JOURNAL OF APPLIED BEHAVIOR ANALYSIS 2010, 43, 327–331 NUMBER 2 (SUMMER 2010)

ENCOURAGING ELECTRICITY SAVINGS IN A UNIVERSITY RESIDENTIAL HALL THROUGH A COMBINATION OF FEEDBACK, VISUAL PROMPTS, AND INCENTIVES

MARTHINUS J. BEKKER, TANIA D. CUMMING, NIKOLA K. P. OSBORNE, ANGELA M. BRUINING, JULIA I. MCCLEAN, AND LOUIS S. LELAND, JR.

UNIVERSITY OF OTAGO, DUNEDIN, NEW ZEALAND

This experiment investigated the combined use of visual prompts, daily feedback, and rewards to reduce electricity consumption in a university residential hall. After a 17-day baseline period, the experimental intervention was introduced in the intervention hall, and no change was made in the control hall. Energy usage decreased in the intervention hall, but energy usage did not change appreciably in the control hall. In the intervention hall, mean daytime and nighttime savings were 16.2% and 10.7%, respectively, compared to savings of 3.8% (day) and 6.5% (night) in the control hall.

Key words: dormitories, electricity savings, feedback, incentives, master-metered residences, visual prompts

---

University students who live in residential halls typically have little or no incentive to moderate behaviors such as electricity usage, because the amount they pay is not directly influenced by how much they use (Natasha Austin, Resident, Salmond College, personal communication, September 10, 2007). This lack of consequences for residents' excessive electricity usage behavior can have financial repercussions for the halls themselves, as well as environmental repercussions (Abrahamse, Steg, Vlek, & Rothengatter, 2005). There also is a response cost in saving electricity, if only the effort of turning off a switch when it is not needed. Slavin, Wodarski, and Blackburn (1981) described how master-metered apartments (apartments in which electricity is included in rent) used 35% more electricity than individually billed apartments.

Prompting, feedback, and incentives have been used to encourage electricity conservation. Incentives increase the likelihood of encouraging proenvironmental behavior change (Boyce & Geller, 2001). For example, Slavin et al. (1981) encouraged residents in master-metered apartment blocks to save electricity by providing rebates when usage was lower than predicted amounts, producing decreases between 1.7% and 11.2%. Abrahamse et al. (2005) reported that education about electricity conservation by itself increased knowledge but did not necessarily encourage change; experiments using positive reinforcers were the most effective.

Feedback has been shown to play an important role in behavior change (Hayes & Cone, 1981; Siero, Bakker, Dekker, & van den Burg, 1996). Petersen, Shunturov, Janda, Platt, and Weinberger (2007) investigated feedback and reward techniques to reduce the electricity consumption of dormitory residents. They compared real-time and weekly Web-based feedback of usage to residents in dormitories in conjunction with an interdormitory electricity conservation competition over a 2-week period with a preceding baseline. Dormitories with ongoing feedback reduced consumption by 55%, and those with weekly feedback saved 31%. Savings were for lighting and appliances only; room and water heating were not

We acknowledge the cooperation and assistance of the staff and students of Salmond College and Cumberland College who were the real stars of this process.

Address correspondence to L. S. Leland, Jr, Department of Psychology, University of Otago, P.O. Box 56, Dunedin 9054, New Zealand (e-mail: leland@psy.otago.ac.nz).

doi: 10.1901/jaba.2010.43-327

included. Prompts, feedback, and reinforcers are clearly important in encouraging desired behavior change (Clayton & Helms, 2009). The present study used these techniques to encourage occupants of a residential hall to reduce their electricity use.

METHOD

Participants and Setting

The participants in this study were the occupants of two residential halls situated within 2 km of each other at the University of Otago in Dunedin, New Zealand. The halls were randomly assigned to either a control or an intervention condition. The control hall had 326 residents, consisting mostly of 1st-year university students aged 18 to 20 years (59% female and 41% male). The intervention hall had 190 mostly 1st-year residents (63% female and 37% male). Most rooms were single occupancy. Heating and hot water costs were not included in the study because they were steam generated. There were no cooling systems present.

