COVID-19 health misinformation: Using design-based research to develop a theoretical framework for intervention

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Design/methodology: Using design-based research methods, in this paper we develop a theoretical framework for addressing COVID-19 misinformation. Using a heuristic analysis of research on vaccine misinformation and hesitancy, we propose a framework for education interventions that use the narrative effect of transportation as a means to increase knowledge of the drivers of misinformation online.

Purpose: Because health misinformation pertaining to COVID-19 is a serious threat to public health, the purpose of this research was to develop a framework to guide an online intervention into some of the drivers of health misinformation online. This framework can be iterated upon through the use of design-based research in order to continue to develop further interventions as needed.

Findings: Our heuristic analysis determined that a key element of narrative transportation includes orientation towards particular audiences. Research indicates that mothers are the most significant household decision-makers with respect to vaccines and family health in general, we suggest narrative interventions should be tailored specifically to meet their interests and tastes, and that this may be different for mothers of different backgrounds and cultural communities.

Originality: While there is a significant body of literature on vaccine hesitancy and vaccine misinformation, more research is needed that helps people understand the ways in which misinformation works upon social media users. The framework developed in this research guided the development of an education intervention meant to facilitate this understanding.

Keywords: COVID-19 vaccine misinformation; narrative intervention; health misinformation; design-based research

Introduction

The spread of COVID-19 across the world has resulted in significant illness, death, and social and economic devastation. Alongside the circulation of the disease itself, researchers have observed a related

increase in unintentional and intentional online health misinformation (Lewandowski et al., 2020; Walter et al., 2020). This is what the World Health Organization (WHO) has called an "infodemic" (Zarocostas, 2020). With respect to COVID-19, misinformation can cause death and increase illness (Tasnim et al., 2020), and as the various COVID-19 vaccines are distributed around the world, potentially reduce vaccine uptake at a time when such vaccines are essential for protecting public health. The work of addressing the COVID-19 infodemic is complicated by it occurring alongside an already established health misinformation crisis. Indeed, the decades-long vaccine misinformation problem has now become an increasing threat given the life-saving impact of COVID-19 vaccines. There is scientific consensus that vaccines, while not a silver bullet, or even the only course of action (Chagla et al., 2020; Slaoui et al., 2020), are one global-scale solution to preventing great loss of life and a potential unknown future of chronic illness associated with COVID-19 infection and recovery (Kaur & Gupta, 2020). In this context, misinformation about vaccines prolongs the pandemic for many people.

Given the impacts of health misinformation on the spread of COVID-19, and therefore on people's lives and livelihoods, intervention into and mitigation of COVID-19 vaccine hesitancy is of utmost importance. As part of a broader research effort related to information flows and COVID-19 (Authors, 2021a), in this paper we describe one aspect of a design-based research (DBR) approach to mitigating the spread of COVID-19 vaccine misinformation online (Authors, 2021b; Authors, 2021c). For the purposes of this paper, COVID-19 vaccine misinformation refers to false information regarding vaccines and the attitudes impacted by such misinformation (Featherstone & Zhang, 2020). DBR is, as Wang and Hannifin (2005, p.6) describe, "a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings." This iterative, interdisciplinary process, consists of examining real world problems, such as COVID-19 vaccine misinformation, to create, use, evaluate, and iterate theoretically-grounded interventions or solutions to those problems. These interventions take an heuristic approach, meaning the design uses principles drawn from the relevant literature to create a theoretical framework to determine design guidelines for the interventions. This type of analysis is common in DBR (Wang & Hannafin, 2005), and can also be thought of as a process to develop first principles for shaping the design, or as a kind of map of what we know to be true for what to include and avoid in the work (Merrill, 2002; Siarto, 2019), and therefore what will be most effective for the design intervention. In the context of education, these interventions often identify specific learning objectives or goals, which are then evaluated and assessed in real-world settings. From there, interventions are iterated upon to improve effectiveness. In this paper, we describe the theoretical framework for the design principles (Authors, 2021b), which informed the production and evaluation of our first design, which was a short comic tailored to an audience of mothers and intended to first educate

about emotions as drivers of misinformation, and second to provide a strategy for interrupting the spread emotionally-driven misinformation (Authors, 2021c).

