Behavioral interventions to increase vaccination rates against Covid-19: Increasing AstraZeneca Vaccine Attitudes and Intention

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Abstract

This thesis first reviews the latest research on behavioral interventions to increase vaccine acceptance and uptake, identifying the policies that work and underlying the determinants of their success. The focus is primarily on studies that appeared after the publication of Brewer et al.'s (2017) in-depth survey of the behavioral literature on vaccination. We identify four major types of interventions that were tested in the lab, online, or the field: social norms-based interventions, opting-out strategies, reminders and recalls, and loss-framed / gain-framed messages (tailored to a particular population or not). Based on the previous literature no experiment testing the different interventions identified in the review with one experiment. The two interventions used in the experiment are social norm-based interventions and loss-framed/gain-framed messages to improve AstraZeneca's COVID-19 vaccine. The experiment was conducted online using Amazon Mechanical Turk with participation restricted to India. We found significant results that the use of empirical message framing stating the number of people who received the AstraZeneca vaccine in Europe to increase vaccination intent and attitudes for both the general COVID-19 vaccine and the AstraZeneca vaccine. Interestingly, a mostly non-significant backlash effect was found in the moral message framing.

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Introduction

Research on behavioral drivers of vaccination, and --in particular-- on vaccine hesitancy, defined as a delay in acceptance or refusal of available vaccination services (MacDonald 2015; Brewer et al., 2017), has been given increased urgency by the Covid pandemic, disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and the consequent global vaccination process. This thesis provides an overview of the most recent literature on the behavioral determinants of vaccine acceptance and uptake, with a particular focus on studies that appeared in the last five years since the publication of Brewer et al.'s (2017) in-depth review article. Afterward, based on the previous literature an experiment testing the different interventions identified in the review will be presented. The thesis's objectives are threefold. The first is to contribute to the burgeoning research on the topic of vaccination acceptance by providing researchers with an overview of the latest interventions that sought to change people's beliefs or behaviors in this domain. The second is to propose an experiment testing the different interventions identified in the review in one experiment. Lastly, and equally important, the objective is to contribute to the current policy debates around the topic of vaccination hesitancy by offering public and private organizations further insights into what works and what does not work in increasing vaccination rates.

From the literature, we classify four types of behavioral interventions. The first type seeks to manipulate people's beliefs about what others do or approve of in the context of vaccination -- these are commonly called "social norms interventions" (Frank, 2020). Some recent field (Karing, 2019; Milkman et al., 2021) and online (Alatas et al., 2019; Bokemper, 2021) experiments have tested the effect of various interventions that leveraged social comparisons or used role models to promote vaccination. As in areas such as pro-environmental-behavior (Cialdini et al., 2006) or tax compliance (Hallsworth et al., 2017) where social norms have proved to work well to change behaviors and beliefs, the results from studies reviewed in this thesis suggest that social norms are a powerful tool to change attitudes and conduct in the context of vaccination.

The second type of study tests strategies that reframe the decision process to possibly make the action easier or be perceived to be easier. One successful strategy adapts the well-known default option nudge, proposing that the default be to receive an automatically scheduled date and time (opt-out) rather than asking the public to individually schedule a vaccination appointment (opt-in) to get vaccinated. Although there are fewer studies that fall within this category, we thought it worth reminding the reader about the results of Chapman et al.'s (2010) field study showcasing the success of an opt-out strategy. Importantly, a more recent study by Giubilini et al. (2019) shows that the opt-out strategy is generally considered acceptable by the targeted population.

The third type of study we review uses reminders or recall systems for people who are due for a vaccination. Reminders make intentions salient and serve as a cue to get vaccinated. Recalls, on the other hand, remind people who are overdue for vaccination. Two recent mega-studies conducted by Milkman et al. (2021a, 2021b) tested different reminder and recall text messages in the field. The most efficient text message reminds people that a shot was "reserved" for them. Others (Yokym et al., 2018; Currat et al., 2020) tested mail reminders/recalls that is a more appropriate method for high-risk individuals who are generally old and may not be as easily reached using phone messages.

The fourth important type of study investigates the effect of messages emphasizing either the risks from not vaccinating (Cuccinello et al., 2020; Lorini et al., 2020) or the benefits from getting a shot (Mowbray et al., 2016). The results show that it is more effective to communicate the risk to oneself and to others than to highlight the benefits from being vaccinated. We also present a study by Altay et al. (2021) that shows the beneficial impact of providing a tailored communication tool by using chatbots. Finally, we point out empirical research showing that some interventions may backfire. For instance, showing images of sick children may decrease rather than increase people's intention to get vaccinated (Pluviano et al., 2017).

In the proposed experiment, the different interventions will be based on message framing. Specifically, framing messages aimed to increase intent to vaccinate and attitudes towards the AstraZeneca vaccine for COVID-19. The AstraZeneca vaccine is of interest to research due to the negative press and stigma towards the side effects of the vaccine causing potentially fatal blood clots. Despite the fears people have with AstraZeneca the European Medical Association believes the "benefits of the vaccine, outweigh the risks" (*AstraZeneca's COVID-19 Vaccine: Benefits and Risks in Context*, 2021). Researching a negatively perceived vaccine provides greater insight on how to shift beliefs from misinformation and vaccine hesitant beliefs. India was chosen as the sample group to test the experiment because of the reacceptance of the AstraZeneca vaccine after a review stopping the distribution made in March 2021, and the low percentage of adults in India vaccinated at the time of the study (May 2021) of 7.9% (Nature Editorial, 2021).

This thesis presents these interventions in detail, focusing on each study's design and results. Section 1 discusses studies focusing on social norms. Section 2 presents the few studies using the opt-out strategy. Section 3 reviews the literature on reminders and recalls. Section 4 discusses the studies that test messages emphasizing different aspects of vaccination (risks, benefits). Section 5 reviews the importance of message framing. Section 6 proposes an experiment testing different interventions identified in the literature and introduces the use of Amazon Mechanical Turk. Section 7 presents the online experiment's methodology and sample. Section 8 analysis the results from the online experiment. Section 9 discusses the results and conclusions made from the experiment and suggests possible future research from the findings made in the experiment.

2. Leveraging Social Norms to Increase Vaccination

Vaccine hesitancy could be the product of social influences such as one's beliefs about what others approve or disapprove of (prescriptive or injunctive norms, see Cialdini et al., 2006) or direct observation of others' behavior (descriptive or empirical norms, see Bicchieri & Xiao, 2009). Both injunctive and empirical norms are commonly acknowledged to play a key role in several policy-relevant domains (Bursztyn et al., 2020). In the context of vaccination, Brunson (2013) reports results from an online survey asking parents in the US to self-report both their own vaccination decisions and the vaccination attitudes of members of their social networks. Parents who failed to meet the recommended vaccination schedule believed that a larger fraction of their social network recommended non-vaccinating and this was a better predictor of vaccination than were demographic characteristics. Therefore, reducing the gap between what one believes others do or approve of and others' real beliefs or behaviors may be a powerful tool to encourage decisions such as vaccine uptake.

A potential response to vaccine hesitancy is to provide endorsement of vaccination from highly visible figures in the media and from the government. Indeed, a large literature in cultural evolution shows that people tend to be more sensitive to social information that is provided to them by prestigious individuals (see Mesoudi, 2011). Prestigious individuals may include political decision-makers, health workers, media representatives, immunization program managers, or community and religious leaders (Brewer et al., 2017). The behavior or public statements of these actors can influence the behavior of the general population and can either encourage or discourage vaccination. One might expect the endorsement to vaccinate from famous people or celebrities to improve vaccination belief and in turn uptake. However, behavioral studies testing celebrity endorsement in domains with high social impact (human rights, poverty, vaccination) remain limited. One of the rare studies on this topic was recently conducted in Indonesia and used Twitter in a randomized controlled experiment to see if celebrity endorsement has an effect on leading people to change their beliefs about vaccination (Alatas et al., 2019). To do so the researchers gained approval from 37 celebrity and 9 influential organization accounts with an average following of 262,647 Twitter followers and 1032 ordinary citizens with an average following of 500, to either randomly tweet or retweet a simple message promoting immunization. A set of 550 tweets was developed in close coordination with the Ministry of Health that sought to improve information about immunization.

The experiment had three main treatments. First, the message source sent from the account of a celebrity or non-celebrity; second, whether the message was original (tweet) or re-posted (retweet); and third, whether the contents of the message included an additional credential reference to the official health department account. In the first tweet, a link to information on immunization from the World Health Organization was included. Retweets were divided into groups either containing just a simple message or providing an additional credibility boost by endorsing the national health department account. All messages included the same hashtag to measure the reach and exposure of the campaign. For each of the 672 total tweets that were originated by the experiment, the authors tracked each time the tweet was liked or retweeted by any of the over 5.5 million unique users who followed at least one of the participants in the study. When the tweet was retweeted by a celebrity's follower, the authors also scraped all of this follower's followers and their liking and retweeting behavior. Finally, a phone survey of 2,441 people who followed at least one of the tweeting participants aimed to capture information on belief in vaccination, past vaccination history for children, knowledge of recent vaccination in their friend's children, and knowledge of immunization on twitter.

The results found celebrity endorsement increased the likelihood of the message being shared and liked by 1.7 times compared to non-celebrities, and authorship from a celebrity was 3 times more likely to be shared and liked. This result is not due to celebrities' higher exposure. In effect, the authors compared likes and retweets of "simple" Twitter accounts when these shared a message from a celebrity compared to when they shared a non-celebrity message. Increasing the credibility of the retweet by including the ministry of health's handle did not increase retweets and likes, but rather decreased these measures by 26%. Exposure to the campaign by seeing

15 tweets from the campaign led to a 15-20% increase in immunization beliefs, while actual vaccination uptake increased on average 12.7%.

In a series of field experiments conducted in India, Banerjee et al. (2021) aimed at studying whether pro-vaccination messages can be more effective when endorsed by trusted local leaders. In 915 villages, the authors collected a full census of the population. Seventeen respondents in each village were randomly sampled from the census to participate in a survey and were asked to identify people with certain characteristics. Within each village, the six people nominated most often by the group of 17 were recruited to be ambassadors for an immunization program targeting young children. The study results suggest that leveraging the community by enrolling local ambassadors seems to be an effective policy. It led to an increase of 26% in the number of children who completed the schedule of immunization every month.

Health care providers such as doctors and health government officials have shown to be the most trusted advisors and influencers of vaccination decisions in the behavioral literature (Paterson et al., 2016). Along with health care providers, highly recognized public health officials in the government endorsing a vaccine have also been shown to increase vaccine acceptance within the general population. Bokemper et al. (2021) compared the effect of endorsement by US government health officials with that of political figures on beliefs and willingness to vaccinate. The experiment consisted of two stages. The first stage asked participants to consider a vaccine with a particular approval date: one week before the presidential election, one week after the election, and a month after the election. After being randomly assigned to a date, participants were asked their likelihood of getting the vaccine and their confidence in its safety and efficiency. The second stage followed the first and randomly assigned subjects to one of six third-party statements: positive or negative statement by the director of the National Institute of Allergy and Infectious Diseases, Dr. Anthony Fauci, positive or negative statement by President Donald J. Trump, joint statement by Trump and Speaker of the House, Nancy Pelosi, or a positive statement from Trump with a negative Pelosi statement. Afterwards, subjects were asked again their likelihood of getting the vaccine and their confidence in its safety and efficiency. A positive statement by President Trump was taken as the baseline condition.

The results from the first experiment showed a significant decrease in vaccine intentions and confidence if made before or a week after the election . If the vaccine is approved a month after the election, vaccine intentions increased by 1.7% compared to if the vaccine was approved a week after the election. In the second stage, endorsement from Dr. Fauci increased vaccination intentions by 21.6%, while a rebuttal from speaker Nancy Pelosi increased intentions by 5.7%. A negative statement from Trump had no significant effect on vaccine intentions and confidence in its safety and efficiency. These results tell us that public confidence in a COVID-19 vaccine is significantly affected by the political context, endorsements from political leaders increases confidence with same party affiliation and decreased or ignored by other party affiliations, and politicization of the vaccine could be particularly detrimental in achieving a high rate of vaccine uptake. Therefore, using politically neutral figures, and in particular health officials, is more likely to increase the intention of the general populace to receive the vaccine.

