MULTIPLE INCENTIVES IN ENCOURAGING CAR POOL FORMATION ON A UNIVERSITY CAMPUS

HARVEY E. JACOBS,¹ DAVID FAIRBANKS,
CHERYL E. POCHE, AND JON S. BAILEY

FLORIDA STATE UNIVERSITY AND WESTERN MICHIGAN UNIVERSITY

The effects of a combined token economy and reserved parking program were evaluated as a means of increasing car pooling among students on a university campus. Following a baseline period, students in two experimental parking lots were notified of the availability of reserved parking and coupons redeemable for 25 cents in merchandise for each occupant of automobiles containing two or more people. Two control lots also were monitored for a comparison of treatment effects. Results indicated variable increases in car pooling in the two experimental lots and no increase in the control lots. Removal of the 25-cent coupons from one treatment lot (reserved parking only) did not adversely affect rates of car pooling. An analysis of individual automobile occupancy rates among car poolers indicated distinct patterns of car pooling and underscored the importance of individual subject data analysis in the present situation. A cost-benefit analysis indicated that even moderately effective car pool programs can be cost-effective on both a public and personal level.

DESCRIPTORS: car pooling, energy conservation, community applications, token economy

Transportation is one of the nation's main uses of energy. Between 1950 and 1973, transportation requirements increased by 84% and in 1973 alone, 97,650,000 personal automobiles consumed 75.3 billion gallons of gasoline, or 30% of the nation's total petroleum supply

for that year (Citizens Advisory Committee on Environmental Quality, 1973).

Automobiles also contribute to problems other than fuel consumption. In 1968, transportation caused over \$1.4 billion in air pollution damage to property, materials, health and vegetation (Barrett & Waddell, 1974). As noted by Dorf (1974), the present one person-one car system is too costly to continue—being less energy efficient than a man on a bicycle, a jet transport, or a horse, and roughly as efficient as a pigeon in flight. Alternative methods of transportation are required.

Several studies have shown the promise of behavioral techniques in modifying transportation behaviors. Everett, Hayward, and Meyers (1974) reported the use of a community-based token economy to encourage college students to use a campus bus system. Foxx and Hake (1977) and Hake and Foxx (1978) demonstrated that individuals would decrease their automobile usage when this resulted in payment commensurate to their mileage reductions. Simi-

This study represents a portion of the research supported by a U.S. Department of Transportation, Federal Highway Administration contract through the State of Florida Department of Transportation and the City of Tallahassee, Florida. Although the order of authorship is representative for the present study, we all worked collectively and equally in the conduct of the entire research program. The authors are grateful to Larry Carter and Robert Chamberlin of TALTRAN, the City of Tallahassee Board of Commissioners, and Terry Denham of the Office of Traffic Safety, Florida State University. We also appreciate the support of the Tallahassee merchants who participated in the token economy and the observers who braved many a cold morning for data collection. Reprints may be obtained from Harvey E. Jacobs, Rehabilitation Medicine Service, Brentwood VA Medical Center, 11301 Wilshire Blvd., Los Angeles, California 90073.

¹Now at the UCLA School of Medicine.

lar results have been demonstrated among employees and fleet drivers through the use of feedback, social recognition, and lotteries (Lauridsen, 1977; Runnion, Watson, & McWhorter, 1978). Other representative studies demonstrating similar effects have been noted by Reichel and Geller (1981).

Another way to reduce transportation energy requirements is to encourage people to use car pools. Car pooling does not require any major fiscal expenditure or technological innovation, and by increasing national automobile occupancy from 1.4 to 2.0 persons per car it would be possible to save 500,000 barrels of gasoline per day while removing 15 million cars from the road (U.S. Department of Transportation, 1973).

Besides national benefits, people who use car pools can save up to \$600 per year in transportation costs when gas, insurance, and operating expenses are taken into consideration (U.S. Department of Transportation, 1975). Unfortunately, few people use car pools, citing the many inconveniences and lack of immediate and direct benefits (Dueker & Levin, 1976; Everett & Hayward, 1974; Reichel & Geller, 1981).

Recently, several approaches designed to facilitate car pool formation have been reported. San Francisco (MacCalden & Davis, 1972), Dade County, Florida (Rose & Hinds, 1976), Boston (Miller & Deuser, 1976) and Fairfax County, Virginia (Fleischman, 1975) have all organized preferential priority lanes for car pools during rush hour traffic. Results have indicated initial small to moderate increases in automobile occupancy during rush hour periods, but no consistent follow-up data. One problem with this approach has been enforcing the multi-occupancy requirement of vehicles using the carpool lane. Drivers have been noted to place mannequins in the backseat of their automobile to give the appearance of a car pool (Reichel & Geller, 1981) and police enforcement is often expensive and ineffective (Rose & Hinds, 1976).

