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RECYCLING BEVERAGE CONTAINERS ON A COLLEGE CAMPUS

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ABSTRACT

Current and anticipated shortages of energy, materials and landfill space have prompted interest in finding cost-effective ways to encourage recycling of scarce resources. One significant source of waste involves the disposal of steel and aluminum beverage containers as trash. The present research sought to increase recycling of beverage containers in college dormitories. Previous research has shown that prompts and reduced response cost can increase recycling. In the present research a multiple baseline design was used in which a single recycling container was first placed in each of four college dormitories. Subsequently, five additional containers were added to each of three dorms at successive, approximately three week intervals. Poster and flyer prompts which encouraged recycling were used throughout both conditions. Additional posters were also distributed when the multiple container procedure was implemented. The results showed substantial increases in recycling of both aluminum and steel cans when the multiple container procedure was used relative to the single container procedure. Data on the cost-effectiveness of these procedures and suggestions for future research are presented.

Diminishing supplies and escalating costs of natural resources suggest that it will become increasingly difficult to maintain our present materials base for production, and thus our life style, in coming decades [1, 2]. The question is whether predicted shortages of materials will result in the collapse of production systems, or whether alternatives to such an eventuality exist.

Unfortunately, while facing serious shortages of materials, the United States continues to discard enormous quantities of materials in landfills each year

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[1, 3]. To compound the problem, decreasing landfill space has intensified interest in finding alternatives to such disposal [4].

One alternative to the diminishing supplies problem is to substitute relatively plentiful materials (e.g., aluminum) for scarce resources (e.g., copper) [5]. However, this solution relies entirely upon the availability of virtually unlimited supplies of non-polluting energy. No present energy source can provide such energy, and alternative breakthroughs are not as yet apparent [2]. Furthermore, substitution would not help to solve our landfill waste problem. Therefore, it does not appear that the substitution of one material for another is a viable alternative at the present time.

A solution which could solve both problems is to recycle rather than discard scarce resources; that is, to find ways to reuse or return consumed materials to the manufacturer for reprocessing, thus extending the supply of materials. One frequently advocated approach is to build centralized waste recovery facilities which would collect garbage from surrounding cities, separate out recyclable materials and burn the remaining wastes for energy [3]. New York State, for example, is currently developing plans to build five such facilities to solve its serious waste disposal problems [6].

The difficulty with this strategy is that centralized waste recovery facilities generally use more energy than is used when waste materials are discarded in landfills [3]. We are thus faced with a dilemma; while recycling seems to offer a solution to pending shortages of materials and landfills, present recycling systems may significantly exacerbate our increasingly serious energy problems.

The high cost of centralized recycling systems is due to inefficiency in separating recyclable materials from other wastes. For example, separating glass from other trash is only about 50 per cent efficient, while sorting colored from clear glass is only 60 per cent efficient, for a net recovery efficiency of only 30 per cent [3]. A solution to this problem may be to minimize separation and sorting costs by recovering materials at the earliest possible point after use. In many cases, encouraging consumers to separate recoverable materials from other wastes may be the most efficient approach to recycling.

One specific source of waste which may be particularly amenable to this strategy is the throwaway beverage container. On a nationwide scale it has been estimated that beer and soft drink containers account for about 50 per cent of all beverage and food containers sold, including meats, milks, cheese, vegetables and candy [3] and in 1972, represented some 60 billion throwaways [7]. Recycling of these containers would conserve a great deal of energy, particularly in the case of aluminum, as the remelt energy cost of aluminum is only 3 to 4 per cent of the original energy manufacturing cost [2].

Of particular interest here is the fact that over 100,000 steel soft drink containers are sold annually in residence halls on the local college campus, and approximately 85,000 aluminum beer containers are also used. All of these containers are presently discarded in landfills and could be recycled. The purpose of the present study was to evaluate a procedure to encourage residents of college dormitories to recycle their beverage containers.

