The Impact of Public Feedback on Three Recycling-Related Behaviors in South Korea

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THE IMPACT OF PUBLIC FEEDBACK ON THREE RECYCLING-RELATED BEHAVIORS IN SOUTH KOREA

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ABSTRACT: The effectiveness of posted feedback on recycling in a lounge area at a South Korean university was studied. Participants were college students, professors, and staff members. The dependent variables were the percentage and number of correctly separated aluminum cans, the percentage and number of correctly separated paper cups, and the weight of recycled paper. An A-B-BC-A time series design was used. During baseline (A), separation containers were provided. Posted written feedback was introduced (B) and graphic feedback was added (BC). All feedback was then withdrawn (A). Written feedback resulted in statistically significant increases in all five measures. Although all five measures increased again when graphic feedback was added, none of the increases was statistically significant. When feedback was removed, all but the percentage of correctly separated paper cups decreased significantly. Although the study was of short duration, the results suggest that publicly posted written feedback can increase recycling.

Keywords: *recycling; public feedback; written feedback; graphic feedback*

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The massive generation of solid waste has become a serious global problem. Although waste minimization programs have been implemented in many European and North American countries, few have achieved their goals (Thogersen, 1994). The most common way to dispose of waste is to bury it in landfills. Worldwide, approximately 70% of municipal solid waste is buried annually, but the capacity of the landfill system is quickly reaching its limits (SRI International, 1999). In the United States, for example, the Environmental Protection Agency (EPA, 2004) has projected that eight states will deplete landfill space within the next 5 to 10 years.

Waste incineration, which can reduce the amount of waste by up to 90%, has been adopted as one alternative. Although the heat generated from the incineration process can be used for other purposes, such as producing electric power, incineration is not a desirable alternative because it adds to existing air pollution problems. The EPA (2004) has ranked incineration and landfill burial as the least environmentally sound disposal strategies. Source reduction (including reuse) was ranked as the most preferred method, followed by recycling and composting, because they conserve natural resources, save energy, decrease greenhouse gas emissions, and reduce the need for landfill space.

In the United States, the percentage of municipal solid waste recycled grew from 9.6% in 1960 to 30.1% in 2000 (EPA, 2004). Only about 50% of the products that could be recycled, however, were recycled in 2000 (EPA, 2004). The EPA has set a goal that 35% of all municipal waste will be recycled by 2005. Even though the goal is only 5% above the current percentage, it represents a considerable increase in the tonnage of waste that must be recycled. That is because the total amount of municipal solid waste increased from 88.1 million tons in 1960 to 232.0 million tons in 2000 and is still growing. In 2000, for example, to have met EPA's goal of 35%, an additional 11.4 million tons of waste would have to have been recycled. The tonnage needed to meet EPA's goal in 2005 will increase as the tonnage of total waste increases. Globally, the situation is similar. The amount of municipal solid waste has been increasing by approximately 1.5% per year and, like in the United States, only about one third of it is being recycled (Glenn, 1999; SRI International, 1999).

In South Korea, where this study was conducted, waste disposal is a very serious problem because of the dense population and small land mass. Specifically, there are more than 45 million people living in an area the size of the state of Indiana. In response, South Korea's Ministry of Environment (2003) has been aggressively promoting recycling since 1995.

Behavioral recycling studies have typically targeted one waste product such as the collection of newspapers or aluminum cans. Interventions have

consisted of the manipulation of both antecedents and consequences of behaviors. The most frequently manipulated antecedent conditions include prompts (e.g., Austin, Hatfield, Grindle, & Bailey, 1993; Burn, 1991; Everett & Peirce, 1991-1992; Jacobs, Bailey, & Crews, 1984), commitment (e.g., Burn & Oskamp, 1986; Cobern, Porter, Leeming, & Dwyer, 1995; Wang & Katzev, 1990), environmental alteration (e.g., Brothers, Krantz, & McClannahan, 1994; Luyben & Bailey, 1979; Luyben, Warren, & Tallman, 1979-1980; Reid, Luyben, Rawers, & Bailey, 1976), and goal setting (e.g., Hamad, Bettinger, Cooper, & Semb, 1980-1981; McCaul & Kopp, 1982). Consequences, in the form of rewards (e.g., Hamad, Cooper, & Semb, 1977; Luyben & Baily, 1979), lotteries (Geller, Chaffee, & Ingram, 1975; Witmer & Geller, 1976), and contests (Couch, Garber, & Karpus, 1978-1979; Jacobs & Bailey, 1982-1983) have also been manipulated.

