

**Online Appendix for
“Disgust, Anxiety, and Political Learning in the Face of Threat”**

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Appendix A. Pilot Study Results

Sample and Design

The pilot study tested our hypotheses in randomized experiments across three subject populations: undergraduate students at a large state university ($N = 167$), non-student adults who worked on or around the university ($N = 83$), and Amazon Mechanical Turk (MTurk) workers ($N = 301$) for a total sample size of 551. The studies were administered over a three-month period in the Spring and Summer of 2015. The same questionnaire was administered across all subject populations, however, the student and adult subjects completed the study in a laboratory setting while MTurk respondents completed the study online at a time and place of their own choosing. The student lab study ran from April 8-10, 2015. The adult lab study was conducted on May 11-15, 2015. The MTurk data was collected on April 20, 2015 and June 17, 2015. The studies were approved by the Human Subjects Committee at <<REDACTED HS# xxxxxx.>>

Subjects began by answering background questions on their attitudes towards public health policy, and then read a brief description of a new public health issue. All participants were presented with two paragraphs of text describing the infectious disease, Chikungunya. We chose this particular disease because it has disturbing symptoms that can be portrayed as both frightening and disgusting. Chikungunya has spread widely in the Caribbean, but has only begun to appear in the United States, providing an opportunity to honestly portray the disease as a potential future health threat. The stimulus (approximately 175 words in length) described the symptoms (fever, rash, and excruciating joint pain), its spread throughout the Caribbean, and the method of transmission (mosquitoes).

Within the text we randomly varied two factors, independently manipulating the level of anxiety and the level of disgust elicited by the disease, making a 2×2 experimental design.

In the *Low Anxiety* conditions, subjects were informed that the disease spreads in tropical climates, making it unlikely to threaten the United States. The *High Anxiety* conditions instead highlighted the ease with which a mosquito can transmit the disease and the difficulty of containing mosquitoes. We expected that information about the level of threat posed by the disease would induce anxiety among our subjects and a separate pretest confirmed our expectations.

Following research on disgust (Clifford and Wendell 2016; Lee, Sohn, and Fowler 2013; Schnall et al. 2008), we manipulated this emotion using images. In the *High Disgust* conditions, three images were embedded in the text displaying symptoms of the disease (an inflamed eye and a rash) and a mosquito drawing blood from a person. All of the information that was conveyed by the images (e.g., symptoms, method of transmission) also was mentioned in the text, which increases our confidence that any effects of the images work through manipulated disgust rather than some other mechanism. A pretest (on a separate MTurk sample) confirmed that these images elicited disgust, but not anxiety. Subjects in the *Low Disgust* conditions did not receive any images (see Appendix B for the text of all stimuli).

Measures

Our outcome measures asked about knowledge of the disease and information search. We also measured subjects' emotional reactions to the disease as a manipulation check. There were four items designed to measure anxiety (afraid, frightened, anxious, worried) and four items measuring disgust (disgusted, grossed out, repulsed, sickened). Knowledge was measured with three factual questions about the disease. The answer to these items had been provided in the text that appeared in all conditions. The facts consisted of the location of the current outbreak (Caribbean), method of transmission (mosquitoes), and symptoms (joint pain, eye inflammation,

vomiting, and fever). Some of the questions involve disgust-eliciting information (e.g., eye inflammation), while others do not (e.g., fever), allowing us to examine whether disgust orients attention to particular facts.

Our last outcome pertained to information seeking. In the laboratory sample (students and staff only), we asked participants if they would like us to send them more information about the disease after the study and we requested their email address. This measure goes beyond standard self-reports because it requires respondents to share their email address with the expectation they will begin receiving email from the researchers. For the MTurk sample, subjects were asked how likely they were to look up more information about the disease. We used a slightly different question because MTurk subjects are incentivized to quickly complete each study, making it unlikely that they would request additional reading material.

Empirical Results

We begin by examining whether the manipulations induced disgust and anxiety. An exploratory factor analysis of the eight emotion items revealed two distinct factors (corresponding with anxiety and disgust). We analyze changes in the factor scores across experimental conditions to test the effectiveness of our treatments. As expected, the *High Disgust* generated significantly higher levels of disgust ($\Delta = 0.54$; $t(533) = 6.70$, $p < .0001$) and levels of anxiety were unaffected by the manipulation ($\Delta = 0.10$; $t(533) = 1.15$, $p = .25$). Unfortunately, the *High Anxiety* treatment did not significantly increase levels of anxiety ($\Delta = 0.07$; $t(533) = 0.81$, $p = .42$), but it also did not affect levels of disgust ($\Delta = -0.14$; $t(533) = -1.62$, $p = .11$). Although the disgust manipulation reliably induced the targeted emotion, the effect of the anxiety manipulation is more ambiguous. This may have occurred because several questions separated the treatment and the self-reported emotion items. As we report below, we replicate

several of the key findings from the literature with respect to anxiety, which suggests that the treatment was effective.

