
INCREASING VACCINATION

A BEHAVIORAL SCIENCE APPROACH

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CENTER FOR
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HINDSIGHT

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INTRODUCTION

Vaccine-preventable diseases are still some of the leading causes of death across the world.^{1,2} Safe and effective vaccines are widely available, but vaccination rates are lower than they should be.

Although only a small percentage of the population is fundamentally opposed to vaccination, lay beliefs about vaccines do contribute to vaccine hesitancy – even if these beliefs are not particularly strong. For instance, beliefs that adverse events are common and that immunity through breastfeeding is safer may create doubt about the value of vaccines. In environments where vaccines are easy to refuse, this doubt may be enough to result in undervaccination.

Among individuals who do not hold false beliefs, strong or otherwise, contextual barriers may be difficult to overcome. For example, obstacles of time, convenience, and the complexity of vaccine schedules pose challenges to getting fully vaccinated, despite the best intentions.

Here we describe the problem of undervaccination from a psychological and behavioral perspective. We describe the problems of false beliefs and the difficulty of correcting them, as well as the contextual barriers that are most likely to contribute to undervaccination. Then we propose solutions aimed at addressing false beliefs and contextual barriers. Each proposed solution is based on a research hypothesis and thus warrants rigorous experimental testing prior to implementation in the field.

We assume that these explanations and proposed experimental interventions are only appropriate in contexts in which vaccines are already available and not subject to shortage or access issues.

¹ World Health Organization. (2017, October). *Measles: Fact sheet*. Retrieved from <http://www.who.int/mediacentre/factsheets/fs286/en/>

² World Health Organization. (2017, May). *Diarrhoeal disease: Fact sheet*. Retrieved from <http://www.who.int/mediacentre/factsheets/fs330/en/>

FALSE BELIEFS CONTRIBUTING TO UNDERVACCINATION

'Anti-vaxxers' are a small but vocal group that fuels vaccine hesitancy globally by promoting false information about vaccines. Prominent false claims include Andrew Wakefield's 1998 study linking autism to the MMR vaccine in England, and Nigerian religious leaders' claims in 2003 that polio vaccines cause sterilization, cancer, and HIV.³ Misleading claims spread quickly via media: major search engines are likely to return at least one anti-vaccination website in the top ten results for searches about vaccines.⁴

Although anti-vaxxers represent a small proportion of the population, false claims may introduce doubts about vaccines to average people. In contexts that do not have strong norms or defaults around vaccination, these beliefs may be enough to encourage individuals to opt out or delay vaccination.

Common biases may make people more susceptible to false lay beliefs:

PEOPLE PREFER NATURAL INTERVENTIONS

Individuals who subscribe to natural beliefs tend to see anything natural as healthy and good, while anything artificial is seen as dangerous and bad. In this worldview, people prefer natural living techniques (such as breastfeeding) over vaccination because they believe natural techniques instill immunity without the risk of disease contamination. Those who subscribe to natural beliefs think that vaccines can backfire and overload the immune system, unlike other ways of building immunities.⁵ Adherents to this worldview tend to be more affluent and educated, indicating that this worldview is not a result of poor education or lack of information, but rather is linked to a strong identity around lifestyle and consumption choices.

RISKS VS. REWARDS ARE MISINTERPRETED

Vaccine adverse events are believed to be far more likely and dangerous than they actually are, whereas the infectious diseases they prevent against are seen as less likely and less dangerous than they actually are. Most vaccines have extremely low risks of serious side effects (between 1 in 500,000 to 1 in 1 million); however, more than half of parents in one study reported concern about serious side effects of vaccines.⁶ This misinterpretation may be due the availability bias, or the tendency to assume salient events are frequent. People may distort the likelihood of adverse events because they are dramatic and easily-remembered in people's minds, whereas vaccine-preventable diseases are largely invisible.