A similar recent study tested Republican and Democrat leadership endorsements from Trump and Biden respectively among self-identified Republicans on COVID-19 vaccine intentions and attitudes (Pink et al., 2021). The treatment varied by using a video of each president endorsing COVID-19 vaccination. The results found a 7% increase in vaccine intentions with Republican endorsement compared to Democrat endorsement, while vaccine attitudes among Republicans were lower with Democrat endorsement and did not significantly change with Republican endorsement. Interestingly, a backlash effect was found with Democrat endorsement when asking if they would encourage others to vaccinate compared to those in the neutral control and Republican endorsement treatment. These results demonstrate the relative advantage of cues from Republican elites for self-identified Republicans and the risk of messages from Democrats in promoting vaccination amongst the largest vaccine hesitant group in the United States.

More generally, research in behavioral science shows that making one's behavior visible to others can encourage both the signal sender and those who receive the signal to adopt the desired conduct (Rogers et al., 2016). In the context of vaccination, the idea behind observability is that when an individual can be recognized as receiving a vaccination either physically (wearing a pin) or online (Instagram post) in their social group it would send a signal to those in their social network that vaccination is the norm. In Sierra Leone, social signaling was tested by having public clinics give colored bands for babies to wear during childhood immunization (Karing, 2019). Childhood immunization consists of vaccines required in the first year of a child's life. The study used colored bracelets as a signal for receiving one of the five newborn vaccines. The control group did not receive bands. Over the course of 22 months and utilizing 120 public clinics, the addition of colored bracelets with a cost of $1 per child had an effect equivalent to 7 to 10 miles' walking distance from the clinic. Therefore, interventions that increase the observability of vaccination rates in one's community are a powerful tool to drive positive change.

Behavioral science research has also shown the capability to use social norms in text messages to increase vaccine uptake. Recently, Milkman et al. (2021) tested 21 text message interventions with Walmart pharmacy patients. For example, the message "More Americans are getting the flu shot than in the past" increased actual vaccination uptake by 1.5% compared to a control group with no message. This intervention promotes the social norm that other Americans are getting vaccinated. This paper will be explained in further detail in section 4.

3. Using Defaults to Make It Easy to Receive Vaccination

Reducing barriers and increasing the ease to receive a vaccination has been shown to increase vaccine uptake, especially for the larger portion of individuals who are not deliberately avoiding vaccination (Schmid et al., 2017). Providing vaccination clinics in more and easily accessible locations, such as schools, offices, and pharmacies has been a common strategy to reduce the cost of and increase access to immunization. However, while increasing the number of available on-site locations to receive a vaccination is a common recommended policy action, vaccination uptake can remain modest, even amongst those who express favorable intentions to get vaccinated (Banerjee et al., 2021). In effect, it appears that even when people desire to vaccinate, they are slow to commit to a specific time to do so. This trend could be a result of choice overload from clinics offering a large array of dates and times for vaccination (Scheibehenne et al., 2010).

Given the challenge people have in turning their intentions into action, researchers have tested strategies that reframe the decision process to possibly make the action easier or be perceived to be easier. One successful strategy has been to reframe the procedure of individually scheduling an appointment (opt-in) to a default option of automatically scheduling an appointment with a date and time (opt-out). In an opt-out system, an individual is given an appointment from the government, employers, schools, or other institutions and are given the freedom to opt-out or cancel the appointment. From an online survey study of British parents on giving the measles vaccine (MMR) in schools, a default vaccination with the ability for parents to opt out was shown to be a feasible, ethically acceptable, and a potentially effective strategy (Giubilini et al., 2019). While this study provides suggestive evidence that the opt-out strategy may increase vaccination rates, there is research that shows causal evidence. Researchers from Rutgers University in the US sent a letter to 408 university employees to inform them about a campaign of vaccination against influenza (Chapman et al., 2010). Employees were divided into two groups. The first group represented the opt-out condition by receiving an email indicating the scheduled date, time and place where they had to be vaccinated, albeit with the option to cancel at any time. The second group represented the opt-in condition by receiving an email requesting them to choose a date and time to be vaccinated. The results showed a significant effect with the opt-out condition having a 92% retention rate, thus, keeping their appointment and receiving a vaccine. While only 50% of the employees in the opt-in condition made the necessary appointment to be vaccinated. In conclusion, when applied to influenza vaccination faculty and staff at Rutgers University were significantly more likely to receive vaccination in an opt-out system than in an opt-in system.

4. Using Reminders and Commitments to Get It to the Top of the Patient's Mind

Reminders or recall systems are used for people who are due for vaccination. For example, messages are sent stating "Flu season has arrived, remember to get your flu shot". Reminders point out intentions to get vaccinated and serve as a cue to get vaccinated. Recalls, on the other hand, remind people who are overdue for vaccination. The most prominent methods to deliver a reminder or recall are through e-mails, postcards, letters, text-messages, and phone calls. For example, the use of a reminder or recall system from primary care physicians has shown to significantly increase the rates of immunization delivery for children and adults (Szilagyi et al., 2000).

A recent mega-study used text message reminders and recalls to increase vaccine uptake. The study took place in the US and researchers partnered with Walmart to test 19 text-based nudges with over 47,000 pharmacy patients (who were unaware they were participating in a scientific study) designed to increase influenza vaccination uptake (Milkman et al., 2021). The top performing message led to a 4.6 percentage point increase in vaccination, which is related to a 11% increase, at the cost of sending two text messages. The first text message, in this condition, was sent 72 hours before the patient's appointment at the local medical center noting that "it's the flu season" and "a flu vaccine is available for you." The second text message in this condition was sent 24 hours before the appointment simply stating: "reminder that a flu shot is *waiting* for you at Walmart". The underlying theory behind this intervention emphasizing that a vaccine has been "reserved" for the patient is the concept of mental accounting. For example, one basic principle in economics is that money is fungible. To say that money is fungible means that, regardless of its intended use, all money is the same. However, studies in behavioral economics found that this principle is often violated in practice (Shefrin and Thaler, 1988; Thaler, 1999; Abeler and Marklein, 2017). For example, people tend to categorize their money into separate non-fungible accounts: savings accounts, retirement accounts, etc. The idea is that one may spend less on temptation goods (for example, buying an expensive watch) if the salary is transferred automatically on the savings account instead of the normal account. Taking money out of the savings account makes one feel more guilty. This is exactly the idea of the reminder that a vaccine has been "reserved" for the patient: in theory, the vaccine can be used for anyone but labeling it as reserved for someone specifically makes that person feel guilty if s/he doesn't take it on time.

The second highest performing message in Milkman et al.'s (2021) study increased uptake by 1.7% by aiming to promote feelings to protect others with a message including "If you get it, you'll help protect family and friends from the flu and possible hospitalization." The third highest performing message was identical to the top performing of a "flu shot waiting for you" and had an additional message of "Will you encourage 1 person to vaccinate". This message increased uptake by 1.7%.After the initial text message was sent, a reminder text was sent 3 days later for both treatments. Other top performing interventions that increased vaccine uptake by more than 3% were two text messages reminding to "don't' forget to get a flu shot", had a hard health behavior quiz, and a message of "remember to ask for your flu shot".

Other than text interventions, mail reminders/recalls are a more costly method to remind people to vaccinate but could be effective with high-risk individuals who are generally old and may not be as technically sophisticated. Researchers in the US randomly sent one of five versions of a letter intended to motivate vaccination to 228,000 Medicare beneficiaries over the age of 65 (Yokum et al., 2018). The five treatments were no-letter (the control group), an informational letter from the National Vaccine Program Office, an informal letter from the acting US Surgeon General, and a letter from the Surgeon General with either a simple or an enhanced active choice (more detailed) implementation intention prompt. The results showed a statistically significant but marginal increase in vaccination uptake of 0.4% to 0.9% increase for all treatments compared to the control of 25.9%. Similar modest results have been found in a recent field study that looked at increasing health care workers' influenza vaccination at a hospital in Switzerland by promoting vaccination at a pre-employment health check and sending a postcard reminder before the next vaccination campaign - "time of year where flu vaccine is available" - (Currat et al., 2020). Therefore, the use of physical mail reminders has limited positive effects.

Contrary to the modest results with mail remainders, behavioral interventions using email reminders and form implementation, asking participants to fill in a non-binding commitment via a form to fill in, have shown to be more successful. The behavioral theory behind form implementation is that making a plan helps people develop a mental link between a situation and the desired response, which as a result increases the likelihood that people will perform the desired action when the opportunity emerges. In a large field experiment, researchers measured the effect of prompts to form implementation-intentions at a midwestern (US) utility firm with 3,272 employees (Milkman et al., 2011). Participants all received reminder mailings by email that listed the times and locations of a free-on-site vaccination clinic for the influenza vaccine. The mailings randomly differed in three treatments. In the first, the mailing had a prompt to write down the date people plan to be vaccinated. In the second, the mailing had a prompt to write down the date and time they plan to be vaccinated. Lastly, in the control condition, no prompt was given. The control group had a vaccination rate of 33.1%. The treatment with solely the prompt to write down the date had a 1.5% increase in vaccine uptake from the control, while the treatment with the prompt to write down the date and time had a 4.2% increase in vaccine uptake compared to the control.

5. The Importance of Message Framing

Using standard messages that are meant to increase people's awareness of the risks associated with some behavior has often led to mixed results (see *Nature Human Behavior*'s 2018 editorial note on "what works for behavior change"). Standard information campaigns rely on the idea that providing people with more information will make them more aware of the costs and benefits which, in turn, is supposed to drive behavior change. In theory, making people aware of the benefits *or* costs related to a specific behavior should have the same effect. However, the existing studies tend to show that people react in very different ways to loss-framed messages (messages that emphasize potential losses) compared to gain-framed ones (messages that emphasize potential gains).

In a recent field study in Italy, messages signed by a high-profile figure to promote credibility were used with the aim to increase risk awareness of employees in several nursing homes (Lorini et al., 2020). The treatment was a letter sent to every single worker in the nursing homes that took part in the study. The letter was signed by a high-profile figure (the Chief Director of the Regional Health Agency) and was meant to raise awareness on the professional responsibility toward fragile people in case of non-vaccination. A leaflet including all the useful information about how to get vaccinated was provided. An anonymous paper-and-pencil questionnaire was implemented to capture the nursing homes workers' intention to get the influenza vaccine. Furthermore, a few months after the study (and after the vaccination campaign ended), the authors used an online questionnaire in the same nursing homes to collect individual data regarding influenza vaccination during the influenza season that ended earlier that year. A similar online questionnaire was administered to nursing home workers in the control and in the treated group one year after the intervention, two years after the intervention, and three years after the intervention. Results show that workers' intention to get vaccinated and self-reported rates of actual vaccination were significantly higher in the treated group compared to the control group. Furthermore, this difference persisted over time.

In relation to studying the effects of highlighting the risks to others of not vaccinating, Cuccinello et al. (2020) aimed to study decision-making when there is a third player who is at risk and cannot decide for themselves, such as the immunosuppressed, newborns, or pregnant women. To empirically assess how the presence of vulnerable individuals affects vaccination intention and behavior, the authors conducted a survey experiment on a sample of Italian parents and a lab experiment with graduate students from an Italian university. In the survey experiment, 507 Italian parents were recruited for the study. The sample was representative of the Italian population of parents on parameters of age, income, gender, and education level. Once enrolled, participants were randomly assigned to either a two-player or a three-player game where participants had to choose between cooperation (framed as Choice 1 in the experiment) and defection (framed as Choice 2). In the three-player game, the third player had no action in the game and his payoff depended on the actions of the two active players, with the payoff being highest when the two cooperated, second highest when at least one cooperated, and lowest when no one cooperated. The game can be seen as mimicking the trade-off between vaccinating or not.