Design, Response Measurement, and Interrater Agreement

This study was conducted as a control group design with a 3-week preceding baseline. The preceding baseline consisted of electricity readings at both control and intervention halls and allowed us to compensate for any intrinsic differences between electricity use in the two halls. The control condition was identical to the baseline condition and consisted only of covert daily electricity meter readings. The 3-week intervention used a combination of feedback, incentives, and education to encourage reduction of electricity use. The measured variable was the amount of electricity recorded as used during each day and each night period, and the independent variable was assignment to either control or intervention conditions.

The dependent variable was the ongoing record of the kilowatt hours (kWhr) on the two (day and night) meters in each hall. All meter readings in the control hall were done between 10:30 a.m. and 11:15 a.m., and 36 of the 39 readings in the intervention hall were done between 8:29 p.m. and 9:03 p.m.; the remaining three readings were within a 2-hr window. Reading procedures included obtaining the date, time, a day reading, and a night reading. Interobserver agreement was calculated by having two meter readers conduct simultaneous recordings on 57% and 48% of the control and intervention readings, respectively, with 100% agreement in both cases. An agreement was reached if each observer's meter readings were within 2 kWh of each other.

Procedure

Consent and approval from the Otago University Ethics Committee were obtained, then daily electricity readings started at both residential halls, which constituted the baseline. The experiment took place from August to October (winter and spring in the southern hemisphere) with a temperature range (daily maximum) between 5 and 12 °C. The experimental materials were put up in the intervention hall during a Monday morning while the majority of the residents were attending classes. We put up nine large posters (29.7 cm by 42 cm) around the hall, calling residents' attention to a savings thermometer. The wording on the posters indicated that residents could get a reward for electricity savings, which would be "good for the environment" and "good practice for flatting" (shared independent living). We also put up smaller (10.5 cm by 14.8 cm) notices in 89 locations around the intervention hall, with specific electricity savings tips for adjacent clothes driers, televisions, light switches, and computers. Both halls had comparable facilities in this regard. We used an "electricity savings thermometer" (in the intervention hall), which was hand-drawn on a whiteboard with colored markers to deliver daily feedback and outline the incentive scheme. We placed the whiteboard directly inside the main entrance. It consisted of a thermometer shape with the various reward levels shown on a scale along the side, indicating the proportional progress towards each reward combined with written descriptions of the rewards. The incentive value increased as the residents saved more electricity. The lowest level (free coffee for a week) cost $150 in New Zealand (NZ) dollars, and subsequent levels went up in NZ$50 intervals, with the most expensive reward valued at NZ$350 (movie night, ice cream plus pizza party).

To update the savings thermometer each day, we calculated the electricity savings by subtracting that day's usage from mean baseline (defined for both halls as the period preceding intervention in the intervention hall) usage for each hall. Then we subtracted the percentage savings in the control hall from the percentage savings in the intervention hall. Subtracting the savings in the control hall controlled for any weather or university schedule-related factors. The differential savings for the intervention hall were converted to a monetary value (kWhr saved multiplied by cost per kWhr, adjusting for the specific day and night billing rates). Each weekday, cumulative progress toward the rewards was updated on the feedback thermometer (the monetary amounts were not given because the required monetary savings may have appeared too small to provide incentive). The study ended after 3 weeks of intervention, and the reward that was reached was announced. We then distributed a social validity questionnaire to give participants an opportunity to comment on the study and for the researchers to assess opinions related to the study.

RESULTS AND DISCUSSION

Over the 3-week intervention period, the intervention hall saved 3,700.31 kWhr equating to NZ$251.31 (adjusted for control saving). This entitled residents to a movie night with snacks. Over a 16-week semester, these savings would equate to 19,734.97 kWhr and NZ$1,344.30. These amounts were calculated by subtracting the percentage change from baseline in the control hall from the percentage change from baseline in the intervention hall, for both day and night, to derive an adjusted percentage change, which should account for extraneous variables that affected both halls. The adjusted percentage change was multiplied by the daily baseline average in the intervention hall to derive a kWhr-per-day savings, for both day and night, which was then multiplied by the respective cost for day and night usage to give a monetary savings per day. The per-day kWhr saved and monetary savings was then multiplied by the relevant time period to determine savings over the intervention period as well as extrapolated savings.

