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MOTIVATING ENERGY EFFICIENT TRAVEL: A COMMUNITY-BASED INTERVENTION FOR ENCOURAGING BIKING*

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ABSTRACT

By promoting safe, energy-efficient travel modes, environmental problems associated with extensive usage of the automobile can be reduced. The effectiveness of a practical incentive strategy for increasing biking and walking on a community bicycle path was evaluated. During a three-week baseline condition, frequencies of biking and walking were observed at two bikeways in a university setting. Then an incentive intervention with an innovative scheme for preventing cheating or circumvention was implemented at one of these pathways for a three-week period, followed by a three-week withdrawal period. The incentive phase was announced in local newspapers and on distributed handbills. Results indicated that during the incentive period, biking frequency at the experimental bike path was significantly greater than during pre- and post-incentive conditions, relative to observed biking on the control bikeway. Further, the pattern of daily biking frequencies during the incentive phase indicated that the increase in biking was directly related to the administration of certain prompting procedures. The cost effectiveness of the behavioral intervention is discussed with reference to communitywide application.

The extensive use of the private automobile has numerous ecological, economical and safety liabilities. Passenger cars alone are responsible for 27 per cent of the annual consumption of petroleum and natural gas in the U.S. [1]. Twenty-five to 30 per cent of the land in cities such as New York, Los Angeles, and Washington is devoted to roads and parking spaces for cars [2]. Additionally,

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large supplies of natural resources are used in the production of automobiles. In 1975, for example, 19 per cent of the steel, 47 per cent of the natural rubber, and 33 per cent of the zinc produced in this country was consumed by the automative industry [1].

Contemporary transportation systems have been a major cause of environmental pollution. Approximately 60 per cent of all air pollution in the U.S. is produced by automobiles [3]. The internal combustion engine of the automobile is responsible for carbon monoxide, hydrocarbons, nitrogen oxides, ozone, and lead; and the automobile is the major culprit of noise pollution, causing 51 to 68 per cent of urban noise [4].

Further, the economic costs of the automobile are tremendous. The average car consumes approximately 700 gallons of gasoline a year [3]. At $1.25 a gallon (a conservative estimate), this amounts to $875 in fuel costs annually per car; and with over 100 million cars in the United States, the amount spent on gasoline is staggering. In terms of energy efficiency (calories/gram/kilometer plotted against body weight), the car is less efficient than a man on a bicycle, a horse, and a jet transport [3]. However, the most tragic consequence of automobile usage is that more than 40,000 U.S. citizens die each year as a result of automobile accidents [3].

The potential contribution of incentive or reward strategies for modifying transportation behaviors has been documented elsewhere [5, 6]. Targets for incentive interventions have included:

1. increasing the use of mass transit [7-9];
2. reducing vehicle-miles-of-travel [10-12];
3. encouraging fuel-saving vehicle operation [13, 14]; and
4. promoting ride sharing [15, 16].

Peter Everett and his students have studied a variety of reward strategies for motivating bus ridership. In essence, this research attempted to increase the immediate positive consequences of bus riding (instead of decreasing the positive consequences of driving) by distributing discount coupons (redeemable at certain downtown businesses) when individuals boarded a specially marked bus. Citizens were informed of this transportation contingency via ads in local newspapers. This technique was developed and refined on a university campus and is currently undergoing communitywide evaluation in two large U.S. cities [5, 17]. The present research applied incentive strategies analogous to those used by Everett et al. in order to promote another alternative to the private automobile—the bicycle.

Besides gas conservation, benefits of biking can include shortened travel time, easy parking, exercise benefits, and increased flexibility in the choice of travel route. A few cities have offered monetary incentives to encourage citizens to bike for the first time. For example, in Washington, D.C., a "National Bike-sidy Program" was devised. Cooperating organizations offered a

$20 rebate to any employee who purchased a bicycle and agreed to use it for office-related trips [18]. This and similar incentive strategies to motivate bicycling appear reasonable, but their effectiveness has not been systematically evaluated. Large-scale applications of community incentive programs to promote the most energy-efficient modes of travel (e.g., biking and walking) are rare, and will perhaps only result after cost-effective, demonstration programs are established and the benefits are disseminated. The present study was designed to evaluate the impact of prompting techniques and an innovative incentive strategy for increasing the bicycling and walking behavior on a community bike path.

