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Abstract

Diagnostic and contact tracing apps are an important weapon against contagion during a pandemic. We study how the content of the messages used to promote the apps influences adoption by conducting a survey experiment on approximately 23,000 Mexican adults. Respondents were randomly assigned to one of three different prompts, or a control condition, before stating their willingness to adopt a diagnostic app and contact tracing app. The prompt emphasizing government efforts to ensure data privacy, which has been one of the most common strategies, reduced willingness to adopt the diagnostic app by about 4 percentage points and the contact tracing app by 3 percentage points. An effective app promotion policy must understand individuals' reservations and be wary of unintended reactions to naïve reassurances.

Keywords: COVID19, Contact tracing apps, Diagnostic apps, Data privacy, Take-up, Priming

JEL Codes:: D90, D91, D62, I12

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Our survey experiment was part of a broader COVID-19-focused survey in Mexico, approved by the IRB of the Instituto Tecnológico Autónomo de México (ITAM) on July 1, 2020, under the name "Social and Behavioral Drivers of Individual Compliance with Preventive Measures during the COVID-19 Epidemic in Mexico." We have obtained informed consent from all participants in this study.

1 Introduction

Many public policies aiming for societal benefit require individuals to undertake actions with positive external effects but private costs—real or perceived. In such cases, compliance rates will tend to fall short of the level needed to attain the policy's goals. Typical examples include vaccination (where the risks are overwhelmingly perceived rather than real), energy consumption, and water use. In the context of the current COVID-19 pandemic, the adoption of contact tracing and self-diagnostic apps is an important instance of this type of policy. Widespread adoption could effectively contain or stop the spread of the disease-causing virus, but individuals have been hesitant to download and use the apps, largely due to privacy concerns (De la Garza, 2020; Klonowska and Bindt, 2020; McClain, 2020; Timberg et al., 2020). These fears have also affected policymakers' decisions (Barber and Knight, 2020; Singer, 2020). For example, in South Carolina in the United States, lawmakers banned such software over privacy concerns (De la Garza, 2020), and in Norway the app was shut down after it had been available for a couple of months (Hautala, 2020).

From the policymaker's perspective, the challenge is how to motivate individuals to comply. A common approach is to take action to mitigate the potential risks to the individual and to reassure the public that the risks are low. However intuitive, the strategy of explicitly addressing the public's worst fears may be counterproductive insofar as it fails to credibly allay those fears and instead focuses attention on them. The present study tests this general proposition in the context of the adoption of COVID-19 diagnostic and contact tracing apps.

Contact tracing is a cost-effective technological tool for reducing infection rates (Aleta et al., 2020; Chiu et al., 2020). It works by notifying those who have been in contact with known virus carriers and asking them to self-isolate for a few days. More than 45 governments worldwide have launched apps that allow individuals to: (a) run a self-diagnostic, and (b) receive information about whether they have been in recent contact with an infected person (Howell O'Neill et al., 2020; OECD, 2020; Wikipedia, 2020). Large technology companies including Apple and Google have added to the effort by building on their existing technology and reach within communities (Klosowski, 2020).

Despite the potential impact of the apps, very few people have downloaded them. Downloads and intentions to use have been lower than acceptance levels, highlighting an intention-behavior gap (Garrett et al., 2021). In the US states that have adopted the technology, downloads have ranged from about 10% in Virginia to 1% in Wyoming (De la Garza, 2020), and there is no widespread support for government action encouraging everyone to download and use contact tracing apps (Zhang et al., 2020). In the case of Mexico, the country in

which we conduct our research, the diagnostic app (COVID-19MX) never attracted substantialinterest from the population. In the rest of the developed world, uptake has also been limited to a minority of the population: ranging from about 26% in Australia to less than 2% in France (Blasimme and Vayena, 2020). These adoption rates fall very short of what is needed for the apps to be effective (Reuters, 2020; Farronato et al., 2020). According to UK authorities, about 80% of smartphone owners would need to use it in order to stop the coronavirus pandemic by using the apps (Kelion, 2020). One of the most commonly cited concerns is data privacy, with people fearing that contact-tracing apps may be tracking their whereabouts and accumulating personal information. Data protection and privacy were some of the main topics discussed by the media in Germany, Austria and Switzerland, and many articles raised questions of whether authorities could be trusted to maintain data protection and privacy (Amann et al., 2021).

Governments have taken many steps to improve the functioning of contract-tracing apps and to ensure data privacy (Singer, 2020). They have also focused their advertisement campaigns on the work they have been doing to ensure privacy (Australian Government Department of Health, 2020; Maryland Department of Health, 2020; UK National Health Service, 2020; Virginia Department of Health, 2020). Data privacy is one of the main concerns experts show when making recommendations for increasing adoption (Blasimme and Vayena, 2020). Still, focusing too much on data privacy in the public discourse, even if that is in fact the main concern preventing people from downloading and using these apps, may backfire. There is evidence, for example, that mentioning crime, even in the context of decreasing trends can provoke a "knee-jerk" reaction that focuses people's minds on the existence of crime instead of focusing on the trend (Gingerich and Scartascini, 2018). One of the potential mechanisms behind this effect may be "priming": subtle cues in the environment may have significant, reliable effects on behavior (Kahneman, 2011). Priming is increasingly used to study the effects of the environment on preferences (Cohn and Maréchal, 2016), including affecting attitudes that enhance gender gaps (Balafoutas et al., 2018). Importantly for our research, priming may affect decisions regarding download of apps (Chong et al., 2018), and priming for privacy may led to increased concern while choosing apps (Rajivan and Camp, 2016). Kahneman (2012) presents a thorough discussion regarding replicability and power of priming studies, and Payne and Brown-Iannuzzi (2016) presents recent evidence suggesting that priming effects are real.

Importantly, that negative reaction could affect the likelihood of adoption. Seen from this perspective, the mere mention of data privacy issues may be triggering in some respondents a

perception of threat that makes it less likely, not more, that they will adopt a contact tracing app. This kind of behavior may be undergirded by well-known cognitive biases, including attribute substitution (Kahneman and Frederick, 2002) and availability heuristics (Tversky and Kahneman, 1973). Continuous emphasis on data privacy and security—even if the goal is to reassure—may generate an overestimation of data privacy risks (Carroll, 1978).

Following on these behavioral principles, we test whether different messages make a difference for stated willingness to adopt diagnostic and contact-tracing apps. We run a survey experiment in a sample of over 23,000 individuals from Mexico recruited through Facebook advertisements and email campaigns to participate in a COVID-19 survey. We randomly allocated respondents to four treatment conditions including a pure control and three treatment vignettes. These vignettes were designed to compare the effectiveness of a data-privacy-oriented message, similar to those governments are using, to other messages used by both the public and the private sector on the willingness to download the diagnostic and contact tracing apps. We assume that these vignettes may act on judgment and behavior by activating mental concepts through subtle cues, that is, through priming (Cohn and Maréchal, 2016).

The Treatment 1 group received a vignette focusing on the role of Facebook as a tool to connect people, and the Treatment 2 group was exposed to a vignette highlighting the work the Mexican government has been doing to make it possible for citizens to conduct bureaucratic procedures online rather than in person, which increases welfare. The Treatment 3 group was exposed to a vignette that emulated the adoption-promotion messages that many countries are providing their citizens: "the government is working hard to ensure data privacy protection." Treatments 1 and 2 thus do not mention privacy concerns, while Treatment 3 does. Respondents in every group, including the control, were then asked whether they would be willing to download a COVID-19 diagnostic app, and, separately, whether they would be willing to download a contact tracing app.

We find, consistent with expectations based on behavioral research, that highlighting the fact that the government is working hard to ensure data privacy decreases the average respondent's willingness to adopt by about 3 percentage points for the contact tracing app and 4 percentage points for the diagnostic app, in comparison with the control condition. In contrast, the other two treatments either had no effect (Treatment 1) or increased willingness to download the app (Treatment 2). Treatment 2, which focused on government efforts to move bureaucratic procedures online and emphasized the resulting gains in convenience, in fact increased stated willingness to download the diagnostic app by about 2 percentage

points. We provide evidence that priming could be the mechanism at work: those who agreed with the priming statements exhibited stronger effects than those who disagreed.

The results are robust to softening the data privacy message provided in Treatment 3: a message focusing on the work the government was carrying out to provide data security and stating that "the data privacy of Mexicans is a priority for the government," showed the same negative effects in a smaller sample of about 1,000 Mexicans.