The theoretical framework is a key component of DBR and design research endeavors more broadly, "not only because it uses theory to ground design, but also because the design and development work is undertaken to contribute to broader scientific understanding" (McKenney & Reeves, 2020, p.84). The theoretical framework is meant to help define the problem in an actionable way while providing an evidence-based approach to the creation of interventions. Therefore, what follows is an heuristic analysis of relevant literature necessary to define the problem and guide the creation of a strategic design to address that problem.

Context

For most internet users, the COVID-19 misinformation crisis has been made increasingly hazardous by specific pandemic-related factors such as increased reliance upon social media and online tools (Dib, Mayoud, Chauvin & Launay, 2021; Drouin et al., 2020). This intensified online engagement has coincided with a proliferation in health-related disinformation campaigns around the world (Patel et al., 2020; Weitz, 2020). What's more, because our scientific understanding of COVID-19 has been taking place in real-time in a public manner, higher rates of anxiety (Jungmann & Witthöft, 2020) and anger (Lwin et al., 2020) about what and who to trust can prevail, impacting how people negotiate misinformation (Han et al., 2020). Such factors combine to create a perfect storm in which people are vulnerable to health misinformation, and in particular COVID-19 vaccine misinformation at a critical time for vaccine uptake.

In many ways, this storm is further exacerbated for caregivers, especially mothers, because they are disproportionately the primary decision-makers when it comes to family health (Matoff-Stepp et al., 2014). While much research has focused on parental vaccine decision-making, mothers are reported to make up approximately eighty percent of household health decisions (Reich, 2016). This suggests that mothers are an ideal group to engage with when it comes to mitigating COVID-19 vaccine misinformation, as they are most likely to act on information related to their family's health, and this is why we chose to engage mothers for our intervention. To engage mothers effectively means understanding where their vulnerabilities to misinformation are in order to specifically address those vulnerabilities. Given that exposure to health misinformation and particularly exposure to vaccine misinformation, can have lasting negative consequences on health and health behaviours (Kata, 2012), consideration of sites of exposure is important. The internet is a prominent source of health information for people, including mothers (Kallen et al., 2019). Yet Suarez-Lledo and Alvarez-Galvez (2021) found that, depending on the topic, up to 87% of health-related information on social media is incorrect. As

regular users of social media (Van Cleaf, 2020), and often highly active online, mothers are likely to be exposed to vaccine and health misinformation. For instance, Regan and Brown (2019) point to the unregulated content and polarizing discourse of online "mom groups" as popular spaces where mothers and caregivers might encounter such misinformation. For example, one study has shown that only 47-54% of health advice found on two prominent parenting forums conformed to scientific evidence (Farrell, 2018).

Mothers may also be increasingly at risk of COVID-19 misinformation exposure specifically because of the increased demands that lockdowns and quarantines have placed on them. Unemployment and social isolation caused by lockdowns have strained many people around the world (Mahler, 2020; Topalidou et al., 2020), yet the higher burden of caregiving expected of mothers exacerbates the potential economic and mental stressors for mothers during the pandemic (Kingsley et al., 2020). Research also shows that mothers are experiencing significantly higher levels of COVID-19-related parental exhaustion than fathers (Marchetti et al., 2020). Not only has COVID-19 unequally burdened mothers, but it has further entrenched the neoliberal model of motherhood by normalizing the expectation that mothers can and should rise to the challenge of navigating a pandemic single-handedly (Güney-Frahm, 2020). O'Reilly (2020) particularly challenges mainstream narratives that honour and thank frontline and essential workers, and argues that these narratives silence and marginalize the frontline and essentialize labour performed by mothers around the world. In the context of this marginalization by mainstream media, O'Reilly observes mothers turning to online groups for support and advice, thereby potentially increasing exposure to misinformation.