METHOD

Subjects and Setting

Subjects were all individuals walking or bicycling in the direction of the Virginia Tech campus (Blacksburg, VA) on either of two bikeways during the observation periods. The "experimental" bike path was approximately two miles in length, connecting the Virginia Tech campus to the Foxridge Apartment complex of approximately 1400 homes. Set in a rural milieu, the asphalt bike path is approximately 1.5 meters wide, and is separated from an unpaved road by a fence and a median of grass. The main section of the bike path is adjacent to a cow pasture. In commuting to campus or downtown Blacksburg, a bicycler coming from the apartment complex would have the choice of using the bike path or a bicycle lane which is part of a heavily traveled road. The travel time of the two routes is equivalent, approximately ten minutes. Preliminary observations at the alternative bike lane indicated that it was used relatively infrequently.

The "control" site was a bicycle lane which extends from the Virginia Tech campus to several large apartment complexes (i.e., more than 1,000 homes) in a direction opposite to that of the experimental site. This bike lane is part of a major road, heavily traveled by university commuters. Most users of both bike paths were students or faculty of the university.

Residents of Foxridge Apartments ($n = 464$) were interviewed and administered pre- and post-intervention questionnaires concerning their transportation habits. This was approximately 13 per cent of the total number of Foxridge residents ($n = 3500$). The residents of all units in even-numbered buildings were solicited for these interviews.

Experimental Design

The study used a quasi-experimental design with a nonequivalent control [19]. The control site was used to account for such contaminants of biking as class schedules, weather conditions, seasonal changes, and the price of gasoline. Using an A-B-A design, the study consisted of three phases: Baseline, Contest, and Baseline.

Procedure

During each phase of the nine-week study, a frequency count was obtained each weekday morning at both the experimental and control sites. Two preliminary frequency counts, from 7:30 a.m. until 5:30 p.m., were obtained at both sites in order to determine the busiest times. These times were included within the observation periods of the study, which were 8:30 a.m. to 10:30 a.m. on Mondays, Wednesdays, and Fridays and 7:30 a.m. to 9:30 a.m. on Tuesdays and Thursdays.

Observers were stationed in cars so that their presence was unobtrusive. Interobserver reliability was obtained for at least one-third of the observation periods of each phase. The data recording sheets included the mode of travel and age range of the subject. The temperature and weather condition (i.e., sunny, cloudy or rainy) were recorded for each observation day.

Baseline (pre-contest)—Frequency counts were obtained as described above for three consecutive weeks of baseline. During the weekend after the last week of baseline, trained researchers interviewed the residents of Foxridge Apartments about their vehicle ownership and commuting behavior. After completing the interviews, the residents were asked to complete a questionnaire about their transportation and exercise habits. Specifically, this questionnaire attempted to assess demographic information, commuting habits, and perceived benefits and drawbacks of various travel modes.[1]

In most cases (i.e., 98% of the time) the questionnaires were retrieved on the same day they were distributed. During questionnaire retrieval the interviewer explained that there would be a contest on the Foxridge Bike Path for the next three weeks in which prizes would be available. The resident received fifteen dated contest coupons, and the contest procedures were explained (as discussed below). Before leaving, the interviewers thanked the resident for completing the questionnaire and indicated that they would be returning in several weeks for a second interview.

Contest—On the final day of baseline, an article appeared in the university newspaper which announced a contest and included fifteen dated coupons. Potential participants were instructed in the newspaper and during the Foxridge interviews, to drop a contest coupon with their name and telephone number into one of the two containers located at either end of the experimental bike path.

[1] A copy of this questionnaire, as well as an outline of the interview, is available from the second author upon request.

The containers were wall mailboxes mounted on large, green, wooden signs (89 X 76 cm) labeled (in black obtrusive letters), "Bike Path Contest–Deposit Coupons Here."

