

The Experts' Perspective of "Ask-an-Expert":
An Interview-Based Study of Online Nutrition and Vaccination Outreach

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Abstract

Social media allow experts to form communities and engage in direct dialogue with publics, which can promote mutual understanding between sciences and publics. However, little is known about experts' participation in online communities, or effective ways to prepare them for public engagement. Here, we explored these issues with experts who voluntarily engage with publics on social media, to understand their public engagement practices. Stimulated recall interviews were conducted with 20 experts who participate in question-and-answer (Q&A) Facebook groups dedicated to vaccines and nutrition. The findings suggest that experts employ diverse considerations in their outreach, partly to establish epistemic trustworthiness. These can be grouped into three goals and two constraints: countering misinformation, establishing benevolence and establishing competence while maintaining integrity and clarity. Empathic failure and burnout both emerged as factors that impair establishing benevolence. We discuss implications for community-level science literacy and for preparing scientists for "bounded engagement with publics".

Keywords: social media, outreach, online communities, science literacy, trustworthiness, vaccines, nutrition

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The rapid rise of social media has changed the landscape of public engagement with science and technology (Baram-Tsabari and Schejter, 2019; Peters et al., 2014). It has created new opportunities for experts in science and health to interact with diverse publics directly, engage in two-way communication, form online communities and participate in existing communities. This increased access to expertise can help non-experts get the information they need despite their "bounded understanding of science" (Bromme and Goldman, 2014). For example, vaccine-hesitant parents who want to learn more about the science that informs vaccine policy and make vaccination decisions can benefit from strong community ties with scientific experts, such as pediatricians or public health specialists.

Recently a U.S. National Academies of Sciences, Engineering and Medicine (2016) (NASEM) report noted that communities can contribute to their members' overall well-being "by virtue of their collective literacy" (p. 73). However, little is known about the ways scientific knowledge is sought and shared within online communities, and the extent of its availability to the general public.

Here, we employed stimulated recall interviews to better understand the practices of experts involved in online communities. We studied experts engaged in a question-and-answer (Q&A) Facebook group dedicated to vaccines, and another group dedicated to nutrition. We draw on the findings to present some implications for community-level science literacy and for teaching scientists to become science communicators.

Literature Review

Here, we review science literacy on the community level, dialogue on social media, scientists' public engagement activities online, and experts' public communication in online communities.

Science Literacy on the Community Level

Any individual necessarily has a limited, or "bounded," understanding of science, and must evaluate and use sources of scientific expertise to make decisions involving science, such as personal health decisions and civic matters (Bromme and Goldman, 2014; Hendriks et al., 2016). Since individuals are nested within communities, communities shape how individuals can engage with science. This idea can be traced back to John Dewey's book *The Public and Its Problems* (1927). In the words of Noah Weeth Feinstein, Dewey believed that "in a diverse and well-functioning community, an individual does not need to know about a particular topic as long as she is meaningfully connected to someone who does" (Weeth Feinstein, 2015, p. 156).

Along similar lines, a recent consensus report by the NASEM on science literacy has highlighted the use of scientific knowledge and skills by social movements, such as the AIDS treatment activist movement of the 1980's (Epstein, 1995) and community groups who conduct measurements to hold environmental polluters accountable (e.g., Brown, 1993). The report attributes the success of these communities to factors including their "organization and composition [...], including the strength and diversity of relationships with scientists and health professionals, scientific institutions, and health systems" (National Academies of Sciences Engineering and Medicine, 2016: 79). As the NASEM report points out, not enough is known about knowledge seeking and sharing within communities, and the accessibility of scientific resources within them. The NASEM report's focus on social movements oriented towards

collective action also raises questions about other types of communities, such as those dedicated to knowledge sharing and personal issues, rather than collective ones.

The Potential for Dialogue on Social Media

It is believed that by conducting meaningful dialogue with publics, scientists can foster positive views toward science and build trust in science and scientists. Experts communicating with publics can accomplish this in different ways, including by "demonstrating that one is listening to others, choosing language that resonates with what individuals are already thinking about, or highlighting common-ground between scientists and non-scientists" (Dudo and Besley, 2016: 3). When diverse stakeholders engage in such dialogue, mutual understanding can emerge (Davies et al., 2009).

Dialogue between scientists and publics can include consultations and deliberations aimed at co-producing policy recommendations or reports or public discussions in which audiences can ask experts questions. In this type of dialogue, "[w]hile the flow of information is primarily one way, audience members are involved in choosing what some of that information is" (Needham et al., 2009: 76). While many studies on publics' interactions with experts have examined shared policymaking, non-policy-related dialogue has remained "under-theorized and under-researched" (Davies et al., 2009: 338).

