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REDUCING CURBSIDE WASTE VOLUMES BY PROMOTING HOUSEHOLD COMPOSTING*

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ABSTRACT

Composting organic waste has the potential to reduce household curbside waste by up to 25%. Unfortunately, many recycling initiatives cannot take advantage of composting as householders live in heavily urbanized areas. In New Zealand, however, most homes have sufficient land area to make this strategy practical. Thirty-seven households (20 experimental, 17 control) took part in a composting initiative which lasted for six weeks. Following a two-week baseline period, the experimental group received the relevant composting resources and information. The results showed that the weight of curbside waste in the 20 experimental households decreased from baseline significantly (29% average decrease in the weight of curbside waste) more than that of the 17 control households (12% decrease), who approached baseline levels in the last week (4% decrease).

INTRODUCTION

As waste disposal sites swell to accommodate the consumerism of our industrial society, communities realize that a possible solution to the problems associated

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with expanding landfills and incineration involves the promotion of effective waste reduction strategies [1]. However, while attitudes toward recycling and other waste reduction strategies can be favorable, the correlation between these positive attitudes and actual recycling and waste reduction behavior is often poor [2], reflecting findings from many other areas of psychology that also note that attitudes are frequently poor predictors of behavior [3-5].

Brislin and Olmstead, suggest that perhaps individuals lack the relevant *knowledge* needed to translate attitudes and behavioral intentions into overt behavior [3]. In the context of reducing curbside waste destined for landfills, De Young et al. suggest that while many municipal bodies focus their attention on waste disposal they, in general, neglect the promotion of waste avoidance strategies [6]. It is possible that a disregard of the latter inhibits the dissemination of relevant knowledge into public awareness; thus, individuals may lack access to this knowledge. Individuals without conservation knowledge are likely to struggle in the formation of waste reduction strategies [7], and are, therefore, less capable of translating their positive attitudes into overt behavior.

Knowledge about the specific aspects of recycling and waste reduction has been argued by some to be more important in predicting actual recycling behavior than knowledge about general environmental issues [2, 8, 9]. Specific knowledge includes practical information about recycling programs such as what materials can be collected, and where the materials can be deposited/collected [7]. Specific knowledge about waste reduction is another important area of practical information, including knowledge about how to reduce packaging waste through consumption and purchasing choices [6], and information about how to reduce organic waste through composting [10]. Without this specific information, even the most concerned conservationist will experience difficulty in translating their attitudes (about general environmental issues) into waste reduction behavior.

Not only must people know what to do and want to do it, they must also have the resources with which to carry out their intentions. Without these resources, the best of intentions and education are of limited use. For example, providing bins for curbside recycling and, thereby, eliminating the need to haul recyclables to a depot increased self-reported recycling [11], and was the most preferred method of recycling by participants in Ewing's study [12]. The participants in Guagnano, Stern, and Dietz's study were provided with the resources to recycle [11]. Additionally, because the bin enabled curbside recycling (as opposed to recycling at a drop off center), inconvenience, identified as a barrier to recycling by Howenstine [7] and Ewing [12], was reduced. It was also probable that resources like Guagnano et al.'s [11] bins acted as prompts that increased the probability of the behavior [13-15].

The question thus becomes, how to motivate and equip people to adopt desirable waste reduction behaviors? In the past, one area of research on conservation promotion has centered around an assumption that individuals "perform conservation behaviors that are economically advantageous" [16, p. 521]. Working upon this assumption, research has tended to utilize economic rewards that are usually removed once the study has been completed. While the studies are often successful at increasing pro-environmental behaviors, this behavior change is not sustained in the long-term when the economic consequences are removed [17, 18]. Another area of research that has investigated the way economics and environmental behavior are linked has concentrated on socioeconomic status. In a review of 80 recycling studies, Schultz, Oskamp, and Mainieri found that "high income is a good predictor of recycling, whereas gender and age are not" (9, p. 105].

