

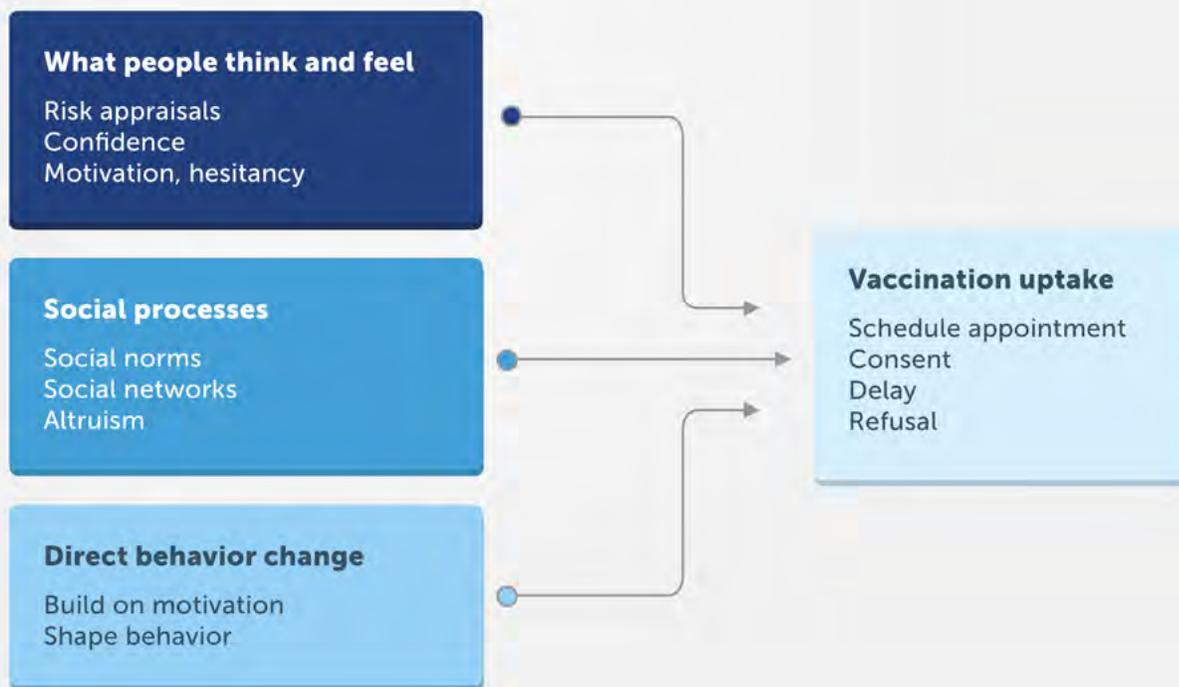
WHAT WORKS TO INCREASE VACCINATION UPTAKE

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INTRODUCTION

Behavioral science offers several ideas about what it takes to get people to vaccinate. The three main propositions are that vaccination results from: (1) what people think and feel, (2) social processes, and (3) direct behavior change (Figure 1). Colleagues and I previously reviewed the evidence for these propositions and put forward what has become known as the Increasing Vaccination Model (Brewer, Chapman, Rothman, Leask, & Kempe, 2017).

Figure 1. The increasing vaccination model



Source: Adapted from Brewer et al. in *Psychological Science in the Public Interest*, 2017.

That paper generated substantial interest from public health organizations, including the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), vaccine manufacturers, researchers, and practitioners (Brewer et al., 2017). However, its length and complexity have been barriers to its use by some practitioners. To facilitate wider

adoption of the model, this paper summarizes the main insights from the earlier work and describes the use of the model by a WHO working group as it considers opportunities to address low vaccination uptake globally, especially through effective interventions.

