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Research Article

Behavioral pre-testing of COVID Tracker, Ireland's contact-tracing app.

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Abstract: Contact-tracing mobile phone apps can play a role in controlling the spread of COVID-19, but their success hinges on widespread public acceptance, uptake and use, which are difficult for public administrators to foresee. We report on a rapid behavioral pre-test of COVID Tracker, Ireland's contact-tracing app, prior to its launch. A large sample of participants were randomized to receive different versions of a trial app. They responded to an online survey while downloading and using the app on their phones in real time. Experimental manipulations focused on: (i) the level of privacy assurance provided in the app, (ii) the goal-framing of the purpose of the app and (iii) the structuring of the exposure notification. Almost one in five participants mentioned privacy concerns in relation to their likelihood of downloading the app, but concerns were lower and engagement stronger in a condition that included additional assurances regarding the privacy of users' data in the app. This finding informed the final version of the app. Overall, our results demonstrate the value and feasibility of pre-testing digital interfaces to improve public administration.

Keywords: COVID-19, Contact Tracing, Mobile Applications, Privacy

Supplements: Open data, Open materials, Preregistration

Contact-tracing mobile phone apps can be a useful public-health tool for controlling the spread of COVID-19, but their success hinges on widespread uptake and use (Lewis, 2021; Ferretti, et al., 2020; Zastrow, 2020; Gibney, McCarthy, & Lindberg, 2020). Some countries have addressed this issue by making app download and use mandatory. However, this approach has typically been avoided in western societies, which have instead relied on voluntary uptake. Where public authorities want to introduce an intervention such as a contact-tracing app, they must consider not only technological functionality but also how the technology is perceived by the public, and how individuals interact with it on a behavioral level (Anglemyer, et al., 2020).

In different countries, research for policy has addressed people's hypothetical likelihood of downloading a contact-tracing app (Trang, Trenz, Weiger, Tarafdar, & Cheung, 2020; Altmann, et al., 2020; Simko, Calo, Roesner, & Kohno, 2020; O'Callaghan, et al., 2020; Kaspar, 2020). We describe work in Ireland that went a step further, using a behavioral experiment to pre-test different versions of the government-backed app, "COVID Tracker".[1] The app aims to facilitate contact tracing, but also contains an "Updates" tab with statistics about the spread of the virus, and a "Check-In" feature, whereby users enter a daily record of any symptoms.

Ireland's Department of Health commissioned the study. The design was agreed and overseen by a subcommittee of the National Public Health Emergency Team (NPHET), which contained some of the country's most senior behavioral scientists and behavioral policy specialists. Participants from a large, representative national sample were randomized to try different versions of the app. They responded to an online questionnaire while going through the process of downloading the app and using it in real time. The

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study focused on three areas: the level of privacy assurance provided in the app, the goal-framing of the purpose of the app, and the structuring of the exposure notification received by users deemed to have had a close contact with an infected person. The trial was pre-registered and took place in June 2020.[2] The app's subsequent launch was successful by international standards, with over 1 million people (of a total adult population of 3.8 million) downloading the app in the first 48 hours (Vin, 2020; Carroll, 2020).

Theory and Hypotheses

Privacy assurances

Contact-tracing apps raise concerns about users' privacy (Sharma, Bashir, & M, 2020; Singer & Sang-Hun, 2020; Bengio, et al., 2020; Abeler, Bäcker, Buermeyer, & Zillessen, 2020), prompting the development of privacy-preserving solutions, such as the Google/Apple Exposure Notification technology used by COVID Tracker (Google, 2020). However, protecting privacy is just one task facing public administrators; reassuring the public that privacy is adequately protected is another. People's reported likelihood of downloading a contact-tracing app is influenced by how well privacy would be protected (Simko, Calo, Roesner, & Kohno, 2020; Altmann, et al., 2020; Trang, Trenz, Weiger, Tarafdar, & Cheung, 2020; Kaspar, 2020).

Individuals tend to have fewer privacy concerns and to be more willing to share their data when assured that data will not be shared with third parties, when perceiving greater control over their data, or when given a justification for the collection of data (Keusch, Struminskaya, Antoun, Couper, & Kreuter, 2019; Gu, Xu, Xu, Zhang, & Ling, 2017; Xu, Teo, Tan, & Agarwal, 2012). However, interventions that increase the salience of privacy issues have sometimes made people less inclined to share data (Marreiros, Tonin, Vlassopoulos, & Schraefel, 2017; John, Acquisti, & Loewenstein, 2009). Thus, we tested whether providing additional assurances regarding privacy within the app would lessen users' concerns, while acknowledging that assurances could back-fire should they confer undue salience to privacy issues.

Hypothesis 1: Providing additional assurances about privacy issues should increase understanding of these issues, reduce concern, promote trust, and increase people's willingness to give consent and engage with the app.