The potential for dialogue between scientific experts and publics has been affected by the growth of the internet and social media as sources of scientific information (Peters et al., 2014). In a 2016 survey, 55% of all Americans cited the internet as their primary source of science and technology information and 69% said they would go online to find information about a specific science and technology issue (National Science Board, 2018). A Eurobarometer survey showed that 35% of all Europeans get science and technology information from the internet in general,

but only 10% use blogs and social media specifically (European Commission, 2013). Young adults in the U.S. often use social media to engage with science and research (37% reported doing so weekly or more). This is roughly as frequent as this population reports engaging with other topics on social media, such as health (42.3%), political campaigns (34%) and entertainment (33.6%) (Hargittai et al., 2018).

Scientists' Public Engagement Activities Online

Large percentages of scientists in developed countries (47-60%) believe that blogs and social media can strongly influence public perceptions of science, as a survey of U.S. and German neuroscientists suggests (Allgaier et al., 2013). Nevertheless, few scientists seem to be motivated to engage with publics online, leaving much of social media's potential for dialogue untapped. More than half of a sample of U.S. university scientists (54%) report that they have not devoted any time to online engagement through websites, blogs or social media in the two years preceding the survey, conducted in 2012. These same scientists stated that they were much less willing to manage a social media account aimed at the public (5% "very willing") than to write an article aimed at the public (25% "very willing") or a blog post (13% "very willing") (Besley, 2015). Scientists are more likely to engage with the public online if they believe that they will enjoy it (odds ratio 1.86) and that the engagement could make a difference (odds ratio 1.24) (Besley et al., 2018).

Another reason why social media's potential for dialogue is not fully realized derives from scientists' communication styles, which often revert to "well-established communication practices and hierarchies" (Davies and Hara, 2017: 565). The scientists and organizations that do establish a social media presence often privilege one-way transmission of knowledge meant to educate publics for various purposes, e.g., to assuage fears of new technologies. One U.S. survey

found that scientists typically prioritized "deficit-like" goals, such as "defending science," over "dialogue-like" goals, such as "building trust," in their public communication online (Dudo and Besley, 2016). A survey among English-speaking science bloggers revealed similar findings (Jarreau, 2015), and so did a study of scientists involved in an online citizen science project (Golombic et al., 2017).

At least some of the reasons for scientists' online communication strategies are social. One set of considerations was described in an interview-based study with Chinese scientists who deliver online science lectures. On the one hand, these scientists wanted to circumvent legacy media, reach a wider audience, develop interdisciplinary collaborations and gain public recognition and economic returns. On the other hand, they also expressed their preference for delivering lectures over public dialogue, wanted to avoid public controversies, uphold the reputations of their institutions and maintain positive relationships with other scientists (Jia et al., 2017). The weight of each these considerations is likely to differ across cultures as well as stages in scientists' careers, as one U.S. university survey suggests. Its findings showed that graduate students found it much more appropriate to publicly discuss controversial science issues on social media than faculty members at the same institution (Howell et al., 2019).

Public Communication by Experts within Online Communities

Only a few studies have examined the ways scientific experts publicly interact with others in online communities. Much of the available research has concentrated on the context of personal health. In the USA, a content analysis of the WebMD online health communities revealed that experts typically provide askers with clinical expertise, refer them to their doctors, and attempt to build rapport with them in various ways, including expressing empathy and encouragement (Huh et al., 2013). Findings from a Dutch study on patients who participate in

shared communities with physicians showed that patients are indeed looking for both clinical expertise and an outlet for expressing feelings and gaining emotional recognition (Vennik et al., 2014).

Experts' experiences of public communication in online communities are particularly under-researched, with the notable exception of a study on health professionals in a Slovenian online health community (Atanasova et al., 2017). These health professionals noted that they enjoyed sharing medical knowledge and dispelling misconceptions and stigma about diseases, but they also reported difficulties managing ethical issues, and often felt overloaded by the number and complexity of questions on the platform.

Summary

Multiple sources suggest that dialogue between experts and other participants within communities has the potential to promote mutual understanding and shape engagement with science. However, little is known about the characteristics of this dialogue in general and online specifically, especially from the experts' perspective. Hence, online communities in which experts take part in online dialogue seem to be a field ripe for research.

Research Goal

In this study, we seek to understand what considerations and practices characterize experts' participation patterns in online Q&A communities. We sought to understand these issues as they are experienced by the experts, in the contexts of vaccines and nutrition.

Research Context

We investigated the scientific experts' communication with the public in the contexts of vaccines and nutrition, because of the pervasiveness of these contexts.

