Plastic Pollution in the Ocean: The Impacts of Visual Information and Text on Beliefs, Attitudes, and Expected Behaviours

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Abstract. An experiment is conducted using an internet-based survey about the problem of plastic pollution in oceans. Treatment groups consist of respondents viewing an underwater photograph illustrating plastic pollution in oceans and/or reading a one-sentence description of the magnitude of the problem. Treatment effects are estimated for a variety of attitude and belief measures as well as for respondents’ expectations about how their own and others’ behaviours will be affected. Results support the external validity of previous estimates as well as providing new insights. For the sample as a whole, estimated effects on expected behaviours are more significant than estimated effects on underlying beliefs and attitudes. Though there are few statistically significant effects on belief and attitude measures, each treatment does result in some statistically significant effects, however. Estimated effects on beliefs and attitudes for those who didn’t hold strong pre-existing pro-environmental attitudes and beliefs were large, suggesting that visual and/or textual information can have large impacts on that group. There are almost no differences across treatments, whether for the sample as a whole or for the subsamples. A large majority of respondents reported that the experimental treatment made them want to learn more about this important environmental problem.

1. Introduction
The problem of plastic pollution in oceans is well known and has been widely publicized. This paper uses an internet-based survey experiment to explore the impacts of three different treatments on respondents’ environmental beliefs, attitudes, and expected behaviours. The treatments consist of viewing an underwater photograph illustrating plastic pollution in oceans and/or reading a brief text describing the amount of plastic pollution in oceans. The experimental design and analysis follow closely on those used by [1] but use a different photograph rather than the images used by [1]; thus the new results provide evidence about the external validity of the earlier study as well as extending that study in a couple of dimensions. The new study broadens the scope of analysis beyond the focus of plastic bags in the oceans to examine plastic pollution in the ocean more generally. It also provides stronger evidence about whether any impact is due to just the photograph used in the study, just the text that accompanies it, or the combination of the two. In [1] the analysis combined the results of different treatments in two different surveys, one of which had a restricted sample size, whereas the present study explores all the different treatments in a single survey with equal-sized treatment groups. The new study also analyses effects separately for respondents who did not hold strong pre-existing pro-environmental attitudes and beliefs.
2. Background
Among the ways that theorists have suggested environmental attitudes, beliefs, and behaviours can be changed are providing information and provoking emotional indignation about threats to the environment. Both the underwater photograph and the brief text used in the survey experiment could trigger change via either or both pathways. As described in [1], several theories from sociology and psychology ([2–8]) provide reasons to expect that the experimental treatments might have impacts.

Respondents’ environmental attitudes, beliefs, and behaviours, both in general and with respect to plastics specifically, are measured using a variety of survey questions. These questions are close to identical to those used in [1] except that questions specifically about plastics were broadened to talk about plastics in general rather than plastic bags in particular. Among the questions is a subset of the questions developed by the creators of the revised New Ecological Paradigm (NEP) concept [9]. The NEP scale or index is created from 15 survey questions though sometimes, as is done in [1] and here, a smaller subset is used to create an index that focuses on the most relevant attitudes and beliefs for a particular issue. Analyses of children’s ecological worldviews, cross-country comparisons, risk perception, and valuation studies have successfully used the NEP scale [10].

3. The Experiment
Qualtrics Research Services recruited a panel of respondents to an internet survey in a way that ensured a sample that was representative of the US population in terms of income and race/ethnicity and that was balanced according to gender. Respondents knew that the survey was about plastic pollution in the ocean but did not know ahead of time about the experimental treatments. The 1,238 respondents who completed the survey were divided into three approximately equal-sized treatment groups. The first group was shown an underwater photograph of plastic pollution in the oceans without additional text. (The photograph was taken by Tunatura and licensed using Shutterstock. It can be viewed at https://www.shutterstock.com/image-photo/detailed-photography-sea-water-contaminated-by-1161808915, accessed on August 11, 2020.) The second group was shown the same short text as that used by [1]: “It is estimated that there are 50,000 pieces of floating plastic in every square mile of the world’s oceans.” The third group was shown both the photograph and the text. The survey, approved by Colgate University’s Institutional Review Board, was very similar to that used in [1].

