# Visual Prompt for Sorting Waste: Feedback Tags

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**Executive Summary**

This study aims to investigate the effect of placing specific feedback tags on UBC's green (organic) waste bins on their users' sorting behavior. Three types of feedback tags are investigated (i.e. positive, negative, and neutral). Information on the tags reflect whether users' sorting behavior at a specific green bin has improved (positive), worsened (negative), or stayed at the same level (neutral) over a certain period of time. Baseline data is collected at eight different locations across the UBC campus, out of which the two locations with the highest contamination rates are chosen to be studied using feedback tags. Data is collected by covert observation. The rate of contamination of each green bin is measured by counting the total number of users and the number of users who cause contamination during a data collection period. Although our results showed all three types of feedback are effective, only the effect of negative feedback is statistically significant. Moreover, the effect varies according to bin location. The findings point to the importance of environmental design strategies for facilitating users' waste sorting behaviors, and, future intervention should aim at fostering users' intrinsic motives to develop the behavior as a habit rather than as rule-following.

**Research Question**

How does the placement of specific feedback tags (positive, negative, or neutral) on UBC's green waste bins affect users' waste sorting behavior across different buildings and space types?

**Hypotheses**

(H1) There will be a decrease in green bin contamination rate after positive feedback is given;
(H2) There will be a decrease in green bin contamination rate after negative feedback is given;
(H3) There will be a decrease in green bin contamination rate after neutral feedback is given;
(H4) There will be no significant difference among the effectiveness of the three types of feedback;
(H5) There will be no significant difference in feedback effectiveness between the two locations.

**Method**

**Participants:** Green bin users (i.e., students, staff, faculty members, etc.) in target areas (i.e., Café area in Earth Sciences Building and first floor lobby in Buchanan A Building).
**Conditions:** The four experimental conditions in this experiment are: (i) pre-experiment baseline condition - no feedback provided; (ii) positive feedback condition - feedback tag with positive message and visual imagery informed bin users of an improvement in contamination rates; (iii) negative feedback condition - feedback tag with negative feedback and visual imagery informed bin users of a worsened contamination rate; (iv) neutral feedback condition -- feedback tag with neutral message and visual imagery informed bin users no change has

occurred in the contamination rates. The feedback tags (**Figure A3**) in all conditions also inform bin users of the most common contaminants in the building.

**Independent variables:** (1) Positive feedback to bin users; (2) Negative feedback to bin users; (3) Neutral feedback to bin users; (4) location;

**Dependent variables:** Contamination rate: defined as the percentage of green bin users in all observed green bin users who placed contaminants. Contaminants identified with criteria provided by UBC **(See Appendix A - Figure A1)**.

**Measures:** Covert observation record of Green bin users 'contamination behaviors.

**Procedures:**

1. Pre-experiment baseline setting phase In the beginning of the study, for a period of 2 days, baseline contamination rates and types were collected in each of these following locations: (i) Café in Buchanan A building, (ii) Café in Sauder Business School, (iii) Café in the Fred Kaiser Building, (iv) Café in the Earth Science Building, (v) 1st floor lobby area in Buchanan A Building, (vi) 2nd floor lobby area in Buchanan A Building, (vii) Kenny Building office area, and, (viii) Buchanan C Building office area. Contamination rates in the first 6 locations were recorded through covert observation by a researcher from 12-2pm, who observed for the number of users who placed contaminants into the large green bin **(See Appendix A - Figure A2)**. In the remaining 2 office areas, due to the smaller sizes of the green bins, researchers counted the number of contaminants by sight at around 3 pm. The most common contaminant was identified for each location and included in the feedback. All data collection was carried on weekdays.

2. Experimental phase Out of all the locations listed earlier, due to limited time and manpower, the café area in Earth Science Building and the 1st floor lobby in Buchanan A were selected for having the highest contamination rates, to test our feedback tag conditions **(See Appendix A - Figure A2)**. In these locations, the neutral feedback tags were applied first, followed by the positive feedback tags and negative feedback tags in order. In each of these conditions, the contamination rate and types were observed for a period of 2 days, through covert observation by researcher mentioned earlier.

3. Post-experiment comparison phase Finally, in each location, the green bin contamination rates under each condition (i.e. positive, negative and neutral) were compared to the location-specific baselines recorded earlier to find any change in contamination (i.e. specific effect of intervention). The specific decreases and increases in contamination rates in each location were also compared to see if intervention effect of different feedback differs across locations.

