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Talk is cheap, but useful: Strategic signalling in NGO-led interventions

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1 Introduction

Non-governmental organizations (NGOs) are frequently found to be more effective than governments in delivering development interventions, particularly in rural or underserved contexts. A growing literature has sought to unpack this "NGO effect," identifying factors such as lower transaction costs, stronger community ties, and reputational capital that enable NGOs to implement programs more successfully than state actors (Usmani et al., 2022, Vivalt, 2020). Yet these same features—especially NGOs' ability to choose where to work and their reliance on visible community engagement—may also create incentives for communities to strategically shape how they are perceived (Brass, 2012, Dipendra, 2019). In contexts where NGO involvement is seen as desirable and conditional, individuals may tailor their responses to interventions in ways that signal need or enthusiasm, regardless of their true beliefs or behaviors. Understanding how the identity of an intervention's implementer influences belief formation, stated support, and willingness to act is therefore essential for interpreting outcomes and targeting resources effectively.

This paper examines whether individuals in Ghanaian villages respond differently to identical water quality information depending on which organization is presented as having implemented the water sampling and testing process—either a government agency or a local NGO. In both treatment arms, the laboratory analysis was conducted by the same independent research institution, and test results were disseminated by enumerators affiliated with a university-led research team. The only randomized variation is the salience of the implementer: participants were told that water samples were collected either by a government agency, the Ghana Environmental Protection Agency (EPA), or by a local environmental NGO, the Center for Social Impact Studies (CeSIS).

To interpret this variation, it is useful to distinguish between three types of agents involved in delivering and evaluating an information intervention: the sender (who conveys the message), the experimenter (who conducts the survey), and the implementer (who is credited with executing the intervention). Existing work has documented that identity dimensions—such as race, gender, ethnicity, perceived expertise, or prestige—associated with these agents can meaningfully shape participant beliefs and behaviors (Alsan and Eichmeyer, 2024, Banerjee et al., 2020, Alatas et al., 2024). Yet most studies do not experimentally isolate these roles, making it difficult to identify whether observed responses are driven by the messenger, the survey team, or the organization behind the intervention.

This study addresses this limitation through a randomized controlled trial conducted in 30 mining-affected communities in Ghana. In partnership with Ghana's EPA and CeSIS, I collected borehole water samples from each study village, which were tested by Ghana Water Research Institute for heavy metals, physiochemical indicators, and E. coli contamination. I constructed a chemical pollution index following World Water Quality Alliance guidelines, and used raw E. coli counts to capture bacterial contamination. Participants first provided incentivized guesses about pollution levels in their own and a neighboring village, then received information about the neighboring village's test results. The key experimental variation was in implementer salience: participants were randomly told that the samples in the neighboring community had been collected either by the EPA or by CeSIS, with the sender and testing institution held constant. This design allows me to estimate how implementer identity affects three core outcomes: belief updating, non-costly expressions of support (such as posterior perceptions of implementer trustworthiness and accuracy), and costly support (such as willingness to participate in future NGO-led programs or to donate to the NGO).

A simple framework motivates the study. If NGOs are perceived as more selective and desirable partners than governments, and if community engagement affects the likelihood of future NGO action, then individuals may have incentives to strategically maintain narratives of high need when interacting with NGOs. In particular, participants may discount "good news" (i.e., test results indicating lower-than-expected pollution) when delivered by an NGO, while simultaneously expressing high trust and favorable views toward the NGO. These responses may reflect strategic signaling rather than Bayesian updating. Importantly, such signaling need not be costly: individuals may express favorable attitudes toward the NGO without actually changing their behavior or willingness to volunteer in future programs.

Three main findings emerge. First, participants who received information from the NGO group updated their beliefs less in response to "good news" about chemical pollution levels, particularly among those who had initially overestimated contamination. Second, these participants expressed significantly more favorable views of the NGO's competence, trustworthiness, and role in future testing—despite not updating their beliefs. Third, these expressive attitudes were not matched by increased willingness to donate to the NGO or volunteer in costly future NGO-led programs. These patterns suggest a divergence between stated support and behavior that may reflect strategic signaling in settings where NGO involvement is seen as conditional.

2 Relevant Literature

This paper contributes to three strands of literature. The first examines how the identity of actors involved in delivering and evaluating an intervention shapes recipients' beliefs and behaviors. The second considers how individuals may strategically tailor their responses to interventions, including through experimenter or implementer demand effects. The third more broadly evaluates whether NGOs are systematically more effective than governments or other actors in delivering public services, and investigates the mechanisms behind these differences.

In the context of randomized evaluations, it is useful to distinguish between three related but conceptually distinct roles: the experimenter, the implementer, and the sender. The experimenter typically refers to the team administering the study and collecting outcome data. The implementer is the organization responsible for delivering the intervention. In information-focused interventions, a third role—the sender—refers to the individual or entity delivering the informational content. These roles may overlap in practice but in this study, I focus on manipulating the salience of the implementer: participants were told that the samples for water quality testing were collected by either government or NGO workers. The survey enumerator, who served as both the experimenter and the sender of information, was consistently framed as part of an independent university-affiliated research group across both treatment arms.

A growing literature shows that the identity of these three types of agents can significantly influence how individuals process information and respond to interventions. Much of this literature focuses on information campaigns, where the sender's identity is manipulated across dimensions such as race or ethnicity (Alsan and Eichmeyer, 2024, D'Acunto et al., 2022), gender, expertise or professional status [Korlyakova, 2021], and celebrity or prestige (Alatas et al., 2024, Banerjee et al., 2020). These studies find that individuals are more likely to trust and act on information when it comes from socially proximate or high-status messengers. For example, Alsan and Eichmeyer [2024] show that racial concordance between senders and recipients increases trust in health messages and uptake of vaccines. Banerjee et al. [2020] and Alatas et al. [2024] demonstrate that individuals are more likely to follow public health guidance when it is delivered by celebrities rather than government officials—and that responsiveness declines when celebrity messengers are explicitly associated with the government. These findings suggest that low trust in government actors can attenuate belief updating and behavior change, even when the information content is identical.

Other studies vary the identity of the implementer—the organization responsible for delivering a program or service. For example, Fischer et al. [2019] compare the effectiveness of NGO-affiliated versus for-profit distributors in selling health products, finding that NGO implementers are more successful at selling relatively unknown items. Frakes and Gruber [2022] show that the racial concordance between healthcare providers and patients increases the use of preventative care.

One closely related study is Imtiaz et al. [2023], which investigates whether perceptions and demand for air quality forecasts differ when the information is attributed to a government versus an NGO provider. Although participants perceive the NGO's information as more accurate, the authors find no differential effect on demand for the forecast service. While the sender and implementer are not separated in that study—the organization delivering the information is also the source being evaluated—the experiment is conceptually close to this paper's design in that it highlights the salience of NGO versus government involvement. By contrast, the present study isolates implementer identity by holding the sender and experimenter constant while varying whether the water quality testing is attributed to a government agency or an NGO. This separation is important because it allows for a cleaner identification of how participants respond to the organizational identity of the implementer, independent of any influence from the individual delivering the message (the sender) or from perceptions of the enumerator (the experimenter). By holding the sender and experimenter constant, this study provides direct evidence on the role of implementer salience in shaping belief updating and expressed support.