Before the experimental treatments, all respondents were asked a few demographic questions and then a series of questions about their general environmental beliefs and attitudes. In addition to the NEP questions described earlier, respondents were asked a four-item Likert scale question, “Do you think your individual actions can have an effect on the environment?” and continuous-scale questions, with possible answers ranging from 1 (strongly disagree) to 5 (strongly agree), about the extent of their agreement with four statements: “I feel personally responsible for the condition of the environment”; “Plastics are a significant source of roadside litter”; “Plastics are a significant source of pollution in landfills”; and “Plastics are a significant source of pollution in oceans.”

Respondents also answered several questions about their use of plastics and recycling. These are largely framing questions, preparing respondents for questions they were asked after treatment about whether they think that the treatment would make them, or others, more likely to reduce their use of plastics or recycle more.

Additional post-treatment questions included whether they felt more knowledgeable after receiving the information and whether the treatment made them interested in learning more about the issue of plastics in the ocean. The latter is a new question, but all the rest follow the design of [1] except they referred to plastics in general rather than just plastic bags. To identify treatment effects on beliefs and attitudes, the survey concluded with a repetition of the questions described earlier.

4. Results
About half of the respondents who saw the brief text said that the survey provided new information, regardless of whether the text was accompanied by the photograph. (Details about these and other results are available upon request.) A statistically significantly smaller fraction, around one-third, of
respondents who saw just the photograph without accompanying text said that the survey provided new information. This pattern suggests that simply viewing the photograph may not convey information about plastic pollution in a way that connects with most viewers. However, about two-thirds of respondents, regardless of which treatment group they were in, said that the treatment made them either definitely or probably want to learn more about the issue. So the photograph and text were equally effective at making respondents want to learn more, but the text was better at conveying information.

The text also had larger estimated effects on respondents’ answers to the survey questions about whether they feel a personal responsibility for the condition of the environment. These effects are shown in table 1. Entries in the table show, by treatment group, the average changes from before treatment to after treatment in respondents’ answers to three questions about their general environmental attitudes and beliefs. Asterisks indicate whether each average change is statistically significant and the bottom row of the table shows p-values for tests of whether the averages are the same across treatment groups. The change in responses about personal responsibility was statistically insignificant for those that saw only the photograph. In contrast, those who saw the text, whether alone or in combination with the photograph, had on average statistically significant increases in their rating of personal responsibility. The point estimate is almost twice as large, though, for those that saw the photo and text together than for those who saw just the text.

This pattern did not extend to all variables examined, however. Regarding the survey question about whether respondents believe that individual actions can affect the environment, also shown in table 1, estimated effects were small for all treatment groups and statistically significant only for the group that saw both photo and text. Yet another different pattern resulted from analysis of the before-and-after change of the NEP-based index, as shown in the last column of table 1: for those who saw text only, no statistically significant change resulted from treatment. For those who saw the photograph, though, whether alone or in combination with text, there was a statistically significant, though small, increase in pro-environmental beliefs. The impact was virtually identical for those two treatment groups, and even though the impact was statistically significantly positive for those treatments and insignificant for the photo-only treatment, the three estimated effects are not statistically significantly different from each other. Analysing the four components of the NEP-based index individually, it appears that almost all of the increase for the treatments including text is due to changes in respondents’ reactions to the statement, “Humans are severely abusing the environment.” This is similar to the findings of [1].

Turning from general environmental beliefs and attitudes to beliefs about plastic pollution specifically, almost no statistically significant treatment effects occurred, as shown in table 2. The layout of table 2 is similar to that of table 1. The only statistically significant treatment effect was that the group that saw both photo and text had, on average, a positive change in their agreement with the statement that plastics are a significant source of roadside litter. Since both the photo and text focus on ocean pollution, not roadside litter, it is mysterious why respondents would agree more after treatment with the statement about roadside litter.