Education has proved to be an especially effective strategy. De Young et al. provided households with informative pamphlets outlining the benefits of, and suggested strategies for, implementing waste reduction behavior [6]. The study found significant reduction of source waste through recycling, consumer decisions (e.g., buying fewer disposable items), in-home reduction techniques (e.g., saving reusable containers), and in-home toxic reduction (e.g., using vinegar and baking soda for cleaning). Also included in the pamphlets was precise information about *how to* perform the desired behavior, as well as where and when to do it (a consideration stressed by Weigel [19]). This educational strategy thus provided the relevant knowledge for individuals to translate their pro-environmental attitudes into conservation behavior. The validity of this study, however, may have been influenced by the self-reporting bias encountered in recycling studies where questionnaire items, rather than recycled items, are measured [20].

Other researchers have noted the success of practical education-based strategies. For example, Sherman surveyed 43 home composting programs m the United States in 1995 and found home composting to be a cost effective way to reduce waste destined for landfills [10]. Most of these successful programs included educational material in the form of brochures, workshops, and material for school children and teachers [10]. Another key feature of the programs was the distribution of subsidized composting bins for residents to purchase [10].

Vossen and Rilla also reported that education through holding composting workshops was successful, with 50% of workshop attendees reporting significant composting efforts, and, over all the active composters, an average of around 18% of total household waste was diverted from the landfill-destined waste stream into the compost heap [21]. Providing information on the specifics of composting through the mail was reported to be the most successful technique for Montgomery County, where composting increased from 39% of households in 1994 to 60% in 1995, following a composting campaign which included the mailed-out information [22]. Other successful interventions that have increased environmentally beneficial behaviors have included the use of a public commitment. For example, Burn and Oskamp found that householders who signed a pledge supporting recycling were more likely to start recycling than a control group of neighboring householders who received no intervention [23].

Another method for increasing commitment to a scheme is to get people to invest in it [24, 25]. It has been found that the more time and money one has invested in a project, the more likely it is that one will continue to commit. This is known as the "sunk cost" effect [24, 25]. Therefore, asking participants to purchase recycling or composting components provides an initial sunk cost into the project, and the time spent sorting appropriate household waste into recycling and/or composting bins provides an ongoing, and escalating, cost. Brockner, Shaw, and Rubin have shown that with a continued and escalating cost (be it time or money) that the original rationale for investing may change [26]. In terms of composting, the rationale may move from conforming to the norm (i.e., "our neighbors are composting, so we should too"), to becoming committed to the wider rationale for composting (e.g., to reduce landfill waste, doing good for the environment, help the soil fertility, no longer have to buy compost).

Much conservation research has been performed in predominantly high-density urban settings [7, 27]. Naturally, the reduction strategies these studies introduced did not include householders composting their organic waste, as the average house lacked the necessary outside area. New Zealand's average section sizes, like those in the suburb of Tvååker, in Varberg, Sweden [28], are capable of facilitating composting, thus creating the economic good of compost and increasing the expected life of waste disposal facilities. While some studies have examined community-based composting programs where organic waste is collected from homes and composted on a large scale [29, 30], only a few studies have investigated small scale composting operations based in individual homes [10, 21, 28, 31].

Accurate measures in the studies of the amount of organic waste diverted from the waste stream to the backyard compost pile are also lacking [31]. In some studies that have attempted to measure the amount of waste diverted, the measure of choice has been estimated self-report [21], while others have asked that participating householders weigh their own organic waste [31]. However, both of these measures are problematic. Research associated with water conservation [32] and recycling [20] has indicated that self-reports are often poorly related to actual behavior. Participants in Gale's study may have also been affected by this bias as there was no way of knowing whether the measurements taken by the participants were actually performed all of the time or whether the weight was estimated, leaving the participant open to a self-report-like bias [31].

Therefore, the present study incorporates the provision of bins at a subsidized cost [10], composting as a central variable [10, 21, 28] with De Young et al.'s educational strategy [6], and a behavioral commitment requirement [23], while using empirical measures of waste to assess the outcome [20]. Further, the experimental and control groups were split between a high income and a lower income area [9]. We expected that households which were given the opportunity to acquire the necessary resources and information needed to compost their waste, would show a decrease in the weight of their curbside waste compared to controls who did not get these resources and information, and that this effect would be more noticeable in the higher income than the lower income area.