The laboratory experiment conducted with 374 graduate students used a similar cooperation game as the one described above. The treatments in the survey and laboratory studies varied on the prompts on a hypothetical scenario of a serious measles outbreak with a high mortality and an effective free vaccine that is available. The prompts either had detailed information or little information on the mortality rates and vaccine side effects. After reading the prompts the participants were asked questions to assess their understanding of the information. Results show that cooperation was significantly higher in the presence of a vulnerable player both in the survey and in the laboratory study. There were no significant framing effects -- that is, the prompts had no significant effect on behaviors. In addition, the two studies offered evidence of conditional cooperation: the more subjects believed that others around them chose to cooperate, the more likely they were to do so.

Contrary to promoting risk appraisals, behavioral science also tested the effect of messages promoting the benefits from receiving a vaccination. Using a focus group design with a total of 41 participants in the UK, researchers tested four message frames on a hypothetical pandemic caused by influenza (Mowbray et al., 2016). They found factual vaccination messages and evidence-based messages to be the most convincing, especially when they gave cost-benefit comparisons. Messages promoting health benefits were perceived as not honest and received poorly, while negative-framed risk reduction messages were perceived to be more balanced and creditable. Lastly, messages aimed to elicit feelings of anticipated regret for not getting vaccinated were poorly received as being patronizing and unprofessional. Therefore, the most effective messages were short, transparent on the potential side-effects, factual, and emphasized the cost and benefits of vaccination, particularly regarding vaccine safety. The study, however, provides only suggestive evidence and had a very small number of participants, thus limiting its generalizability.

Messages can address general concerns or target barriers that are specific to certain groups. One study in the laboratory tested nontailored messages and tailored messages on the acceptance of the HPV vaccine with young adult women in the US (Gerend et al., 2013). The study delivered the messages as questions with the answers. All participants received *nontailored messages* designed as the baseline. The treatment group received additional *tailored messages* based on an earlier survey on the perceived barriers they face (relationship status, sex life, work schedule, financial status, etc) as the treatment variable. The results show that both messages increase vaccination intention with tailored messages being significantly more effective. Following the idea of tailoring messages, Altay et al. (2021), used an autonomous “chatbot” of predetermined answers for common questions about COVID-19 vaccine to change attitudes and beliefs related to the vaccine against COVID-19 in France. The study was conducted online with a large sample that is close to being representative of the French population. Participants answered a belief and intention survey before and after the intervention of clicking on questions about the COVID-19 vaccine. The results found a significant 37% increase in positive attitudes towards the vaccine and a 20% decrease in not wanting to receive the vaccine. Furthermore, the time spent with the chatbot increased positive attitudes with the most negative outlook group having the biggest shift. By answering common questions and concerns about the COVID-19 vaccine, this experiment also falls in the category of using information to debunk myths and misperceptions about vaccination.

Nyhan and Reifler (2015) aimed at correcting myths by providing information debunking myths or about the risks and pros of the influenza vaccination. They used a survey-based online study in the US election poll with the first wave of 1000 respondent's pre-election and 800 returnees post-election to measure time differences. Specifically, the researchers aimed to change beliefs that the vaccine can give you the flu, increase the perceived safety of the flu vaccine, and increase the likelihood of receiving the vaccine. All messages were taken from the CDC website. The results found vaccination intent did not change for most of the participants and had a high significant decrease of 18% in vaccination intent with those who have high concern on being vaccinated when being told that the flu vaccine cannot give you the flu.

Another study on addressing myths and misperceptions with information campaigns focused on parents' beliefs regarding the possible side effects of giving the measles-mumps-rubella vaccine (MMR) to their children (Nyhan et al., 2014). The MMR vaccine for newborn babies is an interesting vaccine to study beliefs as it has well entrenched false beliefs of causing autism in children. Therefore, the vaccine is used to study the effects of misinformation on a vaccine, paralleling the fears regarding the possibility of the AstraZeneca vaccine for COVID-19 causing blood clots. The researchers used messages with a loss-frame on beliefs that the vaccine causes autism and MMR has side effects, and on the parent's intent to vaccinate their child. In total, they had four treatments. One contained messages outlining the lack of evidence that MMR causes autism (autism correction), another contained information about the dangers of measles (disease risks), a third used images of children who have measles, and the fourth treatment used a dramatic narrative about an infant who almost died from measles. None of the interventions increased parental intent to vaccinate a future child. In contrast, the diseased images increased beliefs of MMR having serious side effects by 3.7%. The dramatic narrative also increased side effect beliefs by 6.1%. Another study that found a backfire effect is Pluviano et al. (2017), which compared three strategies to promote vaccination for MMR: contrasting myths versus facts, employing fact and icon boxes, and showing images of non-vaccinated sick children. The study aimed to measure vaccination beliefs linked to side effects and autism and intentions to vaccinate a future child. A backfire effect was observed, reinforcing ill-founded beliefs about vaccination and reducing intentions to vaccinate. Fact and icon box strategy backfired the least. The use of images of sick children led to the strongest backfire effect, illustrating the perils of using loss-framed images and fear appeals to promote preventive health behaviors. The backfire effect seen in the myth versus fact format supports the literature showing that countering false information in ways that repeat it may further contribute to its dissemination.

6. What we learn from existing evidence

From the review of the literature the behavioral interventions that seem to work best to increase vaccination rates has been to utilize social norms, reducing the barriers to vaccinate, making vaccination prominent in people's minds, and to use efficient and direct message framing. Social norms have shown to successfully increase vaccination uptake in field experiments and intentions and attitudes in lab and online experiments. The use of a descriptive social norm in a text message increased vaccination uptake by 1.5% (Milkman et al., 2021). Making an action more visible to others increased vaccination uptake in health care centers and in rural villages (Rogers et al., 2016; Karing, 2019). Lastly, intentions and attitudes increased for the COVID-19 vaccine when presented by self-identified political party elites (Pink et al. 2021). Experiments to reduce the barriers to vaccinate have largely been successful field studies in increasing vaccination uptake. Chapman et al.(2010) demonstrated in their opt-out field experiment a 92% retention rate in the opt-out condition compared to the standard opt-in condition having a 50% retention rate for the appointment. Reminder and recall systems have found significant results in increasing vaccination uptake. Milkman et al. (2021) found a 11% increase in vaccination with their top performing text message reminding a patient it is flu season and a flu shot is waiting for them. Lastly, a large portion of the behavioral research for interventions to change vaccine hesitant beliefs have been to use message framing. Lorini et al. (2020) tested message framing emphasizing the professional responsibility of nursing home employees to get the influenza vaccine and found to increase intention to vaccinate and actual vaccination uptake that persisted over time. Similarly, Cuccinello et al. (2020) emphasized the morals to vaccinate to protect people who are unable to vaccinate and found evidence of conditional cooperation. Mowbrary et al. (2016) tested four different message frames on the influenza vaccine and found that factual evidence-based messages to be the most effective and loss-framed messages and those aimed to elicit feelings of anticipated regret to get vaccinated to be the least effective. Altay et al. (2021) used a question-and-answer format to deliver messages to change attitudes and beliefs of the COVID-19 vaccine in France. They found a 37% increase in positive attitudes toward the vaccine and a 20% increase in intention to vaccinate. Backfire effects have been found in the experiments of Nyhan and Reifler (2015) correcting myths of the influenza vaccine and Pluviano et al. (2017) correcting autism myths for the MMR vaccine. In the experiments, provision of information on the influenza vaccine and the use of loss-frame images of sick children with measles were shown to be not effective. From the literature review it is important to study the behavioral interventions identified in the review but by using identical controlled experimental conditions. Since this has not been done by others, I am proposing such an experiment. The proposed experiment aims to test message frames for the AstraZeneca vaccine to see which messages could increase intention and attitudes towards the vaccine. The experiment will test five treatments of message framing for the AstraZeneca vaccine against COVID-19.

7. Methodology: Experimental evidence on the effect of messages on vaccine intention and attitudes

a. Experimental treatments

The first treatment tests a gain frame message using scientific evidence of the benefits from receiving the AstraZeneca vaccine from the European Medical Agency (EMA). The second treatment tests a loss frame message using scientific evidence and emphasizes the possible detriments of not receiving an AstraZeneca vaccination with information taken from the World Health Organization (WHO). The first two treatments are a gain and loss frame message aim to replicate the results of Mowbray et al. (2016) of short and transparent messages with factual scientific information of the vaccine improves intentions and attitudes. The third treatment tests an empirical message of the number of people in the European Union, the United Kingdom, and Germany who have received an AstraZeneca vaccine according to AstraZeneca's website. The third treatment tests social norms similar results from Milkman et al.'s (2021) social norm text message on making the number of people vaccinated with AstraZeneca in Europe visible to increase vaccination intent and attitudes. The fourth treatment tests a counteracting misinformation message of the AstraZeneca vaccine causing blood clots by comparing statistical information on the chance of experiencing a blood clot with the vaccine versus taking a birth control pill. Statistical information for the birth control pill was taken from the Food and Drug Administration in the United States. The message ended with an emphasis the EMA endorses the vaccine and that the "benefits are greater than the risks" (*AstraZeneca's COVID-19 Vaccine: Benefits and Risks in Context*, 2021). This treatment aims to test the results from Nyhan et al. (2014) and Nyhan and Reifler (2015) where messages framed to dispute myths and misinformation backfired. The fifth treatment tests a moral message for the AstraZeneca vaccine and emphasizes the benefit of protecting others by taking the vaccine with no health organization accredited. The fifth treatment tests a moral frame message and is based on Cucinello et al. (2020) and Milkman et al.'s (2021) message of the benefits to others when getting vaccinated increased vaccine uptake, intention, and attitudes. The control group received a short message about the history of the Eiffel tower. The treatments also test the effect of health provider accreditation from recognized national and international health organizations as the basis from the information provided in the messages; with the fifth treatment not accrediting an organization. A large portion of the literature explained in section 2 tests the effects of messages from political leaders versus health care leaders but testing this effect is not the goal of the experiment, thus, only the effect of health organization endorsement is provided.

b. Implementation of the experiment

Data was collected between May 4 to May 7, 2021. India was selected as the targeted sample population for the experiment because of the low vaccination rate in the country (8% as of April 14; Nature Editorial, 2021), the recent re-acceptance for the AstraZeneca vaccine in the country, the increasing spread of the B.1.617 variant during data gathering (Vaidyanathan, 2021), and the availability of using Amazon MTurk to gather data. The experiment was conducted using an online survey. The AstraZeneca vaccine is tested because of the media controversy over the possible side effects from the vaccine, which would provide insight on a vaccine that is not well perceived by the public compared to its competitors.