Figure 1 shows that the percentage of electricity saved during intervention in the intervention hall compared to its baseline was much higher during both the day (16.2%) and night (10.7%) time than in the control hall, whose residents saved a mean of 3.8% during the day and 6.53% at night during the same period compared to their baseline. Savings achieved were greater than in Slavin et al. (1981), where mean savings of 6.2% were made. However, they were lower than in Petersen et al. (2007), where feedback was combined with an interdormitory competition and savings of 31% to 55% made. These differences support the argument that more immediate and frequent feedback is more likely to produce behavior changes (Siero et al., 1996). Slavin et al. provided fortnightly feedback, in contrast to the constant real-time feedback used by Petersen et al.

Of the 190 residents, 75 completed a social validity questionnaire regarding the intervention. The majority of residents stated they would continue to save electricity in the absence of rewards (74%, using a chi-square goodness of fit test, $\chi^2 = 13.34$, $p < .01$) and that the scheme should be continued in future years

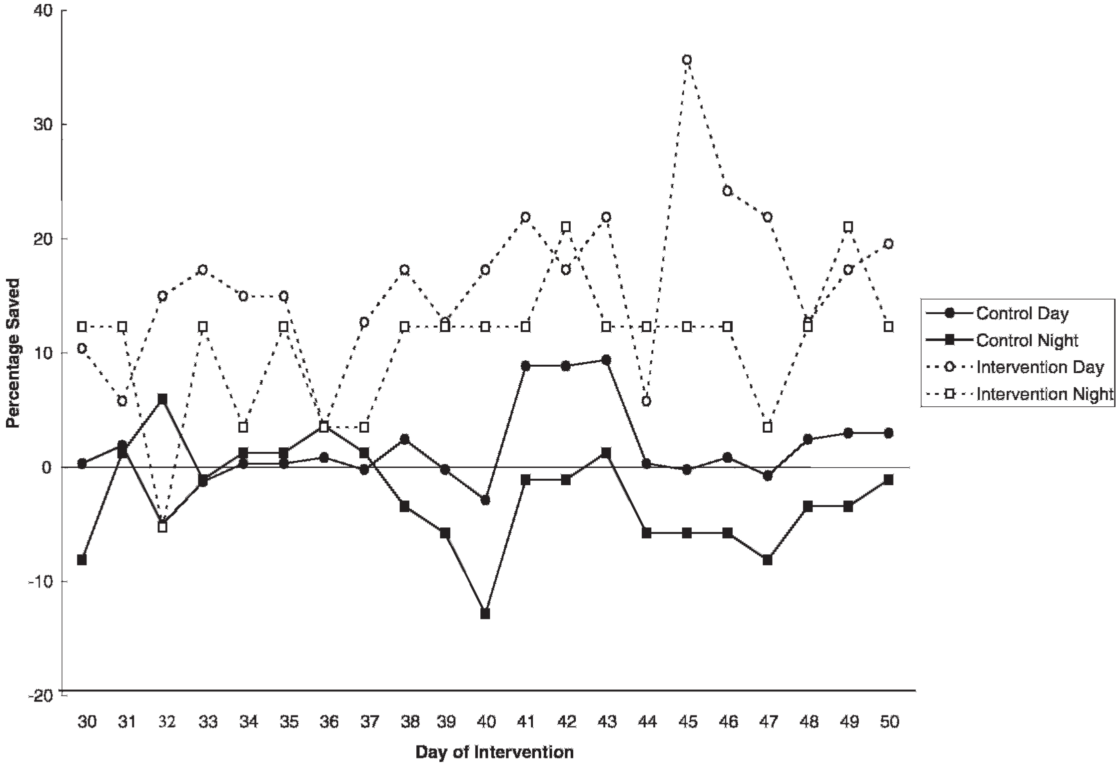

Figure 1. Percentage savings relative to baseline for both halls for daily and nightly electricity usage.

(89%, $\chi^2 = 43.9$, $p < .01$). The mean effort residents put in to saving electricity (on a 1 to 5 scale, 1 = *none at all*, 5 = *a lot*) was 3.1 (*SD* = 1.05), showing that the individual residents perceived that they had not put in excessive effort.

Continuing this scheme over a full academic year (with one semester of baseline and one of intervention) is predicted to be cost effective for halls. Table 1 summarizes the predicted costs of maintaining the intervention. If we were to subtract the costs in Table 1 from the savings (NZ$1,344.30 minus $216.27) and split the remainder evenly between rewarding the residents and savings for the hall budget, that net saving would be $564.02. Based on this analysis there would be an estimated NZ$5.22 net return for every NZ$1 spent on setup and maintenance of the intervention. From another perspective, it only costs NZ$0.01 to save 1 kWhr of electricity. This extrapolation assumes a continuous rate of savings equal to that of the 3 weeks of this study.