Vaccine hesitancy is one of the top ten global health threats (World Health Organization, 2019). Although overall vaccination levels are high in high-income countries, and although overall sentiment towards vaccines is positive, approximately 13% of adults worldwide disagree that vaccines are safe (Larson et al., 2016). Vaccines are also the topic of extensive misinformation, especially online, which leaves the scientific establishment in a "credibility contest" with anti-vaccination activists. Some recommended guidelines for health professionals interacting with vaccine-hesitant parents include building rapport and avoiding adversarial debates (Leask et al., 2012), although the problem seems to be more systemic and derive from a lack of trust in mainstream medicine.

Both vaccines and nutrition provide a context for everyday engagement with science. Large percentages of the adult population search for nutrition-related information on the internet, as evidenced by surveys conducted in the U.S. (McCully et al., 2013), France (Fassier et al., 2016) and Australia (Pollard et al., 2015). The American Dietetic Association has expressed concern about nutritional misinformation from various sources, including online media and marketers (American Dietetic Association, 2006). The association acknowledges that dietitians can promote public health and build businesses using social media, but urges them to take note of the "intentional blurring of boundaries" and "leveling of hierarchies" on social media and follow guidelines of ethics and professionalism (Helm et al., 2016: 1827).

Research Field

This study examined two Hebrew-language *Facebook* groups in which experts voluntarily engage with non-experts about science-related issues: *Medabbrim Al Hissunim* ("Talking about Vaccines"; hereafter "the vaccine group") and *Tish'alu Dietanit* ("Ask a

Dietitian"; hereafter "the nutrition group"). Here, the experts participating in the vaccine group are called "vaccine experts" and the experts participating in the nutrition group are called "nutrition experts." In both groups, askers can pose vaccine-related questions and get answers from community members at no cost (for an example, see Figure 1).

[Insert Figure 1.]

The Vaccine Group

The vaccine group was founded in October 2013 and had over 36,000 members by August 2018; approximately 150 of these are listed as experts including physicians, nurses and scientists, as well as medical students and scientists-in-training. This group took over from previous group called "Parents Talk about the Polio Vaccination," described elsewhere (Orr et al., 2016; Orr and Baram-Tsabari, 2018; Rubin and Landsman, 2016). Most askers are mothers of infants, according to the responders, who are often, but not always, experts. On this group, non-experts may provide answers, but are expected to provide information consistent with the scientific consensus on vaccines. The group receives over 20 new posts every day on average (2017 data), and discussions are often spirited.

The vaccine group is operated by a non-profit organization called *MiDa'at* (derived from the Hebrew term *Haskama MiDa'at*, "informed consent"). The organization dedicates itself to the promotion of public health in Israel, and advocates compliance with the recommended vaccination schedule. In this respect, the vaccine group differs from other Hebrew-language online discussion groups dedicated to vaccination, which are typically managed by anti-vaccination activists, and serve as a platform for discussion and activism that challenges the health authorities.

The Nutrition Group

The nutrition group was founded in May 2016 by a team of dietitians and had over 9,800 members in August 2018. According to the founders, their goal is to promote the status of their profession, in response to the prevalence of nutritional misinformation online in general. The group was also set up to counter the rise in unlicensed nutritional coaches and practitioners of alternative medicine, such as naturopaths.

On the nutrition group, askers may pose questions relating to food and nutrition, and get answers from registered dietitians. The questions posted on the nutrition group span many subjects, including weight loss, child nutrition, nutritional values of food products, and health conditions such as pregnancy, food allergies and intolerances.

Unlike the vaccine group, non-experts are not allowed to answer questions. This leads to a less vibrant atmosphere. Additionally, unlike the vaccine group, many, but not all, of the dietitians have their own private practices, and they use the group to position themselves as experts both within their professional community and towards potential clients.

The Israeli Context

The vaccine and nutrition groups are based in Israel, an OECD member country which has a population of approximately 8.8 million, and is characterized by a high-income economy and a very high Human Development Index. Vaccine coverage rates, dietary habits and internet usage rates in Israel are much like those of other high-income countries (for a detailed description see Supplementary Notes S1).

Methodology

Due to the exploratory nature of this study, a naturalistic, qualitative approach was employed (Lincoln and Guba, 1985). This approach seeks to understand people's experiences,

the meanings they make of them, their tacit knowledge and their subjective understandings and interpretations of the topic under investigation. It is characterized, *inter alia*, by a focus on natural research settings (rather than experimental ones); attempts to capture participants' "thoughts, feelings, beliefs, values and assumptions" through face-to-face interaction and observation (Marshall and Rossman, 2016: 101); the purposeful sampling of information-rich cases (rather than randomly sampling study participants); inductive data analysis; and emergent research designs that may change with the progression of the study (Lincoln and Guba, 1985; Patton, 2015).

