Trash Or Treasure: Using Positive Reinforcement to Reduce Contamination and Increase Recycling in Return-It Bins

Group 7 - Can It!
Hanna Chan, Natalie Chien, Nik Francinilla-De Guzman, Rebecca Jiang, Natalie Lin, Samantha Teng, and Rosalina Zhou

The University of British Columbia
PSYC 421 001 2024-25W2 Environmental Psychology
Professor Jiaying Zhao
April 8, 2025
Prepared for: The Alma Mater Society

EXECUTIVE SUMMARY

Introduction
This study explored whether positive reinforcement messages ("More Clean Bottles = More Money for AMS Food Bank") could reduce contamination and increase the number of eligible recyclable items in Return-It bins.

Research Question
How does a positive reinforcement message influence the number of contaminated and eligible items disposed of in Return-It Bins in the UBC Nest?

Methods
A two-week observational field study was conducted using a between-groups design. Bin 1 (control) and Bin 2 (experimental) were monitored during a baseline and intervention. The experimental bin displayed the positive message during the intervention week, while the control bin did not. Researchers recorded counts of contaminated and eligible recyclable items.

Results
Fisher's Exact Test revealed a statistically significant reduction in contaminated items in the experimental bin compared to the control bin during the intervention ($p = .0002$, Cramér's $V = 0.22$). However, a Chi-squared Test found no significant increase in eligible items between the conditions ($p = .5397$, Cramér's $V = 0.04$).

Recommendations
Based on findings, we recommend that UBC implement positive reinforcement messaging on all Return-It bins across campus, paired with clear signage, strategic bin placement, and digital awareness campaigns to reduce the number of contaminants and increase the number of eligible items.

Table of Contents

INTRODUCTION

The Return-It program was implemented at the University of British Columbia (UBC) as part of the AMS Sustainability zero waste initiative. This program encourages proper disposal of recyclable beverage containers while reinvesting the returns into AMS Food Bank (AMS Sustainability, 2023). In an effort to boost recycling and reduce contamination, we investigated whether positive reinforcement messages could influence recycling behaviors within the UBC Nest Return-It Program.

Studies have shown that signage and education can reduce recycling contamination (Austin et al., 1993), while others argue that motivational appeals, especially those tied to social norms or emotional incentives, can be even more effective (Cialdini, 2003; Kallgren et al., 2000). Further, Kreps (1997) and Abott et al. (2013) advise initiatives to focus on the voluntary nature of directed prosocial actions when using positive reinforcement to encourage environmentally friendly behaviours. Positive reinforcement messaging is effective but can face a ceiling effect in larger scaled environmentally friendly interventions (Ceschi et al., 2021).

Skinner (1958) defined positive reinforcement as the increased frequency in a behavior following the presentation of a stimulus. The Return-It program has a positive reinforcement stimulus in the form of providing AMS Sustainability with 10 cents per bottle returned to reinvest into AMS Food Bank. Although there is an incentive present, individuals using Return-It bins often are either not aware of this or the effect of this incentive is negligible. Research indicates that financial incentives decrease intrinsic motivation to act in an environmentally friendly manner (Xu et al., 2023).

Despite these insights, few studies have tested how prosocial positive reinforcement messages influence recycling outcomes when linked to community benefits, in real-world university settings. Our study addresses this gap by testing a message that connects individual recycling actions to a tangible social outcome: **"More Clean Bottles = More Money for the AMS Food Bank."** This kind of reinforcement not only taps into emotional motivation (hope, pride, contribution to others), but also provides a clear directive for behavior. By observing changes in contamination and eligible items counted before and after message exposure, our experiment contributes to the growing literature on behaviorally informed recycling interventions in shared public spaces.

RESEARCH QUESTION AND HYPOTHESIS

Research question

How does a positive reinforcement message influence the number of contaminated and eligible items disposed of in Return-It Bins in the UBC Nest?

Hypothesis

Given that positive reinforcement has been shown to promote desirable behavior and reduce undesirable actions in public settings, there are two hypotheses for this research study:

Hypothesis 1. Return-It Bins with a positive reinforcement message ("More Clean Bottles = More Money for AMS Food Bank") will have lower contamination levels compared to bins without a message.

Hypothesis 2. Return-It Bins with a positive reinforcement message ("More Clean Bottles = More Money for AMS Food Bank") will have a higher number of correctly recycled items compared to bins without a message.