Previous attempts to increase recycling have used incentives [8, 9] and prompts and reduced response cost [9, 10]. The latter two studies were concerned with newspaper recycling in mobile home parks and apartment complexes, respectively. In those studies, it was reasoned that failure to recycle newspapers may be due to the absence of appropriate prompts or, alternatively, that the response cost of recycling may have been too high because recycling was very inconvenient. Therefore, a procedure was developed to encourage recycling which involved the use of prompts and reduced response cost. A single container was placed in a convenient location in the mobile home park or apartment complex. After a stable recycling rate was established, additional containers were added. Prompts (flyers and posters) were used throughout the studies. The results indicated that increases in recycling occurred when the response cost to recycle was reduced. A similar strategy was used in the present study.

METHOD

Subjects and Setting

Four undergraduate residence halls at SUNY Cortland were selected in the study. Each housed approximately 190 students (60% female and 40% male) on three and one-half floors, plus a small annex which contained a few additional rooms. The residence halls were virtually identical in design, and roughly equivalent in population with approximately 50 per cent freshmen, 23 per cent sophomores, 20 per cent juniors and 7 per cent seniors. A detailed breakdown of the residents by sex and year for each dorm is presented in Table 1.

Each residence hall contained a main lounge on the first floor in which the only soda machine in the dorm was located.

Single Container Procedure

In this procedure a single recycling container was placed adjacent to the soda machine in the main lounge in each residence hall. A large poster (approximately 55 cm. square) which read "Please Recycle Cans" (the letters were approximately 6 cm. high) was attached to the soda vending machine. At the beginning of this phase, a flyer was placed in each mailbox in the dorm, in which residents were:

1. informed that over 100,000 cans were discarded annually in residence halls on this campus;
2. urged to recycle cans to save energy and resources and reduce waste, and;
3. advised of the location of the recycling container.

An abbreviated flyer urging recycling was subsequently placed in mailboxes on Thursday evenings throughout this phase.

Table 1. Distribution of Students by Sex and Year in the Four Residence Halls
(Frequency and Proportion Within and Across Residence Halls)

Residence Hall	*No. Males*	*No. Females*	*No. Freshmen*	*No. Sophomores*	*No. Juniors*	*No. Seniors*	*Total No. of Students*
Hendrick	79	114	100	56	21	15	193
	(.41)	(.59)	(.52)	(.29)	(.11)	(.08)	
Bishop	68	121	93	48	37	11	189
	(.36)	(.64)	(.49)	(.25)	(.20)	(.06)	
Shea	75	127	103	40	47	12	202
	(.37)	(.63)	(.51)	(.20)	(.23)	(.06)	
Fitzgerald	73	108	92	30	46	13	181
	(.40)	(.60)	(.51)	(.17)	(.25)	(.07)	
Overall totals	295	470	388	174	151	51	765
Overall proportions	(.39)	(.61)	(.50)	(.23)	(.20)	(.07)	

The recycling containers were square, white twenty-three gallon Rubbermaid trash receptacles (Model #3569) with swing top lids. They were distinctly different from the round, grey lidless forty-four gallon trash barrels used by the custodians. The message "PLEASE RECYCLE CANS HERE" was stenciled in green letters (about 2 cm. high) on all four sides of the lids.

Multiple Container Procedure

In the Multiple Container procedure an additional recycling container was placed in the trash disposal room on each floor and in the annex (for a total of six containers per dorm). Additional posters, similar to those used in the Single Container Condition, were also distributed throughout the dorm. Flyers were distributed in mailboxes each Thursday evening during this condition.

Experimental Design

A multiple baseline experimental design was used across three residence halls (Hendrick, Bishop, and Shea) [11]. The Multiple Container procedure was implemented in Hendrick after three weeks in the Single Container phase, introduced three weeks later in Bishop, and then two weeks later in Shea. The fourth dorm remained in the Single Container phase throughout the study. This dorm served as an additional control for trends associated with seasonal variations in beverage consumption over the semester.