The survey began with a confidentiality and consent form and provided my contact information if the participants had further questions. Afterwards demographic information of age, gender, and highest education level attainted were gathered. Next, the participants were randomly split into 5 treatment or control groups. An instructional manipulation check (IMC) was used after the participants read their message and was to identify inattentive participants to split the sample. Lastly, a survey was conducted to measure general COVID-19 vaccination intent and attitudes and AstraZeneca vaccination intent and attitudes. In total, the survey had 16 items, four items measured intent, four items measured encouraging others to vaccinate, and 8 items measured attitudes. Half of the items in each category were for general COVID-19 vaccine and the other half in each category were for AstraZeneca vaccine. The first question on intent asked, "When the COVID-19 (AstraZeneca) vaccine becomes available to you, how likely are you to choose to get the vaccine," and was rated on Likert scale from 1 to 10, with 1 being extremely unlikely and 10 being extremely likely. The second question asked if the COVID-19 (AstraZeneca) vaccine was made available would the subject accept to get the vaccine on a four-point scale. The four measures of attitudes were also measured on a 10-point Likert scale. The first measure asked if the benefits of the vaccine are greater than the risks. The second measure asked if the vaccine will keep the subject from getting severely ill. The third measure asked if people have a responsibility to get the vaccine. The fourth measure asked if a large majority of people get the vaccine, would it help the economy. The last two items asked, "if a family member (friend) who was unsure to accept the COVID-19 (AstraZeneca) vaccine, how likely would you be to encourage them to get the vaccine?" These two measures were also on a 10-point Likert scale and is the measurement for encouraging others to vaccinate. The COVID-19 vaccine survey questions were originally derived from the paper by Pink et al. (2021) with the addition of AstraZeneca specific questions added.[1] However, while the questions originally derived from Pink et al.'s paper, the analysis of the survey responses were made separate from their paper.

b.1 Using Amazon Mechanical Turk

Amazon's Mechanical Turk (MTurk) has been shown to be an effective and reliable method to gather participants for research in marketing, political science, psychology, sociology, and economics. Mturk is a crowdsourcing web service for people to complete tasks for compensation. Researchers can set requirements for subjects, such as country of residence and prior approval rate from other tasks. MTurk has the benefit of providing a more diverse and more representative sample of survey respondents than the standard undergraduate college samples (Buhrmester et al., 2011). Furthermore, relative to other convenience samples, researchers found MTurk participants respond to experimental stimuli in a manner consistent with the results of prior research (Cassese et al., 2013). The two largest demographic users on MTurk are the United States and India. One issue with using MTurk is the possibility of participants who are essentially professional workers on MTurk. These subjects could potentially skew experiment results by trying too hard to please researchers as there is an incentive to do so with the reputation system (Bohannan, 2011). Another issue is the low pay participants receive being an economic injustice and more importantly an issue of proper compensation for significant results.

[1] The AstraZeneca questions were the same as the general COVID19 questions with the replacement of COVID-19 to AstraZeneca

Indeed, a large body of evidence has shown that workers withhold effort when their payment is below what they perceive as fair (Chouliarkis & Corre-Lopez, 2014). For example, a pay rate of $0.50 for a 5-minute survey has an effective hourly rate of $6.00, which by contrast a typical undergraduate sample is paid $5-10 per subject and $30 for nonstudent campus samples (Felstiner, 2011). This issue could be seen as an ethical issue rather than an empirical issue as there is a general conclusion that compensation rates do not affect data quality in the MTurk literature (Bohannon, 2011; Chandler et al., 2013). However, Indian participants have different motivators than their American counterparts. Most of the Indian participants earn less than $10,000 per year and rely on their MTurk earnings as basic income, whereas in the United states Americans reported using MTurk as a secondary source of income, because the tasks were fun, and to kill time (Ipeirotis, 2010).

Litman, Robinson, and Rosenzweig (2014) experimented on MTurk testing the extent Indian-based participants are motivated by monetary reward compared to US-based participants, the quality of the data collected among India-based samples, and the effect of monetary compensation on data quality among India-based workers. The manipulation of interest was the payment condition per a task of below minimum wage of 2 cents, at minimum wage of 5 cents, the above minimum wage of 10 cents, and the extreme wage of $1. This payment scheme came from their research that the minimum wage in India for non-agriculture workers was 28-50 cents per hour and their task took 6 minutes to complete. The same payment scheme was used for the American sample. In the survey, participants completed a Big Five Inventory personality questionnaire and a survey on five possible reasons for why they used MTurk.[2] To examine data quality, the authors developed a squared discrepancy procedure, which is a task-based quality assurance approach to identify inattentive participants. The results found that data quality is directly affected by compensation rates for India-based participants and data were of lesser quality among India-based than among American participants, even when optimal payment strategies were utilized. In contrast to previous literature, both Indian-based and American-based workers reported monetary compensation as the primary reason for working on MTurk. The authors concluded that high-quality survey data can be acquired on MTurk for Indian participants when an appropriate pay rate is provided, and task-specific quality assurance procedures are utilized. Therefore, payment for an MTurk worker must be at least equivalent to the minimum wage.

[2] An additional 10 reverse questions were also asked to serve as an attentiveness check.

b.2. Sample

Participation for the experiment was made using Amazon MTurk and was restricted to the Indian population and those with a HIT approval rating above 85%. While the participants were gathered using MTurk, the survey took place using Limesurvey. A total of 519 responses were received, with 20 incomplete responses resulting in a total sample of 499 subjects. The participants were mostly male being about 75% of the sample with 372 males and 127 females. Most of the participants have a graduate degree or higher make up 90% of the sample (see table 1). The average age in the sample was 32.8 (SD=7.6), the oldest was 73 and the youngest was 20. A total of 400 participants were paid .25 cents USD from MTurk and the other 99 participants are assumed to have been gathered from the participants sharing the survey link. The estimated time to take the survey was 5 minutes and the average time taken from MTurk was 9 minutes. Thus, for both 5 minutes and 9 minutes, a payment of .25 cents is appropriate and above the estimated base wage in India for the time spent taking the survey.

To measure COVID-19 vaccine intent and attitudes separately from AstraZeneca vaccine intent and attitudes a reference question was made. The IMC question tested if the participants properly read the message of interest, which asked "which COVID-19 vaccine is mentioned in the passage above". Across the five treatment groups, 45 participants answered the reference question incorrectly and were removed from the AstraZeneca data sample. The COVID-19 vaccine data sample kept these 45 participants as the message discussing AstraZeneca should not have a significant effect on their general COVID-19 vaccine intent and attitudes. In summary, the data sample used to test survey responses on COVID-19 vaccination has 499 respondents and the data sample used to test survey responses on AstraZeneca vaccination has 454 respondents.[3] Table 1 presents the sample demographics of the full *n* = 499 COVID-19 sample and the reduced *n* = 454 AstraZeneca sample. The reduced sample saw a decrease in female subjects, a change in participants younger than 30 depending on treatment, and an increase in subjects with a graduate degree or higher.

[3] Note that these two sample groups overlap with the difference being that the AstraZeneca sample group does not include participants who failed the IMC question.

Table 1
Sample Demographics: COVID-19 (AstraZeneca)

		Treatment group					
		Control	Gain Frame	Loss Frame	Empirical Evidence	Countering Myth	Moral
Sex, %							
	Female	23	28(24)	27(25)	31(30)	17(33)	24(17)
	Male	77	72(76)	73(75)	69(70)	83(67)	76(83)
Age, %							
	Younger than30	28	45(41)	34(40)	39(35)	25(38)	39(27)
	Older than 30	72	55(59)	66(60)	61(65)	75(62)	61(73)
Education, %							
	Undergraduate and below	11	12(4)	10(10)	12(4)	14(9)	6(13)
	Graduate	70	62(77)	61(63)	75(66)	61(78)	76(60)
	Post-graduate	19	26(19)	29(27)	13(30)	25(13)	18(27)
Total N		88	82(70)	93(73)	87(82)	75(78)	74(63)

8. Results

a. Exploratory Factor Analysis

An exploratory factor analysis (EFA) was done to test the reliability and validity of the 16 survey questions. The questions for the analysis were separated by the data samples with 8 items related to the COVID-19 vaccine tested with the COVID-19 sample group and 8 items related to the AstraZeneca vaccine tested with the AstraZeneca sample group. Respectively, according to Pink et al.'s (2021) paper, there should be three factors from the scale. The first factor is on vaccination intent with the question on a ten-point Likert scale “ When the COVID-19 (AstraZeneca) vaccine becomes available how likely you are chosen to vaccinate” (Q1) and a four-point scale asking, “If a COVID-19 (AstraZeneca) vaccine becomes available to you, would you choose to get it…” (Q2). The second factor has four questions on vaccination attitudes (benefits of getting the vaccine, the vaccine will keep me from getting ill, responsibility to get the vaccine, and the vaccine will benefit the economy) on a ten-point Likert scale (Q3-6; see Appendix 1). The third factor two questions on encouraging others to vaccinate on a ten-point Likert scale asking, “If you had a family(friend) who was unsure to accept the COVID-19 (AstraZeneca) vaccine, how likely would you be to encourage them to get the vaccine” (Q7-8).

The EFA began by separating both data samples in half to use half the sample for the EFA and the second half for the Confirmatory Factor Analysis (CFA). Next was to find the associated eigen values for the survey responses by using a principal components/correlation analysis. The initial eigenvalues suggested only one factor in COVID-19 items. However, following a principal axis extraction with an orthogonal rotation (oblimin) a two-factor model was found to be a better fit for the COVID-19 items (table 2). For the AstraZeneca related items, a two-factor model was suggested and was also found to be a good fit with an orthogonal rotation. Oblimin was used as it is expected that items will be correlated with each other and continuous. After the initial factor analysis, Q2 had a low factor loading (F=.3, h^2=.12) with the COVID-19 items and was subsequently removed. Likewise, Q2 had a low factor loading compared to the other item in its factor and was removed from the AstraZeneca items. The COVID-19 model explained 60% of the variance, while the AstraZeneca model explained 69% of the variance (Table 3). The increase in the explained variance with the AstraZeneca model could be the decrease in the sample size but could also be an indication of the treatments affecting the survey items factors are fitted better.

The Kaiser-Meyer-Olin measure was 0.91 for the COVID-19 sample and 0.92 for the AstraZeneca sample which indicates a very high degree of sampling adequacy. Interestingly, the first factor consisted of in the COVID-19 data sample indicated vaccine intent and loaded with 2 questions meant for encouraging others to vaccinate. These same three questions asked for the AstraZeneca vaccine loaded on the second factor together in the AstraZeneca analysis. The two questions for encouraging others were " If you had a family member (friend) who was unsure to accept the COVID-19 (AstraZeneca) vaccine, how likely would you be to encourage them to get the vaccine". The same factor loading could be that those who would more likely encourage a family member or friend to vaccinate would also be likely to receive the vaccine themselves. Therefore, the three items will be classified as vaccine intention. The last eight questions (four per a data sample) measuring vaccine attitudes did load together on the secondary factor with factor loadings ranging from .43 to .63 (*mdn* = .54) for the four COVID-19 questions and .56 to .73 (*mdn* = .67) for the four AstraZeneca questions. The results from the EFA are satisfactory and a CFA was run subsequently.

b. Confirmatory Factor Analysis

Taking the split samples, the CFA began by making the two-factor model for the COVID-19 sample and the AstraZeneca sample to test the relations between latent factors and the observed indicator variables. In the 2-factor COVID-19 model, the survey items Q3 and Q4 had an additional correlation in the model (χ^2/df = 2.155,

CFI = .978, *TLI* = .961, *RMSEA* = 0.081, *SRMR* = 0.026) (table 4). Everything but the RMSEA had a good score showing that we could reject the null hypothesis and show there is no relation between the latent factors and the observed variables. However, with the RMSEA above .08 then we are unable to reject the null hypothesis. The CFA analysis in the 2-factor AstraZeneca model (χ^2/df=2.155; *CFI* = .978; *TLI*=.961; *RMSEA* = 0; *SRMR* =.019) provided better results. These results were good scores, and we could reject the null hypothesis that there is no relation between latent factors and the observed variables. However, the p-value was found not significant (p = 0.538), thus, we cannot say with confidence that we can reject the null hypothesis. The results found in the CFA were not satisfactory and can indicate that the survey items do not measure the intended factors of vaccine intention, attitudes, and encouraging others. One possibility for the not perfect CFA s did not fit due to the limited survey items trying to measure more than one factor, which could also be an explanation for the suggested one-factor model for the COVID-19 sample's EFA. The limited survey items to expected factors could also be alleviated if more data were collected.