Vaccination is one of the most widely accepted health behaviors. Globally, 86% of children have received a measles vaccine, and that percentage is higher in North America and Europe as of 2018 (World Health Organization, 2018). Coverage is even higher for the diphtheria, tetanus, and pertussis (DTP) vaccine. These high rates have caused the incidence of many infectious diseases to plummet in the decades since relevant vaccines have been introduced. Such successes have led to calls for complete eradication of polio and regional elimination or control of other diseases through vaccination. Indeed, at the start of this decade, the WHO and other organizations designated 2011–20 as the Decade of Vaccines.

However, by 2019, the WHO had declared vaccination hesitancy to be one of the top 10 threats to global public health. This threat could have several consequences. *Inadequate coverage* is the uptake of vaccination that fails to meet an agreed-on quality marker (e.g., 90% coverage). While global vaccination coverage rates have steadily drifted upwards, they have stalled in some regions and even slipped backwards in a few countries. *Delay* is getting

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vaccines after the recommended age or spreading the doses out over time. Despite clear findings that the current vaccination schedule is safe, parents are increasingly choosing to spread out or delay vaccines in the mistaken belief that having fewer

vaccines at one time will reduce the risk of harm. *Instability* is variability in coverage over time, most often a sharp drop. Some countries with generally high vaccination coverage have experienced periods of dramatic instability. For example, Japan had achieved 70% coverage for HPV vaccination, yet coverage fell to 7% within a year of an unsubstantiated safety scare. Denmark had a similar issue that it was able to turn around, but only after coverage had fallen by half (Hansen, Schmidtlaicher, & Brewer, 2020).

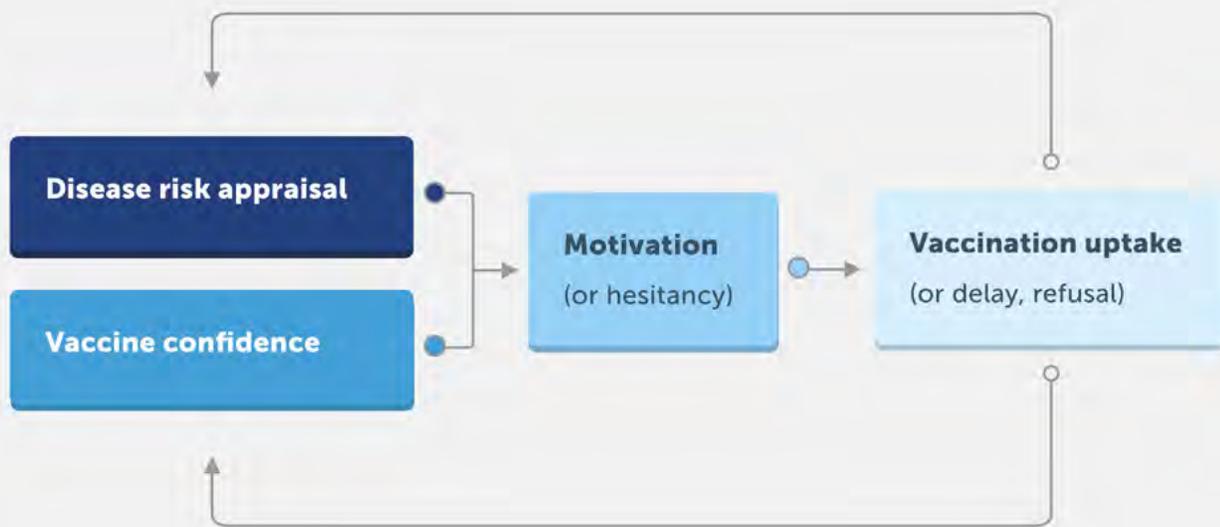
The model presented here is about what works to increase vaccination uptake, which results from a series of behaviors by various actors. A family may talk about vaccines with friends, search for information online, schedule an appointment, travel to a clinic, consent to vaccination, return for any needed follow-up doses, and pay any related costs, such as an administration fee or travel expenses. Providers stock vaccines, recommend them, track their use in medical records, flag who is due and overdue, and manage their vaccine stock.

All of this is in a context of a system in which the state funds some vaccines and, in some countries, private insurance covers other vaccines. In sum, vaccination uptake results from a web of interconnected players, resources, and behaviors, all of which follow predictable patterns.

