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How to make universal, voluntary testing for COVID-19 work? A behavioural economics perspective

Francesco Fallucchi[a], Luise Görges[d], Joël Machado[a], Arne Pieters[b], Marc Suhrcke[a,c,*]

[a] Luxembourg Institute for Socio-economic Resarch (LISER), Maison des Sciences Humaines, 11 Porte des Sciences, L-4366 Esch-sur-Alzette, Luxembourg
[b] Independent Researcher (currently employed by GFA Consulting Group GmbH)
[c] Centre for Health Economics, University of York, Alcuin Block A, York, YO10 5DD, United Kingdom
[d] Institute of Economics, Leuphana University Lüneburg, Germany

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ABSTRACT

Testing is widely seen as one core element of a successful strategy to curtail the COVID-19 pandemic and many countries have increased their efforts to provide testing at large scale. As most democratic governments refrain from enacting mandatory testing, a key emerging challenge is to increase voluntary participation. Using behavioural economics insights complemented with data from a novel survey in the US and a survey experiment in Luxembourg, we examine behavioural factors associated with the individual willingness to get tested (WTT). In our analysis, individual characteristics that correlate positively with WTT include age, altruism, conformism, the tendency to abide by government-imposed rules, concern about contracting COVID-19, and patience. Risk aversion, unemployment, and conservative political orientation correlate negatively with WTT. Building on and expanding these insights may prove fruitful for policy to effectively raise people's propensity to get tested.

Background

Recent research has highlighted the role of extensive testing in monitoring the COVID-19 pandemic [32,38]. As part of an active monitoring strategy, citizens may be invited to submit to testing for at least one of three purposes: (i) testing of the entire population, (ii) testing a sample to monitor the spread of the pandemic, or (iii) testing of individuals who were in contact with a positive COVID-19 case to break infection chains. Peto et al. [29] argue that weekly COVID-19 testing with strict household quarantine and contact tracing could be sufficient to end the pandemic (see also [35], and [30]). Burzynski et al. [8] show in simulation exercises how testing may act as an important element of a broader strategy to curtail COVID-19 infections. Despite the enormous expected health and economic gains associated with frequent and extensive testing [3,8,13], capacity constraints can limit the implementation of such a strategy. Consequently, an increasing amount of work discusses the optimal allocation of (inevitably limited) testing resources (e.g. [11]) and how COVID-19-testing strategies could usefully draw on the experience with former successful disease screening programs [31].

The *success* of any testing strategy depends on people's willingness to participate [28]. In some rare exceptions this success is achieved by imposing relevant threats to noncompliant citizens, as in the Slovakian example that achieved a close to 100% participation rate by imposing quarantine for those not willing to get tested [27]. However, most democratic governments hitherto prefer to rely on voluntary participation. Early evidence from one (small) country – i.e. Luxembourg – that embarked on the first full-population testing strategy points to limited take-up of testing: during the first phase of the large-scale testing in 2020, less than 40% of the over 1.400.000 invitations were taken up. These tests accounted for 26% of all the detected positive cases in Luxembourg, indicating the scope for a higher participation rate to improve the effectiveness of the testing strategy [37].

The take-up of a given voluntary testing offer may not only be too small, but may also face systematic selection bias, if the propensity to get tested varies with particular individual characteristics, including the participant's likelihood of being infected with COVID-19. From an economic perspective, the individual decision to get tested is likely to depend on perceived personal costs and benefits. In addition, there are non-personal benefits that accrue

* Corresponding author.
E-mail address: marc.suhrcke@liser.lu (M. Suhrcke).

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at the societal level, as the government's testing strategy may improve its ability to effectively control the pandemic.

This positive externality may not be taken into account by the individual. Such misalignment of incentives creates a classic *collective action problem*: society as a whole is better off, if the invited people get tested, but the individually rational action is to not get tested (and hope everybody else does). Paradoxically, the problem intensifies as strategies to manage and contain the spread of the virus become more successful: if the chances of contracting an infection are relatively small, so are the expected personal benefits from knowing one's health status, seeking healthcare and protecting others. The above example from Luxembourg may illustrate the need of aligning the societal with the individual benefits to reach a number of individuals willing to get tested that is closer to the socially optimal level.

Understanding people's incentives for or against taking a test may help guide the roll-out and accompanying communication of a successful testing initiative. To date, the literature analyzing individual determinants of the willingness to get tested for COVID-19 remains scarce. In a survey with 897 participants in the US, Thunström et al. [36] design a treatment to proxy for low vs high self-isolation costs. They find that around 70% of respondents would accept an invitation for a free test, with no significant difference across treatments. Younger individuals and people with a high number of personal interactions in their daily lives are the most willing to take a test. Individuals with health insurance are more likely to accept the test than those without – a result that the authors ascribe to "willful ignorance". They further find individuals that identify themselves as Republicans to be less willing to get tested, while those worried about their health status are more willing. Finally, an individual's financial and emotional capacity to sustain self-isolation does not seem to affect the willingness to get tested.