The newspaper ads told contest participants to notice the daily contest number which was placed at the middle of the path. The fifteen contest numbers were one- and two-digit numbers which had been randomly selected. Each day a different number was mounted on a green sign (61 X 46 cm) with the obtrusive message, "Today's Contest Number." This sign was only visible to individuals using the bike path.

Each evening during the contest phase, coupons were counted, and duplicates were removed to assess the total daily number of different contest participants. After removing duplicate coupons, a coupon was drawn at random. The individual was telephoned, and if s/he knew the daily number (posted midway along the bike path), s/he was informed that s/he had won a prize. Coupons were drawn until a daily winner was found.

Prizes, which included store discounts, bicycle tuneups. and jogging shoes, were donated by four Blacksburg merchants, who each contributed three or four prizes. The monetary value of each prize was from $10 to $15. Gift certificates were mailed to the winners; the certificates indicated the prize that had been won and the donating store.

A second component of the contest phase was a variety of prompting strategies designed to inform the public of the bike path contest. These prompts included:

1. contest coupons delivered to Foxridge residents at the end of baseline;
2. an article in each of two newspapers announcing the start of the contest;
3. two contest announcements on a university radio station;
4. delivery of coupons for the third week of the contest at the door of every Foxridge unit during the preceding weekend;
5. six poster announcements of the contest on bulletin boards around campus; and
6. the appearance of contest winners' names in the university newspaper during each week of the contest.

Baseline (post-contest)–The contest materials were removed from the experimental site, and frequency of bike path use was recorded daily for three weeks, as for the Pre-Contest and Contest phases. Prior to the last week of this phase, Foxridge residents who had completed questionnaires during Pre-Contest Baseline were visited by their former interviewers. This visit consisted of a short interview to assess contest awareness and participation, and to determine extent of exposure to the various contest prompts.

RESULTS

Reliability

Reliability data for frequency observations at the two sites were available for twenty-nine observation periods, which was 33 per cent of the total number of observation periods. Reliability was evaluated by calculating the percentage of agreement between two observers on the number of individuals using each of the travel modes per observation period. Per cent agreement was 94 per cent for number of bikers, 91 per cent for number of walkers, and 85 per cent for number of joggers.

Frequency Observations

Biking—Figure 1 presents the frequency of bikers at both sites across days of the experiment. There was a high correlation of daily biking frequency between these sites ($r = .90$). During Pre-Contest Baseline, the number of bikers observed at the experimental site exceeded the number of bikers at the Control site on 86 per cent of the days (i.e., 12 out of 14); during the contest the number of observed bikers was higher at the experimental site on every day; and during the Post-Contest Baseline, the number of observed bikers at the experimental site exceeded the number of observed bikers at the control site on 73 per cent of the observation days (i.e., 11 out of 15).

The data depicted in Figure 1 suggests that the effects of the contest were quite transient (i.e., were no longer apparent during post-intervention baseline). Also indicated were immediate, short-term effects of the prompting strategies. That is, peak usage at the experimental site followed the two days marked with "flier arrows"—when fliers with coupons were delivered door-to-door and when two local newspapers published the contest coupons.

It should be noted that there was substantial day-to-day variability in frequency (i.e., the standard deviation was 46 at the experimental site and 32 at the control site). On rainy days the frequencies at both sites were very low, while sunny days and high temperature days seemed to produce a ceiling effect, obscuring the possible effects of the contest.

There was an average increase in temperature from Pre-Contest to Post-Contest Baseline of 13°F. The mean temperatures for the three phases were respectively: 8.9°C (48°F), 11.7°C (53°F), and 16°C (61°F), with an overall mean of 12°C (54°F). The temperature ranged from 2°C to 20°C (36°F to 68°F) and had a standard deviation of 8.3°C. Both weather conditions and temperature had significant correlations with biking frequency ($r = .74$ and $.40$ for weather condition and temperature, respectively, $ps < .01$).