WHAT PEOPLE THINK AND FEEL

The model's first broad proposition is that what people think and feel motivates vaccination uptake (Figure 2). On the left side of the figure, *disease risk appraisals* are thoughts and feelings about potential health problems caused by infectious agents (perceived risk and fear); *vaccine confidence* is the attitude that vaccines are good (effective) or bad (unsafe). Risk appraisals and confidence *motivate* people to vaccinate or not to do so, as shown in the middle. Another term for low motivation to vaccinate is *hesitancy*. While some people use the terms "confidence" and "hesitancy" interchangeably, it is helpful to separate these ideas: low confidence is a cause of low motivation to vaccinate in the model and, indeed, in research going back 50 years (Sheeran et al., 2016). Finally, motivation to vaccinate leads to *vaccination uptake*, shown on the right. Getting vaccinated can lower some appraisals of disease risk and increase vaccine confidence, as shown by the arrows going from the far right back to the left (Brewer, Weinstein, Cuite, & Herrington, 2004).

Figure 2. What people think and feel



Source: Adapted from Brewer et al. in *Psychological Science in the Public Interest*, 2017

Findings from observational studies support the thoughts and feelings proposition. Vaccine uptake is associated with higher disease risk appraisals, including thinking infectious diseases are likely, serious, and regrettable (Brewer et al., 2007; Brewer, DeFrank, & Gilkey, 2016). Similarly, vaccine uptake is associated with higher vaccine confidence, as shown by believing that vaccines are important, save lives, and have few side effects. Finally, motivation to vaccinate, also called “intention,” is one of the strongest predictors of health behaviors, including vaccine uptake (Sheeran, 2002).

However, experimental evidence from randomized trials generally does *not* support the thoughts and feelings proposition. This stronger body of evidence better answers the question of whether interventions focused on thoughts and feelings can increase vaccine uptake. Risk communication interventions do not appreciably increase vaccine uptake, according to a recent meta-analysis of 16 studies, although the interventions somewhat increased the belief that infectious diseases are likely (Parsons, Newby, & French, 2018). An older meta-analysis, restricted to five risk communication interventions that increased risk appraisals, did find increases in vaccine uptake (Sheeran, Harris, & Epton, 2014).

Similarly, interventions to boost vaccine confidence have generally not increased uptake, and none have shown that increased confidence explains each intervention’s impact. While some intervention studies have increased vaccine confidence, including beliefs that vaccines are safe and effective (Horne, Powell, Hummel, & Holyoak, 2015; Shah et al., 2019), others have not (Nyhan, Reifler, Richey, & Freed, 2014).

Finally, interventions to increase motivation to vaccinate have not shown reliably that they can influence hesitant people, despite success at increasing motivation for other behaviors (Webb & Sheeran, 2006). Decision aids have little support. Motivational interviewing, while promising, has yet to be shown effective in a randomized trial, although it has been included as one component of several effective multicomponent interventions (Dempsey et al., 2018) and has shown promise in quasi-experimental studies (Gagneur et al., 2018).

In sum, while thoughts and feelings motivate people to get vaccinated, interventions targeting thoughts and feelings have shown little promise for reliably increasing vaccine uptake. Furthermore, there is no apparent logic as to when interventions boost vaccine risk appraisals and confidence, have no