Knowledge. According to our first hypothesis, induced disgust should increase the retention of information related to the eliciting object. We tested this hypothesis by analyzing recall of the eye inflammation symptom, which was displayed visually in one of the disgust images. We collapse across *Low Anxiety* and *High Anxiety* conditions to analyze the main effect of the *Disgust* treatment. As expected, the *Disgust* treatment significantly increased recall of this fact from 59% to 86% ($\chi^2(1) = 50.26, p < .001$).

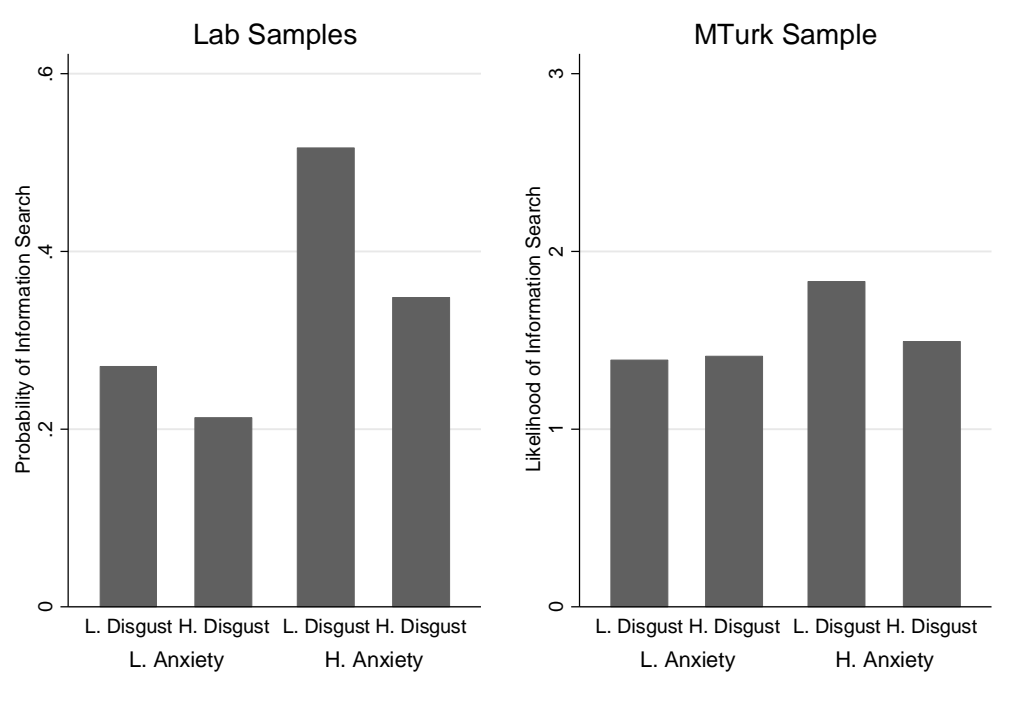
According to our second hypothesis, the *Disgust* treatment should reduce recall of facts that are not tied to the disgust elicitor. As a first test of this hypothesis, we examine two symptoms that were not disgusting. Support H2, the *Disgust* treatment significantly decreased recall of the fever symptom (75% vs. 64%; $\chi^2(1) = 7.38, p < .01$). The *Disgust* treatment also slightly decreased recall of the joint pain symptom, though this effect was not statistically significant (88% vs. 84%; $\chi^2(1) = 1.39, p = .24$). We measured recall of vomiting as a symptom, but here our expectations are less clear. The symptom is disgusting, but it was not tied to the disgust-eliciting images. As a result, the *Disgust* condition decreased recall of this symptom (66% vs. 51%; $\chi^2(1) = 12.19, p < .001$).

We also tested H2 with two more general questions about the method of transmission (mosquitoes) and location of the outbreak (Caribbean). There were high levels of knowledge for how Chikungunya is spread (98% answered the question correctly) and the location of the outbreak (87%), and thus no effects for either outcome ($ps > .87$). Manipulated anxiety did not significantly affect recall of any of the facts provided in the news story.