³ Wakefield, A. J., Murch, S. H., Anthony, A., Linnell, J., Casson, D. M., Malik, M., ... Walker-Smith, J. A. (1998). RETRACTED: Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children. *The Lancet*, 351(9103), 637-641. [http://dx.doi.org/10.1016/S0140-6736\(97\)11096-0](http://dx.doi.org/10.1016/S0140-6736(97)11096-0)

⁴ Downs, J. S., de Bruin, W. B., & Fischhoff, B. (2008). Parents' vaccination comprehension and decisions. *Vaccine*, 26(12), 1595-1607. <https://doi.org/10.1016/j.vaccine.2008.01.011>

⁵ Dubé, E., Vivion, M., & MacDonald, N. E. (2015). Vaccine hesitancy, vaccine refusal and the anti-vaccine movement: Influence, impact and implications. *Expert Review of Vaccines*, 14(1), 99-117. <https://doi.org/10.1586/14760584.2015.964212>

⁶ Freed, G. L., Clark, S. J., Butchart, A. T., Singer, D. C., & Davis, M. M. (2010). Parental vaccine safety concerns in 2009. *Pediatrics*, 125(4), 654-659. <https://doi.org/10.1542/peds.2009-1962>

PEOPLE PREFER PASSIVE HARM TO ACTIVE HARM

Harm that is done through inaction is seen as less immoral than harm through action – a concept known in psychology as the omission bias.⁷ This bias happens because people believe that active harm is more intentional than passive harm. As such, the potential harm done through vaccination is harder to accept than the potential harm done through non-vaccination.

BELIEFS BECOME ENTRENCHED, DESPITE CONFLICTING EVIDENCE

Beliefs can be core to one's sense of identity. Once we commit to a belief, changing our minds can feel difficult or even painful, so we use a wide variety of strategies to cling to that belief at any cost. People with doubts about vaccines might search only for information about dangers of vaccines, while avoiding counter-arguments about vaccine benefits or safety, a tendency known as the confirmation bias. People may also discredit pro-vaccination information preemptively – perhaps by questioning the reputability of the research or the financial interests of the source.

BELIEFS ARE EXTREMELY DIFFICULT TO CHANGE

Attempts to change vaccination beliefs through education alone do not work for people who hold false beliefs.^{8,9} After being told that the flu vaccine cannot cause the flu, individuals who are highly concerned about vaccine side effects actually become less likely to vaccinate.⁸ When individuals are exposed to information that disconfirms strongly-held beliefs, they are motivated to cling to their original beliefs through the consistency bias. As a result of this motivation, they create explanations for why the new information is not relevant or why their existing belief is still valid, which thereby reinforces the existing belief.

⁷ Ritov, I., & Baron, J. (1990). Reluctance to vaccinate: Omission bias and ambiguity. *Journal of Behavioral Decision Making*, 3(4), 263–277. <https://doi.org/10.1002/bdm.3960030404>

⁸ Nyhan, B., Reifler, J., & Ubel, P. A. The hazards of correcting myths about health care reform. *Medical Care*, 51(2), 127-132. <https://doi.org/10.1097/MLR.0b013e318279486b>

⁹ Sadaf, A., Richards, J. L., Glanz, J., Salmon, D. A., & Omer, S. B. (2013). A systematic review of interventions for reducing parental vaccine refusal and vaccine hesitancy. *Vaccine*, 31(40), 4293–4304. <https://doi.org/10.1016/j.vaccine.2013.07.013>

CONTEXTUAL BARRIERS AND FRICTION

False beliefs are a salient and important component of undervaccination, but many contextual factors also contribute to this problem. In the case of organ donation, for instance, the form that governments use makes a huge difference: countries that have opt-out forms (e.g., “check this box if you DON’T want to donate”) have shown much higher rates of organ donation than those with opt-in forms (e.g., “check this box if you DO want to donate”).¹⁰ For vaccination, even when people accept the benefits of vaccination, similar contextual barriers and sources of friction contribute to delayed or missed vaccinations in a variety of ways:

VACCINATION SCHEDULES ARE COMPLEX

Centralized vaccination tracking systems are rare, requiring patients to track their own vaccinations.^{11,12} Vaccination histories may be lost or forgotten when families move, switch to new providers, switch between insurance plans, or lose health insurance altogether.¹³ Further, many vaccines require multiple doses or should be sequenced within a specific time frame, which adds complexity to vaccine schedules. Of the 10 vaccines recommended for all infants under 15 months in the United States, eight of them require multiple doses.¹⁴