**Data analysis:** The contamination rate for the target bin of each location was calculated based on the total number of users and the number of users who caused contamination (see **Appendix C** for a sample calculation). The reduction of contamination rate was also calculated as a percentage, based on the contamination rate obtained during baseline measurement and that obtained during experimental intervention measurement (see **Appendix C** for a sample calculation). The two-way ANOVA analysis (without replication) function in Microsoft Excel was used to analyze the results.

**Results**

In general, the usage of each type of feedback tag was effective for reducing green bin contamination rate across both locations **(Figure 1**) and a summary of the reductions in percentages can be found in **Table B3 (See Appendix B).**

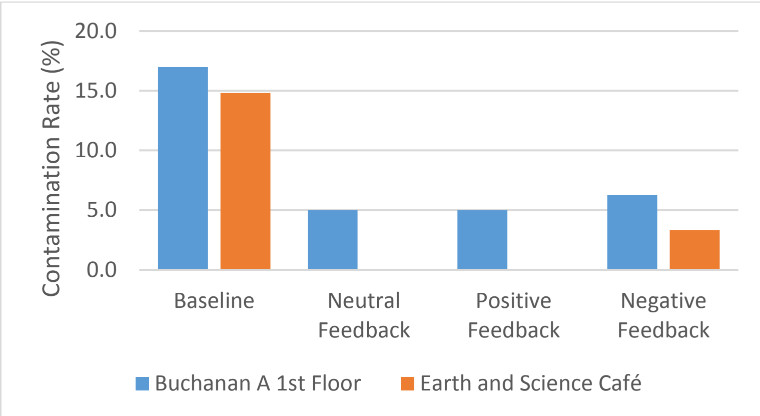


**Figure 1:** The Effect of Feedback Tags

Positive feedback condition The placement of the positive feedback tag reduced the contamination rate of the target green bin on the first floor of Buchanan Building A Block from 17.0% to 5.0% (70.6% reduction). For the target green bin in the café area of Earth Sciences Building, the contamination rate was reduced from 14.8% to 0.0% (100.0% reduction). A two-way ANOVA analysis was performed to evaluate the contamination reduction by positive feedback across locations. A p-value of 0.067 was obtained (indicating that the result is insignificant).

Negative feedback condition The placement of the negative feedback tag reduced the contamination rate of the target green bin on the first floor of Buchanan Building A Block from 17.0% to 6.3% (63.2% reduction). For the target green bin in the café area of Earth Sciences Building, the contamination rate was reduced from 14.8% to 3.3% (77.5% reduction). A two-way ANOVA analysis was performed to evaluate the contamination reduction by negative feedback across locations. A p-value of 0.021 was obtained (indicating that the result is significant).

Neutral feedback condition On the first floor of Buchanan Building A Block (lobby area outside classroom), the placement of the neutral feedback tag reduced the contamination rate of the target green bin from 17.0% (baseline) to 5.0% (70.6% reduction). In the café area of Earth Sciences Building, the placement of the neutral feedback tag reduced the contamination rate of the target green bin from 14.8% (baseline) to 0.0% (100.0% reduction). A two-way ANOVA analysis was performed to evaluate the contamination reduction by neutral feedback across locations. A p-value of 0.067 was obtained (indicating that the result is insignificant). It is worth-noting that these results are identical to the results for positive feedback tags.

