When Private Optimism meets Public Despair:

Dissociable effects on behavior and well-being

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Abstract.

When faced with a threat, peoples' estimate of risk guides their response. When danger is to the self as well as to others two estimates are generated: the risk to oneself and the risk to others. As these estimates likely differ, it is unclear how exactly they drive a response. To answer this question, we studied a large representative sample of Americans facing the COVID-19 pandemic at two time points (N_1=1145, N_2=683). We discover a paradoxical duality: a tendency to be optimistic about one's own risk of infection (private optimism) while at the same time to be pessimistic about the risk to others (public pessimism). These two estimates were found to be differentially related to affect and choice. First, private optimism, but not public pessimism, was associated with people's positive feelings. The association between private optimism and positive affect was mediated by people's sense of agency over their future. However, negative affect was related to both private risk perception and public risk perception. Second, people predominantly engaged in protective behaviors based on their estimated risk to the population rather than to themselves. This suggests that people were predominantly engaging in protective behaviors for the benefit of others. The findings are important for understanding how people's beliefs about their own future and that of others are related to protective behaviors and well-being.

Keywords: Pandemic, Decision-making, Optimism, Well-being, Affect, Risk

The human tendency for optimism has been well documented (Seligman, 2011; Sharot, Korn, & Dolan, 2012; Taylor, Kemeny, Reed, Bower, & Gruenewald, 2000; Weinstein, 1980). For example, people tend to overestimate their financial prosperity (Calderon, 1993) and marriage longevity (Baker & Emery, 1993), while underestimating their risk of disease and other hardships (Weinstein, 1987). What is surprising about such observations is that, anecdotally, people also tend to express pessimism regarding the state of their country, the world and the human race. In general, people are not as optimistic about others' prospects (Perloff & Fetzer, 1986; Kuzmanovik, Jefferson & Vogeley 2015). The question then arises: when faced with a threat to the self *and* to others, how would such diverging estimates of risk drive human response?

It has been suggested that optimism is related to happiness (Dember & Penwell, 1980) and inversely related to depression and anxiety (Garret et al., 2014; Korn, Sharot, Walter, Heekeren, & Dolan, 2014; Strunk, Lopez, & DeRubeis, 2006). If, however, people express private optimism alongside public despair would the respective effects cancel each other out, or would one factor dominate the other? With regards to behavior, a person's estimates of vulnerability and future prospects will guide decision making (Krieger, Murray, Roberts, & Green, 2016). For example, underestimating risk of disease leads to reduced medical screenings (Krieger et al., 2016). Yet, a person's predictions about the vulnerability of society may too drive behavior, especially in cases when a person's own behavior can help protect others. The consequences of private optimism, side-by-side public pessimism, on people's well-being and behavior are currently unknown.

The possible existence of this paradoxical duality - private optimism alongside public pessimism - raises a second unresolved question: how can we explain such disconnect? We test the hypothesis that the dissociation is related to people's sense of agency. People tend to feel more optimistic about things they believe they can control (Zakay, 1984). Often this sense of control is overestimated (Langer, 1975; Tobias-Webb et al., 2017). Nevertheless, if people believe their fate is in their own hands they are more likely to believe they can steer the wheel in the right direction. At the same time, people likely acknowledge they have limited control over the fate of their country, or the health and safety of their fellow citizens. Thus, they may be less confident those elements are heading in the right direction.

To shed light on the relationship between perception of risk (to the self and other), affect and choice we recorded people's estimations of danger during the 2020 COVID-19 global pandemic. As the pandemic touched most of humanity it made it possible to examine the questions outlined above across a large and diverse population. To that end, we surveyed a representative sample of 1145 Americans across 30 States during March 26-29, 2020, as stay at home orders were being issued across the US (Experiment 1). We then surveyed 683 of them again a month later while all states were under lockdown (Experiment 2 – April 23-25, 2020). The second survey allowed us to examine if the results of Experiment 1 hold one month into lockdown and also test for changes over time.

We tested for the paradoxical existence of private optimism and public pessimism; whether it could be explained by considering people's sense of agency; and how private optimism and public pessimism were related to people's well-being and behavior. Understanding the latter was

particularly important as governments worldwide were having to strike a balance between ensuring compliance with behavioral regulations to slow the spread of the virus (e.g., social-distancing, frequent handwashing) and maintaining citizens' well-being during a time of uncertainty.

Methods

Participants, Experiment 1. We tested 1166 individuals between March 26-29, 2020, representative of the US population in terms of age, gender and ethnicity (see **Figure 1a-c**). The individuals were residing in 30 US states at the time of testing (**Figure 1d**). They completed an online questionnaire on Prolific Academic. We tested participants' engagement and attention by asking them to select a particular answer to various "catch trials" throughout the experiment (for example: *Please select 'strongly disagree'*). Participants who did not select the required response more than once were excluded from analysis (N=21). Thus, data of 1145 participants were analyzed (mean age=44.00, SD=15.59; females=52.3%, Democrats=69%, Republicans=31%). 144 participants did not indicate ethnicity and could thus not be included in any models in which ethnicity was a factor. Participants provided informed consent and received $4.66 for their participation. Ethical approval was provided by the Research Ethics Committee at University College London. Sample size was based on a pilot.
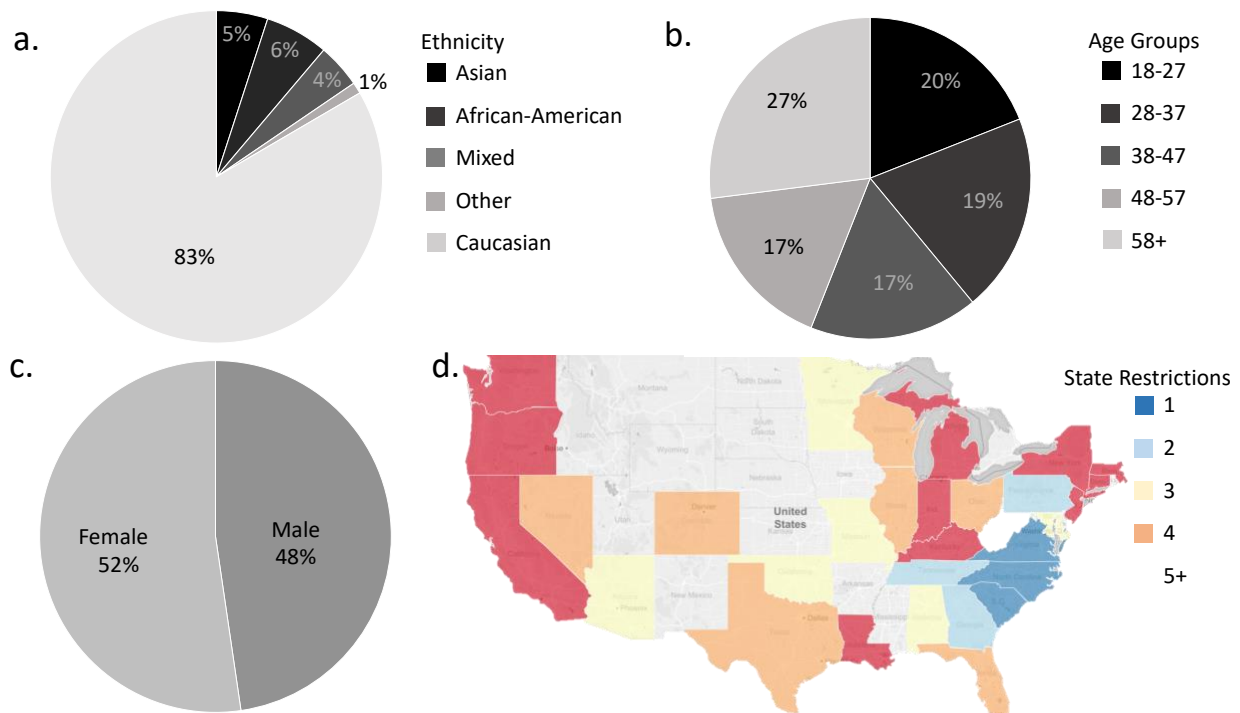

