

CHANGING COMMUTER TRAVEL BEHAVIOR: EMPLOYER-INITIATED STRATEGIES*

ANNE R. KEARNEY

RAYMOND DE YOUNG

The University of Michigan, Ann Arbor

ABSTRACT

Commuter travel has certain features that make it potentially more responsive to interventions than other types of travel. However, from the perspective of the employer attempting to implement a trip reduction program, it is often difficult to determine what type of intervention (or combination of interventions) would be most effective. This article reviews the literature on strategies for changing commuter behavior, with a focus on techniques that an employer might use (i.e., rather than a focus on physical or regulatory barriers to non-conserving behavior). Behavior change strategies are organized into three categories: informational approaches, positive motivational approaches, and coercive approaches. In general, research in commuter behavior change has focused on the application of external, tangible motivation (e.g., financial incentives or disincentives) to the exclusion of self-initiated, less tangible factors (e.g., commitment and self-monitoring techniques). The implications of this bias are discussed along with suggestions for future research.

INTRODUCTION

The private automobile is the largest consumer of transportation energy in the United States, using 67 percent of all gasoline and highway diesel fuel [1]. Perhaps even more significant is the effect of transportation related pollutants on

*The first author would like to acknowledge the support of the Graduate Fellowships for Global Change Program administered by Oak Ridge Associated Universities for the U.S. Department of Energy, Office of Health and Environmental Research, Atmospheric and Climatic Research Division. Both authors also acknowledge support from the U.S. Environmental Protection Agency, Ann Arbor, Michigan (EPA Project No. CX-820479-01-0) and in particular the assistance of Ms. Janet Cohen and Ms. Connie Ruth.

air quality. Automobile emissions contribute 70 percent of the carbon monoxide (CO), 45 percent of the nitrogen oxides (NO_x), 34 percent of the excess hydrocarbons (HC), 73 percent of the lead, and sulfur oxides (SO_x) emitted into the air [2, 3]. Hydrocarbons react in the presence of NO_x and sunlight to form ozone (O₃), a major component of smog. NO_x also contributes to the formation of acid rain. CO₂ is a greenhouse gas—believed to be trapping the earth's heat and contributing to the enhanced greenhouse effect [3]. In addition to lowering air quality and contributing to climate change, air pollution from automobiles causes many thousands of premature deaths each year and is responsible for tens of billions of dollars in annual health care costs [4].

Automobile trips made while commuting to and from work are of particular concern. Of the total vehicle miles of travel (VMT) made by private automobiles, 40 percent is for commuting [5] and during these commuting trips, approximately 80 percent of commuters drive alone [1]. Transportation control measures targeted at commuters may be particularly effective. When compared with other types of travel, commuter travel has features that make it potentially more responsive to interventions: there is relatively greater day-to-day regularity of the trip and common destinations and travel periods suggesting that commuters may be more easily served by alternative modes; the commute trip currently has the lowest vehicle occupancy rate of all travel purposes; the commuters can be easily reached through their employers [6].

The importance of commuter transportation control measures has been recognized at the national level and is a key feature of the 1990 Amendments to the Clean Air Act. One requirement of the Amendments is that employers who are located in ozone areas classified as serious or above and who have more than 100 employees must implement trip reduction programs. This requirement stems from a realization that reducing commute-related VMT can have a significant impact on energy consumption and air quality. It is also interesting to note that the 1990 Amendments include a significant focus on changing behavior rather than just relying on "technological fixes" (e.g., alternative fuels, increased fuel efficiency). It is becoming clear that drastic increases in the number of automobiles on the road and vehicle miles traveled are outpacing gains attributable to technological fixes.

The goal of the employee-initiated trip reduction programs is to reduce commute-related VMT by raising the average vehicle occupancy for employee work trips to at least 25 percent above the area average [3]. The emphasis has been largely on promoting carpools, vanpools, buspools, or public transportation. To a lesser extent, biking or walking, telecommuting, and compressed work weeks (e.g., working a 4 day, 10 hours-per-day week) have been encouraged. Employer-initiated trip reduction strategies have taken many forms, including financial incentives and disincentives, informational campaigns, "no-drive" days, and ride matching programs.