The factors explained above for engaging mothers in an education intervention about COVID-19 health and vaccine misinformation are not experienced in isolation of each other, but are intersecting, and experienced differently across groups. The large structural issues in play that shape what mothers do and are expected to do, mean that addressing COVID-19 misinformation must come with sensitivity to these social pressures. The health decisions mothers make for their families come while negotiating obfuscatory information environments and at times contradictory messaging, often without the support necessary to make, or feel confident in, decisions based on scientific evidence and public health recommendations. Indeed, as Swire-Thompson and Lazer (2020) observe, the "vast amount of information that is possible to be retrieved makes it difficult to separate fact from fiction and interpret the findings, even for highly motivated individuals" (p. 436). This collision of factors impacts both exposure and vulnerability to health and vaccine misinformation. Given that health interventions that engage specific groups are shown to be more effective (Rivera, 2020), designing education interventions specifically for mothers is a theoretically sound, though quite complex, approach. Fortunately, there is much research on vaccine

misinformation and hesitancy that can guide development of this aspect of the theoretical framework for such education interventions.

Educating about vaccine misinformation

Vaccine misinformation and anti-vaccination attitudes have existed as long as vaccines have been understood to be effective (Poland & Jacobson, 2011; Wolfe & Sharp, 2002). The last fifteen years in particular have seen significant growth in this field of study (Habersaat & Jackson, 2020), with interest in vaccine misinformation on social media expanding (Ortiz, Smith, & Coyne-Beasley, 2019), especially in light of the pandemic (Limaye et al., 2021; Puri, Coomes, Haghbayan & Gunaratne, 2020). The study of health misinformation on social media is also extensive (e.g., Suarez-Lledo & Alvarez-Galvez, 2021; Wang, McKee, Torbica & Stuckler, 2019), and while beyond the scope of this research, could inform future iterations of related education design work.

The importance of the impact of health and vaccine misinformation circulating on social media on vaccine attitudes cannot be underestimated (Loomba et al., 2021), as made tragically clear by places with under-vaccinated populations and substantial fourth waves (Chiwaya, 2021). Through our heuristic analysis of what evidence indicates works and fails to work with respect to positively changing vaccine attitudes shaped by social media, it became evident that similar education and communication techniques could be strategically applied to teaching not just about vaccines specifically, but about the systems in which vaccine and health misinformation circulates. In other words, rather than design with persuasion about vaccines in mind, we designed an intervention meant to educate about how misinformation operates on individuals, a tactic Chou and Budenz (2021) also suggest is important in improving vaccine uptake. We did this by drawing on many of the same techniques used by vaccine and health communicators, as we outline next.

A key development in responding to vaccine hesitancy driven by misinformation is understanding the need to move beyond an information deficit model, in which communicators begin with the premise that people make less than ideal choices based on lack of good information, and which is a model shown to be largely ineffective for increasing vaccine acceptance (Nyhan & Reifler, 2015; Seethaler et al., 2019), even as such approaches dominate public health strategies (McKinnon & Orthia, 2017). The deficit model is appealing in its simplicity: to make people pro-vaccination, simply educate them about vaccination science under the assumption that they do not yet know enough about vaccines. However, as demonstrated by the National Academies of Sciences, Engineering, and Medicine et al. (2017), there are four major problems with this premise. First, scientific knowledge is uncertain and changes frequently so teaching scientific literacy is much more complicated than telling people what is correct science and what is not. Second, science communication is often mediated through third-party organizations and science

communicators compete with other voices, so that even if scientists succeed in disseminating "good science," there is no guarantee that it will be represented properly or listened to. Third, and perhaps most importantly, "people do not make decisions based solely on scientific information, but take values and other considerations into account. Thus it cannot be assumed that audiences that fail to act in accordance with the scientific evidence need more information" (National Academies of Sciences, Engineering, and Medicine et al., 2017). Fourth, a scientific message effective for one audience is not automatically effective for all audiences, so that science communication must take into account local context, beliefs, and needs.