GETTING VACCINATED IS INCONVENIENT

Because most vaccines require multiple doses, they require multiple visits to a medical provider. Numerous visits in turn require access to transportation and free time. Many childhood vaccines are mandated by law, providing sufficient impetus for parents to overcome these barriers, but no such mandates exist to induce adults to follow through on their own vaccination. Removing sources of inconvenience may prove valuable in increasing uptake of voluntary vaccinations. For example, offering vaccines at non-traditional locations (such as workplaces or pharmacies) has been shown to successfully increase flu vaccination coverage, particularly for employed, high-income, and highly educated people.¹⁵

SOCIOECONOMIC VARIABLES IMPACT VACCINATION

Populations with poor access to health care or lower socioeconomic status must contend with more fundamental obstacles than simple inconvenience. In Nairobi, Kenya, full vaccination for children varies according to variables such as financial assets, ethnicity, and the mother’s level of education.¹⁶ In the United States, data on child,¹⁷ adolescent,¹⁸ and adult¹⁹ vaccinations show

¹⁰ Johnson, E. J., & Goldstein, D. (2003). Do defaults save lives? *Science*, 302(5649), 1338-1339. <https://doi.org/10.1126/science.1091721>

¹¹ Mehta, B., Chawla, S., Kumar Dharma, V., Jindal, H., & Bhatt, B. (2014). Adult immunization: The need to address. *Human Vaccines & Immunotherapeutics*, 10(2), 306–309. <https://doi.org/10.4161/hv.26797>

¹² Brown, D. W., Gacic-Dobo, M., & Young, S. L. (2014). Home-based child vaccination records—a reflection on form. *Vaccine*, 32(16), 1775-1777. <https://doi.org/10.1016/j.vaccine.2014.01.098>

¹³ Ventola, C. L. (2016). Immunization in the United States: Recommendations, Barriers, and Measures to Improve Compliance: Part 2: Adult Vaccinations. *Pharmacy and Therapeutics*, 41(8), 492–506.

¹⁴ Center for Disease Control. (2017). *Recommended Immunization Schedule for Children and Adolescents Aged 18 Years or Younger, UNITED STATES, 2017*. Retrieved from <https://www.cdc.gov/vaccines/schedules/hcp/imz/child-adolescent.html>

¹⁵ Namhoo, K., & Mountain, T. P. (2017). Role of non-traditional locations for seasonal flu vaccination: Empirical evidence and evaluation. *Vaccine*, 35(22), 2943-2948. <https://doi.org/10.1016/j.vaccine.2017.04.02>

¹⁶ Mutua, M. K., Kimani-Murage, E., & Ettarh, R. R. (2011). Childhood vaccination in informal urban settlements in Nairobi, Kenya: Who gets vaccinated? *BMC Public Health*, 11(6), 1-11. <https://doi.org/10.1186/1471-2458-11-6>

urban-rural, income, state-level, or racial disparities. A study in 2005 found that severe delays for four or more childhood vaccinations were associated with socioeconomic variables, such as having a single mother, having a mother who did not have a college degree, and being black.²⁰ Fundamental socioeconomic barriers such as financial struggle may create high cognitive and emotional burdens on families, leading preventive care and vaccination to fall to the wayside, particularly given that vaccination is already complex and cumbersome.

OPTING OUT IS TOO EASY

Ironically, in many cases, getting an exemption from vaccination may be much easier than getting vaccinated. In Arizona, for example, a personal beliefs exemption form for childhood vaccinations is staggeringly simple to complete. A parent simply writes the child's name and date of birth and signs to show they have been informed of the risks of not getting specific vaccinations. By contrast, in California and Mississippi, only medical exemptions are allowed, and these exemptions must be signed by a pediatrician. States with easy exemption policies have at least double the rates of nonmedical exemptions as states with difficult exemption policies.²¹ Difficult exemption policies are especially important because they communicate that the default option is getting vaccinated and that not vaccinating falls outside of the social norm.