Few studies have examined the effects of posted feedback on recycling behavior, even though such feedback has been shown to alter public behaviors. For example, posted feedback has reduced driving speed (e.g., Ragnarsson & Bjorgvinsson, 1991; Van Houten, Nau, & Marini, 1980), public littering (Schnelle, McNees, Thomas, Gendrich, & Beagle, 1980), community gasoline consumption (Rothstein, 1980), and shoplifting (Carter, Holmstrom, Simpanen, & Melin, 1988). In addition, feedback has been shown to increase performance when added to antecedent interventions such as prompts, commitment, and goal setting (Becker, 1978; DeLeon & Fuqua, 1995; Ralis & O'Brien, 1986). It is also more easily applied in public settings than are rewards, lotteries, and contests that require the distribution of consequences to individuals or small groups. To date, however, the results of the few studies that have assessed the effects of feedback on recycling behaviors have been mixed.

Hamad, Cooper, and Semb (1977) examined the relative effectiveness of public feedback combined with contests versus verbal prompts in a newspaper recycling program conducted in an elementary school. Feedback combined with contests was more effective than were verbal prompts. However, the effects of the feedback alone were not assessed. In a later study, also conducted in an elementary school, Hamad, Bettinger, Cooper, and Semb (1980-1981) evaluated the relative effectiveness of public feedback, goal setting, and self-recording plus rewards for paper recycling. The largest quantity of paper was collected during the goal setting condition, followed by the self-recording plus rewards condition. During the feedback alone condition, however, the amount of paper collected was about 50% below the baseline level.

Two studies have reported positive effects of public feedback. Katzev and Mishima (1992) assessed the effects of posted feedback on newspaper recycling on a college campus using an ABA within-subject reversal design.

Feedback increased the weight of the paper collected by 76.6% above baseline. DeLeon and Fuqua (1995), in a study conducted with residents of university apartments, examined the effects of feedback only, commitment only, and feedback combined with commitment on curbside recycling. Graphic feedback was published weekly in the campus newspaper. Relative to baseline levels, the weight of the paper collected increased approximately 25% for the feedback only group and 40% for the feedback combined with commitment group, whereas the weight did not change for either the commitment only group or for the control group.

These mixed results are not unusual. Balcazar, Hopkins, and Suarez (1985-1986), based on an extensive review of feedback applications conducted over a 10-year period, reported that the effectiveness of feedback depends on several factors, including how it is delivered. They found that graphic feedback was consistently more effective than was either oral or written feedback. They were not able to compare the relative effectiveness of combined delivery methods, such as written plus graphic feedback, however, due to the small number of interventions.

In a later review modeled after the Balcazar et al. (1985-1986) review, Alvero, Bucklin, and Austin (2001) found that when written and graphic feedback were combined, a higher percentage of interventions resulted in consistent effects (86%) than when either written or graphic feedback was used alone (53% and 50%, respectively). However, these percentages were based on only five or six interventions. Although both reviews provide valuable comparisons, they have limitations. First, in both, the number of feedback applications in each category was small. Second, conclusions were based on across-study comparisons, thus other differences in the feedback procedures may have influenced the results.

In a rare study, Wilk and Redmon (1998) directly compared the effectiveness of oral feedback plus goal setting with oral feedback, goal setting, and graphic feedback. Participants were clerical workers in four units of a university admissions office. A multiple-baseline design across units was used. After baseline, oral feedback and goal setting were introduced. Graphic feedback was then added. In all four units, the number of tasks completed increased after the introduction of oral feedback and goal setting. Performance immediately increased further when graphic feedback was added.