Data Collection Procedures

Between 2 and 4 p.m. each day (except Sunday), observers removed and counted the number of steel and aluminum cans collected in each recycling container. Virtually all soda cans were all-steel, while nearly all beer cans were all-aluminum. (While soda cans were sold in the dorms, sixpacks of beer were sold in the college union which was located approximately one-tenth of a mile from the farthest of the four dorms.)

The cans were placed in a plastic bag and temporarily stored until transport to a recycling dumpster. A local recycling plant provided the dumpster and made periodic pickups.

In addition to daily and weekly totals for both steel and aluminum cans, the local vending distributor's records were used to calculate the per cent of steel cans recycled of those sold weekly in each dorm. (Unfortunately, because it was not possible to determine what proportion of the beer cans sold in the union were discarded in the dormitories, a comparable percentage could not be obtained for beer cans.)

Exact records were also kept of the amount of time required to collect the cans, deliver flyers, check the condition of posters (or make and replace them, when necessary), and clean the recycling containers.

Reliability

Before making daily collection rounds, the observers turned over the top card in a well-shuffled deck of fifty index cards, among which were included twelve marked cards. If the card selected was marked, the observer counted the number of cans contained in the plastic storage bag from the previous day in each dorm, and compared the data from this second count with the count recorded on the previous day. Reliability was determined by dividing the smaller of the two counts by the larger, X 100. Twenty-two such comparisons were made throughout all phases of the study, with 100 per cent reliability obtained on each check. (If the observer turned over a marked card, but had made the previous day's collection herself, the card was returned to the deck and a reliability check was not made.)

RESULTS

The results for steel cans are presented first, followed by the data for aluminum cans. Figure 1 presents the number of steel cans recycled each week during the study in the four residence halls.

Inspection of the data in Figure 1 shows a clear increase in the number of cans recycled in all three dorms from the three week periods which immediately preceded implementation of the Multiple Container phase to the three week periods which immediately followed the transitions. The mean number of cans recycled increased from sixty-six to eighty-seven cans per week in Hendrick, an increase of twenty-one cans per week, while increases of seventeen and thirty-nine cans per week were obtained in Bishop and Shea halls from baseline means of twenty-six and seventeen cans, respectively.

It is clear from Figure 1 that the Multiple Container procedure was effective in increasing the number of cans recycled. However, examination of the data throughout each phase (not simply the three week periods surrounding the transitions from Single to Multiple Containers) shows very consistent declining trends in all phases which are longer than three weeks. The presence of these trends makes comparisons of the relative effectiveness of the two procedures tentative. However, even with this qualification, it is possible to make some preliminary comparisons of the relative effectiveness of the two procedures, by comparing the data obtained throughout the entire experimental phases. These data are presented in Table 2.

Table 2 shows that while there was an increase in the mean number of cans recycled per week in each residence hall when the Multiple Container procedure was implemented, the increases are substantially smaller than those obtained for the three week periods surrounding the transition; Hendrick showed a mean gain of only three cans per week, while Bishop and Shea gained an average of twelve and twenty cans per week respectively.