WE AVOID PAIN

Although the pain of a vaccination is temporary and harmless, it likely plays an important, albeit subtle, role in undervaccination. In general, humans are motivated to avoid painful experiences – especially those that are repeated over time. Injections are uncomfortable and feared across multiple contexts, and vaccinations are no exception. Injection site pain is the most common side effect of vaccination, and at least 10% of the population experiences needle phobia.²² Further, fear of needles may actually increase the pain of vaccination.²³ Full vaccination involves dozens of injections across a person's lifetime, which means repeating an uncomfortable, fear-inducing experience.

¹⁷ Hill, H. A., Elam-Evans, L. D., Yankey, D., Singleton, J. A., Dietz, V. (2016). Vaccination Coverage Among Children Aged 19–35 Months – United States, 2015. *Morbidity and Mortality Weekly Report (MMWR)*, 65, 1065–1071.

<https://dx.doi.org/10.15585/mmwr.mm6539a4>

¹⁸ Walker, T. Y., Elam-Evans, L. D., Singleton, J. A., Yankey, D., Markowitz, L. E., Fredua, B., ... Stokley, S. (2017). National, Regional, State, and Selected Local Area Vaccination Coverage Among Adolescents Aged 13–17 Years – United States, 2016. *Morbidity and Mortality Weekly Report (MMWR)*, 66, 874–882. <https://dx.doi.org/10.15585/mmwr.mm6633a2>

¹⁹ Williams, W. W., Lu, P., O'Halloran, A., Kim, D. K., Grohskopf, L. A., Pilishvili, T., ... Fiebelkorn, A. P. (2017). Surveillance of Vaccination Coverage among Adult Populations – United States, 2015. *Morbidity and Mortality Weekly Report (MMWR)*, 66(SS-11), 1–28.

<https://dx.doi.org/10.15585/mmwr.ss6611a1>

²⁰ Luman, E. T., Barker, L. E., Shaw, K. M. (2005). Timeliness of childhood vaccinations in the United States: Days undervaccinated and number of vaccines delayed. *JAMA*, 293(10), 1204–1211. <https://doi.org/10.1001/jama.293.10.1204>

²¹ Omer, S. B., Richards, J. L., Ward, M., & Bednarczyk, R. A. (2012). Vaccination policies and rates of exemption from immunization, 2005–2011. *New England Journal of Medicine*, 367(12), 1170–1171. <https://doi.org/10.1056/NEJMc1209037>

²² Szmuk, P., Szmuk, E., & Ezri, T. (2005). Use of needle-free injection systems to alleviate needle phobia and pain at injection. *Expert Review of Pharmacoeconomics & Outcomes Research*, 5(4), 467–477. <https://doi.org/10.1586/14737167.5.4.467>

²³ Friedmann, P. D., Mello, D., Lonergan, S., Bourgault, C., & O'Toole, T. P. (2013). Aversion to injection limits acceptability of extended-release naltrexone among homeless, alcohol-dependent patients. *Substance Abuse*, 34(2), 94–96.

<https://doi.org/10.1080/08897077.2012.763083>

POTENTIAL EXPERIMENTS TO ADDRESS FALSE BELIEFS

In the domain of false beliefs, research has already demonstrated that ‘myth-busting’ strategies are ineffective and that it is generally quite difficult to change these beliefs. However, alternative approaches to addressing attitudes may show promise. Below we identify strategies that may be high value for testing through randomized controlled trials:

NARRATIVE PERSUASION

Detailed stories of individual experiences are an invaluable tool in health communication, often proving more effective in changing minds than conventional education.²⁴ Narratives put their reader into the shoes of the main character – an effect that can make otherwise abstract or population-level health risks seem far more real, personally relevant, and memorable.²⁵ Narratives change beliefs through emotional routes; they may not provide new information, but they change how people value the information.

Vivid narratives of adverse events have amplified beliefs that vaccines are dangerous, artificial substances that pose greater risks than rewards. Several counter-narratives have potential as interventions against these beliefs:

Narratives Appealing to Emotions

Narratives have been shown to be particularly effective because they elicit strong emotional responses, which in turn are effective for changing attitudes and behavior.^{26,27} Examples of narratives could include stories portraying consequences of vaccination to an individual child or vivid examples of children being spared from disease outbreaks. Such narratives could emphasize the social utility of vaccines (i.e., that we get vaccinated to protect loved ones, not just ourselves). Detailed emotional stories of vaccination may be more likely to change attitudes than simple statistics or informational campaigns since narratives may elicit visceral reactions.

