JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1977, 10, 61-74 NUMBER 1 (SPRING) 1977

GASOLINE CONSERVATION: A PROCEDURE FOR MEASURING AND REDUCING THE DRIVING OF COLLEGE STUDENTS

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The study sought to motivate college students to reduce the number of miles they drove each day and thus save gasoline. Students in two psychology classes were divided by class into two groups. The experimental group was offered various combinations of prizes such as cash, a tour of a mental-health facility, car servicing, and a university parking sticker for reducing driving. The value of the prize received was scaled in terms of per cent reduction in driving. The contrast group received no inducements. The condition in which the experimental group's mileage reduction was reinforced was counterbalanced by two baseline conditions. Several special recording procedures were used to reduce and detect the possibility of subjects altering their odometers, the source of the driving data. Experimental subjects reduced their average daily mileage by 20% relative to the initial baseline; the contrast group did not change. During the one-month reinforcement condition, the 12 experimental subjects saved some 170 gallons (worth $102) of gasoline.

DESCRIPTORS: gasoline conservation, auto-mileage reduction, driving behavior, monetary reinforcement, feedback, self recording, odometer, control groups, drivers, college students

The United States at present imports 30% of its oil each year (United States Energy Research and Development Administration, 1975), and because of the political and economic ramifications associated with dependence on foreign oil, the government has indicated self sufficiency as its energy goal. There are two major approaches to self sufficiency: (1) the long-term approach of developing alternative sources of power, and (2) the more immediate, reducing current levels of fuel consumption. The present paper is concerned with the latter approach, fuel conservation.

The government has used a legislative approach to fuel conservation, examples of which are raising oil tariffs and extending the period of daylight savings time. The main governmental thrust has been to enact legislation aimed at reducing the nation's consumption of gasoline. One method was to reduce the national speed limit from 65 to 70 miles per hour to 55, a speed at which a car consumes less gasoline per mile. Decreasing automobile speed from 70 to 50 miles per hour results in a fuel saving of 30.5%; a reduction from 60 to 50 miles per hour results in a fuel savings of 11.3% (U.S. Department of Transportation, 1973). Other methods have been to increase taxes on gasoline at the pumps and tax automobile manufacturers whose automobiles do not meet certain mileage standards. In summary, the government's legislative approach to fuel conservation has been to enact contingencies in the form of laws or rules. The establishment of positive reinforcement contingencies for fuel-conservation efforts might be a welcome and effective addition to the government's current efforts.

The success of applied behavior analysis in using positive reinforcement to produce positive changes in other nationwide problem areas such

[1]We wish to thank Terri Jennings and Jeffrey Goodman for their assistance as recorders, Robert Provine for allowing us to work with his developmental psychology class, and Robert Neilsen, Director of Safety, University of Maryland Baltimore County for his assistance with the project. Reprints may be obtained from Richard M. Foxx, Psychology Department, University of Maryland Baltimore County, 5401 Wilkens Ave., Baltimore, Maryland 21228, or from Don F. Hake, Psychology Department, West Virginia University, Morgantown, West Virginia

as littering (Burgess, Clark, and Hendee, 1971), pollution control (Geller, Farris, and Post, 1973) and urban transportation problems (Everett, Hayward, and Meyers, 1974) suggests such an approach to fuel conservation. A behavioral analysis of wasteful fuel consumption suggests that reinforcers be made dependent on reduced fuel usage. While petroleum is consumed in a variety of ways, such as to heat homes and to manufacture plastics, the major source of petroleum consumption is transportation (50%), of which the automobile accounts for 60% (Hazard, 1975). Because much of our automobile driving is unnecessary, as the government has recognized, nonessential driving is a promising place to start applying reinforcement contingencies.

There are three initial considerations in designing a reinforcement program to reduce driving. These are to define the driving response, to measure the driving response accurately, and to use reinforcers of sufficient strength to counteract the reinforcing properties of driving. Successfully meeting these initial considerations is no small task. For example, although driving behavior can be defined in a variety of ways, such as the number of trips or amount of time driving, accurate and reliable measurements of such events are difficult, since they rely on the driver's self-reports. A definition of driving that does permit objective measurement is the number of miles a person drives as recorded by the car odometer. Although the odometer is similar in function to the counters employed in laboratory studies of operant behavior, *i.e.,* it provides accurate, reliable, and continuous recordings of mileage that can be expressed per unit of time, special steps must be taken to reduce the possibility of the driver altering the car odometer reading or using another car. Similarly, there are factors to be considered before selecting reinforcers for driving reductions. For example, driving is intrinsically reinforcing for many people, and is an integral part of the response requirements for a variety of powerful extrinsic reinforcers, since people usually drive to work, school, and recreational events. Overcoming these several intrinsic and extrinsic reinforcing properties of driving requires the use of a generalized conditioned reinforcer, such as money, that is effective in nearly all situations. Finally, since much driving is essential (*e.g.,* to work, school, and shopping areas), and since the amount of this essential driving varies from person to person, the response requirement for reinforcement should be individualized.