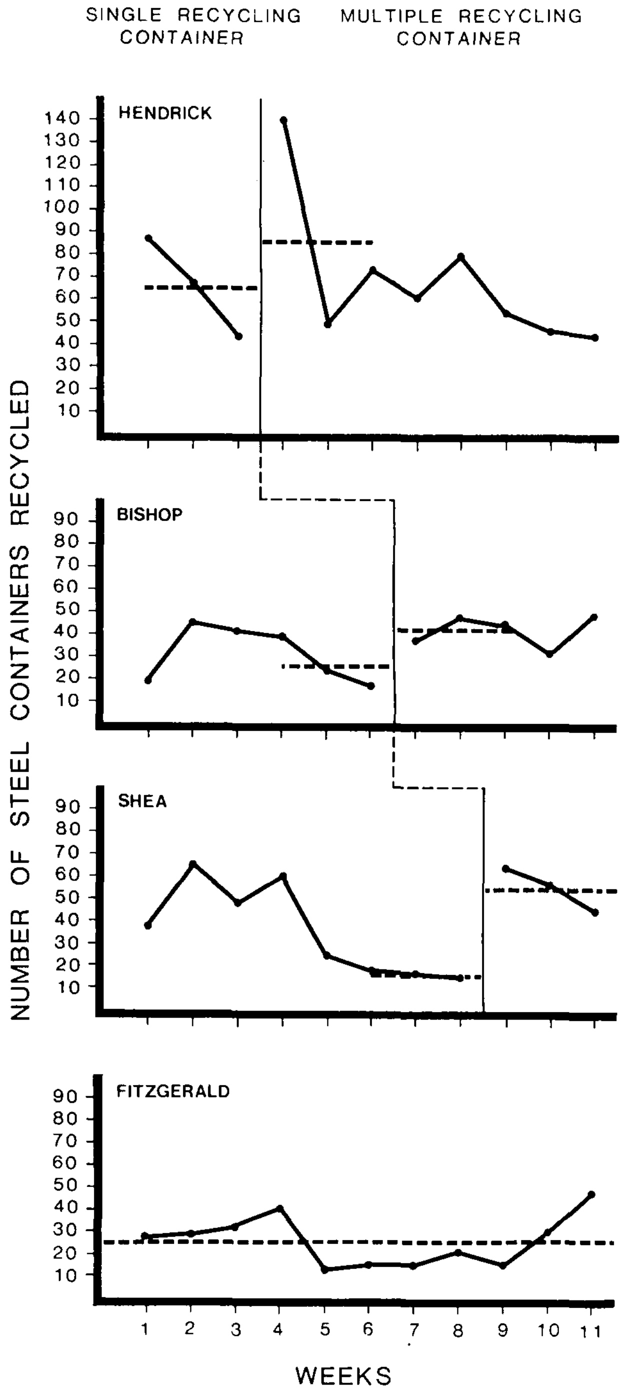

Figure 1. The number of steel beverage containers recycled in the Single and Multiple Container conditions in four college residence halls.

Table 2. The Mean Number of Steel Beverage Containers Recycled Per Week Under the Single and Multiple Container Condition and, in Parentheses, the Per Cent of Containers Recycled of Those Sold. Change Data Between Conditions are Also Included

Residence Hall	*Single Container (%)*	*Multiple Container (%)*	*Change*
Hendrick Hall	65	68	+3
	(23)	(31)	(+8)
Bishop Hall	30	42	+12
	(16)	(33)	(+17)
Shea Hall	35	55	+20
	(11)	(26)	(+15)
Fitzgerald Hall	26	–	–
	(13)	–	–

The per cent of steel cans recycled of those sold in each dorm and the change across conditions are also presented in Table 2. In each case, implementation of the multiple container procedure produced increases in the per cent of containers recycled of those sold, with change scores of 8, 17 and 15 per cent for Hendrick, Bishop and Shea halls, respectively. It is clear from these data that the increases in recycling obtained when the Multiple Container procedure was successively introduced in the dorms was not due to seasonal increases in beverage consumption, but to actual increases in recycling.

The data for aluminum cans shows even greater increases with the additional containers than were obtained with steel cans. In the three week periods before and after the change in conditions, the mean numbers of aluminum cans recycled increased by sixty-five, twenty and seventy-six cans in Hendrick, Bishop and Shea. These data are presented in Figure 2 and Table 3.

These data again show substantial increases in recycling when the multiple containers were introduced. However, because decreasing trends are also observed here, the mean numbers of aluminum cans recycled across each complete experimental phase are also presented in Table 4.

Across the entire phase, the mean number of aluminum cans recycled per week increased by fifty-seven, thirteen and seven cans in Hendrick, Bishop and Shea halls, respectively.