Goal-framing

Presenting one good reason in favor of a particular choice can sometimes be more effective than listing all reasons available (Weaver, Garcia, & Schwarz, 2012). Thus, we reasoned it could be beneficial to frame the use of the COVID Tracker app (and the appropriate action to take in the case of being detected as a close contact) in terms of a single primary goal, and sought to test two candidates for this.

In Ireland during 2020, the trade-off between staying safe and making progress in lifting restrictions on social and economic activity was central to perceptions of the country's management of the COVID-19 pandemic (Lunn, et al., 2020d). Further, willingness to protect family and friends is a main reason why people might be in favor of a contact-tracing app (Altmann, et al., 2020; O'Callaghan, et al., 2020). Thus, in one condition we framed the app as a crucial component in the process of lifting restrictions while reducing the chance that users spread the virus to someone vulnerable.

The coordinated effort against COVID-19 involves individuals making sacrifices for the benefit of the larger group (Lunn, et al., 2020a). Indeed, responsibility to the community was another primary reason people gave in favor of a contact-tracing app (Altmann, et al., 2020; O'Callaghan, et al., 2020). Our second condition framed the app using techniques that have been shown to enhance co-operation in such "collective action problems" including articulation of how downloading the app is "best for all" (Zelmer, 2003; Pavitt, 2018; Chaudhuri, 2011).

Hypothesis 2: How the purpose of the app is framed will affect how likely people are to download, share and use the app.

Hypothesis 3: The reason given for the need to restrict movements after receiving a close contact exposure notification will affect how people react to this notification.

Structure of the exposure notification

Simple modifications to the way information is presented can have significant impacts on how well that information is processed (Lagassé, et al., 2011; Jefford & Moore, 2008; Wogalter & Shaver, 2001; Jolly, Scott, & Sanford, 1995; Duvall Antonacopoulos & Serin, 2015; Kessels, 2003; Ley, 1979; Lorch, Lorch, & Inman, 1993). In the context of COVID-19, organizing information into bullet points and headings can improve recall of instructions regarding self-isolation (Lunn, et al., 2020c). We therefore set out to test something similar with the instructions regarding restricting movements contained in the exposure notification that app users would receive if recorded as a close contact.

Hypothesis 4: Structuring the exposure notification using simplified bullet points under themed headings will improve comprehension of the instructions contained within it.

Materials and Methods

The study was conducted online and consisted of two surveys (completed 3-4 days apart), programmed using Gorilla Experiment Builder (Anwyl-Irvine, Massonnié, Flitton, Kirkham, & Evershed, 2020). Participants recorded responses in real time on their computer/tablet as they downloaded and used the COVID Tracker app on their phones.

Participants

Participants were recruited from an online panel held by a market research company. The sample was selected to be nationally representative, with a modest under-representation of older age groups to reflect age differences in smartphone ownership (Gibney & McCarthy, 2020). Sociodemographic characteristics of the sample are summarized in Appendix A.

A final sample of 1,236 participants was recruited to ensure at least 800 participants would successfully download the app and complete the study. Participants received between €5 and €12 for their time, depending on whether they completed both surveys or the first survey only.

Experimental manipulations

Three main experimental manipulations were applied to materials within both the survey interface and the app itself. The manipulations were run orthogonally, resulting in a 2 x 2 x 2 between-subjects design.

Privacy assurances

This manipulation applied within the app itself wherever there was information about data or privacy: at several points during the on-boarding process of the app, and in the "Check-In" tab.
Participants were randomly allocated to one of two conditions:

- "Baseline": This was the baseline wording provided by app developers, which contained the minimum information about data processed by the app required by regulations.
- "Baseline + Privacy Assurance": This contained additional assurances about the privacy of users' data, written in bold font.

Goal-framing of the app

This manipulation applied at three points:

1) In the text of a "call-to-action" that participants saw within the survey interface prior to downloading the app.

2) Within the app itself, in the text and images used in the introductory screen, and when users are asked to enable the contact-tracing technology.
3) In the text of a sample exposure notification that participants were shown in Survey 2.

Participants were randomly allocated to one of two conditions:

- "Safe Progress" frame: The app was presented as a technological solution to allow life to return to normal while keeping everyone safe. In the sample exposure notification, participants were told to restrict their movements to "avoid infecting someone vulnerable".
- "Collective Action" frame: The app was presented as a collective solution to allow everyone to play their part in the fight against COVID-19. In the sample exposure notification, participants were told to restrict their movements to "play your part to stop the spread."

Structure of the exposure notification
The sample exposure notification was shown to participants within the survey interface in Survey 2. Participants were randomly allocated to one of two conditions:

- "Control": This was the version provided by app developers, with minor changes such as the addition of a rationale for restricting movements, as mentioned above.
- "Intervention": This contained the same information as the control condition but simplified and rearranged as bullet points under themed headings.

Survey 1

Part 1: Before app use (call-to-action and first impressions)
Prior to downloading the app, participants were shown a "call-to-action," which introduced the purpose of the app. Following this, participants answered questions about how likely they would download the app and why, and about their first impressions.