Matching programs that locate individuals who have similar transportation requirements

and can form car pools have typically met with similar success. Andrie and Dueker (1974) noted no appreciable increases in the formation of new car pools in a review of such programs. Carter and Chamberlin (1975) reported similar findings in a program that provided computerized car pool matching service and extensive local publicity to encourage participation. Thus, it appears that information alone may not be sufficient to affect desired transportation changes.

Perhaps the most effective procedure to date has been providing reserved parking facilities to employees who use car pools. For example, by offering priority parking for car pools since 1964, the National Aeronautics and Space Administration in Houston, Texas, has been able to increase worker automobile occupancy to 3.85 persons per car (Pratsch, 1975). Hirst (1976) and Pratsch (1975) have also noted that employers offering reserved parking for car pools (with or without matching service) are generally twice as successful in encouraging car pool participation compared with matching service only. Problems of enforcing car pool parking contingencies or reinforcers were not noted in these programs.

Although each of the previous studies has provided important new information for ride-sharing technology, more work is required. For example, many studies have relied on random spot observations of car pooling or participants' verbal reports that can result in inconsistent or unreliable information. In addition, program results have typically been presented as group data, with very little attention paid to individual participant patterns of behavior. This information seems crucial in determining the appropriate types of interventions required to facilitate greater participation. Finally, more investigation is required into the effectiveness of different procedures that facilitate car pool participation.

The purpose of the present study was to develop a methodology that would allow for the precise quantification of car pooling behavior on both a group and individual participant level. In the present study, this technology was

applied to the analysis of previously reported transportation modification procedures, specifically, reserved car pool parking, car pool matching service, and a community-based token economy program.

METHOD

Subjects and Setting

The study was conducted at four parking lots on the campus of Florida State University during the months of January through March, the university's winter quarter. The lots accounted for 37% of all student parking spaces on campus and represented the only areas with controlled entrances and stable patterns of use. Table 1 presents the size of each lot and user characteristics.

Three of the lots (A, B, and C) were located within one-half mile of each other. Lot D was located on the opposite side of campus, one mile away. According to university regulations, the use of any lot required a \$12.00 parking sticker. In addition, access to Lot C was controlled by a mechanical gate that required 25¢ to operate. The occupants of any car attempting to park in Lots A, B, C, or D between 7:30 a.m. and 10:00 a.m. were considered experimental subjects because prior observations had indicated that few cars entered the parking lots prior to 7:30 a.m. and that the lots were filled by 10:00 a.m.

Observation and Recording Procedures

Individual observers stationed at each entrance of the four parking lots recorded the license plate number of every car entering the lots and the number of occupants in the car. Reliability was conducted on 20 of the 39 experimental days by a second unobtrusive observer located across the street from the lot according to a random observation schedule. Reliability coefficients of agreements divided by agreements + disagreements $\times$ 100 were computed separately for the number of passengers per car and license plate numbers. The mean

Table 1
Parking Lot Sizes and User Characteristics

Lot	Student Spaces	Student or Staff Spaces	% Student Use	% Staff Use
A	130	—	100	—
B	580	—	100	—
C	—	186	95	5
D	—	102	75	25
Total	710	288	92.5	7.5
Total Spaces 998				

reliability for license plates was 95.6% (range 88-100%) while the mean reliability for the number of people in each car was 97.5% (range 89-100%).

Experimental Design

The treatment program consisted of three components: (a) reserved car pool parking, (b) token reinforcers for car pool occupants, and (c) a computer-generated match list of neighboring students interested in car pools. Lots A and B served as treatment lots, while Lots C and D served as control areas.

The program evaluation was based on three separate control procedures: (a) an analysis of whether levels of car pooling during treatment were greater than pretreatment levels (Lots A and B), (b) a comparison of car pooling in the two treatment lots (A and B) as compared to a no treatment-control area (Lot D), and (c) a separate lot (Lot C) to control for a rival hypothesis that any observed treatment effects were due to the migration of already existing car pools on campus to the treatment lots, rather than to the formation of new car pools.