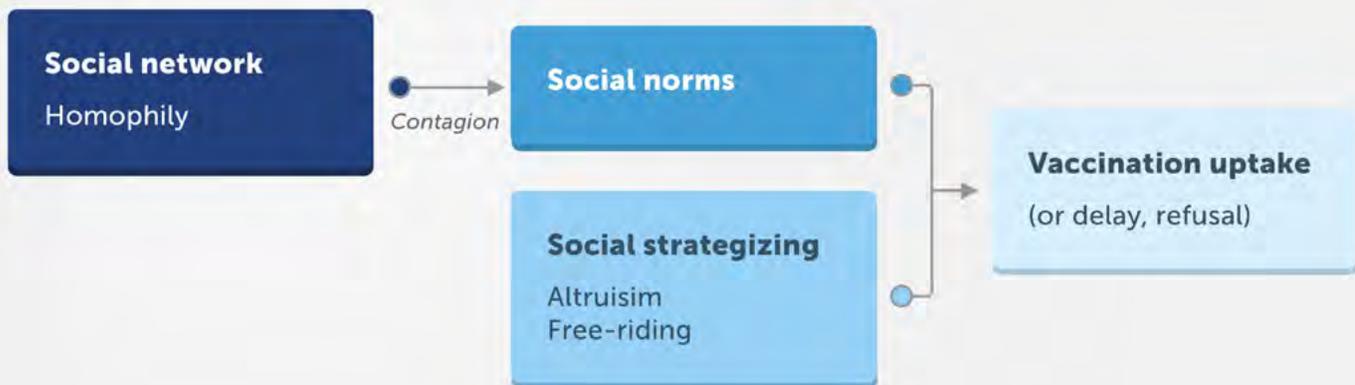
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effect, or even have pernicious effects. I return later to the question of whether thoughts and feelings interventions might generate support for vaccination policies and programs, an important outcome that is distinct from vaccination uptake.

SOCIAL PROCESSES

The model’s second broad proposition is that social processes motivate vaccine uptake (Figure 3). The *social network*, the collection of connections among people, is shown on the left side of the figure. These networks have the characteristic of similarity or homophily—birds of a feather flock together. Social networks exert influence through contagion—that is, through the spread of ideas and behaviors. This spread, shown in the middle, establishes *social norms*—what most people do or expect others to do—along with *social preferences* (altruism, vaccinating to protect others, free-riding, and not vaccinating because others already have). Finally, social norms and preferences about vaccination lead to *vaccination uptake*, as shown on the right.

Figure 3. Social processes



Source: Adapted from Brewer et al. in *Psychological Science in the Public Interest*, 2017.

Findings from observational studies reliably support the social processes proposition. Social networks are well characterized and show robust clustering of people with similar ideas about vaccination in social spaces (Dunn et al., 2017). Social norms are reliably associated with vaccine uptake (Schmid, Rauber, Betsch, Lidolt, & Denker, 2017), with somewhat less evidence showing smaller associations for social preferences. Behavioral scientists have generated substantial and convincing experimental evidence on these questions in the context of vaccination, but almost all of it has non-behavioral outcomes.

No published randomized trials to date have established that social process interventions increase vaccine uptake, but this is a very promising area for future research. Some quasi-experimental studies suggest that social processes show potential, and several currently unpublished studies may soon fill this gap.

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Research on other health behaviors suggests why social process interventions may succeed where thoughts and feelings interventions fail. The “one communicator and one receiver” model of education is the way to change what people know. However, to change what people do, information must come from multiple people in the person’s social network (Centola, 2010; Centola, 2015). Such social processes are especially pertinent in an era defined by social media, anti-vaccine activists, and misinformation. Stories that go viral evoke strong feelings, include rich narrative detail, and offer a simple “gist” or take-home message (Reyna, 2012). Scientists and their research rarely offer any of these things. When experts bring research papers to a firefight, they have lost before they have even started talking. The consequence is that anti-vaccine activists had, for a while, locked down many social media platforms.

More recently, citizen and scientist activists have fought back with increasingly effective tools. Examples include the National HPV Vaccination Roundtable, which created videos of people affected by HPV cancers and their doctors in order to make the consequences of the diseases more vivid. The WHO created a manual for addressing vaccine deniers in public (World Health Organization/Europe, 2016). Shots Heard Round the