Narratives Emphasizing the Natural Qualities of Vaccination

A narrative about the invention of vaccines and the eradication of smallpox could be used to frame vaccines as a natural adjunct to the immune system, rather than an artificial construction. Such a narrative would also serve to emphasize the success of vaccination in eradicating a dangerous illness entirely, which could then be compared and contrasted with the current resurgence of several dangerous illnesses due to undervaccination.

²⁴ Hindyard, L. J., & Kreuter, M. W. (2007). Using narrative communication as a tool for health behavior change: A conceptual, theoretical, and empirical overview. *Health Education & Behavior, 34*(5), 777-792. <https://doi.org/10.1177/1090198106291963>

²⁵ Green, M. C., & Brock, T. C. (2000). The role of transportation in the persuasiveness of public narratives. *Journal of Personality and Social Psychology, 79*(5), 701-721. <https://doi.org/10.1037//0022-3514.79.5.701>

²⁶ Dunlop, S., Wakefield, M., & Kashima, Y. (2008). Can you feel it? Negative emotion, risk, and narrative in health communication. *Media Psychology, 11*(1), 52–75. <https://doi.org/10.1080/15213260701853112>

²⁷ Kopfman, J. E., Smith, S. W., Yun, J. K. A., & Hodges, A. (1998). Affective and cognitive reactions to narrative versus statistical evidence organ donation messages. *Journal of Applied Communication Research, 26*(3), 279–300. <https://doi.org/10.1080/00909889809365508>

PARADOXICAL THINKING

Presenting people with arguments that are even more extreme in support of their beliefs has been shown to make individuals' beliefs more moderate.²⁸ This strategy, known as "paradoxical thinking," is effective because it does not attempt to directly discredit currently held beliefs. Instead, it instills surprise and causes people to refute the extreme viewpoint.

Paradoxical thinking interventions may include statements that address 'natural' beliefs or fears of discomfort:

'Natural' Beliefs

Campaigns could include paradoxical statements such as, "Suffering from preventable diseases builds inner strength and character." An image might show a child in a snow storm with no jacket and have the caption, "A child's natural protection is enough."

Fears of Discomfort

To address fears of painful vaccination, ads might claim, "Better to have more pain later than a little pain now" or "Shots hurt, so I let my child get sick instead."

Rigorous pre-testing of paradoxical thinking interventions would be needed to ensure that people do not interpret these claims as factual or literal. Further, such interventions would need to be targeted at extreme anti-vaxxers, since previous research has established that these interventions backfire in populations with moderate beliefs.

REFRAMING RISKS AND BENEFITS

The potential harm of vaccination is often sensationalized and easily remembered (such as in stories of vaccine adverse events), while the potential harm of refusing vaccination is abstract and forgotten. Health risks are the most obvious consequence of vaccine refusal, but other risks, such as financial ones, are also worth considering. Several tools could be used to make risks and benefits more concrete and salient:

Cost Calculators

Unexpected illness is a major financial issue in American households; every dollar spent on routine childhood vaccination prevents \$3 of personal medical cost in the future, and \$10 of cost to society.²⁹ A cost calculating website or app could be constructed as an aid for making vaccination decisions. Inputs would include the intended vaccinations, any relevant information about the patient's medical situation, and additional costs that might be incurred. The calculator would then display the amount of money likely saved by both the individual and society. Alternative versions of the display would test the impact of presenting the information in different ways (e.g., "\$1000" versus "two months of groceries"). Once finalized, this cost calculating website could be included as a link on the

²⁸ Hameiri, B., Porat, R., Bar-Tal, D., Bieler, A., & Halperin, E. (2014). Paradoxical thinking as a new avenue of intervention to promote peace. *Proceedings of the National Academy of Sciences of the United States*, 111(30), 10996-11001. <https://doi.org/10.1073/pnas.1407055111>

²⁹ Zhou, F., Shefer, A., Wenger, J., Messonnier M., Wang, L. Y., Lopez, A., Moore, M., Murphy, T. V., Cortese, M., Rodewald, L. (2014). *Pediatrics*, 133, 1-9. <https://doi.org/10.1542/peds.2013-0698>

homepages of various medical providers and on vaccination timetables or emailed to patients prior to scheduled medical visits. Such an approach could be effective in making the costs of undervaccination more tangible and easily understood.

