Reducing Contamination in UBC Return - It Bins: The Role of Signage as a Visual Nudge

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Executive Summary

This study investigated whether a visual signage intervention would reduce contamination in Return-It recycling bins at the UBC AMS Nest. The intervention featured a sign, instructing users to pour out liquids before disposing of the container. We implemented a 2x2 between-subjects design with two independent variables: time (baseline vs. intervention) and bin type (control vs. treatment). Data was collected over a three-week period during peak hours, based on feedback from Dr. Zhao. Items were categorized as 'Correctly Disposed' or 'Contaminated', and contamination rates were calculated subsequently. Statistical analysis, including Fisher's Exact Test and chi-square tests, revealed no significant difference in contamination rates between conditions. However, a moderate-to-large effect size was observed in the intervention bin, suggesting a potential behavioural impact. Despite not finding statistically significant results, this study highlights the key considerations for future interventions, including the importance of sample size, visibility and public awareness. We provide a selection of recommendations to optimize signage and implement long-term, multifaceted behaviour-changing strategies.

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Introduction

The Return-It program ("Beverage Products Deposits, Fees, & Container Types," n.d.) in the UBC AMS Nest is a program designed to recycle empty and refundable drink containers. These empty containers are collected by Return-It, who awards the AMS food bank with a certain amount of money per container. Unfortunately, the AMS Nest had to stop the program due to overwhelming contamination, rendering the bins unusable. These contaminants were primarily liquids and foods, though incorrect containers were also an issue.

Behavioural interventions have been shown to have an impact on recycling behaviours (Xia et al. 2022). Particularly, research by Newcomb and Newcomb (2020) has shown that using signs is more effective than not using signs to reduce littering, thus being a common strategy for encouraging positive environmental behaviour. Using this existing research on incorrect disposal, this study considers using signage interventions in a different context to reduce contamination rates in Return-It bins at the Nest student building at the University of British Columbia.

Zhao et al. (2024) investigated how in-store recycling signage influences consumer behaviour by measuring participants' visual attention span and awareness of the drop-off program and bin. Heat maps of the store drop-off bin revealed that areas coloured red, where participants looked the longest, were concentrated primarily at the shelf level. This suggests that shelf-level signage was particularly effective in attracting attention quickly and holding it for extended durations. As such, this study's design places a sign at eye level to grab the attention of AMS Nest visitors, which extends to the existing signage on the Return-It bins that is located below eye level, and thus potentially not in an optimal location to grab attention.

Research by Wu et al. (2018) shows that for signage to be effective and reduce cognitive strain, it should be simple and familiar. Our signage choices stem from findings by Wu et al. (2018), that signage composed uniquely of wording is not effective but that it can be improved by using photos. As such, we use this evidence to make a sign including both simple, well-known images (a Coke bottle and an image of the actual compost bin in the Nest) and limited text to support Nest visitors in using these bins correctly. We extend beyond this work by exploring this in the student building, outside of a lab setting to see if this finding remains true.

Research also indicates that images should remain simplistic to make it quicker for people to understand. Cao et al. (2023) found that representational images (i.e. a photo of the real object) reduce the time it takes to understand what goes in which garbage bin. We consider representational images in a different context, outside of a lab, with specific items permitted in Return-It recycling bins. Interestingly, White et al. (2011) found that perceived efficacy is a key factor for improving recycling behaviours and that making simple signage that is directive can support this efficacy. In addition, Newcomb and Newcomb (2020), found slight advantages for signage that encourage behaviours (using 'do' instead of 'don't'). Thus, to address this gap in signage research, this study takes place in the field and uses simple, encouraging language, "NOT EMPTY? POUR IT IN THE COMPOST BIN!" to encourage Nest patrons to pour their liquids into the neighboring bin, the compost, and thus reduce the contamination of the Return-It bin.

Research Question and Hypothesis

Research Question: How does adding an “Empty the Bottle” signage to existing Return-It bins signage influence contamination and recycling at the UBC Nest?

This study had two hypotheses, the first is that having the “Empty the Bottle” signage will decrease contamination during the intervention period compared to baseline measurements. The second hypothesis is that having the “Empty the Bottle” signage will increase recycling in the intervention bin during the intervention period compared to the baseline period.

