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Maik Kecinski

Deborah Kerley Keisner

Kent Messer

William D. Schulze

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Stigma Mitigation and the Importance of Redundant Treatments

Maik Kecinski[a], Deborah Kerley Keisner[b], Kent D. Messer[a,*], William D. Schulze[b]

[a] Department of Applied Economics and Statistics, University of Delaware, Newark, DE 19716.
[b] Dyson School for Applied Economics and Management, Cornell University, Ithaca, NY 14850.
* Corresponding Author. Tel.: +1 (302) 831-1316
E-mail addresses: Kecinski@udel.edu (M. Kecinski), dkerley@gmail.com (D. Kerley Keisner), messer@udel.edu (K. Messer), wds3@cornell.edu (W. Schulze)

Disgust can evoke strong behavioral responses. Sometimes these extreme visceral responses can lead to stigmatization—an overreaction to a risk. In fact, disgust may be so inhibiting that it leads people to refuse to consume completely safe items such as treated drinking water, leading to important economic and policy implications. Using economic experiments, we provide a measure of the behavioral response to disgust. Our findings suggest that when monetary incentives are provided, the behavioral response may have been exaggerated by previous studies that have relied on survey methods. Furthermore, mitigation steps successfully reduce the stigma behavior. In fact, the results suggest that stigma is primarily reduced not by a specific mitigation step taken but by how many steps are taken consecutively. These results have important implications for policies addressing issues such as the global shortage of drinking water. Some efforts to resolve the shortage have involved recycled water that is completely safe to drink but is often rejected because of reactions of disgust.

Disgust | Stigma Mitigation | Risk | Experimental Economics
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Stigma Mitigation and the Importance of Redundant Treatments

Introduction

In economics, an increase in risk associated with a task or lottery typically requires an increase in expected payoff if the participant is to remain indifferent between choices (von Neumann and Morgenstern 1947, Savage 1951, Friedman and Savage 1952, Fama and Macbeth 1973, Sharpe 1964). How large the increase in expected payoff must be depends on the individuals' risk preferences and the magnitude of the risk (Tversky and Wakker 1995, Holt and Laury 2002, Harrison et al. 2007). For example, if individuals in an experiment are asked to indicate their willingness to pay (WTP) to avoid drinking a glass of spring water versus a glass of river water, one expects the WTP for river water to be higher because of potential health risks from contaminants in the river. How much more an individual would pay should depend on the risk attitude of the individual and the probability of that person falling ill or even dying. Normative economics suggests that individuals have proportionate responses to increases in participatory risk. But what if drinking the river water does not increase the participatory risk? Say it is treated and as clean as the spring water. In that case, its consumption should not increase the individual's WTP relative to spring water. But that may not be the case. Research of psychological stigma has found that individuals can stigmatize river water simply because it used to be contaminated: once in contact, always in contact (the first law of sympathetic magic[1]). This can occur even if the original contagion does not increase the participatory risk. Moreover, individuals understand that the water is clean from an objective scientific perspective and may not be fearful of effects of the water but still do not want to consume it. Their subjective reasoning and the visceral reaction it generates can be explained by disgust (Fallon et al. 1984,

[1] There are two laws of sympathetic magic (see Frazer 1959 and Mauss 1972). *The law of contagion*: Once

Rozin et al. 1985, Rozin et al. 1986, Nemeroff and Rozin 1994, Flynn et al. 2001, Goffman1963, Rozin 2001, Rozin et al. 1995, Hejmadi et al. 2004, Haidt et al. 1994, Rozin et al. 2000). Disgust shares fundamental characteristics with the laws of sympathetic magic and is relatively easy and safe to produce in laboratory settings.