Part 2: Download instructions
Participants were then given detailed instructions on how to download the trial COVID Tracker app.[3] They were given a code to enter on first opening the app which determined which version they received, depending on which experimental conditions they had been assigned to. Participants were aware that the app was a trial version and that contact tracing would not be active. They had multiple opportunities to flag if they were unable or unwilling to download the app.

Part 3: During first app use (on-boarding and consent)
Participants who successfully downloaded the app were instructed to complete the "on-boarding" process on their phones before returning to the survey. This involved receiving information about data privacy, giving consent for the collection of anonymous app usage data (optional), enabling contact-tracing (optional), and providing a phone number to receive a call back in the event of receiving an exposure notification (optional and only asked if contact tracing was enabled). Participants were then asked (through the survey questionnaire) about what they had consented to and what information they had shared with the app.

Participants were then asked to turn their attention to the "Updates" tab of the app, followed by the "Check-in" tab, where it is possible to share daily information about symptoms, with the option of sharing additional anonymous information (age, sex, locality) to make the data more useful. Participants were asked whether they checked in or shared this optional information.

Part 4: After first app use (general impressions and privacy concerns)
Participants could spend more time looking at the app before responding to general questions to gauge their impressions of the app after first use. Participants answered a series of questions to gauge trust, privacy concerns, and understanding (self-reported and objective) of privacy matters relating to the app.

Part 5: Explanatory and sociodemographic variables
Participants answered questions about broader opinions and attitudes that could be related to their attitude to a government-run contact-tracing app, followed by standard sociodemographic questions.

Survey 2

Part 1: Follow-up questionnaire
Participants first answered questions about their app use in the days between surveys before responding to questions repeated from the first survey about their general impressions. They were also asked to imagine testing positive for COVID-19 and to rate their likelihood of allowing the app to notify other users they had been in contact with.

Part 2: Exposure notification
Next, participants were shown (within the online survey interface) the exposure notification screen that users receive if recorded as a close contact, with advice of what to do and not do (with experimental manipulations applied).[4] Participants were asked how they would react to the exposure notification, as well as their understanding of the content. Finally, participants were asked to read some short vignettes, each describing a scenario in which an individual has received a close contact notification but then decides to ignore some advice on restricting movements. They had to rate the acceptability of the behavior.

Results

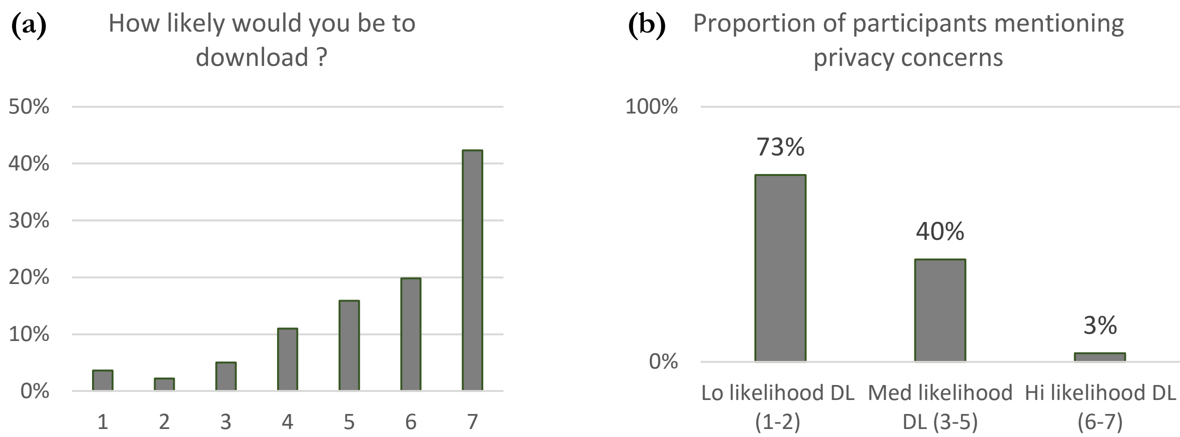
Of 1,236 participants, 27 were excluded as they did not have a smartphone, resulting in a sample of 1,209 participants for Survey 1. Of these, 388 did not download the app or encountered technical difficulties.[5] A final total of 821 participants successfully downloaded and used the app. Of these, 799 (97%) completed the follow-up survey – a very low rate of attrition. Checks for random assignment did not reveal substantive differences between experimental groups for any sociodemographic factors (Appendix B).