Methods

Participants

A priori power analyses were conducted, using G*Power (Faul et al., 2009), for both an F-test and a χ^2 test, each with a targeted effect size of f=0.20, alpha level of α=.05, and statistical power of 1 − β=.80. The analyses indicated that a minimum sample size of 200 observations was required for the F-test and 197 observations for the χ^2 test. However, due to practical constraints, the final dataset consisted of 20 bin audits collected over a three-week period at the UBC Nest. Participants in this context were the general users of the Return-It bins, which included UBC students, faculty, staff, and visitors to the AMS Nest. No personal demographic data was collected as this was a naturalistic observation study focused on bin behaviour rather than individual respondents.

Conditions

Our study adopted a 2x2 design, with two independent variables (IV), each with two levels, creating 4 conditions in total. The first IV was time, with the two levels being baseline and intervention. The second IV was bin type, with the levels being the treatment bin and control bin. During the baseline period, the bins were left without additional signage (see Appendix A). In the intervention period, we added our “Empty the Bottle” (see Appendix B) sign to Bin 1, which is our intervention bin located in front of Kyros Kitchen. Bin 2, our control bin located in front of RBC, remained untouched, along with the original signage. To ensure consistency, the bins remained in fixed locations for both the baseline and experimental conditions; this involves positioning the Return-It bins to the left of the compost bin.

Measures

The dependent variable (DV), contamination rate, was operationalized as levels of contamination within the Return-It bins. Each item being deposited served as a unit of observation, with contamination defined as the presence of liquid-filled containers, food waste,

or other non-recyclables in the Return-It bins. Through categorizing items as ‘Correctly Disposed’ items vs. ‘Contaminated’ items, a calculation for the contamination rate will then be made using the number of ‘Contaminated’ items divided by the total number of items (both ‘Correctly Disposed’ and ‘Contaminated’ items). ‘Correctly Disposed’ items are Return-It accepted containers including cans, plastic bottles, plastic cups, paper drink cartons, drink pouches, and glass bottles. ‘Contaminated’ items consist of bottles with an adequate amount of liquid, food waste, non-recyclables, and containers that did not belong in the Return-It bins such as food containers. For the exact list of containers accepted by Return-It, see Appendix C.

Procedure

The experiment took place from 2025, March 3-21 in the UBC Nest. Each bin was visually observed and audited daily during a three hour period over these three weeks; 11:00 AM-2:00 PM was selected for high likelihood of traffic as it is a common time to visit the UBC AMS Nest to get lunch. Auditors assessed both bins simultaneously to minimize confounds. To see the auditing procedure used by assessors, see Appendix D. Due to a lack of data over the first week (baseline period) with an average of 0-1 bottles per three-hour period, we made the decision to extend the baseline period by another week (2025, March 3-14), pushing back our intervention period (2025, March 17-21). To add to that, we also included an additional check of the bins, through a count and photograph, at a later point in the day to get a better sense of the use of the bins by visitors of the UBC Nest. Furthermore, we initially faced a couple of issues including a lack of data, interference with our conditions and the use of the bins as there were instances where the Return-It bin would be covered, turned around, have bottles removed from the bin, or have a previous failed intervention placed back onto the bin which we had removed for our experiment.

Results

A total of 20 items were recorded across two Return-It bins during a three-week period, with 17 items (85%) correctly deposited and 3 items (15%) categorized as contaminated. Bin 1 served as the intervention bin and received the "Empty the Bottle" signage during Week 3. Bin 2 remained a control throughout the study (see Appendix E).

In Bin 1, 9 items were deposited during the baseline condition, with 8 correctly placed (88.9%) and 1 contaminated (11.1%). During the intervention week, 4 items were deposited in Bin 1, all correctly placed (100%). In Bin 2, the baseline condition included 6 items, 4 of which were correctly placed (66.7%) and 2 contaminated (33.3%). During Week 3, 1 item was deposited in Bin 2 and correctly placed (100%) (see Figure 1. “*Intervention Effect on Item Correctness by Bin*”).

To assess normality, Shapiro-Wilk tests were conducted on data grouped by condition. Results indicated non-normal distributions for both the baseline condition (W=0.79, p=.01) and the intervention condition (W=0.66, p<.001), supporting the use of non-parametric tests (see Appendix F). Levene’s test was conducted to assess the homogeneity of variance and yielded $F(1, 18)$=0.0943, p=.7611. Since the p-value exceeded .05, equal variance between conditions was assumed (see Appendix G).

A chi-square test with Yates' continuity correction was used to evaluate overall differences in contamination rates across both bins. The result was not statistically significant, $\chi^2(1,20)=0.13$, $p=.72$ (see Appendix I) indicating no association between condition and contamination when data from both bins were combined. Due to the small sample size and the presence of zero cell counts, this analysis should be interpreted with caution and is included for descriptive purposes only.