Stillman and Tonin [34] rely on administrative data to analyze community-based determinants of actual test take-up in the context of a population-wide testing campaign in the region of South Tyrol in November 2020. They find that communities characterized by older, more educated, more female and larger households had higher testing rates. The number of testing centers also had a positive and significant correlation with testing rates, even after controlling for population and population density, suggesting that the convenience of the testing procedure had a significant impact. In addition, communities with higher shares of religious marriages also had higher testing rates, whereas proxies for social cohesion do not exhibit a significant relationship.

In this paper, we contribute to the scarce evidence base by exploring the determinants of individual willingness to participate in testing. Using a survey with a set of experimentally validated measures of individual preferences in the United States, we analyze how individual preferences and socio-demographic characteristics relate to the willingness to get tested (WTT). In a second experimental study, conducted during the onset of Luxembourg's large-scale testing program in early June 2020, we show how information about the type of test used (i.e. mouth vs nasal swab testing) affects WTT, in a context where individuals perceive relatively low personal returns but a varying discomfort from the two types of polymerase chain reaction (PCR) testing. Among other results, we find that in the US, age, identifying as democrat, being worried about contracting the virus and having a habit of following the rules is associated with a higher WTT. Regarding individual preferences, we find that altruism, conformism and risk-seeking are linked to a higher WTT. In the Discussion section, we use these results and embed them into the broader related literature in non-COVID-19 contexts, in order to discuss several potential challenges and important channels that policymakers may want to consider in their efforts to reduce individual costs and increase individual benefits associated with testing.

Methods

We implemented two separate and independent opt-in surveys to collect our data: an online survey among a sample of US citizens (US-sample, N = 1213) and an online-survey experiment among students of the University of Luxembourg (LUX-sample, N = 127). The US-sample comprises respondents from 50 different US states who were recruited in mid-June 2020, via the online survey platform CloudResearch, from the Turkprime panel. This panel was chosen because of the heterogeneity among its respondents in terms of several sociodemographic dimensions, positioning it closer to the American National Electoral Study than other online platforms [10]. Subjects in the LUX-sample were recruited from an internal database using the platform ORSEE [18].

To explore potential determinants of the willingness to submit to testing, both of our surveys contain an item that asks respondents to state their willingness to accept a free PCR test. We use this item to code our dependent variable, willingness to get tested (WTT), which takes on the value 1 if the individual states to definitely or likely take a free test offered by the government and 0 otherwise. For the US-sample, we use several well-identified and validated measures of behavioural traits from the behavioural economics literature [14] as our main explanatory variables of interest. These measures have been established as robust predictors of between- and within-country variation of various preferences and economic outcomes and behaviours [15]. We include items that we hypothesized would be related to WTT, such as risk-aversion, altruism, and patience. Following recent advances in economics investigating the influence of individual preferences to comply with norms on behaviour (for an overview, see [17]), we also include a novel survey question capturing conformism. We would expect individuals that are more risk averse, more altruistic, more patient and more conformist to display a higher propensity to get tested.

We also include questions about the perceptions of the COVID-19 pandemic, e.g. on how respondents evaluate the current spread of the virus where they live (see Appendix A). Other things equal, we would expect a self-perceived faster spread of the virus to increase the respondents' willingness to get tested. In line with related WTT research (e.g. [36]), we also include standard socio-demographic variables, as they may shape people's preferences for testing. For instance, with rising age, and hence rising risk to suffer severe consequences from an infection, individual WTT should increase; people with higher educational attainment and higher incomes should be more willing to get tested, as they would perceive lower private costs of doing so, among others due to being better placed to cope with self-isolation, in case of a positive test result.

We use the US-sample to explore the link between the above-mentioned behavioural variables and WTT, because it is a relatively large and heterogenous sample that offers ample variation in our variables of interest. By contrast, since our LUX-sample is relatively small and homogenous, we set-up a survey experiment to explore how another behavioural aspect impacts on WTT, the anticipation of physical discomfort experienced during the test. We ran this survey experiment during the first week of June 2020, before students could receive an invitation from the large-scale testing initiative. We randomize about half of our respondents into a treatment showing them a picture describing a nose-swab test alongside the WTT question, and the other half into a treatment showing them a mouth-swab test. This treatment was motivated by discussion in the public sphere about the discomfort of the nose swab (see e.g. [26]) and initial confusion about the method used within the large-scale testing.

Table 1
Willingness to get tested: Average marginal effects from probit regressions (US-sample).