An interesting example is drinking water contaminated by a cockroach. In a study in which dead sterilized cockroaches were dipped into glasses of spring water, Rozin et al. (1986) showed principal refusal of participants to drink the water even though there was no increased risk associated with it. These results are important because of their implications for policy and their potentially large monetary effects. For example, shortages of drinking water in many regions around the world are a major and growing problem affecting ecosystems, agriculture, industries, and human health and raise the risk of conflict in those regions (Postel et al. 1996). Though water is a renewable resource, water sources may not be able to recharge when demand is high, causing regional disparities between supply and demand. One potential way to counter this problem is to move water from places that have large supplies to areas in need. But moving water over large distances is expensive. Gleick and Palaniappan (2010) compared the value of a supertanker filled with oil, which would carry a market value of $250 million at a barrel price of $70 per barrel, to one filled with high-quality drinking water, which had a market value of only $500,000, making it extremely expensive to dedicate such tankers to water. Many regions are facing a condition known as peak water: half of the existing water stock has been depleted and water production is declining. One frequently proposed and subsequently rejected idea for ensuring safe drinking water is recycled water generated by treating wastewater and sending it back to households for consumption. Although such water is completely safe, a study by Doria (2010) found that most projects failed because of public perceptions. Individuals appeared to perceive the water as contaminated, that it still carried the properties of the contaminants present before it was treated, and thus was stigmatized because of those contaminants. In such cases, individuals would refuse to consume the recycled water at any price. These conclusions relied on stated preference surveys and, given the hypothetical nature of that research, may not reveal true preferences regarding disgust and the cost to overcome it. Rozin et al. (1986) first showed that disgust could be created in the lab by dipping a dead sterilized cockroach into drinking water and recording participants' reactions to the water, offering a unique way to study stigmatization in a risk-free setting. In the same study, the authors showed that experiment participants strongly preferred not to eat pieces of fudge shaped like dog feces or vomit. These experiments were creative and the results interesting; however, given the hypothetical nature of the choices made in the experiments, the results may not be representative of situations in which individuals make incentive-compatible choices—choices in which they receive payment and must actually perform the task.

Rozin et al.'s (1986) findings deserve further exploration. Participants in the experiments may have perceived consumption of cockroach-contaminated water or oddly shaped pieces of fudge as a moral violation, leaving them psychologically offended or disgusted. It is important, then, to keep in mind that social and cultural norms strongly influence such reactions (Gerard and Rabbie 1961, Goffman 1963, Kahan 1998, Meigs 1978). In western societies, feces, most body parts and secretions, and insects (especially in North American cultures) are generally considered as disgusting (Rozin et al. 1985). Moreover, Despite social adjustments that can negate or mitigate a stigma, some stigmas can persist and be difficult to remove despite concerted effort, a phenomenon known as *once in contact, always in contact* (Hejmadi et al. 2004, Hoffmann et al. 2014). For example, experiments have shown that orange juice that had been in contact with a dead sterilized cockroach and then frozen for a year still resulted in participants completely rejecting consumption of the juice (Rozin 2001). Messer et al. (2006), in economic research involving communities that neighbor large superfund clean-ups, found that responses to mitigation of a stigma may be time-sensitive. When contamination was not removed relatively soon after it occurred, the value of homes surrounding the sites declined even after the point where no human health risks from the contamination remained.

Motivated by these policy situations, we conducted experiments with 94 participants in which drinking water was "contaminated" by contact with a dead, sterilized cockroach as in previous studies designed to invoke a stigma response in participants (Rozin 2001, Schulze and Wansink 2012, Kerley Keisner et al. 2013). The experiments (1) provide an adequate measure of disgust relating to water contamination without increasing the risk associated with drinking the modified water; (2) explore approaches for reducing disgust and, if successful, measure the extent of this reduction; and (3) provide a scale ranking the successful mitigation approaches by the degree of measured mitigation.