Figure 1. Overview of demographics. Sample(N=1145) is representative of the US population in terms of **(a)** Ethnicity, **(b)** Age, and **(c)** Gender. **(d)** Participants resided in 30 US States at time of testing. Approximately 40 participants were tested in each of the states. We computed the level of each of those state's behavioral restrictions (see methods) from 1 (most lenient in blue) to 5 (most severe in red). The demographics of participants in Experiment 2 are similar to those portrayed here (see methods).

Participants, Experiment 2.
683 participants in Experiment 1 completed a follow-up survey on April 23-25, 2020 - a month after Experiment 2 on Prolific Academic (mean age=46.00, *SD*=15.22; 18-27 years old=13.5%; 28-37 years old =17.9%; 38-47 years old =18.2%; 48-58 years old =18.4%; over 58 years old =32.1%; females=51.1%; Democrats=68.4%; Republicans=31.6%; Asian=4.5%; African-American=6.3%; Mixed=4.5%; Other=1.6; Caucasian=83%). The individuals were residing in 30 states at the time of testing. None of the participants failed more than 1 of the catch trials. Participants provided informed consent and received $2.34 for their participation. Ethical approval was provided by the Research Ethics Committee at University College London.

Materials, Experiment 1.
Participants completed an online survey which lasted approximately 30 minutes. In addition to the questions that formed this study, additional information was gathered as part of parallel studies conducted by members of our lab. These focused mostly on habits, personality, psychopathology and other opinions regarding the crisis. We detail the additional information gathered in **supplementary material**. Below we detail the information gathered via the online survey which is part of the current study.

Demographics: Participants indicated their age, gender, ethnicity, level of education, household income, health insurance satisfaction, political orientation, whether they had children and their current place of residence. The latter enabled us to calculated the level of restrictions in the participant's location (see below).

State restrictions. Using information available from each state's government websites we quantified the level of restrictions in each participant's state on the date they completed the survey. In particular, we assigned one restriction point to each of the following restrictions and then summed up the points for each state/date: 1) school closure, 2) places of worship closure, 3) non-essential businesses closure, 4) prohibition of social gatherings, 5) prohibition of outdoor walks and runs, 6) official "Stay at Home" Order issued. A higher number indicates more restrictions.

Relative Private Optimism. Participants were asked to indicate: "Relative to others of your age and gender do you think you are less/more likely to get COVID-19?" on a scale from 1 (much less likely) to 5 (much more likely). Assessing one's risk relative to others has often being used in the literature as a measure of optimism (Weinstein, 1980). For regressions, mediations and graphs we reverse scored participants' responses such that high numbers will indicate high private optimism and low numbers low private optimism (that is a 1 became a 5, a 2 became 4 and so on).

Public Pessimism. Participants were asked to indicate: "Do you think COVID-19 presents a real danger to the health of the human population?" using continuous visual analogue scale from 0 (not really) to 100 (extreme danger). High numbers indicate public pessimism.

Happiness. Participants were asked two question to assess their happiness: (i)"Taken all together, how happy are you with your life these days? Mark your rating relative to the least and most happy time of your life." Participants were asked to respond on a continuous visual analogue scale ranging from 0 (least happy time of your life) to 100 (most happy time of your life). (ii) "Think about right now. How happy are you at this moment?". Participants were asked

to respond on a continuous visual analogue scale ranging from 0 (very unhappy) to 100 (very happy). Results are the same regardless of which question we look at. Thus, we report results of the first question here and of the second in the supplementary.

Anxiety. We assessed general anxiety using the short version of the State-Trait Anxiety Inventory (STAI, Marteau & Bekker, 1992).

Compliance measures. Participants rated on a continuous visual analogue scale ranging from 0 (none at all) to 100 (a lot): a) "How much effort do you make to wash your hands regularly?"; b) "How much effort do you make to socially distance yourself from others?"; c) "How much effort do you make to avoid touching your face?", as well on a continuous visual analogue scale ranging from 0 (zero) to 100 (many times) d) "In the past week how many times have you been to another person's house ?"; e) How many days this week have you been closer than 1 meter to another person (except those you live with)?". Items d) and e) were reverse coded to compute a mean score of compliance.

Sense of agency. Participants completed a questionnaire assessing sense of agency (Lachman & Weaver, 1998). The questionnaire comprises of two sub-scales; personal mastery and perceived constraints. The personal mastery sub score quantifies a person's sense of efficacy or effectiveness in carrying out goals. The perceived constraints sub-score quantifies to what extent a person believes there are obstacles or factors beyond one's control that interfere with reaching goals. To get one score reflecting sense of agency we first inversed the score on the second scale, such that a higher score reflects less perceived constraints. We then averaged the two sub-scores such that a higher score reflects a higher sense of agency.

LOT-R. Participants also completed the Life Orientation Optimism Test (LOT-R, Molina et al., 2013) that measures trait optimism.

Materials, Experiment 2.
Materials and procedure were the same as in Experiment 1 except for the following changes:

1. In Experiment 1 we assessed relative private optimism by asking participants how likely they thought they were to get COVID-19 relative to others their age and gender. By contrast, public pessimism was assessed by asking participants to indicate whether the virus presented a danger to the health of the human population. To rule out that the findings in Experiment 1 were a result of assessing perceptions of "infection risk" vs. "danger" rather than assessing perception related to the self vs. the human population, we changed the question assessing "public pessimism". In particular we asked participants "How likely do you think a person is to get COVID-19?" on a scale from 1 (extremely unlikely) to 5 (extremely likely)". 500 of our participants were additionally asked the original question regarding danger to the health of the human population.

2. We added a question to assess "absolute private optimism" by asking participants "How likely do you think you are to get COVID-19?" on a scale from 1 (extremely unlikely) to 5 (extremely likely)".

3. Many of the items introduced in the survey completed by subjects in Experiment 1 for the parallel studies conducted in the lab were not introduced in Experiment 2. We also did not record LOTR.