Comparing Risks of Disease and Side Effects

Risks of non-vaccination could be made more concrete by comparing them to risks of side effects. People could be given pamphlets or other decision aids that list the symptoms and probability of a disease, compared to the risks and side effects of vaccination. This intervention may weaken the potential for omission bias by making the consequences of refusing or delaying a vaccine seem more harmful.

SOCIAL NORMS

Social norms have been widely shown to shift attitudes and behavior, including health behavior.³⁰ People tend to do what they think is expected or common. Leveraging social norms could be used in the following ways:

Showing Vaccination is Common

Highlighting pre-existing, high rates of vaccination has been shown to increase people's intentions for vaccinating themselves.³¹ More media attention could be given to the high number of people who are getting vaccinated (rather than the low but growing number of people who refuse vaccinations). Social media platforms could be used to identify people in social networks who have been vaccinated and message these norms to people: e.g., "Six of your closest friends have wisely chosen to get the flu vaccine this week. Will you?"

Connecting Vaccination with Identity

Campaigns could portray vaccination as an outgrowth of shared values or proper behavior for particular social groups. In Australia, a campaign called "I Immunise" was used to target people who identified with practices like breastfeeding or home-birthing by showing that families with these shared practices also vaccinated themselves and their children.³² The ads included statements like, "I use cloth nappies, I eat wholefoods, and I immunise."

SOCIAL PRESSURE

The desire for acceptance could be used to frame vaccination as socially desirable.

Communicating Right and Wrong Behavior

Vaccine refusal could be framed as socially undesirable behavior. Using a similar tactic, Listerine coined the term "halitosis" in the 1920s and aired ads claiming that bad breath makes people unpopular. Listerine's ads were especially effective because they provided a

³⁰ Reid A. E., Cialdini R. B., Aiken L. S. (2010). Social norms and health behavior. In: Steptoe A. (eds). *Handbook of Behavioral Medicine* (263-274). Springer, New York, NY. https://doi.org/10.1007/978-0-387-09488-5_19

³¹ Hershey, J. C., Asch, D. A., Thumsaathit, T., Meszaros, J., & Waters, V. V. (1994). The roles of altruism, free riding, and bandwagoning in vaccination decisions. *Organizational Behavior and Human Decision Processes*, 59(2), 177-187. <https://doi.org/10.1006/obhd.1994.1055>

³² Attwell, K., & Freeman, M. (2015). I Immunise: An evaluation of a values-based campaign to change attitudes and beliefs. *Vaccine*, 33(46), 6235-6240. <https://doi.org/10.1016/j.vaccine.2015.09.092>

quick solution, assuring people that bad breath could “be instantly remedied” with Listerine. Ad campaigns for vaccines could do the same for vaccine adherence by associating failure to vaccinate with social rejection. Campaigns could warn, “Is your child playing with someone who isn’t vaccinated?” Alternatively, social media could be used to encourage people to publicly identify as people who vaccinate, similar to how people can indicate on Facebook that they have voted on election day. Vaccinators with social clout in their communities, as well as social influencers, could be recruited to make their views and choices more visible and positive.

POTENTIAL EXPERIMENTS

TO ADDRESS CONTEXTUAL BARRIERS

Contextual variables that make vaccination cumbersome and aversive may influence vaccination rates, even for those who are not opposed to vaccination. Here we outline potential interventions that may make vaccination easier and more pleasant, as well as strategies that may make non-vaccination more difficult and unpleasant. The following interventions should be tested through randomized controlled trials:

REMINDERS

Simple reminders increase actions by focusing people's attention on intentions they have created in the past.³³ Since reminders have been shown to increase vaccination, an app could be created to prompt individuals to get vaccinated at their next visit to a medical provider.^{34,35,36} To help track vaccine schedules, the application could also include personal or family records of vaccines using methods similar *VaxTrac*, which uses a person's fingerprint to securely access vaccination records and ensure that even those who don't interact with the medical system regularly preserve these records.