METHODS

Participants

The target sample size for this between-groups design was determined through a power analysis, which recommended 785 items to ensure power= .9 and α= .05 (*see Appendix II - Fig. 1.1.*). However, the researchers managed to only collect a sample size of 232 items (*see Appendix II - Fig. 1.2),* with 95 from the Bin 1 (control) and 137 from the Bin 2 (experimental). The study focused on items in the bins rather than individual participant data. The sample of bin users likely consisted of young adults aged 18-30, primarily students and staff from the University of British Columbia.

Conditions

This between-groups design involved two independent variables (IVs). The first IV was the type of bin: Bin 1 served as the control bin with no intervention, and Bin 2 served as the experimental bin, which displayed a positive reinforcement message on a poster during the intervention week. The second IV was the time period: baseline (March 5-11) and intervention (March 13-19). This design resulted in four conditions:

1. Bin 1 (control) during baseline (March 5-11)
2. Bin 1 (control) during intervention (March 13-19)
3. Bin 2 (experimental) during baseline (March 5-11)
4. Bin 2 (experimental) during intervention (March 13-19)

The positive reinforcement message, "More Clean Bottles = More Money for the AMS Food Bank," was displayed on Bin 2 during the intervention week (*see Appendix I*). This message aimed to target proper recycling behaviors by associating recycling with rewarding a charitable cause, where more clean bottles meant more money for the AMS Food Bank.

Measures

The two primary dependent variables were the number of contaminated items and the number of eligible recyclable items disposed of in the bins. Contaminated items were defined as non-recyclable materials disposed of in the bins (e.g., food waste, plastic bags). Eligible recyclable items were clean items that meet the Return-It program's criteria for recycling (e.g., plastic bottles, cans, juice boxes) (*see Appendix I*). The researchers observed both bins daily from 11:00 am to 5:00 pm during both the baseline (March 5-11) and intervention (March 13-19) weeks to record the number of contaminated and eligible recyclable items. Working in pairs, researchers took 2-hour shifts and rotated each day to ensure the bins were constantly observed. Additionally, photos were taken at 11:00 am before observation began, and at 5:00 pm after observation ended each day for each bin, to capture changes during the unobserved periods.

It is important to note that contamination rates and recycling rates were not directly calculated. Instead, raw counts of contaminants and eligible recyclables were conducted to assess recycling behaviors.

Procedure

The study aimed to assess the impact of a positive reinforcement message on recycling behaviors at the AMS Student Nest, a high-traffic area on the University of British Columbia Vancouver campus. The primary objective was to determine whether the presence of a positive reinforcement message led to a reduction in contamination and an increase in eligible recyclable items disposed of correctly.

The study utilized two Return-It bins: Bin 1 (control) and Bin 2 (experimental). During the baseline week (March 5-11), both bins were monitored without any intervention, and the types of items disposed of were categorized as either contaminants or eligible recyclables. During this period, data were collected daily from 11:00 am to 5:00 pm to account for variations in foot traffic and recycling activity.

During the intervention week (March 13-19), a positive reinforcement message was placed on Bin 2, while Bin 1 remained unchanged. Researchers continued to monitor both bins daily from 11:00 am to 5:00 pm, recording the number of contaminated and eligible recyclable items.

Challenges in the study include relatively low volume of items disposed of, external events that led to increased foot traffic, and having an unintended poster placed on Bin 1 during the baseline period (March 10) (*see Appendix II - fig. 2.1*). Despite these issues, sufficient data was collected to draw meaningful conclusions.

RESULTS

Descriptive Statistics

Over the period of the two-week observational study, a cumulative total of 232 items were recorded across both the Return-It bins. In the baseline week, 95 items were collected from both bins, of which 86 (90.5%) were marked as eligible and 9 (9.5%) as contaminated. However, in the intervention week, a cumulative total of 137 items were gathered, comprising 119 (86.9%) being categorized as eligible and 18 (13.1%) as contaminated *(see Appendix III - Table 1.1)*.

While the overall number of items disposed of went up during the intervention week, largely due to coincidental campus events (e.g., UBC Triathlon, Storm the Wall), preliminary comparisons revealed differences in the proportion of contaminated and eligible items by condition *(see Appendix III - Fig, 1.1)*. Specifically, the experimental bin, which received the positive reinforcement poster, had decreased the number of contaminated items from 9 to 4, while overall item disposal had increased *(see Appendix III - Fig. 1.2)*.