One of the most common trip reduction strategies has been the use of financial incentives and disincentives to change behavior. These programs have been met

with varying and often unpredictable degrees of success. Often, they are highly successful at initiating behavior change but they can be associated with negative reactions. Research into the motivations and attitudes of commuters suggest that mode choice is not solely an economic/optimization phenomena but, rather, is a complex social and psychological one [7]. Because of this, it has become necessary to approach to problem from social and psychological perspectives as well as from an economic perspective. The field of behavioral science, specifically studies in conservation behavior, is particularly well suited to this challenge. What follows is a review of the literature on travel-related behavior change techniques, with an emphasis on employer-initiated strategies for reducing commuter travel.

THE FRAMEWORK

Categorization of Behavior Change Strategies

From the perspective of the employers charged with implementing trip reduction programs, it is useful to organize behavior change strategies into three categories: informational approaches, positive motivational approaches, and coercive approaches [8]. Each is briefly introduced below. These are not mutually exclusive categories, successful programs may combine strategies. Several excellent reviews of behavior change strategies are available [9-15]. Stern [16] surveys this literature as it relates to global environmental issues and Granzin and Olsen [17] provide a concise review of demographic, informational, and non-economic motivational predictors of conservation behavior.

Information Strategies

This category includes a variety of education and communications based approaches. Some of these approaches attempt to change behavior by increasing awareness and knowledge about issues. Others explicitly identify the target behavior and explain in detail how that behavior is to be carried out. Less frequently attempts are made to draw upon deeper perceptual changes—where one gains insight or understanding that goes beyond simple awareness and contributes to the development or modification of a personal value system.

Positive Motivational Strategies

This category includes approaches that use either extrinsic or intrinsic motivation to either make the target behavior more appealing or provide social support for those choosing the behavior. Included also are strategies that seek to enhance one's discovery of intrinsic satisfactions or other intangible rewards derived from carrying out the target behavior. As a group these strategies do not constrain individual choice. They work with human interest, making the target behavior more tempting.

Coercive Motivational Strategies

Coercive techniques change behavior by greatly constraining one's choice, making it difficult or costly to pursue certain behaviors. Included are the use of economic or social disincentives, and the use of physical or regulatory barriers to non-conserving behavior (e.g., high occupancy vehicle lanes on commuter routes, restricting the availability of or banning certain transportation options).

The Source of Behavior Change Initiation

In addition to the categorization discussed above, strategies also differ on the source of behavior change initiation. Behavior change can be initiated by the environment, by others, and by the participants themselves. It is most common to develop programs where the behavior change is initiated either by some outside entity or by some aspect of the behavior setting. Furthermore, these strategies generally employ interventions that can be directly and relatively easily manipulated. In contrast, strategies that rely more on intrapsychic forces are generally less easily manipulated (e.g., there is nothing to give or withhold), although they are nonetheless powerful.

The research articles reviewed in this article are organized by the categories discussed above. Most of the articles reviewed also could be arrayed in the 2×3 framework suggested by these categories (see Figure 1). It is possible to imagine that people are obedient mainly to external cues or signals. If humans developed in such a way they would be extremely sensitive to information and motivation presented by other people or by the behavior setting (top row of the figure). However, it is just as likely that humans are obedient to their own behavioral plans and intentions. The notion that people are sensitive to *both* external and self-initiated sources becomes important when one realizes that most research on commuter travel behavior has focused on the former.

STRATEGIES WITH EXTERNAL SOURCES OF BEHAVIOR CHANGE

Positive Motivation

Financial Incentives

Much of the empirical research done on the promotion of public transportation ridership has focused on various bus fare manipulations including token reinforcements, variable-ratio reinforcement, and free bus service. For the employer this usually translates into public transportation subsidies. Everett and his colleagues have undertaken a series of studies exploring the effect of various forms of monetary reinforcement on bus ridership. An early study employed both prompting and positive reinforcement to encourage bus ridership [18]. The study