The purpose of the present study was to develop a methodology for measuring driving behavior and to use it to reduce the nonessential driving of college students.

METHOD

Subjects

University students in a developmental psychology course and an abnormal-psychology course were asked to volunteer for a study on driving habits. In each class, volunteers who drove completed a questionnaire, which asked them: (1) to list all the cars they drove, (2) to estimate how many miles per month they drove each car, (3) to estimate the per cent of the driving for each car done by someone else, (4) to indicate whether or not the speedometers of the cars were functional, and (5) to sign their name if they were willing to participate in a study on driving habits. The respondents were informed that their participation was voluntary and that they could decline to participate at any time. The questionnaires were given twice, one week apart, to assess the reliability of the students' responses.

Criteria for subject selection. Subjects were selected on the basis of their questionnaire responses. To be selected, a student had to satisfy all of the following criteria: (1) that 90% or more of his/her driving as indicated by miles driven per month was done with a single car, hereafter called the designated car, (2) that he/she was the owner or co-owner of that car, (3) that no more than 10% of the driving on the designated car was done by anyone else, (4) that

the speedometer of the designated car was functional, (5) that there had been perfect agreement between the two questionnaires on the number and types of cars that the subjects drove, (6) that the estimated monthly mileage on the designated car exceeded 200 miles, and (7) that the student agreed to participate in the study.

Final subject selection. There were 50 students in the developmental class and 67 in the abnormal-psychology class. Twenty-seven of the developmental students and 51 of the abnormal-psychology students completed the questionnaires. In the developmental class, 11 students satisfied the subject criteria; 19 were selected from the abnormal-psychology class. Two developmental students were dropped during the study: one student's car broke down midway through the reinforcement condition and the other bought a new car during the first baseline condition. Seven abnormal-psychology students were dropped during the study. During the initial baseline, three dropped the course, one bought a motorcycle, and two had car engine trouble that required lengthy repair work. One declined to participate at the end of the initial baseline period. Thus, nine students in the developmental class (contrast group) and 12 students in the abnormal-psychology class (experimental group) participated throughout the study. Table 1 lists the make, model, year, and mileage of each subject's designated car, the estimated per cent of the mileage on that car attributable to the subject, and the estimated per cent of the subject's monthly driving mileage attributable to the designated car.

Experimental design. There were two conditions: (A) a baseline condition, in which no consequences were attached to driving behavior, and (B) a reinforcement condition, in which subjects were rewarded for decreasing their average miles driven per day. The experimental group received the usual A, B, A order of conditions and the contrast group was under baseline conditions throughout the study. Thus, the experimental design permitted comparisons both within-subjects (ABA reversal design) and between the two groups. The contrast group was used to control for time-related variables (*e.g.,* weather, exams, vacations, and increased fuel costs) and any possible effects of the subjects' "knowing" they were participating in a study on driving behavior. Because the experimental group might take more class time (*e.g.,* more mileage checks, explanation of the reinforcement condition, and debriefing) than we felt we could ask another instructor to allow us, the first author's abnormal-psychology class was designated as the experimental group. However, the two classes were comparable in many respects: both were lower division courses, both contained students from several different majors other than psychology, and both contained students from all four grade levels. In addition, both were taught in a traditional manner, with no undue emphasis on learning principles. The experimental subjects were aware that their course grades were independent of their participation in the study and their average grade was not higher than the rest of the class. The study began on February 25, 1975 and ended on May 15 of the same year.

Reliability of the response measure: the odometer reading. A car odometer provides a continuous and nearly 100% reliable measure of miles driven as long as it is not artifically manipulated. Two procedures were employed at each odometer check to detect if the reading had been altered. The first was to determine that the odometer was always operational. This was accomplished by having an experimenter ride in the car around a two-tenths of a mile oval course and note whether or not the odometer recorded the distance. Second, the make, model, year, and license number of each driver's car was recorded to ensure that the odometer reading was always recorded for the designated car.

Odometer alterations were also unlikely for other reasons. First, it would have been very difficult for the average driver to disconnect and reconnect the odometer cable at other times. Second, it was illegal to disconnect an odometer cable and to do so also results in the speedometer not functioning. Finally, all subjects' odometer

Table 1

Subject	Make	Model	Year	Car's Mileage to Nearest Thousand	Per cent Reported Used by Subject Only	Per cent of Subject's Reported Monthly Mileage
EXPERIMENTAL GROUP						
S1	Dodge	Dart	1965	80,000	100	94
S2	Ford	Maverick	1973	26,000	100	90
S3	Datsun	510	1969	31,000	100	100
S4	AMC	Gremlin	1972	48,000	100	100
S5	Chevrolet	Caprice	1966	81,000	100	100
S6	VW	Beetle	1971	72,000	100	97
S7	Dodge	Colt	1974	14,000	100	100
S8	Plymouth	Valiant	1974	3,000	100	100
S9	Chevrolet	Vega	1973	15,000	100	92
S10	Ford	Torino	1971	56,000	100	90
S11	Plymouth	Fury	1968	31,000	95	100
S12	Chevrolet	Chevelle	1967	99,000	90	100
Mean			1970	46,000	98.8	96.9
CONTRAST GROUP						
S1	Chevrolet	Vega	1973	16,000	100	100
S2	AMC	Gremlin	1973	18,000	100	98
S3	VW	Beetle	1974	5,000	100	91
S4	Chevrolet	Chevelle	1968	67,000	100	95
S5	Int'l	Scout	1974	19,000	90	100
S6	VW	Beetle	1968	93,000	100	98
S7	Mercury	Comet	1966	61,000	100	99
S8	Chevrolet	Nova	1969	66,000	100	95
S9	Ford	Custom	1966	80,000	95	100
Mean			1970	47,000	98.3	97.3

