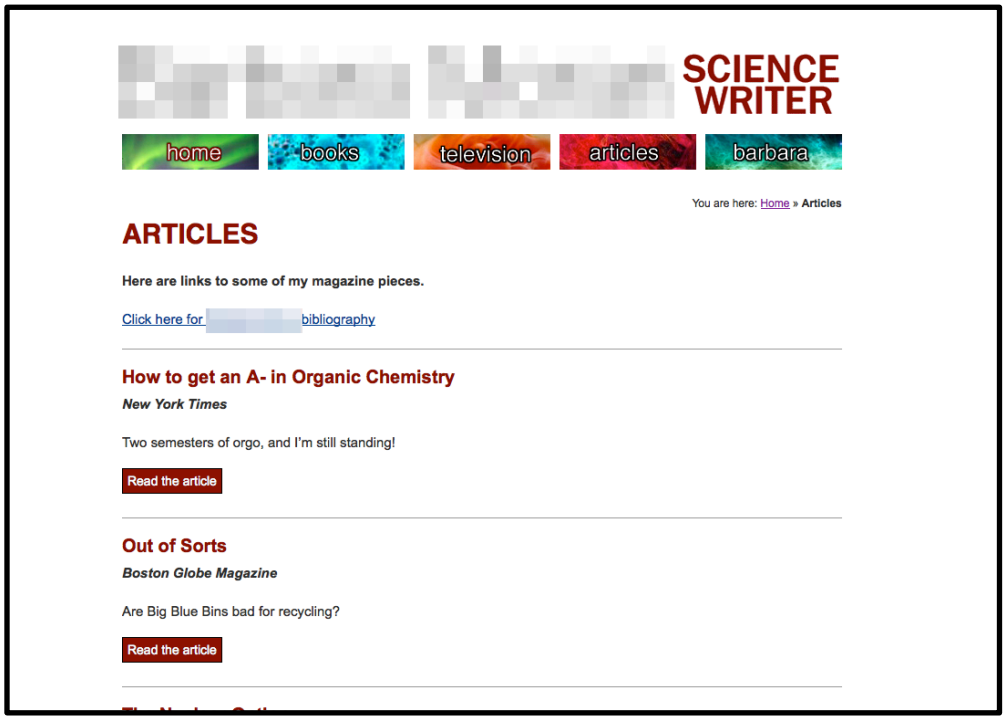


Participant I



Participant J



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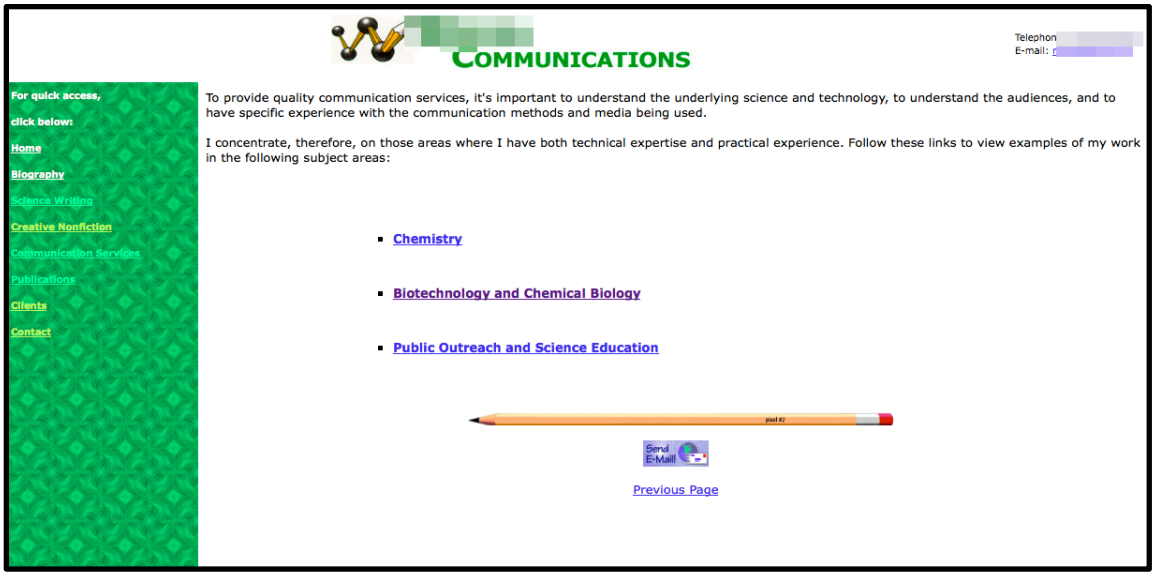
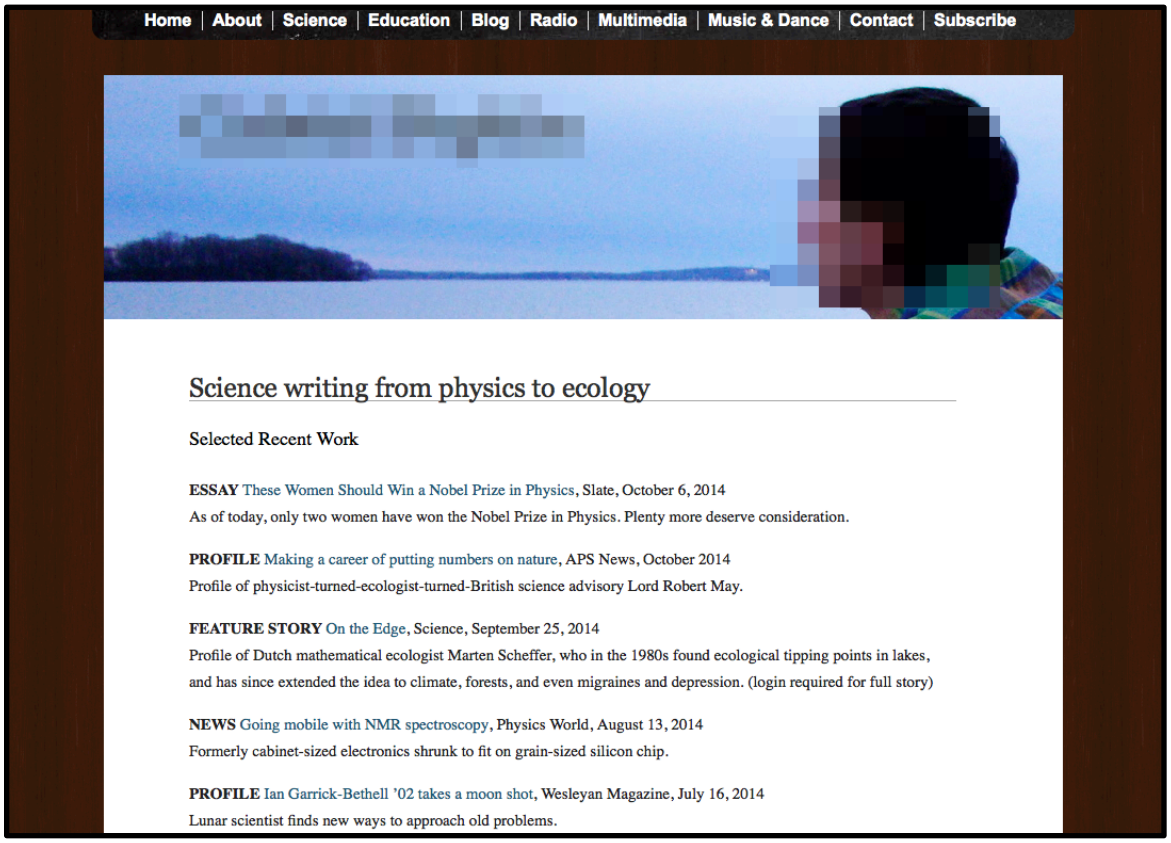


Participant L



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Science writing from physics to ecology

Selected Recent Work

ESSAY These Women Should Win a Nobel Prize in Physics, Slate, October 6, 2014
As of today, only two women have won the Nobel Prize in Physics. Plenty more deserve consideration.