This paper also contributes to a second strand of literature on strategic or socially desirable responding in the context of experiments. Classic work on experimenter demand effects shows that individuals may modify their behavior or survey responses to align with what they believe the experimenter expects, even in incentive-compatible settings [de Quidt et al., 2018]. More recently, Shenoy and Lybbert [2024] introduce the concept of implementer desirability bias—a form of demand effect where participants adjust behavior to support the organization delivering the intervention, rather than the experimenter. In their field experiment, participants who were reminded of the implementing NGO's role purchased more seeds in a failed agricultural program, potentially to signal alignment or attract future support.

More broadly, this paper contributes to an emerging literature that studies whether NGOs are systematically more effective than governments or other actors in delivering public services and interventions. Meta-analyses find that NGO-led interventions are associated with larger treatment effects, even when conducted on a similar scale as government-led interventions [Vivalt, 2020]. Usmani et al. [2022] argue that these differences may arise not only from variation in technical capacity or resource flexibility, but also from how NGOs are perceived by participants. These perceptions can, in turn, shape how individuals engage with an intervention—whether by complying more readily, exhibiting greater enthusiasm, or signaling higher levels of need. This paper contributes to this literature by testing one such mechanism directly: whether the perceived identity of the implementing organization influences how individuals respond to new information, and whether these responses reflect sincere belief updating or strategic signaling intended to attract NGO attention.

3 Framework

In contexts where NGOs have discretion over when and where to intervene, community members may have incentives to strategically signal high levels of need. Unlike governments—which are expected to serve all areas regardless of local conditions—NGOs often target support based on perceived severity of a problem or community engagement. This selectivity can create an incentive for individuals to express beliefs or attitudes that increase the likelihood of attracting NGO attention or resources.

This framework suggests that participants may not treat new information about water quality in a purely Bayesian fashion. Instead, they may selectively interpret or respond to information depending on who they believe is responsible for providing it. In particular, if the source is an NGO—and if participants perceive NGO support as valuable but limited—they may resist updating beliefs when the information suggests that pollution levels are lower than previously thought. At the same time, they may express strong trust in the NGO and signal a desire for continued engagement, even if their beliefs about the problem do not align with findings from the NGO.

This yields several key implications for how participants might respond to the intervention:

- **Implication 1 (Selective Updating):** Participants may be less likely to revise beliefs downward when "good news" (i.e., evidence of lower-than-expected pollution) is delivered by an NGO rather than the government. This would be consistent with individuals strategically maintaining a narrative of high need in order to encourage continued NGO involvement.

- **Implication 2 (Expressive Support):** Even when participants do not revise their beliefs, they may express stronger trust in the NGO, report more favorable views of its credibility, and indicate a desire for it to conduct future testing.

- **Implication 3 (Belief–Action Divergence):** Strategic signaling may also manifest in a divergence between stated preferences and behavioral intentions. For example, individuals may signal high support for NGO involvement without increasing their willingness to participate in unpaid NGO-led activities or change water use behavior.

4 Experimental Design

I conducted a pre-registered experiment from August 30 to September 14, 2024, using a household survey administered to 1,062 participants across 30 villages in the Obuasi, Prestea-Huni Valley, and Tarkwa municipal districts—regions characterized by significant mining activity. In preparation for the intervention, water samples were collected from the primary borehole in each village between June 23 and July 1, 2024, and laboratory testing was conducted between July 1 and August 1, 2024.

4.1 Water Quality Testing and Index Construction

To measure groundwater pollution, researchers from the Ghana Environmental Protection Agency (EPA) and the Centre for Social Impact Studies (CeSIS) jointly conducted the sampling of water from the primary borehole in each study community. These samples were then tested independently by Ghana Water Research Institute for a range of microbial and chemical parameters.

Throughout the paper, I refer to two summary pollution measures constructed from these test results, "chemical pollution" and "bacteria pollution", to align with the terminology used in the intervention. Chemical pollution is a composite index capturing the concentration of heavy metals and physiochemical contaminants (e.g., lead, arsenic, nitrates), while bacteria pollution is based on the count of E. coli colony-forming units per 100mL. The chemical water quality index aggregates multiple metal and physiochemical parameters into a single measure, with each pollutant weighted based on its health significance and deviation from Ghana Standards Authority (GSA) drinking water standards. This approach reflects the fact that different communities may face varying exposure to different pollutants depending on local geological conditions and mine type—for example, arsenic levels may be elevated in areas with pyrite-rich rock formations. Using an index allows for a more comprehensive assessment of chemical contamination while avoiding the cognitive burden of presenting multiple separate test results to participants. Any presence of E. coli in a water sample is considered a potential health risk, and the raw count was used as a continuous measure of bacterial contamination.

To improve clarity during the information dissemination phase, both pollution measures were mapped onto color-coded risk categories (green, yellow, orange, red) specified by the World Water Quality Alliance. These color-coded categories were used when introducing the test results to the participants. A full description of the sampling procedures, parameter list, index construction, and color classification thresholds is provided in Appendix A.

4.2 Sampling and Recruitment

Villages were selected based on three criteria: (1) reliance on groundwater sources (e.g., boreholes, tube-wells) as the primary drinking water supply, (2) proximity to an active mine within a 20 km radius, and (3) a minimum 20-minute driving distance from any other selected study village. These criteria were chosen to identify communities for whom groundwater contamination from mining activity is a salient concern—even if actual exposure cannot be directly confirmed—and where waterborne contamination is less easily detectable. Spatial separation between villages also helped reduce the risk of information spillovers during the experiment.

Each village was paired with its closest neighboring village within the same municipal district, ensuring unique village pairings.[1] Surveys were carried out simultaneously in both villages within a pair. This ensured that participants in each village received information about their matched pair community on the same day that the paired village received its own information, reducing the likelihood of cross-village information sharing over time.

Within each selected village, households were sampled using a systematic random approach based on the left-hand rule: starting from the community borehole, enumerators surveyed every fifth household, spiraling outward in a counterclockwise direction. In each household, a screening questionnaire was administered to identify respondents who (i) knew about the drinking water source of the household, (ii) could report whether the household used any water purification method, and (iii) correctly answered a set of basic numerical literacy questions indicative of the ability to interpret the pollution index used in the study. Among those meeting these criteria, one household member was randomly selected for the full survey.

Surveys were administered immediately after participant recruitment by trained local enumerators using tablet-based instruments. Enumerators introduced themselves as part of an independent research study conducted by the University of Ghana and the University of California, Davis, and explicitly clarified that the study was not sponsored by the government or any NGO. This framing was designed to minimize experimenter demand effects by holding constant perceptions of the experimenter across treatment arms.

Interviews were conducted in participants' homes, lasted approximately 1.5 hours, and consisted of multiple sections. To preserve response integrity, participants were not allowed to revise previous answers after receiving new information treatments. Respondents received a base payment of 70 GHC for completing the survey, with the opportunity to earn additional compensation based on responses to incentivized questions.

[1] In cases where multiple villages were linked to the same closest neighboring village, one village was randomly assigned its closest match, while subsequent villages were sequentially assigned their second-closest, third-closest, and so forth.