c. Overview of the results

Fig 1: Intention to vaccinate COVID-19

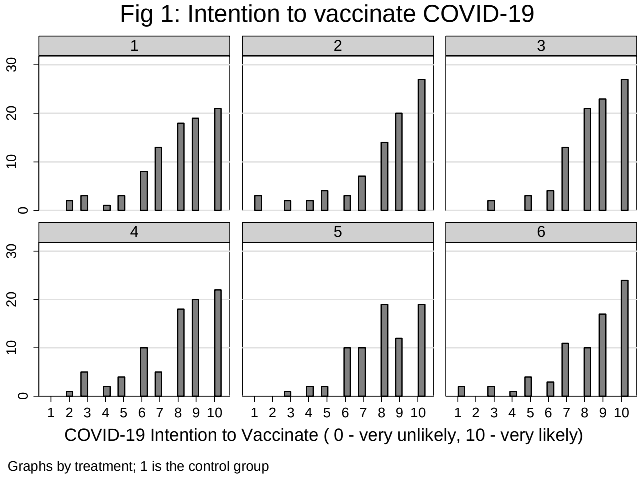
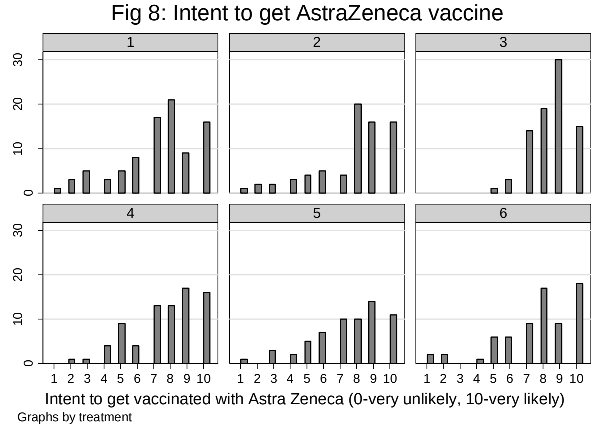


Fig 8: Intent to get AstraZeneca vaccine



Figures 1 and 8 showcases the frequency of the responses for the COVID-19 sample on general COVID-19 vaccine related questions and responses for the AstraZeneca sample on the AstraZeneca vaccine related questions. The histogram labeled 1 represents the control group. The histograms labeled 2 to 6 are the treatments of loss frame, empirical, misperception, moral, and gain frame, respectively. The largest differences between are the decrease in responses of 9 and 10 in the AstraZeneca sample. In treatment three, however, we see a large increase in the "likely" response of 9 in the AstraZeneca sample. Similar results are found for the rest of the treatment groups and their respective histograms are found in the appendix (fig 2-14).

An independent t-test was made as a pre-test measure for the question on intent and a combined measure of attitude for each treatment compared to the control. Attitudes were defined as the mean score of the four questions dealing with attitude. The 87 participants in the COVID-19 sample who received the empirical treatment compared to the 88 in the control group demonstrated a significant increase in intent (*8.398* ± .161), t(179) = -1.859, p =.065 (table 5). The empirical treatment compared to the control group also demonstrated a significant increase and attitudes (8.266 ± .154), t(179) = -2.079, p = .041. Similar significant results were found with the 82 participants in the AstraZeneca sample for the empirical treatment group compared to the control group (table 6). There was no significant effect for the other treatments.

d. Individual level analysis

A Tobit regression was first made to test the between-subject design treatment effects and to classify the treatment groups as a categorical variable. The treatment groups are regressed on the control variable. Thus, the results are based on the differences between a treatment group and the control. After a Tobit regression and OLS regression were made to see if the outcomes are like the Tobit regression to get a better interpretation of the coefficients.

Table 7
Tobit Regression

		Treatment				
		Gain Frame	Loss Frame	Empirical	Myth	Moral
COVID-19 Vaccine						
	Covid Intent	0.410	0.434	0.693***	0.042	0.179
	Covid Family	0.352	0.151	0.514*	0.265	-0.229*
	Covid Friend	0.444	0.463***	0.534*	0.286	-0.129
	Covid Benefit	0.121	0.143	0.330	0.366	-0.351
	Covid Keep getting ill	0.303	0.609	1.005***	0.374	0.236
	Covid Responsibility	-0.006	0.273	0.447	0.412	-0.426
	Covid Economy	0.002	0.282	0.711***	0.348	-0.034
AstraZeneca						
	AZ Intent	0.603***	0.646	1.357***	0.545	0.300
	AZ Family	0.008	-0.145	0.978***	0.287	-0.150
	AZ Friend	-0.002	-0.138	0.718***	0.236	-0.153
	AZ Benefit	-0.051	0.092	0.730***	0.682*	-0.149
	AZ Keep getting ill	-0.240*	0.436	1.110***	0.568***	-0.019
	AZ Responsibility	0.046	-0.040	0.646***	0.299	-0.440
	AZ Economy	-0.021	0.041	0.712***	0.404	-0.226

****p* < .01, ** *p* < .05, * *p* < .1
Note: treatment group is based on the control group and data is clustered at session level (day)

d.1 Intention to get the vaccine

As predicted in the pre-test, the empirical treatment group that provided scientific data on the number of people who received the AstraZeneca vaccine in Europe had the best results. In the Tobit regression (table 7), the treatment was statistically significant for the general COVID-19 vaccine questions for increasing intentions to vaccinate (*cf* =.693, *p* =.001) and encouraging a family member (*cf* =.352, *p*=.084) and a friend (*cf* =.534, *p*=.079) to vaccinate. Interestingly, a significant effect was found in loss frame treatment on the item encouraging a friend to vaccinate (*cf* =0.463, *p*=.000). The AstraZeneca focused questions measuring intention had highly significant effects in the empirical treatment (*cf*=.1.36, *p*=.069; *cf*=.978, *p*=.000; *cf*=.718, *p*=.000). This suggests that the empirical intervention successfully increased AstraZeneca vaccine intentions and attitudes. Unlike in the general vaccine questions, the AstraZeneca questions had significant effects in the gain frame treatment for increasing intentions to vaccinate (*cf*=.603, *p*=.014). Unexpectedly, the moral treatment had a backfire effect on most items on intent and attitudes. However, all but the item encouraging a family member to vaccinate in the COVID-19 sample (*cf* =-.229, *p*=.1) did not have a significant effect. Overall, the results in the Tobit regression for vaccine intention and significantly supports the effectiveness of the empirical treatment.

In the OLS regression (Table 8), similar more restricted effects were found in comparison to the Tobit regression for the measures of intent. Specifically, for the COVID-19 sample, a significant effect was found in the empirical treatment on the intention measure (*cf*=.527, p=.078) and the loss frame message for encouraging a friend to vaccinate (*cf*=.426, p=.089). The AstraZeneca sample found significant effects for all three question items on intent for the empirical treatment (*cf*=1.25, *p*=.037; *cf*=.83, *p*=.015; *cf*=.69, *p*=.025). Thus, showcasing that the empirical message frame increased AstraZeneca vaccine intention by 1.25 units for every 1% increase on the intention indicator. Similarly, a .83 and .64 unit increase in vaccine intention per a 1% increase in intention was found in encouraging a family member or friend to vaccinate, respectively. No other measure of intention was found statistically significant in the AstraZeneca sample.

Table 8
OLS Regression

		Treatment				
		Gain Frame	Loss Frame	Empirical	Myth	Moral
COVID-19 Vaccine						
	Covid Intent	0.231	0.247	0.527*	-0.018	0.132
	Covid Family	0.318	0.169	0.474	0.198	-0.148
	Covid Friend	0.379	0.426*	0.503	0.236	-0.059
	Covid Benefit	0.130	0.114	0.234	0.232	-0.287
	Covid Keep getting ill	0.226	0.459	0.773***	0.265	0.240
	Covid Responsibility	0.029	0.155	0.390	0.271	-0.367
	Covid Economy	0.007	0.191	0.508	0.226	-0.020
AstraZeneca						
	AZ Intent	0.469	0.541	1.255**	0.465	0.278
	AZ Family	0.060	-0.064	0.834**	0.221	-0.044
	AZ Friend	0.079	-0.070	0.639**	0.200	-0.070
	AZ Benefit	-0.026	0.046	0.524	0.550	-0.174
	AZ Keep getting ill	-0.246*	0.326	0.920***	0.402	-0.046
	AZ Responsibility	0.010	-0.069	0.537*	0.158	-0.382
	AZ Economy	-0.074	-0.054	0.502***	0.259	-0.192

***p < .01, ** p < .05, * p < .1
Note: treatment group is based on the control group and data is clustered at session level (day)

d.2 Attitudes toward the vaccine

In the Tobit regression, attitudes toward the general vaccine were highly significant for the empirical treatment on the question that the vaccine will keep me from getting ill (*cf*= 1.005, *p*=0.000) and vaccine benefits the economy (*cf=.71, p*=.007; Table 7). No other question item focusing on attitudes had significant results in the COVID-19 sample. In the AstraZeneca focused items, significant results were found for every attitude question in the empirical treatment and showed that the treatment increased attitudes. Unexpectedly there was a significant negative relationship found in the AstraZeneca question on the attitude that the vaccine will keep me from getting ill (*cf*=-.24, *p*=.056). This backfire effect could have been caused by the negative misinformation of the vaccine causing blood clots. However, in the fourth treatment that addresses the myth and misinformation a highly significant positive effect (*cf*= .568, *p*=.006) was found, thus, demonstrating the effectiveness of the message frame. The correcting misinformation treatment also found a significant effect in increasing the attitude question that the benefits outweigh the risk (*cf*=.682, p=.06). This effect is interesting as it shows the effectiveness of the message frame emphasizing the benefits of the AstraZeneca vaccine outweigh the risks of developing a blood clot side effect.

In the OLS regression (table 8), only the empirical treatment had a positive significant effect on the attitude that the COVID-19 vaccine will keep me from getting sick (*cf*=.773, *p*=.01). For items related to the AstraZeneca vaccine attitudes increased in the empirical treatment with the questions that the AstraZeneca vaccine will keep me from getting ill (*cf*=.920, *p*=.000), responsibility to get vaccinated (*cf*=.537, *p*=.061), and the vaccine is beneficial for the economy (*cf*=.502, *p*=.009). However, the last measure of attitude that the benefits outweigh the risks (*cf*=.524*, p*=.17) was not significant in the OLS regression. A slightly significant backfire effect was maintained in the OLS regression in the gain frame message with the question that the AstraZeneca vaccine will keep me from getting ill (*cf*=-.246, *p*=.06).

9. Discussion

A review of the latest research on the behavioral determinants of vaccine acceptance and uptake found four major types of interventions that were tested in the lab, online, or in the field: social norms-based interventions, opting-out strategies, reminders and recalls, and loss-framed / gain-framed messages (tailored to a particular population or not). Based on the previous literature no experiment testing the different interventions identified in the review with one experiment. The experiment had five treatment groups and a control group. The first treatment group was given a gain frame message focusing on the scientific benefits of receiving the Astra Zeneca vaccine. The second treatment group was given a loss frame message focusing on the scientific detriments of not receiving an Astra Zeneca vaccine. The third treatment group was given an empirical message on the number of people who have received the Astra Zeneca vaccine in the European Union. The fourth treatment group was given a moral message that focused on the moral duty one has for the community and others to receive a vaccination. The fifth treatment group was given a message discussing the misperception / negative information the Astra Zeneca vaccine has been receiving on the internet and the media. Specifically, addressing the fears of developing blood clots from the Astra Zeneca vaccine by stating the highly statistical unlikelihood of developing blood clots compared to developing blood clots from birth control contraception.

The pre-test results from the CFA analysis indicated that there could be other possible latent factors unobserved in the question items based on the models explained earlier. This result could be caused by a low sample size or the limited number of questions aimed per a factor. Thus, an extension of this experiment should gather a larger sample size and/or include more questions in the scale to better capture the factors of vaccination intent and attitudes. Despite the issues found in the CFA, the EFA showcased that the items in the scale are reliable and valid. The next pre-test measure made was a t-test for each question on the treatment compared to the rest of the sample and found significant results for the empirical treatment. Thus, it is expected to find significant effects for the empirical treatment in the regression analysis.

