Evaluating the Impact of Stop-and-Reflect Signage on Recycling Behaviour and Contamination in Return-It Bins at the UBC Nest

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Executive Summary

We investigated whether visual cues could reduce contamination and increase correct recycling behaviour in Return-It bins at the University of British Columbia (UBC) Nest. We monitored two Return-It bins at the Nest across a baseline and intervention period. Bin A was the experimental condition and received our nudge-oriented signage. Bin B remained as a control. Our signage included a multi-part nudge: thumbs-up/thumbs-down icons, a reflective question, a visual stop sign, and prescriptive/proscriptive information. We collected and categorized 130 deposited items across the two bins, counting the number of correctly recycled items versus contaminants such as food waste, liquids, paperboard, and plastic. Data collection occurred over 4 weeks during peak AMS Nest traffic hours. We analyzed the data using Chi-square tests of independence. We used Fisher's exact tests later to account for small sample size and low bin use. Our study yielded no statistically significant difference between the control and experimental bins in either contamination or correctly recycled items across baseline and intervention periods. Further research with larger sample sizes is needed to evaluate the effectiveness of multi-fold nudges in reducing contamination and increasing correct recycling in university settings.

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Introduction and Literature Review

This research, in collaboration with AMS Sustainability, aims to improve sorting behaviour in UBC's Return-It bin program. The AMS Sustainability team identifies contamination as the primary barrier to the program's success. While specific data on Return-It bins in B.C. is limited, broader recycling data indicates contamination rates often exceed Recycle BC's 5% threshold (Recycle BC, 2019). Therefore, the current study explores how to solve the issue of contamination. Contamination in the study is defined as the incorrect disposal of any non-recyclable materials in recycling receptacles (Catlin et al., 2021).

In particular, we explore how visual cues can serve as a behavioural nudge to increase appropriate recycling behaviour. The current Return-it bin signage consists of simple texts and visuals (see Appendix B), and lacks attention-grabbing elements, which we will implement in our study.

Our study draws on the choice architecture concept of 'nudging', introduced by Thaler and Sunstein in their 2008 book. 'Nudging' is a subtle behavioral intervention that influences decision making, without restricting one's freedom of choice (Thaler and Sunstein, 2008). Nudges have shown to be an effective tool to utilize in low-stakes decision, such as the decision to toss an item correctly into a recycling bin. (Thaler and Sunstein, 2008). Our study expands on this concept, by integrating a multifold nudge system as our intervention, as follows: (1) informational cues using green and red boxes, paired with a social nudge in the form of a thumbs-up and thumbs-down icon, (2) reflective question, (3) stop sign (Appendix A). We will henceforth refer to this intervention as 'Stop-and-Reflect' signage.

In our Stop-and-Reflect visual poster, we presented our first nudge by featuring clear visual segmentation (thumbs up/down icon, green and red box) to cue bin users toward correctly sorting their recyclables, while maintaining their autonomy.

Our second nudge is focused on language. Language plays a key role in how users interpret visual signage. As an example, individuals are prone to tuning out commands in public spaces, as discussed in Werner et al., 1998. Restrictive language, such as the term 'Do Not Throw Trash Here,' may activate bin users' dismissive schemas (Werner et al., 1998). In contrast, reflective language invites individuals to pause and consider their actions. Our visual poster includes the following question: 'Is your container clean and empty?' By utilizing reflective language, bin users were prompted to elicit empathy and personal responsibility over their recycling behaviours. (Werner et al., 1998).

This leads us the final fold of our nudge system: the integrated use of both visual cues and reflective language. Our Stop-and-Reflect poster includes a visual stop signal and a short, open-ended prompt. The use of a stop sign was drawn from Ólafsson's (2016), which demonstrated that clear, direct content along with visual cues, significantly improved recycling behaviour in a university setting.