readings had always increased by a reasonable amount at each odometer check.

Ensuring that the subject was driving the designated car. To determine if the subjects were in fact using their designated cars, rather than other cars, odometer checks were conducted at the university, a place to which all the subjects had to drive. Conducting the odometer checks at the university also permitted all cars to be checked in one day, since a check could be announced in the students' classes. To reduce the possibility of subjects using their designated cars only on a check day, all checks for the experimental group were unannounced. That is, the check was not announced until the day it was to be conducted, at which time the subjects were asked to indicate at what time that day they were leaving campus. At that time, an experimenter met them at the check point. Use of a car other than the designated one would have been indicated by a subject being present in class but not showing up for the check or showing up in another car. For the contrast subjects, the checks were unannounced except for the last one, which was announced at the previous class meeting.

Another concern was that a subject could still "beat the system" by going home to pick up his designated car after the announcement in class. This concern was met by conducting one of the unannounced checks while the subjects were still in class and was accomplished by having each subject indicate on a university map the location of his car that day. After collecting the maps, and while the students were still in class, two experimenters drove to the location of each car and both checked the car odometer reading by

looking through the window, also checking to make sure that it was the designated car.

Recording days. The contrast group's class met from 2 to 3 p.m. on Monday, Wednesday, and Friday; hence, odometer checks were made between 3 and 6 p.m. on one of those days when a check was scheduled. Since the experimental group's class met from 12:30 to 1:45 p.m. on Tuesday and Thursday, odometer checks were made between 2 and 6 p.m. on whichever one of those days a check was scheduled. The difference in class schedules ensured that the two groups were never checked on the same day.

Two graduate students, unaware of the design of the study, assisted the authors as recorders. At least three recorders usually participated in each check period, such that one person never checked all of the cars for a single check period and one person never checked any particular car exclusively over the course of the several checks.

Procedure

Initial baseline. The subjects were informed in class that the driving study was to start that afternoon. They were asked to bring their cars to an unloading zone on an oval drive in front of the university administration building. The students were asked when they were leaving campus that day and told to bring their cars by at that time. When a student arrived with his car, an experimenter recorded the model, make, year, and license-plate number of the car, the odometer reading, and then rode with the student around the oval drive while watching the odometer. The experimenter talked with the subject but did not explain the purpose of the odometer reading or the intent of the study. If the subject questioned the experimenter, the experimenter simply informed him that his driving habits were being studied.

Duration of the initial baseline varied for both groups, because of class attendance: subjects had to attend three classes (two questionnaires and the initial baseline check) before their participation could begin. The initial baseline ordinarily lasted 28 days (range 23 to 30 days) for the contrast group, and 35 days (range 21 to 35 days) for the experimental group. If a subject was not in class on a check day, he was checked on the day of the next class meeting. No contingencies were in effect during initial baseline. On the last day of initial baseline, all subjects were told in class to bring their cars by the check point that day. The driving study had not been mentioned in either class since the first baseline check.

Reinforcement condition for the experimental group. On the day of the final baseline odometer check, each experimental subject was given a personal fuel conservation guide, which listed mileage-reduction goals from 10 to 50% and the prizes that corresponded to each reduction. Table 2 shows Part I of the guide. The mileage-reduction goals were percentage reductions in miles driven per day relative to the subject's initial baseline average. The minimum reduction to qualify for a prize was 10%, which earned a $5 prize. Five dollars were added to the cash award for each additional 10% reduction up to a 50% reduction. Anyone achieving a 20% or greater reduction also qualified for a guided tour of a mental-health facility. The two persons achieving the greatest per cent reduction also received a refund for the cost ($10) of their university parking sticker. The person achieving the third largest reduction received a free oil change and lube job from a nearby service station.

The subjects were asked to read through their guides, to ask questions if they had any, and to sign their names if they agreed to participate. We explained that the purpose of the study was to motivate students to reduce or eliminate unnecessary driving, but that we did not wish them to endure any hardships and that we expected them to use their cars to drive to school or in case of an emergency.