As expected from the t-test the empirical treatment had the most significant results. Specifically, in both the Tobit regression and OLS regression highly positive significant effects were found for measures of intention and attitudes. In both regressions, a greater significant effect was observed for the AstraZeneca focused questions compared to the general COVID-19 related questions. This is a promising result indicating the effectiveness of the empirical treatment when focused on the AstraZeneca vaccine. Furthermore, while highly significant effects in the 1% level were found in the Tobit regression, the OLS regression only found 1% significance on two attitude measures (keep from getting ill and benefits the economy). A 5% level of significance were observed for the three measures of intent and a 10% level of significance was found for the attitude measure of responsibility and no significant effect was found for the attitude measure of benefits outweighing the risks. In summary, we can say with confidence that the empirical treatment successfully increased intention and attitudes towards the AstraZeneca vaccine. Specifically, the intention to get the AstraZeneca vaccine if made available in the next three months increased by 1.25 units in the empirical treatment compared to the control. Encouraging a family member or a friend to get the AstraZeneca vaccine in the empirical treatment compared to control increased by .83 units and .64 units, respectively. Attitudes towards the AstraZeneca vaccine that it keeps me from getting ill increased by .92 units, it is a responsibility to get the vaccine increased by .54 units, and the vaccine will improve the economy increased by .50 units in the empirical treatment compared to control. These results exceed the findings of Milkman et al. (2021) and the theory of social norm that showcasing the number of people who have already received the AstraZeneca vaccine increases the intention and attitudes towards the vaccine.

Significant effects were also found for the other treatments in the Tobit regression. The gain frame treatment had significant effects on the Astra Zeneca questions of intent and one question on attitude. While there was a positive highly significant effect for intent to get the vaccine is made available in the next three months, there was a slight backlash effect on the attitude measure that the AstraZeneca vaccine will keep me from getting ill. The backlash effect was held in the OLS regression with a 1% increase in the belief that the AstraZeneca vaccine will keep me from getting ill leads to a .25 unit decrease in the belief compared to control. The limited significant effects showed in the gain frame and loss frame slightly support the findings of Mowbray et al. (2016). However, as mentioned in the results, the misinformation myth treatment saw a positive significant effect for the same attitude question and an additional attitude question that the benefit outweighs the risk in the Tobit regression. This result is promising as it shows that the treatment of combating myths and misinformation with scientific evidence of comparing the risk of blood clots with the AstraZeneca vaccine outweighs the risks of contracting COVID-19. Specifically, the attitude measures of the AstraZeneca vaccine's benefits outweigh the risk and keeps me from getting ill had positive and highly significant results. Therefore, we can refute the results of Nyhan et al. (2014) and Nyhan and Reifler (2015) of a backlash effect occurring with a message frame combating myths and misperceptions.

The moral treatment had the most surprising results with a clear backfire effect observed for all measures except intention to receive the COVID-19 and AstraZeneca vaccine is made available to me in the next three months. The only significant effect observed was in the Tobit regression on intent with the question asking would you encourage a family member to vaccinate with the COVID-19 vaccine. In this question, a 1% increase in the intent to recommend to a family member led to a .23 unit decrease in intention compared to control. These results go against the findings of Cucinello et al. (2020) that a moral message increasing vaccination intent and attitudes. It is possible that the lack of accreditation from a national or international health organization could have influenced the results. However, without further research and the lack of significant results it is not possible to claim with confidence. Another possibility for the backlash effect could be in support of Mowbray et al. (2016) that message framing should aim to include factual scientific information.

Conclusion

In conclusion, the experiment highly supports the findings of Mowbray et al. (2016) in using message framing with factual scientific information. In particular, the empirical message framing making the AstraZeneca appear as the social norm in Europe increased the vaccine's intent and attitudes in India. These results also showcase the strength in the reliability of using figures from Western nations in improving attitudes and intent in other countries. However, the sample group recruited from MTurk does not align with the general population in India with over 70% of the subjects being male and having a graduate degree or higher. The higher observed educated population and males gathered from MTurk could have been caused by the limited sample size and brings into question the reliability of using MTurk in India. However, this bias could also be caused by the ethical issue that those who have internet access, and a computer are from a higher class of educated individuals and in the case of India being a male dominate society compared to Western nations.

Further research from the insights gained from the experiment should include a time-series measure to see if an empirical message frame increases actual vaccine uptake. Indeed, an increase in intention to vaccinate should correlate with an increase in vaccine uptake as seen in Lorini et al.'s (2020) paper that intention to get vaccinated and self-reported rates of actual vaccination were higher in the treated group than the control group and persisted over time. A study that could be done could replicate Milkman et al.'s (2021) experiment and use an empirical framed message in a text to see if there is an increase in vaccination uptake. However, it is important to note that these results are related to the COVID-19 vaccine and the results can differ when compared to other less salient vaccines. Lastly, another interesting experiment would be to apply the message framing results found in the paper with an opt-out strategy field study to see if there is an increase in uptake (Chapman et al., 2010).

References

AstraZeneca's COVID-19 vaccine: benefits and risks in context. (2021, April 28). European Medicines Agency. https://www.ema.europa.eu/en/news/astrazenecas-covid-19-vaccine-benefits-risks-context

Bohannon, J. (2011). Social Science for Pennies. *Science*, *334*(6054), 307. https://doi.org/10.1126/science.334.6054.307

Brewer, N. T., Chapman, G. B., Rothman, A. J., Leask, J. & Kempe, A. (2017). Increasing vaccination: Putting psychological science into action. *Psychological Science*, 18(3), 149-207.

Brunson, E. K. (2013). The Impact of Social Networks on Parents' Vaccination Decisions. *PEDIATRICS*, *131*(5), e1397–e1404. https://doi.org/10.1542/peds.2012-2452

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk. *Perspectives on Psychological Science*, *6*(1), 3–5. https://doi.org/10.1177/1745691610393980

Bursztyn, L., Rao, A., Roth, C., & Yanagizawa-Drott, D. (2020). Misinformation During a Pandemic. National Bureau of Economic Research, 1–114. https://doi.org/10.3386/w27417

Cassese, E. C., Huddy, L., Hartman, T. K., Mason, L., & Weber, C. R. (2013). Socially Mediated Internet Surveys: Recruiting Participants for Online Experiments. *PS: Political Science & Politics*, *46*(04), 775–784. https://doi.org/10.1017/s1049096513001029

Chandler, J., Mueller, P., & Paolacci, G.(2013).Methodological concerns and advanced uses of crowdsourcing in psychological research. Manuscript submitted for publication. http://www.jessechandler.com/uploads/2/8/0/5/2805897/mturk_adv_methods.pdf

Chapman, G. B., Li, M., Colby, H., & Yoon, H. (2010). Opting In vs Opting Out of Influenza Vaccination. *JAMA*, *304*(1), 43. https://doi.org/10.1001/jama.2010.892

Chouliarakis, G., & Correa-López, M. (2014). A fair wage model of unemployment with inertia in fairness perceptions. Oxford Economic Papers, 66(1), 88–114.

Cialdini, R. B., Demaine, L. J., Sagarin, B. J., Barrett, D. W., Rhoads, K., & Winter, P. L. (2006). Managing social norms for persuasive impact. *Social Influence*, *1*(1), 3–15. https://doi.org/10.1080/15534510500181459

Cucciniello, M., Pin, P., Imre, B., Porumbescu, G., & Melegaro, A. (2020). Altruism and Vaccination Intentions: Evidence from Behavioral Experiments. *MedRxIV*.

Currat, M., Lazor-Blanchet, C., & Zanetti, G. (2020). Promotion of the influenza vaccination to hospital staff during pre-employment health check: a prospective, randomised, controlled trial. *Journal of Occupational Medicine and Toxicology*, *15*(1), 15–34. https://doi.org/10.1186/s12995-020-00285-w

Felstiner, A. (2011). Working the Crowd: Employment and Labor Law in the Crowdsourcing Industry. *Berkeley Journal of Employment and Labor Law, 32*(1), 143-203. Retrieved May 30, 2021, from http://www.jstor.org/stable/24052509

Frank, R. H. (2020). *Under the influence: Putting peer pressure to work*. Princeton University Press.

Felstiner, A. (2011). Working the Crowd: Employment and Labor Law in the Crowdsourcing Industry. *Berkeley Journal of Employment and Labor Law, 32*(1), 143-203. Retrieved May 30, 2021, from http://www.jstor.org/stable/24052509

Gerend, M. A., Shepherd, M. A., & Lustria, M. L. A. (2013). Increasing Human Papillomavirus Vaccine Acceptability by Tailoring Messages to Young Adult Women's Perceived Barriers. *Sexually Transmitted Diseases*, *40*(5), 401–405. https://doi.org/10.1097/olq.0b013e318283c8a8

Giubilini, A., Caviola, L., Maslen, H., Douglas, T., Nussberger, A.-M., Faber, N., Vanderslott, S., Loving, S., Harrison, M., & Savulescu, J. (2019). Nudging Immunity: The Case for Vaccinating Children in School and Day Care by Default. *HEC Forum*, *31*(4), 325–344. https://doi.org/10.1007/s10730-019-09383-7

Hallsworth, M., List, J. A., Metcalfe, R. D. & Vael, I. (2017). The behavioralist as tax collector: Using natural field experiments to enhance tax compliance. *Journal of Public Economics*, 148, 14-31.

Ipeirotis, P. (2010).Demographics of Mechanical Turk[Working Article]. New York University.http://hdl.handle.net/2451/29585,http://scholar.google.com/scholar?cluster=8873729056826117132&hl=en&as_sdt=0,33

Karing, A., (2019). Social Signaling and Childhood Immunization: A Field Experiment in Sierra Leone, Working Paper. University of California Berkeley.

Lorini, C., Ierardi, F., Gatteschi, C., Galletti, G., Collini, F., Peracca, L., Zanobini, P., Gemmi, F., & Bonaccorsi, G. (2020). Promoting Influenza Vaccination among Staff of Nursing Homes According to Behavioral Insights: Analyzing the Choice Architecture during a Nudge-Based Intervention. *Vaccines*, *8*(4), 600. https://doi.org/10.3390/vaccines8040600

MacDonald, N. E. (2015). Vaccine hesitancy: Definition, scope and determinants. *Vaccine*, *33*(34), 4161-4164.