Analysis, Experiment 1.
We performed one-sample two-tailed t-tests to test whether participants considered themselves less at risk to get COVID-19 than others of the same age and gender, which we refer to as relative private optimism, and whether participants considered the danger posed by COVID-19 to the health of the human population as significantly higher than midscale, which we refer to as public pessimism. To quantify behavioral compliance, we averaged each participant's scores on all compliance questions (see above). Three separate linear regressions were run to assess the effect of relative private optimism and public pessimism on compliance, anxiety, and happiness controlling for all demographics (age, gender, ethnicity, household income, healthcare insurance satisfaction, political orientation, level of education, children, state restrictions). The same regressions were run again with sense of agency as an additional predictor. We also performed two separate regressions to predict relative private optimism and public pessimism from all demographics and two separate regressions to predict relative private optimism and public pessimism from sense of agency controlling for all demographics.

Mediation analyses were performed (Baron & Kenny, 1986) to assess the relationship between sense of agency, private optimism, public pessimism and the dependent variables. A multilevel modelling approach was used (Preacher, 2015). Quasi-Bayesian Estimation and bootstrapping were performed as implemented in the "mediation" package in R (Tingley, Yamamoto, Hirose, Keele, & Imai, 2014). Bootstrapping is a non-parametric approach, which is based on resampling with replacement. Analyses were conducted in R with an alpha cut-off of 0.05 across all computations. Standardized coefficients and standard errors are reported for all computations.

Analysis, Experiment 2.
Analysis was the same as in Experiment 1 except for the following changes: We assessed public pessimism using participants' rating of "How likely do you think a person is to get COVID-19?". Regression analyses and mediation were performed controlling for all demographics except state restrictions, as level of restriction was constant across all states at the time of data collection (level 5 across all states). All analyses were repeated, replacing relative private optimism with absolute private optimism to examine if results differ. Finally, to examine if any of the main variables altered during the month of lockdown temporal effects were inspected. In particular, performing paired-sample t-tests between participants' responses in Experiment 1 and Experiment 2.

Results, Experiment 1.

Private optimism exists side by side public pessimism.
We found clear indication of relative private optimism and public pessimism in our sample. In particular, on average participants perceived their own likelihood of getting COVID-19 to be significantly lower than of others their age and gender (*M*=2.80, *SD*=0.88, *t*(1144)=1805.51, *p*<0.001). On a population level this result indicates an optimism bias (that is expectations are more optimistic than reality). This is because our representative sample as a whole is unlikely to be less susceptible than others their age and gender to COVID-19. For each individual participant, however, one cannot assert whether the perception that one is less likely to be infected with

COVID-19 than others is optimistically *biased* (that is positive expectations that are unrealistic) or simply *optimistic* (that is positive expectations of future probabilities which can be realistic or unrealistic). As expected, trait optimism, assessed via the LOT-R scale, which measures optimism about one's own future, was positively correlated with our measure of private optimism ($r(1143)=0.138$, $p<0.001$), but not public pessimism ($r(1143)=-0.002$, $p=0.955$).

Alongside relative private optimism participants exhibited public pessimism. In particular, on a scale from 0 to 100, with 100 being the greatest danger to humanity, participants rated the danger COVID-19 poses to the health of the human population as high ($M=74.48$, $SD=20.08$), and significantly greater than midscale ($t(1144)=41.25$, $p<0.001$). There was a weak correlation between our measures of relative private optimism and public pessimism ($r(1143)=0.24$, $p<0.001$).

To examine if private optimism was related to people's sense of agency over their own life we asked subjects to complete the Sense of Control Scale (Lachman & Weaver, 1998), which examines people's sense of mastery and perceived constraints. As hypothesized, sense of agency was strongly related to relative private optimism. A linear model predicting relative private optimism from sense of agency controlling for all demographic factors revealed a significant effect for sense of agency ($\beta=0.09$, $p<0.006$, **Figure 2a**). In contrast, a linear model predicting public pessimism from sense of agency controlling for all demographic factors did not reveal a significant effect for sense of agency ($\beta=-0.04$, $p=0.174$, **Figure 2b**).

In terms of demographics, females, older individuals and Democrats were all more likely to express both private pessimism (Betas from a model predicting private optimism including all demographic factors and sense of agency: Political Orientation: $\beta=0.13$, $p<0.001$; Age: $\beta=-0.11$, $p=0.001$; Gender: $\beta=-0.08$, $p=0.008$, **Figure 2a**) and public pessimism (Betas from a model including all demographic factors and sense of agency: Political Orientation: $\beta=-0.25$, $p<0.001$; Age: $\beta=0.11$, $p<0.001$; Gender: $\beta=0.11$, $p<0.001$, **Figure 2b**).
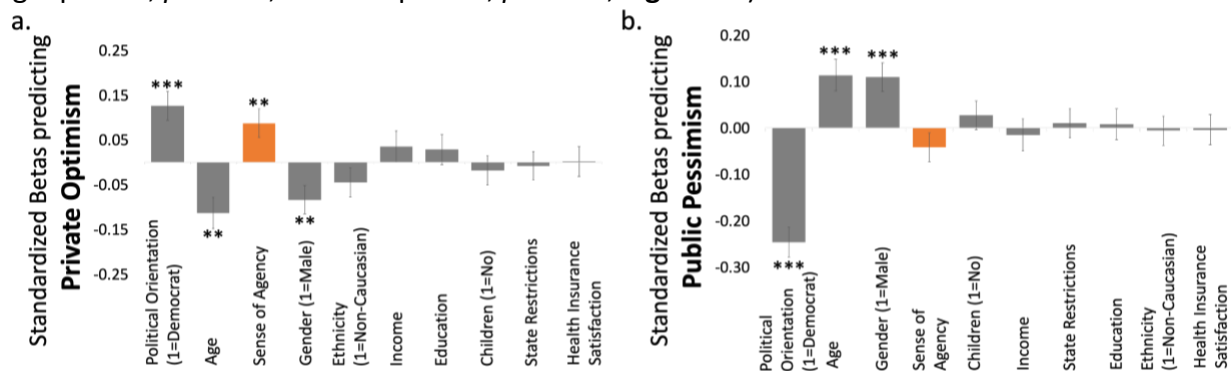

Figure 2. Factors associated with private optimism and public pessimism (Experiment 1). Displayed are the Beta coefficients from a linear model predicting (a) private optimism (that is "Relative to others of your age and gender do you think you are less/more likely to get COVID-19?"; the variable is inverse coded such higher numbers indicate greater private optimism) and (b) public pessimism (that is "Do you think COVID-19 presents a real danger to the health of the human population?"). **(a)** People with strong sense of agency (orange bar) were more likely to express private optimism as were males, younger individuals, and Republicans. **(b)** Females, older individuals and Democrats were all more likely to express

public pessimism. Regressors are ordered from the strongest to the weakest. $**p<0.001$, $***p<0.0001$, Error Bars SEM.

Thus far we have shown private optimism side by side public pessimism in relation to the health threat of COVID-19. The former was strongly associated with people's sense of control over their life. We next examine how private optimism and pubic pessimism were related to well-being (happiness and anxiety) and behavior.