Our results suggest that the most obvious approach to increasing adoption—directly addressing privacy issues—may not be the best, and in fact it may have counterproductive effects. A focus on fixing data privacy issues may activate data privacy fears or, alternatively, signal that data privacy is a more important issue than one believed. A different approach—such as one that highlights the goodwill of government or the convenience of online apps—may be potentially more effective. In other words, highlighting value to the citizen, rather than risk, might be a more effective way to motivate adoption. Beyond the specific context of the COVID-19 pandemic, our results provide experimental evidence that straightforward priming can importantly influence (self-reported) behavior intentions.

2 Methods

2.1 Participant Recruitment and Data

We conducted a survey experiment embedded within a larger survey focusing on COVID-19 experiences, attitudes, and behaviors. In the same survey, we also included the survey experiment described and analyzed in Martínez et al. (2021). Therefore, recruitment methods and sample description are the same for both articles. The survey experiments have been designed to be orthogonal to each other to ensure there is no cross-contamination, and randomization into treatment and controls is independent of each other.

The questionnaire was pre-tested on a small sample of colleagues and acquaintances, and subject to the IRB's recommendations. Survey respondents were recruited through a Facebook ad campaign and a separate email campaign. The Facebook ad campaign targeted a general audience composed of individuals over 18 years of age living in the Mexican states of Sonora and Guanajuato, it was associated with the official Facebook account of the Inter-American Development Bank (IDB), and it was run by the Knowledge, Innovations and Communications Department of the IDB. The ads can be found in Figure A.1 and Figure A.2 in the Online Appendix. The ad was very simple, consisting of a photograph and a short text inviting people to share their COVID-19 related experiences. The campaign took

place between July 7 and July 21, 2020. The second recruitment channel consisted of an email sent by various secretaries of the Guanajuato state government in Mexico, using their email distribution lists on Sendy. The list of secretaries that participated in this recruitment process by providing their contact lists are the following: the Secretary of Economic Development, Secretary of Tourism, Secretary of Health and Secretary of Education. This email campaign consisted of two rounds of invitations that took place on July 10 and July 17, 2020, and no exclusion criteria were applied.

The Facebook ads directed respondents to a dedicated project webpage within the IDB website where respondents were able to access the baseline survey. The invitations from the government secretaries did not direct respondents to the dedicated project webpage within the IDB website, instead leading respondents directly to the baseline survey. The survey was programmed in Qualtrics and could be completed either on a computer or a mobile device. The baseline survey itself stated on the welcome page that participation was voluntary and that respondents could end the survey at any time and for any reason. It also stated that only those who were at least 18 years of age should respond, even though neither the survey nor the treatments contain any age-inappropriate content. At the end of the survey, we asked respondents whether the individual recommended using her responses in our analysis or not according to how confident the person felt about the quality of the responses. We made clear that there were no consequences if the individual selected "Do not use." A total of 52,507 people clicked on the Facebook ad, yielding 15,542 complete and usable surveys.A total of 14,059 people clicked on the email ad, yielding 7,642 complete and usable surveys. For purposes of the present study, we pooled all usable survey responses from both recruitment channels, for a total of 23,184 respondents. In addition to the main sample, we recruited an additional sample of about 1,000 respondents via a separate email sent out by the Government of Sonora to its preexisting mailing list. We use this smaller sample for the robustness test (Table B.2 shows summary statistics for this sample.)

A majority of respondents indicated that they would be willing to download the app. About 92% of respondents answered that they would probably or surely download the tracing app. The equivalent figure for the diagnostic app is 88% (Figure A.3 in the Online Appendix displays the distribution of responses for the control group).[1] These numbers exceed the typical fraction of people who actually download these kinds of apps in countries where they are available, and they suggest that one or more of the following possibilities are at work:

[1]The fact that we asked first about the diagnostic and then about the contact tracing may have primed individuals to think about the disease, which could have increased baseline levels of responses for the contact tracing app.

(i) People are not overly concerned about privacy; (ii) people feel that the diagnostic app is either more intrusive or less useful (or both) than the contact tracing app; (iii) social desirability bias is inflating the share of people who state that they would download either app. Note that the high share of people who report willingness to download the apps in the control condition creates the potential for a ceiling effect that constrains the ability of treatment arms T1-T3 to increase take-up.

The first column of Table 1 provides basic descriptive statistics for the control group (these should be close to sample means due to randomization of treatment assignment.) The average respondent is female (67%), has completed secondary education (about 58% of the individuals in the sample have completed secondary education or higher), and reported knowing someone who had previously been exposed to COVID-19 (65%), and someone who has died of COVID-19 (57%). About 12% of the sample reported having attended a party in the last 7 days, 43% reported having visited family members in the last 7 days, 72% reported that it is risky to perform activities in enclosed spaces such as gyms or restaurants, and 36% think that their neighbors keep social distance from others.

The population in our sample seems to be more female and more educated than the average Mexican person as per the latest available Mexican Population Census. For example, while in our sample 67% of the respondents are female, they are only 51% in the overall population. Moreover, while the share of Mexicans with superior (post-secondary) or university education is about 22%, it is around 50% in our sample. We cannot precisely estimate age in our sample because respondents were asked to select an age bracket. Our median respondent is in the category [25-39] and the median Mexican person is 29 years old. However, we can estimate that our sample may under-represent older individuals. In Mexico, about 15% of the population is 55 years or older, while it is slightly higher than 10% in our sample (by design, we do not sample minors). [2] As such, our recruitment method may be under-sampling older and less educated individuals who may be less likely to use computers or smartphones, or respond to Facebook ads. In spite of the differences between our sample and the general population, we have no strong reason to believe that it affects the external validity of the results.

2.2 Experimental Design

Every individual in our sample was randomized into one of four treatment conditions, including a pure control. In the three other conditions, individuals were exposed to a priming

[2]Mexican census and demographic data are available from INEGI at https://www.inegi.org.mx/.

vignette followed by a question related to the priming vignette. The vignettes and the related questions differed across the treatment conditions. Subsequently, individuals were asked two outcome questions, respectively about their willingness to download a COVID-19 diagnostic app and a contact-tracing app. Those in the control condition were not shown a vignette/related question—they were only asked the two outcome questions.

The design of the vignettes was driven by the objective of testing ways to promote app adoption different from the currently popular approach of privileging data privacy. One of the two alternative vignettes focuses on the usefulness of the most popular social networking app, Facebook, while the second alternative focuses on the convenience of using online means to conduct business with government. Thus, we do not attempt to introduce a new narrative but rather to test how other common messages regarding apps compare to the widely-used data privacy-focused messages in their effects on willingness to download the diagnostic and contact-tracing apps. In each vignette, a short question was added at the end with the aim of revealing if the message was actually successful in priming the respondents.

The vignette/related question in Treatment 1 (T1) specifically highlights the usefulness of Facebook as a tool to keep in touch with friends. The original Spanish text is provided in the Online Appendix. The text reflects the spirit and tone of Facebook's own campaigns: "Facebook was built to bring people close together and build relationships" (Mosseri, 2018; Facebook, 2019).

> **T1:** *Facebook is the most popular social networking tool in Mexico and in the world. It allows its users to share pictures, news, and personal information with their friends. In addition, through its mobile app, it allows frequent contact with loved ones. Do you agree that the Facebook mobile app increases contact with your loved ones?* [Yes/No]

The vignette/question in Treatment 2 (T2) focuses on the convenience of online services and on the government efforts to move bureaucratic procedures online. This is based on actual efforts by the Mexican government aiming to: "provide information, services, and a platform for participation to the population...[and to revolutionize] the relationship between the citizen and the state."(Gobierno de Mexico, 2020). The Mexican government's digital strategy has also been copied and pursued by regional and local governments (Eje Central, 2020).

> **T2**: *The government of Mexico has shifted many in-person bureaucratic procedures to online platforms. In addition, thanks to mobile apps, some of those*

procedures can be performed from any location. For example, Mexicans can now pay fines online at any time and from any location. Do you agree that online services increase the welfare of Mexicans? [Yes/No]

Treatment 3 (T3) highlighted government efforts to address and mitigate data privacy concerns, as highlighted earlier.

T3: *Online platforms and mobile apps, which we can use to buy online and pay services, can have security issues. The government of Mexico is working very hard to protect data privacy so no Mexican is worried or affected by it. Is data protection an important issue for you?* [Yes/No]

As a robustness check, we later present an alternative vignette also built around privacy concerns but using a different rhetorical structure. The goal of the robustness analysis is to ensure that it is the emphasis on data privacy concerns, and not some other idiosyncratic feature of the vignette, that is driving the effects we find.