The students were asked to bring their guides to the final baseline odometer check that afternoon where their miles per day during baseline would be calculated, as well as the miles per day they would need to achieve each percentage reduction from 10 to 50%. This information was

Table 2

Personal Fuel-Conservation Guide Part I

Mileage-Reduction Goals	*Prizes*
1) 10% reduction in average miles per day.	$5
Example: If during your baseline you drove 900 miles in 30 days, your miles driven per day would be 30. To qualify for a 10% reduction you must average less than 27 miles per day, a 10% or 3-miles-less-per-day reduction.	
2) 20% reduction in average miles per day.	$10 plus a guided tour of a mental-health facility if you wish.
3) 30% reduction in average miles per day.	$15 plus a guided tour of a mental-health facility if you wish.
4) 40% reduction in average miles per day.	$20 plus a guided tour of a mental-health facility if you wish.
5) 50% reduction in average miles per day.	$25 plus a guided tour of a mental-health facility if you wish.

GRAND PRIZES

The two persons who achieve the greatest per cent reduction in miles driven per day will *also* receive a ten dollar refund from the university for the cost of the present year's parking sticker.

The person who achieves the third largest per cent reduction will *also* receive a free oil change and lube job from a nearby service station.

Rules.

A. In order to qualify for a prize, you must present your car for an odometer check sometime between April 8 and April 15. You must also present your car for an odometer check at the end of the study, which will be approximately 1 month from today.

B. You may use any strategies you want for reducing your miles per day (*e.g.*, car pooling, eliminating unnecessary trips, walking) except for borrowing another person's car or tampering with your car.

C. We would like for you to return the front worksheet page of this guide at the end of the study.

recorded on Part II of the personal fuel-conservation guide, which is shown in Table 3. Part II also contained a worksheet with 30 spaces, on which the students could keep a daily record of their miles per day.

The students were told that the study would end in about one month when the determination of who qualified for prizes would be made. They were told also that additional odometer checks would be made during the reinforcement condition.

Three odometer checks were conducted during the 28-day reinforcement condition: two were made within the condition and one at the end. One check was made midway (14 days) after the condition had begun. Each experimental subject's miles per day during the first 14 days of the reinforcement condition was recorded on an index card, along with the subject's per cent increase or decrease in miles per day relative to his baseline average. The cards were returned to the subjects during the next class meeting. The second within-condition check was made 23 days after the condition had begun, and was accomplished by using the map procedure described previously. The final check of the reinforcement condition was made 28 days after the condition had begun. At this time, the subjects were told that the study had ended. Each subject's miles per day during the condition was recorded on an index card along with the prize(s), if any, that the subject had earned. These cards were given to the subjects at the next class meeting.

When the index cards were returned, the subjects were informed that the prizes would be awarded on the last day of regularly scheduled classes. Those that had not qualified for a prize

Table 3

Personal Fuel Conservation Part II

Name _____. Type of Car _____.

I. *Baseline.*

A. Odometer reading at end of baseline
Date _____ (Start of Study) _____.

B. Odometer reading at start of baseline
Date _____ _____.

C. Total days in baseline _____; total miles in baseline _____.

D. Miles driven per day in baseline _____.

II. *Study.*

A. Keeping track of your miles per day on a daily or weekly basis may help you to reduce driving. The following chart can be used to keep track of your miles driven per day.[a]

(1) Date	(2) Days from Start of Study	(3) Miles driven from start of study	(4) Average Miles per day (3) ÷ (2)

[a]This was part of a larger form: 30 spaces were provided for calculation on the actual form.

were told that they would be paid $1.50 for having participated in all of the odometer checks. The contrast subjects were told also at this time that they would receive $1.50 for having participated in all of the odometer checks.

Contrast group. The initial baseline contingencies remained in effect for the contrast group. One odometer check was scheduled midway through the condition (14 days after the reinforcement condition began for the experimental subjects) and a final odometer check was made when the condition ended. This condition ordinarily lasted 28 days (range 21 to 28 days).

Final baseline condition. No contingencies for reducing driving were in effect during this return to baseline. For the contrast group, the final baseline was no different than the two previous conditions. The condition ordinarily lasted only 14 days (range 10 to 14 days) for the contrast group and 16 days for the experimental group, because of the rapid approach of the end of the school year; the condition was, in fact, terminated on the last day of regularly scheduled classes. On that day, the experimental group was informed that one final odometer check was to be made that day and that their prizes would be awarded when they brought their cars to the check point. The contrast subjects were given their $1.50 at this final check.

Debriefing of subjects. During the last regularly scheduled class and just before the final odometer check, all subjects were debriefed concerning the design, intent, and results of the study. The experimental subjects were asked also to write a paragraph describing whatever strategies they had employed to reduce their driving

during the reinforcement condition. Those who had not been successful were asked to describe why.