4.3 Main experiment

The survey instrument consisted of three distinct stages. In the first stage, enumerators collected demographic information and elicited participants' prior beliefs about water pollution levels in both their own community and a neighboring, paired community. In the second stage, participants were randomized into either the NGO or government treatment arm, received water quality information for the neighboring community, and were surveyed on key outcomes of interest. In the final stage, participants were shown the water quality test results for their own community.

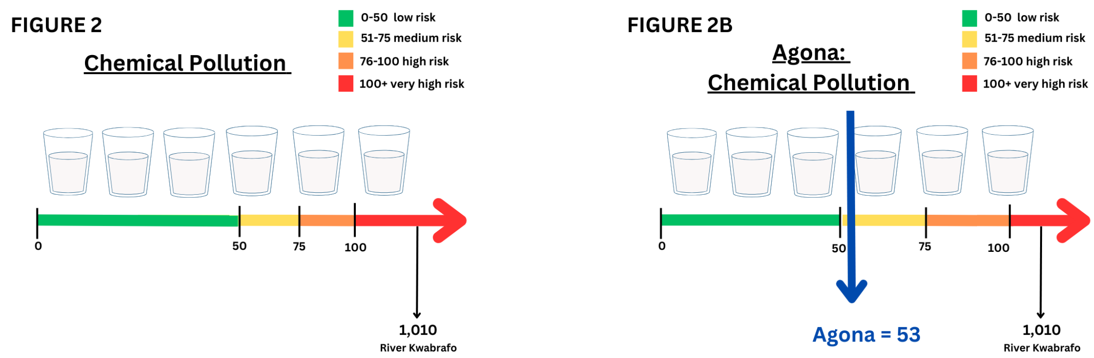
During the first stage, after collecting demographic data, participants were presented with a set of statements designed to measure trust in various societal actors, including teachers, neighbors, government workers, NGO/aid workers, police officers, and religious leaders. For each statement, respondents indicated whether they agreed, disagreed, or neither agreed nor disagreed. Including multiple actor types helped obscure the focus on comparing perceptions of NGOs and government actors. Respondents were also asked a set of direct pairwise comparisons: how much more (or less) they trusted one institution relative to another, with response options ranging from "a lot more" to "a lot less." Finally, participants rated their perceptions of borehole water quality in their own community on a Likert scale ranging from "not polluted at all" to "very heavily polluted."

After these baseline belief measures, enumerators introduced the water quality testing component. Participants were informed that the borehole water in their community had recently been tested by an independent university research team. Enumerators then provided standardized background information on groundwater contamination and the types of pollutants being measured. This information was presented identically across treatment arms and consisted of three components:

1. **Sources of contamination:** Chemical pollutants were described as typically originating from industrial activities such as mining, while bacterial contamination was attributed to poor sanitation practices (e.g., open defecation or animal waste).

2. **Health consequences:** Chemical pollution was framed as contributing to long-term health risks, including cancer and birth defects. Bacterial contamination, by contrast, was associated with shorter-term health outcomes, such as diarrhea.

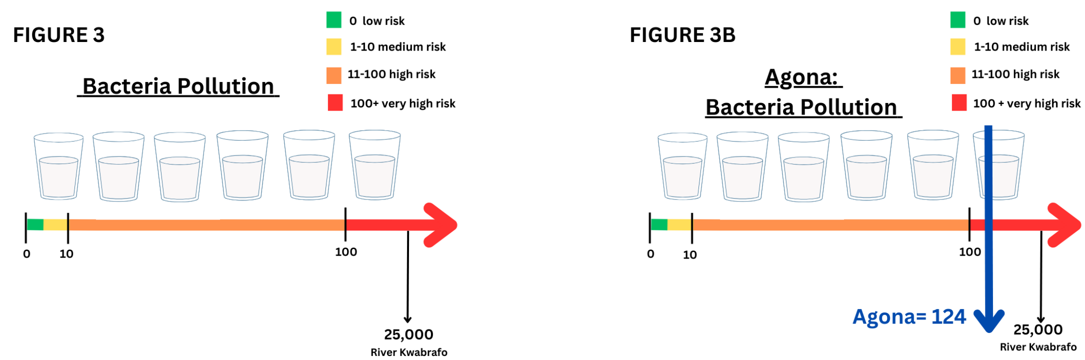
3. **Mitigation strategies:** Participants were told that bacterial contamination can be mitigated through boiling, chlorine tablets, or household filtration, while these methods are often ineffective for removing heavy metals. In the case of chemical pollution, the only effective strategy is to switch to a cleaner water source.



(a) Before information treatment

(b) During information treatment

Figure 1: Scale for Communicating Chemical Pollution



(a) Before information treatment

(b) During information treatment

Figure 2: Scale for Communicating Bacteria Pollution

Enumerators then explained the scales that would be used to present test results (shown in Panel 1a in Figures 1 and 2). These scales mapped the chemical and bacterial pollution levels onto color-coded risk categories. Each category was paired with a plain-language description to improve interpretability. For example, medium chemical pollution was described as "This water sometimes makes people sick when you drink it," while high chemical pollution was described as "This water often makes people sick when you drink it." The risk scales also included a highly polluted reference point—River Kwabrafo, a contaminated river that runs through the study area. A planned reference point for "safe" water (sachet water) was removed after lab tests revealed that nearly 15% of sachet samples contained unsafe levels of *E. coli*. To avoid promoting sachet water as a safer alternative, the research team decided not to include it in the materials shown to participants.

To ensure comprehension, enumerators administered a series of questions following the explanation of the pollution scales. These checks confirmed that participants understood the meaning of the risk categories and the differences between chemical and bacterial contaminants.

To conclude the initial stage, participants were asked to provide incentivized guesses of the chemical and bacterial pollution levels in their own community. Participants received a bonus payment of GHC 10 if their guess was within 5% of the actual test value, GHC 5 if within 10%, and GHC 2 if within 20%. They were also asked to guess the pollution levels in a neighboring, paired community. To aid comprehension, participants first selected the color-coded risk category they believed the result would fall into, and then provided a numerical estimate within that range.

In the second stage, participants received information on pollution levels from borehole water samples taken from the neighboring community. These test results were presented using a visual aid identical to the scale explained in the earlier stage, with the addition of a marker indicating the neighboring community's test result (see Panel 1b in Figures 1 and 2). Participants were randomized into one of two treatment arms: a government condition or an NGO condition. Randomization was stratified at the village level. In the government arm, the message emphasized that water samples were collected by the Ghana Environmental Protection Agency (EPA); in the NGO arm, it emphasized that samples were collected by the Centre for Social Impact Studies (CeSIS), a local NGO.

The following is an example of the script delivered to participants, depending on treatment arm:

- **Government:** "Our research team from the University of California, Davis and the University of Ghana has tested the borehole water in your community. Before we share the results of the water quality test from your community, we would first like to share the results of the water quality test for your neighboring community, Agona. The water samples in Agona were collected by workers from the Ghana Environmental Protection Agency (EPA), which is a government organization working on environmental issues. Samples collected by government workers showed that the chemical level from the borehole water in the neighboring community, Agona, was 53. This is medium risk."

- **NGO:** "Our research team from the University of California, Davis and the University of Ghana has tested the borehole water in your community. Before we share the results of the water quality test from your community, we would first like to share the results of the water quality test for your neighboring community, Agona. The water samples in Agona were collected from workers at the Centre for Social Impact Studies, which is a local non-governmental organization (NGO) working on environmental issues. Samples collected by NGO workers showed that the chemical level from the borehole water in the neighboring community, Agona, was 53. This is medium risk."