	Model 1	Model 2	Model 3	Model 4
Age	.003 (.001)***	.003 (.001)***	.003 (.001)***	.003 (.001)***
LowincTRUE	-.017 (.037)	-.023 (.037)	-.036 (.038)	-.019 (.037)
Edu_lowTRUE	-.061 (.041)	-.066 (.041)	-.074 (.043)*	-.061 (.041)
Edu_highTRUE	-.041 (.040)	-.064 (.039)	-.065 (.041)	-.049 (.040)
RetiredTRUE	-.048 (.043)	-.048 (.043)	-.051 (.044)	-.042 (.043)
Self-empTRUE	-.070 (.058)	-.066 (.058)	-.066 (.060)	-.066 (.058)
UnempTRUE	-.065 (.033)*	-.061 (.034)*	-.063 (.034)*	-.060 (.034)*
Altruism	.019 (.006)***	.020 (.006)***	.020 (.006)***	.019 (.006)***
Conformism	.012 (.004)***	.010 (.004)**	.010 (.005)**	.011 (.004)**
WorriedTRUE	.179 (.027)***	.175 (.027)***	.173 (.027)***	.181 (.027)***
FollowrulesTRUE	.187 (.032)***	.195 (.032)***	.200 (.033)***	.188 (.032)***
Risktolerance	.014 (.005)***	.015 (.005)***	.013 (.005)**	.014 (.005)***
Patience	.011 (.006)*	.009 (.006)	.008 (.006)	.011 (.006)*
RepublicanTRUE	-.061 (.027)**	-.062 (.027)**	-.055 (.028)**	-.061 (.027)**
State Fixed Effects	NO	YES	YES	NO
State Random Intercepts	NO	NO	NO	YES
Full Sample	YES	YES	NO	YES
AIC	1376.904	1405.818	1325.872	1373.547
BIC	1453.417	1732.273	1568.485	1455.161
Log Likelihood	-673.452	-638.909	-614.936	-670.774
Deviance	1346.904	1277.818	1229.872	
Num. obs.	1213	1213	1158	1213

Average marginal effects and standard errors (reported in parentheses) are obtained from probit regressions with self-reported willingness to get tested for an active COVID-19 infection as dependent variable. Regression results in column 2 are obtained by additionally including state fixed effects to the regression shown in column 1. Column 3 shows results from a smaller sample excluding respondents from states with less than 5 observations. Column 4 shows results from a multilevel probit model including random slopes for the federal states. Stars indicate statistical significance at

*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

In what follows, we make regular reference to the main results from the two separate analyses, i.e., a set of probit regressions of WTT on individual characteristics for the US-sample, and a between-treatments comparison of the WTT conditional on the type of testing for the LUX-sample, using a test of proportions for independent observations (χ^2 test). In Appendix B, we provide a short technical description of the Probit model and report in Appendix Table 4 the descriptive statistics of the two samples with respect to age, gender and the individual characteristics elicited.

Results

Table 1 below presents the main results from our US-sample. Several individual characteristics are correlated with WTT, and these results hold under different model specifications, including after controlling for state-level fixed effects (Model 2) and after exclusion of states with few observations (Model 3). (Table 2)

As expected, WTT is increasing in **age**. The average effect is small (one additional year of age is associated with a 0.3 percentage point increase in the willingness to get tested), but highly significant. The socioeconomic situation of the individual matters in so far as WTT is lower among those on low incomes, among those with lower levels of educational attainment and among the retired and self-employed (though not statistically significantly so for any of these, p = 0.64 for low income, p = 0.15 for low level of education, p = 0.26 for retired respondents, p = 0.22 for the self-employed). Being **unemployed** significantly decreases individual WTT (p = 0.051). Results are robust across different model specifications.

The majority of the behavioural questions help explain people's WTT in the expected direction: a higher level of **altruism** is associated with higher WTT. A one-point increase on the experimentally validated, 10-point altruism scale [14] entails an average increase of 2 percentage-points in WTT. Similarly, using a novel survey item to measure individual valuation of gaining other people's approval (conformism), we find that a one-point increase on the (10-point) conformism scale is associated with an average increase of one percentage-point in WTT. Being worried about the situation is associated with a substantially higher WTT; people who report that they are worried about contracting COVID-19 on average report an 18-percentage-point higher WTT. Similarly, people who generally follow the rules imposed by the government, show a substantially higher WTT (+ 19 percentage points).

Perhaps somewhat surprisingly, we find that individuals who are more risk-seeking report a significantly higher WTT. This could indicate that WTT increases in individuals' self-assessed likelihood of having contracted an infection, which should in fact be lower among the risk-averse who avoid most situations that bear an elevated infection risk. The findings of Thunström et al. [36] are in line with this interpretation, showing that respondents who have sought higher risk and met more people during the three days preceding the survey are significantly more willing to get tested. A second finding emerging from our analysis that complements this interpretation is the observation that higher levels of patience are associated with a significantly higher WTT, presumably because more patient individuals find it easier to forgo the present-day rewards that lie in risky interactions for the sake of future health.