The outcome questions were:

Diagnostic application: *If a federal government app were available for your smartphone that could help you to identify coronavirus symptoms, and inform you what to do, at no cost, and with no data usage, would you download it to your phone?* [Definitely yes / I think so / I don't think so / Definitely not]

Contact Tracing application: *If, in addition to the previously-described features, the app could also alert you if you had been in contact for more than 15 minutes with an infected person, and it notified the people who were near you if you became infected, without identifying personal information (yours or others'), would you download the app?* [Definitely yes / I think so / I don't think so / Definitely not]

Table 1 explores balance on covariates across the four treatment conditions. The first column of the table provides means and standard deviations of covariates collected in the baseline survey (i.e., prior to treatment assignment) for those eventually assigned to the control group. The next three columns (2-4) provide the differences between that group and each of the other treatment groups. Only 5 out of 48 coefficients are significant at the 5 percent level or higher. We take this as evidence that the randomization was successful.

In addition to the main sample, we recruited an additional sample of about 1,000 respondents. We use this smaller sample for the previously mentioned robustness test. Table B.2 verifies balance on predetermined covariates across treatment arms for this sample. Due to randomization, average causal effects can be estimated by regressing each of the two outcome variables (respectively derived from each of the two outcome questions) on a set of treatment-condition indicators, minus an omitted reference category (the control group).

2.3 Estimation Strategy

We estimate the following linear regression model:

$$y_i = \alpha + \beta_1 T_{1,i} + \beta_2 T_{2,i} + \beta_3 T_{3,i} + u_i, \tag{1}$$

where y_i is the value of a dependent variable (either stated willingness to download the diagnostic app or stated willingness to download the tracing app) for individual i. For the main analysis, we code the dependent variables as dichotomous variables taking the value of 0 for responses "definitely no" and "I don't think so" and the value of 1 for responses "I think so" and "definitely yes." Thus, equation 1 can be interpreted as a linear probability model. We also present results of ordered logit models using the original four response categories.

The variable $T_{1,i}$ takes the value of 1 if respondent i was assigned to the vignette emphasizing Facebook's usefulness to keep in contact with others, and the value of 0 otherwise; $T_{2,i}$ similarly indicates assignment to the vignette focusing on the government's efforts to shift bureaucratic procedures online; and $T_{3,i}$ indicates assignment to the vignette about the government's efforts to protect data privacy. The coefficients β_n, $n = 1, 2, 3$, respectively estimate the causal effects of treatment assignment—in comparison with assignment to the control—on the probability of answering either "I think so" or "definitely yes." The coefficients estimate intent-to-treat effects (since we do not observe whether respondents actually read or paid attention to the assigned vignette). Therefore, our estimates constitute lower bounds to treatment-on-the-treated effects.

3 Results

Estimates for the analysis with the dichotomized dependent variables are shown in Table 2. Columns 1 and 5 display equation 1 estimates with no additional controls, for the contact tracing app and diagnostic app outcome questions, respectively. Columns 2-4 and 6-8 also

control for a broad set of variables, with the goal of adjusting for potential imbalances (however small) and potentially increasing the precision of the treatment dummy variables. The set of control variables includes the following: age, sex, and educational attainment, whether the respondent or somebody she knows has been exposed or has died because of COVID-19, whether the respondent or somebody she knows had H1N1, beliefs regarding the probability of being infected and/or having to go the hospital, whether the respondent attended a party or visited family recently, her evaluation of the risk of contagion associated with indoor activities, and beliefs about whether others around her practice social distancing. Columns 3 and 7 additionally control for state fixed effects, and columns 4 and 8 instead control for municipal fixed effects. The results change very little across specifications. Figure 1 presents dot plots of regression coefficients corresponding to columns 2 and 6 in the table. The dot plots also display the coefficients for all the control variables.

Individuals assigned to treatment T3, which refers to government efforts to ensure data privacy, are 4 percentage points less likely to state they are willing to download the diagnostic app, and 3 percentage points less likely to state willingness to download the contact tracing app, than those in the control group. Treatment T1, which refers to the usefulness of Facebook for keeping in touch with others, has no effect. Interestingly, treatment T2—emphasizing government efforts to move procedures online—increased stated willingness to download the diagnostic app by about 2 percentage points, but did not impact willingness to download the contact tracing app, suggesting that indirectly emphasizing potential benefits may be a better way to motivate app adoption than talking about efforts to mitigate privacy risks. Equality-of-coefficients tests at the bottom of the table show that the treatment effect estimates mentioned in this paragraph are both statistically different from the control and statistically different from each other.

The results from the ordered logit model are shown in Figure 2. These estimates reveal that the negative treatment effect of the privacy issues treatment (T3) on the dichotomized stated likelihood to download either app reflects a reduction in the likelihood of answering "definitely yes" (about 6.5-7.5pp) alongside an increase in the likelihood of all other answer categories—with the biggest increase in the "I think so" category (about 4pp).

The coefficient estimates corresponding to the control variables (Figure 1) highlight baseline differences in stated willingness to download the apps across population subgroups. Older and more educated individuals are less likely to answer that they would download the apps. Women, as well as those who were directly exposed or knew somebody who was exposed to, or died because of, COVID-19, were more likely to say they would download the

apps. Also more likely to download the apps were those who perceived that their probability of ending up in the hospital was higher, and those who thought it risky to carry out activities indoors with other people. On the other hand, those who reported having attended a party in the previous 7 days were less likely to respond that they would download the apps.

3.1 Mechanism

We now make use of the Yes/No questions asked right after each of the three treatment vignettes to shed light on the mechanism linking treatments and outcomes. These post-vignette questions are provided alongside each of the vignettes in Section 2.2 (in English) and in the Online Appendix C (in Spanish). For example, after the T3 vignette (emphasizing government efforts to protect data privacy), the following question was asked: "*Is data protection an important issue for you?*" If concerns about data privacy really drove the estimated negative effect of T3 on the likelihood of downloading the contact tracing app, one would expect the effect of T3 to be larger (more negative) among those who responded "Yes" to the follow-up question than among those who responded "No." The general idea is that an individual's reaction to a treatment vignette is potentially conditioned on the individual's agreement or disagreement with whatever it is that the vignette makes salient.

The data support this hypothesis (as it can be observed in detail in Figure A.4 and Figure A.5 in the Online Appendix). Those individuals who answered "Yes" to the post-vignette question were *less* likely to choose "Definitely yes" as a response to the download question than those who answered "No" (70% vs 76%) and more likely to choose "I think so," "I don't think so," and "Definitely no." We take this finding as additional evidence in support of the idea that priming individuals to think about an area of concern to them (in this case, data privacy), even if the purpose is to assuage their concerns (as in treatment T3), could backfire by discouraging the desired behavior (i.e., willingness to download the contact tracing app).

For the other two treatment arms, the opposite pattern holds. Among those assigned to treatment T2, those who answered "Yes" to the question: "*Do you agree that online services increase the welfare of Mexicans?*" were more likely to state they were willing to download the contact tracing app than those who answered "No." (80% of those who answered "Yes" chose "Definitely yes" as their response to the willingness-to-download question, while 73% of those who answered "No" did.) Similarly, among individuals assigned to treatment T1, those who responded "Yes" to the question "*Do you agree that the Facebook mobile app increases contact with your loved ones?*" displayed a higher probability of stating that they

definitely would download the app than those who answered "No." Again, the same results hold for the diagnostic app (Figure A.5). These results are consistent with the idea that the perceived convenience of, or satisfaction with, online services in general are additional drivers of app adoption, and overall a better strategy to motivate compliance with the policy.

3.2 Robustness

In order to check whether something idiosyncratic about the wording of the data privacy treatment—rather than the fact that it draws attention to data privacy—is driving the results, we conducted a second survey experiment on a smaller sample of about 1,000 individuals. In that experiment, we added a fourth treatment. Individuals assigned to the new treatment received the following vignette:

> **T4:** *Ensuring citizen data privacy is of utmost importance for governments around the world, and Mexico is no exception. The data privacy of Mexicans is a priority for our government. Do you agree that protecting your privacy is a priority of the government?* [Yes/No]

This vignette aimed to emphasize, even more than T3, the actions that the government was taking to ensure data privacy, and to highlight that providing security was an explicit priority of the government.