Experimental Design

We collected data on participants' willingness to accept (WTA) payment to drink various types of water. Specifically, participants were asked to submit an offer that represented "the lowest amount of compensation they would be willing to accept" to drink each water. We used the Becker-DeGroot-Marschak (BDM) mechanism's (Becker et al. 1964) preference-revealing properties to elicit incentive-compatible WTA data, thus quantifying individual participants' values for each type of water. These experiment were IRB-approved and all subjects submitted signed consents before participating. Each participant was paid $10 as compensation for their time in addition to the amount they earned in the experiment.

The experiment consisted of four sessions involving two treatments with 24 participants per session. The first step involved providing instructions (see Appendix A); all were given adequate time to thoroughly review the instructions and then were encouraged to ask questions in case anything about the experiment remained unclear.

In the second step, participants completed a practice session to further acquaint them with the experimental procedure before completing actual experiments. During the practice session, participants had an opportunity to drink as much spring water as they desired at no charge to ensure that they were not thirsty during the second part of the experiment.

Finally, participants completed the high-incentive part of the experiment in which they submitted WTA values for a series of samples of water. After they made their offers for each sample, the experimenter drew a random number and compared the participant offers to that number. When an offer was less than or equal to the randomly drawn number, the participant received payment equal to the randomly drawn number and performed the task (drank the water sample). When the offer was greater than the randomly drawn number, the participant received no payment and did not perform the task.

The BDM mechanism has been widely used to elicit WTP and WTA and been shown to produce demand-revealing, incentive-compatible results (Boyce et al. 1992, Irwin et al. 1998, Messer et al. 2010). Assuming that participants want to maximize expected utility (*EU*), they will choose value for *B* that will maximize the following objective function:

(1) $$\max_B EU = \int_0^B p(R)U(Y^0 + E + V - R)dR + \int_B^E p(R)U(Y^0 + E)dR$$

where V represents the true value of the task to the individual, $p(R)$ is the probability that the price (R) is randomly selected, Y^0 is the initial income, and $U(Y)$ is a function of income and the value of avoiding the task. Maximizing expected utility results in the following first partial derivative:

(2) $$\frac{\partial EU}{\partial B} = p(B)[U(Y^0 + E + V - B) - U(Y^0 + E)] = 0$$

The first-order condition equals zero and maximizes the objective function when the bid (B) equals the true value (V) of avoiding the task, suggesting that it is optimal for participants to bid their true values (Irwin et al. 1998).

In our experiments, participants could offer any amount between $0.00 and $30.00 to drink three ounces of the sample of water. An offer of $0 guaranteed payment of at least $0 and meant that the participant would definitely drink three ounces of the water. An offer of $30 ensured that the participant would not have to drink the water but also meant that no payment would be received. It follows, then, that the highest value participants could offer and still indicate some willingness to drink the water was $29.99.

In the practice session, all participants were trained in using the BDM mechanism to ensure a thorough understanding of the mechanism and the computer software used to submit offers. During this training, participants were asked to submit an offer representing the least compensation they would accept and still be in favor of a program involving a personal loss of $2, $5, or $8. Thus, participants were asked to indicate the minimum payment they were willing to accept, in order to lose a certain amount of money.

After completing the training session, participants moved on to the experiment. They were asked to make offers on seventeen types of water[2] subject to two treatments, [T1] and [T2] as indicated:

(1) spring water (SW) [T1, T2],

(2) cockroach water (CW) [T1, T2],

(3) boiled (B) cockroach water [T1, T2],

(4) filtered (F) cockroach water [T1, T2],

(5) diluted (D) cockroach water [T1, T2],

(6) tested (T) cockroach water [T1, T2],

(7) boiled, filtered (BF) cockroach water [T1],

(8) filtered, tested (FT) cockroach water [T1]

(9) boiled, diluted (BD) cockroach water [T1],

(10) boiled, tested (BT) cockroach water [T2],

(11) filtered, diluted (FD) cockroach water [T2],

(12) diluted, tested (DT) cockroach water [T2],

(13) filtered, diluted, and tested (FDT) cockroach water [T1],

(14) boiled, filtered, and tested (BFT) cockroach water [T1],

(15) boiled, filtered, and diluted (BFD) cockroach water [T2],

(16) boiled, diluted, and tested (BDT) cockroach water [T2],

(17) boiled, filtered, diluted, and tested (BFDT) cockroach water [T1, T2].