To increase the sensitivity of the data to possible effects of the intervention, daily difference scores were calculated (i.e., observed daily frequency of bikers at the experimental site minus the observed daily frequency of bikers at the

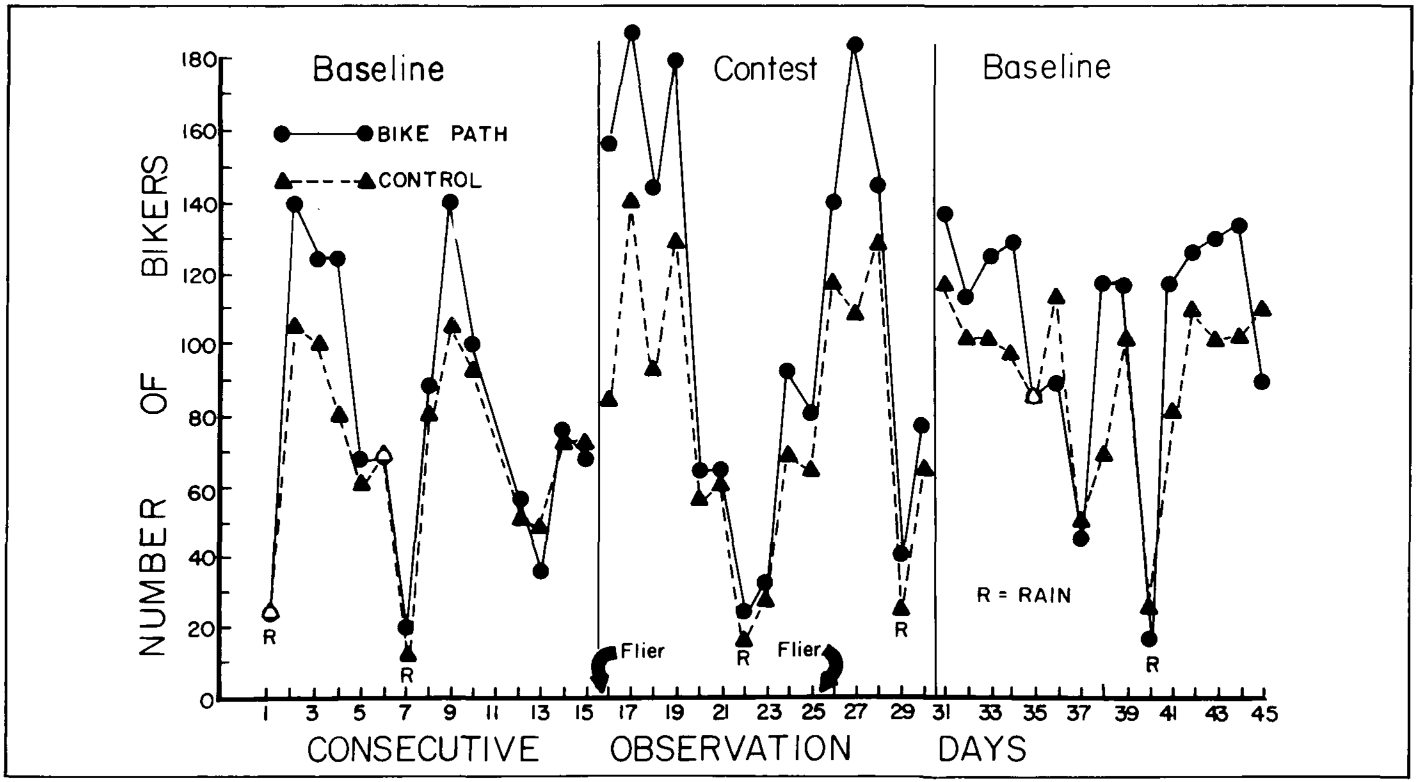

Figure 1. Observed frequencies of biking at two bikeways (i.e., labeled bike path and control). The contest condition was implemented at only one site (i.e., the bike path).

control site). These scores were then used in a one-way ANCOVA using temperature and weather condition as covariates. This analysis showed a significant main effect of phase, $F(2,39) = 5.41, p < .01$. The mean difference between sites during the contest (i.e., 28.5 bikers per day) was significantly greater than the mean difference during Pre-Contest Baseline (12.2 bikers) and Post-Contest Baseline (13.4 bikers), as indicated by a Duncan's Multiple Range Test ($p < .01$). The mean usage differences during the Pre- and Post-Contest phases were not statistically different ($p > .05$).