In describing our results, we do not report p-values, but instead follow the approach of Cumming (2014) in reporting effect sizes plus confidence intervals. We do this for the following reasons. Firstly, because we were working collaboratively with policymakers, we were required to obtain and report many measures, leading to a large number of potential statistical tests of differing policy import. In such circumstances, as documented by Rubin (2021), there is no current consensus among researchers on appropriate adjustment of p-values (or α-values). Secondly, since our study was directly linked to a specific policy implementation, we note Points 3 and 5 of the American Statistical Association's *Statement on Statistical Significance* and *P-Values* (Wasserstein & Lazar, 2016), which state that p-values should not be the basis for policy decisions and do not measure the size of an effect or the importance of a result. The latter point is particularly relevant where a policymaker must choose between two alternative implementations with no clear prior position regarding which is superior.[6]

Likelihood of downloading the app and privacy concerns

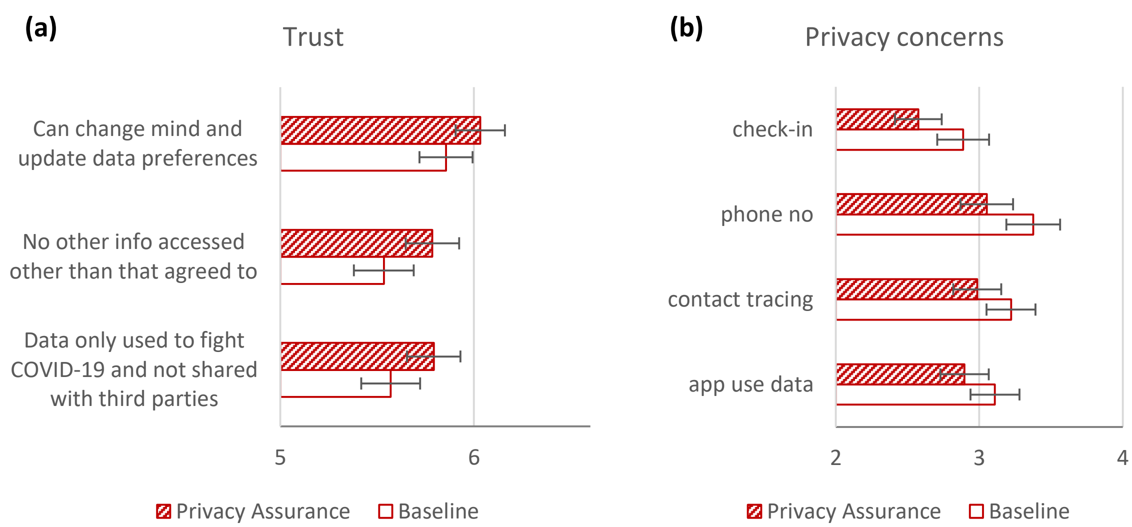
The majority of participants indicated that they would be likely to download the real COVID Tracker app, when asked after reading the "call-to-action" but before downloading and using the trial app – 78% gave a score above the midpoint of the 7-point scale (Figure 1(a)). When asked to give a reason for their score in an open text answer, 19% mentioned privacy concerns of some kind. This was especially common among participants unlikely to download the app (rating 1 or 2), but also prominent among those who gave intermediary scores (3 to 5) (Figure 1(b)).

Figure 1
Likelihood of downloading and prevalence of privacy concerns



Note: Pooled results showing (a) participants' stated likelihood of downloading COVID Tracker in real life, on a scale from 1 (Definitely would not download) to 7 (Definitely would download) (*n* = 1,209) and (b) the proportion of participants mentioning privacy concerns when asked for the reason for their rating, split by whether they stated a low, medium, or high likelihood of downloading the app (*n* = 71, *n* = 386, *n* = 752, respectively).

Figure 2
Effects of privacy assurances on trust and privacy concerns



Note: Responses to items regarding (a) participants' level of agreement with statements about trust regarding the data they were asked to share, on a scale from 1 (Strongly disagree) to 7 (Strongly agree), and (b) participants' stated level of concern at different points when using the app, on a scale from 1 (Not at all concerned) to 7 (Very concerned).

Privacy assurance manipulation (Hypothesis 1)