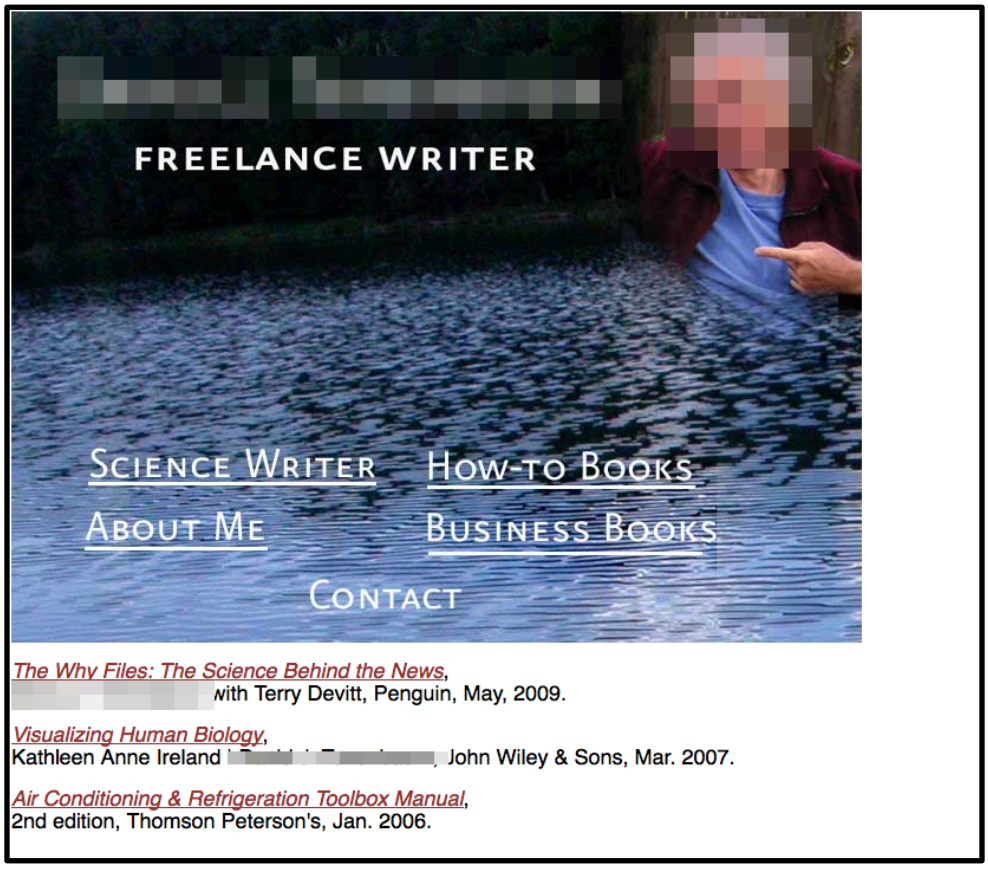
PROFILE Making a career of putting numbers on nature, APS News, October 2014
Profile of physicist-turned-ecologist-turned-British science advisory Lord Robert May.

FEATURE STORY On the Edge, Science, September 25, 2014
Profile of Dutch mathematical ecologist Marten Scheffer, who in the 1980s found ecological tipping points in lakes, and has since extended the idea to climate, forests, and even migraines and depression. (login required for full story)

NEWS Going mobile with NMR spectroscopy, Physics World, August 13, 2014
Formerly cabinet-sized electronics shrunk to fit on grain-sized silicon chip.

PROFILE Ian Garrick-Bethell '02 takes a moon shot, Wesleyan Magazine, July 16, 2014
Lunar scientist finds new ways to approach old problems.