Analysis of Contaminated Items (Hypothesis 1)

To evaluate Hypothesis 1, which predicted that the presence of a positive reinforcement message would result in a reduction in contamination, a 2×2 contingency table was constructed comparing the number of contaminated and non-contaminated items between the baseline and intervention conditions *(see Appendix III - Table 2.1)*. Due to a zero value in one of the cells during the baseline condition (no contamination observed in Bin 1), the assumptions of the chi-square test were violated. Therefore, a Fisher's Exact Test was used.

Fisher's Exact Test *(see Appendix III - Fig. 2.1)* revealed a statistically significant association between condition and contamination status, p = 0.0002, indicating that contamination was significantly lower in the intervention condition. An effect size was calculated using Cramér's V, which yielded a value of 0.22 *(see Appendix III - Fig. 2.2)*, indicating a small-to-moderate association between the presence of the poster and contamination levels. These results support Hypothesis 1, suggesting that the positive reinforcement message was effective in reducing contamination in the Return-It bins.

Analysis of Eligible Items (Hypothesis 2)

To test Hypothesis 2, which posited that the number of correctly recycled (eligible) items would increase in the presence of the positive reinforcement message, a second 2×2 contingency table was created comparing the number of eligible items between the baseline and intervention conditions *(see Appendix III - Table 3.1)*. In this case, the assumptions of the chi-square test were met.

A Chi-squared Test of Independence revealed that the difference in eligible item disposal between the two conditions was not statistically significant. $\chi^2(1, N = 232) = 0.3761$, p = .5397 *(see Appendix III - Fig. 3.1)*. Although the raw number of eligible items was higher in the intervention condition (n = 119) than in the baseline condition (n = 86), this difference was not statistically meaningful. The corresponding Cramér's V = 0.04, suggesting a negligible effect size *(see Appendix III -Fig. 3.2)*.

Therefore, Hypothesis 2 was not supported, indicating that the positive reinforcement message did not significantly increase the number of eligible items disposed of in the Return-It bins.

DISCUSSION

This study examined whether a positive reinforcement message could reduce contamination and increase the number of eligible items placed in Return-It Bins. The results suggest that the intervention was effective in decreasing contamination, but not in increasing eligible item disposal. Statistical analysis revealed a significant decrease in contamination during the intervention week, which supports hypothesis 1— positive reinforcement would effectively decrease contamination in Return-It bins. This suggests that clear messaging likely decreased confusion and prompted more thoughtful disposal behavior. Although these results indicate a decrease in contamination, the effect size was small which suggest unintended behavioural changes. This implies that participants may be shifting contamination to adjacent bins due to uncertainty about what eligible items mean.

In contrast, there was no statistically significant increase in the number of eligible items during intervention week, which led to the rejection of hypothesis 2 — positive reinforcement messaging would increase the amount of eligible items being disposed of. This result may be attributed to several confounding factors. For instance, events taking place in the NEST during the experimental week could have influenced foot traffic and bin usage, leading to inconsistent disposal behavior. Additionally, confusion caused by the presence of other recycling bins nearby may have made it harder for participants to understand or act on the poster message, diluting its potential effect on proper recycling.

These results have several implications. First, they reinforce prior research showing that positive reinforcement can modify behavior when the messaging is simple, visible, and emotionally motivating (Micaelsen & Esch, 2023). The significant reduction in contamination builds upon previous findings that emotional appeals, like pride or contributing to a cause, can enhance environmental responsibility (Liu & Yang, 2022). Second, the lack of a significant increase in eligible items highlights the limitations of relying solely on messaging, especially in environments with competing stimuli or unclear infrastructure. This finding aligns with previous research that motivational messaging alone may not be enough — positive reinforcement should be combined with other strategies like clear signage or social norm reinforcement to effectively increase desired recycling behaviors (Metzler 2023).

Limitations

This study had several limitations. The sample size (N = 232) fell short of the target (N = 785), limiting the statistical power of the results. Only two bins were used over a short time frame, which limited data collection. Additionally, usage varies between bins, with Bin 2 consistently receiving more items, likely due to better visibility and surrounding seating. This imbalance may have influenced contamination and usage rates and reduced the overall effect size. Uncontrolled factors also impacted data accuracy. During the final control week, an unknown poster was installed on Bin 2, which may have affected disposal behavior (*See Appendix II - Fig 2.1*). Furthermore, increased foot traffic from campus events such as the triathlon, Makers Market, and Storm the Wall may have skewed typical disposal patterns. Future studies are recommended to include larger sample size, longer data collection periods, the inclusion of more bins, and control for external events to better assess the impact of positive reinforcement on eligible item disposal and contamination rates.