A comparison of the data obtained from Fitzgerald Hall in both Figures 1 and 2 did not reveal any systematic trends in recycling over the semester which could account for the changes obtained when the Multiple Container procedure was implemented. However, inspection of these data, and the data from the other residence halls, indicates considerable variability in the number of cans recycled

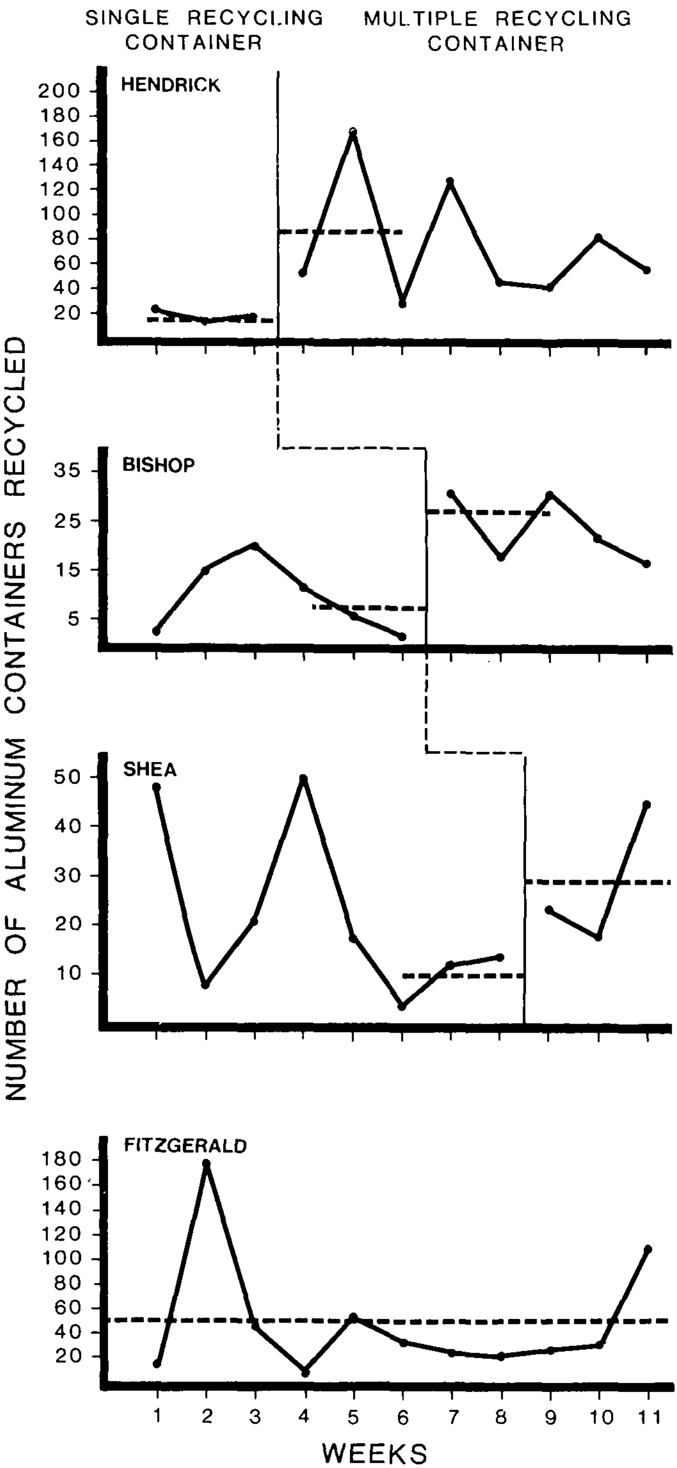

Figure 2. The number of aluminum beverage containers recycled of those sold in the Single and Multiple Container conditions in four college residence halls.