The "epistemic trustworthiness" framework informed the design of the study because promoting public trust in science is considered one of the important outcomes of science outreach (Bromme and Goldman, 2014). This framework argues that scientific experts are generally considered as trustworthy if they are perceived to have three features: (1) competence; (2) integrity, *i.e.*, they adhere to a "reliable belief-forming process" and "the rules of [their] profession" when answering questions (Hendriks et al., 2016, p. 153); and (3) benevolence, *i.e.*, they offer "advice or positive applications for the trustor or (more generally) for the good of society" (Hendriks et al., 2016, p. 153).

Here, interviews were conducted with a sample of expert answerers from both the vaccine group ($n = 10$) and from the nutrition group ($n = 10$) (Table 1). In the vaccine group, five participants were "clinicians" (physicians, medical students or nurses) and five were "researchers" (bio-scientists or bio-scientists-in-training, *e.g.*, graduate students). Of the nutrition group participants, all were clinical dietitians or nutritionists (hereafter "nutrition group experts"). Snowball sampling was used, with the "snowball criteria" of being an expert with at least six months' experience answering questions in the group. Group administrators served as

the initial informants for referrals to experts. Within the vaccine group, purposive sampling was employed as well, to ensure representation of both clinicians and researchers. We refer to each of the interviewees by a pseudonym, without professional titles such as "Doctor," to reflect the way they appear on Facebook.

Interviews lasting approximately 45 minutes were conducted with each expert, yielding a total of 15.5 hours of recorded interviews. The first part of each interview was semi-structured and dealt with the interviewee's reasons for participating in the group and on perceptions of the askers. The second part was a stimulated recall interview (Dempsey, 2010), which can also be considered a reconstruction interview (Reich and Barnoy, 2016). In this part, each participant was provided with screenshots of four to six Facebook threads they had recently participated in from their respective group. The interviewees were then asked to read each thread, provide their interpretation of each question and explain their considerations when composing their answers. This method complements the semi-structured interview by "bringing informants a step closer to the moments in which they actually produce action" (Dempsey, 2010: 349) and prompts them to reflect upon their own decision-making in specific, real-life situations, rather than in general terms (Dempsey, 2010; Lyle, 2003)(For the interview protocol, see Supplementary Notes S1.)

In total, the twenty interviewees reflected upon 114 threads, or 5.7 threads per participant (Table 1). Face-to-face interviews were conducted at the participants' homes, workplaces or universities, or in public places such as cafés, as chosen by the participants. The interviews with Hila and Rafael were transcribed by the first author and all others were transcribed by a professional service.

All transcripts were coded by the first author in MAXQDA (VERBI Software, 2017). Two coding methods were used to analyze both parts of the interview transcripts: "process"

coding, in most cases, and "in vivo" coding, sparingly. These methods were chosen as both were recommended by Saldaña (2016) as methods of attuning oneself to participant actions and perspectives. "Process coding" means assigning gerunds (words ending with "-ing") "to connote action in the data" (p. 105), such as "establishing competence" and "empathizing with askers." "In vivo codes" refer to words or short phrases from the terms used by participants themselves, such as "Get off Facebook," borrowed from one interview transcript to represent all utterances in all transcripts in which experts exhort askers to avoid vaccination debates on social media altogether.

Ethics Statement

Before beginning data collection, approval for this study was obtained from the authors' institutional review board (approval numbers 2016-19, 2017-71 and 2017-75). Additional permission was obtained from the *MiDa'at* board of directors and from the administrators of the nutrition group. For additional information on the ethical features of this work and the researchers' positionality, see Supplementary Notes S1.

Findings

The experts cited a diverse set of considerations in their online outreach about vaccines and nutrition. These considerations can be grouped into three "goals" and two "constraints." The three goals were countering misinformation, establishing benevolence and establishing competence. The two constraints had to do with maintaining integrity and maintaining clarity (Figure 2). Some of these, but not all, stemmed from the perceived need to establish epistemic authority, and were consistent with notions developed in the theory of epistemic trustworthiness proposed by Hendriks et al. (2016). In the following section, we describe these five considerations and discuss them briefly.

[insert Figure 2.]

Goals

Countering misinformation. Experts from both groups, but especially from the vaccine group, indicated that they volunteered in reaction to pervasive, and sometimes dangerous, false information, often circulating online. Several vaccine group answerers expressed anger and frustration in response to anti-vaccination activism. They wanted to “set the record straight” for hesitant parents, to promote informed decision-making. One expert described the vaccine group as a means of protecting herd immunity, and preventing people from “falling into an ocean of charlatans” (Abraham, vaccination). Another quote exemplifies experts' interest in refuting falsehoods, as well as their feelings of frustration:

"I wrote that one of the rumors that *annoyed* me the most [...] was about immunological memory. [...] People keep saying as if it were a fact: 'Infants have no immunological memory. Obviously.' And that's so *wrong*. It's so easy to *disprove*." (Hila, vaccination)

Multiple vaccine experts referred to the spread and recalcitrance of vaccine- and nutritional-related misinformation and attributed it to a wide variety of factors. Some commonly cited factors included the impact of naturopaths and other alternative medicine practitioners, who challenge mainstream medicine. Other factors cited included the public being uninformed or misguided:

"I think it's terribly easy to scare people, especially when it has to do with their children.