Information Search. To test our expectations regarding information search, students and staff were asked whether they would like us to email them more information about the disease. Respondents who asked for further information were then asked to select up to seven topics. MTurk subjects instead asked how likely they would be to look up more information.

Levels of information search are shown across experimental condition in Figure A1. Given the differences between the outcome measures, the results are presented separately for the lab and online samples. For lab participants (students and adults), we analyze the dichotomous outcome using chi-square tests. We analyze the amount of information requested (lab study) and the likelihood of looking up information (MTurk) using *t*-tests.

Figure A1. The Effects of Disgust and Anxiety on Information Search (Pilot Study)



Note: The left panel represents the probability of requesting information and the right panel represents the self-reported likelihood of looking up information.

As expected, lab respondents were substantially more likely to request information in the *High Anxiety* conditions (43%) than the *Low Anxiety* conditions (24%; $\chi^2(1) = 9.40, p < .01$), and they requested information on more topics ($t(233) = 2.72, p < .01$). The disgust manipulation had the opposite effect, reducing the probability of information search from 41% to 28% ($\chi^2(1) = 3.99, p < .05$) and decreasing the amount of requested information ($t(233) = 2.18, p < .05$). There also is evidence that the effects of disgust are strongest when anxiety or threat is high. In the *Low Anxiety* conditions, the *Disgust* treatment reduces information search by only 6 percentage points ($\chi^2(1) = 0.48, p = .48$). By contrast, in the *High Anxiety* condition, information search drops by 17 percentage points ($\chi^2(1) = 3.63, p = .06$). The difference between these two effects is not statistically significant ($p = .52$), but the pattern is consistent with the claim that disgust has the most potent effects on information search when threat is high. Additionally, anxiety has its largest effects when disgust is low. In the *Low Disgust* conditions, the anxiety manipulation increased information search by 25 percentage points ($\chi^2(1) = 6.68, p < .05$), but in the *High Disgust* conditions, *Anxiety* increased information search by only 14 percentage points ($\chi^2(1) = 2.86, p = .09$).

We conduct a similar analysis on the MTurk sample, using the self-reported likelihood of looking up information. Information seeking was low in this sample, with 51% of subjects saying they were “not too likely” or “not likely at all” to look up additional information about Chikungunya. The effects of the experimental conditions are similar to our lab samples, but weaker, perhaps due to the incentives of the MTurk platform. The *High Anxiety* condition again results in greater information search ($t(299) = 2.01, p < .05$) when collapsing across *Disgust* conditions (i.e., the main effect of *Anxiety*). This effect is particularly clear when we limit the analysis to the *Low Disgust* conditions ($t(146) = 2.35, p < .05$). The *High Disgust* manipulation

reduces information search, but this main effect is not statistically significant ($t(299) = 1.17, p = .24$). Once again, however, the effect of disgust is strongest when we focus on the *High Anxiety* conditions. Here, the percentage of respondents expressing any intention to look up information (i.e., the percentage falling in the top four categories of the five-point scale) drops from 92% to 76% ($t(132) = 1.71, p = .09$). The interaction between *High Anxiety* and *High Disgust* is not statistically significant ($p = .23$), but the pattern is consistent with our expectations. Overall, across the three samples anxiety increases information search, while disgust decreases the desire for new information.

Two issues emerged in the pilot study that we addressed in later studies. First, when it came to the knowledge analyses, disgusting information was recalled at a significantly higher rate when presented in images, rather than in the text alone (e.g., compare eye inflammation with vomiting). This difference in effects may have been driven by the visual presentation, rather than the emotional response, a confound we addressed in Study 1. Second, in the pilot study, anxiety was manipulated with text while disgust was manipulated with images. While we had a principled reason for making this design choice—i.e., it was difficult to find relevant images that reliably induced anxiety—we corrected this imbalance in Study 1 by manipulating both emotions with text. We also increased our sample sizes substantially, so that we could investigate the interaction between anxiety and disgust in the domain of information search.

Appendix B. Treatment Materials for Pilot Study

[Instructions: randomize between high and low anxiety text. Independently randomize presence of disgusting images.]