Finally, individuals who classify their political orientation as Republican are significantly less willing to get tested (-6 percentage points). The finding is in line with recent evidence showing that Republicans tend to perceive the dangers associated with a COVID-19 infection as less severe than Democrats [2,7]. This suggests that Republicans perceive the dangers of an (undetected) COVID-19 infection as lower relative to non-Republicans, possibly leading them to attach a lower value to knowing their infection status.

In our LUX-sample, we examine how WTT is affected by the type of test to be performed, comparing the scenarios of a mouth swab versus a nasal swab. Overall, we find that the mouth swab increases willingness to get tested by more than 40 percentage-points compared to the nasal swab (78% vs. 37%, $\chi^2(1)=21.75$, *p-value:* <0.001). A commonly reported motive as to why respondents in the nasal treatment expressed doubts or unwillingness to

Table 2
Willingness to get tested: Probit regression results.

	Model 1	Model 2	Model 3	Model 4
(Intercept)	-1.455 (.262)***	-1.126 (.295)***	-1.062 (.300)***	-1.481 (.266)***
Age	.010 (.003)***	.011 (.003)***	.011 (.003)***	.010 (.003)***
LowincomeTRUE	-.055 (.115)	-.078 (.121)	-.117 (.122)	-.060 (.117)
Edu_lowTRUE	-.190 (.129)	-.220 (.136)	-.242 (.139)*	-.195 (.130)
Edu_highTRUE	-.132 (.129)	-.217 (.136)	-.219 (.139)	-.160 (.130)
RetiredTRUE	-.153 (.137)	-.162 (.143)	-.170 (.146)	-.135 (.138)
Self-empTRUE	-.216 (.173)	-.216 (.184)	-.214 (.190)	-.204 (.176)
UnempTRUE	-.207 (.107)*	-.204 (.113)*	-.211 (.114)*	-.194 (.109)*
Altruism	.060 (.018)***	.067 (.019)***	.066 (.019)***	.063 (.018)***
Conformism	.038 (.014)***	.033 (.015)**	.033 (.015)**	.035 (.014)**
WorriedTRUE	.597 (.099)***	.614 (.103)***	.604 (.104)***	.612 (.100)***
FollowingrulesTRUE	.550 (.091)***	.604 (.096)***	.613 (.097)***	.557 (.093)***
Risktolerance	.046 (.016)***	.050 (.017)***	.042 (.017)**	.046 (.016)***
Patience	.034 (.019)*	.031 (.020)	.028 (.020)	.034 (.019)*
RepublicanTRUE	-.192 (.086)**	-.204 (.089)**	-.181 (.091)**	-.192 (.087)**
State Fixed Effects	NO	YES	YES	NO
State Random Intercepts	NO	NO	NO	YES
Full Sample	YES	YES	NO	YES
AIC	1376.904	1405.818	1325.872	1373.547
BIC	1453.417	1732.273	1568.485	1455.161
Log Likelihood	-673.452	-638.909	-614.936	-670.774
Deviance	1346.904	1277.818	1229.872	
Num. obs.	1213	1213	1158	1213

Coefficients and standard errors (reported in parantheses) are obtained from probit regressions with self-reported willingness to get tested for an active COVID-19 infection as dependent variable. Regression results in column 2 are obtained by additionally including state fixed effects to the regression shown in column 1. Column 3 shows results from a smaller sample excluding respondents from states with less than 5 observations. Column 4 shows results from a multilevel probit model including random slopes for the federal states. Stars indicate statistical significance at

*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

Table 3
Willingness to get tested in LUX-sample: Probit regression results (coefficients and average marginal effects).

	Coefficients	AMEs
(Intercept)	.366 (.851)	
treatmentmouth	1.167 (.248)***	.422 (.079)***
risktolerance	-.042 (.049)	-.014 (.016)
altruism	-.004 (.058)	-.001 (.019)
conformism	-.035 (.043)	-.012 (.014)
patience	.058 (.054)	.019 (.018)
age	-.015 (.026)	-.005 (.008)
worriedTRUE	.104 (.262)	.034 (.087)
followingrulesTRUE	-.397 (.387)	-.128 (.119)
AIC	166.512	
BIC	192.109	
Log Likelihood	-74.256	
Deviance	148.512	
Num. obs.	127	

Coefficients (Column 1), Average Marginal Effects (column 2) and standard errors (reported in parantheses) are obtained from probit regressions with self-reported willingness to get tested for an active COVID-19 infection as dependent variable. Stars indicate statistical significance at $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

Table 4
Descriptive statistics.