Each of the 96 participants was assigned to one of the four experiment sessions of 24 participants. In each session, the participants made offers on twelve of the seventeen types of

[2] See Appendix B for more details on the types of water.

water—all submitted offers on types 1 through 6 and on 17; T1 participants made offers on types 7 through 9, 13, and 14; and T2 participants made offers on types 10 through 12, 15, and 16. The participants were randomly assigned to individual computers equipped with privacy shields and Microsoft Excel with Visual Basic to collect their decisions.

Results and Discussion

A summary of average WTAs and a comparison of WTAs for the different types of water via paired and unpaired *T*-tests are presented in table 1. We find that participants require $0.38 on average to drink a three-ounce cup of spring water. Most participants (89%), however, required no compensation to drink spring water. The average WTA for spring water that had been in contact with the cockroach was much higher, $3.70, but interestingly, the majority of participants (68%) still required no compensation to drink it. This result indicates that cockroach-contaminated water does evoke stigma for some people, as indicated by the overreaction to participatory risk associated with the significant increase in average WTA. But when the decision involves actual monetary gain, as it does in our experiment, the stigma response may not be as extreme as indicated in studies of stated preferences. Still, some participants viewed the cockroach-contaminated water as stigmatized and signaled their refusal to drink it by offering $30 even though there was no additional risk. The difference in the mean WTA between spring water and cockroach water is significant at the 1% level. Furthermore, we find significant differences at the 1% level for spring water versus all of the single mitigation treatments of cockroach-contaminated water (boiling, filtering, diluting, and testing). However, when we compare contaminated water after a single mitigation treatment to untreated contaminated water, we find significant differences at the 5% and 1% levels. Thus, a single mitigation step may alleviate some but not all of the consumers' concerns about the contamination.

An interesting observation comes from graphical representation of the data in the form of the supply curves presented in Figure 1. Effective mitigation may depend not on completion of a single specific type of mitigation measure but instead on completion of multiple mitigation measures. The supply curves depict the percent of participants who would accept each type of water as a function of price (dollar offer). In every case, as the amount paid increases, a greater proportion of the participants is willing to drink the water. For three and four mitigation steps, the supply curves run close together and intertwine, suggesting redundancy associated with adding a fourth mitigation step. Overall, the supply curves highlight another important point—contrary to results from stated-preference experiments suggesting that contaminated water is completely refused, we find, with respect to consumption of cockroach water, that there is a price at which the stigma can be overcome.

To generate WTA estimates and account for truncation at \$0 and \$30, we used a two-limit random-effect Tobit regression model. Each participant submitted twelve offers (one for each type of water presented). However, when considering both treatments, there were seventeen offers. The dependent variable was the value (*V*) representing each participant's offer. Dummy variables were introduced to indicate the specific type of water while spring water (*S*) was omitted. The model can be summarized by a mathematical formulation for person *i*:

$$V_{ij} = \alpha + \beta_1 * C_{ij} + \beta_2 * B_{ij} + \beta_3 * F_{ij} + \beta_4 * D_{ij} + \beta_5 * T_{ij} + \beta_6 * BF_{ij} + \beta_7 * FT_{ij} + \ldots + \beta_{17} * BFDT_{ij} + \mu_i + \varepsilon_i$$

where $\mu_i \sim N(0, \sigma_\mu^2)$ and $\varepsilon_{ij} \sim N(0, \sigma^2)$.

Table 2 shows the results of this model. On average, participants required an extra \$17.50 to drink untreated cockroach-contaminated water relative to spring water, representing a significant difference at the 1% level. Furthermore, the analysis shows that participants, on average, also required a significantly greater payment to drink contaminated water that had undergone one mitigation step relative to spring water.