The current study was conducted to determine whether publicly posted written feedback would increase recycling on a South Korean college campus, which would replicate Katzev and Mishima's (1992) results, and whether graphic feedback would have incremental effects, as in Wilk and Redmon (1998). In addition, the study extended earlier work by targeting the separation and recycling of three waste products (aluminum cans, paper

cups, and paper) rather than one. The correct separation of recyclable materials is an important component of any cost-effective recycling program, as commingled materials require later manual or automated separation at disposal sites, which is costly and inefficient. The feedback was introduced after separation containers were made available during the baseline phase.

METHOD

PARTICIPANTS AND SETTING

The study was conducted at a South Korean university that had a total of approximately 12,000 students and 600 faculty members. Participants were employees, professors, and college students who worked or attended classes in the same university building. The study was conducted in a lounge area containing two vending machines for soft drinks and coffee.

APPARATUS

Before the study began, two waste containers were in the lounge. These were replaced with four separation containers, each 44 × 44 × 75 cm, for paper cups, aluminum cans, paper, and nonrecyclable trash. The containers were placed next to each other in a row. A label for one type of waste material was attached to each container. In addition, a 110 × 80 cm poster soliciting the appropriate separation of waste was placed on the wall above the four containers. The poster stated (in Korean):

Please recycle!
For more efficient recycling,
1. Please separate your waste.
2. Dump cans in the can container. Please do not put anything such as cigarette butts or gum in the cans.
3. Dump paper cups in the paper cup container. Please do not put anything such as cigarette butts or gum in the cups.
4. Dump papers only in the paper container.
5. Dump other materials in the trash container.

During the treatment phases, two types of feedback boards were used: written and graphic. On the written-feedback board, the date (month and day)

Month _____ Date _____

Weight of recyclable paper collected yesterday: _____ kg

Percentage of correct separation of paper cups and cans:

Paper cups _____ %

Cans _____ %

Figure 1: An Illustration of the Written Feedback Board Translated Into English

was specified, and underneath, the weight of the recyclable paper collected and the percentage of aluminum cans and paper cups separated correctly the previous day. Figure 1 displays an English translation of the written feedback board. On the graphic feedback board, the weight of the paper and the percentage of cans and paper cups correctly separated were graphed by session over time (similar to Figures 2, 3, and 4, but without the phase-change lines and labels). The feedback boards were 75×50 cm and were hung across the front of the four separation containers during the relevant treatment phases. They were also attached to the two vending machines.

EXPERIMENTAL DESIGN

An A-B-BC-A time-series design was used. After an initial baseline phase with the four separation containers (A), written feedback was introduced (B). Graphic feedback was then added to the written feedback (BC). In the final phase, the written and graphic feedback were withdrawn (A).

DEPENDENT VARIABLES

The main dependent variables were the percentage of correctly separated aluminum cans, the percentage of correctly separated paper cups, and the weight of recyclable paper collected. Secondary dependent variables included the number of correctly separated aluminum cans and the number of correctly separated paper cups. Percentages were used as the main dependent variables for aluminum cans and paper cups because the total number of items collected varied considerably from session to session depending upon

the traffic in the lounge area. The percentage of correctly separated cans and cups was calculated as follows: the number of correct items in the appropriate container divided by the total number of items in the container, multiplied by 100. The weight of recyclable paper was measured after all other items were removed. The unit of measurement was kilograms, and the scale was sensitive to one decimal place.

EXPERIMENTAL CONDITIONS AND PROCEDURES

Waste collected from 4 p.m. to 9 p.m. Mondays through Thursdays was targeted for observation. Measures were not taken Fridays, Saturdays, or Sundays because few staff, faculty, and students were on campus those days. Immediately before 4 p.m. on Mondays through Thursdays, an experimenter emptied all four containers. At 9 p.m., an observer measured the total number of items in the aluminum and paper cup containers, the correct number of items in each, and the weight of recyclable papers in the paper container. Materials in the trash container were not measured.

Baseline. The four separation containers were placed in the lounge, and the poster soliciting the appropriate separation of waste materials was posted. This phase lasted for eight consecutive sessions.

Written feedback. The written feedback boards, indicating the percentage of cans and paper cups correctly separated in each container for the previous day and the weight of the paper collected the previous day, were attached to the four separation containers and the two vending machines. The feedback boards were posted at 9 a.m. Mondays through Thursdays. The feedback boards displaying the data for Thursdays were not posted until Monday mornings, when the staff, faculty, and students returned to campus. This phase lasted for seven consecutive sessions.