RECOMMENDATIONS

Our project supports AMS sustainability goals by demonstrating how behavioral psychology can enhance recycling practices. As part of the UBC SEEDS Sustainability Program, our work exemplifies the “living lab” approach—bridging academic research with operational priorities to inform campus policies and planning (UBC SEEDS Sustainability Program, 2019). By applying theory to practice, the initiative contributes to building a resilient, sustainable campus community while aligning with SEEDS’ mission to advance sustainability through student-led research.

To ensure this work has lasting impact, we recommend a campus-wide implementation of our positive reinforcement poster *(see Appendix IV - Fig. 1.1)*, using our tested poster to create consistent visual cues that reduce user confusion and encourage proper recycling behavior. This is consistent with Michaelsn and Esch’s (2023) findings that positive reinforcement can effectively modify behavior. To evaluate the long-term effectiveness, we suggest that UBC conduct longitudinal studies in a variety of settings and seasons. To address the low volume of items collected compared to projections, we recommend that UBC conducts further research around high-traffic areas such as the AMS Nest and academic buildings to identify more strategic bin placements that maximize visibility and accessibility. This aligns with Rosenthal and Linder’s (2021) findings that making bins easier to locate and more accessible could encourage higher participation rates and reduce contamination.

To amplify the impact of these physical interventions, we also suggest that UBC leverage its existing communication platforms—such as Instagram, digital signage, and student newsletters—to raise awareness about the Return-It program. These channels can educate the campus community on what qualifies as an eligible item, as well as to emphasize the environmental importance of responsible recycling. This recommendation supports UBC SEEDS’ objective of using interdisciplinary engagement to address sustainability challenges and helps foster a culture of collective responsibility (UBC SEEDS Sustainability Program, 2019). Furthermore, we recommend integrating waste-sorting guidance into student orientation and residence onboarding, helping to build sustainable habits early and establish a shared understanding of campus expectations.

REFERENCES

Abbott, A., Nandeibam, S., & O'Shea, L. (2013). Recycling: Social norms and warm-glow revisited. *Ecological Economics*, *90*, 10–18. https://doi.org/10.1016/j.ecolecon.2013.02.015

Abubakar IR, Maniruzzaman KM, Dano UL, AlShihri FS, AlShammari MS, Ahmed SMS, Al-Gehlani WAG, Alrawaf TI. Environmental Sustainability Impacts of Solid Waste Management Practices in the Global South. Int J Environ Res Public Health. 2022 Oct 5;19(19):12717. doi: 10.3390/ijerph191912717. PMID: 36232017; PMCID: PMC9566108.

Austin, J., Hatfield, D. B., Grindle, A. C., & Bailey, J. S. (1993). Increasing recycling in office environments: The effects of specific, informative cues. Journal of Applied Behaviour Analysis, 26(2), 247–253. https://doi.org/10.1901/jaba.1993.26-24

Cakanlar, A., Hunter, M., & Nenkov, G. Y. (2024). Recycle right: How to decrease recycling contamination with informational point-of-disposal signage. Journal of the Academy of Marketing Science. https://doi.org/10.1007/s11747-024-01058-1

Caguiat, I. D., Chiu, R., & Wong-Abul, E. (2023, July 1). *July 2023 Sustainability Priorities Report*. UBC AMS. https://www.ams.ubc.ca/wp-content/uploads/2023/07/July-2023-Sustainability-Priorities-Report-reduced.pdf

Ceschi, A., Sartori, R., Dickert, S., Scalco, A., Tur, E. M., Tommasi, F., & Delfini, K. (2021). Testing a norm-based policy for waste management: An agent-based modeling simulation on nudging recycling behavior. *Journal of Environmental Management*, 294, 112938. https://doi.org/10.1016/j.jenvman.2021.112938

Cialdini, R. B. (2003). Crafting Normative Messages to Protect the Environment. *Current Directions in Psychological Science*, 12(4), 105-109. https://doi.org/10.1111/1467-8721.01242 (Original work published 2003)