Lot C was chosen to assess car pool migration because of its distinct nature. Specifically, it was within two blocks of the treatment lots and served the same area of the campus. In addition, car poolers to this lot would also have the added incentive of saving the 25-cent lot admission fee by parking in one of the two reserved car pool parking lots (A and B) rather than Lot C. As a result, it was felt that, of the four experimental areas, this lot would be the most appro-

priate indicator of car pool migration between lots.

Experimental Conditions and Events

Baseline. Baseline observations began in all four lots during the second week of the school quarter and continued until the rate of car pooling appeared stable.

Reserved parking plus tokens. Drivers entering Lots A, B, or C during days 6-9 of the baseline period received a flier that listed the benefits of car pools, indicated that parking spaces would be reserved for car poolers in Lots A and B beginning the following Monday, and asked that each car occupant fill out a form for a program that matched them with other potential car poolers who lived within one-half mile of them. Results of the matching program were mailed to each participant the following week with information on how to form a car pool.

Beginning on day 10 of the study, approximately 45 spaces were reserved near the entrance of each Lot A and B for car pools of two or more people. The actual number of spaces reserved each day was based on previous car pool participation levels, with the remaining spots allocated for single occupant automobiles. At no time were car pools turned away from either treatment lot due to a lack of space. A sign reading "Car pool required from 7:30-10:00 a.m." reduced confusion about the barricaded sections.

Car pools were met at the reserved parking entrance by an observer who explained that each time they car pooled they could park in the reserved section and that each person would receive a coupon redeemable for 25¢ in merchandise at participating stores. The stores offered a wide variety of reinforcers ranging from food and drink, to educational supplies, to time on pool tables. Storekeepers were reimbursed each week for the coupons that they redeemed. No redemption conflicts or instances of forgery were noted over the course of the study.

Reserved parking only. On day 28 of the

experiment, all cars in Lot A were given one day's notice that bonus coupons would no longer be distributed but that reserved car pool parking would remain in effect. Coupons and reserved parking were still available in Lot B. The study terminated after 39 days due to the end of winter quarter classes.

Data Analysis

In addition to determining the general effectiveness of the incentive program on daily levels of car pooling, change in the behavior of individual drivers was also an important factor to consider. Due to the nature of the subject population, changes in the overall rate of car pooling could have been caused by several factors. For example, increases in car pooling frequency could have been a function of infrequent car pooling by a large number of drivers or consistent participation by a smaller group of individuals. Because the study did not encompass all parking spaces on campus, it was also necessary to track automobiles across parking lots to determine their frequency of car pooling as a function of baseline and treatment conditions. The following categories were established for these purposes.

New car pool. Automobiles that appeared solely as single occupant vehicles during baseline and subsequently appeared with two or more occupants at least five times during the treatment period were considered newly formed car pools. Because the typical student averaged 2 to 3 morning trips to campus each week, five multiple occupant trips during the treatment period indicated a minimum increase in car pooling from 0% during baseline to 33% of all arrivals during the treatment period and was considered to be a satisfactory change in behavior.

Migratory car pools. Automobiles that appeared as car pools at least five times during the treatment period but that had not appeared at all (either as single occupant or car pool vehicles) during the baseline period comprised this category. Although these cars exhibited sig-

nificant car pooling behavior as defined by the new car pool group, no inference can be made about any changes in their behavior because they did not appear in the baseline data. These may have been automobiles that already car pooled to different parking lots but moved to the experimental lots to take advantage of the incentives or they may have been newly formed car pools from other lots who moved for a similar reason.

Existing car pools. Any automobile that car pooled at least once during baseline and continued to car pool at least five times during incentive conditions.

Below criteria. All other trips made by automobiles that car pooled less than five times during the treatment period.

RESULTS

Group Data

The daily percentage of car pools in each parking lot was determined by dividing the total number of cars containing two or more people entering the lot by the total number of cars arriving during the experimental session. As seen in Figure 1, car pooling in Lot A increased from an average of 11% ($n = 21$ per day) during baseline to 21% ($n = 35$ per day) during the treatment conditions. Removal of the bonus coupons from this lot during the final 10 days of the study appeared to have no effect on participation.

Increases in car pool participation were much lower for Lot B. During baseline, car pools accounted for approximately 11% ($n = 45$ per day) of all automobiles arriving to this lot and increased to an average of 14% ($n = 50$ per day) during the incentive condition.