The relationship between private optimism and happiness is mediated by a sense of agency. We were interested whether and how relative private optimism and public pessimism influence peoples' sense of happiness in times of crisis. We thus asked our participants to indicate "how happy are you with your life these days?" on a scale from least happy time of my life to most happy time of my life. In general, participants indicated that they were significantly less happy relative to other times of their live (M=48.28, SD=24.60, t(1144)=2.37, $p<0.018$).

Interestingly, while relative private optimism had a significant positive relationship with happiness (Beta from a model predicting relative happiness from relative private optimism, public pessimism and all demographic variables as controls revealed a significant effect for relative private optimism β=0.09, $p<0.007$, **Figure 3a & b**), public pessimism did not (Beta from the same model β=-0.01, $p<0.649$, **Figure 3a & c**). It seems that the belief that one is relatively immune to COVID-19 protected people's sense of happiness during the crisis (and vice versa), but believing COVID-19 is a threat to the health of the human population did not significantly affect happiness.

Adding "sense of agency" into the previous model predicting happiness revealed that sense of agency was the variable most strongly associated with happiness. Interestingly, the standardized Beta coefficient signifying the relationship between sense of agency and happiness (β=0.31, $p<0.001$) was more than double the size than that of participants' income and happiness (β=0.13, $p<0.001$), which was the next strongest variable associated with happiness. In addition, age, political orientation and satisfaction with health insurance were also related to happiness (age: β=0.10, p=0.003; political orientation β=0.06, p=0.059; satisfaction with health insurance β=0.09, p=0.006) as was relative private optimism (β=0.06, p=0.045). Those with a sense of agency, relative private optimism, higher income, older individuals, and those satisfied with their health insurance were all less likely to report a negative influence on their happiness due to the COVID-19 crisis (**Figure 2d**). We note that all these factors were included in one model and thus the results indicate independent effects of each variable.

To examine if the relationship between relative private optimism and happiness was mediated by participants' sense of agency, we computed a mediation model, controlling for all demographic variables (see **Methods**). Indeed, sense of agency partially mediates the effect between relative private optimism and happiness (**Figure 3e**). This is apparent as when controlling for sense of agency the relationship between relative private optimism and happiness remained significant but reduced in size (total effect: β=0.09, p=0.007, path c': β=0.06, p=0.045). Bootstrapping revealed that the indirect effect was indeed significantly different from 0 (β=0.02,

p=0.01 [0.01, 0.05]). Relative private optimism was positively related to sense of agency (path a: β=0.08 p=0.01) and sense of agency predicted happiness when relative private optimism was accounted for (path b: β=0.30, p<0.001). We did not find evidence for the reverse mediation, that is relative private optimism did not mediate the relationship between sense of agency and happiness (total effect: β=0.31 , p<0.001; path c': β= 0.31, p<0.001; path a: β=0.08, p=0.01; path b: β=0.30, p<0.001 , bootstrapped indirect effect: β=0.01, p=0.08 [-0.0004, 0.01]. The findings suggest that private optimism is related to happiness not only because positive expectations can directly induce positive feelings, but also because private optimism is related to a sense of agency which in itself increases happiness.
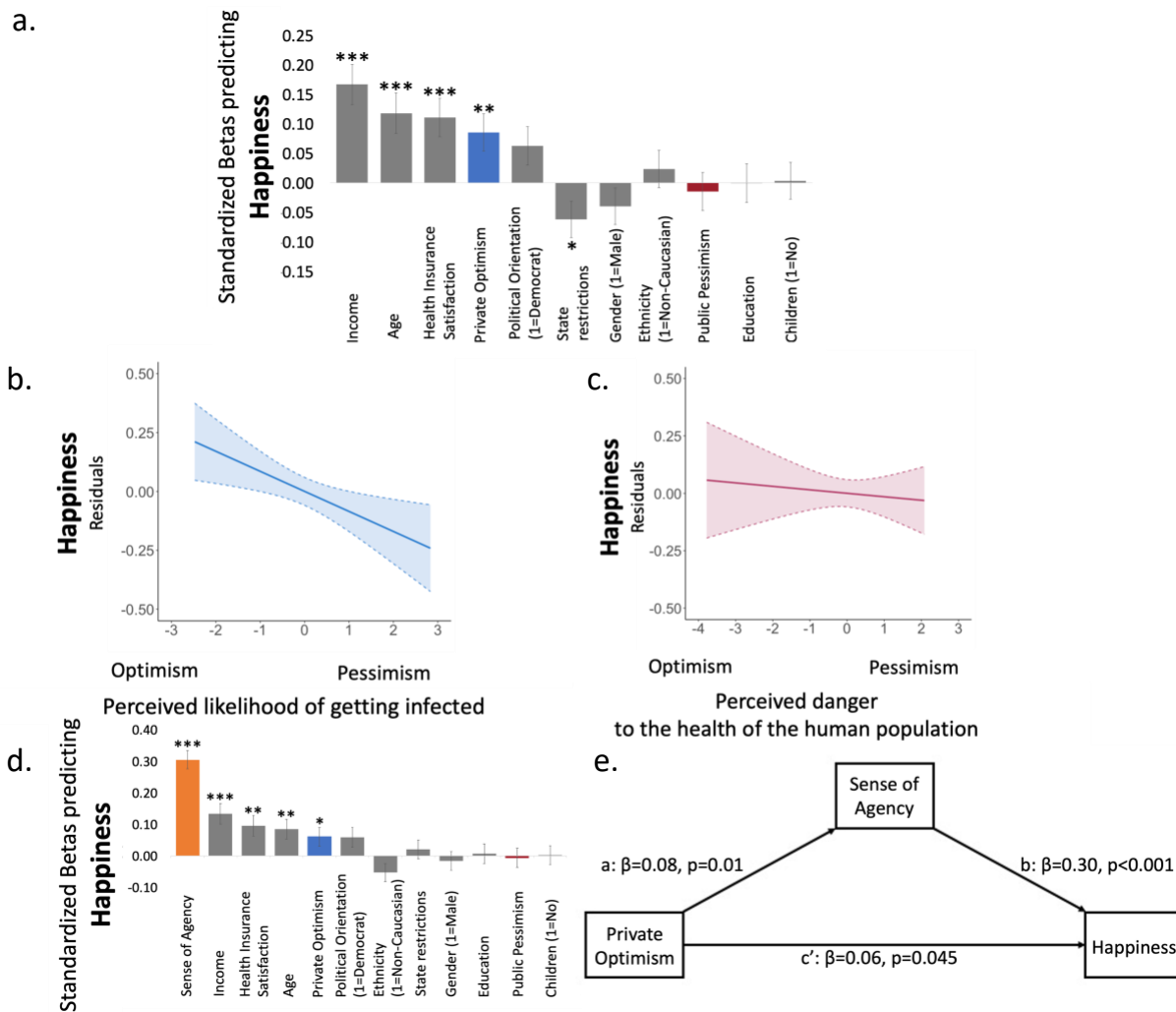

Figure 3. Factors associated with happiness (Experiment 1). (a) Displayed are the Beta coefficients from a linear model predicting happiness, which shows that those who report greater private optimism (blue) are happier. Public pessimism (red), however, is not associated with happiness. These associations are also portrayed in **(b & c)**. Here, the Y and X axis display residuals from the same linear model, which includes all demographic controls. Clouds represent confidence intervals. **(d)** Adding sense of agency (orange) to the model reveals that sense of agency is the strongest factor predicting happiness and reduces the association between private optimism and happiness. Indeed, a formal mediation model

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shows that **(e)** sense of agency partially mediated the relationship between private optimism and happiness. Regressors are ordered from the strongest to the weakest. *$p< 0.05$, **$p<0.001$, ***$p<0.0001$, Error Bars SEM.