	US-sample	LUX-sample
Age	47.7 (18.2)	25.8 (4.8)
Fraction of women	0.63 (0.48)	0.60 (0.49)
Risk tolerance	5.76 (2.80)	5.15 (2.70)
Altruism	8.13 (2.38)	7.47 (2.21)
Conformism	5.58 (3.08)	5.31 (2.87)
Patience	7.94 (2.31)	6.82 (2.32)
N	1213	127

get tested is the invasiveness of the procedure and possible pain. In the mouth treatment, participants exert much less reluctance to get tested to begin with. Among the few that are reluctant, common concerns relate to the usefulness of the test, given their (perceived) low risk of infection. The LUX-sample also answered to a similar set of questions as the US-sample. We report in Table 3 in Appendix B a similar analysis as for Table 1. Note that the treatment difference is strongly significant after controlling for individual characteristics.

Discussion

In this section, we discuss the implications of our empirical results explicitly in the context of the wider literature on WTT in the (under-researched) COVID-19 context and in the broadly related literature outside COVID-19, with a view to identifying several potential aspects that policymakers interested in increasing the effectiveness of their testing strategy might want to take into account. We do so by organizing our and other researchers' findings, using a (behavioural) economic framework. Accordingly, we assume – as a first approximation of real-word decision-making – that people act "rationally", *as if* they weigh their personal (monetary and non-monetary) costs and benefits of testing and ultimately choose the course of action that yields the highest expected net benefits. The so identified private costs and benefits may represent useful policy targets or channels, in the sense that testing policies can be designed with the aim of reducing perceived costs or increasing expected benefits from getting tested.

The expected costs comprise both the monetary and non-monetary costs of taking the test. Policies designed to keep costs as low as possible need to consider several dimensions:

Monetary costs need to be kept to a minimum, since even small increases can have detrimental effects on take-up rates [33]. This is relatively easy to achieve, if tests are administered free-of-charge and a sufficiently large number of test facilities are accessible, limiting individual travel costs.

Convenience and safety. Other costs include, at the very least, the time spent at and travelling to the test facility, as well as the expected physical discomfort associated with the test procedure. If people perceive an elevated risk of contracting an infection at the test facility, this presents an additional cost. Making testing convenient and safe for test-takers will reduce individual costs associated with testing [34] – if at a higher cost to the government. In the case of testing technologies, the potential public costs of reducing the individual's costs are somewhat difficult to predict. Apart from potential differences in prices that are easy to compare, testing technologies might also differ in accuracy. A higher rate of false-negative test results could reduce the effectiveness of the government's testing efforts and thus induce a substantial cost with respect to controlling the spread of the virus. If more comfortable methods of testing have a higher risk of producing false-negative results than less comfortable ones (e.g. mouth vs. nose swab), governments might prefer the more accurate method. Yet, the potential loss in accuracy associated with adopting a more comfortable method for population-wide testing could be justified, if its availability leads to a significant gain in the fraction of people willing to undergo testing. The strategy followed by Luxembourg's authorities after a slow start in test take-up was to clearly state in the invitation letter to participate in the large-scale testing that the test carried out would rely on a throat swab. In contrast, nasal swab tests are prescribed to individuals with COVID-19 symptoms or who have been in contact with a positive case. Our survey experiment, which was carried out at the onset of Luxembourg's large-scale testing, does indeed indicate that the fear from physical discomfort has a substantially negative impact on WTT.

Psychological costs. People may anticipate incurring psychological costs from a positive test result, based on fear about the health consequences [1], or about potential social stigma [25], depending on the extent to which the outcome will be visible to others. Moreover, the psychological costs of (further) isolation maybe large [6]. Psychological costs from a positive diagnosis can be addressed in two ways: medical treatment including counselling upon a positive diagnosis, as well as de-stigmatisation of positive individuals at the societal level. However, while counselling may well reduce the negative psychological impact of a positive diagnosis on those actually infected, it is unclear whether its provision will also reduce the anticipated psychological impacts (and hence costs) of receiving a positive diagnosis for those who have yet to get tested. Policy measures aimed at de-stigmatisation are more likely to reduce the expected costs of a positive diagnosis, as for example public campaigns are noticeable also to the non-infected population. However, they walk a fine line between reducing fear of an infection and trivialisation of the disease, which in itself may reduce the willingness to get tested [25].

Self-isolation upon testing positive. Our results and the existing literature are inconclusive regarding the role of financial constraints and economic status [34, 36], [33]. On one hand, low-income individuals have a lower opportunity cost of an imposed quarantine, which could increase their willingness to get tested. On the other hand, a constrained budgetary situation might imply that quarantine would be financially unbearable, thereby reducing individual WTT. Since self-isolation would require further physical absence from work, or from school or university, potential indirect monetary losses may pile up. The question of how to reduce costs from self-isolation upon receiving a positive test result seems crucial to convince people to submit to testing, especially if testing is voluntary and isolation is mandatory in case of a positive test result. The testing strategy needs to consider the various ways in which self-isolation can induce costs and how compensation may best occur, while avoiding incentivising individuals to actively seek infection. This may include compensation for income loss, opportunities for exam re-sits, or other suitable measures.