No consistent changes were noted in car pooling trends in either control lot during the course of the study. Car pooling declined slightly in Lot C, from 11% to 9.8% over the duration of the study and from 9.4% to 8.9% in Lot D during the same period of time.

Individual Car Pool Analysis

Table 2 presents the levels of car pool participation across each of the four parking lots according to the individual car pool analysis. Lot A, which exhibited the largest overall increase in car pooling (Figure 1), also showed the greatest increase in trips by new car poolers during the treatment period, followed by Lots B, C, and D. The data also suggest an inverse relationship between the percentage of new

Fig. 1. The percentage of car pools as a function of total cars entering each lot across experimental days. A computer match list of neighboring students was mailed on the 13th day to drivers in lots A, B, and C who had requested this service.

Table 2

Percentage of car pooling trips to each lot as a function of individual car pool analysis criteria.

	New Car Poolers	Migrators	Existing Car Poolers	Below Criteria Car Poolers
Lot A	20	14	37	29
Lot B	10	7	37	47
Lot C	6	3	36	55
Lot D	0	5	32	63

car pooler trips in any given lot to the percentage of below criteria car pooler trips in the same lot. Lot A, which had the greatest percentage of new car pooler trips also had the lowest percentage of below criteria car pooler trips. Lot D, which exhibited no new car pools during the study, had the largest percentage of below criteria vehicle trips (63%). Lots B and C exhibited corresponding median relationships. This may indicate that the incentive program affected the establishment of car pools as well as their frequency of participation. The percentage of trips by migrators observed at each lot during treatment followed a similar progression with a greater percentage of trips by migrators to Lot A, followed by Lots B, D, and C.

A frequency analysis of the number of trips by each newly formed car pool to Lots A and B during the treatment period indicated that the majority of these car pools made eight or fewer trips to the treatment lots during the 30 days that the incentives were in effect. This does not indicate that these vehicles carried only one person on remaining days but must be evaluated relative to the fact that: (a) most vehicles appeared on campus only two or three mornings a week and (b) many of the newly formed car pools did not begin until several days or weeks following treatment implementation. Once people began car pooling they did so on a more frequent basis, rather than sporadically over the entire treatment period.

Bonus Coupons

Program participants redeemed a total of

1,719 coupons or 83% of the 2,082 coupons distributed. Of the coupons redeemed, 69% were used at restaurants, 24% at a local bookstore, and 7% at a nearby bar. Total cost to the program for the coupons was \$429.75.

Cost-Benefit Analysis

Another method for analyzing program effectiveness compared cost of implementation to capital saved by the need for fewer parking spaces for the same number of people. Although such savings could not be realized from existing parking facilities, a successful car pooling program could alleviate pressures for the construction of new spaces, allow for more convenient parking, or allow existing spaces to be diverted for other uses such as building or recreation.

Based on projections by the university traffic planning department, the cost of developing, constructing, and maintaining one parking space on the campus was estimated at \$3,600 over a 15-year period (Denham, Note 1). Table 3 pre-

Table 3
Cost-Benefit Analysis of Program Effects

<i>Benefits of program in parking spaces saved</i>	
Average number of parking spaces saved per day in the experimental lots	19
Cost per parking space	\$ 3,600
Savings (19 spaces × \$3,600)	\$68,400
<i>Program Costs</i>	
Bonus Coupons	\$429.75
Match List Expenses	
Computer Programming and Run	20.00
Key Punching	22.50
Mailing	39.00
Handouts and Prompts	24.00
Labor (One gate observer per incentive lot, 2 lots, 2½ hours per day for 40 days at \$2.65 per hour)	600.00
Total cost of the program	\$1,135.25
Cost per parking space saved	\$40.45
Length of program possible based on number of spaces (19) saved	60.25 quarters (20.08 years)

sents the cost associated with the present program over the one quarter of study and the savings possible as reflected by the number of parking spaces that were saved per day by people car pooling. Costs for data collection and analysis were not included in the estimate since they would not be incurred in a nonexperimental application.

Table 3 indicates that the program could economically sustain itself based on savings relative to costs associated with developing new parking spaces. The 20 years that the present program could run (excluding summer quarters when parking problems do not exist because of reduced enrollment) on the revenue saved from parking construction is greater than the life span of parking spaces prior to renovation. When the efforts and savings of the present program are compared to the more expensive cost per space involved in the construction of urban parking garages the economics become even more favorable in situations where more parking space is needed.