METHOD

Participants

The participants were 37 households from the New Zealand city of Dunedin. To balance the sample, roughly half of each of the experimental and control groups were recruited from the areas of Maori Hill (n = 19) and Woodhaugh (n = 18). New Zealand Census information concerning socio-economic status was used to differentiate these areas (average income per person in each community: Maori Hill = NZ$21,496, Woodhaugh = NZ$8845) [33].

Recruitment

One-hundred and ninety-six households (102 in a high SES area and 94 in a lower SES area) were approached directly by a project worker. The relevant person in the household was asked whether their kitchen's organic waste was disposed of in the Council rubbish collection, and whether or not they owned the property in which they resided. The 52 households meeting these criteria were offered the opportunity to purchase a subsidized composting bin and a kitchen scrap bin (Offer = $21.50, Total Bin Retail Cost = $47.90, D.C.C. Subsidy = $26.40 or 55%). Those accepting this offer became the experimental group (n = 20). Those rejecting this offer were asked if they would participate in a control condition—this became the control group (N = 17). A further 16 households declined to participate; 6% of the high and 10% of the lower SES groups.

Materials

Two separate information sheets outlining the study's objectives and requirements, plus a consent form were given to the participants in both conditions. Twenty *Gardenwise Composters* (210 liters, Cost = NZ$39.95 each, manufactured by Perroplas One Ltd.) and *Mini Bin's* (8 liter, Cost = NZ$7.95 each, twist off lid), for kitchen use, were made available to the experimental group at a 55% discount.

A one-page composting flyer specifically designed for this study, plus a copy of *RottWheeler* [34] and *Compost: A Guide to Home Composting* [35], were given to those in the experimental condition. This material provided the relevant information for the effective use of composting bins. It included precise information on *how* to perform the desired behavior, as well as where and when to do it.

Separate data sheets were provided for the two independent weighings of the weekly curbside rubbish. Weighing of rubbish used locking *Digi* (SAK baseworks and DI10 indicator) digital scales.

Experimental Design

A field study with a (non-randomly self-selected) control group design with preceding baseline was employed in the present study. The study itself ran over the course of six weeks, the frst two weeks of which comprised the baseline period. The bins and educational material were distributed after the second week of baseline recordings—the remaining four weeks of the study comprised the intervention period. Data recordings m the baseline and intervention periods served as comparative measures to establish whether there was a significant reduction in the weight of household rubbish after the bins and educational material were distributed. This gave us a factorial design with two conditions (experimental treatment vs. control) by two socioeconomic statuses (high and low) by two phases (baseline and intervention). Thus, there were two manipulated variables, each with two factors. One variable (between-subjects design) was Condition, its factors being experimental versus control group membership. The other between-subjects design variable was area, its factors being high socioeconomic status (Maori Hill) versus low socioeconomic status (Woodhaugh). The measured variable was the weight in kilograms of each household's rubbish, for each week, over the baseline and intervention periods.

Procedure

Informed consent was obtained in writing from each participant involved in the study before any experimental data was recorded. Once the participants were recruited, their household rubbish was weighed once a week by two independent recorders from the project for the duration of the study. To aid data collection, the participants (both experimental and control) were asked to put out their rubbish on a Tuesday afternoon to allow enough time for weighing before the Wednesday morning Council collection.

After the baseline period (two rubbish recordings), participants in the experimental condition were visited by a project worker who distributed the bins and educational material. The Dunedin City Coumcil's *Rot Line* number was also given to the experimental group where more composting information could be obtained and support given. At the end of the study the control group was offered the opportunity to purchase bins at the subsidized rate, however, none did so.

RESULTS

Interobserver Reliability

There were 222 data recordings from the *Digi* locking digital scales, for each of which there were two observers present from the project. One-hundred and eighty-five were independent recordings (the first baseline reading was done on a consensus basis between observers and not recorded independently and is, therefore, not part of this calculation). An agreement was defined as the two independent observers recording the same weight (in kilograms, to two decimal places) when reading the scales. Reliability was 100% for the 185 independent recordings.

Cost and Benefifs

These costs and benefits are considered from the perspective of both the Dunedin City Council (D.C.C.) and the individual households. They detail what would be required to continue the intervention for *one household* at a 55% subsidy rate (bins only).