Private optimism and public pessimism are related to anxiety.
Thus far we showed that relative private optimism, but not public pessimism, was associated with happiness during the COVID-19 crisis. We next examined if these factors were related to a negative affective state – anxiety, which we measured using the short version of STAI (Marteau & Bekker, 1992). We found that pessimism, both private and public, were strongly associated with high anxiety (Betas in a model including all demographics, relative private optimism: β=-0.13, $p<0.001$, **Figure 4a & b**, public pessimism: β=0.13, $p<0.001$, **Figure 4a & c**). This was true also if we added sense of agency into the model, which in itself was negatively associated with anxiety and was the strongest predictor of it (β=-0.31, $p<0.001$). In addition, younger individuals, females, Caucasians, individuals with lower income, people not satisfied with their health insurance and Democrats were more anxious (age: β=-0.17, $p<0.001$; gender: β=0.11, $p=0.001$, ethnicity: β=0.07, $p=0.018$, income: β=-0.06, $p=0.049$, satisfaction with health insurance: β=-0.07, $p=0.019$, political orientation: β=0.06, $p=0.037$, **Figure 4d**).

To examine if the relationship between relative private optimism and anxiety was mediated by participants' sense of agency, we computed a mediation model as described above (**Figure 4e**). We found that relative private optimism predicts anxiety (total effect: β=-0.13, $p<0.001$). When controlling for sense of agency, this effect remained significant but reduced in its effect size, indicating a partial mediation (path c': β=-0.10, $p<0.001$). Relative private optimism was positively related to sense of agency (path a: β=0.08 $p=0.01$); those who expressed more optimism expressed more sense of agency. Third, sense of agency predicted anxiety when relative private optimism was accounted for (path b: β=-0.31, $p<0.001$). Bootstrapping revealed a significant indirect effect of relative private optimism on anxiety (β=-0.02, $p=0.01$ [-0.05, -0.005]). We did not find evidence for the reverse mediation – that is, private optimism did not mediate the relationship between sense of agency and anxiety (total effect: β=-0.31 , $p<0.001$; path c': β=-0.31, $p=0.001$; path a: β=0.08, $p=0.012$; path b: β=0.30, $p<0.001$, bootstrapped indirect effect: β=-0.01, $p=0.015$ [-0.02, 0.00]. Moreover, there was no evidence for sense of agency mediating the relationship between public pessimism and anxiety (total effect: β=0.13, $p<0.001$; path c': β=0.13, $p=0.001$; path a: β=-0.03, $p=0.41$, path b: β=-0.30, $p<0.001$, bootstrapped indirect effect: β=0.01, $p=0.45$[-0.01, 0.03]. The findings suggest that private optimism is related to anxiety not only because positive expectations can directly reduce anxiety, but also because private optimism is related to a sense of agency which in itself reduces anxiety.
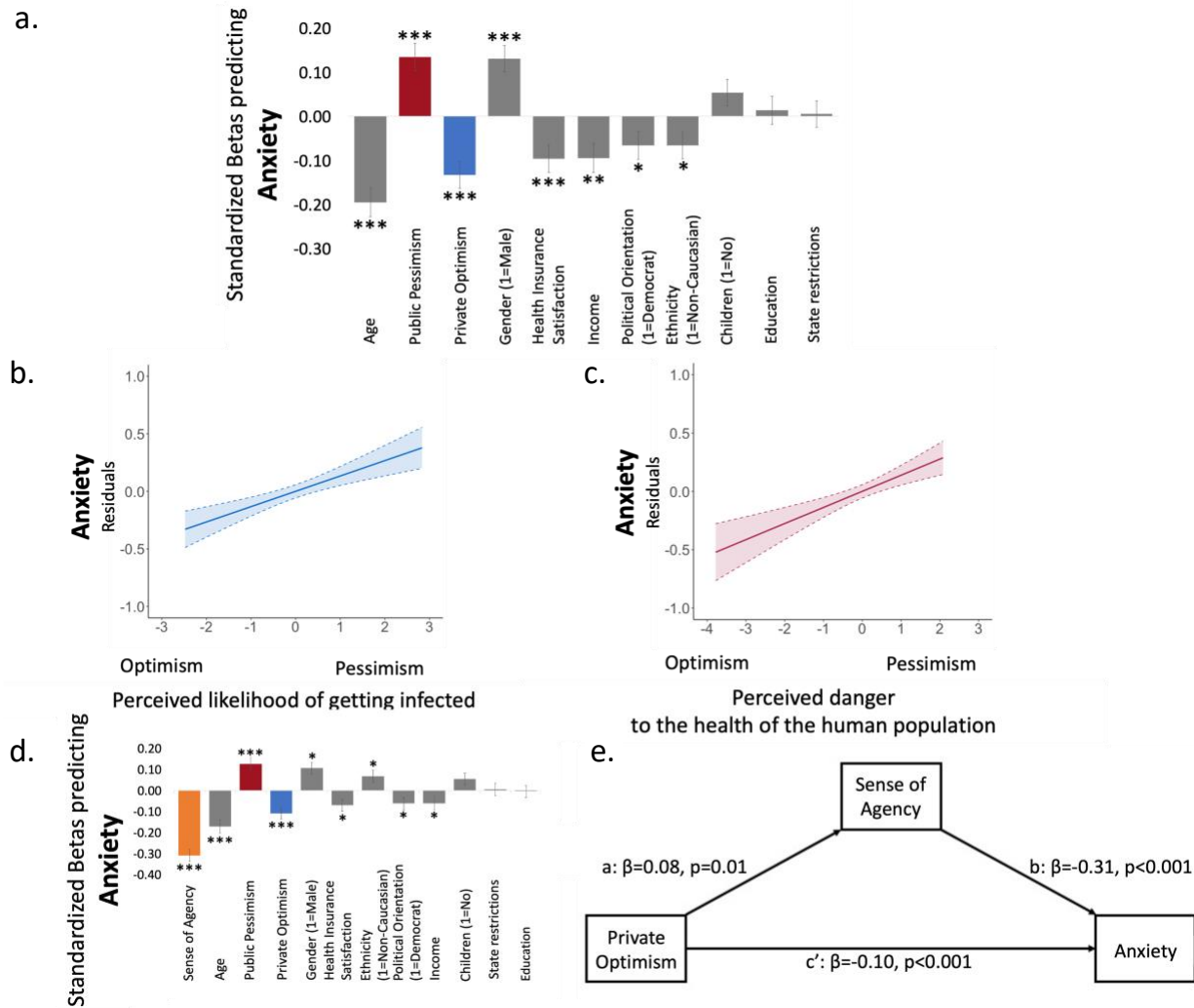
Figure 4. Factors associated with anxiety (Experiment 1). (a) Displayed are the Beta coefficients from a linear model predicting anxiety (STAI scores), which shows that those who report lower private optimism (blue) and public pessimism (red) reported greater anxiety. These associations are also portrayed in **(b & c)**. Here, the Y and X axis display residuals from the same linear model, which includes all demographic controls. Clouds represent confidence intervals. **(d)** Adding sense of agency (orange) to the model reveals that sense of agency is the strongest factor predicting anxiety and reduces the association between private optimism and anxiety. Indeed, a formal mediation model shows that **(e)** sense of agency partially mediated the relationship between private optimism and anxiety. It did not mediate the relationship between public pessimism and anxiety (figure not shown). Regressors are ordered from the strongest to the weakest. *$p<0.05$, **$p<0.001$, ***$p<0.0001$, Error Bars SEM.