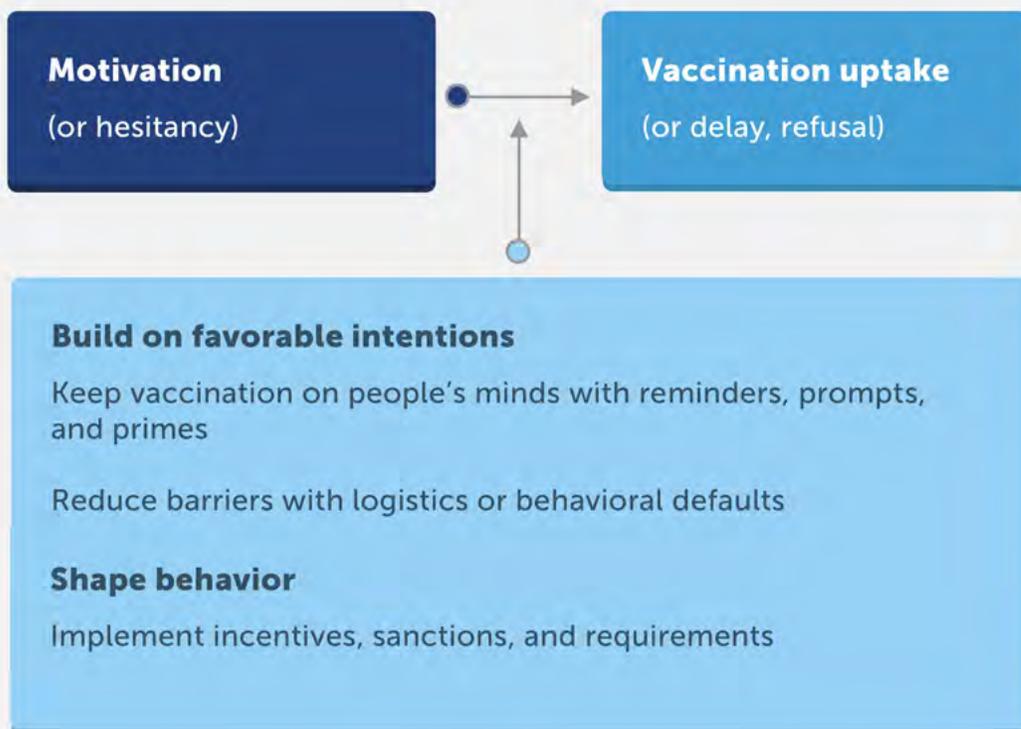
World has developed a rapid-response collective of volunteers to defend health care providers attacked for their vaccine advocacy. Quantifying the impact of anti- and pro-vaccine activism and tools is an important area for new research.



DIRECT BEHAVIOR CHANGE

The third broad proposition in the model is that fostering direct behavior change increases vaccine uptake (Figure 4). The general idea is that one can increase vaccine uptake without ever changing what people think and feel or the social world they encounter. Thus, direct behavior change takes *motivation* as a given. One can *build on favorable intentions* to vaccinate by keeping vaccination on people’s minds and reducing barriers to it. Alternatively, one can ignore intentions altogether and *shape behavior* with incentives, sanctions, and requirements—techniques that do not rely on predisposition to vaccinate. These interventions lead to *vaccination uptake*, shown on the right.

Figure 4. Direct behavior change



Source: Adapted from Brewer et al. in *Psychological Science in the Public Interest*, 2017.

One approach to direct behavior change is to build on people's good intentions. That means, first, to identify the people who already intend to vaccinate or are open to it, and then to make it as easy as possible for them to do so. Interventions include keeping vaccination on people's minds with reminders and prompts and reducing barriers with default appointments, standing orders, and other logistical and behavioral defaults. Randomized trials generally support the use of building on vaccination intentions to increase uptake. Another approach is to shape behavior with incentives, sanctions, or requirements, including work and school vaccination mandates. Again, randomized trials have repeatedly found support for the effectiveness of behavior-shaping interventions. The key shared characteristic of these strategies is that they use policies and practices to increase vaccination without changing what people think or feel.