Despite the previous research conducted on stimulating better recycling behavior, a key knowledge gap remains in understanding how visual and linguistic nudges as a combined behavioral tool, may lead to the reduction of contaminants along with an increase in correctly recycled items, which will be referred to as refundables in the current study. While visual nudges and reflective language have been studied independently, they have not been tested as a combined tool in the context of decreasing contamination in refundable recycling systems like the Return-It bins at UBC.

Our study serves to address this knowledge gap, by testing whether Stop-and-Reflect visual signage can both improve recycling behaviour and decrease contamination in the Return-It bins at the UBC Nest. Specifically, our research question is: *How can Stop-and-Reflect visual signage reduce contamination and increase correct recycling in Return-It bins in the UBC Nest?* Given this, we make two hypotheses: (1) Stop-and-Reflect signage will reduce the number of contaminants deposited in the Return-It bins, compared to the current signage; and (2) Stop-and-Reflect signage increase the number of correctly disposed recyclable containers deposited in the Return-It bins, compared to the current signage.

Methods

Sample

Since our study measured recyclable and non-recyclable items deposited in Return-It bins, our sample included items being recycled, rather than individual bin users. A priori power analysis, conducted for a chi-square test of independence, indicated that 197 samples were required to detect a significant effect size ($F = 0.2$) with $\alpha = .05$ and power = .8. A total of 130 items were collected due to time constraints and limited foot traffic during the data collection period.

Conditions

Our study observes two Return-It bins on the bottom floor of the UBC Nest. Each bin represented either the control condition or experimental condition. 'Bin A,' the experimental condition, is situated near The Pit, and 'Bin B', the control condition, is located near the INS Market. In the control condition, no Stop-and-Reflect signage was added to the bin, and in the experimental condition, it was added. Both conditions allowed us to test how our independent variables, the intervention period and the presence of Stop-and-Reflect signage, related to our hypotheses that the implementation of Stop-and-Reflect signage would decrease contamination counts and increase refundable counts.

Measures

Our study involved monitoring the dependent variables, the number of contaminants and refundables, deposited in each bin. These items were broken down into five different categories. Firstly organics/ contaminated refundables, this category would have food, or refundables that are soiled by food. Next category is paperboard contaminants for cardboard or paper that ends up in the bin. After that are plastic contaminants, for items like single use plastics that cannot be refunded. As liquids were posed as one of the largest bin contaminants, a category for half-filled containers was also added. The last category is refundables, meaning anything that the Return-It program would offer a monetary refund on (Return-It, 2025).

Procedure

Before the implementation of signage, baseline data was collected for both Bin A and Bin B for 7 days. During the baseline period, each bin was observed from 11AM-2PM from March

4th to March 11th excluding weekends, as these are the hours of peak AMS Nest traffic. Two observers took a tally of how many recyclables and contaminants are placed in each bin for inter-rater reliability. After the baseline period, Stop-and-Reflect signage was added to Bin A, and Bin B was left unchanged. Bin A was chosen to be the experimental condition, as it had more items overall than Bin B. The bins were then observed for another twelve (12) days during the same peak hours from March 13th to March 28th, excluding weekends. It is important to note that during the data collection period, there is often one observer per bin, which may have limited inter-rater reliability. To overcome this, photos were taken of the bin contents every hour and records were kept in a shared document so the item counts in the bins could be cross-checked periodically. When binners left, new pictures were taken as a reference point for the changes to the bins. At the end of the data collection period, two Chi-square tests of independence and a Cramérs V test were performed to determine the significance of count changes. A Fisher's Exact test was later performed as it was deemed more appropriate due to the presence of low expected cell counts in our contingency tables and the sample size being too low to justify the chi-square result.

Results

As only categorical data count was collected, we will be reporting the number of items and proportions of contaminants and refundables per bin and period. For contaminants, Bin A (experimental) contained 3 items (27.3%) during the baseline period and 8 items (72.7%) during the intervention. Bin B (control) also contained 3 items (18.8%) during the baseline and 13 items (81.2%) during the intervention. For refundable items, Bin A contained 29 items (44.6%) at baseline and 36 items (55.4%) during the intervention, whereas Bin B contained 11 items (28.9%) at baseline and 27 items (71.1%) during the intervention period. See Appendix C for the table of the results.