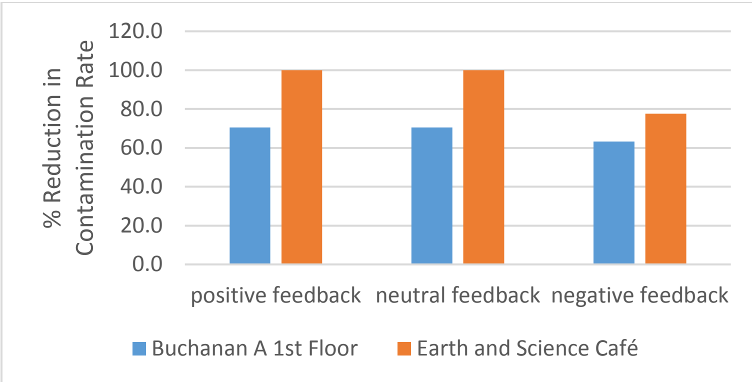


**Figure 2:** Comparison of Treatment Effects Among Types of Tags and Between Locations

A greater reduction in contamination rate was found in Earth and Science Café for all types of feedback tags used as compared to that on the 1st floor of Buchanan A Building (**Figure 2**). A two-way ANOVA analysis was used to evaluate the significance of this difference. A p-value of 0.040 was obtained (indicating that the result is significant). In addition, a two-way ANOVA analysis was used to compare the effectiveness of intervention among the three types of feedback tags. A p value of 0.20 was obtained, indicating that there is no significant difference in treatment effectiveness among the different types of feedback tags.

## Discussion:

All kinds of feedback included in this study led to high reduction in bin contamination rates (>60%). Furthermore, the two-way ANOVA suggests that there are no significant differences in effectiveness between all types of feedback. This suggests that providing feedback tags, regardless of the nature of its message, is effective in reducing contamination of green bin. However, although all feedback conditions led to reduced rates of contamination in green bins, only the reduction in the negative feedback condition is statistically significant ($p=0.021$). Therefore, our results support (H2) and (H4), but not (H1) and (H3).

Comparing locations, contamination reduction is generally greater in café area of the Earth Sciences Building than in the 1st floor lobby of Buchanan A Building. Two-way ANOVA shows that the difference is significant ($p=0.040$). This suggests that intervention effectiveness of the same type of feedback differs depending on location. In sum, although all feedback, regardless of types, may be similarly effective in reducing contaminations, effectiveness of feedback may vary across a range of locations. (H5) is thus not supported.

The differences of intervention effectiveness between locations may owe itself to the very different function and atmosphere of the locations observed in this study. The participants' emotional state and availability of cognitive resources may be very different in an educational area (i.e. Buchanan A) than in a resting area (i.e. Earth Sciences Building café). It may be beneficial to look at how location types, personal mental states and bin use interact. One way we can at least look at how different location types interact with bin use is to include data across more locations.

**Limitation of study:** The lack of statistical significance in the neutral and positive condition may owe itself to the small sample sizes included in this study. The small sample sizes were a result of the narrow time frame (i.e. 12-2pm) used for observation in this study.

Although it is reasonable to assume 12-2pm to be the time when people are in most active use of green bins because of lunch hours, green bin usage in those two intensive hours is still a fraction of the total usage. It is also possible that the body of contaminants found in green bins made their way into the green bin sporadically through the day, and our study missed a lot of this valuable data. Thus, in order to overcome the problem with small sample sizes, it may be beneficial to monitor the green bins for a longer duration of time covering more stages of a day.

Furthermore, there are many other factors from the environments we conducted our observations in that we did not control. For instance, we could not control how the cleaning lady's scolds affected participants' sorting behavior (this did happen in our trials), and more subtlety, how people might have altered their sorting behavior simply by witnessing the sorting behavior of the person before them. Moreover, it was difficult for researchers to confirm if the participants have read the feedback tags or have read them correctly or not. In effect, behavioral change unrelated to reading of tags may contaminate our data, and this may potentially weaken our confidence and ability to establish link between providing feedback and contamination reduction.

Creating a similar sorting scenario in a laboratory setting will destroy the ecological validity of the study, but it is possible to reduce some interference, such as informing UBC staff not to intervene erroneous bin use, or have more observers at one location at one time to better cover different aspects of bin use (e.g. tag reading, disposed item, contamination, etc.) and increase inter-rater reliability. It may also be beneficial to explore how bin users consume feedback information by changing features of the feedback tags, such as adjusting the sizes of the image and words, changing word fonts, style of message or omitting and adding information to the feedback tags.

**Recommendations for UBC Clients:**

The more appropriate use of green bins in the Earth Sciences Building, rather than in Buchanan A building, may be related to differences in availability of cognitive resources in different types of area. As Buchanan A lobby is an educational space, students are likely to be preoccupied with their lectures and transitions between classes, whereas in the Earth Sciences café, students are more likely to be in a restful state. Student's fewer available cognitive resources in Buchanan A than Earth Sciences café, as a result of their mental state and surroundings, may explain the discrepancy in appropriate green bin use across these two locations.