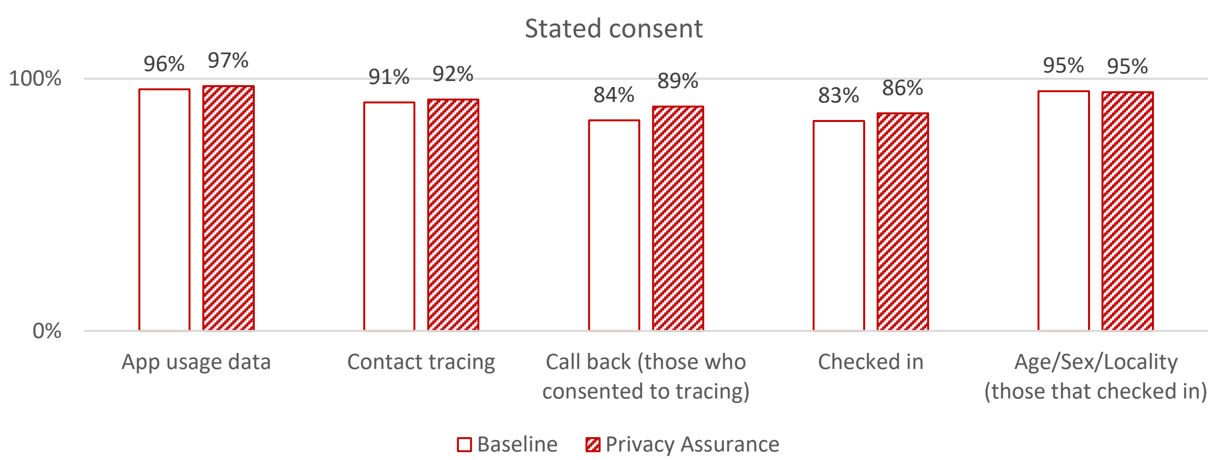
Trust and privacy concerns

Responses to questions about trust in relation to data, and about participants' level of concern about the privacy of their data are shown in Figure 2. In order to assist interpretation of effect sizes, all graphs relating to 7-point scales are shown with an x-axis range approximately equal to one standard deviation (Witt, 2019). Error bars represent 95% confidence intervals in all graphs. Ratings were combined taking the mean to create one score for trust and one for privacy concerns. Trust was high overall, but higher among participants in the Privacy Assurance condition (*M*=5.7 Baseline vs. *M*=5.9 Privacy Assurance, 95% CI of difference[7] [0.03, 0.41]), while privacy concerns were lower (*M*=3.1 vs. *M*=2.9, 95% CI of difference [0.05, 0.49]). Crucially, a similar pattern was observed when focusing on only those participants who raised privacy concerns unprompted in the first survey section (*M*=4.3 vs. *M*=4.9, 95% CI of difference [0.04, 1.11] for trust; M=4.3 vs. *M*=3.9, 95% CI of difference [-0.01, 0.88] for privacy concerns). The same applied to participants who said they would be less likely (rating of 5 or lower) to download the real app (M=4.7 vs. M=5.0, 95% CI of difference [0.00, 0.76] for trust; *M*=4.1 vs. *M*=3.7, 95% CI of difference [0.03, 0.70] for privacy concerns).

Consent

Stated consent to the collection of data about app usage, to participation in contact tracing (and if so, sharing a phone number to receive a call back), and reported use of the check-in feature (and if so, sharing of additional sociodemographic information) was high overall, with 61% of participants agreeing to share all information (Figure 3). Consent was slightly higher in the Privacy Assurance condition, with an additional 1 in 20 participants sharing their phone number to opt in to receive a call back following an exposure notification (84% vs. 89%, 95% CI of difference [0%, 11%]).

Figure 3
Effects of privacy assurances on stated consent



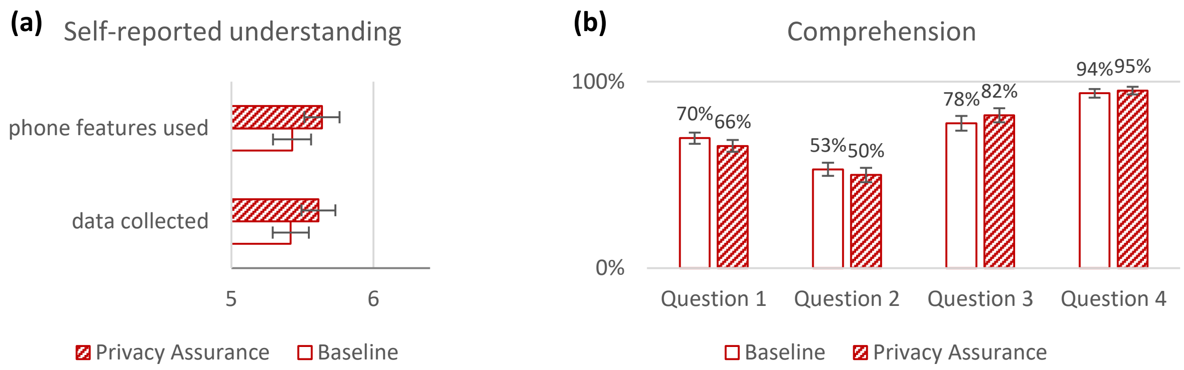
Note: Stated consent at relevant points during app set-up and use. Data from participants who responded "not sure" are excluded. The "Call back" option required consent to share the participant's phone number.

Comprehension

Figure 4(a) displays participants' self-reported understanding of what data is processed by the app and what phone features must be enabled for the app to function. Participants in the Privacy Assurance condition reported higher levels of understanding in relation to both data processed by the app (*M*=5.4 vs. *M*=5.6, 95% CI of difference [0.02, 0.37]) and phone features employed by the app (*M*=5.4 vs. *M*=5.6, 95% CI of difference [0.03, 0.39]).

However, this difference was not reflected in actual measures of comprehension. Comprehension was measured through four questions about data/phone features used by the app. In each case, participants had to select all correct answers from a list. Comprehension scores were created by calculating separately the percentage of correct answers chosen and the percentage of incorrect answers not chosen, and averaging these for each question (Figure 4 (b)). Participants in the Privacy Assurance condition did not display better comprehension. Indeed, they performed slightly worse on the first question, which concerned personal data processed by the app (*M*=70% vs. *M*=66%, 95% CI of difference [-0.1%, 8.6%]).