Low Anxiety Text

Now we'd like to ask you some questions about a new public health issue, but first we'd like to give you a little background

Health officials in the United States are preparing for the influx of the Chikungunya disease that has been rapidly spreading in the Caribbean, and has recently made its way to the U.S. Chikungunya is characterized by a fever, rash, and excruciating joint pain. In Haiti, it is known as the “breaking bone” disease, because victims feel as if their bones are breaking. These horrific symptoms typically last a week, but have been known to persist for years, sometimes even causing chronic arthritis. Chikungunya can also cause nausea and vomiting, and inflammation of the eyes. Currently, there is no vaccine or treatment for the disease.

< Disgust images >

The disease is contracted through mosquito bites, making it difficult to contain in tropical climates, but less of a threat in the United States. The virus is spread by mosquitoes that do not survive in colder climates. Thus the vast majority of instances of the disease in the U.S. are cases that were contracted abroad. Nevertheless, experts recommend taking standard precautions to avoid mosquito bites.

High Anxiety Text

Now we'd like to ask you some questions about a new public health issue, but first we'd like to give you a little background

Health officials in the United States are preparing for the influx of the Chikungunya disease that has been rapidly spreading in the Caribbean, and has recently made its way to the U.S. Chikungunya is characterized by a fever, rash, and excruciating joint pain. In Haiti, it is known as the “breaking bone” disease, because victims feel as if their bones are breaking. These horrific symptoms typically last a week, but have been known to persist for years, sometimes even causing chronic arthritis. Chikungunya can also cause nausea and vomiting, and inflammation of the eyes. Currently, there is no vaccine or treatment for the disease.

< Disgust images >

The disease can be contracted through a single mosquito bite, making it extremely difficult to contain. The virus is spread by day-biting mosquitoes which makes it difficult to use chemical control measures. Prior to 2014, Chikungunya was rare in the U.S. However, the Centers for Disease Control has confirmed 39 cases since June, including cases in Tennessee, Georgia, Florida, Rhode Island, and Minnesota.

Disgust Treatment Images:



Appendix C: Treatment Materials for Study 1

Low Disgust, Low Anxiety



Recently Discovered Infectious Disease May Reach the U.S.

Erin Mathews, REUTERS

LONDON – The World Health Organization (WHO) reported that at least three people from England contracted Tugela River Virus (TRV) after returning from a trip to Paris. TRV is a recently discovered infectious disease that attacks the body's immune system and spreads through interpersonal contact. Initial research suggests that TRV requires prolonged contact to contract the disease. As a precaution, government officials are trying to identify the passengers who were on the plane with the infected travelers, some of whom went on to take flights to other countries in Europe.

The story of Luke, one of the infected travelers, illustrates the dangerous course of TRV. Initially, Luke just felt under the weather, but he knew it was serious when the real symptoms began to set in. Following a period of general fatigue, TRV symptoms progress to severe headaches, followed by joint pain that leaves victims bed-ridden. Luke spent the first day of his illness confined to his bed, before going to the hospital. According to experts, most victims of TRV are able to make a full recovery. No cure currently exists, but doctors hope to develop a vaccine as quickly as possible.

High Disgust, Low Anxiety

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Low Disgust, High Anxiety



Recently Discovered Infectious Disease May Reach the U.S.

Erin Mathews, REUTERS

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High Disgust, High Anxiety



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Appendix D: Additional Models and Empirical Results for Study 1

Table A1, below, displays the results of an exploratory factor analysis of the self-reported emotion items in Study 1. The model was restricted to two factors to correspond with the two discrete emotions we sought to measure. Factor loadings greater than 0.4 are shown in bold. We find two clear factors that correspond with anxiety and disgust and little evidence of item cross-loading.

Table A1. Factor Analysis of Emotional Responses to TRV (Study 1)

	Factor 1	Factor 2
Disgusted	0.87	0.08
Grossed out	0.90	-0.01
Repulsed	0.82	0.12
Afraid	0.12	0.83
Anxious	0.05	0.82
Worried	0.02	0.88

Note: Columns display factor loadings submitted to promax rotation. Factor loadings >.4 are shown in bold.

Table A2, below, displays logit and ordered logit models predicting factual recall items from Study 1 while controlling for both the *High Anxiety* and the *High Disgust* conditions.