Perception of global risk, rather than private risk, are strongly associated with behavioral response.

The above results show that private and public pessimism about COVID-19 are related to anxiety during the crisis. We next examined whether they are also associated with people's behavioral response to the crisis. To that end we assessed participants' self-reported compliance with the

behaviors advised (or ordered) by government officials in response to the COVID-19 outbreak. We found that compliance was high. Participants' reported putting effort into social distancing, frequent hand washing and avoidance of face touching (respectively: $t(1144)=180.39$, $p<0.001$; $t(1144)=151.66$, $p<0.001$, $t(1144)=83.03$, $p<0.001$, **Supplementary Figure 1a**). Moreover, they were unlikely to have visited other people's homes in the last week or to have come within 1 meter of people outside their own residence (respectively: $t(1144)=187.15$, $p<0.001$; $t(1144)=96.74$, $p<0.001$, **Supplementary Figure 1a**).

We averaged participants' scores on all these measures such that each participant had one score reflecting behavioral compliance. We found that while public pessimism was strongly related with behavioral compliance (Beta in a model including relative private optimism, public pessimism and all demographic controls $\beta=0.35$, $p<0.001$, **Figure 5a & c**), relative private optimism was not ($\beta=0.04$, $p=0.189$, **Figure 5a & b**). Adding sense of agency into the model did not alter the results, which in itself was not related to behavioral compliance ($\beta=-0.05$, $p=0.101$, **Figure 5d**). In addition, older individuals and females were more likely to comply (Age: $\beta=0.14$, $p<0.001$, Gender: $\beta=0.12$, $p<0.001$, **Figure 5d**). The relationship between public pessimism and behavioral compliance could not be explained by high anxiety alone, as even when we add anxiety into the model the effect of public pessimism on behavioral compliance remains significant (Betas in a model including private optimism, public pessimism, anxiety and all demographic controls Anxiety: $\beta=0.03$, $p=0.28$, Public pessimism: $\beta=0.35$, $p<0.001$).
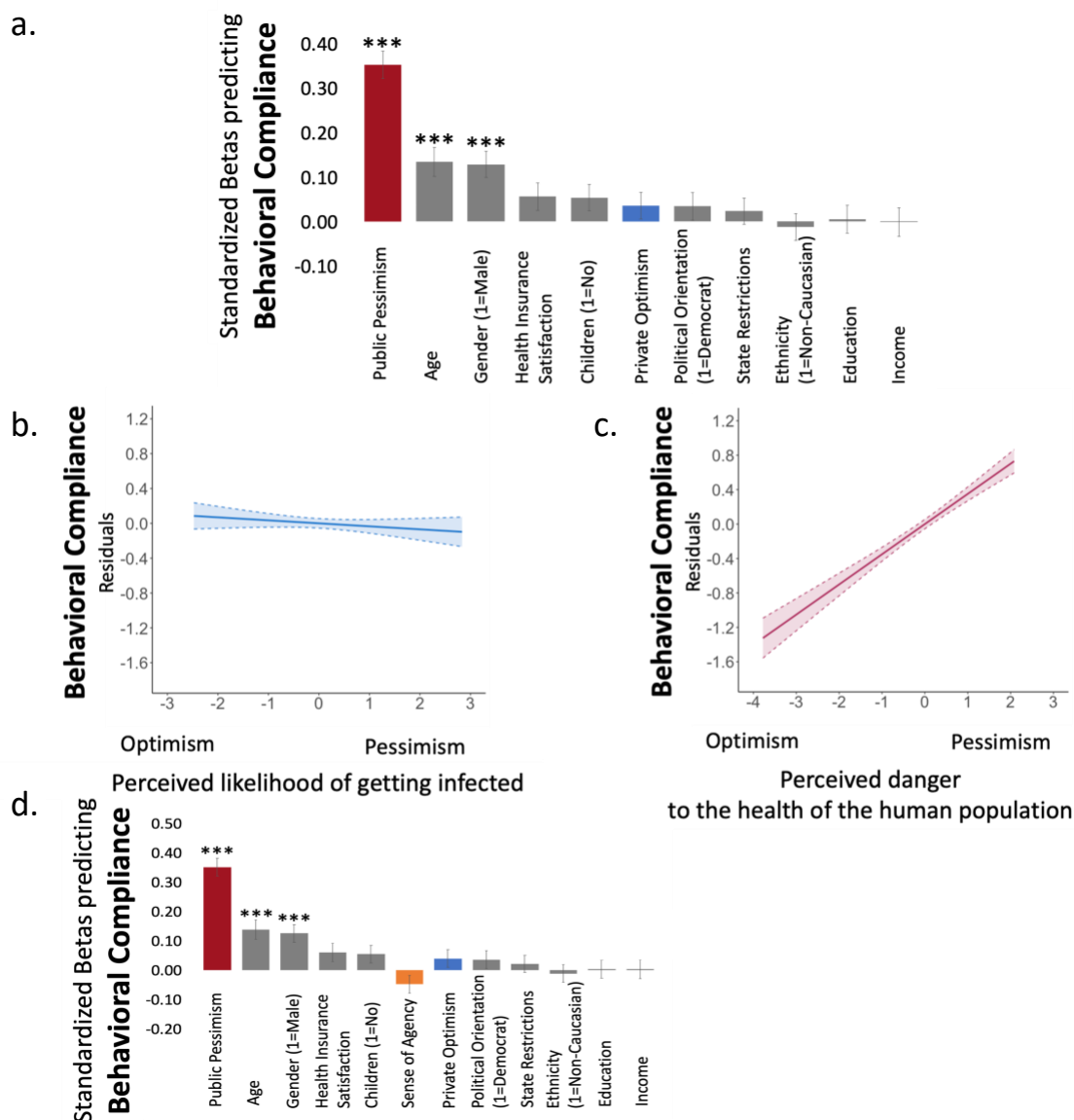
Figure 5. Factors associated with behavioral compliance (Experiment 1). Compliance is computed as an average score of effort in handwashing, avoidance of face touching, social distancing, avoidance of visiting others' houses, avoidance of being closer than 1 meter to another person outside one's own household. **(a)** Displayed are the Beta coefficients from a linear model predicting behavioral compliance, which shows that those who report higher public pessimism (red) are more likely to comply. Private optimism (blue), however, is not associated with behavioral compliance. These associations are also portrayed in **(b & c)**. Here, the Y and X axis display residuals from the same linear model, which includes all demographic controls. Clouds represent confidence intervals. **(d)** Adding sense of agency (orange) to the model reveals that sense of agency is not related to behavioral compliance. Regressors are ordered from the strongest to the weakest. *$p< 0.05$, **$p<0.001$, ***$p<0.0001$, Error Bars SEM.