Although larger payments were required for cockroach-contaminated water that had undergone two mitigation steps (with the exception of DF), overall some significance is lost; the increase in payment required for FT and DT water was significant only at the 10% level and was not significant at any level for DF water. In the case of three mitigation measures, participants required significantly more money (relative to spring water) only for BDT. After four mitigation measures, participants did not require significantly greater payment to drink the treated water compared to spring water. These results supported our observation from the supply curves that stigma is reduced not by one particular type of treatment of contamination but by a more comprehensive, multi-treatment approach.

We used a Wald test to determine whether the regression coefficients for each number of mitigation steps are jointly equal to zero. Based on the Wald test, we cannot reject the null hypothesis that the coefficients in each mitigation-step group are equal to zero. Therefore, inclusion of each individual mitigation step may not improve the overall fit of the model. The associated *p*-values are 0.31 for one mitigation step, 0.59 for two mitigation steps, and 0.85 for three mitigation steps. While the Wald test confirms our previous conjecture in that there are no significant differences between the coefficients for the three groups, it does not provide information about any redundancy of mitigation steps.

To identify the most effective combinations of steps, we added one more regression (see table 3). In this model, we introduced dummy variables to indicate the number of mitigation steps rather than water type. Once again, spring water was omitted. The two-limit random-effect Tobit model for person i can be summarized as

$$V_{ij} = \alpha + \beta_1 * 1mitigate_{ij} + \beta_2 * 2mitigate_{ij} + \beta_3 * 3mitigate_{ij} + \beta_4 * 4mitigate_{ij} + \mu_i + \varepsilon_i$$

where $\mu_i \sim N(0, \sigma_\mu^2)$ and $\varepsilon_{ij} \sim N(0, \sigma^2)$.

This regression shows that nearly all of the coefficients are positive and significant at the 1% level (the exception is four mitigation steps with a coefficient that is significant at the 5% level), indicating that participants required significantly greater compensation to be willing to drink the contaminated water and treated waters relative to spring water. To determine whether the regression coefficients are jointly equal to zero and thus do not add significant explanatory power to the overall model, we ran another Wald test. This time, we can reject the null hypothesis for two of the three joint effects, indicating that the coefficients for one and two mitigation steps are not simultaneously equal to zero ($\alpha = 0.009$) and, therefore, significantly improve the fit of the model. The same holds true for two and three mitigation steps ($\alpha = 0.006$), thus, including both explanatory variables improves the fit of the model. The Wald test for three and four mitigation steps, on the other hand, is not significant ($\alpha = 0.728$) so there is no further significant improvement achieved by including four water treatments.

This result further bolsters our finding that successful treatment of cockroach-contaminated water depends on the number of mitigation steps applied rather than on the specific mitigation measure used—two treatments are better than one and three are better than two, but a fourth treatment provides no significant improvement. This also is shown by the rightward-shifting supply curves in Figure 1, which start with cockroach water on the far left and move ever closer to spring water on the far right with the curves for three and four mitigation steps intertwined.

The results of these experiments make three important contributions in addressing our research objectives: First, they provide an adequate measure of disgust associated with water contamination without increasing the risk to participants from drinking the modified water. We developed a measure of disgust in a laboratory setting by eliciting participants' WTA drinking cockroach-contaminated water. Most participants reacted rationally to this risk-free choice by offering a zero bid. Some participants attached stigma to the cockroach water and refused to drink it. On average, we did not find a complete refusal to drink contaminated water; instead, we measured how much compensation was required for participants to drink water that might be deemed disgusting.

These results hold important policy implications as they pertain to recycled water, a possible solution to satisfy demand for drinking water in the future. One of the United Nations' (2010) millennium development goals is the human right to water and sanitation, that all citizens worldwide should have sufficient water (50 to 100 liters per day) that is safe, affordable (costs less than 3% of their annual income), and accessible (supplied within 30 minutes or 1,000 meters of their homes). Simultaneous population growth and global warming pose a considerable threat to the availability and provision of such water (Immerzeel et al. 2010, Vörösmarty et al. 2000).