Multiple studies identified a wide variety of factors that impact vaccine hesitancy, reinforcing the notion that providing information isn't enough to change behaviour. For example, Dubé et al., (2013) in their review of vaccine hesitancy literature, pointed to sensationalist coverage of vaccine controversies by traditional media and vocal anti-vaccination campaigns on social media, as a key contributor to vaccine hesitancy. Expanding this research, Dubé et al., (2018) examined the underlying factors of vaccine hesitancy in high income countries, and pointed to the importance of maintaining vaccination as a social norm by countering anti-vaccine misinformation. Yaqub and colleagues reviewed empirical research in multiple European nations, noting that reasons for vaccine hesitancy include a lack of trust in vaccine-related institutions and experts (Yaqub et al., 2014). More recently, Guzman-Holst et al., (2020) examined the barriers to vaccination in Latin America, identifying a range of factors, such as group influence and low socio-economic group membership. In a systematic review of existing literature, Ortiz-Sánchez et al., (2020) identified that such anti-vaccine movements on social networks such as Twitter, Facebook, and YouTube use multiple strategies to rapidly spread their message including bots and narratives of harm and profit. Considered together, these studies suggest that providing additional information on vaccine safety alone is unlikely to be enough to solve the vaccine hesitancy problem for a range of diverse audiences.

Instead of adopting an information deficit model, the research we have detailed above suggests the use of a sociological perspective for intervention, in which things such as identity and group affiliation, as well as technical knowledge, more heavily influence behaviour and beliefs (Lander & Ragusa, 2020). This approach enables us to develop an education intervention grounded in specificity, as with the case of engaging mothers, which research into vaccines hesitancy underscores the need for (Olson, Berry & Kumar, 2020). Rather than rely on a frame that suggests that people do not understand vaccine science and thus refuse vaccines, Lander and Ragusa (p. 2) argue that effective anti-vaccination messaging seems to first pass a verisimilitude threshold in which it is judged true by its audience because "it conforms to their individual and social experience" and it seems "lifelike." Notable here is that lack of information is not a primary factor in turning the tide from hesitancy to objection, but instead the focus on

how well the information conforms to lived experience influences vaccination decisions. In a related sociological approach, other researchers have recognized that anti-vaccine messages are often not supported by scientific evidence in the first place and are therefore unlikely to be dispelled through the information deficit model, researchers have turned to addressing the narrative models through which anti-vaccine messages and vaccine misinformation are rendered credible despite lack of scientific evidence. Kata (2012) outlines the tactics and the tropes (e.g., catchphrases, commonly used narratives, motifs etc.) the anti-vaccination movement deploys as starting points for thinking about how to increase vaccine uptake. She suggests the tactics used include skewing the science, shifting hypotheses about why vaccines are dangerous, censorship, and attacking the opposition, both personally and legally. Tropes, for example, include things such as calling vaccines toxic, that they should only be used if 100% safe, that they are unnatural, and importantly, that parents are experts in their own children (a claim Reich (2016) emphasizes as well). This approach has also been adopted by Bricker and Justice (2019), who argue that anti-vaccination messages utilize two main rhetorical tools — anecdotes of children harmed by vaccines, and suggestions of conspiracies within governments and pharmaceutical companies to suppress the truth about vaccines — to assert credibility despite a lack of scientific evidence.