Participant M



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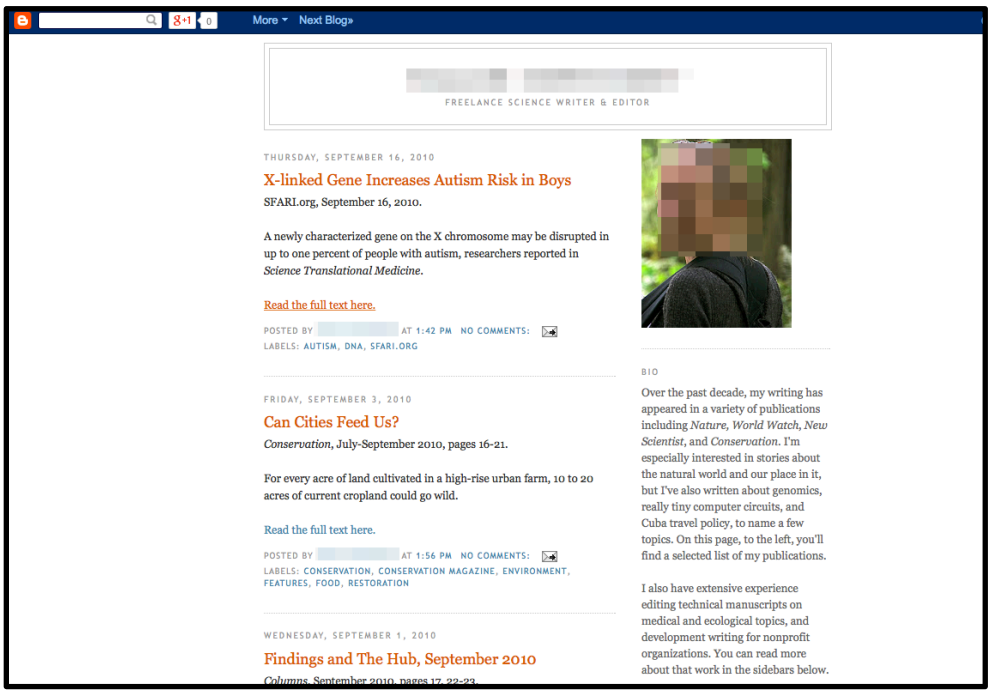
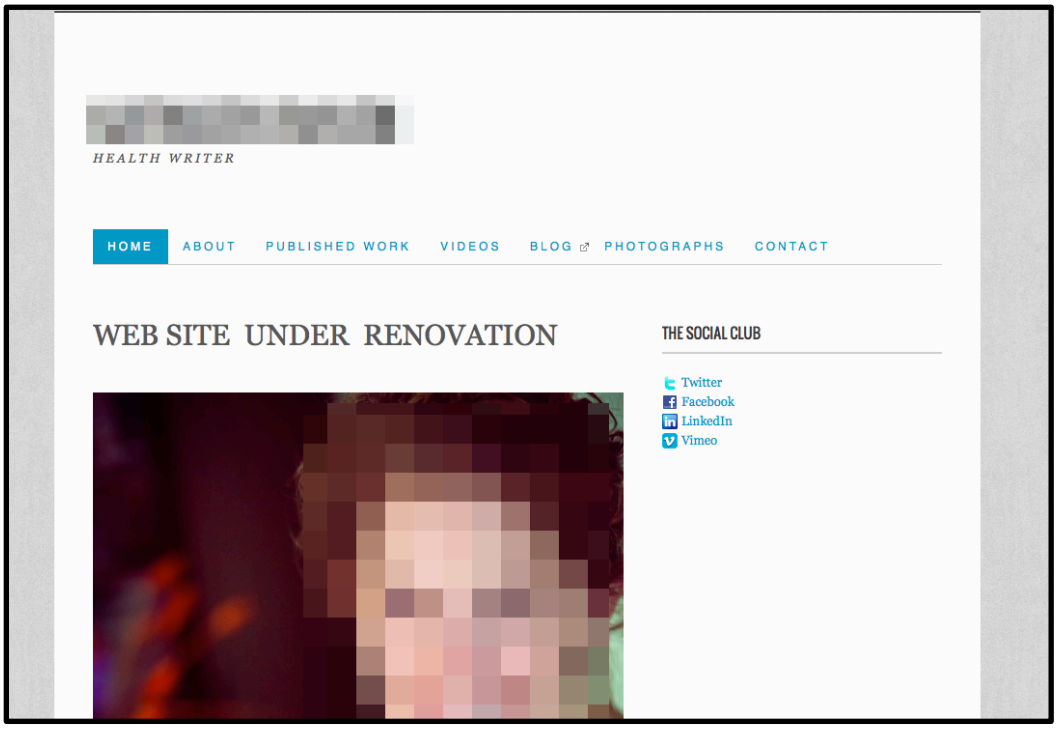