Main Analysis

Contamination

To evaluate whether the Stop-and-Reflect signage reduced contamination in the Return-It bins compared to the original signage (Hypothesis 1), we conducted a chi-square test of independence comparing Bin A and Bin B across the baseline and intervention periods. The results revealed no statistically significant association between signage condition and contaminant count [$\chi^2(1, N = 27) = 0.27$, $p = .60$, $V = .10$]. The effect size was negligible. See Appendix D for the graph.

The assumption of independence of observations was met. However, 50% of the expected cell counts were below 5, violating the key assumption that no more than 20% of expected cell frequencies fall below this threshold. Due to this violation and the small sample size, a Fisher's Exact Test was conducted. The test confirmed the absence of a statistically significant difference ($p = 1.00$), with an odds ratio of 1.625. This suggests slightly lower contamination in the experimental bin, but the effect was likely due to chance. Thus, results do not support the first hypothesis where stop-and reflect signage will reduce contamination in Return-It bins compared to the existing sign.

Refundables

To assess whether the signage increased refundable items (Hypothesis 2), a second chi-square test of independence was performed on correct refundable counts across the two bin conditions and time periods. This analysis also found no significant difference between the experimental and control conditions [$\chi^2(1, N = 103) = 2.48$, $p = .11$, $V = .15$]. The effect size was small. See Appendix D for the graph. Therefore, no support was found for hypothesis 2.

Both chi-square analyses were limited by small sample sizes and low expected frequencies in several cells, which may have reduced the statistical power of our tests. While Fisher's exact tests were used to mitigate these limitations, no significant effects were found. Taken together, our analyses provide no evidence to support the effectiveness of the Stop-and-Reflect signage in reducing contamination or increasing refundable items in Return-It bins.

Discussion

The results did not show a statistically significant reduction in contamination or a significant increase in correct recycling behaviors between the experimental and control conditions, nor across the baseline and intervention periods. As our results suggest, both conditions experienced a rise in the total amount of refundable and contaminated items from the baseline to the intervention period. Although contaminant counts increased for both the experimental and control bins, the increase was more pronounced in the control bin. The experimental bin A rose by 45.4 percentage points (from 27.3% to 72.7%), while the control bin B increased by 62.4 percentage points (from 18.8% to 81.2%). For refundables, both bins saw a rise in count, however, the control bin had a greater increase. Bin A saw a 10.8 percentage point increase (from 44.6% to 55.4%), whereas Bin B experienced a 42.2 percentage point increase (from 28.9% to 71.1%), again showing a more substantial rise in the control bin.

Regarding our multi-fold nudge system, each individual nudge – the thumbs up/down icon, the reflective question, the stop sign, and informational nudge – appeared to have possibly unintended effects. The injunctive norm nudge (i.e., thumbs up and thumbs down) for refundables and contaminants surprisingly did not align with current research findings, which show considerable effectiveness in promoting environmental behaviour changes (Rhodes et al., 2020; Mundt et al., 2024). The same ambiguity applies to the reflective and informational nudges – 'is your container empty and clean?' and the (un)accepted items guide respectively – which also demonstrated effectiveness in previous research (Tening & Harder, 2023; Schäufele-Elbers et al., 2024). The inspiration in creating the signage was founded on the concepts suggested in McNabb (2017), which suggested that using visual nudges increased the likelihood of a desired change. In the context of our study, this allowed for the combined use of the multi-fold nudges to be based on experience rather than experimental conjecture.

Rather than reinforcing one another, the nudges in our multi-nudge system may have introduced competing cues that weakens their individual effect. The stop feature designed to trigger cognitive reflection could have overpowered the other nudges and deterred users from disposing their items in the experimental bin. This could explain the observed increase in refundable items in the control rather than the experimental bin. Overall, it remains unclear whether the nudges failed due to contextual limitations, reduced salience, or interference from the stop sign's stronger visual impact.