Written plus graphic feedback. Graphic feedback was added to the written feedback. In addition to the written feedback boards, the graphic feedback boards were attached to the four separation containers and the two vending machines at 9 a.m. Mondays through Thursdays. Once again, the feedback boards displaying the data for Thursdays were not posted until Monday mornings. This phase lasted for five consecutive sessions.

Withdrawal. Baseline conditions were reinstated. This phase lasted for seven consecutive sessions.

INTEROBSERVER AGREEMENT

Interobserver agreement was obtained for 30% of the sessions. A second observer independently counted and calculated the percentage of the cans and cups that were correctly separated in each container and weighed the paper. The percentage of interobserver agreement was calculated by dividing the smaller of two measures recorded by the observers by the larger measure and then multiplying the quotient by 100. The mean interobserver agreement was 95.5% for the percentage of correctly separated aluminum cans (ranging from 94.2% to 97.4%), 94.8% for the percentage of correctly separated paper cups (ranging from 92.4% to 95.8%), and 95.0% for the weight of the recyclable paper (ranging from 83.3% to 100%).

RESULTS

Figure 2 displays the percentage of correctly separated aluminum cans across the four phases of the study. The number of correct, the number of incorrect, and the total number of items deposited in the aluminum can container for each session are provided in the appendix. The percentage of correctly separated cans was used as the main dependent measure because of the high variability in the total number of items deposited across sessions (ranging from 31 to 254). During baseline, the average percentage of correctly separated cans was 62.4%. When written feedback was introduced, it increased to 75.5%. When graphic feedback was added it increased by only 2.7%, to 78.5%. When both written and graphic feedback were withdrawn, the average percentage decreased to 62.8%, which was close to the baseline level.

Figure 3 displays the percentage of correctly separated paper cups across the four phases. The number of correct, the number of incorrect, and the total number of items deposited in the paper cup container for each session are provided in the appendix. As with the aluminum cans, the percentage of correctly separated cups was used as the main dependent measure because of the high variability in the total number of items deposited across sessions (ranging from 27 to 144). The average percentage of correctly separated cups was 43.5% during baseline. It increased to 64.8% when written feedback was introduced. When graphic feedback was added to written feedback, the average increased by 5.1%, to 69.9%. When both written and graphic feedback were withdrawn, the average percentage decreased to 63.3%; however, this was above the baseline level.

Figure 4 displays the weight of the paper collected across the four phases. The average weight was 1.3 kg during baseline and increased to 5.9 kg when

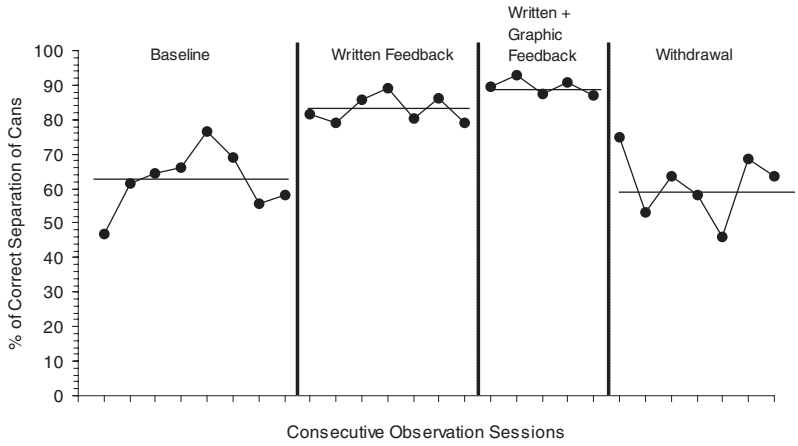

Figure 2: Percentage of Correctly Separated Aluminum Cans as a Function of Separation Containers, Written Feedback, and Graphic Feedback