RESULTS

Figure 1 shows that the reinforcement condition did reduce the driving of the experimental group. During the initial baseline, the experimental and contrast groups respectively averaged 36.1 and 32.1 miles driven per day. During the reinforcement condition, however, the experimental group's average decreased to 27.6 miles per day. The experimental group's odometers were checked three times during the 28-day reinforcement condition: during the first 14 days, the group's daily mileage was 27.8; during the next nine days, 26.8; and during the last five days, 29.8. The contrast subjects, on the other hand, increased their driving during the reinforcement condition to an average of 35 miles per day. The two odometer checks during the reinforcement condition for the contrast group showed an average of 35.5 miles per day during the first 14 days and 34.8 during the last 14 days. When baseline conditions were re-instated, the experimental subjects increased their driving to 34.4 miles per day, a figure close to their initial baseline level. The contrast subjects continued to drive about the same as during the previous two conditions, 35.1 miles per day.

The individual data are given in Table 4, which lists each subject's sex, the number of days in each condition, the average miles driven per day during each condition, and the per cent change during the reinforcement condition relative to the initial baseline (the basis on which prizes were awarded). Nine of the 12 experimental subjects showed at least some reduction during the reinforcement condition, ranging from 5.1 to 81.7% and averaging 30.2%. The other three experimental subjects increased their driving by 6.1, 9.8, and 17.1%. The average reduction for the entire experimental group was 19.9%. Seven of the nine contrast subjects drove more during the reinforcement condition: their

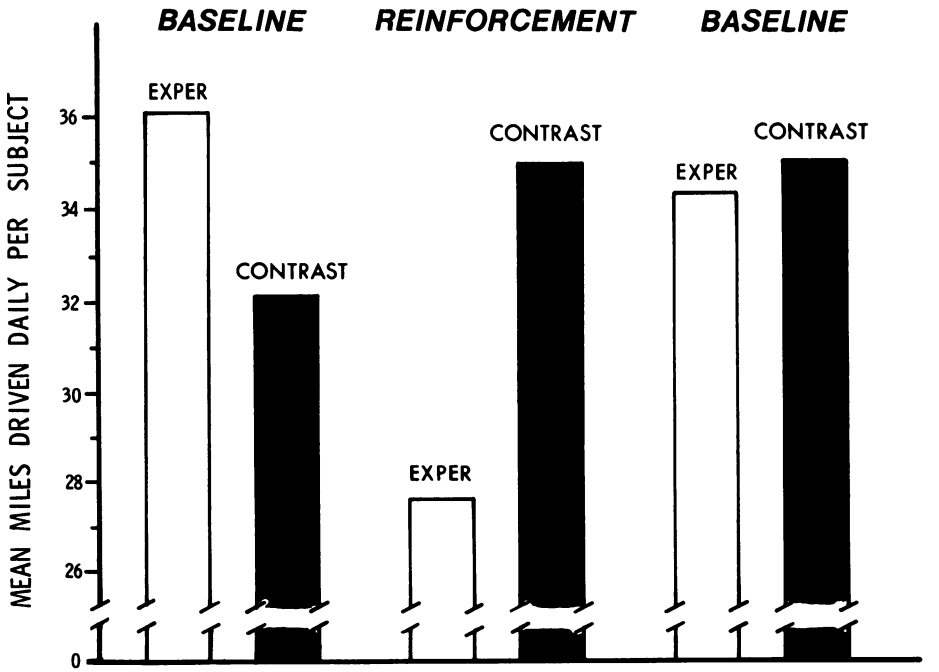

Fig. 1. The mean miles driven daily per subject by the experimental (N = 12) and contrast (N = 9) groups. During the two baseline conditions, no contingencies were in effect for mileage reduction. In the reinforcement condition, the experimental group's mileage reductions were reinforced; the contrast group remained under baseline conditions.

per cent increases ranged from 7.5 to 32.2% and averaged 14.2%. Two contrast subjects decreased their driving by 3.3 and 55.7%. The overall average for the nine contrast subjects was an increase of 4.5%.

Nine of the 12 experimental subjects showed at least some increase from the reinforcement condition to the final baseline, while only four of the nine contrast subjects showed any increase over this time. A closer examination of the final baseline for the experimentals raised some gratifying possibilities. First, a comparison of the final and initial baselines for the experimental subjects who reduced their driving during the reinforcement condition raises the important possibility that the money saved by driving less may have been sufficient to maintain at least some of the behaviors that led to reduced driving in the reinforcement condition. Seven of these nine subjects drove less in the final baseline than in the initial one. Second, the finding that the three subjects who increased their driving during the reinforcement condition also increased again during the final baseline suggests that the reinforcement condition controlled their driving, at least to the extent that they did not drive indiscriminately during the reinforcement condition.