REMOVING FRICTION

Beneficial actions (vaccination) are sometimes more difficult than harmful actions (skipping vaccination). To increase uptake, friction could either be added to non-vaccination or removed from vaccination. For instance, everyone (e.g., in a workplace or school) could be required to receive an injection for a recommended vaccination. The opt-out procedure would then involve choosing a saline solution rather than the vaccine. In such a situation, vaccination would not be more difficult or uncomfortable than non-vaccination, which may increase vaccination.

Another method for reducing friction might be self-injection, which has been implemented in a variety of health contexts, including insulin injections, hormone therapies, and biologics. Vaccinations could be obtained and self-administered outside physicians' offices to potentially reduce barriers like the cost of physician visits or the need to schedule appointments.

FINANCIAL PAIN

Financial pressure could be leveraged to help the consequences of diseases feel more salient. Insurance companies could require that members who don't vaccinate themselves "pay in

³³ Rogers, T., & Milkman, K. L. (2016). Reminders through association. *Psychological Science*, 27(7), 973-986. <https://doi.org/10.1177/0956797616643071>

³⁴ Davidson, R. A., Fletcher, S. W., Retchin, S., & Duh, S. (1984). A nurse-initiated reminder system for the periodic health examination. Implementation and evaluation. *Archives of Internal Medicine*, 144(11), 2167-2170. <https://doi.org/10.1001/archinte.1984.04400020069012>

³⁵ Dexter, P. R., Perkins, S., Overhage, J. M., Maharry, K., Kohler, R. B., & McDonald, C. J. (2001). Computerized reminder system to increase the use of preventive care for hospitalized patients. *New England Journal of Medicine*, 345(13), 965-970. <https://doi.org/10.1056/NEJMsa010181>

³⁶ Szilagyi, P. G., Rodewald, L. E., Savageau, J., Yoos, L., & Doane, C. (1992). Improving influenza vaccination rates in children with asthma: A test of a computerized reminder system and an analysis of factors predicting vaccination compliance. *Pediatrics*, 90(6), 871-875.

advance” for potentially inevitable diseases. These policies could be announced on the websites of employer-sponsored health plans. Websites might offer a comparison between vaccinating and not vaccinating in a way that highlights the consequences of disease: “Members can choose between getting the shingles vaccine or increasing their premiums to cover treatments for severe symptoms of shingles, including painful rash, fluid-filled blisters, and long-term excruciating nerve pain (postherpetic neuralgia).”

INCORPORATING VACCINATION IN ROUTINE CARE

People are more likely to follow through with actions when they are defaulted into them. Vaccinations could be incorporated as a default into standard care by checking patients' vaccine status at every provider visit and explicitly offering any vaccinations they require. For example, all elderly patients in hospitals could be given the flu vaccine prior to discharge. For patients who are too frail to receive the vaccine, primary caregivers could act as “surrogate” recipients of the vaccine to protect loved ones from the flu.

IMPROVING PLEASANTNESS OF VACCINATION

People tend to repeat behaviors that are pleasant and avoid behaviors that are unpleasant. Numerous methods could be used to improve the experience of vaccination.

Reward Substitution

Research has shown that immediate rewards are more motivating than future rewards.³⁷ Reward substitution, or coupling difficult behaviors with immediate rewards, has been shown to increase health behaviors such as gym attendance.³⁸ In the case of vaccinations, there is no obvious immediate reward and only a painful experience. Instead of emphasizing outcomes like increased immunity or reduced risk of disease, doctors could consider pairing vaccination with other pleasant activities, such as small candy or soothing music. It may even be effective to use open-label placebos (sugar pills that patients are told have no impact on the body), which have been used successfully to treat lower back pain,³⁹ ADHD,⁴⁰ and irritable bowel syndrome.⁴¹ Simply taking a pill (even if the pill is known to have no impact) may reduce the anxiety and fear that act as barriers to vaccination.