The personal expected benefits are derived from knowing one's current COVID-19 status, from pro-social preferences and social image concerns. Both monetary and non-monetary incentives can trigger willingness to get tested, but the effectiveness of these incentives are likely to depend on the weight that each individual places on the different channels mentioned:

Knowing one's own health status. While individuals may differ in their valuation of knowing their health status, such knowledge will tend to allow them to (1) quickly eliminate uncertainty about their COVID-19-related health status; (2) benefit from healthcare at an early stage if infected, improving the odds of a quick recovery; (3) actively prevent infecting others in their immediate personal environment, such as family and friends, as well as contacts in other relevant settings (work, school) and (4) obtain proof of no active infection, e.g. to avoid a quarantine when travelling internationally or having been in contact with an active infection case. Our results show that being worried about contracting the virus increases WTT. Hence, it is important for the population to feel some concern though no panic about the pandemic. Communication regarding the consequences of an infection and the disease control strategy, including testing, needs to be clear, fact-based and appear as trustworthy for individuals from different socio-cultural and political spectrums. Differences in WTT between Republican and Democrat voters in the US, highlighted by our results, underline this necessity.

Prosocial benefits. Testing can contribute to the benefits derived from protecting the health of loved ones and other members of society. Although Campos-Mercade et al. [9] do not specifically look at willingness to test, they find prosocial individuals to be more likely to follow health guidelines such as physical distancing, isolating at home when sick, or buying face masks. Our results also confirm that altruism is significantly correlated with WTT. It may thus be possible to trigger non-monetary incentives for testing, e.g., by appealing to people's sense of solidarity or their desire to do good.

Social image benefits. People may also benefit from doing what is regarded by others as "the right thing to do". Research in other contexts has shown that social image concerns are an important motivator for individuals to vote [5]; the prospect of telling others about whether or not one has voted increases the participation in elections [12]. Examples abound on how social norms can induce higher participation, by reminding people of the behaviour of others, neighbours, colleagues etc. [16]. In our US-sample, conformism seems indeed to increase willingness to get tested. In the context of COVID-19 testing, these results imply that sending a text message to inform people about, say, the number of people who submitted to testing in the same neighbourhood during the past week could motivate individuals to submit to testing, too.

Monetary benefits. A straightforward way of increasing expected benefits of test-taking would be to set monetary rewards for compliers. Such has been suggested in a recent opinion piece by Levitt et al. [24], proposing a COVID lottery that gives away large prizes every week to random test participants, where a completed test would allow participation in the lottery, with winners announced at regular intervals. Levitt et al. also recommend a second financial incentive for anyone who tests positive for COVID-19 and is thus required to stay home. Whether such an approach can be effective remains an open question. Evidence from previous uses of lotteries show limited or no effect, for instance in the case of promoting voter turnout in London [20], or take-up rates of cancer screening [22]. Undoubtedly, the size of the financial incentive will play a key role in the effectiveness of the policy. Notably, there is much evidence in the behavioural literature indicating that monetary incentives may crowd out intrinsic motivation [4]. This suggests that providing monetary incentives may well be ineffective (and render other efforts ineffective, too), if pursued in parallel to strategies that aim to create prosocial and social image incentives. For instance, a recent study by Kölle et al. [21] shows that providing monetary incentives to register for voting reduces the perceived moral imperative to do so.

Conclusion

The different benefit and cost considerations on the individual's decision to comply with a public testing strategy highlight the complexity of designing an effective approach. Different incentives need to be taken into account to reach sufficient participation rates. Moreover, consideration should be given to the way specific subgroups of the population are incentivized, especially those that combine a relatively low willingness to get tested with a higher exposure to potential infection, such as people with less financial means or those that tend to not follow the rules.

In light of the high public health and economic stakes associated with getting the testing strategy right, as a core component of a successful COVID-19 policy, there is an urgent need to understand what works best, and at what cost. This calls for further research into the different behavioural responses to the alternative testing strategies currently discussed and implemented throughout the world, including practical implementation, accessibility and communication of the policy. On top of the short term benefits in the current, unprecedented COVID-19 crisis, these insights could inform faster and more efficient policy responses in potential future disease outbreaks. In addition, understanding willingness to participate in testing programs might shed further light on effective ways of raising participation in other important disease control strategies, such as vaccine campaigns [23] or health screening programs [19].

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Declaration of Competing Interest

None.