Figure 3 summarizes the regression results (the full regression estimates are provided in Table B.3 in the Appendix). The results for treatments T1-T3 are very similar to those in the main analysis, serving as a replication exercise. Moreover, the results for the new privacy treatment (T4) are virtually identical to those of the main privacy treatment (T3) for both willingness-to-download outcome questions. Respondents assigned to T3 and T4 were about 4-6 percentage points less likely to state willingness to download either app. The fact that results are almost identical for T3 and T4 provides additional support for the idea that priming respondents about data privacy, regardless of the specific wording used, is the likely driver of the observed effect.

4 Discussion

Covid-19 has been raging across the world. According to most experts, in order to control the spread of the virus, it is important to know who has the virus and who has been in

contact with people who have it. That way, individuals infected can be isolated and receive adequate care. In order to achieve the levels of information necessary for the policy to be effective, and as complements to other types of contact tracing, governments have developed apps for self-diagnostic and for contact tracing. Individuals who suspect having the virus can seek professional help and isolate themselves to avoid potentially infecting others. Also, individuals can be informed when they have been in contact with somebody with a positive test. But for these apps to work, they have to be downloaded and used by a large share of the population. Governments have been relatively unsuccessful so far at getting citizens to download and use these apps. In order to increase take up, many have resorted to highlighting their efforts to ensure data privacy. However, those very messages of reassurance may prime individuals to worry about data privacy and as a result reduce their willingness to download the apps.

In this paper, we presented experimental evidence that stressing efforts to address concerns about data privacy may backfire. Mentioning privacy concerns generates a "knee-jerk" reaction against the download of the app. Moreover, this reaction is stronger for those who most agree with the prime, and it is robust to two different wordings of the prime. Overall, our findings suggest that mentioning privacy concerns, rather than reassuring the citizen, could convey the message that data privacy is something that the citizen *should* be worrying about. It is also possible that the mere mention of "data privacy" could trigger a fear reaction. Discerning between these, and related, hypotheses about the precise mental processes at work is beyond the scope of this paper, but an interesting direction for future research.

In contrast, avoiding mention of privacy concerns but focusing instead on the benefits of online government services increased the rate of stated willingness to download the apps. This positive effect may be due to the fact that this treatment highlights the government's positive record. It is also possible that this treatment indirectly emphasizes the benefits of using online services in general, thereby leading individuals to focus on the benefits of the apps rather than on their risks. The findings presented here may travel well to other related policy areas where safety is a concern, such as vaccination. More broadly, our results demonstrate the effectiveness of priming individuals as a means to influence (self-reported) intended behavior.

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Table 1: Balance Table

	Control	Difference w.r.t. control (coeff and s.e.)			Sample Size
	(av and s.e.)	T1	T2	T3	
	[1]	[2]	[3]	[4]	[5]
Age (group)	1.417	0.008	0.016	0.005	22,896
	(0.007)	(0.010)	(0.010)	(0.010)	
1. Younger 25	0.208	0.000	0.001	-0.005	22,896
	(0.005)	(0.008)	(0.008)	(0.008)	
1. Older 55	0.101	0.009*	0.015**	0.005	22,896
	(0.004)	(0.006)	(0.006)	(0.006)	
1. Female	0.674	-0.006	-0.023***	-0.007	23,072
	(0.006)	(0.009)	(0.009)	(0.009)	
Education (group)	2.6	-0.011	-0.005	-0.014	22,925
	(0.008)	(0.012)	(0.012)	(0.012)	
1. College	0.682	-0.009	-0.006	-0.006	22,925
	(0.006)	(0.009)	(0.009)	(0.009)	
1. Exposed Covid	0.653	0.004	0.001	-0.004	22,625
	(0.006)	(0.009)	(0.009)	(0.009)	
1. Death Covid	0.568	0.023**	0.017*	-0.005	23,184
	(0.007)	(0.009)	(0.009)	(0.009)	
1. Older 65 Home	0.266	-0.014*	0.008	-0.007	23,093
	(0.006)	(0.008)	(0.008)	(0.008)	
1. Exposed H1N1	0.19	0.006	0.006	0.004	23,184
	(0.005)	(0.007)	(0.007)	(0.007)	
Prob Infection	51.591	-0.088	-0.786	0.153	22,964
	(0.379)	(0.530)	(0.531)	(0.538)	
Prob Hospital	45.146	0.301	-0.028	0.308	22,988
	(0.336)	(0.470)	(0.471)	(0.478)	
1.Attend Party	0.125	-0.006	-0.005	-0.000	23,087
	(0.004)	(0.006)	(0.006)	(0.006)	
1. Visit	0.431	-0.010	-0.015	-0.002	23,085
	(0.007)	(0.009)	(0.009)	(0.009)	
1. Risky Inside	0.723	0.013	0.020**	0.017**	23,184
	(0.006)	(0.008)	(0.008)	(0.008)	
1. Social Distance	0.361	0.000	0.008	-0.014	23,098
	(0.006)	(0.009)	(0.009)	(0.009)	

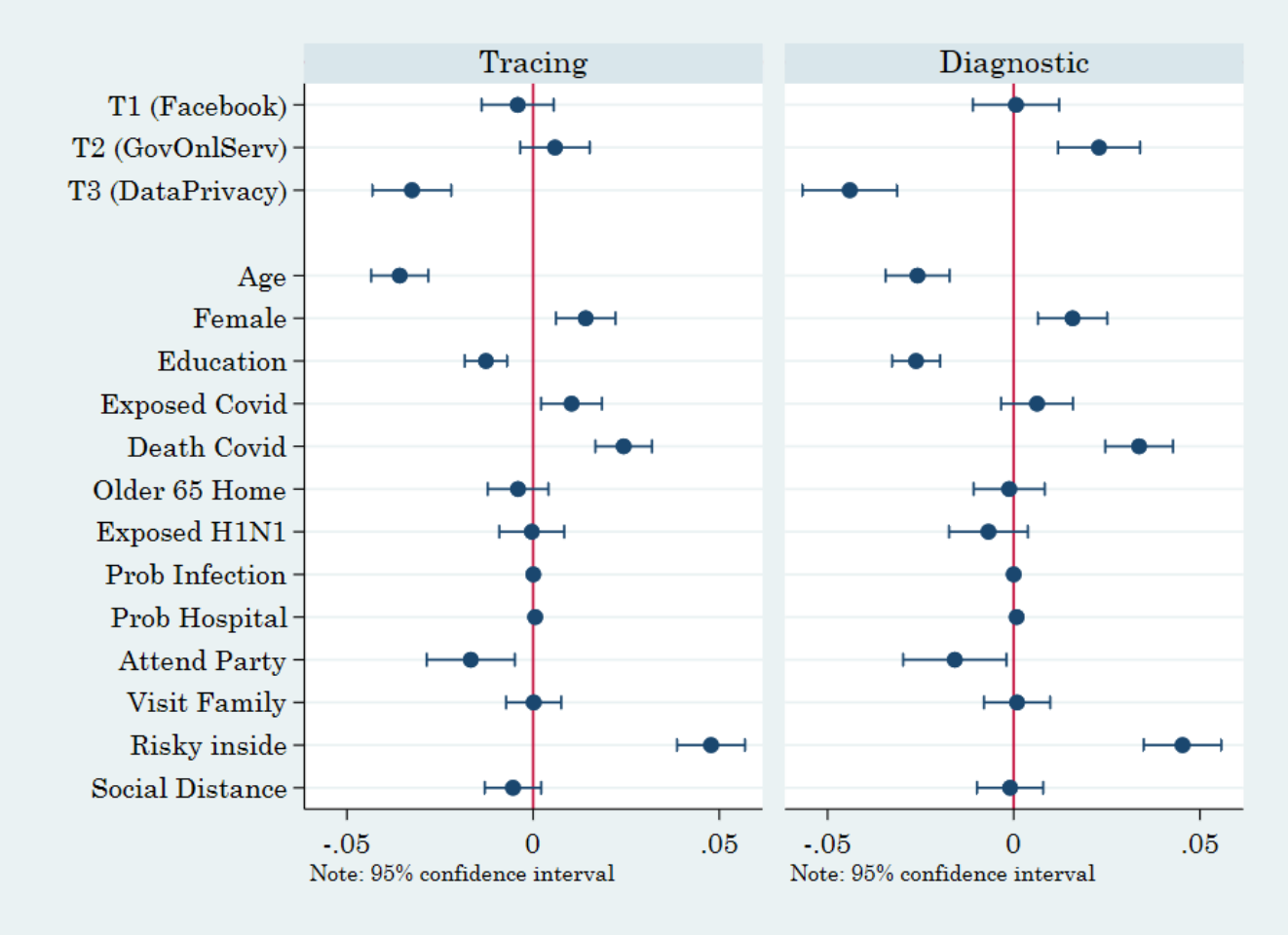
Notes: Each row shows statistics for a different observable variable we have. Survey questions that serve the basis for the variables here, are available in Appendix C. Column [1] shows the sample average and the standard deviation in parenthesis for the control group. Columns [2]-[4] shows the regression coefficient and the standard error in parenthesis corresponding to an OLS regression. Column [5] shows the sample size for each regression. Standard errors are robust. *** p<0.01, ** p<0.05, * p<0.1
Source: Authors' calculations