It is also evident that car pool participants benefited directly in terms of reduced automotive expenses. Based on a 10-mi round trip to campus for the typical student at a cost of 26¢/mi (Highway Users Federation, 1973), participants collectively saved \$2,256 through the 868 additional car pooling trips that occurred during the treatment period. This also conserved 620 gallons of gasoline based on an average automobile consumption rate of 14 mpg (Federal Energy Administration, 1977). The specific amount saved by each student would depend on distance from school, frequency of car pool participation, and type of automobile used.

DISCUSSION

It is not clear why Lot A exhibited a much greater increase in car pooling than Lot B during the incentive program. The lack of a similar magnitude of effect in Lot B urges caution in the interpretation of the present findings. It is possible that the number of reserved spaces

relative to the size of each parking lot influenced car pooling. The 45 spaces reserved daily in Lot A represented 35% of the 130 total spaces in that lot. The same 45 reserved spaces in the 580 car capacity Lot B represented less than 8% of all parking spaces there. This could have made the reserved parking program more prominent in the smaller lot and placed a greater demand on drivers (i.e., if you park in Lot A, car pooling must be given serious consideration). Unfortunately, it was not possible to investigate this possibility since the program was only allowed to reserve as many spaces as it could fill each day.

Both Lot C, which served as a quasi-control lot, and Lot D, which served as a formal control lot, exhibited minor but similar declines in car pooling during the study. Though automobiles arriving to Lot C were notified of the incentives available in the two treatment lots, very few drivers took advantage of this opportunity. This finding is consistent with the relatively low proportion of migrators noted in the individual car pool analysis and indicates that parking proximity may be an important variable for future incentive programs to consider.

Although 25% of the individuals who parked in Lot D were not students, this does not invalidate it as a control lot. The staff members who parked in this lot typically worked in the administration building on a regular 9:00 a.m. to 5:00 p.m. shift and had stable commuting patterns. Any changes in student transportation habits would have been identified in such a situation. Similarly, no differences in transportation habits or car pooling levels were noted between this lot and other lots during a series of studies conducted during the preceding year on this same campus (Poche, 1976). In addition, the percentage of existing car pools to this lot, as noted in the individual car pool analysis, (which would indicate pretreatment levels of car pooling) was similar to the three other lots involved in the study. This lot was also deemed acceptable because it was the farthest removed controlled access lot from the treatment area.

Therefore it was the least likely to be affected by the treatment procedures and the most appropriate available lot for a control measure.

The individual car pool analysis appears to be one of the most important aspects of the study. This procedure allowed for the precise tracking of a small group of subjects (car poolers) within the larger and uncontrollable population of all campus commuters and may serve as a model for other systematic investigations in community settings. Without these data it would not have been possible to partition treatment effects among the different groups of drivers, resulting in an inaccurate assessment of program impact in creating new car pools.

The results of the individual car pool analysis also suggest that future research should target specific groups of commuters for specific interventions. As noted in the present study, the frequency of car pooling varied greatly among the participants. Increasing the frequency of car pooling by occasional participants (response maintenance) is just as important in increasing overall automobile occupancy as encouraging solo drivers to begin to car pool (response acquisition), but each population may be responsive to a different set of contingencies. The use of the individual car pool analysis as a preintervention assessment could facilitate the selection of the most effective treatment procedure.

The fact that 83% of the token coupons were redeemed suggests their viability as reinforcers and confirms the findings of Everett et al. (1974). Although the rate of car pooling to Lot A remained stable following the removal of the bonus coupons, it is possible that coupons were an effective element in facilitating initial car pool participation or that they would be effective in situations where reserved car pool parking was not possible. Such analyses were not within the realm of the present study and must await further investigation.

The cost-benefit analysis indicated that even a moderate increase in car pooling could be cost-effective on both a public and personal

level. Though the actual savings in parking spaces that can be produced relates to future construction plans, such plans are often realized much sooner than expected due to urban pressures. The implementation of an effective car pooling program becomes a viable option at that time. One additional saving which could not be estimated in the present study was the reduction in environmental damage as a function of the fewer number of automobiles on campus during the treatment period. Though this savings may have been minimal in the present study, such changes can be highly significant in larger populations.

In summary, the present study demonstrated the use of individual subject analysis in the evaluation of a large-scale car pool incentive program and provided important insight into the specific behavioral effects that had not been previously reported. Techniques such as the present analysis offer one answer to the challenge of conducting research in larger and less controlled community settings.

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Received March 26, 1979

Final acceptance June 22, 1981