Scary information tends to be more viral..." (Dan, vaccination);

"Anything that's 'yellow' [sensationalistic] catches on more easily" (Matan, vaccination);

"A new generation of mothers came along, who don't know what Hepatitis A or measles are [...] who believe all this nonsense" (Yokhi, vaccination)

Several vaccine experts commented on the importance of teaching the public how to identify misinformation, especially by reliably sourcing online information:

"Most people in the public read headlines on Ynet [a popular news website] and believe them. [...] My goal is that people won't rely, will show some skepticism, when they read a text, that they won't always take it for granted. Even if it's a text I am writing."

(Abraham, vaccination)

"I knew in this case that [the asker] had asked the same question in an anti-vaccination group as well, and I don't remember whether she got very scary answers [...] but here it was important for me to drive this message home: How to filter out answers that you get and whom you should rely on and whom you shouldn't. [...] 'I suggest you always ask whomever is answering what their education and training in this area are and what information they are relying on in their answer.'" (Dan, vaccination)

By contrast, in the context of nutrition, the importance of countering misinformation was emphasized in only one interview, by Meital (a nutrition group expert), who presented two anecdotes to illustrate this issue: one was about an asker who was misled to believe that fruits fermented in the stomach, and one about a person who was defrauded into buying harmful and expensive diet pills, which almost got him hospitalized. The latter anecdote implies a concern about misinformation driven by vested interests.

Overall, this goal represents a desire to establish mainstream science and medicine as a reliable source of knowledge. However, part of this goal also rests on the assumption that the asker knows, or at least can easily be taught, how to assess the reliability of online information.

Establishing competence. Answerers in both groups, but especially in the vaccine group, sought to establish that they, as individual experts, were reliable sources of information. One way they did this was by emphasizing their professional backgrounds in the group descriptions, and in many cases, by providing credentials such as "doctor," "clinical dietitian" and "group administrator" with their own answers as well.

Another way experts established competence was by providing direct evidence for their claims by relying on scientific literature and citing relevant policy documents. For example, Yokhi (vaccination) explained how she drew on a literature review she had conducted in an answer about aluminum in vaccines, and Rafael (nutrition) wrote in his answer that he ran a quick search in medical databases to answer a question about a certain food-related psychological disorder. In another case, Ma'ayan (vaccination) expressed her satisfaction that she was able to pinpoint misguided vaccination advice from a physician, and was able to support her claim using the national vaccination guidelines.

Several experts mentioned that their knowledge was necessarily limited and that they deliberately avoided answering questions outside their relative expertise. For example, the "researchers" in the vaccine group, such as Shlomo and Shira, were careful not to encroach into the territory of "clinicians." Instead, they focused on "biological questions and things that can be quoted from the vaccination guidelines." (Shira)

In parallel, clinicians recognized the value of having researchers in the vaccine group:

It's possible that an immunologist or a microbiologist might give answers that I cannot. This has to do with knowing exactly how many weeks immunoglobins last, and how exactly a live attenuated vaccine is produced. But since the questions also stem from anxiety, I think there's value in having a practitioner, who sees the children, write answers. (Matan, vaccination)

I don't do this but some of the scientists here [...] they say [to askers]: 'Why don't you list some papers and we'll analyze them. And we'll see what's correct, what's incorrect, how a paper like this should be approached (Yokhi, vaccination)

The experts also mentioned that the personal circumstances of each asker affected their ability to respond. This was brought up several times in the nutrition group, where askers were given information to support independent decision-making, and were often encouraged to make their own decisions, and to try foods for themselves to determine whether they would find them tasty and easy to digest:

Let's say someone asks if it's bad to eat food with a lot of salt, or [to eat] offal. Some people might answer, 'don't eat offal, it's not recommended.' Just like that. That's a bad answer, in my opinion. [...] It's very old-fashioned in nutrition to say, 'don't eat this, it's not healthy.' Because, okay, offal has cholesterol, but it also has B vitamins, and iron. It can be eaten in moderation. You see? That's a good answer. It explains the rationale behind the recommendation. (Meital, nutrition)

Now [the asker] has lactose intolerance, so on the one hand I remind her of that. [...] On the other hand, I try to get her to take responsibility. 'You can try certain things and keep track of your symptoms.' I mean, *there's no way that the person can just get an answer, and remain passive and simply comply.* That type of approach will never last. In

my opinion, that approach is out of date. [...] I'll tell her that goat milk is generally tolerated better, it's worth trying, and so are hard cheeses that are low in lactose. (Avital, nutrition)

This goal places epistemic authority on the individual answerer, with some significant caveats. The answerer's knowledge on the topic in question is dictated by his or her disciplinary training and must be adapted to the unique circumstances of each asker. A similar acknowledgment of this limitation was found when answerers referred askers to health professionals (see "Maintaining Integrity").