The cost of supplying the subsidized bins per household was NZ$26.40 (NZ$1.00 = US$0.70). The cost of the custom designed pamphlet was 10 cents per household. The cost of the *RottWheeler* was 81 cents, while *Composting: A Guide to Home Composting* was 60 cents, per household (Personal Communication, Angela McErlane, Waste Minimization Officer, D.C.C., August 8, 1999). If this scheme was adopted by the D.C.C., households would be expected to collect the bins and educational material themselves, consequently delivery was not considered a cost in a widespread introduction of this intervention. Therefore, the total cost to the Dunedin City Council of introducing the intervention, with subsidized bins, to one household would be NZ$27.81.

The quantitative benefits to the Council and ratepayers of this intervention are difficult to estimate, as the main benefit would be the longevity of the landfill. With the data available to the study, this can only be realized in terms of the average weekly reduction (in kilograms) of landfill-destined rubbish in the average experimental as compared with the average control household.

From a household's point of view, their contribution to the cost of the bins was $21.50. These were conservatively estimated to last five years. The benefits of these bins can be realized in terms of the reduced number of rubbish bags the house would have to purchase. One bag was approximately 50 cents. There is also the benefit of providing compost for the participating households' gardens, although this was not easily quantified in monetary terms.

From the point of view of the City Council, analyzing this information is best done by using the costs of introducing the intervention into one household, with the average reduction in weekly rubbish that the average experimental household can generate. This was determined for each household in the experimental group using the following formula:

(Average weekly rubbish in the Baseline period) –
(Average weekly rubbish in the Intervention period).

This reduction in rubbish weight was then averaged over all experimental houses to yield the required benefit statistic. The average weekly reduction of landfill-destined rubbish per experimental household was 3.7 kilograms or 29%, while for the average control household it was, overall, 1.23 kilograms or 12%. In the last week of recording the average control household's reduction from baseline had reduced to .42 kilograms or a savings of only 4% of landfill destined rubbish per household.

The city's cost of achieving this reduction/benefit in the experimental group was the cost of providing bins and literature to each household, which was $27.81. The amount of rubbish that could be saved from the landfill, given a constant 29% saving, over the useful life of the bins (five years) would be 962 kg. Therefore, the cost to prevent one kilogram of organic waste from entering the landfill is 29 cents; or, more relevant to the Council, $29 per metric ton.

From the householder's point of view the cost to acquire the bins was $21.50. A conservative estimate for the average weight of a bag of rubbish is 7 kg. Thus, the average Experimental household would save 27.5 bags per year over five years or $13.75 per year. Given these values, the bins would pay for themselves in 1.56 years (or sooner if the value of the compost produced was included in this analysis).

Data Analysis, Calculation, and Presentation

As can be seen in Figure 1, there was a reduction in the experimental group's weekly rubbish output after the intervention (29%). The control group also showed a reduction (12%).

To evaluate these changes over time, a repeated measures three-way (Condition × Area × Week) ANCOVA [36] was carried out, with the weight of rubbish deposited by each household at the first baseline weighing as the covariate and the weekly weight of each household's deposited rubbish on subsequent weeks, as the dependent variable. This was done to control for the differential amounts of rubbish deposited by each household without intervention. The sphericity test (for autoregression) failed ($p < .0001$) so the Greenhouse-Geisser degrees of freedom adjustment was used for the week-to-week comparisons. A significant main effect for condition was found in this analysis ($F(1, 32) = 4.99$, $p = .033$), suggesting that being part of the experimental group reduced rubbish weight significantly more than being part of the control group. A main effect was also found for Week ($F(2.17, 71.53) = 22.99$, $p < .0001$), suggesting that there was a significant reduction in rubbish deposited over the weeks independent of area and condition. The week-by-condition interaction was also significant. Figure 1 shows that this was because, when baseline data is considered, there was a significantly greater and longer maintained decrease in weight of rubbish in the experimental group than in the control group.