Moving Vaccination to the Start of a Visit

Remembered pain is based on the most intense pain in an experience and the pain at the end of the experience.⁴² Thus, vaccinations could be moved to the start of provider visits

³⁷ Segar, M. L., Eccles, J. S., & Richardson, C. R. (2011). Rebranding exercise: Closing the gap between values and behavior. *The International Journal of Behavioral Nutrition and Physical Activity*, 8(1), 94. <https://doi.org/10.1186/1479-5868-8-94>

³⁸ Milkman, K. L., Minson, J. A., & Volpp, K. G. M. (2014). Holding the Hunger Games Hostage at the Gym: An Evaluation of Temptation Bundling. *Management Science*, 60(2), 283–299. <https://doi.org/10.1287/mnsc.2013.1784>

³⁹ Carvalho, C., Caetano, J. M., Cunha, L., Rebouta, P., Kaptchuk, T. J., & Kirsch, I. (2016). Open-label placebo treatment in chronic low back pain: a randomized controlled trial. *Pain*, 157(12), 2766–2772. <https://doi.org/10.1097/j.pain.0000000000000700>

⁴⁰ Sandler, A. D., & Bodfish, J. W. (2008). Open-label use of placebos in the treatment of ADHD: A pilot study. *Child: Care, Health, and Development*, 34(1), 104-110. <https://doi.org/10.1111/j.1365-2214.2007.00797.x>

⁴¹ Kaptchuk, T. J., Friedlander, E., Kelley, J. M., Sanchez, M. N., Kokkotou, E., Singer, J. P., ... Lembo, A. J. (2010). Placebos without deception: A randomized controlled trial in irritable bowel syndrome. *PLoS ONE*, 5(12). <https://doi.org/10.1371/journal.pone.0015591>

⁴² Do, A. M., Rupert, A. V., Wolford, G. (2008). Evaluations of pleasurable experiences: the peak-end rule. *Psychonomic Bulletin & Review*, 15(1), 96-98. <https://doi.org/10.3758/PBR.15.1.96>

and less painful activities could be performed after vaccination in order to help patients remember the experience more positively, which should increase the likelihood that the experience would be repeated.

Reframing Discomfort

Reappraisal, or changing the way one understands painful experiences, has been shown to change the emotions surrounding an experience.⁴³ Patients could be told information about vaccines that helps them cope with the pain of needles or injection site reactions: for instance, “When you feel pain in your arm, it means the vaccine is working in your body and that your body is strong and healthy.”

⁴³ Cutuli, D. (2014). Cognitive reappraisal and expressive suppression strategies role in the emotion regulation: an overview on their modulatory effects and neural correlates. *Frontiers in Systems Neuroscience*, 8, 175. <http://doi.org/10.3389/fnsys.2014.00175>

CONCLUSION:

IMPLEMENTING INTERVENTIONS IN THE FIELD

Many behavioral biases and contextual barriers have stood in the way of vaccinations being adopted at the rates needed for herd immunity. Previous research has already pointed to ineffective uptake strategies, such as attempts to correct myths about vaccines.^{8,9} Thus, future research should prioritize testing based on the existing research and the potential impact of new strategies. Research findings should be replicated across multiple experiments to demonstrate their validity.

Further, because vaccine beliefs and process barriers may vary by region, different obstacles may matter more in some countries versus others. Since previous vaccine interventions have been shown to influence populations differently (particularly those who are high in hesitancy versus more moderate), the impact of any intervention should be rigorously measured through randomized controlled trials and replicated across contexts.

Behavioral interventions must be scalable in order to maximize their overall impact on vaccination. Potential intervention channels include ad campaigns, pamphlets at medical providers' offices, or short commercials or radio ads, targeting both individuals and providers. Interventions can also make use of existing tools, procedures, and systems in physicians' offices, schools, workplaces, or neighborhoods. Mobile apps may also provide an additional channel for scaling interventions.

Although no single intervention is likely to address all of these obstacles, testing multiple interventions and intervention combinations would allow policymakers, providers, and public health institutions to discern which approaches are most effective in increasing global vaccination.

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