Fisher's Exact Test was conducted separately for each bin to provide a more accurate analysis of contamination differences. In Bin 1, the proportion of correctly placed items increased from 88.9% during baseline to 100% during the intervention. Fisher's Exact Test yielded $p=1.00$, with an associated effect size of Cohen's $h=0.64$ (see Appendix I), indicating a moderate to large practical effect despite the lack of statistical significance. In Bin 2, the correct placement rate increased from 66.7% during baseline to 100% during Week 3. Fisher's Exact Test again yielded $p=1.00$, with Cohen's $h=0.78$, reflecting a large effect size (see Appendix H).

Finally, the overall effect size across both bins was Cohen's $h=0.93$, which is considered large by conventional standards. Although no statistically significant differences were found in either individual or combined analyses, the observed effect sizes suggest that the intervention may have had a meaningful impact on reducing contamination and increasing correct placements. However, due to the limited sample size and low cell counts, these findings warrant further investigation with a larger sample.

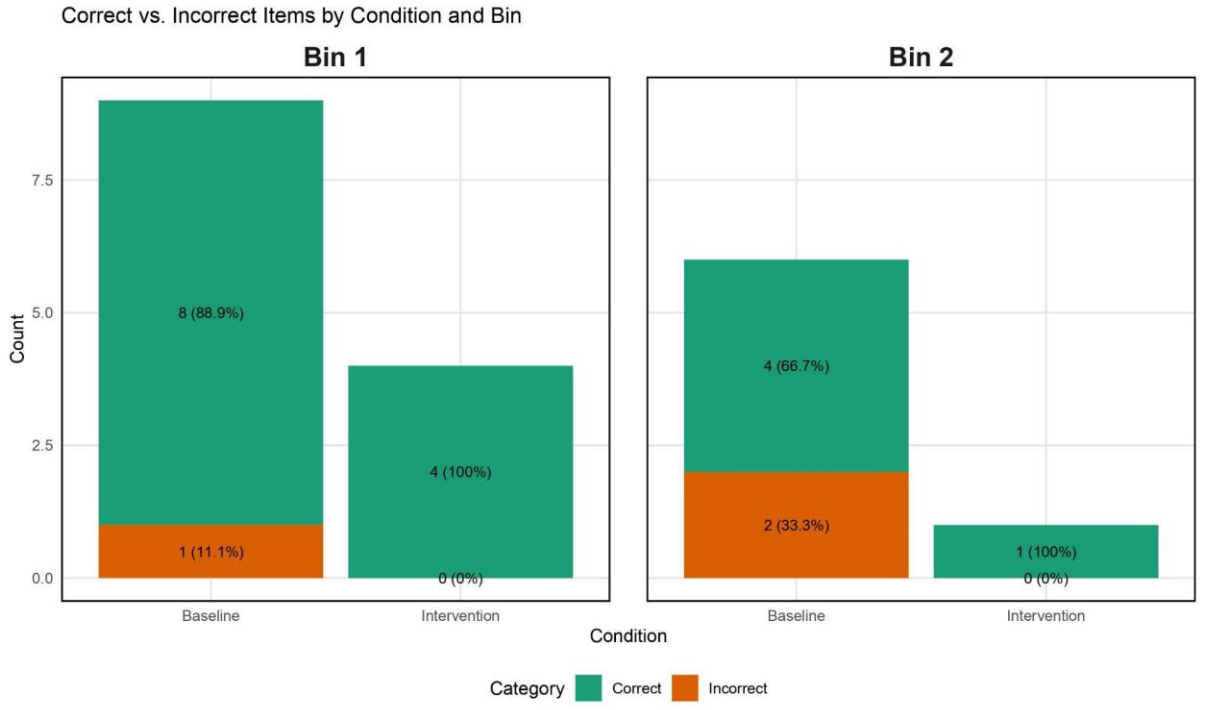

Figure 1. *Intervention Effect on Item Correctness by Bin*

Discussion

Main

Overall, this study offers an initial insight into the potential influences of reducing contamination in UBC Return-It bins. While our intervention aimed to reduce the contamination through the addition of an " Empty the Bottle" sign, the results were not statistically significant.

While our signage did not significantly reduce contamination, our findings are partially consistent with previous literature indicating that simple visual signage, with real-life photos of objects, can encourage pro-environmental behaviours (Newcomb & Newcomb, 2020; Xia et al., 2022; Wu et al., 2018, Cao et. al., 2023). The difference between our results and past findings is likely due to our small sample size and the short testing period.