Table 4

Subjects' Miles Driven per Day

EXPERIMENTAL GROUP

		Baseline I (21-35 days)		*Reinforcement (28 days)*			*Baseline II (16 days)*	
Subject	*Sex*	*Days*	*Miles Driven/Day*	*Days*	*Miles Driven/Day*	*Per Cent Change*	*Days*	*Miles Driven/Day*
S7	F	35	60.0	28	11.0	−81.7	16	31.0
S12	F	21	26.9	28	10.9	−59.5	16	11.1
S8	F	35	48.1	28	28.2	−41.5	16	45.9
S4	M	35	22.1	28	14.4	−34.7	16	12.4
S1	M	35	32.1	28	24.3	−24.4	16	29.9
S10	F	28	25.9	28	22.7	−12.4	16	32.7
S2	M	35	65.3	28	60.8	− 6.9	16	48.5
S5	M	35	37.5	28	35.3	− 5.9	16	35.1
S11	F	33	27.7	28	26.3	− 5.1	16	42.4
S3	M	35	32.9	28	34.9	+ 6.1	16	44.6
S9	F	28	34.3	28	37.7	+ 9.8	16	38.4
S6	F	35	20.8	28	24.4	+17.1	16	41.1
$\bar{x}$			36.1		27.6	−19.9		34.4

CONTRAST GROUP

		Baseline I (23-30 days)		*Reinforcement (21-28 days)*			*Baseline II (10-14 days)*	
Subject	*Sex*	*Days*	*Miles Driven/Day*	*Days*	*Miles Driven/Day*	*Per Cent Change*	*Days*	*Miles Driven/Day*
S6	M	28	17.0	28	7.5	−55.7	12	13.1
S3	M	28	28.3	28	27.4	− 3.3	12	23.0
S5	F	30	36.0	28	38.7	+ 7.5	10	35.9
S9	M	23	28.7	28	31.3	+ 9.0	12	38.2
S1	M	28	36.7	28	40.4	+10.0	14	44.7
S2	M	28	23.8	28	26.2	+10.0	12	22.6
S8	F	25	32.0	26	35.8	+11.7	12	32.8
S7	M	30	52.4	21	62.5	+19.2	12	77.9
S4	M	28	34.2	28	45.2	+32.2	12	28.0
$\bar{x}$			32.1		35.0	+ 4.5		35.1

Use of the designated car. The unannounced checks indicated that experimental subjects were driving their designated cars, rather than other ones: if an experimental subject was in class on the afternoon a check was announced (there was 96.6% attendance by the experimental subjects on these days), he always showed up with the designated car for the check that afternoon. There was no instance of a subject being in class on the day of an unannounced check and not showing up for the check that afternoon. It was not likely that the subjects first returned home to pick up their designated cars, because most of them brought their cars by the check point soon after class, and most were commuters who lived a considerable distance away. The map check provided evidence that the subjects were driving their designated cars; conducting it while the subjects were in class prevented any possibility of a subject returning home for his designated car. All 12 experimental subjects were in class on the day of the map check and the check revealed that all 12 had driven the designated car.

Another concern was that the experimental subjects may have switched cars on those days that the abnormal class did not meet and no unannounced checks were made. Two factors argue against such a possibility. First, the four subjects (Subjects 7, 12, 8, and 4) who achieved the greatest mileage reductions had indicated on their pre-experimental questionnaires that they had access to only one car. A second test of whether or not subjects had driven their cars on nonclass days was made by comparing each subject's actual odometer mileage in each condition with the total roundtrip distance between home and school he would have to drive if he had attended class each day during each condition. Switching cars would be indicated if a subject's actual odometer mileage was less than his total required driving to and from school. The subject's daily roundtrip mileage to school was calculated from a city and state map. As a measure of reliability, each subject was phoned and asked the roundtrip mileage between his home and the university. The two mileage figures were usually within one to two miles of each other, but whenever there was a discrepancy, the map mileage was used. The subject's roundtrip mileage was multiplied by the number of school days in each condition, thereby yielding a total school mileage figure (all subjects had classes five days per week). The subject's school mileage figure was then expressed as a per cent of the actual total odometer mileage. Table 5 shows that for all subjects and under all conditions, the actual odometer reading was greater than the total required driving mileage between home and school. The mean percentages for the 17 subjects who lived off campus (from both groups) indicate that under each condition approximately 40 to 48% of the subjects' actual mileage was between home and the university. Also, the mean percentages for the off-campus subjects of both groups were quite stable across conditions: 44.0, 40.6, and 39.4 for the contrast group and 39.5, 48.0, and 45.5 for the experimental group.

Table 5 also suggests that dormitory students may have an easier time achieving mileage reductions: Subject 6 had the largest reductions in the contrast group and Subjects 7 and 12 had the largest reductions in the experimental group, but one dormitory student (Subject 6) did have the largest increase in the experimental group. Dormitory students do not have the largest single type of essential driving for students, *i.e.,* between home and school; therefore, a larger percentage of their driving is necessarily nonessential and perhaps easier to reduce. Although elimination of dormitory students from both groups would not have affected the magnitude of group differences in the present study (the difference would remain 25%), dormitory students may be a factor to eliminate or counterbalance in future research that uses a group design. The variable would not seem to be a factor in within-subject comparisons, although it might be an interesting variable to study because of its apparent relation to nonessential driving.