Establishing benevolence. The vaccine group experts reported that they aimed to establish benevolence by empathizing with askers, avoiding aggression and moralizing, and by distancing themselves from the medical establishment. These included:

Quelling fears and empathizing with askers: "I think this asker is a mother who is stressed out about feeding her twins [solid foods] [...] I wanted to put her at ease, it doesn't work like clockwork, they don't have to start eating [solid foods] on a particular day" (Rebecca, nutrition); "I make sure to mention that I'm a parent [...] to be more relatable, to make it more personal" (Dan, vaccination);

Avoiding aggression and moralizing: "A bad answer would be: 'Don't space out the vaccines, you'd be hurting the child.' That would create apprehension." (Abraham, vaccination);

Distancing oneself from the medical establishment: "This commenter writes something about how in government ministries not everything is free from ulterior motives. [...] So I'm thinking, people think we are spokespeople for the Ministry of Health. [...] I know this makes people think we're from the establishment and makes them want to hear anti-establishment

opinions that must be right [said sarcastically]." (Dan, vaccination); "I think that as Israelis, in general we don't have a lot of confidence in the establishment. [...] I think that's why a non-establishment response is needed as well" (Yokhi, vaccination).

Several interviewees in the vaccine group remarked that establishing benevolence can conflict with the goal of countering misinformation, since the anger and frustration associated with countering misinformation can cause "empathic failure" (Zaki and Cikara, 2015), as the following quote demonstrates:

And the worst is when someone asks an innocuous question and people project [malicious] intentions [...] and start saying 'Oh yeah? What makes you say that?! That's wrong!' (Shira, vaccination)

There used to be a lot of arguments and wrangles [about vaccines], and over time you realize that's not the right way to go about it; it just makes people double down. (Tomer, vaccination)

Several vaccine experts also reported burnout from participating in the vaccine group, which can interfere with voluntary activity in general and with empathizing with askers in particular.

I think it's passé to write, 'vaccinate, it's good for your children.' Because we've been there, done that. Maybe the group hasn't but I have. [...] I trust the rest of the team to answer [...] I don't try to persuade parents to vaccinate anymore. [Interviewer: Why not?] It's something I do here as part of my job, it's possible that *I'm tired and burnt out* of this issue. (Vered, vaccination, emphasis added);

I pretty much burnt myself out, I used to answer with a lot of patience and empathy, now it's hard for me to find that patience and empathy, and I don't have the time, so I prefer to [do other tasks for the organization – redacted]. (Shira, vaccination, emphasis added)

Constraints

Maintaining integrity. In both groups, the experts reported that they maintained integrity. They did so in several ways, one of which was directed at their peers and two which were directed at askers: (1) maintaining collegiality with peers, (2) referring askers to health professionals when warranted, and, in the case of vaccine questions, (3) "stealing thunder," or preemptively acknowledging the risks of vaccination to diminish the force of anti-vaccination claims.

Maintaining collegiality. In both groups, experts mentioned the importance of maintaining collegiality by avoiding second-guessing or contradicting their peers, both in the group and more generally, and even asking permission to expand upon peers' answers. For example, Rafael, a nutrition expert said that he privately asked permission from another nutrition expert to add further information to a thread. Similarly, another participant reported a case in which she was tempted to second-guess a doctor who was mentioned in a thread, but refrained from doing so to maintain collegiality:

I was tempted to ask who the doctor was who told her this nonsense [...] it clearly wasn't an adverse reaction to the vaccine. [Interviewer: So what did you do?] Nothing. [...] It's none of my business. I need to let her professionals do their work even if I think they're wrong. (Yokhi, vaccination)

"See a health professional." Experts in both groups were careful to avoid providing medical advice, catch-up vaccination schedules (in the vaccine group) or diet plans (in the nutrition group). One of the reasons for this constraint was legal, as Israeli law stipulates that all legal and professional liability legislation applies to the online environment as well. This precludes the provision of medical advice without obtaining the consultee's medical history and conducting warranted physical examinations (Israel Ministry of Health, 2012). Interviewees also encouraged askers to maintain their continuity of care with their existing health professionals. One clinician said she had been alerted to these issues by a superior, and added: "Now I don't give individual answers anymore. [...] I write my answer in more general terms." (Vered, vaccination)

A similar phenomenon was observed in a content analysis of health communities on WebMD as well, where 20% of the moderator posts referred the askers to their health care providers; liability issues were cited as the reason (Huh et al., 2013).