What all of these methods share is an attention to the non-informational aspects of health messaging that best resonate with people, particularly through narrative cohesion or story. In this context, a story is defined as a form of communication consisting of structure with an event occurring, usually to one or more characters, which results in a change in the character(s). On one side of the debate about vaccine communication, researchers argue that scientific and health information presented in a narrative format is more accessible, relatable, and influential than the same information presented as stated facts or statistical data (Bakker et al., 2019; Fagerlin et al., 2005; Ratcliff & Sun, 2020). With respect to persuasion, ample empirical research has demonstrated the power of narrative (Appel & Mara, 2013; Green & Brock, 2000). On the other side of the debate, researchers argue that narrative formats present no benefits over non-narrative formats (Dunlop et al., 2010; Ecker et al., 2020; Reinhart, 2006; Zebregs et al., 2015), or even that non-narrative formats are more effective (Golke et al., 2019; Greene & Brinn, 2003; M. B. W. Wolfe & Woodwyk, 2010). In short, while narrative strategies have been shown to have mixed effects in pro-vaccine communication (Kim & Nan, 2019; Winterbottom, et al., 2008), what the literature makes clear is that the reasons for mixed effects are not yet clearly understood (Kim, 2020).

In spite of the inconsistent results with respect to narrative, recent research into COVID-19 vaccines and misinformation does suggest it remains an effective approach (Gesser-Edelsburg, 2021). A significant benefit of working with narrative is that it can engage people such that it approaches Ladner and Ragusa's verisimilitude threshold, as they observe as well (2020). Indeed, we propose that interventions into misinformation may be well served by narrative or storytelling, which the literature on

vaccine hesitancy also calls for (Shelby & Ernst, 2013). Importantly, narrative interventions need to be well attuned to their chosen audiences' lived experiences and concerns in order to increase their appeal and effectiveness. This means tailoring narrative interventions to particular groups in order to best achieve the desired impact.

Research demonstrates that positive impact can be achieved in messaging or education interventions through skillful application of narrative vis-a-vis the transportation effect and immersion. Immersion, as Moore and Green (2020) explain, "draw[s] more from automatic, experiential modes of thinking" (p.1), and possibly relies on the experiential thinking system, which is "more automatic and emotionally driven" (p.1), as opposed to more rational and analytic forms of thinking. Immersion can be facilitated by the effect of transportation, which as Sestir, Moore, and Green (2020) observe is the experience of "deep cognitive and affective absorption into the depicted story or world" (p. 1). This is the experience in which a story captures our attention fully, bringing us into the events and context of the story such that we are present with the information. In other words, transportation occurs in stories oriented towards Lander and Ragusa's (2020) verisimilitude threshold, and facilitates immersion in a story, or the feeling "of mental absorption individuals feel when reading a story, watching a movie, or playing a video game" (Moore & Green, 2020, p.1), and which may activate more emotional, experiential forms of mental processing.

Quality too is important. In order for a story (i.e., a narrative intervention) to be effective, it must also enable the suspension of disbelief through things like consistent character motivation, plausibility, and writing/media that does not break immersion. When a story fails to achieve these things, the audience is pulled from the transportational effects of the story and into an awareness that someone is trying to tell them a story, such as when one reads frequent spelling or grammar errors in a text, or disbelieves that a character would behave in a particular way (Green & Donahue, 2009; Schreiner et al., 2018). Although not fully understood, one effect of transportation is that it seems, at least in the moment, to reduce resistance to ideas being presented through the proposed process of "co-activation of attention, imagery, and emotion" (Green, 2004; Schreiner et al. 2018), suggesting an opening into what may be perceived as controversial information. Overall, there is extensive evidence which suggests that increased transportation, which itself is a testable experience, yields more persuasion (Green & Brock, 2002).

Another key factor in the effectiveness of transportation is familiarity. Research has shown that being familiar with characters, as well as similar to characters in a story, results in increased transportation effects (Green, 2004). Which is to say that when people see themselves in a story, there is evidence to believe that they will find the story more persuasive or influential. As such, it makes sense to tailor narrative interventions to targeted groups, which, beyond the outlined factors above (e.g., attention

to gender roles, race, and social pressures), is part of the reason in the context of this work for selecting mothers as a primary group to engage, as the comic we designed aims to do (Authors 2021c).