Cash prizes. Prizes were awarded on the basis of per cent reduction during the reinforcement

condition relative to the initial baseline. Six of the nine experimental subjects who reduced their driving qualified for cash prizes: Subject 10, $5; Subject 1, $10; Subject 4, $15; Subject 8, $20; and Subjects 7 and 12, $25 each. Subject 8, who achieved the third greatest per cent reduction, was also awarded a certificate entitling her to a free oil change and lube job at a nearby service station. Subjects 7 and 12, the grand-prize winners, were also awarded a remission of their university parking fee equalling $10. The six experimental subjects who did not qualify for cash awards and the nine contrast subjects were each paid $1.50 for bringing their cars to all of the odometer checks. A total of $22.50 was paid to these individuals, bringing the total cost of the experiment to $152.50, including a $10 value for each parking sticker and the car servicing.

Use of the personal fuel-conservation worksheet. The experimental subjects turned in their daily mileage worksheets at the end of the reinforcement condition. Only six subjects had used the worksheet to keep a daily record of their miles driven, but five of these six achieved cash prizes, including the three grand prizes. During the odometer checks in the reinforcement condition, most of the experimental subjects spontaneously verbalized whether they were above or below their initial baseline level. A few subjects who were keeping a daily mileage record even stated the exact miles per day they had averaged up to that moment. At the final odometer check during the reinforcement condition, all subjects were able to verbalize whether or not they had qualified for a cash prize and the amount of the prize before we had performed the final calculations determining the prize winners.

Table 5

Subject	*Per Cent Change (Baseline I vs. Reinforcement)*	*Roundtrip Mileage to School*	*Per Cent of Total Mileage Accounted for by Driving to School*		
			Baseline I	*Reinf.*	*Baseline II*
EXPERIMENTAL GROUP					
S7	−81.7	0[a]	—	—	—
S12	−59.5	0[a]	—	—	—
S8	−41.5	20	28.5	50.6	32.7
S4	−34.7	10	31.0	49.4	60.5
S1	−24.4	18.5	39.5	54.4	46.4
S10	−12.4	12	33.1	37.8	27.5
S2	− 6.9	44	46.2	51.7	68.0
S5	− 5.9	13, 20[b]	23.8	40.5	42.7
S11	− 5.1	9	21.7	24.4	15.9
S3	+ 6.1	27	56.3	55.2	45.4
S9	+ 9.8	36	75.0	68.2	70.3
S6	+17.1	0[a]	—	—	—
CONTRAST GROUP					
S6	−55.7	0[a]	—	—	—
S3	− 3.3	17	42.9	44.3	49.3
S5	+ 7.5	18.5	37.7	34.1	30.9
S9	+ 9.0	10	25.8	22.8	17.5
S1	+10.0	30	58.4	53.0	47.9
S2	+10.0	22	66.0	60.0	64.9
S8	+11.7	34	80.8	73.1	69.1
S7	+19.2	14	19.6	21.3	12.0
S4	+32.2	10	20.9	15.8	23.8

[a]Dorm student.

[b]Changed residences during the reinforcement condition. Per cent of total mileage accounted for by driving to school was based on 13 roundtrip miles during Baseline I and 20 roundtrip miles during the Reinforcement and Baseline II conditions.

Strategies for reducing driving. At completion of the study, the experimental subjects were asked to write a paragraph describing either their successful strategies for reducing driving or explaining why they had failed. The three grand-prize winners employed almost identical strategies. They eliminated unnecessary trips, sought rides from others, stopped taking long trips on weekends, and did more walking. The other three winners reported similar strategies and added others, such as riding a bicycle and "I refused to play taxi-cab driver for my family". Of the six winners, five reported that the cash prizes were the primary source of their motivation. Only Subject 1 reported that his main source of motivation was to determine if he was capable of reducing his driving. Subject 10, who achieved a 12.2% reduction, reported that she could have achieved a greater reduction had she not been required to drive her mother to jury duty during three of the four weeks of the reinforcement condition.

Three subjects reduced their driving but did not qualify for a prize, because their reductions were less than 10%. All reported that they had made an effort to reduce their driving but that extenuating circumstances had prevented them from achieving their goals. Subject 5 reported that during the reinforcement condition he moved to an unfamiliar neighborhood. Because all of his friends resided in his old neighborhood, he found it necessary to drive often between his new home and the old neighborhood. Subject 2 reported that he tried to reduce his driving, but that the cash prizes were not sufficient to offset the lure of weekend trips to the beach. The three subjects who increased their driving during the reinforcement condition had valid reasons. Subject 9 reported that she had to chauffeur her brother, whose car had broken down. Subject 3 reported that not enough money was involved to motivate him to reduce his driving and that he had become more involved in social activities at the University. Subject 6, who had the greatest increase, 17.1%, listed several factors that caused her to increase her driving. First, she had just transferred to the university at the beginning of the spring semester and, not knowing the area, had driven home every weekend, a round-trip distance of 40 miles. Second, she was involved in two school projects that required her to drive. Finally, because most of her friends in the dormitory did not have cars, she did all the driving within her circle of friends.