Despite not finding statistically significant results, our study provides insights into the challenges of behaviour change interventions in public waste disposal contexts. Our data suggests that proper recycling behaviour may already be well established among UBC Nest users, indicating that the (marginal) impact of additional signage may be small in low-contamination environments. The addition of the Return-It bins nearby recycling bins might be confusing to patrons who have a well established recycling behaviour, which is to select the regular recycling bin by default. Furthermore, this work highlights the need for multi-layered interventions. While signage alone may not shift behaviour significantly in this context, future strategies could incorporate educational messaging, social norms, or incentives to strengthen behavioural intent and awareness (Xia et. al., 2022). The findings also suggest that future signage may benefit from strategic bin placement and enhanced visibility to improve salience.

Limitations

The most significant limitation of our study was the small sample size. Despite having a target sample size of 200 we only collected 20 samples. This limited the statistical power and made it difficult to identify significant differences between intervention and control conditions. Additionally, our measurement, counting individual bottles, may have created a floor effect, whereby our low contamination at baseline made it challenging to detect changes during the intervention.

Moreover, the short, one-week duration of the intervention with three hours of observations a day reduced how large of a sample size we could obtain and also may not have left sufficient time for students to become aware of the signage and adjust their behaviours.

Another factor that may have limited the strength of our findings is the lack of awareness about the purpose of Return-It bins. Although our sign may have provided a clear message, participants who were unsure about the bin's purpose or how to use it correctly may have been less motivated to pay attention to the signage or adjust their disposal behaviour. Our findings indicate a potential connection to previous research regarding how the lack of information or awareness about waste prevention makes it challenging to recycle correctly (Cox. et al., 2010).

Prior to conducting our study, the Return-It bins were not in use, and the opening of the bins were taped shut, which may have desensitized patrons to the bins, even with additional signage, thus undermining the effectiveness of our intervention

Furthermore, multiple signs and recycling campaigns were occurring in the Nest at the same time, including some placed on the same bins we used. This may have introduced

confounding variables, making it hard to tell if any changes in contamination were actually caused by our sign.

Recommendations

This study revealed several recommendations for the AMS Nest. Firstly, our low sample size is evidence that there is a low awareness of the bins. Based on existing research, we recommend considering an educational campaign to educate patrons on the existence and locations of the Return-It bins (Xia et al. 2022). The education campaign should also consider educating students and staff on the benefit of participating in this program, which is to ultimately support the financing of the AMS food bank; something that directly supports students. Broadly, our study contributed to this financing, though more effective signage would support this initiative further. Next, this study had a short intervention period due to time constraints. We recommend the AMS Nest extend the duration of data collection to understand the effectiveness of the signage and to ensure that patrons have the time to know about the bins and their purpose. Similarly, there were multiple signs from different interventions during this study's intervention, which may have affected the results. We recommend that the AMS Nest implement one intervention at a time to determine if this specific intervention is effective or not. Lastly, while the contamination in the Return-It bins was minimal, the study contributed to identifying primary contaminants, which identified liquid as the most common contaminant. We recommend the AMS Nest to continue exploring signage targeting liquid contamination.