These results suggest that while relative private optimism was related positively to happiness and negatively to anxiety, surprisingly it was not associated with behavioral compliance. Public pessimism on the other hand, was associated with behavioral compliance. It seems that participants' strong view about COVID-19 being a danger to the human race provided the key reason to change behavior to protect the human population.

Results, Experiment 2
In Experiment 1 we found divergent effects of private optimism and public pessimism on happiness and behavioral compliance and converging effects on anxiety. To assess private optimism in Experiment 1 we asked participants about their risk of getting infected relative to others. To assess public pessimism, however, we asked about whether they believed the virus presented a danger to the health of the human population. It is possible that assessing perceptions of "infection risk" vs. "danger" was driving the results rather than assessing perception related to the self vs. the human population. We thus ran Experiment 2 (N=683) in which we assessed private optimism as before but to assess public pessimism we now asked "How likely do you think a person is to get COVID-19?" on a scale from 1 (extremely unlikely) to 5 (extremely likely)". This enabled us to assess both private and public optimism/pessimism in relation to getting infected. The subjects we tested in Experiment 2 were 683 of the same subjects we ran in Experiment 1, tested one month later. This further enables us to examine if any of our main variables of interest changed during the four weeks our participants spent under lockdown. As we report below we replicate the results of Experiment 1 in Experiment 2. Finally, we also assessed "absolute private optimism" by asking participants "How likely do you think you are to get COVID-19?" on a scale from 1 (extremely unlikely) to 5 (extremely likely)".

Results of Experiment 2 replicate Experiment 1
The findings of Experiment 2 replicated Experiment 1, suggesting that the results are not due to the exact phrasing of the questions and are robust over time. As in Experiment 1, we found clear indication of relative private optimism and public pessimism in our sample. Participants perceived their own likelihood of getting COVID-19 to be significantly lower than for others their age and gender ("relative private optimism": $M=2.80$, $SD=0.88$, $t(682)=6.12$, $p<0.001$). They also estimated their absolute risk of being infected as relatively low ("absolute private optimism": $M=2.85$, $SD=1.0$, and significantly lower than midscale: $t(682)=3.90$, $p<0.001$), while estimating the likelihood of "a person" to get COVID-19 as significantly higher than midscale ("public pessimism": $M=3.56$, $SD=1.02$, $t(682)=14.30$, $p<0.001$). Comparing the latter two revealed that participants rated the likelihood of themselves getting COVID-19 significantly lower than the likelihood of "a person" to get COVID-19 ($t(682)=18.38$, $p<0.001$). They also estimated the danger to the health of the human population as high ($M=70.96$, $SD=27.79$, $t(499)=18.91$, $p<0.001$).

The results of Experiment 2 show the same effects as in Experiment 1 of private optimism and public pessimism on happiness (private optimism: $\beta=0.09$, $p<0.029$, **Supplementary Figure 3a & b**; public pessimism: $\beta=-0.06$ $p<0.120$, **Supplementary Figure 3a & c**), anxiety (private optimism: $\beta=-0.13$, $p=0.001$, **Supplementary Figure 4a & b**; public pessimism: $\beta=0.14$, $p<0.001$, **Supplementary Figure 4a & c**) and behavioral compliance (private optimism: $\beta=0.01$, $p=0.832$, **Supplementary Figure 5a & b**; public pessimism: $\beta=0.15$, $p<0.001$, **Supplementary Figure 5a &**

c). Thus, once again we find that relative private optimism was related positively to happiness and negatively to anxiety, but surprisingly it was not significantly related to behavioral compliance. Once again, sense of agency was associated with private optimism (β=0.18, $p<0.001$, **Supplementary Figure 2a**) and mediated its effects on happiness (bootstrapped indirect effect is significant: β=0.08, $p=0.001$ [0.03, 0.12], **Supplementary Figure 3e**) and anxiety (bootstrapped indirect effect is significant: β=-0.09, $p<0.001$ [-0.14, -0.04], **Supplementary Figure 4e**). The only main divergence between Exp 1 and Exp 2 was that in Exp 2 sense of agency was related also to public pessimism (β=-0.11, $p=0.004$, **Supplementary Figure 2b**). This finding may be explained by the narrative adopted by governments encouraging their citizens to take precautions in order to protect others. People with a high sense of agency may thereby consider the risk to others as lower due to the protective measures they adopt.

Experiment 2 shows that relative private optimism and public pessimism are robust irrespective of the exact phrasing of questions and time periods. For full details and statistics of Experiment 2 see **Supplementary Material**.