Table 3. The Mean Number of Aluminum Cans Recycled During the Three Week Period Before and After the Transition From the Single Container Phase to the Multiple Container Phase

Residence Hall	*Single Container*	*Multiple Container*	*Change*
Hendrick Hall	18	83	+65
Bishop Hall	7	27	+20
Shea Hall	10	86	+76

both within dorms across weeks and across dorms. For example, while Hendrick averaged sixty-five steel cans per week in the Single Container phase, the other dorms averaged between twenty-five and thirty-five cans. In addition, Fitzgerald averaged fifty aluminum cans per week for the entire semester, while the remaining three dorms averaged between nine and twenty-two cans. The latter difference is due to extreme peaks in Fitzgerald's data which occurred intermittently during the semester. Interestingly, there appeared to be greater variability in the data for aluminum can recycling than for steel.

DISCUSSION

The results show that the Multiple Container procedure consistently produced increases in recycling of both steel and aluminum beverage containers, relative to the Single Container procedure. When the three week periods before and after the transition are compared, it is clear that substantial increases were obtained in all six comparisons. Furthermore, in four of the six comparisons of means across the entire phases, large increases were also obtained when the Multiple Containers were introduced, while in the remaining two comparisons the changes were small but in the anticipated direction. These data support previous research and demonstrate that reducing the response cost required to

Table 4. The Mean Number of Aluminum Beverage Containers Recycled Per Week Under the Single and Multiple Container Conditions, and the Change Across Conditions

Residence Hall	*Single Container*	*Multiple Container*	*Change*
Hendrick Hall	18	75	+57
Bishop Hall	9	24	+13
Shea	22	29	+ 7
Fitzgerald Hall	50	–	–

recycle cans produced increases in recycling and thus may contribute to our materials, energy and waste disposal problems [9, 10].

However, although it is clear that while providing multiple containers did produce immediate increases in recycling, the gains achieved declined over time after the transition to the Multiple Container procedure in the six comparisons. In fact, a declining trend after the initial weeks in each condition seemed to be characteristic of much of the data in both Single and Multiple Container conditions. The reasons for these declines are not clear, but it seems likely that research will be required to find ways to maintain the gains achieved here.

Overall, the Multiple Container procedure produced proportionately greater increases in recycling of aluminum versus steel containers. One interpretation of this difference is that, while students probably drink only one soda at a time, beer is often consumed with friends in a party atmosphere. Consequently, a greater number of containers probably accumulate after drinking beer than after drinking soda. Students may be more likely to walk down the hall to recycle the greater number of containers that occur after drinking beer than make the same response to recycle a single soda container. Support for this interpretation is seen in the greater variability in the aluminum can data than was obtained for steel cans, which may reflect the periodic occurrence of parties. (It was known, for example, that the high peaks in the data from Fitzgerald correspond to the occurrence of large parties.)

Both measures used—the number of cans recycled and the per cent of cans recycled of those sold—showed increases in recycling when the Multiple Container procedure was implemented. Both sources of data are important because they provide the basis for benefit/cost analyses of the present precedures and also show the impact of these procedures on the actual problem of container waste in residence halls. The latter question is considered first.

Despite the increases in recycling obtained, only about one-third of the steel containers sold were actually recovered by the Multiple Container procedure. It seems likely that many aluminum containers were discarded as well. Thus, while the procedures used were effective in encouraging recycling of materials which would otherwise be discarded, methods which have a greater impact on the total problem clearly are needed to significantly reduce materials waste.

A preliminary cost analysis of each procedure was also performed based on the estimated costs and benefits to be expected if each procedure were implemented for the entire semester. To obtain these estimates, the data were averaged across weeks and dorms and then prorated for the entire semester. (The results of this analysis are considered preliminary and suggestive only since the assumption that the findings would be maintained at obtained levels for the entire semester may not be valid. Furthermore, because the Multiple Container procedure always followed the Single Container procedure, sequence effects may distort the estimates of the actual number of cans that would have been recycled if the Multiple Container procedure had been introduced alone.)

Costs included both materials and labor, while benefits included only the value of the materials sold. (The benefits from reductions in the total waste generated by each dorm per week were not included because of the high cost involved in obtaining these data.)