Walking—Walking remained relatively constant across phases at both sites, being low at the experimental site (an average of 7 walkers per day) and high at the control site (an average of 140 walkers per day). A 2 (Site) × 3 (Phase) Chi Square analysis of the frequency of walkers was nonsignificant ($\chi^2 = .03$), indicating that walking frequencies at the sites were not dependent upon experimental phase. The correlation of walking frequency between sites was .42 ($p < .01$).

Contest Participation

Daily contest participation was determined by counting the number of contest coupons deposited each day after the removal of duplicates. The number of different contest participants each day ranged from 22 to 135; mean daily participation frequencies for the three contest weeks were 99, 35, and 61, respectively. For 21 per cent of the subjects who were hand-delivered coupons, a coupon was counted on at least one day of the contest.

On ten days of the contest (66%), the first person who was called knew the contest number, and on the remaining five days (33%), an average of two persons had to be contacted before a winner was found. An average of five participants per day deposited duplicate coupons.

Questionnaire Data

The major intent of the questionnaires was to assess the commuting and transportation habits of the community. The bulk of this information, which will not be discussed in the present article, is available upon request to the second author. The majority of questionnaire respondents were students at Virginia Tech and two thirds of them were male. The usual mode of travel to campus was driving (82% of the respondents); approximately 12 per cent biked and 6 per cent walked. Fifty-three per cent of the respondents reported that they owned both a car and a bicycle.

In reporting awareness of the bike path, 81 per cent of the respondents reported that they had seen it and could draw a map of it, while an additional 15 per cent reported that they had seen it but were not sure where it led. Ninety-five per cent of the respondents reported being aware of the bike path contest. However, less than half of these residents (i.e., 43%) reported entering the contest.

DISCUSSION

Over the past decade a variety of behavioral studies have shown the potential of community-based prompting and reward strategies for protecting the environment [5, 20]. For example, the application of desirable consequences following specific environment-related, target responses has increased litter pick up, resource recovery, residential energy conservation, bus ridership and ride sharing. All of the behavioral community research in this area demonstrated beneficial behavior change only while the short-term treatment strategy was in effect; and so far there have been relatively few long-term applications of the effective behavior-change strategies which were developed in these research projects. The present study offers further evidence that prompts and incentives can be applied successfully to promote environment preservation, but one may certainly question the utility of adding yet another demonstration of reward efficacy to the environment and behavior literature. This discussion will attempt to justify the professional dissemination of the present research report.

First, to the authors' knowledge there has been no published account of a systematic attempt to evaluate strategies for motivating biking. Our literature search updated prior reviews [5, 6, 17, 20], and actually resulted in a paucity of studies which had evaluated techniques for encouraging energy efficient travel. Table 1 summarizes the outcome of this literature search, showing that the promotion of transit use has received the most comprehensive attention, but that even in this realm there is much to be done. Most of the cells in Table 1 (representing the pairing of a particular behavioral intervention with an energy-efficient travel behavior) have no related research investigation.

Our literature review further indicated that the prompting and incentive procedures of the present study were among the most feasible for large-scale application. Newspaper promotion of the project was accomplished at minimal cost (i.e., $20 for the campus newspaper and no charge for the town newspaper), and the daily rewards were donated by local merchants at no monetary expense (as long as their contributions were acknowledged in the newspaper account of the project). The managers of the only two bicycle shops in town were quick to offer bike-related rewards, realizing that increases in bicycling meant additional business for them.