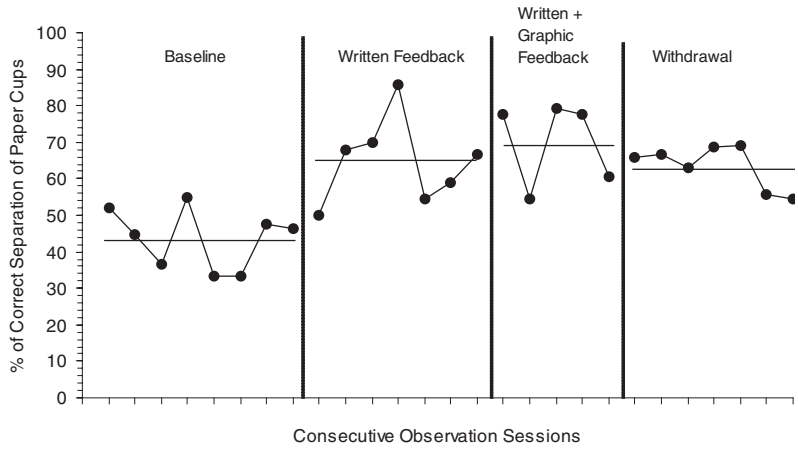

Figure 3: Percentage of Correctly Separated Paper Cups as a Function of Separation Containers, Written Feedback, and Graphic Feedback

written feedback was introduced. When graphic feedback was added to written feedback, the average increased to 8.8 kg. When both written and graphic feedback were withdrawn, it decreased to 3.4 kg.

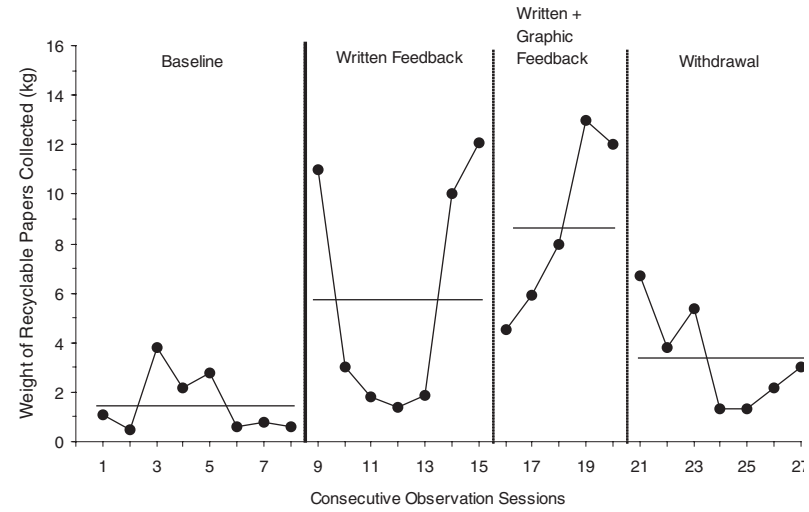

Figure 4: Weight of Recyclable Papers Collected as a Function of Separation Containers, Written Feedback, and Graphic Feedback

To determine whether the mean differences were statistically significant across experimental phases, contrast tests were conducted comparing the mean differences during the (a) baseline and written feedback phases, (b) written feedback and written plus graphic feedback phases, and (c) written feedback plus graphic feedback and withdrawal phases (King & Minium, 2003; Myers & Well, 2003). To maintain the family-wise error rate (FWE) at .05, the Dunn-Bonferonni method was used, whereby *p* is compared with .05 divided by the number of comparisons (Dunn, 1961; Myers & Well, 2003). Thus, in this case, .05 was divided by three, and *p* was compared to .0167. As displayed in Table 1, the mean differences between baseline and the written feedback phase for all three dependent variables were statistically significant. None of the mean differences, however, was significant between the written feedback and written feedback plus graphic feedback phases. Finally, the mean differences between the written plus graphic feedback and withdrawal phases were statistically significant for the percentage of correctly separated aluminum cans and kilograms of paper but not for the percentage of correctly separated paper cups.