Therefore, future intervention design should focus on how to lower the cognitive demands of using green bins properly. While the feedback tags tested in this study have been designed with that intention, perhaps more measures other than feedback tags may be taken to further lower cognitive demands.

Furthermore, the fact that negative feedback seems to be more effective in reducing contamination rates to a certain reflect the motives or the reasons why clients observe green bin use. They follow green bin use because they do not want to break rules, rather than they think the rules are good to themselves. The former is an extrinsic motivator while the latter is more intrinsic. Therefore, we need to find out some intervention strategies that will intrinsically motivate clients to perform the green bin use for their own good

## Appendix A: Pictures


**Figure A1:** Evaluation Criteria

(a) Large Bin

(b) Small Bin

**Figure A2:** Bin Types


(a) Positive (b) Neutral (c) Negative

**Figure A3:** Feedback Tags


**Figure A4:** Feedback Tag Placement

## Appendix B: Data

**Table B1:** Raw Data

| Date | Location | Location Type | Bin Type | Condition | Method | Time | Duration | Total # of Users | Contamination | Contamination Type |
|---|---|---|---|---|---|---|---|---|---|---|
| 02-Mar | Buchanan Café | food | large | baseline | observation | lunch | 2 hr | 30 | 0 | N/A |
| 02-Mar | Sauder Café | food | large | baseline | observation | lunch | 2 hr | 22 | 0 | N/A |
| 03-Mar | Buchanan Café | food | large | baseline | observation | lunch | 2 hr | 29 | 0 | N/A |
| 03-Mar | Sauder Café | food | large | baseline | observation | lunch | 2 hr | 11 | 0 | N/A |
| 07-Mar | Kaiser Café | food | large | baseline | observation | lunch | 2 hr | 13 | 0 | N/A |
| 07-Mar | Earth and Science Café | food | large | baseline | observation | lunch | 2 hr | 10 | 2 | plastic |
| 08-Mar | Kaiser Café | food | large | baseline | observation | lunch | 2 hr | 18 | 0 | N/A |
| 08-Mar | Earth and Science Café | food | large | baseline | observation | lunch | 2 hr | 13 | 2 | plastic |
| 09-Mar | Buchanan A 1st Floor | classroom | large | baseline | observation | lunch | 2 hr | 21 | 1 | plastic |
| 09-Mar | Buchanan A 2nd Floor | classroom | large | baseline | observation | lunch | 2 hr | 5 | 0 | N/A |
| 10-Mar | Buchanan A 1st Floor | classroom | large | baseline | observation | lunch | 2 hr | 23 | 8 | coffee cup/sleeve |
| 10-Mar | Buchanan A 2nd Floor | classroom | large | baseline | observation | lunch | 2 hr | 5 | 0 | N/A |
| 14-Mar | Buchanan C Office | office | small | baseline | direct measurement | afternoon | N/A | 13 | 1 | coffee cup |
| 14-Mar | Kenny Office | office | small | baseline | direct measurement | afternoon | N/A | 34 | 0 | N/A |
| 15-Mar | Buchanan C Office | office | small | baseline | direct measurement | afternoon | N/A | 22 | 1 | coffee cup |
| 15-Mar | Kenny Office | office | small | baseline | direct measurement | afternoon | N/A | 32 | 1 | coffee cup |
| 16-Mar | Buchanan C Office | office | small | baseline | direct measurement | afternoon | N/A | 9 | 0 | N/A |
| 16-Mar | Kenny Office | office | small | baseline | direct measurement | afternoon | N/A | 32 | 0 | N/A |
| 17-Mar | Buchanan C Office | office | small | baseline | direct measurement | afternoon | N/A | 19 | 1 | coffee cup |
| 17-Mar | Kenny Office | office | small | baseline | direct measurement | afternoon | N/A | 34 | 0 | N/A |
| 24-Mar | Buchanan A 1st Floor | classroom | large | neutral | observation | lunch | 2 hr | 29 | 2 | coffee cup/sleeve |
| 24-Mar | Earth and Science Café | food | large | neutral | observation | lunch | 2 hr | 12 | 0 | N/A |
| 27-Mar | Buchanan A 1st Floor | classroom | large | neutral | observation | lunch | 2 hr | 28 | 1 | coffee cup |
| 27-Mar | Earth and Science Café | food | large | neutral | observation | lunch | 2 hr | 14 | 0 | N/A |
| 28-Mar | Buchanan A 1st Floor | classroom | large | positive | observation | lunch | 2 hr | 20 | 0 | N/A |
| 28-Mar | Earth and Science Café | food | large | positive | observation | lunch | 2 hr | 25 | 0 | N/A |
| 03-Apr | Buchanan A 1st Floor | classroom | large | positive | observation | lunch | 2 hr | 18 | 2 | coffee cup/sleeve |
| 29-Mar | Earth and Science Café | food | large | positive | observation | lunch | 2 hr | 16 | 0 | N/A |
| 30-Mar | Buchanan A 1st Floor | classroom | large | negative | observation | lunch | 2 hr | 19 | 0 | N/A |
| 30-Mar | Earth and Science Café | food | large | negative | observation | lunch | 2 hr | 18 | 1 | plastic |
| 04-Apr | Buchanan A 1st Floor | classroom | large | negative | observation | lunch | 2 hr | 26 | 3 | coffee cup, plastic |
| 31-Mar | Earth and Science Café | food | large | negative | observation | lunch | 2 hr | 11 | 0 | N/A |