The messages varied only in the identity of the organization credited with collecting the water samples; the structure and content were otherwise identical. A similar message was provided for bacteria pollution, with the relevant E. coli level and risk classification substituted in place of the chemical pollution result.

4.4 Outcomes

This study focuses on three main groups of outcomes: (1) belief updating, which is the pre-specified primary outcome; (2) non-costly expressions of support, such as stated trust or perceived accuracy of the implementer; and (3) costly expressions of support, including willingness to volunteer time for future NGO-led interventions or to allocate monetary resources. All outcomes other than belief updating were pre-specified as secondary outcomes.

1. **Belief updating about own community pollution:** Prior to receiving the test result for the neighboring community, participants were asked to report their beliefs about the level of chemical and bacteria pollution in their own community. After receiving the neighboring test result, they reported their posterior beliefs about pollution levels in their own community. Belief updating is defined as the difference between posterior and prior guesses for each pollution type.

2. **Non-costly expressions of support (Perceptions and stated attitudes):** After receiving the neighboring community's test result, participants were asked a series of questions to elicit their perceptions towards the implementer. For each of the following statements, participants indicated whether they agreed, disagreed, or neither agreed nor disagreed:

    - I believe that the [government (EPA)/NGO] workers conducted the water test in the neighboring community correctly.
    - I believe that the [government (EPA)/NGO] test results from the neighboring community are truthful and accurate.
    - I would trust the [government (EPA)/NGO] workers to provide me with other information about environmental issues, such as air pollution.

    Additional measures included whether the participant's view of the implementer became more or less favorable after learning the test result and which implementer (government, NGO, or other) they would prefer to conduct water testing in their own community.

3. **Non-costly expressions of support (Perceived accuracy):** Participants were asked to estimate what the pollution level for their own community would be if the NGO or the government had conducted the water test in their own community. These questions were worded as follows:

    - Suppose the government (EPA) tested the borehole water in your community. What number on this scale do you think a test by the government (EPA) would show for the [chemical/bacteria] pollution in the borehole water of your own community?

- Suppose the NGO (CeSIS) tested the borehole water in your community. What number on this scale do you think a test by the NGO (CeSIS) would show for the [chemical/bacteria] pollution in the borehole water of your own community?

We define perceived accuracy as the absolute value of the difference between a participant's posterior guess for pollution in their own community and their guess for what the implementer (EPA or CeSIS) would have told them.

4. **Costly expressions of support:** After receiving the neighboring community test result, participants were asked how they would split a 10 GHC donation made by the research team on their behalf between the EPA and CeSIS, as well as their willingness to participate in two upcoming programs described as being led by the NGO. Both programs required volunteering time, with no financial compensation. The first program is a water management committee, described as supporting ongoing water quality improvement efforts, including organizing future water quality testing. The second program involves monitoring and documenting mining company violations for escalation to the NGO, who would advocate on the community's behalf to the mining company.

5. **Additional secondary outcomes:** We also collected additional secondary outcomes related to stated water use behaviors and policy preferences. These are detailed in Appendix B.

5 Econometric specification

The primary exogenous variable of interest is treatment assignment, which varies the salience of the implementing organization—either the government (EPA) or the NGO (CeSIS). Throughout the paper, I refer to assignment to the NGO condition as the "treatment group" and assignment to the government condition as the "control group." Let NGO_i denote a treatment assignment indicator equal to 1 if individual i in village v was assigned to the NGO arm, and 0 otherwise.

To estimate the effect of implementer identity on belief updating, I focus on the change in participants' beliefs about pollution levels in their own community after receiving test results for a neighboring community. The primary specification is:

$$\begin{aligned}\text{Updating}_i = \alpha + \beta_1 NGO_i + \\ \beta_2(\text{True Neighbor Pollution}_i - \text{Prior Neighbor Belief}_i) + \\ \beta_3 NGO_i \times (\text{True Neighbor Pollution}_i - \text{Prior Neighbor Belief}_i) + X_i'\gamma + \epsilon_i\end{aligned} \quad (1)$$

The outcome, Updating_i, is defined as the difference between individual i's posterior and prior beliefs about pollution in their own community. The variable NGO_i is an indicator equal to 1 if the participant was assigned to the NGO treatment group (CeSIS) and 0 if assigned to the government control group (EPA). The signal term, $(\text{True Neighbor Pollution}_i - \text{Prior Neighbor Belief}_i)$, which I also refer to as "initial error", captures the extent to which the participant was surprised by the test result in the neighboring community. The interaction term captures whether the weight placed on the signal differs by treatment arm. The vector X_i includes community fixed effects and a set of control variables selected via the double post-LASSO procedure in Belloni et al. (2014).

This specification can be motivated by a Bayesian learning model in which participants treat the test result for the neighboring community as informative about pollution levels in their own community. In such a model, individuals update their beliefs according to:

$$Posterior_i = \lambda Signal_i + (1 - \lambda) Prior_i \tag{2}$$

which implies that belief updating is proportional to the size of the signal. In this context, the signal is defined as the difference between the true pollution level in the neighboring community and the respondent's prior about that level. Appendix C provides evidence that respondents' find pollution levels from the neighboring community informative about pollution levels their own community by demonstrating a strong and statistically significant positive relationship between priors about pollution levels in one's own community and the paired neighboring community.

The coefficient β_2 captures the weight placed on the signal by participants in the government treatment arm. The coefficient β_3 captures the difference in signal responsiveness between the NGO and government arms, such that $\beta_2 + \beta_3$ gives the implied signal weight for participants in the NGO treatment arm. A causal effect of the information where participants update towards the provided signal would imply that $\beta_2 > 0$ and $\beta_2 + \beta_3 > 0$. A negative and significant β_3 would indicate that participants in the NGO group update less towards the information signal than those in the government group.

Note that β_1 represents the difference in average updating between treatment arms when the signal is equal to zero—that is, when the participant's prior about the neighboring community is exactly correct. Since the effect of treatment is expected to vary with the signal, β_1 should not be interpreted as the average treatment effect. I estimate Equation 1 separately over an updating measure for chemical pollution and an updating measure for bacteria pollution.

To test for differences in secondary outcomes of interest between the government and NGO group, I estimate the following specification:

$$\text{Y}_i = \alpha + \beta_1 NGO_i + X_i'\gamma + \epsilon_i \tag{3}$$

where Y_i is an outcome of interest elicited after the test result for the neighboring community was shared.

I obtain p-values from t-tests with heteroskedasticity robust standard errors for two-sided hypothesis tests of coefficients. To adjust for multiple hypothesis testing, I will additionally present Benjamini Krieger Yekutieli (2006) sharpened q-values.

6 Results

6.1 Sample and balance

I test for balance of key demographic and baseline beliefs about pollution between the two treatment arms. Table 1 presents the means for the two treatment arms, differences between the two treatment arms, and t-tests of the null hypothesis of zero difference. With the exception of the number of household members, there are no statistically significant differences.