Milkman, K. L., Beshears, J., Choi, J. J., Laibson, D., & Madrian, B. C. (2011). Using implementation intentions prompts to enhance influenza vaccination rates. *Proceedings of the National Academy of Sciences*, *108*(26), 10415–10420. https://doi.org/10.1073/pnas.1103170108

Milkman, K. L., Patel, M. S., Gandhi, L., Graci, H., Gromet, D., Ho, Q. D. H., Kay, J., Lee, T., Bogard, J., Brody, I., Chabris, C., Chang, E., Chapman, G. B., Dannals, J., Goldstein, N. J., Goren, A., Hershfield, H., Hirsch, A., Hmurovic, J., . . . Duckworth, A. (2021a). A Mega-Study of Text-Message Nudges Encouraging Patients to Get Vaccinated at their Pharmacy. *SSRN Electronic Journal*, 1–30. https://doi.org/10.2139/ssrn.3780356

Milkman, K. L., Patel, M. S., Gandhi, L., Graci, H., Gromet, D., Ho, Q. D. H., Kay, J., Lee, T., Akinola, M., Beshears, J., Bogard, J., Buttenheim, A., Chabris, C., Chapman, G. B., Choi, J. J., Dai, H., Fox, C. R., Goren, A., Hilchey, M., … Duckworth, A. (2021b). A Mega-Study of Text-Based Nudges Encouraging Patients to Get Vaccinated at an Upcoming Doctor's Appointment. *SSRN Electronic Journal*, 1–69. https://doi.org/10.2139/ssrn.3780267

Mowbray, F., Marcu, A., Godinho, C. A., Michie, S., & Yardley, L. (2016). Communicating to increase public uptake of pandemic flu vaccination in the UK: Which messages work? *Vaccine*, *34*(28), 3268–3274. https://doi.org/10.1016/j.vaccine.2016.05.006

Nature Editorial. (2021, May 17). *India's COVID-vaccine woes — by the numbers*. Nature. https://www.nature.com/articles/d41586-021-00996-y?error=cookies_not_supported&code=2d5ea576-331b-4a6b-86a1-3f28b0804992

Nature Human Behavior (2018). What works for behaviour change, 2, 709, https://doi.org/10.1038/s41562-018-0459-4

Nyhan, B., & Reifler, J. (2015). Does correcting myths about the flu vaccine work? An experimental evaluation of the effects of corrective information. *Vaccine*, *33*(3), 459–464. https://doi.org/10.1016/j.vaccine.2014.11.017

Nyhan, B., Reifler, J., Richey, S., & Freed, G. L. (2014). Effective Messages in Vaccine Promotion: A Randomized Trial. *PEDIATRICS*, *133*(4), e835–e842. https://doi.org/10.1542/peds.2013-2365

Paterson, P., Meurice, F., Stanberry, L. R., Glismann, S., Rosenthal, S. L., & Larson, H. J. (2016). Vaccine hesitancy and healthcare providers. *Vaccine*, *34*(52), 6700–6706. https://doi.org/10.1016/j.vaccine.2016.10.042

Pink, S. L., Chu, J., Druckman, J., Rand, D. G., & Willer, R. (2021). Elite party cues increase vaccination intentions among Republicans. https://doi.org/10.31234/osf.io/f9jq5

Pluviano, S., Watt, C., & Della Sala, S. (2017). Misinformation lingers in memory: Failure of three pro-vaccination strategies. *PLOS ONE*, *12*(7), e0181640. https://doi.org/10.1371/journal.pone.0181640

Rogers, T., Ternovski, J., & Yoeli, E. (2016). Potential follow-up increases private contributions to public goods. *Proceedings of the National Academy of Sciences*, *113*(19), 5218–5220. https://doi.org/10.1073/pnas.1524899113

Scheibehenne, B., Greifeneder, R., Todd, P. M., Joop, van der P., Michael, B., & R., L. D. (2010). Can there ever be too many options? A meta-analytic review of choice overload. *Journal of Consumer Research*, *37*, 409–425. doi:10 .1086/651235

Shefrin, H. M., & Thaler, R. H. (1988). The behavioral life-cycle hypothesis. *Economic Inquiry*, 26, 609– 643.

Schmid, P., Rauber, D., Betsch, C., Lidolt, G., & Denker, M. L. (2017). Barriers of Influenza Vaccination Intention and Behavior – A Systematic Review of Influenza Vaccine Hesitancy, 2005 – 2016. PLOS ONE, 12(1), e0170550. https://doi.org/10.1371/journal.pone.0170550

Szilagyi, P. G., Bordley, C., Vann, J. C., Chelminski, A., Kraus, R. M., Margolis, P. A., & Rodewald, L. E. (2000). Effect of Patient Reminder/Recall Interventions on Immunization Rates. *JAMA*, *284*(14), 1820. https://doi.org/10.1001/jama.284.14.1820

Thaler, R. H. (1999). Mental accounting matters. *Journal of Behavioral Decision Making*, 12(3), 183– 206.

Vaidyanathan, G. (2021). Coronavirus variants are spreading in India — what scientists know so far. *Nature*, *593*(7859), 321–322. https://doi.org/10.1038/d41586-021-01274-7

Yokum, D., Lauffenburger, J. C., Ghazinouri, R., & Choudhry, N. K. (2018). Letters designed with behavioural science increase influenza vaccination in Medicare beneficiaries. *Nature Human Behaviour*, *2*(10), 743–749. https://doi.org/10.1038/s41562-018-0432-2

Appendix

Table 1
Sample Demographics: COVID-19 (AstraZeneca)

		Treatment group					
		Control	Gain Frame	Loss Frame	Empirical Evidence	Countering Myth	Moral
Sex, %							
	Female	23	28(24)	27(25)	31(30)	17(33)	24(17)
	Male	77	72(76)	73(75)	69(70)	83(67)	76(83)
Age, %							
	Younger than30	28	45(41)	34(40)	39(35)	25(38)	39(27)
	Older than 30	72	55(59)	66(60)	61(65)	75(62)	61(73)
Education, %							
	Undergraduate and below	11	12(4)	10(10)	12(4)	14(9)	6(13)
	Graduate	70	62(77)	61(63)	75(66)	61(78)	76(60)
	Post-graduate	19	26(19)	29(27)	13(30)	25(13)	18(27)
Total N		88	82(70)	93(73)	87(82)	75(78)	74(63)

Table 2
Exploratory Factor Analysis of COVID-19 scale

Items	F1	F2	h2
Q1		0.62	0.71
Q2		0.3	0.12
Q3	0.73		0.57
Q4	0.73		0.51
Q5	0.73		0.71
Q6	0.73		0.53
Q7		0.96	0.9
Q8		0.88	0.73
		PA2	PA1
SS Loadings		2.44	2.34
proportion var		0.31	0.29
cumulative var		0.31	0.6

Note: Extraction method; parallel analysis; rotation method; oblimin.
F1, F2 corresponds to Attitudes and Intent, respectively.
Green items represent factor loading scores greater than .30.

Table 3

Exploratory Factor Analysis of AstraZeneca scale

Items	F1	F2	F3	h2
Q1			0.82	0.86
Q2			0.38	0.35
Q3	0.42			0.5
Q4	0.76			0.6
Q5	0.85			0.82
Q6	0.74			0.69
Q7		0.91		0.35
Q8		0.7		0.89
		PA1	PA2	PA3
SS Loadings		2.36	2.11	1.23
proportion var		0.3	0.24	0.15
cumulative var		0.3	0.53	0.69

Note: Extraction method; parallel analysis; rotation method; oblimin.
F1, F2 corresponds to Attitudes and Intent, respectively.
Green items represent factor loading scores greater than .30.

Table 4

Confirmatory Factor Analysis Goodness-of-Fit Measures

Models	χ^2	df	p-value	χ^2/df	CFI	TLI	RMSEA	SRMR
covidf2	36.147	13.000	0.000	2.781	0.971	0.953	0.084	0.033
azf2	11.872	13.000	0.538	0.913	1.000	1.002	0.000	0.019
covidf2 corr benefit +keep	25.854	12.000	0.011	2.155	0.978	0.961	0.081	0.026

Note: The two-factor solution exhibits adequate values for all goodness of fit parameters. Model 1 is for COVID sample model 2 is for AstraZeneca sample

Table 5

Independent t-test COVID-19 vaccine intent and attitudes by treatment

	Treatment	mean	std. error	df	p-value	t-test
Intent						
	Control	7.909	0.210		0.393	0.857
	Gain Frame	8.108	0.249	160	0.539	-0.616
	Loss Frame	8.122	0.249	168	0.512	-0.657
	Empirical	8.398	0.161	179	0.065	-1.859
	Myth	7.862	0.225	173	0.879	0.153
	Moral	8.013	0.196	161	0.720	-0.359
Attitudes						
	Control	7.810	0.164		0.316	1.020
	Gain Frame	7.871	0.170	160	0.794	-0.261
	Loss Frame	7.960	0.069	168	0.396	-0.851
	Empirical	8.266	0.154	179	0.041	-2.079
	Myth	8.031	0.160	173	0.335	-0.967
	Moral	7.690	0.183	161	0.636	0.475

Note: Intent is Q1, and attitudes is the combined score of the four questions measuring attitude

Table 6
Independent t-test AstraZeneca vaccine intent and attitudes by treatment

	Treatment	mean	std. error	df	p-value	t-test
Intent						
	Control	7.216	0.241		0.022	2.315
	Gain Frame	7.657	2.675	156	0.222	-1.225
	Loss Frame	7.740	0.260	159	0.141	-1.478
	Empirical	8.451	0.128	168	0.000	-4.443
	Myth	7.667	0.226	164	0.177	-1.355
	Moral	7.476	0.268	149	0.475	-0.716
Attitudes						
	Control	7.673	0.156		0.395	0.853
	Gain Frame	7.579	0.191	156	0.699	0.387
	Loss Frame	7.712	0.214	159	0.881	-0.150
	Empirical	8.259	0.155	168	0.009	-2.658
	Myth	7.990	0.167	164	0.167	-1.388
	Moral	7.460	0.226	149	0.424	0.802

Note: Intent is Q1, and attitudes is the combined score of the four questions measuring attitude

Table 7
Tobit Regression

		Treatment				
		Gain Frame	Loss Frame	Empirical	Myth	Moral
COVID-19 Vaccine						
	Covid Intent	0.410	0.434	0.693***	0.042	0.179
	Covid Family	0.352	0.151	0.514*	0.265	-0.229*
	Covid Friend	0.444	0.463***	0.534*	0.286	-0.129
	Covid Benefit	0.121	0.143	0.330	0.366	-0.351
	Covid Keep getting ill	0.303	0.609	1.005***	0.374	0.236
	Covid Responsibility	-0.006	0.273	0.447	0.412	-0.426
	Covid Economy	0.002	0.282	0.711***	0.348	-0.034
AstraZeneca						
	AZ Intent	0.603***	0.646	1.357***	0.545	0.300
	AZ Family	0.008	-0.145	0.978***	0.287	-0.150
	AZ Friend	-0.002	-0.138	0.718***	0.236	-0.153
	AZ Benefit	-0.051	0.092	0.730***	0.682*	-0.149
	AZ Keep getting ill	-0.240*	0.436	1.110***	0.568***	-0.019
	AZ Responsibility	0.046	-0.040	0.646***	0.299	-0.440
	AZ Economy	-0.021	0.041	0.712***	0.404	-0.226

*=10%, **= 5%, ***=1% significance level
Note: treatment group is based on the control group and data is clustered at session level (day)

Table 8
OLS Regression

		Treatment				
		Gain Frame	Loss Frame	Empirical	Myth	Moral
COVID-19 Vaccine						
	Covid Intent	0.231	0.247	0.527*	-0.018	0.132
	Covid Family	0.318	0.169	0.474	0.198	-0.148
	Covid Friend	0.379	0.426*	0.503	0.236	-0.059
	Covid Benefit	0.130	0.114	0.234	0.232	-0.287
	Covid Keep getting ill	0.226	0.459	0.773***	0.265	0.240
	Covid Responsibility	0.029	0.155	0.390	0.271	-0.367
AstraZeneca	Covid Economy	0.007	0.191	0.508	0.226	-0.020
	AZ Intent	0.469	0.541	1.255**	0.465	0.278
	AZ Family	0.060	-0.064	0.834**	0.221	-0.044
	AZ Friend	0.079	-0.070	0.639**	0.200	-0.070
	AZ Benefit	-0.026	0.046	0.524	0.550	-0.174
	AZ Keep getting ill	-0.246*	0.326	0.920***	0.402	-0.046
	AZ Responsibility	0.010	-0.069	0.537*	0.158	-0.382
	AZ Economy	-0.074	-0.054	0.502***	0.259	-0.192

*=10%, **= 5%, ***=1% significance level

Note: treatment group is based on the control group and data is clustered at session level (day)