Enginkaya, E., & Sağlam, M. H. (2024). Recycling Reinforced: The Synergistic Dynamics of Sustainable Behavior. *Sustainability*, *16*(9), 3827. https://doi.org/10.3390/su16093827

Kals, E., Schumacher, D., & Montada, L. (1999). Emotional Affinity toward Nature as a Motivational Basis to Protect Nature. Environment and Behavior, 31(2), 178-202. https://doi.org/10.1177/00139169921972056 (Original work published 1999)

Kallgren, C. A., Reno, R. R., & Cialdini, R. B. (2000). A Focus Theory of Normative Conduct: *When Norms Do and Do not Affect Behavior. Personality and Social Psychology Bulletin*, 26(8), 1002-1012. https://doi.org/10.1177/01461672002610009 (Original work published 2000)

Kang, Y.-C., Hsiao, H.-S., & Ni, J.-Y. (2022). The Role of Sustainable Training and Reward in Influencing Employee Accountability Perception and Behavior for Corporate Sustainability. *Sustainability*, 14(18), 11589. https://doi.org/10.3390/su141811589

Xu, L., Yang, H. and Ling, M. (2023). Factors moderating the effect of financial incentives on household recycling: A motivation crowding perspective. *Environmental Impact Assessment Review*, 100, p.107078. https://doi.org/10.1016/j.eiar.2023.107078.

Liu, Z., & Yang, J. Z. (2022). Predicting Recycling Behavior in New York State: an integrated model. *Environmental Management*, (70) 6, 1023-1037. https://doi.org/10.1007/s00267-022-01708-6

Metzler, M. (2023, June). Effectiveness of motivational messages, information and reminders on recycling: Experimental study in Hammonton, New Jersey. GGU Law Digital Commons. https://digitalcommons.law.ggu.edu/capstones/223/

Michaelsen, M. M., & Esch, T. (2023). Understanding health behavior change by motivation and reward mechanisms: a review of the literature. *Frontiers in behavioral neuroscience*, 17, 1151918. https://doi.org/10.3389/fnbeh.2023.1151918

Skinner, B. F. (1958). Reinforcement today. *American Psychologist*, *13*(3), 94–99. https://doi.org/10.1037/h0049039

SEEDS Sustainability Program. (2019, January 10). Sustain.ubc.ca. https://sustain.ubc.ca/programs/seeds-sustainability-program

Rosenthal, S., & Linder, N. (2021). Effects of bin proximity and informational prompts on recycling and contamination. *Resources, Conservation and Recycling*, 168, 105430. https://doi.org/10.1016/j.resconrec.2021.105430

APPENDIX I: Intervention Poster (Original)

Figure 1.1 - Positive Reinforcement Poster (Original)