6.2 Initial beliefs

I begin by documenting the extent to which respondents' prior beliefs about water quality differ from objective test results that will be shared with them for their paired neighboring community. Figure 1 presents the distribution of initial belief errors, calculated as the difference between the test result for their paired neighboring community and the respondent's prior belief about pollution levels in the neighboring community, for both chemical and bacteria pollution. Negative values indicate overestimation of pollution, relative to the results that will be shared during the information treatment. For both types of pollution, the majority of respondents overestimated the level of contamination in the neighboring community's borehole water (70% for chemical pollution and 62% for bacteria pollution). These patterns indicate that many participants received information during the intervention that contradicted their priors and suggested that pollution was less severe than initially believed.

This setting—where the signal often constitutes "good news"—is particularly well-suited to examining differences in belief updating by implementer identity. If individuals view NGOs as more responsive or more selective in where they intervene, they may have stronger incentives to downplay good news when the NGO is salient, either by under-updating their beliefs or by overstating remaining need. The salience

Variable	(1) GOVT N	(1) GOVT Mean/(SE)	(2) NGO N	(2) NGO Mean/(SE)	(1)-(2) Pairwise t-test N	(1)-(2) Pairwise t-test Mean difference
Age	546	38.055 (0.645)	518	38.342 (0.640)	1064	-0.287
Respondent is female	546	0.636 (0.021)	518	0.633 (0.021)	1064	0.002
Completed secondary school	546	0.385 (0.021)	518	0.380 (0.021)	1064	0.004
Head of household	546	0.505 (0.021)	518	0.525 (0.022)	1064	-0.020
Number of household members	546	5.209 (0.120)	518	5.542 (0.133)	1064	-0.334*
Number of kids under 5	546	0.780 (0.043)	518	0.815 (0.047)	1064	-0.034
Concerned about borehole quality (prior)	546	0.654 (0.020)	518	0.645 (0.021)	1064	0.009
Perceive borehole as polluted (prior)	546	0.108 (0.013)	518	0.112 (0.014)	1064	-0.004
Av. daily expenditure on sachet water (prior)	546	5.630 (0.282)	518	5.193 (0.204)	1064	0.437
Av. daily number of trips to borehole (prior)	546	7.302 (0.182)	518	7.216 (0.180)	1064	0.086
Treats drinking water (prior)	546	0.103 (0.013)	518	0.110 (0.014)	1064	-0.007
Participates in farming	546	0.500 (0.021)	518	0.481 (0.022)	1064	0.019
Use borehole frequently	546	0.416 (0.021)	518	0.434 (0.022)	1064	-0.019
Asset Index	546	0.005 (0.020)	518	0.000 (0.020)	1064	0.004
Familiar with NGO (prior)	546	0.249 (0.019)	518	0.222 (0.018)	1064	0.027
Familiar with EPA (prior)	546	0.573 (0.021)	518	0.566 (0.022)	1064	0.008
Trust NGO More (prior)	546	0.648 (0.020)	518	0.664 (0.021)	1064	-0.016
Comfortable speaking about government?	546	0.676 (0.020)	518	0.722 (0.020)	1064	-0.046
NGO more competent (prior)	546	0.683 (0.020)	518	0.689 (0.020)	1064	-0.006
NGO more trustworthy (prior)	546	0.670 (0.020)	518	0.674 (0.021)	1064	-0.003
NGO more beholden to private interest	546	0.368 (0.021)	518	0.371 (0.021)	1064	-0.003
Social desireability score	546	9.355 (0.089)	518	9.413 (0.086)	1064	-0.058
Number of comprehension questions correct	546	4.888 (0.017)	518	4.890 (0.017)	1064	-0.002
Prior: own chemical pollution	546	45.874 (2.351)	518	43.761 (1.731)	1064	2.113
Prior: own bacteria pollution	546	16.154 (1.355)	518	20.012 (2.880)	1064	-3.858
Prior: neighbor chemical pollution	546	54.910 (2.389)	518	54.936 (2.477)	1064	-0.026
Prior: neighbor bacteria pollution	546	21.515 (1.554)	518	25.185 (3.201)	1064	-3.671
F-test of joint significance (F-stat)						0.809
F-test, number of observations						1064

If the table includes missing values (.n, .o, .v etc.) see the Missing values section in the help file for the Stata command iebaltab for definitions of these values. Significance: ***=.01, **=.05, *=.1. Full user input as written by user: [iebaltab age d_female completed_secondary d_hoh num_hh_mem num_kid_u5 prior_very_concerned_borehole prior_borehole_polluted spend_sachet num_trips d_treat_water d_farming use_borehole_frequently asset_index d_familiar_ngo d_familiar_epa trust_ngo_more speak_out_govt ngo_more_competent ngo_more_trustworthy ngo_more_biased sd_score num_compq_corr prior_own_chem_num prior_own_bac_num prior_nbr_chem_num prior_nbr_bac_num, grpvar(d_treat) savetex("output/tables/balance_tab") ftest rowvarlabels replace]

Table 1: Balance Test

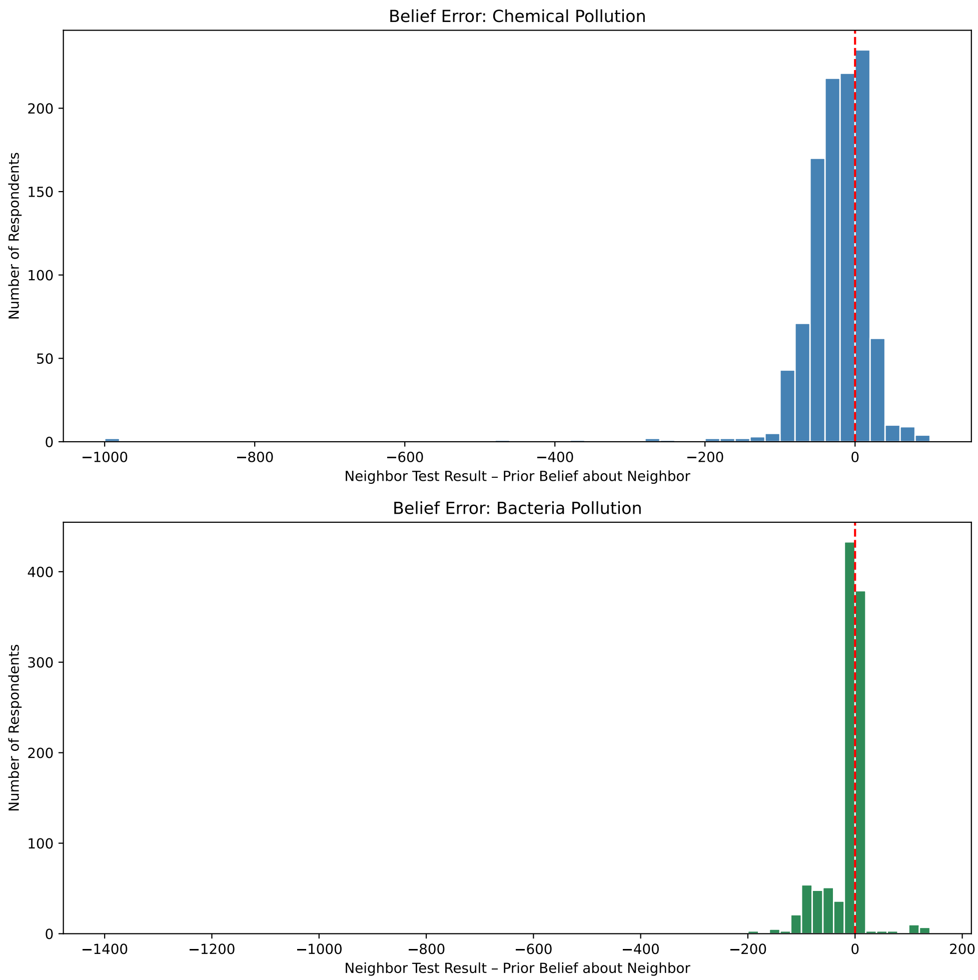


Figure 3: Errors in Initial Pollution Beliefs

of the implementer thus creates a testable contrast in whether participants incorporate new information symmetrically across organizational contexts.