Table 2: Willingness to download the app

	Tracing App				Diagnostic App			
Treatments	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
T1 (Facebook)	-0.000	-0.004	-0.004	-0.004	0.002	0.001	0.000	0.001
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
T2 (GovOnlServ)	0.008	0.006	0.006	0.006	0.024***	0.023***	0.023***	0.023***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
T3 (DataPrivacy)	-0.029***	-0.032***	-0.032***	-0.032***	-0.042***	-0.044***	-0.044***	-0.043***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.007)
Constant	0.927***	0.870***	0.881***	0.879***	0.892***	0.849***	0.879***	0.842***
	(0.003)	(0.017)	(0.036)	(0.025)	(0.004)	(0.019)	(0.037)	(0.030)
Observations	22,776	21,251	21,251	21,251	22,724	21,194	21,194	21,194
R-squared	0.003	0.027	0.029	0.040	0.006	0.024	0.026	0.036
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Fixed Effects	No	No	State	Muni	No	No	State	Muni
T1=T2=T3	0	0	0	0	0	0	0	0
T1=T2	0.086	0.039	0.038	0.038	0.001	0.001	0.001	0.001
T1=T3	0.001	0.001	0.001	0.001	0	0	0	0
T2=T3	0	0	0	0	0	0	0	0

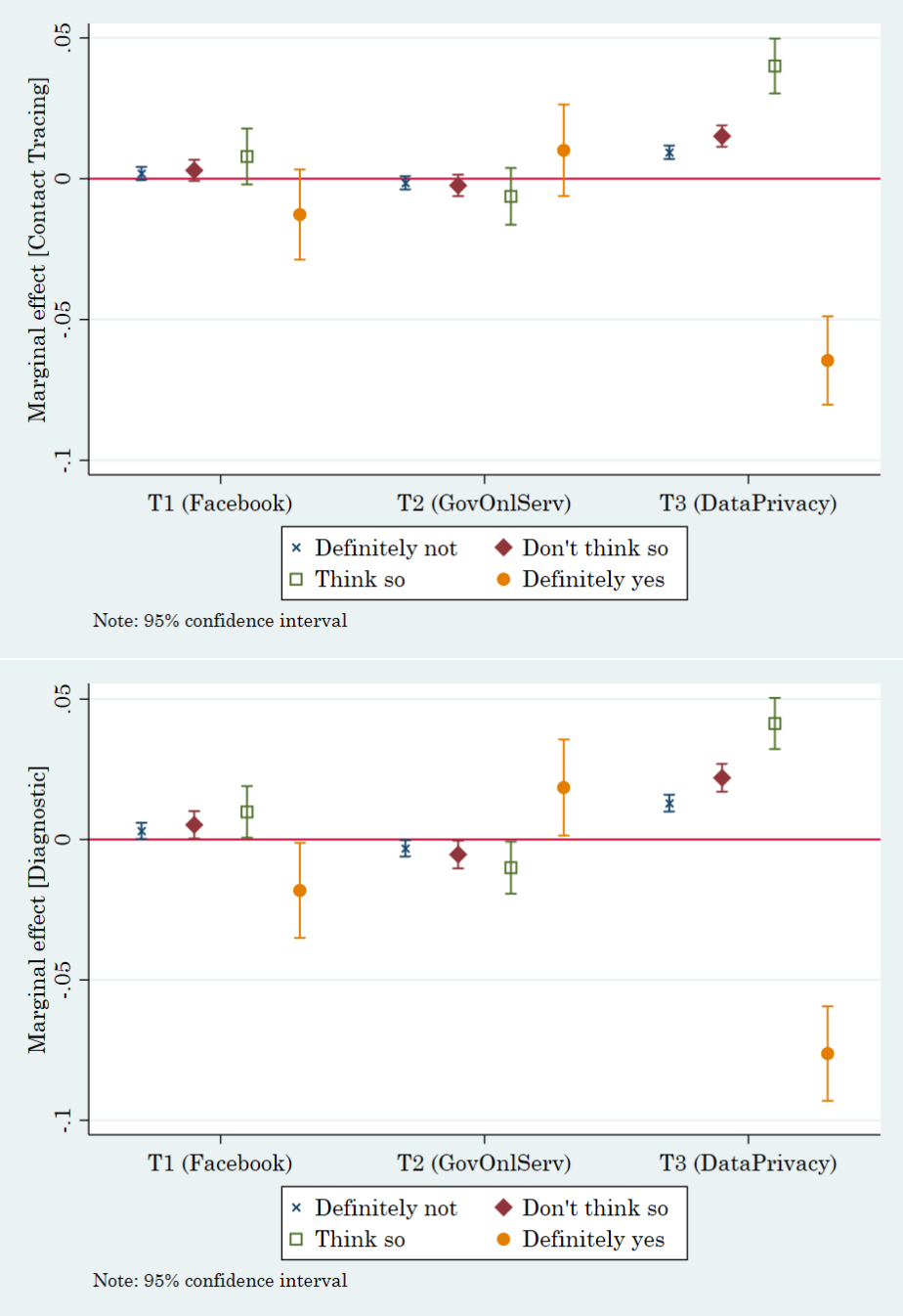
Notes: each row shows the regression coefficients and the standard error in parenthesis corresponding to an OLS regression. Dependent variables take the value 0-1 according to the willingness of the respondent to download each application. Survey questions used for the construction of the dependent variables available in Appendix C. Standard errors are robust. *** p<0.01, ** p<0.05, * p<0.1.
Controls include: sex, age, education, exposed to Covid, death to Covid, older than 65 at home, knows infected H1N1, belief about infection probability, belief about hospitalization probability, attends party, visits family, risk inside evaluation, and others practice social distancing. Survey questions used for the construction of the control variables available in Appendix C.
Source: Authors' calculations

Figure 1:
Treatment Effects and Coefficient Estimates



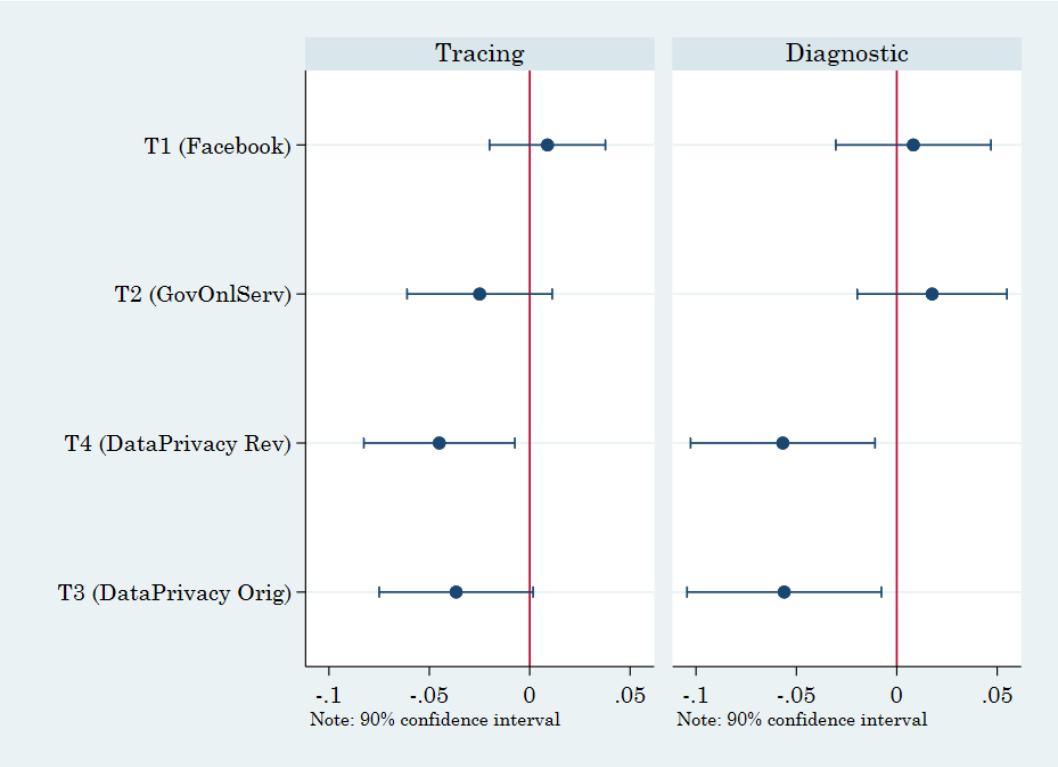
Notes: This figure shows the treatment effects and coefficients for the two dependent variables. It corresponds to columns [2] and [6] in Table 2.