Source of Change	Positive Motivation	Coercion	Information
Environment/ Others	<ul style="list-style-type: none"> • MATERIAL INCENTIVES Bachman and Katzev (1982) Deslauniers and Everett (1977) Everett, Hayward, and Meyers (1974) Giuliano, Hwang, and Wachs (1992) Jacob, Fairbanks, Poche, and Bailey (1982) Katzev and Bachman (1982) Modarres (1993) • ORGANIZATIONAL SUPPORT: Ride Matching: Ferguson (1990) Hekimian and Hershey (1981) Hershey and Hekimian (1983) Guaranteed Ride Home: Brownstone and Golob (1992) Giuliano, Hwang, and Wachs (1992) Kadesh and Elder (1989) Winslow (1991) Corporate Support: Malaspina et al. (1992) Angeli and Ercolano (1991) Giuliano et al. (1992) Leader: Hake and Foxx (1978) • OTHER INCENTIVES: Alternate Work Schedule: Bonswall, Spencer, and Tang (1984) Ferguson (1990) Modarres (1993) Sierra Research, Inc. (1990) Wegmann and Stokey (1983) Preferential Parking: Brownstone and Golob (1992) Jacobs (1982) 	<ul style="list-style-type: none"> • MATERIAL DISINCENTIVES: Angeli and Ercolano (1991) Dowling, Feltham, and Wycko (1991) Ferguson (1990) Sierra Research, Inc. (1990) Surber, Shoup, and Wachs (1984) Wachs (1991) 	<ul style="list-style-type: none"> • DECLARATIVE KNOWLEDGE: Bonswall, Spencer, and Tang (1984) Giuliano, Hwang, and Wachs (1992) Modarres (1993) Reichel and Geller (1981) Rosenbloom (1982) • PROCEDURAL KNOWLEDGE: Brunso and Hartgen (1976) • FEEDBACK: Hayward and Everett (1976) • OTHER: Booth and Waksman (1985)
Self	<ul style="list-style-type: none"> • COMMITMENT: Bachman and Katzev (1982) 	<ul style="list-style-type: none"> • DUTY/RESPONSIBILITY: Aho (1977) Nelson (1981) 	<ul style="list-style-type: none"> • SELF-MONITORING: Hake and Foxx (1978)

Figure 1. Categorization of selected literature.

was conducted on campus buses. Throughout the experiment riders paid the regular ten cent fare. During the intervention period, all riders on one of the campus busses (which were marked on the outside) were thanked for riding the bus and handed twenty-five cents. This did result in an increase in ridership over baseline rates; however, the procedure was not very cost-effective and it is not known if the contingencies attracted individuals who normally rode another bus or walked.

In an attempt to reduce the costs of reinforcing bus ridership, Everett et al. introduced a token reinforcement procedure [19]. Tokens were redeemable at specified businesses for a variety of items or could be used in the place of bus fare. The procedure increased ridership over baseline. In a follow-up study an intermittent schedule of token reinforcement was employed during which every third passenger, on average, received a token [20]. There was no greater effectiveness of this intermittent reinforcement over that of continuous reinforcement; both led to a similar increase in bus ridership over baseline. This suggests that intermittent token reinforcement may provide an economically viable approach to increasing bus ridership.

A potential problem with the Everett et al. studies, is that, in general, passengers might have walked if they hadn't bussed; the campus setting may thus have been inadequate for testing the effects of financial incentives on bus ridership. In answer to this problem, Bachman and Katzev [21] extended the findings of Everett et al. to a large urban mass transit system. In their study, eighty-three non-bus riders were recruited and randomly placed in one of four treatment groups: 1) a control group where bus route and schedule information was provided, 2) a commitment condition where subjects agreed to ride the bus two times per week for four weeks, 3) a group in which subjects were given unlimited free tickets, and 4) commitment plus free tickets. During the four-week treatment period, only one person in the control group ever boarded a bus. All of the other treatment groups showed levels of ridership which were significantly higher than baseline levels. Interestingly, no systematic differences were found between the treatment groups, suggesting that while free tickets may increase bus ridership, so might other, non-financial, strategies (e.g., commitment).

An extension of Bachman and Katzev [21] compared the effectiveness of various economic incentives [22]. Participants were randomly assigned to five groups: 1) a control, 2) a credit only group where subjects were allowed to board the bus at any time and be billed in full at a later date, 3) a credit plus inverted fare group where subjects were billed at a later date at half price if they rode the bus frequently, 4) a credit plus differential fare group where subjects were billed later at half price for all off-peak hours, and 5) a group which received free tickets. Results indicate that credit alone and credit plus off-peak reductions did not significantly increase ridership. Reduced fares for frequent riding and free tickets both led to a small but significant increase in ridership. In general, it was found that while selective economic incentives can facilitate ridership, the

changes were small and were not sustained when the incentives were removed. It is also important to note that increases in bus ridership were not associated with a reduction in car miles driven by study participants.