6.3 Belief Updating

I next examine whether respondents update their beliefs differently depending on whether the information is framed as coming from a government agency or a NGO. In a standard Bayesian framework, causal revisions in response to information would imply a positive relationship between belief updating and the signal provided (neighboring community test result - prior guess for pollution level in neighboring community). Since most participants initially overestimated pollution levels, the intervention generally provided “good news” by revealing that water quality was better than expected. Such information should lead to downward revisions in beliefs.

To estimate the causal effect of implementer identity on belief updating, I use the specification outlined in Equation 1, which regresses the change in beliefs about own-community pollution on the error relative to the signal (the difference between the test result for the neighboring community and the respondent's prior belief about that community), treatment assignment, and their interaction. This approach allows for testing whether the degree of responsiveness to information—i.e., the weight placed on the signal—differs between the NGO and government treatment arms.

Table 2 reports the corresponding regression estimates: respondents in the NGO group updated toward the provided signal for chemical pollution less, and this difference was more pronounced among individuals whose priors were furthest from the signal. These differences are statistically significant in the full sample, as well as robust to focusing on the set of respondents who correctly recall the implementer of the neighboring community or the set of respondents whose initial guess on the pollution scale matches Likert scale measures of prior perceptions of how polluted the borehole water is in their own community.

To understand which types of respondents are driving the lower updating towards the signal, I estimate a version of Equation 1 that replaces the continuous measure of initial error with error bins for "near" correct respondents, large-overestimators, moderate overestimators, moderate underestimators and large underestimators.[2]. Figure 4 plots the marginal effects from the binned regression, highlighting that the reduced belief updating towards the signal in the NGO group is driven by large overestimators, who update downward less when provided information on the test result than large overestimators in the government group. These findings suggest that participants may have strategically discounted "good news" when it was delivered by an NGO—possibly due to perceived benefits of sustaining a narrative of high need to attract future NGO engagement.

Table 2: Effect of Implementer Identity on Updating Towards Signal (chem), error relative to nbr

	(1) Full	(2) Correct Recall Both	(3) Consistent
NGO	-9.700***	-10.19***	-9.528***
	(3.596)	(3.892)	(3.571)
NGO × Initial Error	-0.532***	-0.541***	-0.539***
	(0.147)	(0.158)	(0.150)
Initial Error (relative to nbr)	0.765***	0.757***	0.772***
	(0.117)	(0.134)	(0.117)
N	1062	904	945
Mean Update	-13.621	-13.621	-13.621

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

[2] Near correct respondents are those whose initial error falls within $0.5 \times IQR$ of the error. Respondents making larger over or underestimates than the near-correct group are divided into two groups based on the median error within these two bins.

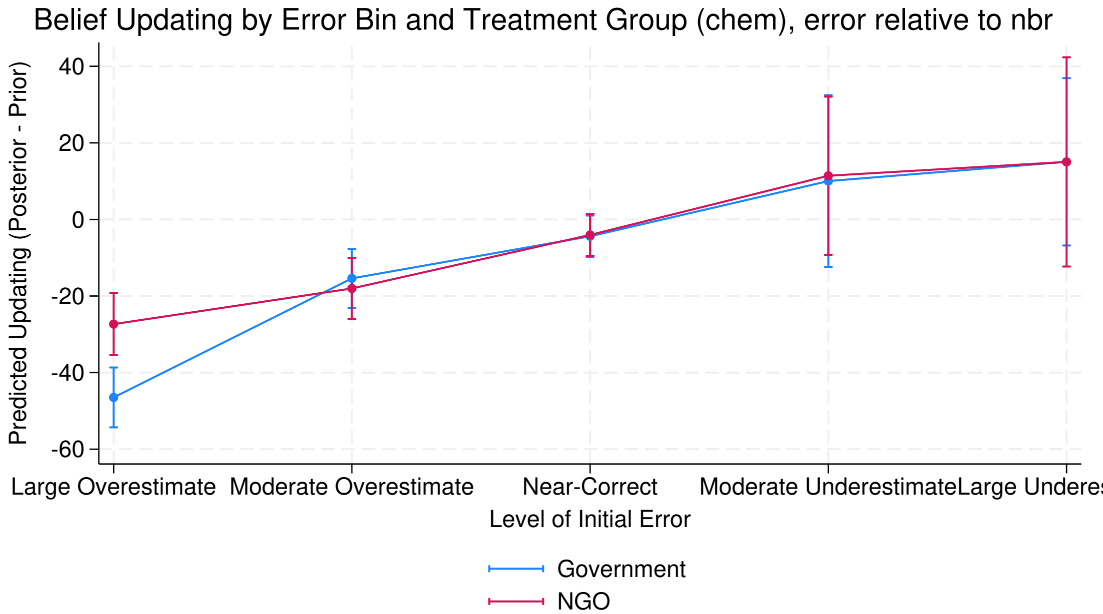


Figure 4: Belief Updating for Chemical Pollution, by Level of Initial Error

For bacteria pollution, the pattern is reversed: Table 3 and Figure 5 show that respondents in the NGO group exhibit somewhat greater belief updating toward the signal, driven by large overestimators. However, these results are less robust across specifications. One potential explanation for this asymmetry lies in the perceived source of each type of pollution. Chemical contamination is widely associated with industrial activities, such as mining, that are outside of the community's direct control and more plausibly the focus of NGO advocacy or intervention. In contrast, bacteria pollution is often linked to local sanitation practices, such as open defecation, and may be viewed as a community-responsibility issue. As such, there may be less incentive for individuals to strategically exaggerate the severity of bacteria pollution when interacting with an NGO.