### Table 1. Changes in general attitude and belief variables.

| Treatment group          | Individual actions mattera | Personal responsibility | NEP-based index |
|--------------------------|----------------------------|-------------------------|-----------------|
| Saw text only            | -0.02                      | 0.11**                  | 0.05            |
| Saw photo only           | 0.03                       | 0.07                    | 0.09***         |
| Saw photo and text       | 0.07*                      | 0.20***                 | 0.09***         |
| p-values for F tests of equal means | 0.06 | 0.04 | 0.55 |

*aReverse-coded.  
For tests of zero means, *p < 0.05, **p < 0.01, ***p < 0.001.*
Table 2. Changes in beliefs about plastic pollution.

| Treatment group       | Roadside litter | Landfill pollution | Ocean pollution |
|-----------------------|-----------------|--------------------|-----------------|
| Saw text only         | 0.04            | 0.02               | 0.03            |
| Saw photo only        | 0.02            | -0.04              | 0.02            |
| Saw photo and text    | 0.07*           | 0.05               | 0.02            |
| p-values for F tests  | 0.51            | 0.14               | 0.93            |

For test of zero means, *p < 0.05, **p < 0.01, ***p < 0.001.

The generally insignificant effects in table 2 may, however, be due to the fact that about three-fourths of respondents thought that each problem was quite significant (rating their agreement with the statement of importance as greater than or equal to 4 (“Agree”) on a 5-point continuous scale) even before the experimental treatment. For example, when the sample was restricted to those who rated the significance of plastic pollution in the ocean less than 4, the estimated treatments effects were all large and highly significant statistically.

This suggests that the experimental treatments might be more effective for respondents who had less pro-environmental attitudes and beliefs. Table 3 shows results that confirm this guess. Each column of the table shows, by treatment group, the change in one of the attitude or belief variables when the sample is restricted to those who didn’t have strong pre-existing pro-environmental attitudes or beliefs. For example, the first column reports results only for those who said that their individual actions probably or definitely did not have an effect on the environment. The other columns report results for the subsets of the sample who rated their agreement with the relevant statements less than 4 (“Agree”) on their 5-point continuous scales. All treatments had large and statistically significant effects on all variables. So there is strong evidence that seeing visual or textual information has a large pro-environmental effect on people who do not already hold strong pro-environmental attitudes or beliefs. There is no statistically significant difference across treatments, however, except for the marginally significant difference with regard to the belief that individual actions matter. For that variable, seeing the text only had the smallest effect, followed by seeing the photo only, with the largest estimated effect being for the photo-and-text treatment.

Table 3. Changes in attitude and belief variables for respondents without strong pre-existing pro-environmental attitudes and beliefs.

| Treatment group       | Individual actions matter | Personal responsibility | Litter | Landfill pollution | Ocean pollution |
|-----------------------|---------------------------|-------------------------|--------|--------------------|-----------------|
| Saw text only         | 0.34***                   | 0.26***                 | 0.32***| 0.35***            | 0.39***         |
| Saw photo only        | 0.48***                   | 0.22***                 | 0.29***| 0.33***            | 0.36***         |
| Saw photo and text    | 0.65***                   | 0.35***                 | 0.35***| 0.37***            | 0.29***         |
| p-value for F test    | 0.05                      | 0.15                    | 0.84   | 0.93               | 0.74            |
| Number of observations| 177                       | 747                     | 357    | 323                | 274             |

*Reverse-coded.
For tests of zero means, *p < 0.05, **p < 0.01, ***p < 0.001.