Figure 4
Effects of privacy assurances on comprehension

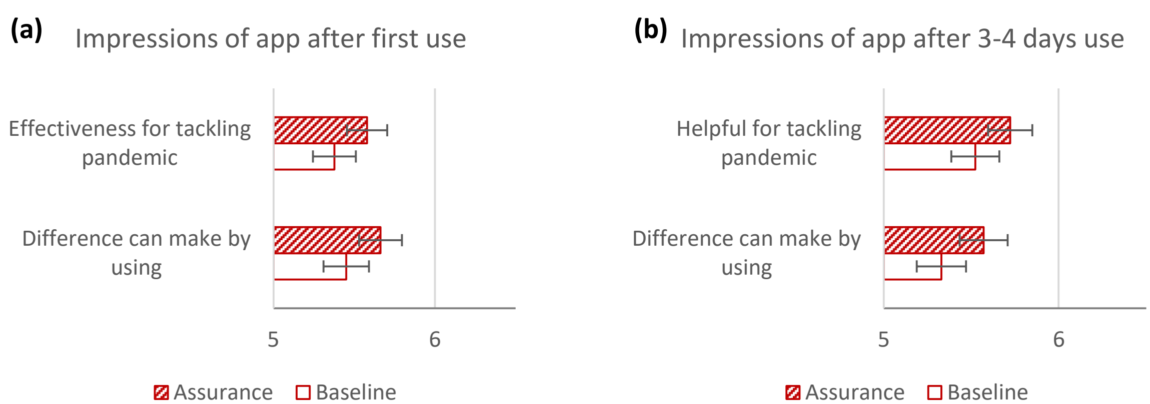


Note: Participants' (a) self-reported understanding of the data processed by the app and the features of their phone utilized by the app on a scale from 1 (I didn't understand this at all) to 7 (I understood this perfectly), and (b) actual performance on comprehension questions (mean of percentage of correct options chosen and percentage of incorrect options not chosen for each question).

Other effects

Privacy assurances had other unanticipated effects: participants in the Privacy Assurance condition gave higher ratings for the overall effectiveness of the app (*M*=5.4 vs. *M*=5.6, 95% CI of difference [0.02, 0.39]) and the difference they felt they could make by using it (*M*=5.5 vs. *M*=5.7, 95% CI of difference [0.02, 0.40]) (Figure 5 (a)). The proportions of participants in each condition who mentioned privacy concerns in the first part of the survey were similar (19% vs. 18%, 95% CI of difference [-4%, 7%]) suggesting that these effects were not due to imperfect randomization. The pattern persisted in responses to the second survey several days later (*M*=5.5 vs. *M*=5.7, 95% CI of difference [0.01, 0.39]; *M*=5.3 vs. *M*=5.6, 95% CI of difference [0.05, 0.44]) (Figure 5(b)).

Figure 5
Effects of privacy assurances on overall impressions of the app



Note: General impressions regarding the effectiveness of the app (a) immediately after first use (Survey 1) and (b) after 3-4 days use (Survey 2), as measured on 7-point scales.

Goal-framing manipulations

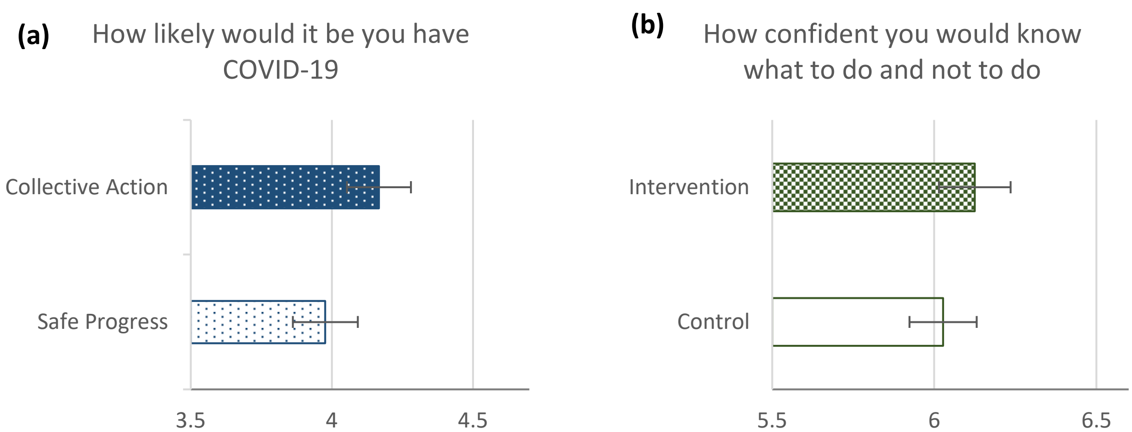
Effects of goal-framing on app uptake and impressions (Hypothesis 2)

The framing of the purpose of the app in the initial call-to-action presented to participants did not alter the stated likelihood of downloading the real app (*M*=5.6 for both frames, 95% CI of difference [-0.15, 0.21]), other indicative measures taken prior to participants downloading the app, outcome measures subsequent to app download, nor those in the follow-up survey.