6.4 Costly vs. Non-Costly Support

Finally, I examine whether respondents' stated perceptions of the implementer differ between the NGO and government treatment arms. After receiving the information treatment, participants answered a series of questions designed to capture non-costly, expressive forms of support—such as perceived competence, trustworthiness, and endorsement of the implementer. As shown in Table 4 (Columns 1–3), respondents in the NGO group were significantly more likely to state that the implementer had conducted the neighboring community's test correctly, that the results were accurate, and that they would trust the implementer to provide information on other environmental issues. They were also significantly more likely to report that

Table 3: Effect of Implementer Identity on Updating Towards Signal (bac), error relative to nbr

	(1) Full	(2) Correct Recall Both	(3) Consistent
NGO	2.998*	1.663	1.199
	(1.726)	(2.086)	(1.952)
NGO × Initial Error	0.281***	0.181	0.150
	(0.0866)	(0.143)	(0.137)
Initial Error (relative to nbr)	0.417***	0.364***	0.403***
	(0.0668)	(0.0771)	(0.0721)
N	1062	904	945
Mean Update	-10.626	-10.626	-10.626

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

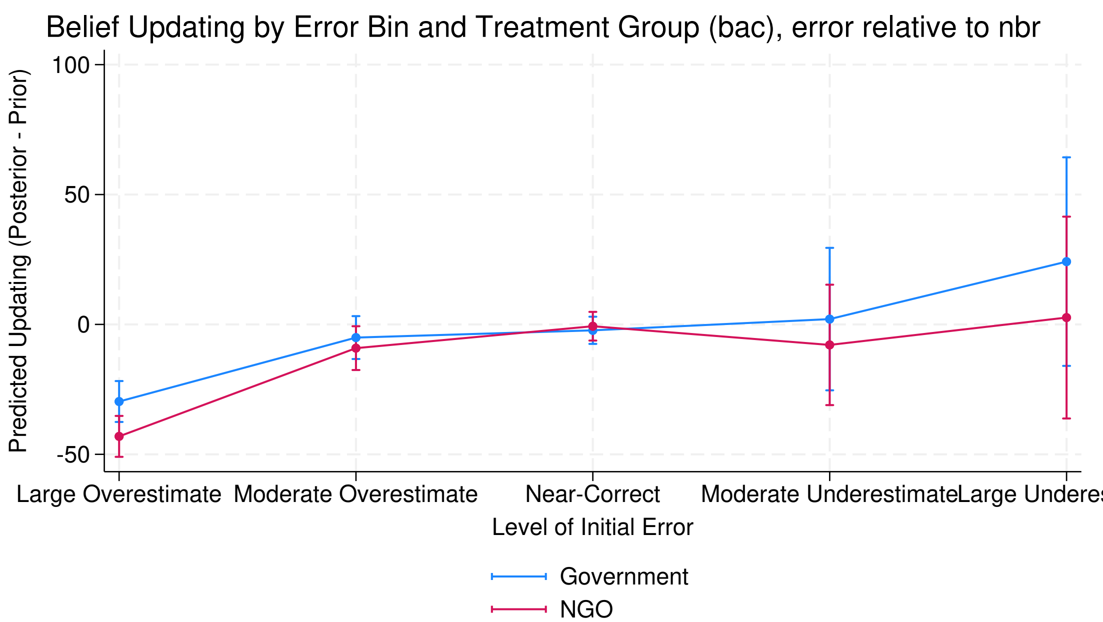


Figure 5: Belief Updating for Bacteria Pollution, by Level of Initial Error

their opinion of the implementer had improved after receiving the information (Table 4, Column 4), and that they preferred the NGO to conduct water testing in their own community (Table 5, Column 5). These patterns suggest that when expressions of support are non-binding and costless, participants in the NGO group are more inclined to signal favorability toward the implementer.

By contrast, the treatment does not generate consistent differences in costly forms of support. Participants in the NGO group were no more likely to allocate a greater share of a donation to the NGO over the EPA (Table 3, Column 5), nor were they more likely to volunteer for time-intensive, unpaid roles in future NGO-led programs (Table 4, Columns 1–2). The largest and most consistent effects are observed for low-cost, expressive responses, rather than for material or behavioral commitments.

This distinction is consistent with the interpretation that participants may be strategically signaling support for the NGO when it involves no personal cost, while withholding more demanding forms of engagement. Taken together with the belief updating results, these findings suggest that individuals may use stated attitudes to shape how external actors perceive their community's need and willingness to engage—especially when NGOs are seen as desirable or selective partners.

Table 4: Effect on Implementer Perceptions, Heterogeneity by Under vs. Overestimator (error relative to nbr)

	(1) Source is Competent	(2) Source is Accurate	(3) Trust Source for Other Info	(4) View Source More Favorably	(5) GHC Donated to NGO
NGO	0.163***	0.193***	0.194***	0.147***	0.0770
	(0.0400)	(0.0431)	(0.0425)	(0.0515)	(0.191)
NGO × Overestimator	0.0176	0.00744	0.0524	-0.0402	0.0363
	(0.0544)	(0.0572)	(0.0562)	(0.0656)	(0.244)
Overestimator	-0.114**	-0.0905*	-0.0816*	0.00370	-0.0475
	(0.0453)	(0.0475)	(0.0472)	(0.0490)	(0.169)
N	904	904	904	904	904
Dep. variable mean	.761	.732	.746	.461	5.984

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Effect on Stated Interest in Collective Action Activities, Heterogeneity by Under vs. Overestimator (error relative to nbr, chem)

	(1) Participate in NGO Water Committee	(2) Participate in NGO Monitoring Program	(3) Test Borehole Again	(4) Test Sachet Water	(5) Prefer NGO Test Again	(6) Prefer Govt Test Again	(7) GHC on Borehole Testing	(8) GHC on Sachet Testing
NGO	0.0432	-0.00597	-0.0326	0.0105	0.161***	-0.107**	-21.32	-22.23
	(0.0610)	(0.0608)	(0.0325)	(0.0528)	(0.0568)	(0.0446)	(48.79)	(14.25)
NGO × Overestimator	-0.0429	0.0540	0.0275	-0.0558	-0.0702	0.0274	-3.614	21.60
	(0.0717)	(0.0716)	(0.0398)	(0.0634)	(0.0678)	(0.0543)	(55.24)	(16.13)
Overestimator	0.00766	-0.0820	-0.0202	-0.0342	-0.00418	0.0197	11.87	-4.182
	(0.0529)	(0.0530)	(0.0267)	(0.0442)	(0.0523)	(0.0442)	(31.24)	(10.80)
N	904	904	904	903	904	904	821	651
Dep. variable mean	.59	.539	.907	.702	.659	.187	90.901	42.679

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Effect on Stated Future Water Use Behaviors, Heterogeneity by Under vs. Overestimator (error relative to nbr, chem)

	(1) Use Alt. Water Source More Frequently	(2) Treat Borehole Water	(3) Treat Sachet Water
NGO	0.106**	0.00275	-0.0347
	(0.0538)	(0.0316)	(0.0587)
NGO × Overestimator	-0.0623	0.0258	0.0463
	(0.0641)	(0.0407)	(0.0698)
Overestimator	-0.0960**	-0.0377	-0.0755
	(0.0460)	(0.0309)	(0.0515)
N	904	904	904
Dep. variable mean	.439	.875	.543

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

7 Conclusion

This study shows that the identity of an intervention's implementer can influence how individuals interpret and respond to information—even when the content, delivery, and experimenter are held constant. In a randomized evaluation in mining-affected communities in Ghana, participants updated their beliefs less when favorable water quality information was attributed to an NGO rather than a government agency. At the same time, they expressed more trust in and support for the NGO, despite showing no greater willingness to contribute financially or engage in future programs. These patterns are consistent with strategic, low-cost signaling aimed at encouraging further NGO involvement.

The findings contribute to a growing literature on implementer desirability bias, demonstrating that not all belief updating or stated support in information interventions should be interpreted as sincere or behaviorally consequential. When NGOs are seen as selective and desirable providers, individuals may have incentives to portray their community as in need—especially when such portrayals are inexpensive. In doing so, they may bias impact evaluations and distort organizational decisions about where to work. These expressive but strategic responses, while subtle, underscore the importance of carefully considering implementer identity in the design, interpretation, and scaling of development interventions.