Figure 2: Treatment Effects - Ordered Logit



Notes: These figures show the change in probabilities associated with each treatment for the two dependent variables. It corresponds to the margins of the coefficients in columns [1] and [4] in Table B.1.

Figure 3:
Treatment Effects - Sonora sample



Notes: This figure shows the treatment effects and coefficients for the two dependent variables. It corresponds to columns [1] and [4] in Table B.3 .

A Online Appendix: Figures

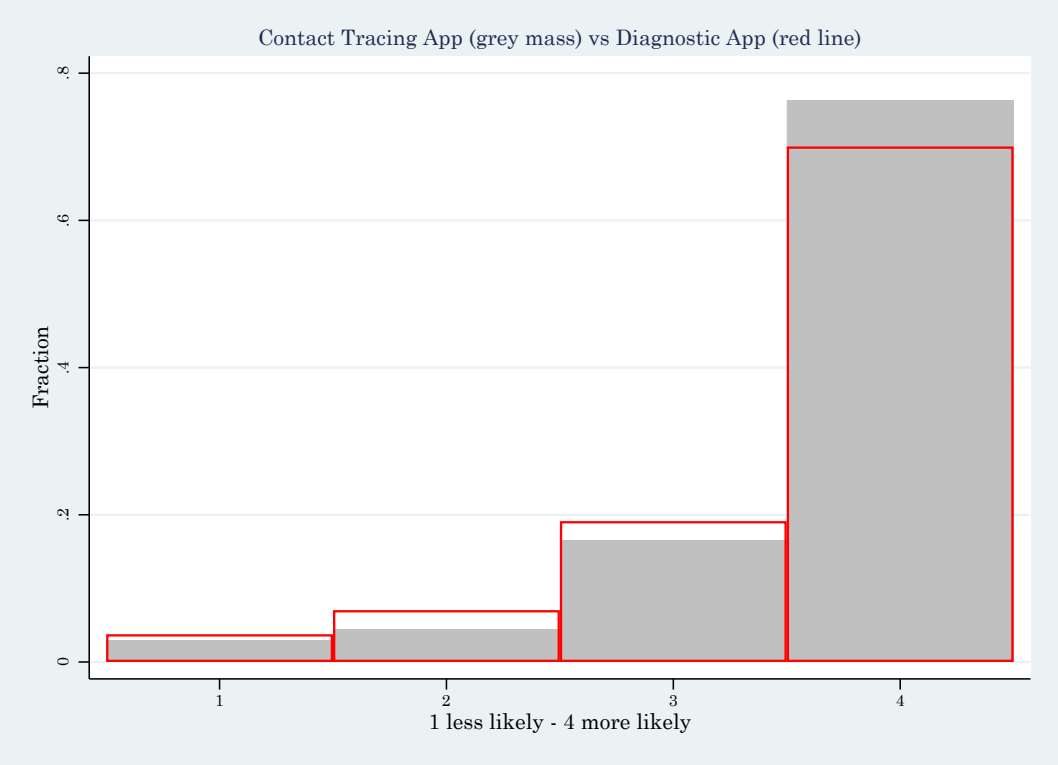
Figure A.1: Facebook Ads - Recruitment

Notes: The figure shows a couple of examples of the ads used for recruitment. Figure A.2 shows the different combinations of pictures used to construct these ads.

Figure A.2: Facebook Ads - Set of pictures for the ads

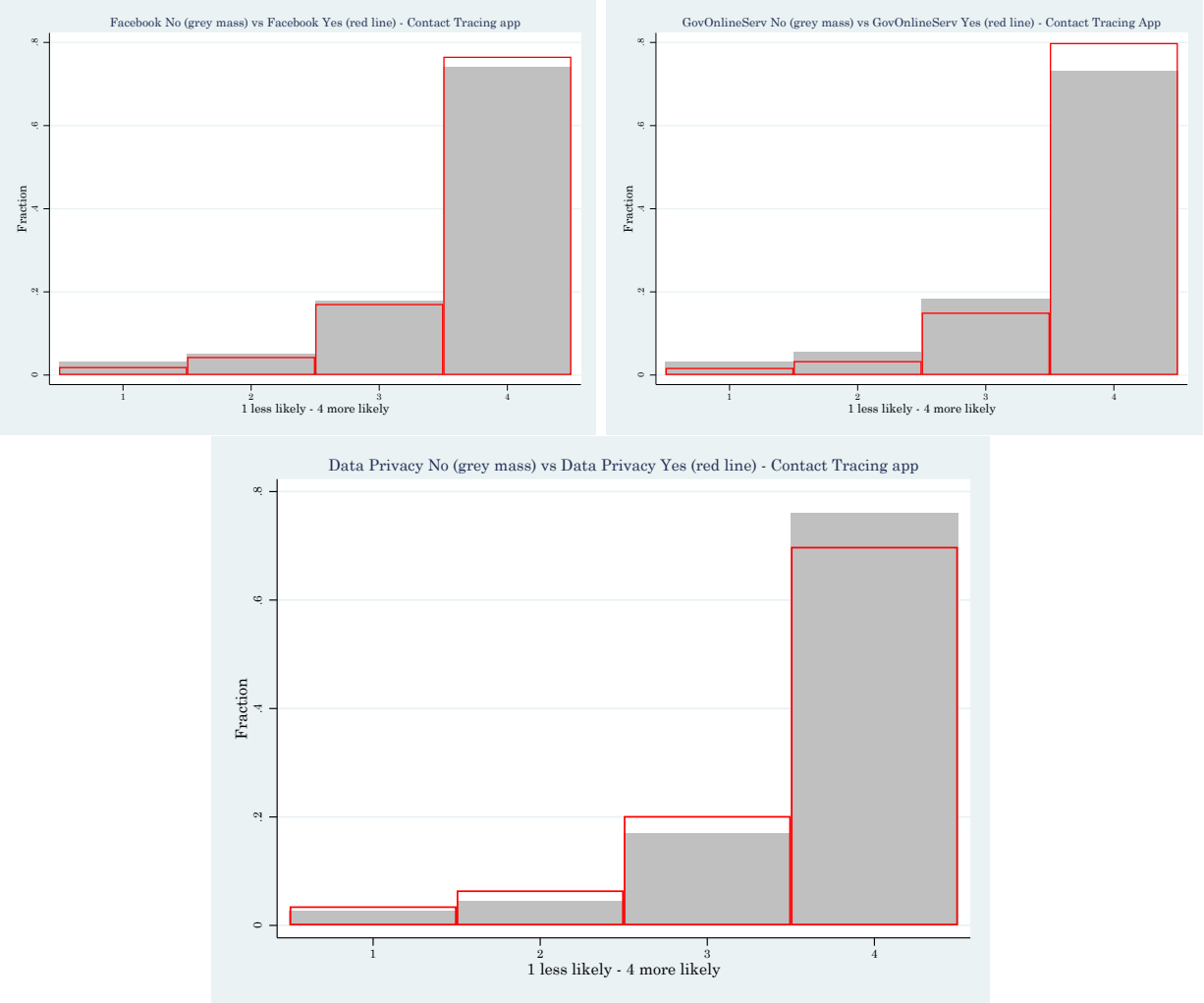
Notes: The figure shows the different pictures that were used to construct the set of ads used for recruitment.