Direct behavior change interventions are the most reliably effective option available, but they do have limitations. For example, while vaccination reminder/recall interventions are effective, few clinics effectively implement them. In one randomized trial, less than 1% of families received a reminder/recall letter or call when the task was assigned to clinics, but 87% received the notices when the county health department handled the responsibility (Kempe et al., 2015). Furthermore, notices from a centralized source are more effective when they include the name of the patient's provider (Kempe et al., 2015). In another example, school requirements (sometimes called mandates) effectively increase uptake of most vaccines (Greyson, Vriesema-Magnuson, & Bettinger, 2019) but do not raise HPV vaccine uptake among adolescent girls (Moss, Reiter, Truong, Rimer, & Brewer, 2016). As well, the process of implementing requirements can create substantial work for immunization programs and distract their staff from other essential tasks (Omer, Betsch, & Leask, 2019). All of this suggests that the right implementation strategy is critically important for direct behavior change interventions.

OTHER CONSIDERATIONS

Several important considerations should guide any application of this model.

| Provider Recommendations

By far, the single most potent intervention for increasing vaccine uptake is a provider recommendation (e.g., Newman et al., 2018). However, it is still unclear whether

recommendations are effective because they increase confidence, set a social norm, or reflect a direct behavior change technique. Quite possibly, provider recommendations exert influence through all three of the model's behavioral propositions. The most active aspect of the model from the standpoint of provider recommendations may be direct behavior change, given the few barriers present in many clinics: the vaccine is in stock, staff can deliver it, and a state program or private insurance generally covers the cost. Given that providers have more power than patients in clinical interactions, injunctive social norms are also likely to play some role. It may even be that providers persuasively shape what people think and feel by building on their unique relationships with the families they see. Research is needed to elucidate basic questions about what makes provider recommendations most effective.

While most evidence for provider recommendations is correlational, several trials have focused on the impact of training providers to communicate more effectively about vaccination. In my own research (Brewer, Hall, et al., 2016), colleagues and I have trained providers to raise the topic of adolescent vaccination using presumptive language (Opel et al., 2013) that we call an "announcement" and then to use a structured communication approach if questions come up. A presumptive announcement might sound like this: "Now that Sophia is 12, she is due for three vaccines. Today, she'll get vaccines against meningitis,



HPV cancers, and whooping cough." The Announcement Approach Training is a one-hour, physician-led, in-clinic training, offered with continuing medical education credits (materials are available at hpvIQ.org). The training increased HPV vaccine uptake by 5% within three months (Brewer, Hall, et al., 2016) and has now been delivered to over 1,200 providers in the United States and the United Kingdom. This communication approach builds on direct behavior change principles by assuming most parents just need a prompt to vaccinate.

Interactions Among the Propositions

No strong data are available to explain how the three parts of the model interact, but I offer my own speculation, based on correlational studies and insights I have gathered from people on the front lines of vaccination. First, although interventions to change what people think

and feel may not change behavior directly, they may provide other indirect benefits. Most of the policies and programs aimed at direct behavior change—by far the most effective way to increase vaccination uptake—require public confidence in vaccination. Thus, interventions that increase vaccine confidence may create an environment that supports direct behavior change interventions.

Second, interventions to change social processes may also change what people think and feel about diseases and vaccination. Although this has not yet been well-documented in the context of vaccination, it is a reasonable speculation based on social network studies in other areas.

Third, implementing direct behavior change interventions almost certainly affects other parts of the model. For example, establishing or removing vaccine recommendations, or imposing requirements for certain vaccines, likely affects confidence in vaccination. Similarly, leaders standing up for existing policies may bolster confidence, while setting these policies aside in the face of public opposition may erode confidence in vaccination.

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| Global Settings

Most vaccination intervention studies are from the United States, and some are from other high-income countries. Only a handful of intervention studies from low- and middle-income countries have examined vaccination incentives and educational programs. While these have generally shown the same results as studies in high-income countries, caution is warranted in applying these interventions in global settings until formative work is done within the local communities and, perhaps, trial-level evaluations are conducted. Such research could be a two-way street, with vaccination programs in high-income countries benefitting from learning what is effective in increasing vaccine uptake in low- and middle-income countries.