Stealing thunder. Several vaccine experts mentioned that they aimed to preempt arguments against vaccination by acknowledging its known risks, and by describing the limitations of their argument. For example, Dan spoke in favor of openness about adverse effects of vaccines:

I try to give broad, balanced answers, not 'yes, get vaccinated, absolutely.' I mean, to explain the data, the considerations, to be open to the idea that bad things happen too, there are side effects. Not to hide it and sweep it under the rug, I don't know, I think that among certain people this creates trust. (Dan, vaccination)

Similarly, another participant advocated against splitting vaccines between several visits to the clinic, but also provided a scenario in which that advice does not hold. He added:

[When you add] the argument showing when you *do* have a good reason to divide them up, you show the asker: 'I'm not against spacing out vaccines, I'm not extreme' [...] and then you show him you're not a fanatic [...] you have real insights based on knowledge. And most askers who come [to the vaccine group] to learn, accept this answer [and might say] 'wow, thanks, that's news to me.'" (Abraham, vaccination)

Maintaining clarity. Several answerers briefly referred to attempts to adapt their answers to askers' prior knowledge and keep their answers brief, to avoid information overload. For example, Dan (vaccines) made a point of avoiding detailed descriptions of the effects of vaccine-preventable diseases when writing an answer advocating vaccination. Some clear communication techniques included using infographics, avoiding scientific or medical jargon, and using similes and metaphors. For example, in one answer, Tamar (nutrition) included a link to an infographic describing several ways to discern whether an infant is getting enough breast milk. Similarly, Hila (vaccines) pointed out an asker's follow-up question in the transcript, which referred to a scientific term. She speculated that not all askers would have the courage to ask such questions. A more nuanced opinion was voiced by Shira (vaccines), who found that overly simplified explanations may come across as condescending.

Discussion

This study provides a rare account of experts' communication in practice. It does so in the context of online communities, and from the expert perspective.

Thus, the study contributes to two fields within the scholarly literature: community-level science literacy and scientists' public engagement activities in online communities.

Community-Level Science Literacy

The findings show that experts can form online communities and conduct informal dialogue with the public. This motivation, especially in the case of vaccines, may be prompted by the desire to promote "public understanding of science" and fight misinformation. Absent from these findings are other goals appearing in the literature, such as promoting mutual understanding between publics and sciences, and advocating for policy change in light of a collective problem. Firstly, this means that online communities can form around the dissemination model and suggests that dissemination is appropriate when publics express a clear desire for reliable scientific information (Trench, 2008).

Secondly, this finding raises important questions about the definition of community-level science literacy and its operationalization. Can the communities described in this study be considered science literate as well because people are potentially connected with sources of expertise? If so, how can this science literacy be defined and measured? We propose rethinking the concept and relating it to components such as the mutual understanding between stakeholders within these communities on science-related issues, and the opportunities that the communities afford to their individual members. For example, perhaps a community is science literate if the strength and diversity of relationships within it can provide a parent with resources to make sense of personal health issues, or help an engineer design a culturally appropriate medical device.

Scientists' 'Bounded Engagement with Publics' in Online Communities

Our findings suggest that when experts engage with online communities, they work within a complex set of goals and constraints which shape the knowledge that they are able and willing to share with non-experts. These goals and constraints are sometimes in conflict, and may

vary as a function of the context. For example, in communities that discuss controversial topics, such as vaccination, a major goal for experts is establishing their trustworthiness. To do so, they put forward features such as their benevolence and competence. In less-controversial contexts, such as nutrition, this goal is less prominent.

Alongside the goals, our findings underscore the constraints that accompany this outreach. After the term "bounded understanding of science" coined by Bromme & Goldman (2014) we propose the term "bounded engagement with publics" to describe the ways experts negotiate these conflicting goals and constraints.

This bounded engagement can be described using the "map of the moral terrain of science" suggested by Heather Douglas (2014). This framework describes scientists' ethical responsibilities while bridging between research ethics and philosophy of science. It divides these responsibilities into three "bases," or categories: (1) responsibilities toward good empirical reasoning, e.g., by conducting open-minded inquiry; (2) responsibilities toward the scientific community, e.g., by giving colleagues credit as appropriate and conducting fair peer reviews; and (3) responsibilities toward the broader society, e.g., by respecting the autonomy of human research participants.