APPENDIX II: Methods

I. Participants

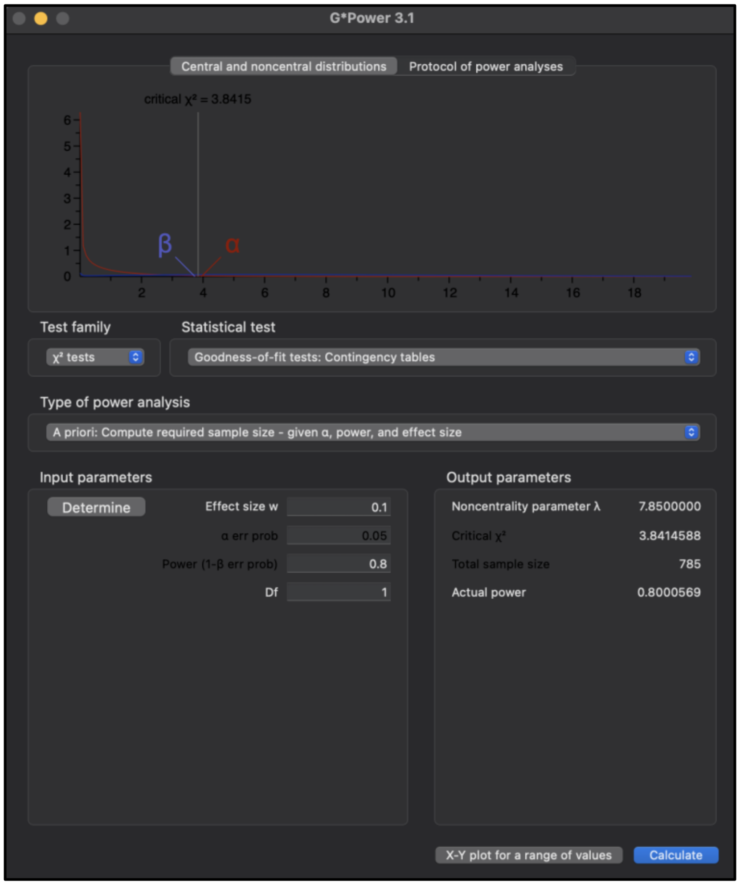

Figure 1.1 - Power Analysis Result

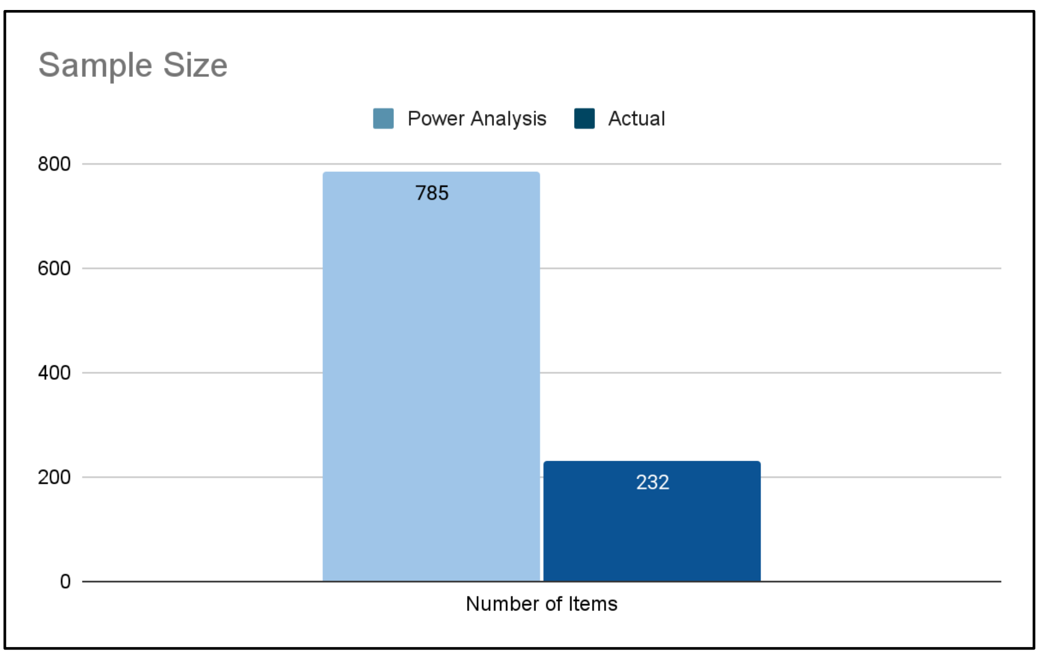

Figure 1.2 - Power Analysis vs Actual Count (Sample Size)