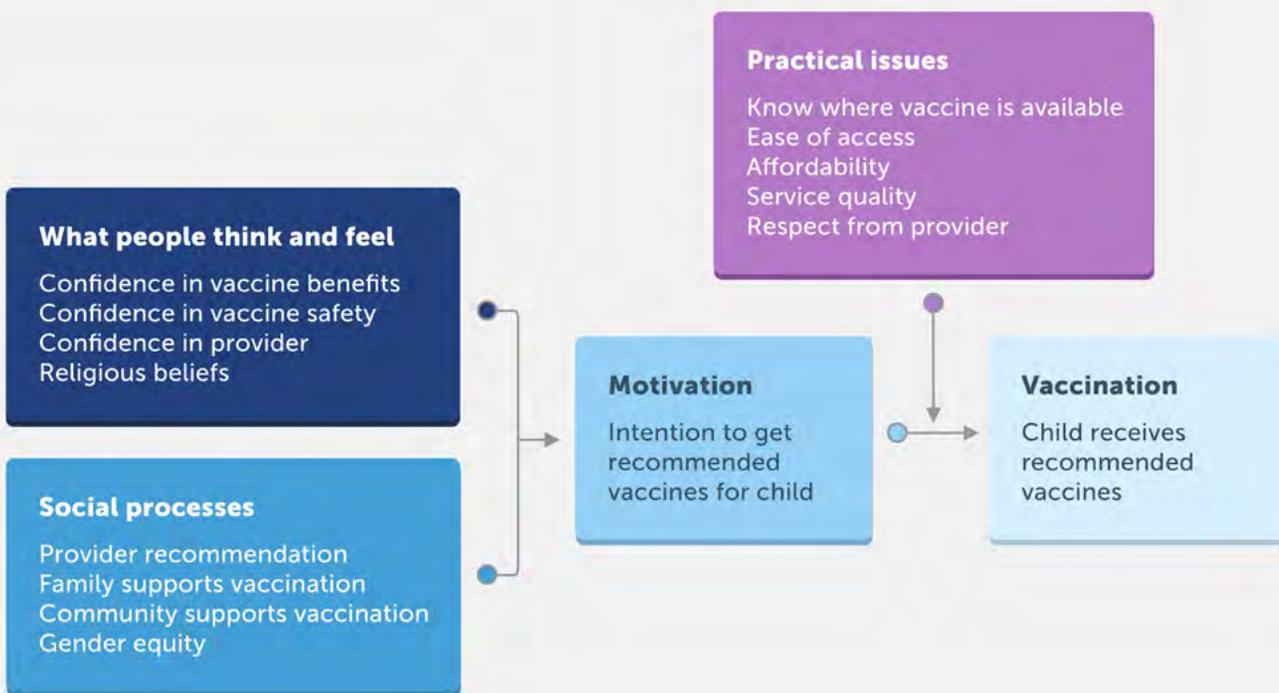
| Timeliness and Stability

The available evidence primarily examines vaccine uptake. Because few studies are available on vaccination timeliness and stability, application of the model to these outcomes remains preliminary and warrants additional study. An area of growing interest is in understanding what leads to and sustains the resilience of vaccination programs.

ADAPTATION OF THE MODEL BY THE WORLD HEALTH ORGANIZATION

Following on its designation of vaccine hesitancy as one of the top 10 threats to global public health, the WHO established an expert working group to identify the behavioral and social drivers of vaccination uptake around the world. The working group has adapted the Increasing Vaccination Model, as shown in Figure 5, as the basis for its work. The boxes in the model have remained the same over time, even as the working group has continued to winnow the list of variables in each box.

Figure 5. Adaptation of the increasing vaccination model



Source: Adapted from Brewer et al. in *Psychological Science in the Public Interest*, 2017

Among the noteworthy highlights from this adaptation:

- Motivation to vaccinate is in its own box, allowing the working group to emphasize the distinction between confidence and hesitancy.
- Provider recommendation is in the social process box. This categorization was not a settled issue in the original paper, but it allowed the working group to keep track of this important variable.