Figure A.3:
Distribution of responses - control group



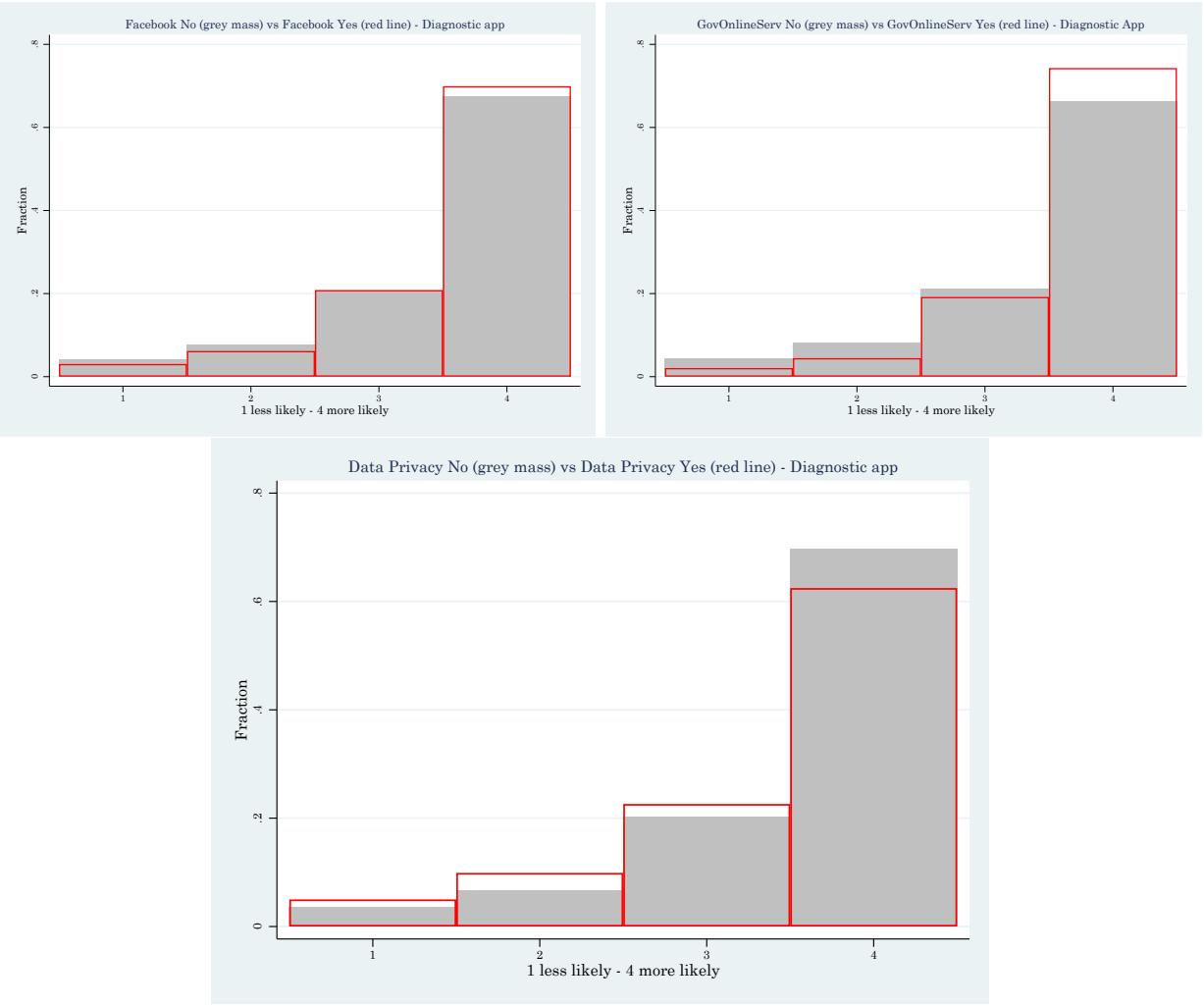
Notes: This figure shows the distribution of responses to the questions regarding the download of the apps.

Figure A.4: Responses to the vignette statement - Contact Tracing App



Notes: This figure shows the histograms for the responses regarding the tracing app for those who answered 'yes' (prompted) and 'no' (not prompted) to the questions included in the treatment vignettes.

Figure A.5: Responses to the vignette statement - Diagnostic App



Notes: This figure shows the histograms for the responses regarding the tracing app for those who answered 'yes' (prompted) and 'no' (not prompted) to the questions included in the treatment vignettes.

B Online Appendix: Tables

Table B.1: Willingness to download the app [Ordered Logistic Regression]

	Contact Tracing App			Diagnostic App		
Treatments	[1]	[2]	[3]	[4]	[5]	[6]
T1 (Facebook)	-0.067	-0.081*	-0.080*	-0.084**	-0.096**	-0.098**
	(0.043)	(0.046)	(0.046)	(0.040)	(0.042)	(0.042)
T2 (GovOnlServ)	0.053	0.044	0.046	0.085**	0.089**	0.089**
	(0.044)	(0.046)	(0.046)	(0.040)	(0.042)	(0.042)
T3 (Data Privacy)	-0.341***	-0.369***	-0.369***	-0.352***	-0.377***	-0.378***
	(0.042)	(0.045)	(0.045)	(0.040)	(0.042)	(0.042)
Observations	22,776	21,251	21,251	22,724	21,194	21,194
Controls	No	Yes	Yes	No	Yes	Yes
Fixed Effects	No	No	State	No	No	State
T1=T2=T3	0	0	0	0	0	0
T1=T2	0.005	0.006	0.006	0.001	0.001	0.001
T1=T3	0	0.001	0.001	0	0	0
T2=T3	0	0	0	0	0	0

Notes: each row shows the regression coefficients and the standard error in parenthesis corresponding to an ordered logit regression. Dependent variables take the values 1 (definitely would not) to 4 (definitely would) according to the willingness of the respondent to download each one of the apps. Survey questions used for the construction of the dependent variables available in Appendix C. Standard errors are robust. *** p<0.01, ** p<0.05, * p<0.1.
Controls include: sex, age, education, exposed to Covid, death to Covid, older than 65 at home, knows infected H1N1, belief about infection probability, belief about hospitalization probability, attends party, visits family, risk inside evaluation, and others practice social distancing. Survey questions used for the construction of the control variables available in Appendix C.
Source: Authors' calculations

Table B.2: Balance Table - Sonora Sample

	Control	Difference w.r.t. control (coeff and s.e.)				Sample Size
	(av and s.e.)	T1	T2	T3	T4	
	[1]	[2]	[3]	[4]	[5]	[6]
Age (group)	1.317	0.066	0.067	0.024	0.054	976
	(0.035)	(0.051)	(0.052)	(0.050)	(0.050)	
1.Female	0.915	0.017	-0.006	0.031	0.016	982
	(0.02)	(0.027)	(0.029)	(0.026)	(0.026)	
Education (group)	2.613	0.055	0.029	0.052	0.033	976
	(0.043)	(0.060)	(0.061)	(0.059)	(0.059)	
1.Exposed Covid	0.899	0.006	-0.003	0.035	0.021	969
	(0.021)	(0.030)	(0.031)	(0.028)	(0.028)	
1.Death Covid	0.82	0.024	-0.029	-0.019	0.009	982
	(0.027)	(0.038)	(0.040)	(0.040)	(0.037)	
1.Older 65	0.216	-0.037	0.020	0.103**	-0.050	977
	(0.029)	(0.040)	(0.043)	(0.045)	(0.039)	
1.Exposed H1N1	0.23	0.010	0.005	0.001	0.033	982
	(0.03)	(0.043)	(0.043)	(0.043)	(0.042)	
Prob Infection	47.658	-1.264	1.729	-1.478	-0.093	972
	(2.035)	(2.863)	(2.867)	(2.925)	(2.740)	
Prob Hospital	44.919	-4.998**	-1.427	-1.078	-2.570	971
	(1.594)	(2.216)	(2.385)	(2.351)	(2.248)	
1.Attend Party	0.275	-0.041	-0.061	-0.056	-0.086**	979
	(0.032)	(0.044)	(0.044)	(0.042)	(0.043)	
1.Visit	0.570	-0.0150	0.018	-0.030	-0.016	979
	(0.035)	(0.050)	(0.050)	(0.049)	(0.051)	
1.Risky Inside	0.695	-0.002	-0.048	0.005	0.063	982
	(0.033)	(0.047)	(0.048)	(0.045)	(0.045)	
1.Social Distance	0.337	0.129	0.064	0.101**	0.020	979
	(0.034)	(0.049)	(0.049)	(0.048)	(0.049)	

Notes: Each row shows statistics for a different observable variable we have. Survey questions that serve the basis for the variables here, are available in Appendix C. Column [1] shows the sample average and the standard deviation in parenthesis for the control group. Columns [2]-[5] shows the regression coefficient and the standard error in parenthesis corresponding to an OLS regression. Column [6] shows the sample size for each regression. Standard errors are robust. *** p<0.01, ** p<0.05, * p<0.1
Source: Authors' calculations