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Appendix A

Existing Return-It Bin Signage

Appendix B

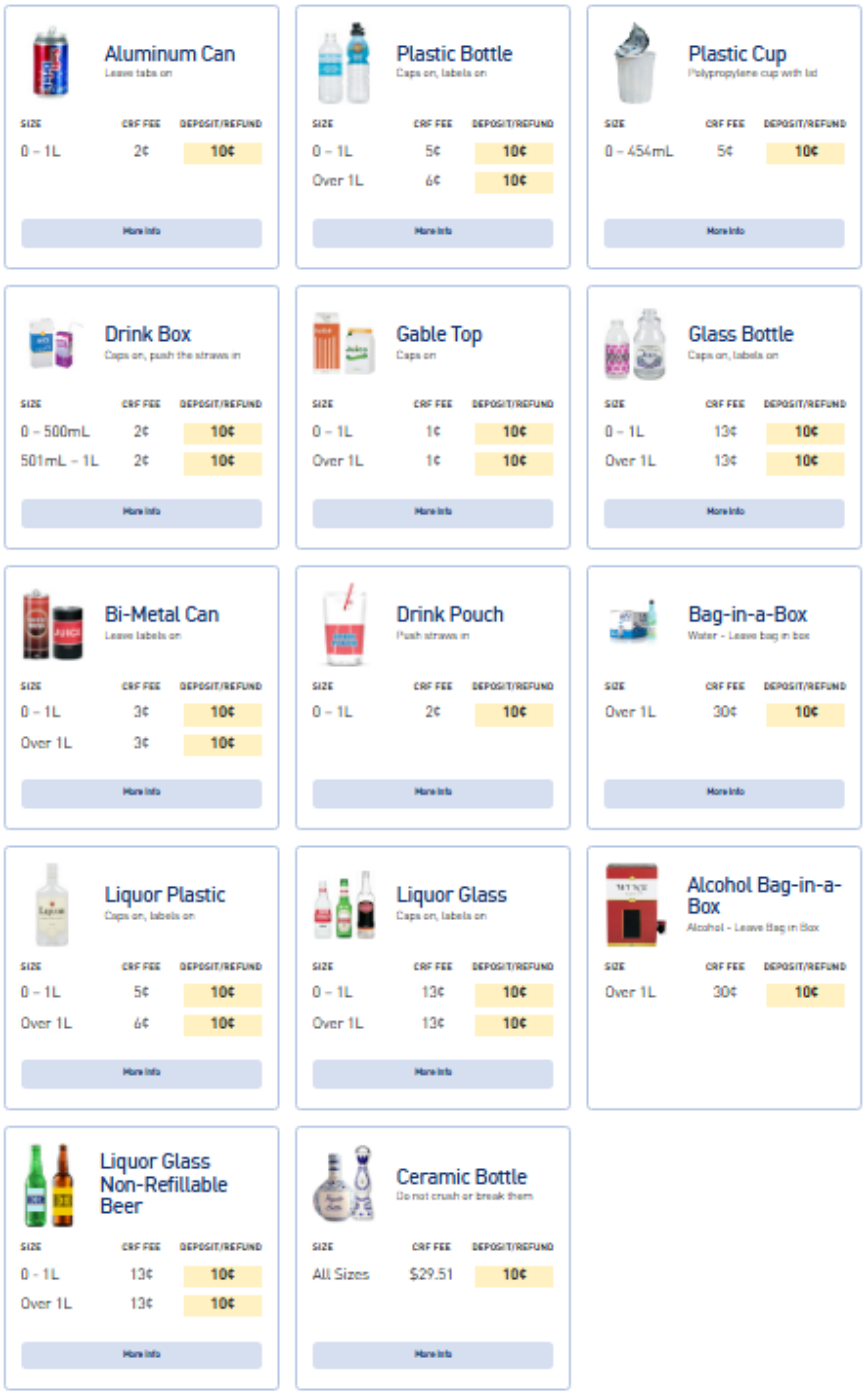
Intervention ‘Empty the Bottle’ Signage

Figure B1. ‘Empty the Bottle’ Signage Design

Figure B2. ‘Empty the Bottle’ Signage set up during the intervention phase.

Appendix C

Return-It Accepted Containers



Note. Image of beverage containers accepted by Return-It. https://www.return-it.ca/beverage/products/

Appendix D

Audit Procedure Checklist

Date: _____

Time: _____

Auditor Name: _____

Bin Location: _____

Condition (Circle one): Baseline / Control / Treatment

Bin fullness (Circle one): Low / Medium / High / Overflowing

1. Correctly Disposed Items (Empty, Properly Recycled)

   Count: _____

2. Contaminated Items (Contains Liquid/Residue, Incorrect Disposal)

   Count: _____

Additional Observations

Notes/Comments: _____

Appendix E

Contingency Table

	Correct	**Incorrect**	**Total**
Baseline	12 (80.00%)	3 (20.00%)	15 (100.00%)
Intervention	5 (100.00%)	0 (0.00%)	5 (100.00%)
Total	17 (85.00%)	3 (15.00%)	20 (100.00%)

Appendix F

Shapiro-Wilk Results

Condition	**Week**	**n**	**Unique Values**	***W***	***p*-value**	**Interpretation**
Baseline	1	10	3	0.7941	0.0123	Non-normal
Baseline	2	10	3	0.7809	0.0085	Non-normal
Intervention	3	10	2	0.6552	0.0003	Non-normal

Appendix G

Levene's test Results

Df	***F* value**	**Pr(>F)**	**Interpretation**

1	0.0943	0.7611	Equal Variances

Appendix H

Statistical Test Results (combined)

Test	**Bin 1**	**Bin 2**	**Combined**
$\chi 2$ (*p*-value)	1.00	1.00	0.72
$\chi 2$ statistic	0.00	0.00	0.13
Fisher's Exact	1.00	1.00	N/A
Cohen's *h*	0.64	0.78	0.93