- The direct behavior change section is renamed “Practical issues.” Many working group members had roles in vaccination programs globally which led them to see barriers and practical issues as especially important. They felt that the new name emphasized barriers that vaccination programs can address.

Before using the model, the working group had not engaged with several of the concepts related to social processes. The model shifted their thinking in that domain, leading the group to consider the roles of families, community leaders, and gender equity.

Based on this model, the WHO working group has developed a survey on the behavioral and social drivers of vaccination around the world. The survey is being piloted in six low- and middle-income countries and should be available for use globally in 2021.



CONCLUSION

Direct behavior change is clearly the most promising approach to increasing vaccination uptake, and research supports the use of many different techniques, as shown at the bottom of Table 1 (Brewer et al., 2017). No single intervention is effective on its own, however, making it necessary to adopt more than one. Insofar as each intervention acts on different parts of the system that provides vaccination, their combination may be truly additive or even multiplicative in its effects. It is also possible that the initial intervention activates the “easy” cases to vaccinate and that additional interventions add little. More information is needed on this topic, but given the high cost of trials, such knowledge may be out of reach.

In contrast, interventions to change what people think and feel are often expensive and hard to sustain, and they may not be especially effective (as shown at the top of Table 1). An important caveat here is that interventions by providers in clinical settings may be influential if they effectively use communication approaches based on information, persuasion, and engaged listening.

Interventions targeting social processes are promising insofar as they build on multiple nodes of social networks or happen in clinical settings. In this era of social media and vocal vaccine activism, the conversations about vaccination, both in the

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Table 1. Impact of interventions to increase vaccination uptake

	LIKELY IMPACT
<p>Intervention targets what people think and feel</p> <p>Messages that increase disease risk appraisals</p> <p>Education campaigns that increase confidence</p> <p>Decision aids</p> <p>Motivational interviewing</p>	<p>○</p> <p>○</p> <p>○</p> <p>○</p>
<p>Intervention targets social processes</p> <p>Messages that change altruism or free-riding beliefs</p> <p>Descriptive norm messages</p> <p>Social network interventions that build on contagion</p> <p>Healthcare provider recommendations</p>	<p>○</p> <p>◐</p> <p>◐</p> <p>●</p>
<p>Intervention targets direct behavior change</p> <p>Reminders and recalls</p> <p>Presumptive healthcare provider recommendations</p> <p>Onsite vaccination</p> <p>Default appointments</p> <p>Incentives</p> <p>School and work requirements (mandates)</p> <p>Sanctions</p>	<p>◐</p> <p>●</p> <p>●</p> <p>●</p> <p>●</p> <p>●</p> <p>●</p> <p>●</p>

LIKELY IMPACT ○ no or very small ◐ modest ● substantial

public sphere and in private settings, have an outsized influence on programs and policies. What this adds up to remains to be seen, but research is under way that should shed light on the pitfalls and promises of social processes.

Thinking more broadly about public support for vaccination, work is needed to understand how to ensure resilience in the face of safety scares. Interventions to boost vaccine confidence may not increase vaccination uptake directly, but they may have a side benefit of increasing support for effective policies and programs. Interventions through social media—to add supportive stories and information or to limit misinformation—may also increase

vaccination support. Other strategies can also be considered, including targeted efforts when new vaccines are launched and to address unsubstantiated vaccine scares. Indeed, data are accumulating to support the value of efforts by countries to bolster confidence during such scares (Hansen et al., 2020).

As we move into a new decade, it is essential to ensure the resilience of vaccination programs and the global success story they represent. The Increasing Vaccination Model offers important insights to support such efforts. Building on the large existing body of evidence can ensure a steady path forward for vaccination programs globally.



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THE SABIN-ASPEN
**VACCINE SCIENCE
& POLICY GROUP**



Foreword by Harvey V. Fineberg and Shirley M. Tilghman



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