Fig 1: Intention to vaccinate COVID-19

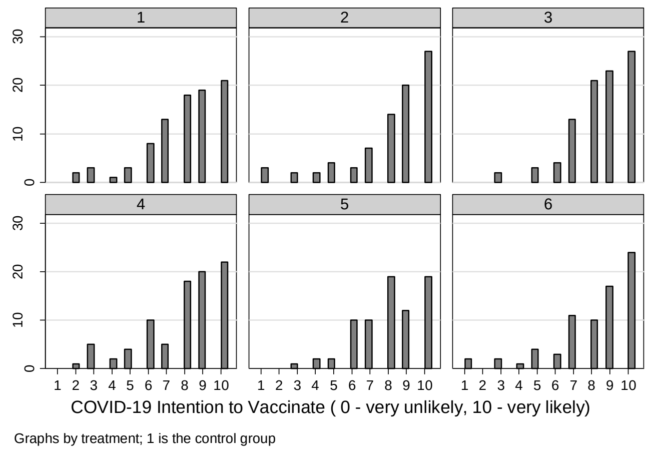


Fig 2: Encourage Family to Vaccinate COVID-19

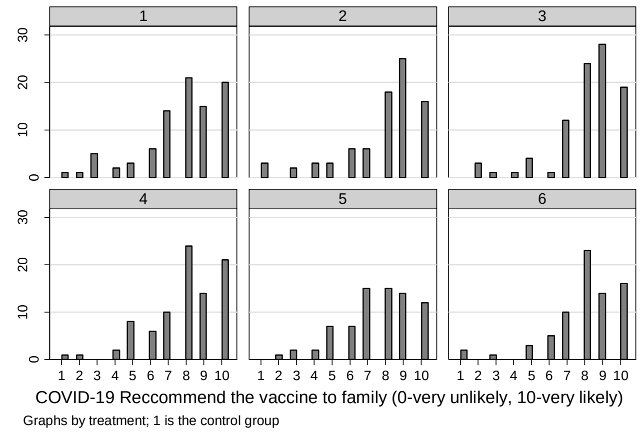


Fig 3: Encourage Friend to Vaccinate COVID-19

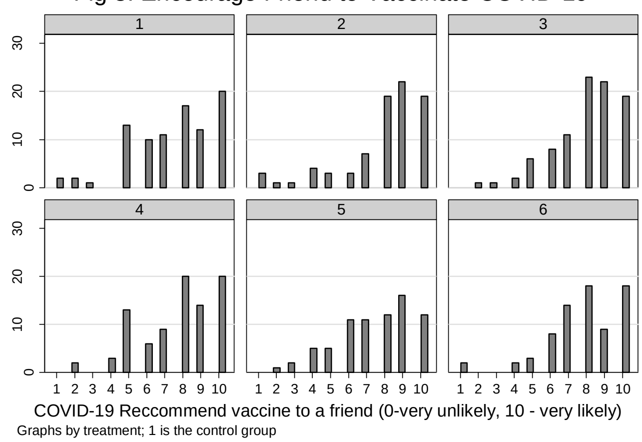


Fig 4: Benefit to Vaccinate COVID-19

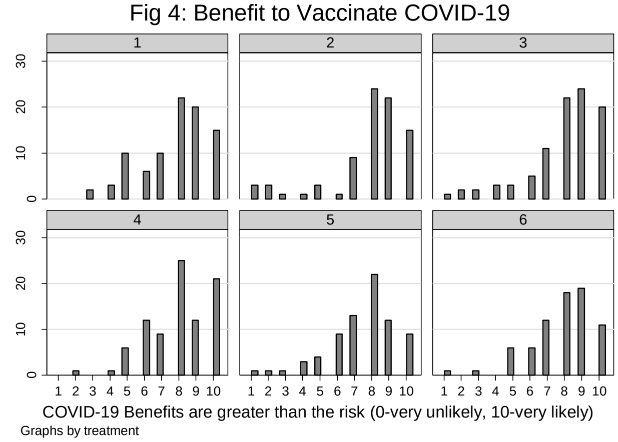


Fig 5: Vaccine no ill COVID-19

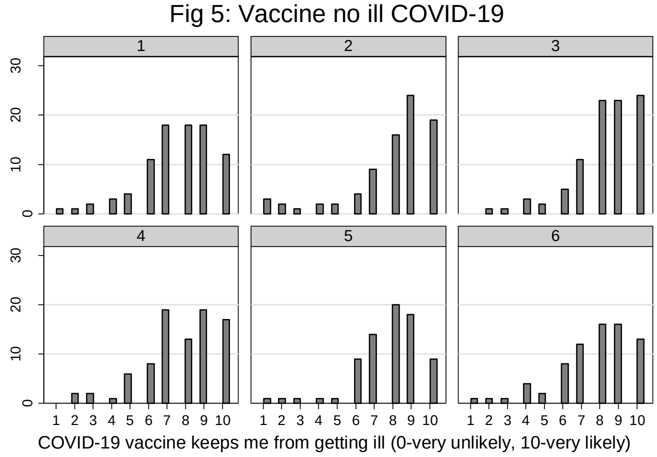


Fig 6: Responsbility to vaccinate COVID-19

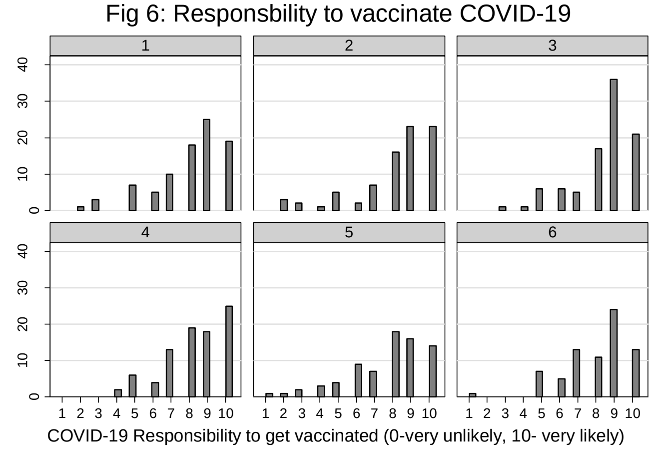


Fig 7: Vaccine and the economy COVID-19

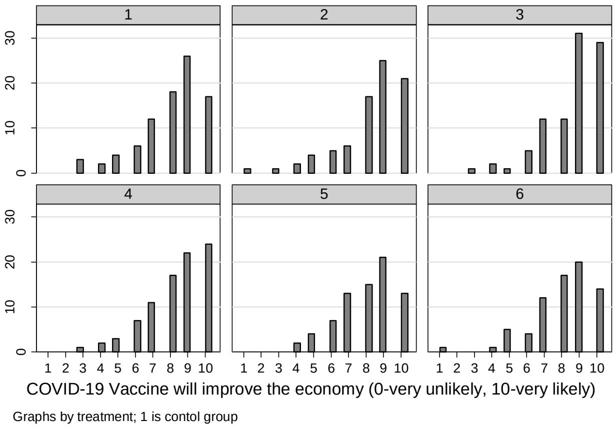


Fig 8: Intent to get AstraZeneca vaccine

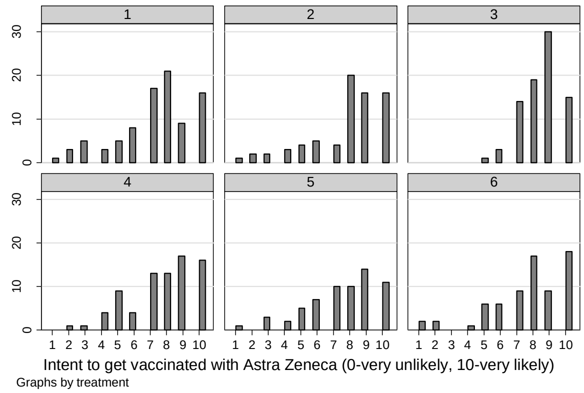


Fig 9: Encourage family to get AstraZeneca

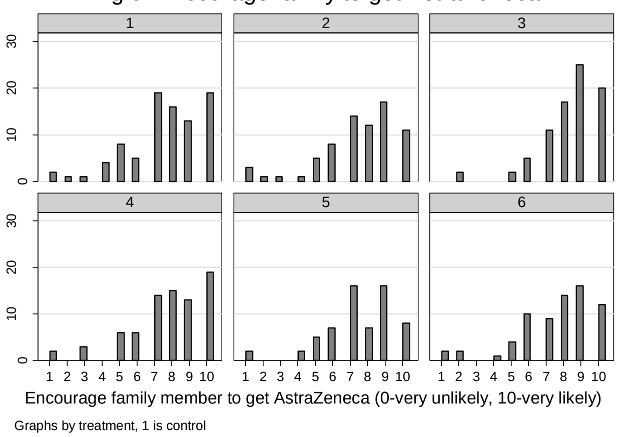


Fig 10: Encourage friend to get Astra Zeneca

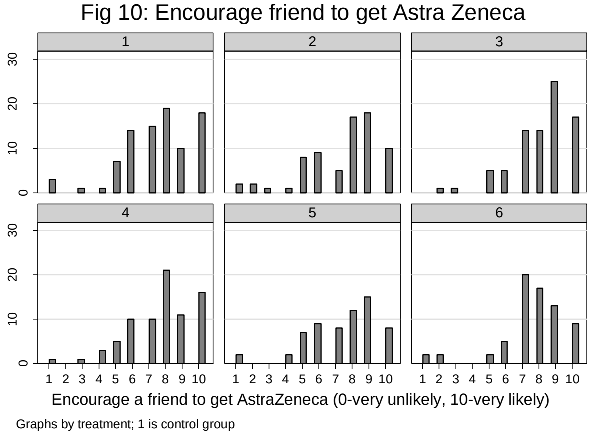


Fig 11: AstraZeneca benefits greater than risk

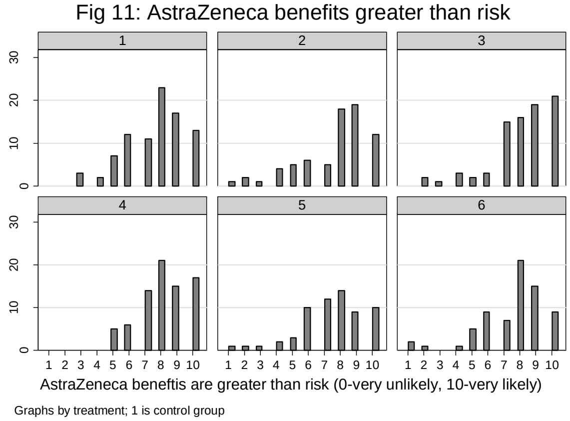


Fig 12: AstraZeneca no ill

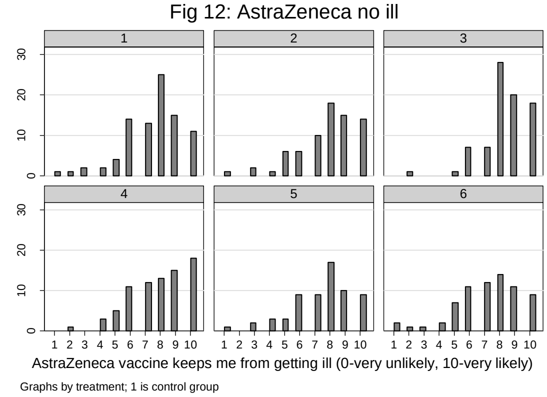


Fig 13: Responsibility to get AstraZeneca

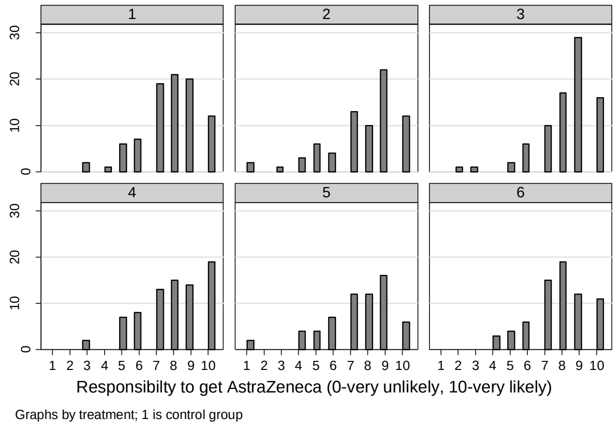


Fig 14: AstraZeneca improves economy