There are additional unmeasured benefits to the intervention, such as reduction of carbon emissions and reduced environmental impact (Petrie et al., 2007). Further, reduced usage of appliances reduces their general wear and tear, thus decreasing the need to maintain and replace expensive items. On a more global level, decreased electricity usage lowers pressure on electricity providers to build new plants, again reducing environmental impact. For the residents, there were social benefits, such as fostering a sense of positive social identity by working together towards a common reward (Vaughan & Hogg, 2002). There are also potential ongoing benefits for the residents, who may use the electricity-saving techniques to save money once they leave the hall.

Table 1
Costs of Maintaining the Intervention Based on 1 Academic Year

	Item	Cost per unit (NZ$)	Number needed	Total cost
Poster printing	Large color posters	$0.90	9	$8.10
	Small posters on colored paper[a]	$0.22 for 4	80	$4.40
	Small (A6) posters on white paper	$0.07 for 4	16	$0.28
Labor	Poster design	$11.25 per hr (NZ minimum wage)	1 hr	$11.25
	Putting up posters		0.5 hr	$5.63
	Baseline meter readings and calculations		0.5 hr	$5.63
	Meter readings and calculations in intervention (weekdays)		25 min per week for 16 weeks (6.66 hr)	$75.00
	Updating thermometer and checking and replacing posters (weekdays)		25 min per week for 16 weeks (6.66 hr)	$75.00
Stationery	Whiteboard	$135.00	1 (over 5 years)	$27.00
	Whiteboard marker	$2.99	1 (over 2 years)	$1.50
	Permanent marker	$2.99 for 3	3 (over 2 years)	$1.50
	Adhesive tape for posters	$1.99 for 2	1	$1.00
Total				$216.27

[a] This includes 7 replacement posters that were used after some small posters were damaged or removed. No large posters required replacement.

This experiment demonstrated that the combination of visual prompts, feedback, and incentives can effectively encourage behavior change regarding electricity usage. The intervention hall saved more than the control hall, enough to earn a reward for their residents. It should be noted that the baseline and intervention periods were relatively short, making it more difficult to conclude that the trends seen would continue over long periods of time. In addition, this experiment did not examine heating or hot water usage, because these were steam generated. Future studies could validate the present findings by investigating a larger sample size over a longer time period and may include some measure of reducing hot water and heating consumption as well.

REFERENCES

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology*, *25*, 273–291.

Boyce, T., & Geller, E. (2001). Encouraging college students to support pro-environment behavior: Effects of direct versus indirect rewards. *Environment and Behavior*, *33*, 107–125.

Clayton, M. C., & Helms, B. P. (2009). Increasing seat belt use on a college campus: An evaluation of two prompting procedures. *Journal of Applied Behavior Analysis*, *42*, 161–164.

Hayes, S. C., & Cone, J. D. (1981). Reduction of residential consumption of electricity through simple monthly feedback. *Journal of Applied Behavior Analysis*, *14*, 81–88.

Petersen, J. E., Shunturov, V., Janda, K., Platt, G., & Weinberger, K. (2007). Dormitory residents reduce electricity consumption when exposed to real-time visual feedback and incentives. *International Journal of Sustainability in Higher Education*, *8*, 16–33.

Petrie, S., Wear, S., Cameron, C., Gulliver, S., Leslie, K., & Tsui, K. (2007). *New Zealand's greenhouse gas inventory 1990–2005: The national inventory report and common reporting format*. Wellington, New Zealand: Ministry for the Environment.

Siero, F. W., Bakker, A. B., Dekker, G. B., & van den Burg, M. T. (1996). Changing organizational energy consumption behaviour through comparative feedback. *Journal of Environmental Psychology*, *16*, 235–246.

Slavin, R., Wodarski, J., & Blackburn, B. (1981). A group contingency for electricity conservation in master-metered apartments. *Journal of Applied Behavior Analysis*, *14*, 375–363.

Vaughan, G., & Hogg, M. (2002). *Introduction to social psychology* (3rd ed.). Sydney, Australia: Pearson Education.

Received April 4, 2008
Final acceptance December 19, 2008
Action Editor, Kenneth Silverman