APPENDIX A

Details on survey data collection:

We conducted an online-survey experiment among students of the University of Luxembourg (LUX-sample, N = 127) and an online survey among a sample of US citizens (US-sample, N = 1215). Subjects in the LUX-sample were recruited from an internal database using the platform ORSEE (Greiner, 2015). The US-sample comprises respondents from 50 different US states who were recruited, via the online survey platform CloudResearch, from the Turkprime panel, which is heterogeneous in many sociodemographic dimensions (Chandler et al., 2019). Both surveys contain an item that asks respondents to state their willingness to get tested for free, our main variable of interest (WTT). In the main text, we report results from a probit regression of WTT on individual characteristics (US-sample) or a treatment indicator (LUX-sample).

US-sample: Questionnaire

How likely do you think you will contract COVID-19?

- ○ Extremely likely (1)
- ○ Somewhat likely (2)
- ○ Neither likely nor unlikely (3)
- ○ Somewhat unlikely (4)
- ○ Extremely unlikely (5)

How safe do you think you are with respect to contracting COVID-19 after the restrictive measures taken by the State you currently live?

- ○ Extremely safe (1)
- ○ Moderately safe (2)
- ○ Neither safe nor unsafe (3)
- ○ Moderately unsafe (4)
- ○ Extremely unsafe (5)

How much are you following the restrictions that the State you currently live in imposed to contain the spread of COVID-19?

- ○ Completely (1)
- ○ Quite a lot (2)
- ○ A moderate amount (3)
- ○ Quite a little (4)
- ○ Not at all (5)

How do you evaluate the current spread of the COVID-19 virus in your State?

- ○ The pandemic has just started (1)
- ○ The pandemic is before the peak (2)
- ○ The pandemic is at its peak (3)
- ○ The pandemic passed the peak (4)
- ○ The pandemic is almost over (5)

How many of these diseases do you have? Cardiovascular diseases, diabetes, Hepatitis B, chronic bronchitis, kidney diseases and cancer.

- ○ (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ or more (6)
- ○ I prefer not to answer (7)

What is your age?

____

In which state do you currently reside?

▼ Alabama (1) ... I do not reside in the United States (53)

In which city you currently reside?

____

What is the highest level of school you have completed or the highest degree you have received?

- ○ Less than high school degree (1)
- ○ High school graduate (high school diploma or equivalent including GED) (2)
- ○ Some college but no degree (3)
- ○ Associate degree in college (2-year) (4)
- ○ Bachelor's degree in college (4-year) (5)
- ○ Master's degree (6)
- ○ Doctoral degree (7)
- ○ Professional degree (JD, MD) (8)

Choose one or more races that you consider yourself to be:

- ○ White (1)
- ○ Black or African American (2)
- ○ American Indian or Alaska Native (3)
- ○ Asian (4)
- ○ Native Hawaiian or Pacific Islander (5)
- ○ Other (6) ____________________________________

What is your gender?

- ○ Male (1)
- ○ Female (2)
- ○ Other (3)

Please indicate includes your entire household income in (previous year) before taxes.

- ○ Less than $10,000 (1)
- ○ $10,000 to $19,999 (2)
- ○ $20,000 to $29,999 (3)
- ○ $30,000 to $39,999 (4)
- ○ $40,000 to $49,999 (5)
- ○ $50,000 to $59,999 (6)
- ○ $60,000 to $69,999 (7)
- ○ $70,000 to $79,999 (8)
- ○ $80,000 to $89,999 (9)
- ○ $90,000 to $99,999 (10)
- ○ $100,000 to $149,999 (11)
- ○ $150,000 or more (12)

Which statement best describes your current employment status?

- ○ Working (paid employee) (1)
- ○ Working (self-employed) (2)
- ○ Not working (temporary layoff from a job) (3)
- ○ Not working (looking for work) (4)
- ○ Not working (retired) (5)
- ○ Not working (disabled) (6)
- ○ Not working (other) (7) ____
- ○ Prefer not to answer (8)

Do you smoke?

- ○ Yes (1)
- ○ No (2)
- ○ Occasionally (4)

Do you think of yourself as closer to the Republican or Democratic party?

- ○ Republican (1)
- ○ Democratic (2)
- ○ Independent (3)

Here is a 7-point scale on which the political views that people might hold are arranged from extremely liberal (left) to extremely conservative (right). Where would you place yourself on this scale?

	0	1	2	3	4	5	6	7
Political Ideology ()								

Suppose your State decides to offer free testing for COVID-19 on a voluntary basis to identify as many infected people as possible and take the necessary measures to prevent others from being infected. Would you be willing to get yourself tested?