II. Procedure - Challenges during data collection

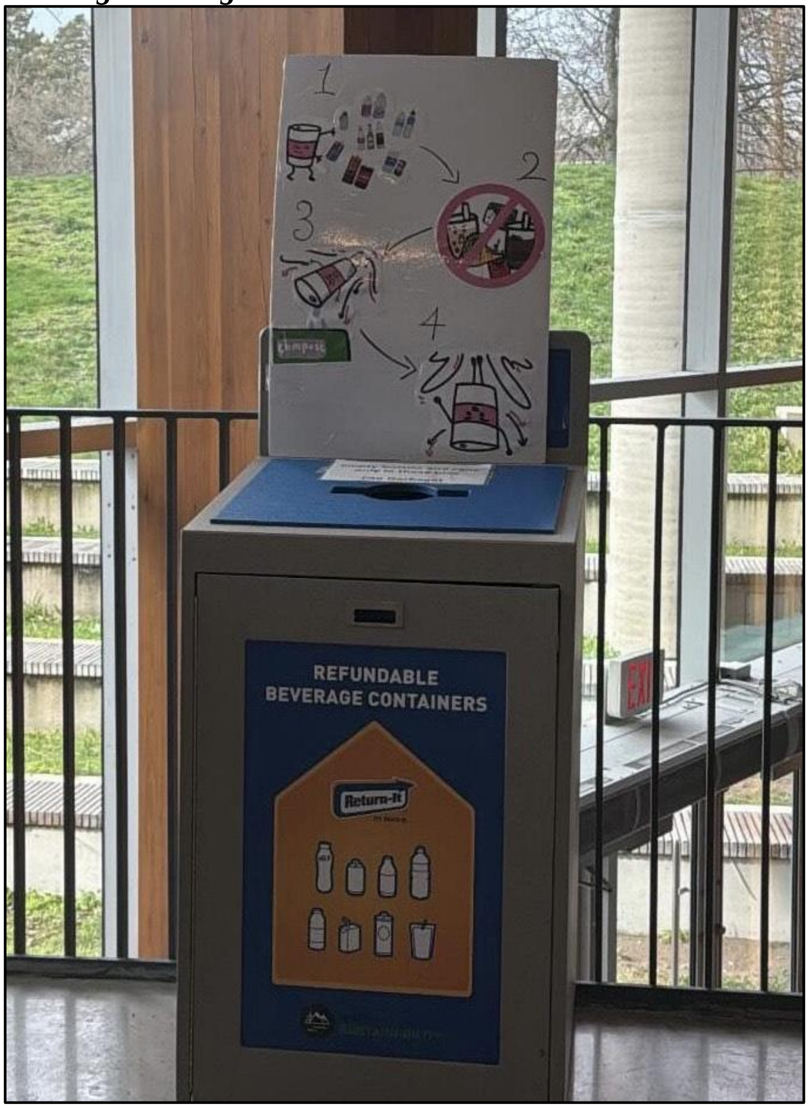

Figure 2.1 - Unknown poster placed on Bin 1 during the baseline period

APPENDIX III: Statistical Results and Graphics

I. Descriptive Statistics

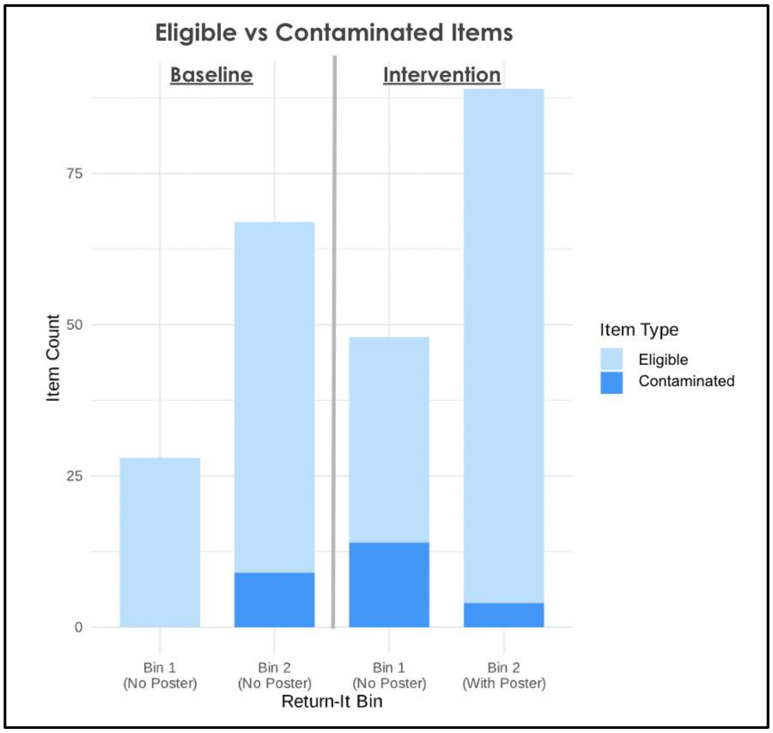

Figure 1.1 - Breakdown of Eligible vs Contaminated Items (Total)