Area alone did not significantly influence the weight of rubbish that went to the rubbish dump, but the week-by-area interaction was significant ($F(1.63, 79.93) = 6.10$, $p = .0028$) suggesting that the participants in the two areas acted differently over the intervention weeks, across conditions. Figure 2 shows a bigger initial

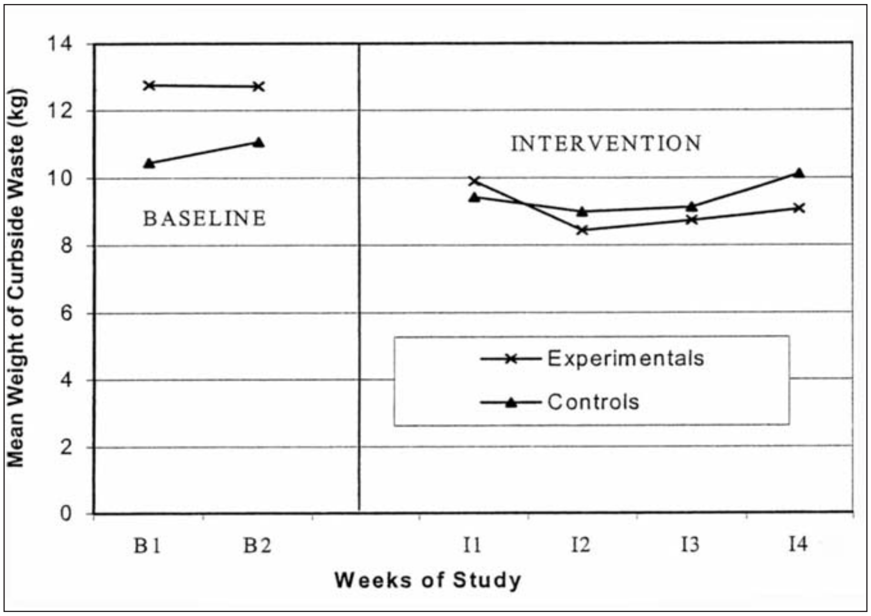

Figure 1. Average output of rubbish for Experimental and Control groups in each period.

decrease in the weight of curbside rubbish deposited by the experimental group members in the lower socioeconomic area (Woodhaugh) and a terminal loss of effect in this area while the experimental group decrease in the higher socioeconomic area (Maori Hill) was somewhat less initially but did not revert during the study. The three-way interaction among these variables was not greater than chance.

Post-hoc Student Newman-Keuls Range Tests [37] were performed on the cell means, adjusted for the rate of baseline rubbish deposited in the first week to determine the location of these differences. For the experimental group the adjusted cell mean for baseline 2 (12.079 kilos) was significantly ($q > 8.00$, $p < .001$) greater than each of the individual intervention means, which (with the exception of intervention week 2's weights being significantly ($q(4) = 4.21$, $p < .025$) lower than intervention week 1's) do not differ from each other. For the control group) the adjusted cell mean for baseline 2 (11.82 kilos) is significantly ($q > 4.20$, $p < .05$) greater than each of the first three weeks of "intervention" but not significantly different from the fourth week.

A more detailed analysis of this data revealed that the two areas in the experimental group show the same pattern as the overall experimental data, the baseline adjusted mean was significantly different from all interventions and the