As noted above, however, interventions need to be contextual and attuned to differences across mothers, i.e., the category of "mother" is not homogenous or monolithic. What may elicit transportation and deep immersion for a white mother may not be effective or even culturally safe for a Black or Indigenous mother, and health communication strategies need to take this into account. Indeed, it's distinctly possible that a narrative intervention that relies upon a trusted medical authority as a character, such as a doctor, or even simply a white person, to deliver its message may in fact backfire for racialized mothers, given the racist and abusive medical histories experienced by such groups (Bunch, 2021; Quinn et al., 2016). The difference in attitudes towards the COVID-19 vaccines across racial groups demonstrates this, with studies in the US and the UK finding racial minorities are more than twice as likely to refuse or delay a COVID-19 vaccine (Hanson, 2021; Razai et al., 2021). Furthermore, understanding the differences between motivations to vaccinate or not across groups is also a central concern. Under-vaccination in some groups is not the same as refusing vaccination; each comes with different structural causes, which must be understood in order to effectively enable transportation for different audiences. For example, if a white mother is vaccine hesitant because of exposure to misinformation that has told her that an organic food diet is the preferred alternative to possible vaccine injury to her child, a narrative that speaks to community health may not shift her perspective. In contrast, a narrative that fails to alleviate concerns about transparency may not effectively respond to the hesitancy of racialized mothers.

In summary, as is the case of any educational intervention, it is important to be clear on who the audience is for an intervention, and to understand its needs and desires, as well as the external (e.g., social, technological) pressures that this group of people face (Dick, Carey, and Carey, 2005). Understanding these aspects can provide insight into the vulnerabilities faced by the group to be engaged, thereby connecting with its members in a supportive and non-judgmental way. In the context of this particular research, this means an intention to engage with mothers who are likely to be exposed to health misinformation, in a way that understands their unique and intersectional needs during the pandemic. It's also important to understand the means of persuasion that dominate anti-vaccine propaganda, and to effectively counter these (Bricker & Justice, 2019; Browne et al., 2015; Kata, 2012), which we suggest may be facilitated by using immersive narratives high in transportation effect to teach about the mechanisms typically used in the spread of misinformation.

The next step in this process is translating theory into practice. This means identifying particular learning objectives that the intervention is intended to address, designing the activities that the audience will engage with, identifying the delivery vehicles and environments in which the intervention will take

place, and aligning the learning objectives with assessments intended to evaluate the degree to which the intervention was effective. To date, we have identified learning objectives and designed one intervention tailored for mothers in the form of an illustrated narrative. We have evaluated this intervention (Authors, 2021c) and are currently creating an iteration of it for further implementation and evaluation. Significantly, this isn't a linear process: theory informs practice, and practice will inform theory and iterations of the intervention. Other examples of interventions that align with the design considerations outlined in this paper are anything from scripted Tiktok videos, targeted public health campaigns on Facebook, or Instagram posts or stories shared by popular mom influencers. This content can include stories that resonate with mothers as mothers, that address their concerns about vaccine safety, the ease and benefit of vaccines, and perhaps even the risks associated with failing to vaccinate. No matter what form a narrative intervention takes, it needs to be attuned to cultural differences, and be representative of mothers who face varying socio-economic barriers and who have different experiences of historical racism and privilege within the medical establishment.

Conclusion

In this paper, we outlined a theoretical framework developed through design-based research to create an education intervention into the topic of misinformation exposure online. Based on who makes the majority of health decisions for families, and is therefore likely to be influential on vaccine uptake, we selected mothers as ideal learners to engage with on the topic. Drawing on an heuristic analysis of vaccine misinformation and communication literature, we determined that the use of narrative-driven interventions designed specifically for mothers would be an effective approach. As our design-based research continues to unfold we will continue to evaluate further iterations strategy in a way that will have application across these differences and provide guidance for practitioners and policymakers as they negotiate the fraught terrain of vaccine misinformation throughout and beyond the COVID-19 pandemic.

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