In the context of this study, the very act of communicating science to the public arguably serves the broader society, since the experts provide knowledge relating to vaccines and nutrition, promoting individuals' agency and autonomy. This is captured by the "countering misinformation" goal. However, the experts' ethical commitments to the scientific community and the broader society are also manifested in the communication practices themselves, in ways captured by the "maintaining integrity" constraint. For example, they would neither second-guess diagnoses or treatment protocols in their online outreach, nor provide any of their own.

Ethical concerns have been voiced by scientists who deliver online lectures (Jia et al., 2017) and by health professionals who moderate online health communities (Atanasova et al., 2017). Taken together, these findings suggest that ethical issues are a major concern for experts conducting online outreach.

Another constraint relates to the experts' affective state. Expert burnout is a recurring problem, which can produce empathic failure, undermine the quantity and quality of answers and increase the turnover of volunteer answerers. The findings of this study mesh with the claim that Expert Q&A platforms are difficult to sustain (Shah, 2017), and that online experts in health communities can suffer from overload (Atanasova et al., 2017). This finding suggests that psychological wellbeing can be a major concern for experts conducting online outreach.

Limitations

The findings of this study should be examined with several limitations in mind. Firstly, as in most qualitative studies, the sample does not allow statistical inference to broader populations because of both its size and the sampling method. Secondly, the use of recall interviews is an "indirect method of obtaining evidence of cognitive activity" (Lyle, 2003: 872) and could have elicited participants' current analyses and reflections rather than re-tracing their thought process, especially since some interviews were conducted months after the dialogues appearing in the screenshots took place.

A third limitation derives from the differences between the groups, as the interviews with the nutrition group were shorter: $M_{nutrition} = 35$ minutes ($SD = 13$ minutes) vs. $M_{vaccines} = 56$ minutes ($SD = 23$ minutes). Subsequently, nutrition interviews generally yielded fewer insights, which could be explained in several ways. One possibility is that nutrition questions were often simpler to answer than questions about vaccination, being less controversial. A second possibility

is that most interviews with nutrition experts took place over the phone, with interviewees reading from a screen rather than from paper, and this may have affected their motivation to provide lengthy, detailed answers.

Despite these limitations, the study offers a glimpse into online outreach from the experts' perspective and elaborate on the epistemic trustworthiness framework. Our findings also extend Douglas' framework of the moral terrain of science into the realm of science communication.

Directions for Future Research

Further research on science literacy in online communities can take several directions. Firstly, future studies can focus on experts' empathic failures in science communication and on burnout, and on ways to mitigate them. Secondly, researchers could evaluate the outcomes of experts' participation in online communities. Thirdly, future studies could incorporate insights from experts' communication practices into the design of science communication training, a "rapidly developing, but as yet under-conceptualized field" (Baram-Tsabari and Lewenstein, 2017: 286). This direction seems particularly promising, given the worldwide growth of social media and the high regard given to promoting trust in science within this field (Barel-Ben David and Baram-Tsabari, 2020).

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Tables

Table 1

Group, professional background, pseudonym, and gender of the participants and number of threads discussed in the interviews

	Vaccine Group	Nutrition Group
Clinicians	Dan (M, 6 threads)	Adina (F, 6 threads)
	Ma'ayan (F, 6 threads)	Avital (F, 6 threads)
	Matan (M, 6 threads)	Meital (F, 6 threads)
	Vered (F, 5 threads)	Polina (F, 6 threads)
	Yokhi (F, 6 threads)	Rafael (M, 6 threads)
		Rebecca (F, 6 threads)
		Renana (F, 6 threads)
		Stavit (F, 6 threads)
		Tamar (F, 6 threads)
		Yael (F, 6 threads)
Researchers	Abraham (M, 5 threads)	
	Hila (F, 6 threads)	
	Shira (F, 5 threads)	
	Shlomo (M, 5 threads)	
	Tomer (M, 4 threads)	

Note: M = Man, F = Woman.

Table 2

Code frequency: Counts of interview transcripts that contained at least one segment with each code.

Code	Vaccine Group Experts	Nutrition Group Experts
Countering misinformation (Goal)	9	3
Establishing competence (Goal)	9	5
Establishing benevolence (Goal)	10	6
Maintaining integrity (Constraint)	8	10
Maintaining clarity (Constraint)	6	4

Note: Each group was composed of a total of 10 interview transcripts: one transcript for each participant.

Figures

Figure 1. Mock-up of a Facebook thread. A "thread" consists of a post (A) that constitutes a query, and its associated comments (C-F). Comments C and D were written by an expert in response. This post received one "like" (B). This mock-up was modeled on a thread from the vaccine group, and was chosen for its conciseness. Content was translated from Hebrew, URLs were truncated for brevity and names were changed to protect the privacy of the participants.

Figure 2. Experts' considerations when answering questions about vaccines and nutrition on Facebook groups.