Contrast tests were also conducted to determine whether the mean number of correctly separated aluminum cans and paper cups differed across phases, although these data must be interpreted cautiously because of the

TABLE 1
Results of Contrast Tests for the Percentage of Correctly Separated Aluminum Cans, Percentage of Correctly Separated Paper Cups, and Kilograms of Paper

	Baseline Versus Written Feedback		*Written Versus Written Plus Graphic Feedback*		*Written Plus Graphic Feedback Versus Withdrawal*	
Dependent Variable	*t*	*p*	*t*	*p*	*t*	*p*
% of aluminum cans	5.64	.000*	1.56	.133	–6.70	.000*
% of paper cups	4.30	.000*	.93	.363	–1.19	.245
Kg of paper	2.63	.015*	1.50	.148	–2.83	.009*

*$p < .0167$.

high variability in the total number of items deposited in the containers across sessions. The average number of correctly separated aluminum cans for the baseline, written feedback, written plus graphic feedback, and withdrawal phases was 58.9, 102.3, 124.4, and 89.4, respectively. The average number of correctly separated cups for the four phases was 22.0, 55.6, 76.8, and 35.0, respectively. As above, *p* was compared to .0167 to maintain the FWE.

Table 2 displays the results of the contrast tests. As with the percentages of correctly separated cans and cups, the mean differences for the number of correctly separated cans and cups between baseline and the written feedback phase were statistically significant. Again as with the percentages, the mean differences for the number of correctly separated cans and cups between the written feedback and written plus graphic feedback phases were not statistically significant.

The mean differences between the written plus feedback and withdrawal phases for the number of correctly separated cans and the number of correctly separated cups were statistically significant. In both cases, the mean decreased when feedback was removed. The results of the contrast test between the final two phases for the number of correctly separated paper cups differed from the results of the contrast test for the percentage of correctly separated paper cups reported earlier. That is, although there was a significant difference between the mean number of paper cups separated correctly during the written plus feedback phase and the withdrawal phase, there was not a significant difference between the mean percentage of paper cups separated correctly during these final two phases.

TABLE 2
Results of Contrast Tests for the Number of Correctly Separated Aluminum Cans and Paper Cups

	Baseline Versus Written Feedback		*Written Versus Written Plus Graphic Feedback*		*Written Plus Graphic Feedback Versus Withdrawal*	
Dependent Variable	*t*	*p*	*t*	*p*	*t*	*p*
No. of aluminum cans	3.67	.001*	1.65	.112	–2.61	.016*
No. of paper cups	4.43	.000*	2.47	.021	–4.87	.000*

*$p < .0167$.

DISCUSSION

In this study, posted feedback increased the recyclable products that were separated and collected in a public lounge at a university. When written feedback was introduced, all of the following measures increased significantly over baseline levels: (a) the percentage and number of correctly separated aluminum cans; (b) the percentage and number of correctly separated paper cups; and (c) the weight of recyclable paper. When feedback was removed, all but the percentage of correctly separated paper cups decreased significantly. These results support those of DeLeon and Fuqua (1995) and Katzev and Mishima (1992) who reported positive effects of feedback on recycling behavior. More generally, the results also support those of other researchers who found that posted feedback affected the behavior of people in a public setting (Carter et al., 1988; Ragnarsson & Bjorgvinsson, 1991; Rothstein, 1980; Schnelle et al., 1980; Van Houten et al., 1980).

The increases in the recyclable products collected occurred after a baseline period during which separation containers were available. Thus, the results indicate that posted feedback can improve performance above levels that may occur with this type of environmental alteration. On the other hand, it should be noted that the increases from the feedback intervention were dependent upon the provision of four separation containers. Such environmental alterations have consistently improved recycling behavior (e.g., Brothers et al., 1994; Luyben & Baily, 1979; Luyben et al., 1979-1980; Reid et al., 1976) and are probably necessary pre-conditions for the effectiveness of the current type of intervention.

Although all five measures increased when graphic feedback was added to the written feedback, none of the increases was statistically significant. These results conflict with those reported by Wilk and Redmon (1998). In their study, the number of tasks completed by office workers in each of four units increased substantially when graphic feedback was added to vocal feedback and goal setting. It could be that the posted written feedback in the current study was more effective than was the private vocal feedback and goal setting used by Wilk and Redmon, eliminating some potential for further improvement. Posted feedback may result in social contingencies that support the desired behavior. Moreover, these social contingencies could eliminate differences between written and graphic feedback. Additional studies that compare the relative effectiveness of different feedback procedures are certainly needed.