- ○ Definitely not (1)
- ○ Likely not (2)
- ○ Not sure (3)
- ○ Likely yes (4)
- ○ Definitely yes (5)

Display This Question:
If Suppose your State decides to offer free testing for COVID-19 on a voluntary basis to identify as... = Not sure
Please explain, in a few words, why you are unsure about getting tested
____

Display This Question:
If Suppose your State decides to offer free testing for COVID-19 on a voluntary basis to identify as... = Definitely not
Or Suppose your State decides to offer free testing for COVID-19 on a voluntary basis to identify as... = Likely not
Please explain, in a few words, why you are not willing to get tested
____

How do you see yourself: Are you a person who is generally willing to take risks, or do you try to avoid taking risks? Please use a scale from 0 to 10, where a 0 means you are “completely unwilling to take risks” and a 10 means you are “very willing to take risks”. You can also use the values in-between to indicate where you fall on the scale.

	0	1	2	3	4	5	6	7	8	9	10	
	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (9)	10 (10)	11 (11)	
Completely unwilling to take risks	○	○	○	○	○	○	○	○	○	○	○	Very willing to take risks

How do you assess your willingness to share with others without expecting anything in return? Please use a scale from 0 to 10, where 0 means you are "completely unwilling to share" and a 10 means you are "very willing to share". You can also use the values inbetween to indicate where you fall on the scale.

	0	1	2	3	4	5	6	7	8	9	10	
	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (9)	10 (10)	11 (11)	
Completely unwilling to share	○	○	○	○	○	○	○	○	○	○	○	Very willing to share

Are you generally concerned about whether other people approve or disapprove your behavior? Please use a scale from 0 to 10, where 0 means you are "not concerned at all" and a 10 means you are "very concerned". You can also use the values in-between to indicate where you fall on the scale.

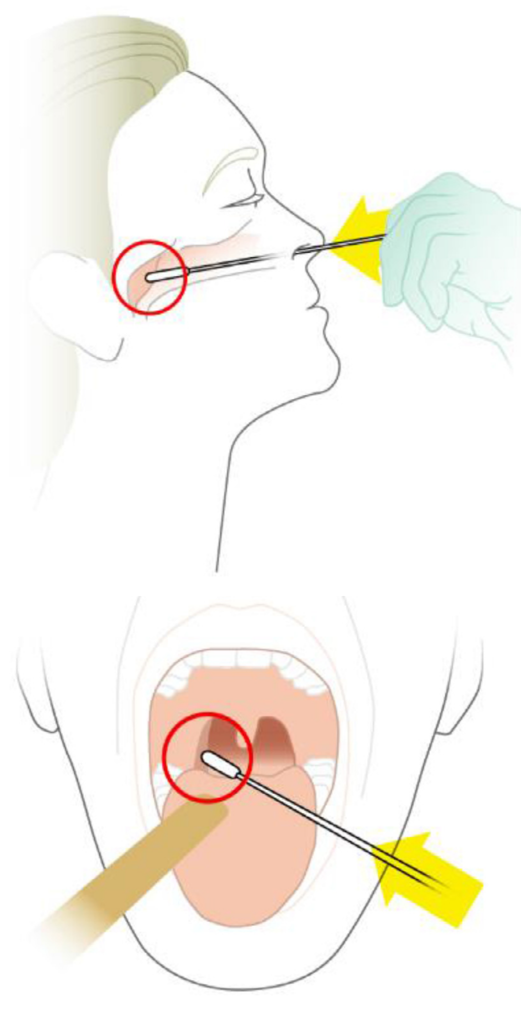
	0	1	2	3	4	5	6	7	8	9	10	
	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (9)	10 (10)	11 (11)	
Not concerned at all	○	○	○	○	○	○	○	○	○	○	○	Very concerned

In comparison to others, are you a person who is generally willing to give up something today in order to benefit from that in the future? *Please use a scale from 0 to 10, where a 0 means you are "completely unwilling to give up something today" and a 10 means you are "very willing to give up something today". You can also use the values in-between to indicate where you fall on the scale.*

	0	1	2	3	4	5	6	7	8	9	10	
	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (9)	10 (10)	11 (11)	
Completely unwilling to give up something today	○	○	○	○	○	○	○	○	○	○	○	Very willing to give up something today

Luxembourg sample: Question regarding testing method

Testing for COVID-19 is currently organized on a voluntary basis. Several types of tests have been developed. Would you be willing to get yourself tested using the procedure shown below?



APPENDIX B

Our probit results are obtained from the following model:

$$P\left(y_{ij}=1\middle|x_{ij},b_j\right) = \Phi\left(\beta_0+\beta x_{ij}+b_j\right),$$

Where $P(y_{ij}=1|x_{ij},b_j)$ is the probability that willingness to test, *y*, is equal to 1 for individual *i* living in state *j*, given *i*'s individual characteristics (in vector x_{ij}). The standard normal cumulative distribution $\Phi(\bullet)$ is defined as the inverse link function. ß is a vector containing the effects of the personal characteristics of *i* (such as age, risk aversion, etc.) and b_j is, depending on the specification, a vector containing state-level fixed effects or the state-level random intercepts.

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