Table B.3: Willingness to download the app - Sonora

	Contact Tracing App			Diagnostic App		
Treatments	[1]	[2]	[3]	[4]	[5]	[6]
T1 (Facebook)	0.009	0.019	0.012	0.008	0.017	0.006
	(0.018)	(0.017)	(0.018)	(0.023)	(0.024)	(0.026)
T2 (GovOnlServ)	-0.025	-0.020	-0.021	0.018	0.023	0.022
	(0.022)	(0.023)	(0.024)	(0.023)	(0.024)	(0.025)
T3 (Data Privacy Orig)	-0.045**	-0.021	-0.029	-0.057**	-0.033	-0.044
	(0.023)	(0.022)	(0.023)	(0.028)	(0.027	(0.028)
T4 (Data Privacy Rev)	-0.037	-0.036	-0.042	-0.056*	-0.059*	-0.069**
	(0.023)	(0.024)	(0.025)	(0.029)	(0.031)	(0.033)
Constant	0.965***	1.014***	1.078***	0.939***	0.965***	0.995***
	(0.013)	(0.061)	(0.079)	(0.017)	(0.068)	(0.089)
Observations	965	916	916	968	919	919
R-squared	0.008	0.026	0.049	0.014	0.024	0.052
Controls	No	Yes	Yes	No	Yes	Yes
FixEffects	No	No	Muni	No	No	Muni
T1=T2=T3=T4	0.040	0.038	0.074	0.005	0.013	0.009
T1=T2	0.110	0.075	0.153	0.671	0.796	0.518
T1=T3	0.015	0.048	0.059	0.018	0.061	0.081
T1=T4	0.043	0.018	0.029	0.026	0.013	0.021
T2=T3	0.435	0.993	0.761	0.005	0.035	0.018
T2=T4	0.654	0.578	0.471	0.009	0.006	0.004
T3=T4	0.755	0.559	0.647	0.983	0.427	0.467

Notes: each row shows the regression coefficients and the standard error in parenthesis corresponding to an OLS regression. Dependent variables take the value 0-1 according to the willingness of the respondent to download the app. Survey questions used for the construction of the dependent variables available in Appendix C. Standard errors are robust. *** p< 0.01, ** p< 0.05, * p< 0.1.
Controls include: sex, age, education, exposed to Covid, death to Covid, older than 65 at home, knows infected H1N1, belief about infection probability, belief about hospitalization probability, attends party, visits family, risk inside evaluation, and others practice social distancing. Survey questions used for the construction of the control variables available in Appendix C.
Source: Authors' calculations

C Online Appendix: Original questions

Table C.1: Original Questions - Dependent Variables

Variable	Dummy	Discrete coding	Original Survey Question (Spanish)	Translated Survey Question
			Si hubiera una aplicación móvil del gobierno federal para tu teléfono que te permitiera saber si tienes algún síntoma de coronavirus y te dijera qué hacer, sin costo y sin consumir datos, ¿la instalarías en tu teléfono?	If a federal government app were available for your smartphone that could help you to identify coronavirus symptoms, and inform you what to do, at no cost, and with no data usage, would you download it to your phone?
Diagnostic	1	4	Seguro sí	Definitely yes
application	1	3	Creo que sí	I think so
	0	2	Creo que no	I don't think so
	0	1	Seguro no	Definitely not
		.	No sé / prefiero no responder	I don't know / I prefer not to answer
			Si además de lo anterior, esa aplicación también te alertara si estuviste en contacto por más de 15 minutos con una persona infectada de coronavirus, y les notificara a las personas que estuvieron en contacto cercano contigo, sin identificar ningún nombre, ni el tuyo ni el de las otras personas, ¿la instalarías en tu teléfono?	If, in addition to the previously-described features, the app could also alert you if you had been in contact for more than 15 minutes with an infected person, and it notified the people who were near you if you became infected, without identifying personal information (yours or others'), would you download the app?
Contact	1	4	Seguro sí	Definitely yes
Tracing	1	3	Creo que sí	I think so
application	0	2	Creo que no	I don't think so
	0	1	Seguro no	Definitely not
		.	No sé / prefiero no responder	I don't know / I prefer not to answer

Table C.2: Original Questions - Control Variables

Variable	**Coding**	**Original Survey Question (Spanish)**	**Translated Survey Question**
Age (group)		¿Cuál es tu edad?	How old are you?
	1	18-24	18-25
	1	25-39	25-40
	2	40-55	40-56
	2	55-64	55-65
	3	65+	65+
	.	No sé / prefiero no responder	I don't know / I prefer not to answer
1.Female		¿Cuál es tu género?	What is your gender?
	1	Femenino	Female
	0	Masculino	Male
	0	Otro	Other
	.	No sé / prefiero no responder	I don't know / I prefer not to answer
Education (group)		¿Cuál fue el último nivel educativo que completaste?	What was the highest level of education you completed?
	0	No fui a la escuela	I did not go to school
	1	Primaria	Primary
	1	Secundaria	Secondary
	2	Preparatoria	High School
	3	Superior o universitaria	Higher or university
	3	Maestría u otro nivel más avanzado	Master's degreer another more advanced level
	.	No sé / prefiero no responder	I don't know / I prefer not to answer
1. Exposed COVID-19		¿Tú o algún amigo, familiar o colega tuyo han tenido Coronavirus?	Have you or a friend, relative or colleague of yours had Coronavirus?
	1	Sí	Yes
	0	No	No
	.	No sé / prefiero no responder	I don't know / I prefer not to answer
1. Death COVID-19		¿Conoces a alguien que haya muerto por Coronavirus?	Do you know someone who has died from Coronavirus?
	1	Sí	Yes
	0	No	No
	.	No sé / prefiero no responder	I don't know / I prefer not to answer

Table C.3: Original Questions - Control Variables

Variable	Coding	Original Survey Question (Spanish)	Translated Survey Question
1. Older 65 Home		Incluyéndote a ti, ¿en este momento vive en tu hogar algún adulto mayor de 65 años?	Including you, is there an adult over 65 living in your household at this time?
	1	Sí	Yes
	0	No	No
	.	No sé / prefiero no responder	I don't know / I prefer not to answer
1. Exposed H1N1		Durante la crisis del virus de influenza H1N1 en el verano del año 2009 en México, ¿tú o alguien que conoces se enfermaron del virus?	During the H1N1 influenza virus crisis in the summer of 2009 in Mexico, did you or someone you know become ill with the virus?
	1	Sí	Yes
	0	No	No
	.	No recuerdo / No sé	I don't remember / I don't know
Prob. Infection		En tu opinión, ¿qué tan probable es que tú te contagies de Coronavirus en los siguientes 6 meses?	In your opinion, how likely is it that you will get Coronavirus in the next 6 months?
	1-100	Barra deslizante: variable continua	Sliding bar: continuous variable
Prob. Hospital		En tu opinión, si una persona de tu edad se contagia de Coronavirus, ¿qué tan probable es que termine hospitalizado/a?	In your opinion, if a person your age is infected with Coronavirus, how likely is it that they will end up hospitalized?
	1-100	Barra deslizante: variable continua	Sliding bar: continuous variable
1. Attend Party		En los últimos 7 días, ¿tú o alguien en tu hogar realizaron alguna de las siguientes actividades?	In the last 7 days, did you or someone in your household perform any of the following activities?
		Visitar a parientes o amigos en su casa.	Visit relatives or friends at home
	1	Sí	Yes
	2	No	No
1. Visit		En los últimos 7 días, ¿tú o alguien en tu hogar realizaron alguna de las siguientes actividades?	In the last 7 days, did you or someone in your household perform any of the following activities?
		Asistir a una reunión o fiesta con más de 10 personas	Attend a meeting or party with more than 10 people
	1	Sí	Yes
	2	No	No
1. Risky Inside		Ahora piensa en el riesgo de contagio. ¿Qué tan riesgoso crees que es ir a un gimnasio cerrado?	Now think about the risk of contagion. How risky do you think it is to go to an indoor gym?
	1	Riesgo alto	High risk
	0	Riesgo medio	Medium risk
	0	Riesgo bajo	Low risk
	.	No sé / prefiero no responder	I don't know / I prefer not to answer
1. Social Distance		Pensando en tus vecinos y conocidos, ¿dirías que en general toman o no toman las siguientes medidas? Mantener sana distancia de otras personas	Thinking about your neighbors and acquantances, would you say that in general they follow the following measure? Keep social distance from others
	1	Sí	Yes
	0	No	No