Several factors may have contributed to the null result. First, the data collected throughout the baseline period already showed limited use of the bins. Throughout both baseline and intervention periods, participants did not appear to notice the bin or our poster. This implies that the visual intervention may not have been prominent enough to disrupt habitual behavior. Secondly, the placement of the Return-It bin, near many other bins and waste receptacles, may have reduced its visibility and prominence. The smaller size of the Return-It bin compared to the other bins and a different colour scheme may have likewise contributed to its limited use. Lastly, the extensive amount of information displayed on the bins and options available might have overwhelmed users, discouraging them from engaging with our signage.

The small sample size and limited duration (4 weeks) may have prevented us from capturing longer-term behavioural trends. The two bins being placed very closely to each other on opposite sides of a stairwell are possibly a confound and a limiting factor to the impact of our intervention. Finally, our intervention was only up for 3 hours a day. Before and after that 3-hour period, the signage was hidden and the bins closed, which could have lowered the possibility to have our new signage noticed by bin users or create a visual and informational continuity. The bins were already closed for an extended time before our data collection period, and the program is not well known within UBC. Hence, if there was going to be a behavioural change, it would take longer than 4 weeks of 3-hours-a-day exposure of the sign intervention. Despite these limitations, the study offered important points to consider, as well as some insights that could guide future research. Notably, competition and an overwhelming number of options cause confusion and decision fatigue. Differences in how unrelated garbage collection schemes work, which there are a few, also play into the confusion. For subsequent iterations, it is worth investigating the potential interaction between nudges in a university setting, particularly whether the stop sign alone contributed to hesitation among bin users, or if the effect emerged from a combination with other factors such as bin lineup or signage placement. Future studies could also test whether a smaller-sized stop sign could mitigate this effect.

Recommendations for UBC Client

Despite the intervention not leading to statistically significant findings, our group made valuable observations during the data collection period, which may allow us to provide insightful recommendations (for a sample observation, refer to Appendix E). The most prominent behaviour we witnessed was the overuse of the grey recycling bin. Since the grey recycling bin and the Return-It bin ask for overlapping items, bin users seemingly opted for the grey recycling bin that they may be more accustomed to using (refer to Appendix E for visual depiction). Even after careful deliberation of where to deposit their refundable, many bin users chose the recycling bin. As people's reliance on the grey bin is likely hindering use of the Return-It bin, we recommend increasing awareness of the Return-It program in the AMS Nest. Another recommendation that may be worth exploring is for the AMS to better integrate the Return-It bin into the lineup of other waste disposal options. Currently, the Return-It bins are placed on either end of the waste disposal lineup and do not have the same size and structure as the other bins, they may be easy to overlook. That points towards the need for more research on either (1) experimenting with different bin placements or (2) placing signage on the grey bin that discourages refundable deposits in it and instead, redirects bin users to the Return-It bin.

Another potential way to differentiate between the many bins could be to focus on the Return-It bins' connection with AMS food bank funding as a social motivator.

Regarding signage, we would also suggest experimenting with different nudge arrangements combinations, as well as various signage types such as humorous or interactive signage, as well as signs that reference pop culture (McNabb et al., 2017). Future studies may also consider focusing solely on either proscriptive or prescriptive information, rather than combining prescriptive and proscriptive information, as this has been shown to be effective in reducing contamination (Çakanlar et al., 2024). Experimentation with signage will likely be a feasible and cost-effective method to address the current problem with contamination.

This project has given the AMS Nest the opportunity to explore more avenues for reducing contamination in their Return-It bins. Although the findings were not statistically significant, we hope our findings and observations may allow for the AMS Nest to create relevant and insightful future studies.