Furthermore, our incentive program was substantially less labor intensive than most other community-based reward programs for promoting energy efficient travel [8-12]. Specifically, managing the daily bicycle contest took less than an hour per day, which included:

1. replacing the daily contest number;
2. removing the contest coupons from the depository at each end of the bike path;

Table 1. Empirical Evidence for Interactions Between Possible Behavioral Interventions and Targets for Increasing the Energy Efficiency of Transportation

	Target for Energy Efficient Transportation [b]								
	Increase Miles per Gallon			*Energy Efficient Travel Mode*					
Behavioral Intervention [a]	*Driving Behaviors*	*Purchase Decisions*	*Reduce Vehicle Miles of Travel*	*Carpool*	*Vanpool*	*Bus*	*Bicycling*	*Hitchhiking*	*Walking*
Prompting [c]				2		3			
Informational Systems				1		2			
Education									
Modeling									
Feedback [d]	4		2						
Goal Setting [c]			2						
Commitment									
Positive Reinforcement	2		3	4	1	6			
Negative Reinforcement									
Punishment									

[a] Discussions of these treatment strategies as they pertain specifically to the solution of environmental problems can be found in recent texts by Cone and Hayes [20] and by Geller, Winett, and Everett [5].

[b] The numbers in the cells indicate the number of studies that were found which evaluated the impact of the particular intervention technique on the respective transportation behavior.

[c] The prompting and goal setting interventions were combined with a consequence strategy (i.e., positive reinforcement).

[d] All but one feedback intervention were combined with positive reinforcement.

3. randomly selecting a coupon; and
4. telephoning potential winners until the daily contest number was verbalized.

Thus, such an incentive program is perhaps feasible for several community settings, requiring a small amount of management time each day from a single volunteer or staff member of a community recreation, transportation, or energy agency.

In addition to requiring minimal management time, the incentive strategy included an innovative tactic for preventing undermining or cheating, which may actually be applicable to a variety of community programs for motivating the usage of a particular facility. That is, contest participants had to use the bike path in order to read the daily contest number and become eligible to win the contest. Without this contingency and only a coupon depository at each end of the bike path, it is likely that several individuals would have attempted to "beat the system" by depositing contest coupons without using the bike path. Indeed, such a system could not prevent contest participants from driving their car to the coupon depositories and dropping in coupons for their friends as well as for themselves.

It is critical to incorporate strategies for preventing cheating in community-based reward programs, especially since prior investigators have witnessed frequent attempts to circumvent reinforcement contingencies. For example, in a recycling program that offered a raffle ticket for each visit to a recycling center, some participants carried a load of recyclables to the door of the center and then made numerous round trips inside to deliver one recyclable item at a time and receive one raffle ticket per trip [21]. Similarly, evaluations of community efforts to promote ridesharing by offering reduced highway tolls or access to special express lanes for vehicles with several passengers have found at least three types of cheating:

1. hitchhikers have solicited rides very successfully at the entrance to the toll road or express lane [6, 20];
2. drivers have picked up riders at bus stops before entering the target area [6]; and
3. drivers have placed an appropriate number of manikins or inflatable dummies in their vehicle in order to appear like a carpooler [20, 22].

Almost all of the community-based reward programs to promote environment-preserving behaviors have shown beneficial impact *only* while the behavioral intervention was in effect [5, 20]; the incentive program evaluated herein was no exception. Not only was an increase in bike-path usage limited to the contest period, but the substantial increases occurred in close time proximity to the two special prompting conditions (i.e., when contest coupons appeared on distributed handbills and in local newspapers). This dependence on antecedent prompting procedures was particularly prominent in the present study because the prompting ads provided the necessary contest coupons. However, community involvement in any program is likely to vary with the timing of prompts administered to announce the motivational strategy. Evaluations of relationships between prompting techniques and program participation have been notably absent in the literature [5, 20].

It is possible that a longer incentive period and more frequent prompting would have allowed for indigenous reinforcers such as enjoyment, exercise and reduced field costs to support biking. Indeed, most reward programs are implemented with hopes that a motivated increase in target behaviors will be maintained by natural contingencies after the contrived incentives are discontinued. As indicated earlier, however, response maintenance following the removal of behavioral interventions to promote energy conservation or environment preservation has been practically nonexistent [5, 6, 20, 23]. Thus it may be more beneficial to develop community-based motivational programs which remain cost effective if continued over extended periods. Such an intervention may well be represented by the prompting and incentive strategies developed in the present research to encourage usage of a safe, energy conserving bike path.

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