Analysing respondents’ expectations of changes in their own or others’ behaviours after seeing the photo and/or text, all treatments resulted in statistically significant increases, as shown in table 4. Around two-thirds of respondents expected their own behaviour to change while a little less than half of respondents expected others’ behaviours to change. Both estimated changes were virtually identical across treatment groups.
Table 4. Changes in reported knowledge and expected changes in behaviour.

| Treatment group     | Own behaviour expected to change | Others' behaviour expected to change |
|---------------------|----------------------------------|-------------------------------------|
| Saw text only       | 0.65***                          | 0.44***                             |
| Saw photo only      | 0.67***                          | 0.45***                             |
| Saw photo and text  | 0.69***                          | 0.46***                             |
| p-values for F tests of equal means | 0.43                              | 0.81                               |

For tests of zero means, * p < 0.05, ** p < 0.01, *** p < 0.001

5. Discussion

In many ways the experimental results are similar to those of [1], providing evidence of external validity and suggesting that respondents think similarly about the problems of plastic bags in the ocean and more general plastic pollution in the ocean. For each treatment, approximately the same fractions of respondents thought that the treatment provided new information. Experimental results suggest that the treatments have larger effects on behaviours than on underlying beliefs and attitudes. A majority of respondents thought after the experimental treatment that their own behaviours would change to be more pro-environmental, and a smaller but still sizeable fraction thought that others’ behaviours would change in similar ways if they were exposed to the same treatment. All treatments had statistically significant positive effects on some, but not all, environmental beliefs and attitudes, though the effects were small. Regarding differences across treatments, seeing a combination of photo and text resulted in the largest estimated effect on a belief in personal responsibility, followed by the text-only treatment, whereas the photo-only treatment had no statistically significant effect.

Results were not identical to those of [1], however. There is strong evidence that all treatments resulted in large pro-environmental changes in attitudes and beliefs for those who didn’t already have strong pro-environmental attitudes and beliefs. This is an issue [1] did not explore. Looking at the sample as a whole, in general there were fewer statistically significant estimated treatment effects in the new experiment. There were almost no statistically significant differences across treatments. In the new experiment the only statistically significant difference across treatments was in the impact on a belief in personal responsibility, or, for the subsample of those without strong pre-existing pro-environmental attitudes, the belief that their individual actions affect the environment. In contrast, in [1] there were some other statistically significant differences across treatments as well. The conjecture in [1] that images without text have a smaller impact that treatments that include text is not strongly supported by the new experiment: except as noted above there were no discernible differences. In [1] the treatments that included text (but not the photo-only treatment) had statistically significant impacts on the belief that plastics are a significant source of ocean pollution, as one might expect. But in the new experiment none of the treatments had statistically significant effects on that belief when the sample as a whole was analysed, and all the point estimates of treatment effects were very small. In [1] all treatments caused statistically significant increases in the belief that individual actions matter, but in the new experiment the only statistically significant effect was for the photo-and-text treatment.

Since the treatments in both the current experiment and [1] consist of brief exposures to images and/or a one-sentence description of the magnitude of plastic pollution in oceans, it may not be surprising that estimated treatment effects are small. Since there were some statistically significant effects, though, and because of the large estimated effects on those without strong pre-existing pro-environmental attitudes and beliefs, providing respondents visual or textual information does seem to be a way to change beliefs, attitudes, and behaviours, especially for those who do not already hold pro-environmental attitudes and beliefs. More prolonged or detailed exposure to the treatments might well have larger effects. And, as noted in [1], much environmental art is meant to be more emotionally shocking than the images used in that or the new experiment. Those other artworks might have larger impacts. In addition, a large majority of respondents thought that plastic pollution in the ocean was a significant problem even before any experimental treatment; effects on other, less publicized environmental problems might be larger, as suggested by the larger estimates for the subsample without...
strong pro-environmental attitudes and beliefs. All experimental treatments resulted in a large majority of respondents wanting to learn more about plastic pollution in the ocean. So even brief exposure to visual or textual information might lead to changes in beliefs, attitudes and behaviours in the future as people learn more about this important environmental problem.

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