Estimates indicate that the Single Container procedure would require:

1. $1.52 in materials;
2. $25.00 for the recycling container, and;
3. Six hours of labor which, valued at the minimum wage of $2.65 per hour, would cost $15.90.

Excluding the cost of the recycling container, the total cost for materials and labor each semester is estimated at $17.12. Proceeds from the sale of steel containers (at $.75 per 100 lbs.) and aluminum (at $.19 per lb.) are estimated to be $.81 and $3.00 per semester, for total receipts of $3.81. The benefit/cost ratio would be $3.81/17.12 and equals 0.22. In other words, it would cost $17.12 to "earn" $3.81.

Comparable figures for the Multiple Container procedure are: $3.82 for materials, $31.80 for twelve hours of labor, and $150.00 for the initial investment for the recycling containers. The total operating costs for materials and labor is estimated at $35.62 per semester. Receipts for steel and aluminum at the rates given above would be $1.16 and $5.27, respectively, for a total of $6.43 per semester. The benefit/cost ratio for the Multiple Container procedure is $6.43/$35.62 and equals 0.18.

It is clear from these data that neither of these procedures is cost effective if labor costs are included. However, if the procedures could be implemented by volunteers from the dorms or incorporated into the regular duties of the maintenance staff, the labor charge could be excluded, in which case the benefit/cost ratios for the Single and Multiple Container procedures are 2.51 and 1.68, respectively. Under these conditions both are cost effective, but the Single Container procedure is the more efficient approach of the two. (Since maintenance personnel regularly clean hallways and lounges and empty trash receptacles, and since checking posters and/or emptying recycling containers would therefore add only a few minutes each week to their schedules, it seems likely that labor costs can be excluded from the costs of the program, particularly if the Single Container procedure is adopted.) Finally, if the cost of the containers were paid from the "profit" obtained each semester under the Single and Multiple Container procedures (assuming no labor costs), it would require nineteen and fifty-seven semesters, respectively, to pay for the containers under each of the two conditions.

Summary and Conclusions

The procedures used here were clearly effective in encouraging consumers to recycle beverage containers which normally would have been discarded.

Preliminary comparisons of the Single and Multiple Container procedures further indicate that more cans were recycled when the response cost to recycle was reduced, although the benefit/cost ratios may be unreliable due to the short durations used for each condition and the limited number of settings employed. Second, sequence effects may influence the data obtained in the Multiple Container procedure. Third, the relative contribution of the prompts and the proximity of the containers cannot be separately assessed, because these variables were combined in the procedures used. In addition, while the procedures used did promote large initial increases in recycling, the effects of both procedures generally seemed to decrease over time. Finally, a large proportion of the steel (and probably aluminum as well) cans were discarded under both procedures. Consequently, further research should assess the stability and representativeness of the present results, more adequately compare the two procedures, and/or find an alternative approach which would both recover a greater proportion of the materials discarded and maintain the gains indefinitely. Previous research suggests that incentives may be effective although it is not clear at this time how rewards could be used in a cost effective approach to this particular problem [8, 9].

One final point should be mentioned. It could be argued that research to encourage recycling of beverage containers is unnecessary since the solution to beverage container wastes already exists (i.e., "bottle bills"). However, it is important to note that even though bottle bill legislation has been passed in a few states, similar legislation has been defeated (sometimes repeatedly) in many others. This is true even though passage of bottle bills saves energy, reduces waste and litter, and provides jobs. From this example it is clear that energy conservation is not a sufficiently important stimulus to gain legislative votes. The importance of research of the kind reported here is that it may play an important role in shaping a pro-ecological "culture"—one in which behavior patterns which conserve energy and reduce waste are widely accepted. It is anticipated that the development of such a culture will provide the "pressure" needed to force legislators to vote for pro-ecological legislation, and thus work constructively toward the solution to our ecological problems.

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