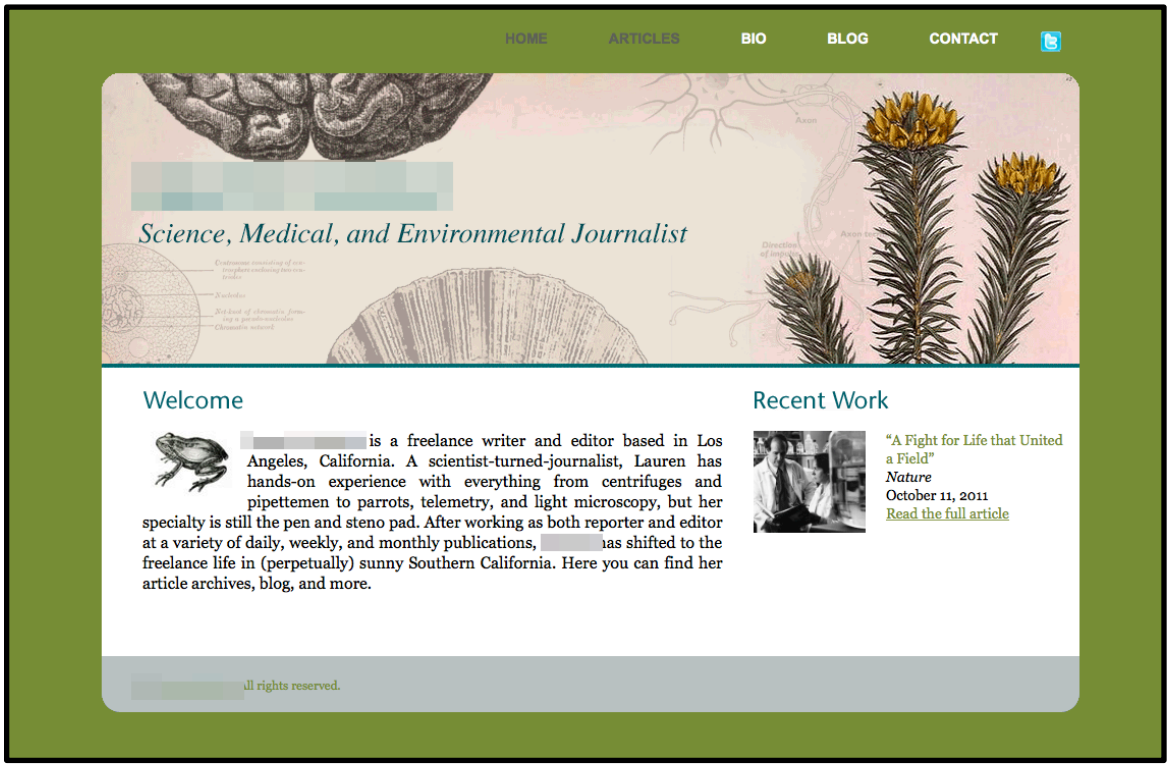


Participant O



Participant P



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