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Appendix A

'Stop-and-Reflect' Signage

Appendix B

Return-It Bin Original Signage

Appendix C

Contaminant and Refundable Counts by Condition and Time Period

Table C.1
Contaminant count and proportions across condition and phase

	Baseline period		Intervention period		Total	
	n	%	*n*	%	*n*	%
Experimental bin (A)	3	27.3	8	72.7	11	100
Control bin (B)	3	18.8	13	81.2	16	100
Total	6	22.2	21	77.8	27	100

Table C.2
Refundable item count and proportions across conditions and phase

	Baseline period		Intervention period		Total	
	n	%	*n*	%	*n*	%
Experimental bin (A)	29	44.6	36	55.4	65	100
Control bin (B)	11	28.9	27	71.1	38	100
Total	40	38.8	63	61.2	103	100

Appendix D

Figure D.1

Contaminant Count by Phase and Bin Condition

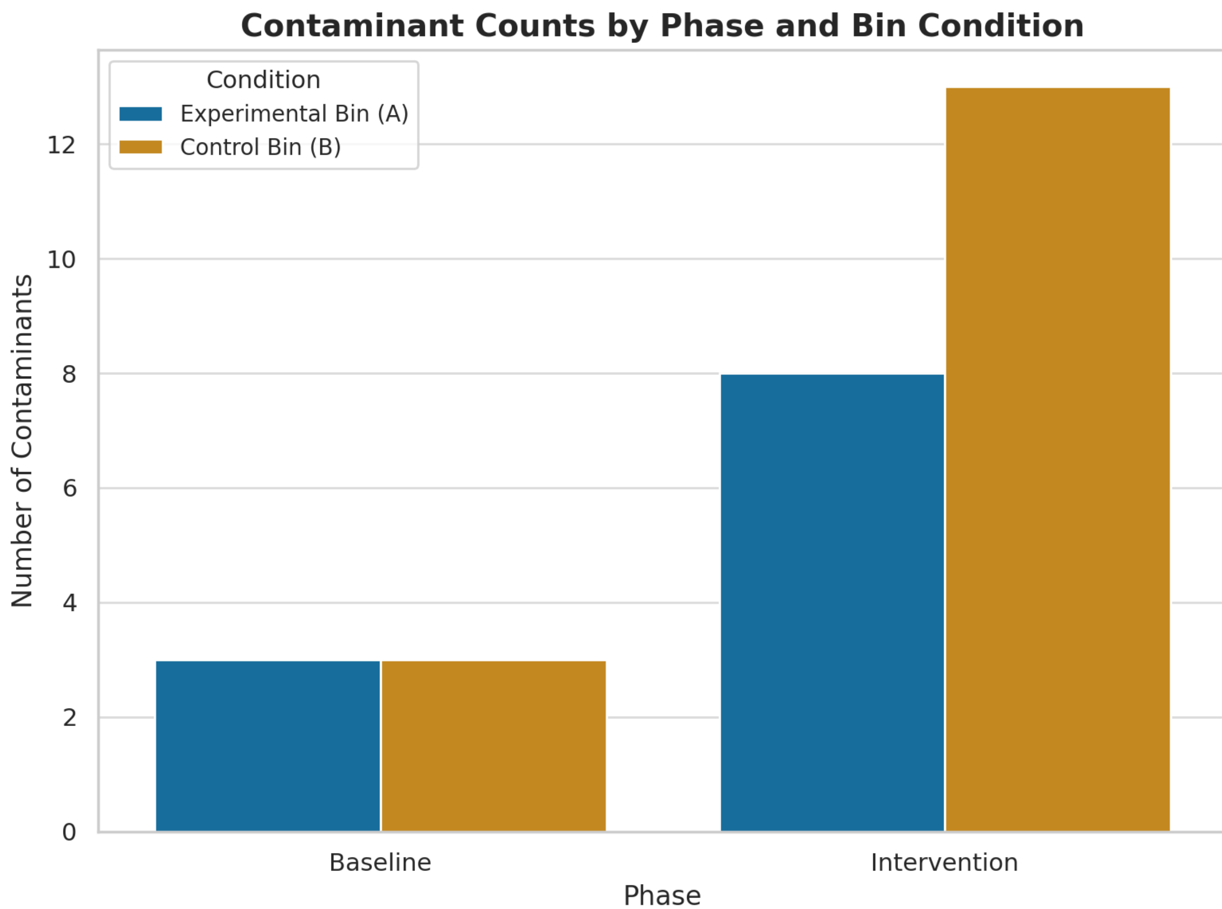
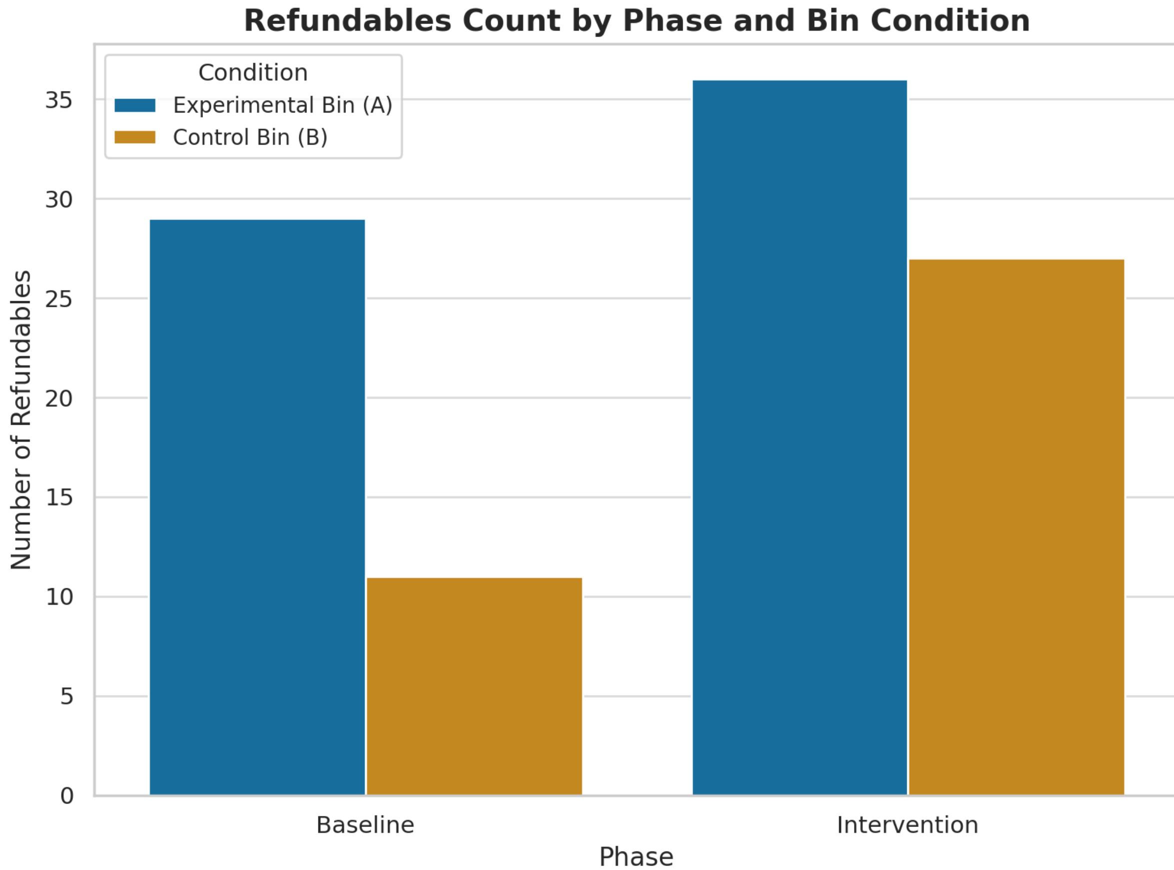


Figure D.2

Refundable Count by Phase and Bin Condition



Appendix E

Recycling Behaviour Observational Video

https://youtu.be/Ng5Rmtz6NKw