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Appendix A: Water Quality Testing and Index Construction

A.1 Sample Collection and Laboratory Testing

Water samples were collected from the primary borehole used for drinking water in each of the 30 study communities. Three samples were taken from each community. The sampling process was coordinated with Ghana's Environmental Protection Agency (EPA) and CeSIS. All samples were analyzed by the Ghana Water Research Institute using standard testing protocols. For each sample, two categories of parameters were tested:

- **Chemical**: including heavy metals and physiochemical parameters
- **Bacteria**: measured by *Escherichia coli* (E. coli) colony-forming units (CFU) per 100mL

A.2 Chemical Pollution Index Construction

The chemical water quality index is based on the methodology developed by the World Water Quality Alliance (WWQA) and adapted to the Ghanaian context. For each chemical parameter i in village v, we compute a normalized sub-index q_{iv} based on the observed concentration C_{iv} and the standard threshold value S_i using the formula:

$$q_{iv} = \left(\frac{C_{iv}}{S_i} \right) \tag{4}$$

S_i is the standard guideline value for the ith parameter based on the Ghana Standards Authority when available, or the World Health Organization (WHO) if unavailable.[3].

The chemical pollution index for each village is constructed as a weighted average of these sub-indices:

$$\text{Chemical Pollution Index} = \sum_{i=1}^{N} W_i q_{iv} \tag{5}$$

where W_i is the relative weight assigned to parameter i. It is calculated according to $W_i = \frac{w_i}{\sum_{i=1}^{N} w_i}$, where N is the number of parameters included in the index and w_i is a weight of 1-5 based on its toxicity and potential health risks.

A.3 Parameters and Standards Used in Index

The chemical pollution index includes the following parameters, with reference values drawn from Ghanaian Standards Authority and WHO guidelines:

Table 7: Reference Values and Weights Used for WQI Calculation

Parameter	**Standard Value** (S_i)	**Weight** (w_i)
Nitrate (mg/L)	10	5
Sulphate (mg/L)	250	4
pH	6.5–8.5	4
Turbidity (NTU)	5	4
Chloride (mg/L)	250	4
Fluoride (mg/L)	1.5	5
Electrical Conductivity (μS/cm)	1000	4
Sodium (mg/L)	200	3
Lead (mg/L)	0.01	5
Iron (mg/L)	0.3	4
Manganese (mg/L)	0.4	5

[3]The sub-index for pH is calculated in a slightly different way: $Q_{pH} = \frac{M_{pH}-7.0}{S_{pH}-7}$, where $S_{pH} = 8.5$ if $M_{pH} >= 7$ and 6.5 otherwise

To measure microbial groundwater quality, referred to as bacteria pollution in this paper, I use the E-coli count in accordance with WHO, which recommends that it be separated from the chemical index. For microbial quality, an E-coli count greater than 0 indicates contaminated water.

Both chemical and bacteria pollution are linked to color-coded risk categories defined by the World Water Quality Alliance as follows:

Table 8: Chemical Pollution Risk Categories

Risk Category	**Chemical Pollution Index**
Low risk	0–50
Medium risk	51–75
High risk	76–100
Very high risk	>100

Table 9: Bacteria Pollution Risk Classification

Risk Category	**E. coli Count (CFU/100mL)**
Low risk	0
Medium risk	1–10
High risk	11–100
Very high risk	>100

Appendix B: Outcome variables

Category	**Outcome Name**	**Definition**
Belief Updating	Belief updating – chemical pollution	Posterior minus prior guess for chemical pollution in respondent's own community.
Belief Updating	Belief updating – bacteria pollution	Posterior minus prior guess for bacteria pollution in respondent's own community.
Non-Costly Support	Perceived accuracy – chemicals	Absolute difference between posterior guess and guess for what implementer would have told them (chemicals).
Non-Costly Support	Perceived accuracy – bacteria	Absolute difference between posterior guess and guess for what implementer would have told them (bacteria).

Continued on next page

Table 10 – continued from previous page

Category	Outcome Name	Definition
Non-Costly Support	Stated belief – implementer competency	Agreement with statement: Implementer conducted the test correctly (3-point Likert scale).
Non-Costly Support	Stated belief – implementer trustworthiness	Agreement with statement: Test results are truthful and accurate (3-point Likert scale).
Non-Costly Support	Stated belief – implementer endorsement	Agreement with statement: Would trust implementer for future information (3-point Likert scale).
Non-Costly Support	Improvement in perception	Dummy = 1 if participant reports more favorable view of implementer after receiving info.
Non-Costly Support	Preference for implementer of future testing	Dummy = 1 if participant reports they would prefer the NGO to test their own community's borehole water in the future
Costly Support	Donation allocation	Share of GHC 10 allocated to government vs. NGO for leading an environmental improvement project.
Costly Support	Willing to serve on NGO-organized water committee	Dummy = 1 if participant expresses interest in unpaid NGO water committee role.
Costly Support	Willing to participate in Observatory Program	Dummy = 1 if participant expresses interest in NGO-led monitoring program.
Other	Prefers water quality investment	Dummy = 1 if participant ranks water quality as top investment priority for government.
Other	Intent to switch water sources	Dummy = 1 if participant reports intent to use alternative water source.
Other	Intent to treat water	
Other	Intent to use other water sources	Dummy = 1 if participant reports intent to switch to other source aside from main borehole.

Appendix C: Relationship between priors on neighboring community pollution and own community pollution

I test for whether participants' belief that pollution in their paired neighboring community is informative of pollution levels in their own community by estimating the following regression:

$$ln(\text{Own Community Pollution}_{iv}) = \beta_0 + \beta_1 ln(\text{Neighbor Community Pollution}_{iv}) + \epsilon_{iv} \quad (6)$$

where the dependent variable, $ln(\text{Own Community Pollution}_i v)$ is individual i's (log) priors on pollution in one's own community v and $ln(\text{Neighbor Community Pollution}_i v)$ is i's log prior about the pollution level in the neighboring community that was matched to their own community, v. I pool all communities together and include community-specific fixed effects.

	(1) Ln(Prior Pollution Own Community)
Ln(Prior Pollution Neighboring Community)	0.663***
	(0.0275)
Observations	991
R2	0.462

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.05$

Table 11: Neighbor vs. Own Pollution Prior - Chemical

	(1) Ln(Prior Pollution Own Community)
Ln(Prior Pollution Neighboring Community)	0.648***
	(0.0315)
Observations	567
R2	0.540

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.05$

Table 12: Neighbor vs. Own Pollution Prior - Bacteria

The log-log specification gives the coefficients an "elasticity" interpretation: the coefficient of 0.663 indicates that a 1% increase in beliefs about the neighboring community chemical pollution levels increases beliefs about chemical pollution in one's own community by 0.66%.[4]. The R^2 reported for the regression indicates that about 46%-54% of the variation in beliefs about one's own community pollution is explained by beliefs about the neighboring community pollution and community fixed effects.

[4] This is larger than the elasticity found by Wiswall and Zafar [2015] between self beliefs and population earnings of 0.31

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