Effects of goal-framing on reaction to exposure notification (Hypothesis 3)

There was little effect of goal-framing on how worried participants said they would feel, were they to receive an exposure notification (*M*=5.1 Collective Action vs. *M*=5.2 Safe Progress, 95% CI of difference [-0.10, 0.27]). However, participants thought it would be more likely that they have COVID-19 were they to receive such a notification if they had been told to restrict their movements to play their part in stopping the spread of the virus, rather than to avoid spreading the virus to someone vulnerable (*M*=4.2 vs. *M*=4.0, 95% CI of difference [0.03, 0.35]) (Figure 6(a)).

Figure 6
Reactions to sample exposure notification



Note: Stated presumed likelihood of having contracted COVID-19 if an exposure notification were received, assuming no symptoms are being experienced, on a scale from 1 (Extremely unlikely to have COVID-19) to 7 (Extremely likely to have COVID-19), and (b) Stated confidence in knowing what to do and not do if an exposure notification were to be received on a scale from 1 (Not at all confident) to 7 (Very confident).

Structure of exposure notification intervention (Hypothesis 4)

Participants who received the intervention version of the exposure notification were slightly more confident in knowing what they should and should not do if they were to receive such a notification (*M*=6.0 Control vs. *M*=6.1 Intervention, 95% CI of difference [-0.05, 0.25]) (Figure 6(b)) and displayed slightly better actual comprehension, as measured by performance on three MCQs (*M*=1.5 vs. *M*=1.6, 95% CI of difference [-0.03, 0.19]).[8]

Discussion and Conclusion

The additional privacy assurances tested in this study were incorporated in the final version of Ireland's COVID Tracker app, which was successfully launched in July 2020. This final section discusses further implications of some of the relevant findings, as well as potential lessons for public administrators looking to pre-test apps, or indeed any technology or service that relies on widespread uptake and acceptance.

Concerns about privacy are widespread. Although the Irish public held a primarily favorable view of COVID Tracker prior to its launch, with a majority open to downloading it, almost one in five participants spontaneously mentioned privacy concerns. These concerns were especially prevalent among those least likely to download the app, in line with previous studies (Simko, Calo, Roesner, & Kohno, 2020; Altmann, et al., 2020; Trang, Trenz, Weiger, Tarafdar, & Cheung, 2020; Kaspar, 2020). Crucially, while participants in these surveys were prompted to think about privacy, either by being asked explicitly or through mentions of privacy in the description of an app, there was no prior mention of data privacy in this study at the point when participants expressed these concerns. Moreover, given the use of an online sample, who had already consented to participating in a study, this level of privacy concern may be an underestimation of concern in the general population.

Including additional privacy assurances within the app lowered privacy concerns and increased trust. Importantly, this was also true of those participants who were more hesitant about downloading the app, or who had mentioned privacy concerns unprompted. A difference in engagement was seen with regards to sharing a phone number. Overall, our results provide evidence for most of Hypothesis 1, regarding the effectiveness of privacy assurances in reducing concern, promoting trust, and increasing willingness to engage with the app. There were also potential spill-over effects of the additional assurances on general perceptions of the app, leading to a more favorable view of its effectiveness.

One aspect of Hypothesis 1 that was not supported, however, concerned the effect of privacy assurances on understanding. Although participants who saw the additional assurances self-reported better understanding of what data is processed by the app and what phone features it uses, this was not reflected in objective measures of comprehension. This highlights an important point regarding the ethics of how privacy information is communicated: while simple assurances can lessen app users' concerns and boost engagement, there is a danger that they mislead users, even unintentionally. Public authorities need to be alert to this possibility and carefully weigh up the benefits of using techniques to increase trust against any potential detriment to comprehension. More generally, it is important to note that a privacy assurance does not constitute a privacy guarantee–concrete steps need to be taken to ensure that privacy assurances are matched by the precautions necessary to preserve privacy in the way they imply.

We found no support for Hypothesis 2. Alternative goal framing did not alter stated likelihood to download, share or use the app. It is possible that participants held pre-existing views on the benefits of contact tracing that overrode the reasons presented. Alternatively, high levels of support may have produced a ceiling effect, preventing detection of more subtle differences. Of course, it remains possible that both frames were simply equally effective: in a previous study we failed to find a difference between two different messages for motivating social distancing, although both performed better than a control (Lunn, et al., 2020b).