Table A2. Effects of Disgust and Anxiety on Knowledge of TRV (Study 1)

Outcome:	Treatment-Specific Symptoms	Fatigue	Cure	Spread
Model:	Ologit	Logit	Logit	Logit
<i>Experimental Conditions</i>				
High Disgust	0.41 ** (.13)	-0.46 ** (.15)	-0.13 (.30)	0.05 (.16)
High Anxiety	0.01 (.13)	-0.13 (.14)	0.34 (.30)	-0.09 (.16)
Intercept	-	1.34 *** (.14)	2.94 *** (.26)	1.36 *** (.14)
Observations	1000	1000	1000	1000

Note: Standard errors in parentheses. + $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$. Cutpoints for the ordered logit model are not shown here.

Table A3, below, displays logit and ordered logit models of information search from Study 1. Each model controls for both the *High Anxiety* and the *High Disgust* condition. Also included are models demonstrating the interactive effects of the treatment conditions on information search.

Table A3. Effects of Disgust and Anxiety on Information Search (Study 1)

Outcome:	<u>Behavioral Measures</u>				<u>Self-Report Measures</u>			
	Info Request	Info Request	Info Count	Info Count	Info Search	Info Search	Discussion	Discussion
Sample:	Full	Full	Full	Full	Full	Full	Full	Full
Model:	Logit	Logit	Ologit	Ologit	Ologit	Ologit	Ologit	Ologit
<i>Experimental Condition</i>								
High Disgust	-0.13 (.14)	0.28 (.21)	-0.08 (.14)	0.26 (.21)	-0.11 (.11)	0.21 (.16)	-0.20 + (.11)	0.09 (.17)
High Anxiety	0.24 + (.14)	0.62 ** (.21)	0.21 (.14)	0.53 ** (.20)	0.04 (.11)	0.36 * (.16)	0.04 (.11)	0.33 * (.17)
Disgust x Anxiety	-	-0.76 ** (.29)	-	-0.64 * (.29)	-	-0.63 ** (.23)	-	-0.56 * (.23)
Intercept	-1.04 *** (.13)	-1.26 *** (.16)	-	-	-	-	-	-
Observations	991	991	991	991	993	993	986	986

Note: Standard errors in parentheses. + $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$. Cutpoints for ordered logit models are not shown here.

Appendix E: Treatment Materials for Study 2

[Instructions: randomize presence of *Disgust* images and *Map* image independently. Randomize placement of images within each condition.]

Houston is a hotspot for the outbreak of infectious diseases in the U.S. The hot and humid climate and the large number of international travelers make it easy for new diseases to spread. Recently, experts have become concerned about the spread of Dengue Fever, a mosquito-borne disease that has shown up in Houston in the last few years. Dengue is common in many parts of the world, including Mexico, South America, and Africa. Experts are worried that travelers may bring the disease to the U.S. and infect local mosquito populations with the disease, which will then spread to humans. The disease can often spread undetected because about 20 percent of those who contract the disease never experience symptoms.

< Image placement 1 >

Dengue Fever is characterized by a sudden high fever, severe headaches, and joint and muscle pain. The illness can also cause a skin rash [*shown to the right*]. Symptoms usually last about a week after infection. Once you have contracted Dengue Fever, you become more susceptible to a more severe variant of the disease. This version of the illness can cause capillaries to leak, causing bleeding in the eyes, nose, and gums [*shown right*]. In the worst case, it can progress to massive bleeding and death.

< Image placement 2 >

There is currently no vaccine for Dengue, so experts recommend taking precautions to avoid mosquito bites by covering up, using mosquito repellent, and staying indoors when possible.

Disgusting Images:



Map Image:



Appendix F: Additional Models and Empirical Results for Study 2

Table A4, below, displays the results of an exploratory factor analysis of the self-reported emotion items in Study 2. The model was restricted to three factors to correspond with the three discrete emotions we sought to measure. Factor loadings greater than 0.4 are shown in bold. We find three clear factors that correspond with anxiety, anger, and disgust. However, we do find some unexpected cross-loading on the “revulsion” and “anxiety” items.

Table A4. Factor Analysis of Emotional Responses to Dengue (Study 2)

	Factor 1	Factor 2	Factor 3
Disgusted	-0.01	0.01	0.92
Grossed out	-0.05	0.02	0.88
Revulsion	0.77	0.01	0.03
Anxiety	0.40	0.05	0.41
Nervous	0.91	-0.06	-0.04
Worry	0.67	0.13	-0.06
Angry	0.07	0.74	0.05
Hateful	-0.03	0.86	0.04
Resentful	-0.03	0.87	-0.03

Note: Columns display factor loadings submitted to promax rotation. Factor loadings >.4 are shown in bold.