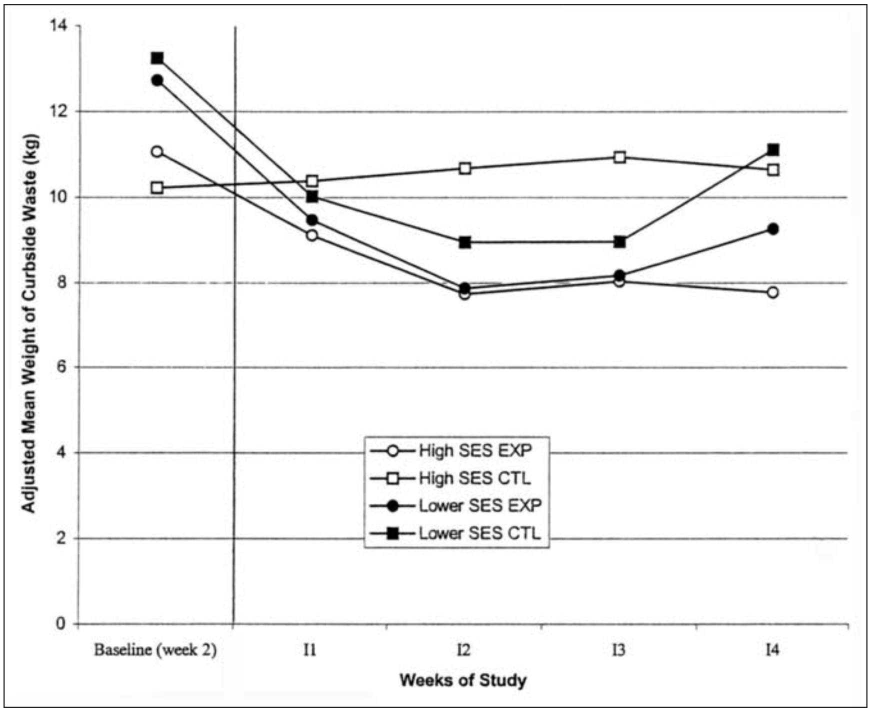

Figure 2. Adjusted mean weights of rubbish for Experimental and Control groups in the high (Maori Hill) and lower (Woodhaugh) SES areas.

interventions did not differ from each other. The Maori Hill (higher SES) control group showed no differences between baseline and intervention, or among the intervention weeks. However, the Woodhaugh (lower SES) control group shows a drop between baseline and all the intervention weeks. The last intervention week shows a significantly higher weight of curbside rubbish than the preceding two weeks.

As a further comparison between the high and lower SES groups, we looked at the proportion of eligible households in these two areas that declined to participate in the study in any capacity. In the higher SES group this was 6 out of 25 households, and in the lower SES group this was 9 out of 27 households. A Fisher's exact probability test on this data shows no significant difference ($p < .40$) between these proportions.

DISCUSSION

The results of this intervention indicated that empowering households, by providing resources and information, was successful at significantly reducing the weight of waste the householders put out on the curbside (compared with the control group), for the four-week course of measurement of the intervention. The main effect for "weeks" demonstrates that being part of the study produced significant differences in waste output for both the experimental and control groups. Post-hoc tests show that these significant differences were sustained in the experimental group (but not the control group), while also being in the direction of a reduction in the weight of curbside waste. The reduction in initial waste in the controls appears to have been only in the lower SES subgroup. Remember that both experimentals and controls had been asked to change their behavior. Experimentals by composting and putting their curbside rubbish out the night before it was to be collected for weighing, and controls by putting their rubbish out early for weighing. It is probable that this necessary attention paid by the control householders to their disposal behavior accounts for the initial decrease in the weight of curbside rubbish put out by the control group.

The way that participating households were allocated to condition (experimental or control group) could be seen as a selectivity bias, as controls were chosen from those who had first declined to participate as part of the experimental group. This could explain the finding that the decrease in rubbish weight during the intervention period was significantly greater in the experimental group compared with the control group, as those in the experimental group were already interested in composting (and, hence, were more likely to compost, thus reducing the weight of their rubbish). However, the use of this type of control group is valid as the analysis was concerned with the difference of the weight of rubbish for each group (experimental and control) before and after the intervention was implemented. Because we looked at the change in rubbish weight for each group, the lower level of interest in composting in the control group could not account for the significantly smaller difference in rubbish weight in the control group in baseline compared with intervention. The only problem with the design was that those in the experimental group expressed an interest in composting. As it would have been difficult to persuade those uninterested in composting to purchase the composting bins this possible confound could not be resolved.

When considering the results of this study in terms of real world recommendations, a useful conclusion may be that people interested in composting were more likely to do so when given both the means and sunk cost motivation (by way of the composting bin at a reduced rate) and the information [24, 25]. The function of the control group was to compensate for extraneous effects of the experiment (e.g., Hawthorne effects and extra-experimental variables like weather). Their self-selection as households who did not wish to purchase bins should, in no way, have modified the amount of rubbish they put out on the curbside and so they were a valid control for this variable.

The empirical differences in the weight of rubbish served to validate the effectiveness of De Young et al.'s belief in an "educational strategy" for increasing recycling [6], when it is combined with the provision of resources [10, 11], in a context where a commitment has been made [23-26]. Our experimental participants made their commitment by the sunk cost method of purchasing their bins [24, 25]. The results also support the findings of other composting programs that have employed education-based strategies, such as those described by Sherman [10], Vossen and Rilla [21], and Riggle [22], while overcoming some of the problematic measuring issues through the use of empirical measurements rather than self-report.