Participants exhibit adaptation.
Examining subjects' responses at the beginning of lockdown and again a month into lockdown revealed a positive change in well-being. First, a month in, anxiety was lower than it was when states were just entering lockdown (Experiment 1: $M=46.67$, $SD=15.57$; Experiment 2: $M=44.4$, $SD=15.86$; $t(682)=5.31$, $p<0.001$, **Figure 6a**). This result aligns with past studies showing that humans adapt well to adversities and environmental change (Bonanno et al., 2002; Bonanno, Wortman, & Nesse, 2004; Brickman, Coates, & Janoff-Bulman, 1978; Dijkers, 1997; Frederick & Loewenstein, 1999). Participants experienced an increase in their sense of agency (Experiment 1: $M=24.32$, $SD=6.79$; Experiment 2: $M=24.90$, $SD=7.75$; $t(682)=1.92$, $p=0.055$, **Figure 6e**) and perceived the danger of COVID-19 to humanity as less than they did at the beginning of lockdown (Experiment 1: $M=75.54$, $SD=20.51$; Experiment 2: $M=70.96$, $SD=24.79$, $t(499)=5.21$, $p<0.001$, **Figure 6d**). They exhibited stable happiness (Experiment 1: $M=47.53$, $SD=24.86$; Experiment 2: $M=48.56$, $SD=24.46$ $t(682)=1.29$, $p=0.196$, **Figure 6b**) and private optimism (Experiment 1: $M=2.78$, $SD=0.88$; Experiment 2: $M=2.80$, $SD=0.88$; $t(682)=0.39$, $p=0.70$, **Figure 6c**).
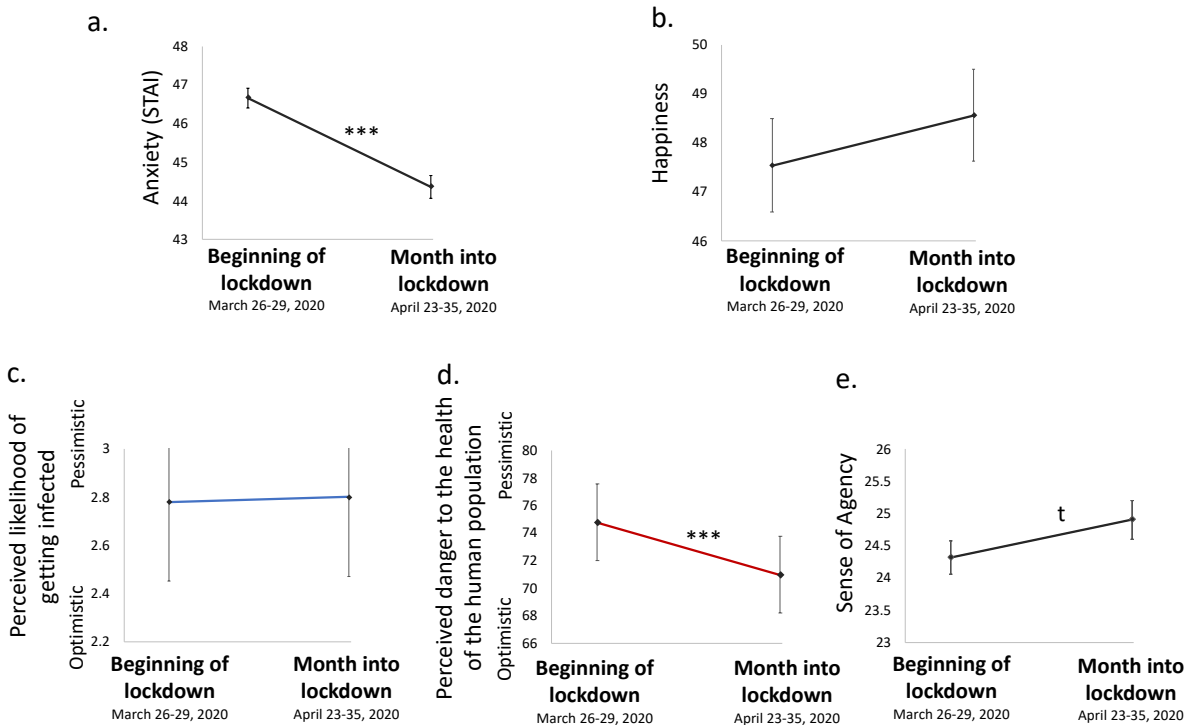
Figure 6. People adapt to lockdown. We tested participants at two timepoints; around the time lockdown was imposed (Experiment 1, March 26-29,2020) and one month into lockdown (April 23-25, 2020). We found that **(a)** anxiety was lower one month into lockdown relative to the beginning of lockdown. **(b)** Happiness and **(c)** private optimism remained stable. **(d)** Perceived danger of COVID-19 to humanity decreased and **(e)** individuals reported an increase in their sense of agency and. $^t p$=0.05, **p<0.001, ***p<0.0001, Error Bars SEM.

Discussion.

Perceptions of risk can drastically diverge when estimating risk to the self and to others. Here we show that both estimates matter for people's response, yet in different ways. Surveying a representative sample of Americans over two timepoints during the COVID-19 pandemic we found that people expressed private optimism along with public pessimism. People believed they were at significantly lower risk of getting infected than others their age and gender and that their risk of infection, in absolute terms, was somewhat low. At the same time, they believed the risk of infection to "a person" was somewhat high, and posed a significant danger to the health of the human race. We refer to the first finding as "private optimism" and the second as "public pessimism".

We reveal that private optimism and public pessimism have diverging associations with well-being and behavior. First, private optimism but not public pessimism was related to people's happiness. Individuals who believed they were less at risk than others were happier. However, believing humanity was facing great danger was unrelated to people's happiness. This suggest that expectations regarding one's own future are more important for people's positive affect than expectations regarding the future of humanity. At the same time, both were related to

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negative affect. This suggests that while perception of public risk relates mostly to negative affect, perception of private risk relates to both positive and negative affect.

The relationship between private risk perception and affect (both happiness and anxiety) was found to be mediated by people's sense of control. Consistent with the notion that a sense of agency drives optimism, individuals who believed they have control over their outcomes were more likely to believe they were at lower risk of being infected. People who believe they have the freedom to make their own fate by controlling their actions would likely believe they can make the right choices to reduce the likelihood of being infected. Those beliefs were strongly associated with people's happiness, in accordance with suggestions that a sense of control is related to well-being (Langer & Rodin, 1976). At the beginning of the crisis sense of agency was not related to public pessimism, which fit our assumption that even if people believe they can master their own destiny they are unlikely to believe they can control the fate of their species. Surprisingly, however, a month into the crisis an association between a person's sense of agency and public pessimism emerged. One possible interpretation of this result is related to the narrative adopted by governments encouraging their citizens to take precautions in order to protect others. We speculate that people with a high sense of agency may thereby consider the risk to others as lower due to the protective measures they adopt.

Intriguingly, the likelihood that individuals changed their behavior to mitigate risk was related to people's views regarding the danger the virus posed to people in general, but not significantly related to whether they believed they themselves were at high risk. That is, people who believed the virus posed a great danger to humanity reported putting greater effort in social distancing, hand washing and avoiding touching their faces. This effect remained even when controlling for anxiety and replicated across both time points. We thus speculate that the main motive for behavioral change was reducing the risk to the population as a whole, rather than the risk to the self. This finding, as well as all other main findings, replicate across our two experiments despite using slightly different phrases of key questions.

We tested the same participants across the two timepoints - at the beginning of the crisis when states were moving into lockdown (Experiment 1) and a month later when all states were under lockdown (Experiment 2). This enabled us to document changes across time. Consistent with the notion that humans adapt well to adversities and environmental change (Bonanno et al., 2002, 2004; Brickman et al., 1978; Dijkers, 1997; Frederick & Loewenstein, 1999) we observed a positive change in well-being. A month into lockdown anxiety was lower than it was when states were just entering lockdown. Moreover, participants experienced an increase in their sense of agency and perceived the danger to humanity as less than they did at the beginning of lockdown. Private optimism and happiness remained stable.

Here we examined people's perception of a specific threat – a global pandemic. There is reason to believe, however, that the paradoxical existence of private optimism and public pessimism will generalizes to other threats. For example, following the financial collapse of 2008 polls showed that people expressed pessimism about the financial future of their country while simultaneously expressing relative optimism about their own financial prospects (Ipsos MORI, 2008). With

regards to climate change, people express relative optimism about the likely effects of climate change in their own region, but pessimism with regards to the effects on their nation and the planet as a whole (Dunlap & Gallup, 1993). Future studies are needed, however, to examine whether the effects on well-being and behavior reported in this study generalize to other threats such as war, financial collapse and climate change. The results of such studies would be important for predicting the impact of such threats on people's well-being and for understanding when and why people are likely to change their behavior to mitigate risk. For example, similar to the findings reported here, it is possible that the likelihood that people make "green choices" is related to their belief that climate change poses a threat to humanity, regardless of whether they believe it poses a personal risk. Such knowledge can be useful for advocates and policy makers in framing information to encourage individuals to select actions that protect themselves and others from natural and man-made threats.

Declaration of Interests

The authors declare no competing interests.

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