**Table B2:** Summarized Baseline Measurement

| Location | Condition | Total # of Users | Contamination | Contamination Rate (%) |
|---|---|---|---|---|
| Buchanan Café | baseline | 59 | 0 | 0.0 |
| Sauder Café | baseline | 33 | 0 | 0.0 |
| Kaiser Café | baseline | 31 | 0 | 0.0 |
| Earth and Science Café | baseline | 23 | 4 | 14.8 |
| Buchanan A 1st Floor | baseline | 44 | 9 | 17.0 |
| Buchanan A 2nd Floor | baseline | 10 | 0 | 0.0 |
| Buchanan C Office | baseline | 63 | 3 | 4.5 |
| Kenny Office | baseline | 132 | 1 | 0.8 |

**Table B3:** Summarized Intervention Measurement

| Location | Condition | Total # of Users | Contamination | Contamination Rate (%) |
|---|---|---|---|---|
| Buchanan A 1st floor | baseline | 44 | 9 | 17.0 |
| Buchanan A 1st floor | neutral | 57 | 3 | 5.0 |
| Buchanan A 1st floor | positive | 38 | 2 | 5.0 |
| Buchanan A 1st floor | negative | 45 | 3 | 6.3 |
| Earth and Science Café | baseline | 23 | 4 | 14.8 |
| Earth and Science Café | neutral | 26 | 0 | 0.0 |
| Earth and Science Café | poaitive | 41 | 0 | 0.0 |
| Earth and Science Café | negative | 29 | 1 | 3.3 |

## Appendix C: Sample Calculations

1. The calculation of contamination rate R (example):

   Given that

   i. A total of 10 users used the target green bin during a data collection session
   ii. 8 of them sorted correctly
   iii. 1 of them threw one coffee cup (incorrect) and one plastic bag (incorrect) into the target green bin
   iv. 1 of them threw one metal can (incorrect) into the target green bin

   Then

   R $= \frac{[the\ number\ of\ target\ green\ bin\ users\ who\ sorted\ incorrectly]}{[the\ total\ number\ of\ target\ green\ bin\ users]} * 100\%$
   $= \frac{n_c}{n_t} * 100\%$
   $= \frac{2}{10} * 100\%$
   = 20%

2. The calculation of reduction in contamination rate (example):

   Given that

i The contamination rate obtained during baseline measurement at a specific location is 15%

ii The contamination rate obtained during intervention measurement (e.g. positive feedback tag) at that location is 5%,

Then

$$\text{Reduction} = \frac{[baseline\ contamination\ rate] - [intervention\ contamination\ rate]}{[baseline\ contamination\ rate]} * 100\%$$

$$= \frac{15\% - 5\%}{15\%} * 100\%$$

$$= 66.7\%$$

The contamination rate at this location has reduced by 66.7% due to the current intervention.

**Table C1:** Example of Excel ANOVA Analysis Result

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Rows | 6.4591814 | 1 | 6.4591814 | 45.8891894 | 0.09330387 | 161.447639 |
| Columns | 123.35005 | 1 | 123.35005 | 876.339194 | 0.02149705 | 161.447639 |
| Error | 0.14075606 | 1 | 0.14075606 | | | |
| | | | | | | |
| Total | 129.949988 | 3 | | | | |