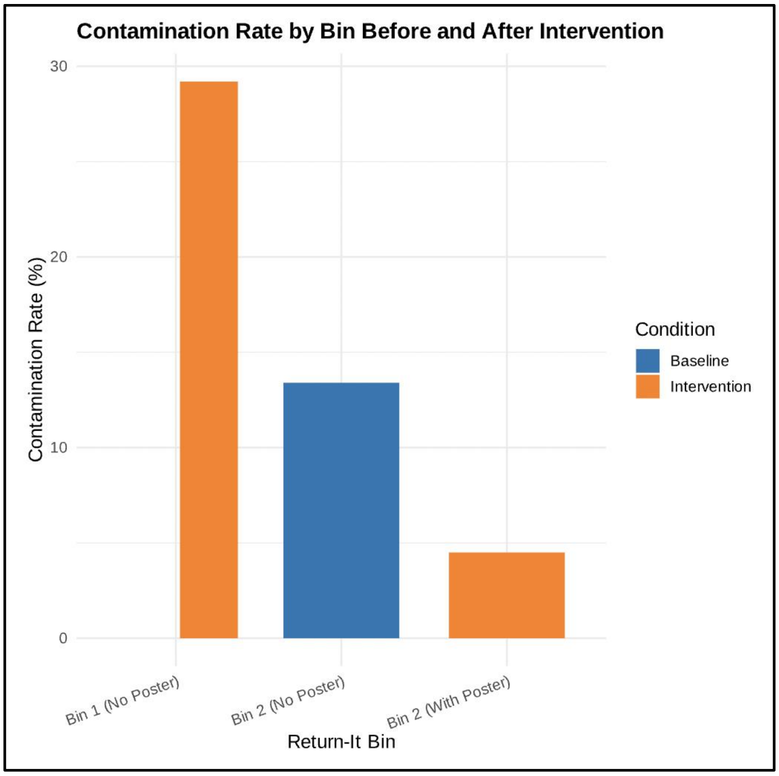

Figure 1.2 - Contamination Rate by Bin

Total Items (Eligible + Contaminated)
Baseline: 95 Intervention: 137

Total Items (Contaminated)
Baseline: 9 Intervention: 18

Total Items (Eligible)
Baseline: 86 Intervention: 119

Table 1.1- Results per Measure

II. Analysis of Contaminated Items (Hypothesis 1)

Baseline

Control Bin *n* = 28	0 [0.00%]
Experimental Bin *n* = 67	9 [13.4%]

Intervention

Control Bin *n* = 48	14 [29.2%]
Experimental Bin *n* = 89	4 [4.5%]

Table 2.1- Results (Contaminants): Raw Count and Rate

```
              Baseline Intervention
Control              0           14
Experimental         9            4

ile Browser  Fisher's Exact Test for Count Data

data:  contam_data
p-value = 0.0001526
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
 0.0000000 0.2411278
sample estimates:
odds ratio
         0
```

Figure 2.1 - Fisher's Exact Test Result (Contaminated Items)

```
[8]: contam_data <- matrix(c(0, 14, 9, 4), nrow = 2, byrow = TRUE)

     chi_result1 <- suppressWarnings(chisq.test(contam_data, correct = FALSE))

     chi_sq1 <- chi_result1$statistic[[1]]
     n1 <- sum(contam_data)
     k1 <- min(dim(contam_data))

     # Cramér's V formula
     cramers_v1 <- sqrt(chi_sq1 / (n1 * (k1 - 1)))
     cramers_v1

0.733799385705343
```

Figure 2.2 - Cramer's V (Contaminated Items)

III. Analysis of Eligible Items (Hypothesis 2)

	Baseline		Intervention
Control Bin *n* = 28	28 [100%]	**Control Bin** *n* = 48	34 [70.8%]
Experimental Bin *n* = 67	58 [86.6%]	**Experimental Bin** *n* = 89	85 [95.5%]

Table 3.1- Results (Eligible Items): Raw Count and Rate

```
                 Baseline Intervention
Control                28           34
Experimental           58           85

        Pearson's Chi-squared test

data:  eligible_data
X-squared = 0.3761, df = 1, p-value = 0.5397
```

Figure 3.1 - Chi-square Test (Eligible Items)

```
[9]: # Chi-square test
     chi_result2 <- chisq.test(eligible_data, correct = FALSE)

     # Extract chi-square statistic and total N
     chi_sq2 <- chi_result2$statistic[[1]]
     n2 <- sum(eligible_data)
     k2 <- min(dim(eligible_data))

     # Cramér's V formula
     cramers_v2 <- sqrt(chi_sq2 / (n2 * (k2 - 1)))
     cramers_v2

     0.0428325167400704
```

Figure 3.2 - Cramer's V (Eligible Items)

APPENDIX IV: Recommendations

Figure 1.1 - Positive Reinforcement Poster