Second, they explore possibilities that may reduce disgust and, if found, to measure the reduction. Our results suggest that treating water with simple mitigation measures can reduce the disgust experienced by consumers. And up to a point, combining multiple steps is even more effective. Significant reductions in average WTA are achieved by these mitigation measures, indicating that recycled water projects may be accepted and successful if relatively simple, inexpensive mitigations such as extra filters and boiling the water are added.

Our third objective was to rank successful mitigation approaches by the degree of stigma mitigation measured. Our results show that combining several simple mitigation measures may adequately reduce individual perceptions of disgust associated with once-contaminated water. Although single mitigation steps significantly reduce WTA, it may not matter which single step is performed. A more comprehensive approach of combining three or four measures proved to be the most effective in reducing disgust. With three measures being just affective as four measures, making the additional fourth measure redundant. These result further supports the notion that simple, inexpensive mitigation measures can be effective in diminishing the stigma associated with objectively safe but subjectively disgusting recycled water.

Conclusion

We provide a monetary measurement of disgust using participants' willingness to accept monetary compensation to consume various types of treated and untreated contaminated water, allowing us to put a price on stigma associated with disgust. We show that the stigma can be successfully mitigated by four water treatments (filtering, boiling, diluting, and testing), reducing participants' overreaction to the risk of consuming the water. All of the mitigations tested significantly decrease the compensation required and thus the degree of disgust associated with the water. Finally, we ranked the successful mitigation approaches. Interestingly, although each mitigation measure individually significantly reduced WTA, none was significantly more successful than another. We did, however, find significant differences for combinations of mitigation measures. Two-step approaches were more successful than one-step approaches, and three- and four-step approaches were more successful than two-step approaches. Adding a fourth step did not induce a significant reduction over three steps. These results clearly demonstrate the range in which mitigation is most effective and the importance of redundant treatments.

Our study of contaminated water samples allowed us to study disgust and shares fundamental properties with studies of stigma related to fear of increased risk associated with a task, item, or technology. Additionally, the concept of disgust offers experimenters a way to research responses safely, avoiding ethical dilemmas related to settings and tasks that can induce fear and subject participants to adverse health effects.

Our results are relevant to a wide variety of stigma related issues, such as recycled wastewater as a solution to impending global shortages of drinking water. Recycled wastewater proposals have been intensely debated and mostly opposed. In the 1990s, for example, San Diego's plan to use recycled water for drinking was abandoned because of negative perceptions of such water after the city had already invested in large sunk costs (Ross et al. 2014). Similar public opposition to recycled water projects was reported in Australia (Ross et al. 2014, Uhlmann and Head 2011, Po et al. 2003). Two things directly link our findings to recycled drinking water. First, even though public perceptions have been overwhelmingly negative because of reactions of disgust to wastewater (once in contact, always in contact), once decisions involve monetary incentives, as in our revealed-preference experiment, public overreaction is not necessarily as harsh as suggested by research involving hypothetical choices. Second, even for people who experience high levels of disgust related to recycled wastewater, simple mitigation measures can successfully mitigate the stigma associated with the water, resulting in wider acceptance as indicated by the lower WTA compensation for such water.

We note that extrapolation of these results beyond water contamination may be difficult since individual stigmas present unique levels of disgust and sometimes of danger that depend on social and cultural norms and the amount of risk involved. Therefore, we encourage further studies to shed additional light on the complex phenomenon of stigma. In addition, some stigmas may be difficult or even impossible to study experimentally, largely because of ethical boundaries related to studying risk in an environment, such as the experimental economics laboratory, that traditionally does not permit deception. For this reason, situations that provoke disgust rather than being actually dangerous are ideal for studying stigma and its mitigation.

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