DISCUSSION

The results showed that some drivers can be motivated by reinforcement contingencies to reduce their driving. The experimental group reduced daily mileage by almost 20% when prizes were offered for mileage reductions. During the same period, the contrast group showed no such reductions. Nine of the 12 experimentals reduced their driving, six by more than 12% and four by more than 30%. Although the subjects were students, they represented a reasonable cross-section of drivers, because the university was essentially a commuter college, with only 16% of students living on campus. Hence, mileage reductions were achieved by drivers who differed from each other in terms of sex, marital status, how much they drove each day, whether they lived at home or in dormitories, and the distance they lived from the university.

The use of an experimental design that permitted both within-subject and between-groups comparisons showed that the reinforcement contingencies were responsible for the experimental subjects' driving reductions. The within-subjects ABA comparison showed that reductions by the experimental group were correlated with the reinforcement condition. The use of a contrast group for between-group comparisons indicated that the results were not due to the effects of time, weather, exam schedules, vacations, or any other events related to the passage of time. Further, the contrast results showed that the odometer checks, the knowledge that one's driving behavior was being monitored, and subject expectations alone could not account for the experimental group's mileage reductions, since

their daily mileage did not change throughout the study.

The present study went beyond a demonstration that reinforcement contingencies could motivate individuals to reduce their nonessential driving. Perhaps more importantly, it provided a methodology for studying driving behavior. Aside from the obvious difficulties in finding effective reinforcers to motivate individuals to reduce their driving, it was important to ensure that their attempts were legitimate. Much of the present study was concerned with this latter consideration. The use of the odometer as a recording instrument, unannounced odometer checks, the map procedure, the initial questionnaires for subject selection, checks of the make, model, year, and license-plate number of each car and checks to ensure that each odometer was functional were attempts to ensure accuracy of the data.

Several factors appear to have contributed to the program's success. The personal fuel guide provided the six subjects who used it with daily feedback as to how successfully they were accomplishing their mileage-reduction goals. Additional feedback was provided midway through the reinforcement condition when each subject was given an index card containing his miles driven per day to date and the percentage it represented above or below his initial baseline average. The two odometer checks during the reinforcement condition were feedback as reminders to the subjects that their mileage was being recorded. The reinforcers were effective for most of the subjects. The cash prizes and the cash value of the three grand prizes appeared to be the major motivators. Earning a tour of a mental-health facility was important to some of the subjects, since five of the six who earned it showed up for the tour. The scaling of reinforcers in terms of size of reduction achieved was probably a factor in the program reaching such a large percentage of the subjects, because it took into account the subjects' differing amounts of essential driving and, hence, their differing abilities to reduce their driving. For example, a single response requirement that was too large for some subjects could have resulted in those subjects "giving up" and driving indiscriminately. Similarly, a single response requirement that was too easy could have also resulted in indiscriminate driving once the subject had surpassed the easy requirement. The present "scaled" or "individualized" response requirement was probably effective because it had several driving goals, ranging from small to large. An unscheduled reinforcer was the unspent money for gasoline that the subjects saved. During the 28-day reinforcement condition, the experimental subjects drove 7.6 fewer miles per day per person or 2554 fewer miles as a group, saving 170 gallons of gasoline (calculated at one gallon per 15 miles driven), which at 60 cents a gallon equalled an average savings of $8.50 per subject.

Three experimental subjects did not reduce their driving during the reinforcement condition. The answers as to why were revealed, in part, in their written statements at the end of the study. One stated that he was not motivated by the reinforcers; the other two stated that their efforts were hampered by circumstances beyond their control. It could be argued, however, that even these two were not sufficiently motivated by the reinforcers. Larger cash payments or prizes or other reinforcers may have been sufficient to motivate all three to reduce mileage.

A crucial question is whether the present program could be employed with other populations and on a widespread basis. Any organization such as private companies, state and federal governments, and universities to which people drive could institute such a program. All of these organizations are in a position to provide reinforcers, as well as the necessary odometer checks to prevent the illegal garnering of reinforcers. The reinforcers would not have to be limited to cash; natural driving-related reinforcers, such as preferential parking or leaving early and arriving late could be given to mileage reducers. For drivers other than students, however, larger cash amounts may be necessary. Some form of gov-

ernment intervention, such as tax credits or subsidies, may be necessary to motivate institutions to perform such a service. However, it would appear to be in the best interest of these organizations to implement such a program with company owned or institutional vehicles, since any mileage reductions would represent an immediate monetary saving on gasoline costs to the organization.

The authors wish to continue to study variables related to gasoline consumption, such as the durability of the present effects, the role of nonessential driving, the effects of reinforcers other than money, and the effects of lottery contingencies. Another source of concern is to develop improved methods of measuring and recording driving. This would include modifications such as considering dormitory students as a separate class, more frequent odometer checks, and selecting subjects who have access to only one car.

The present study should be viewed as a first step in the development of effective behavioral solutions to the energy problem. As such, it demonstrated the feasibility of reinforcement contingencies to affect people's driving. Further studies will hopefully yield additional potentially viable solutions. It is hoped that the present effort will help serve as a catalyst for those efforts.

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Received 11 August 1975.
(Final acceptance 20 April 1976.)