The cost of interventions should always be weighed against their benefits. One of the advantages of feedback, along with its simplicity and flexibility, is its cost-effectiveness. These characteristics, together with its proven effectiveness in a wide variety of settings, probably account for its widespread use.

Simplicity, flexibility, and cost-effectiveness are also important requirements for practical and effective recycling programs. Antecedent interventions, such as environmental alteration, have been successful, at least in the short-term, and are probably the most simple, flexible, and cost-effective programs. Once the environment has been altered, the intervention can be relatively easily maintained over time. Nonetheless, because it must be maintained over time, even this type of intervention involves response cost.

In the current study, posted feedback increased recycling considerably above levels achieved with the separation containers alone. Thus, even though feedback is more expensive than environmental alterations, it is less expensive and involves less response cost than interventions involving consequences. Although consequence interventions, such as providing monetary rewards, have been used to increase recycling (e.g., Hamad et al., 1977; Jacobs & Bailey, 1982-1983; Luyben & Baily, 1979), problems associated with the cost of the interventions have been identified (DeLeon & Fuqua, 1995; Katzev, & Pardini, 1987-1988; Porter, Leeming, & Dwyer, 1995). DeLeon and Fuqua (1995) have pointed out that "those interventions that rely on monetary incentives or time-intensive interventions have financial costs that may limit their applicability" (p. 235). Therefore, feedback could be an excellent intervention strategy for recycling programs that need to balance practicality, effectiveness, and cost.

The present study had several limitations. First, the intervention phases were short. The written feedback condition lasted 7 days, and the written plus

graphic feedback condition lasted only 5 days. These restrictions were imposed by the length of the semester at the college. The incremental effects of adding graphic feedback may have been observed more clearly if the intervention phases had lasted longer. In addition, the long-term maintenance of the changes was not assessed. Unfortunately, this has typically been the case in behavioral recycling studies (Dwyer, Leeming, Cobern, Porter, & Jackson, 1993; Porter et al., 1995). Clearly, additional studies are needed to investigate the long-term effectiveness of behavioral interventions (Boyce & Geller, 2001; Geller, Winett, & Everett, 1982).

Additional limitations relate to the setting in which the study was conducted. In the lounge area of a university, the types of recyclable products are limited. In addition, it is relatively easy to measure the products collected and to provide public feedback. Therefore, more studies need to be conducted in a variety of settings to determine the feasibility of the public feedback procedure and assess the generality of the present findings.

The results of the current study indicated that publicly posted feedback can be an effective strategy to increase appropriate recycling behavior. It is important, however, for future studies to examine the long-term effectiveness of feedback and its generality across different settings.

APPENDIX
The Number of Correct, Incorrect, and Total Items in the Aluminum Can and Paper Cup Containers for Each Session

		Aluminum Can Container			*Paper Cup Container*		
Phase	*Session*	*Correct Items*	*Incorrect Items*	*Total Items*	*Correct Items*	*Incorrect Items*	*Total Items*
Baseline	1	67	76	143	14	13	27
	2	69	43	112	26	32	58
	3	38	21	59	19	33	52
	4	67	34	101	33	27	60
	5	72	22	94	20	40	60
	6	90	40	130	25	50	75
	7	50	40	90	19	21	40
	8	18	13	31	20	23	43
Written feedback	9	127	29	156	44	44	88
	10	72	19	91	51	24	75
	11	116	19	135	60	26	86
	12	113	14	127	72	12	84
	13	95	23	118	50	42	92
	14	117	19	136	60	42	102
	15	76	20	96	52	26	78
Written and graphic feedback	16	110	13	123	63	18	81
	17	158	12	170	48	40	88
	18	119	17	136	114	30	144
	19	116	12	128	90	26	116
	20	119	18	137	69	45	114
Withdrawal	21	72	24	96	46	24	70
	22	135	119	254	20	10	30
	23	98	56	154	17	10	27
	24	70	50	120	55	25	80
	25	112	114	226	38	17	55
	26	76	35	111	50	40	90
	27	63	36	99	19	16	35

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