It would seem that the provision of affordable bins assisted households in composting their organic waste, thus emphasizing the importance of situational factors in predicting recycling behavior [11, 24, 25]. It is likely that the presence of the bins in the kitchen and yard also served as ongoing prompts for composting behavior for the experimental group, helping to sustain the behavior beyond the point at which the control group's improved waste disposal was starting to tail off (Figure 1).

It is also of note that there was no significant overall effect for Area/SES. Previous research has shown that those belonging to higher social classes and socioeconomic groups are more likely to be involved in recycling activity [9]. However, no overall differences were observed between the high SES and lower SES experimental group members. Furthermore, there was no significant difference between the proportions of eligible households in the two groups that agreed to participate in the study in some capacity. We did find a difference between the response to the commitment to participate by the high SES group and the lower SES group when the experimental and control groups were combined. The high SES group showed an initial drop in the rate of rubbish depositing and then showed a plateau after the second week of intervention, while the lower SES group showed the same pattern with a return toward baseline levels in the last week of the study. The control participants from the lower SES area were more affected by their participation in the experiment than were the higher SES area control participants, while the experimental intervention participants were not different as a function of SES area (Figure 2).

It appears that the lower SES control group was more willing to increase their conservation behavior than the higher SES group. They may have rejected the subsidy offer because it still involved a noticeable expenditure, while the higher SES control group may have rejected it because they were genuinely uninterested/unconcerned. It is likely that attempts to make simple correlations between socioeconomic status and conservation behavior are misguided and unhelpful. For instance, McGuire found that although higher income houses reported more recycling, when their refuse was analyzed there were no significant differences when compared to low income houses [38]. This suggests that many of the studies that report this correlation are reporting verbal behavior rather than actual recycling behavior. While income is linked to being able to afford conservation resources, our results suggest that income alone is an inadequate predictor of conservation behavior when the resources needed for that behavior are made equally available to both high and low income areas.

How do we put these resources into the hands of a community that is willing to use them? Government bodies are the only people who have the power to do this. Cost-effectiveness analysis of this composting initiative showed that it is in the interest of these bodies to consider such schemes as it would cost $29 to prevent a ton of rubbish from entering the landfill. The implementation of such projects would increase the longevity of the landfill and postpone the expenditure needed to create new facilities. This deferral of expenditure could be realized in terms of the interest earnable or payable on this expenditure and ultimately benefit the taxpayer, not to mention the environment. More municipalities need to start exploring these strategies, as local governments have in some parts of the United States (e.g., described in [10, 21, 22]) and Sweden [28], in order to assist willing conservationists to overcome the barriers, such as lack of knowledge and resources. Without this guidance, the pro-environmental attitudes found in the community will remain attitudes, never becoming conservation behavior.

The individual household also stands to gain from accepting a subsidy offer. The cost of the bins would be recovered in a year and a half; for those houses in lower socioeconomic areas this benefit is appreciated. Without the D.C.C. subsidy, many of the experimental participants from Woodhaugh would never have started composting their organic waste; thus, some financial support is required if these resources are to be made equally available to all within the community. The benefits go beyond these financial incentives; every ton of organic material that is prevented from going to the landfill would become useful in improving soil in household gardens instead. Taken as a whole, the cost-effectiveness analysis of this composting initiative demonstrates that little is lost through implementing this scheme, while much is gained.

By weighing the weekly rubbish of households in the community, this study has been able to show that De Young et al.'s strategy [6] was effective in reducing curbside waste. While few studies have trialed composting under this framework, the underlying principles of education are applicable to all pro-environmental research. In general, people have sincere attitudes toward conservation, yet sadly fail to act in accordance with these beliefs. It is essential for the community to realize that these failings are not necessarily a function of apathy; instead they may represent a willing, but ill-equipped and under-informed populace. The findings of this study demonstrate that by making the bins available and by teaching residents how to compost, it is possible to translate sympathetic attitudes into positive behavior.

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