In addition to our main finding, we found minor support for Hypotheses 3 and 4, regarding the sample exposure notification. Participants in the "Collective Action" condition thought it would be slightly more likely that they have COVID-19 should they receive a notification than participants in the "Safe Progress" frame, implying that they might be more likely to act as though they have the virus and therefore be more cautious. Participants who received the intervention version of the exposure notification structure were slightly more confident in knowing what they should or shouldn't do were they to receive the notification. A simple reduction in perceived uncertainty may be beneficial for adherence to guidelines (Lee, 2001).

Our study demonstrates the value of pre-testing features of technological interventions like a contact-tracing app. However, caution must be exercised in extending specific results regarding receptivity to other contexts. One of the likely reasons COVID Tracker was well received is that trust in the Irish government was generally high in the early stages of the pandemic, and the app was branded to situate it within a coherent set of state communications. Trust is a key determinant of privacy concern (Bergström, 2015). Another important factor was the timing of this study and the app's launch. We found anxiety about the pandemic to be one of the drivers of likely app uptake, in agreement with another Irish survey (O'Callaghan, et al., 2020).

Despite these limitations, the study's general approach is of wider value. Recording reactions to app download and use in real-time via an online survey, while requiring some subtlety in design, constituted a valuable technique for obtaining rich experimental data from a large sample of potential users. Furthermore, this study demonstrates that behaviorally pre-testing public health apps is a feasible and worthwhile exercise, even under considerable time pressure.

Notes

1. https://covidtracker.gov.ie/
2. The full pre-registered design can be found at https://osf.io/3nd7v. An additional area of focus was to be the "Updates" tab of the app, which contains the latest information about the spread of the virus. Unforeseen limitations on the availability of statistics that were to be displayed in an alternative version of this tab meant that this intervention could not be run as intended. The results from this intervention are therefore not presented here as no robust conclusions can be drawn from them.
3. This was a two-step process: iOS users needed to first download an app called TestFlight, while Android users had to first join a Google group in order to then download the trial app.
4. For ethical reasons these notifications were not sent through to the app on their phone, in case they were mistaken for a real notification.
5. For the vast majority this was due to issues with downloading and installing the trial version. It should be noted that, being a two-stage process, this was a more complicated task than simply downloading a standard app. Furthermore, the app would not have been compatible with some older phones. Just 3% of participants who did not download the app said it was because they did not feel comfortable doing so.
6. For reasons of transparency, note that this approach to reporting was not pre-registered but was prompted by the comments of an anonymous reviewer. However, our hypotheses and reported measures do closely follow the pre-registration.
7. Given the large sample sizes, in the calculation of confidence intervals we assume that the normal approximation underpinning the Central Limit Theorem holds.
8. Closer inspection of responses to the question "Imagine you received a close contact exposure notification but were not experiencing any symptoms. Which of these pieces of advice most accurately matches the guidelines you saw?" revealed that as many as 46% of participants incorrectly selected "Follow general advice but monitor your symptoms" as the answer. This was intended to mean following the general advice that everyone in the country has been given, but given the large proportion selecting this option (considerably larger than the 30% that selected the correct answer), it is possible that some of these interpreted it instead as following the advice they were given in the exposure notification. If these responses are excluded, the intervention has a larger positive effect on comprehension.

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Appendix

Appendix A
Sociodemographic characteristics of the sample

		Participants who downloaded		All participants	
		n	%	n	%
Gender	Men	401	49	604	50
	Women	420	51	605	50
Age	Under 40	345	42	451	37
	40 – 59	330	40	484	40
	60 +	146	18	274	23
Education	Degree or above	405	49	565	47
	Below degree	416	51	644	53
Employment	Employed	528	64	735	61
	Not employed	293	36	474	39
Urban-Rural	Urban	541	66	770	64
	Rural	280	34	439	36

Appendix B: Tests for random assignment across experimental conditions

Privacy assurances (participants who downloaded the app)

		Baseline (*n*=421) %	Privacy Assurances (*n*=400)
Gender	Men	51	47
	Women	49	53
Age	Under 40	42	42
	40 – 59	42	38
	60 +	16	20
Education	Degree or above	49	50
	Below degree	51	50
Employment	Employed	63	66
	Not employed	37	33
Urban-Rural	Urban	63	68
	Rural	37	32

Goal-framing (all participants)

		Collective Action (*n*=597)	Safe Progress (*n*=612)
		%	
Gender	Men	50	50
	Women	50	50
Age	Under 40	35	39
	40 – 59	41	39
	60 +	24	22
Education	Degree or above	44	49
	Below degree	56	50
Employment	Employed	61	61
	Not employed	39	39
Urban-Rural	Urban	65	62
	Rural	35	38

Structure of the exposure notification (participants who completed survey 2)

		Control (n=399)	Intervention (n=400)
		%	
Gender	Men	51	47
	Women	49	53
Age	Under 40	42	41
	40 – 59	41	39
	60 +	17	20
Education	Degree or above	48	50
	Below degree	52	50
Employment	Employed	66	63
	Not employed	34	37
Urban-Rural	Urban	67	66
	Rural	33	34