Token reinforcement has also been applied to encourage car pooling. Jacobs et al. combined the effects of a token economy and reserved parking as a means of increasing car pooling among students at a university campus [23]. Spaces in two lots were reserved for car pools and car poolers were given tokens redeemable for merchandise at participating stores. After the initial treatment period, the tokens were taken away while the reserved parking remained in effect. Results indicate that both tokens and the reserved parking were effective in promoting car pooling. It is interesting to note that the rate of car pooling remained stable after the removal of the tokens; this indicates that while tokens may have been an effective element in encouraging initial car pooling, preferential parking on its own was enough to sustain car-pooling behavior.

Financial contingencies have been extensively used by employers promoting ride reduction; many of these strategies have been quite effective at encouraging behavior change. In a survey of 1110 employer sites, it was found that all mode-specific financial incentives (e.g., public transportation, car pooling, van pooling, walking, biking) were significantly related to an increase in average vehicle ridership [24]. Brownstone and Golob report that when combined with other incentives (i.e., employer-provided preferential parking, freeway HOV lanes, guaranteed rides home for ride sharers) a ride-share cost subsidy can significantly reduce solo commuting [25]. Another evaluation of transportation demand management programs concluded that those programs with the greatest impact (i.e., reduced trips by over 30%) all provided incentives and disincentives to affect employee travel behavior (these largely included financial contingencies such as commuter subsidies and parking fees but also included non-financial contingencies such as preferential parking) [6].

It is difficult to determine the relative effectiveness of individual economic incentives from these case studies, as most employers use a combination of incentives. For example, CH2M Hill, an architectural/engineering firm in Bellevue, Washington was able to decrease the number of employees commuting by single occupancy vehicle from 89 percent to 54 percent through a combination of restricted parking, transportation allowances, and high occupancy vehicle subsidies [6].

While positive tangible motivation does seem to be successful at initiating changes in commuting behavior, the issue of durability, particularly in those studies involving financial incentives, is much more problematic. These studies typically employ an A-B-A reversal design where the return to baseline provides one type of evidence of the validity of the intervention. However, this same evidence points out the intervention's non-durable nature [19, 20, 26, 27]. The effectiveness of an intervention, which is better dealt with as a multi-dimensional concept, must consider both the immediate and the long-term effects. Changes in

travel behavior need to be lifelong and, preferably, maintained without constant financial input.

Organizational Support

Ride matching and coordination — There is evidence contradicting the notion that explicit incentives or disincentives are the only means by which the employees can be induced to change their travel behavior; other methods, such as organizational efforts, have been shown to be effective as well [28]. One area that has received particular attention is the promotion of ride sharing through ride-share matching services and on-site ride-share coordinators. One study of companies in southern California found that ride-matching services were more important than direct incentives for inducing people to ride share [29].

An evaluation of the National Ridesharing Demonstration Program (NRDP) which was established by the Department of Transportation in 1979, showed that contact with a ride-share program was strongly associated with an increase in employee ride-sharing [30]. However, not all matching strategies are equally as effective. The two most common programs, offering locator lists (usually mounted in a lobby or some other common area) and computerized match systems, have been found to have the least appeal. Interest in being contacted by a car pooler or having the help of a coordinator is generally greater than the interest in either locator lists or computerized matches [29, 31].

Personalized ride-matching assistance has had a profound effect in increasing the success rates of programs across the country [32, 33]. The Share-A-Ride program in Silver Spring, Maryland, has successfully used a personalized approach to ride-share matching to overcome the traditional barriers to ride sharing. The program humanizes the ride-share assistance process by making use of personalized marketing, matching, and follow-up contact [34].

The role of an on-site coordinator has also been shown to have a positive effect on the number of employees participating in ride-share programs. By way of example, a review of the car-pool coordinator demonstration project undertaken by the New York State Department of Transportation in 1979, showed that car-pool coordinator activities produced a positive shift in both employee attitudes toward car pooling, and the proportion of employees who participated in car pools [7]. Typical activities carried out by ride-share coordinators include disseminating information about the program, providing car-pool matching, and answering employee inquiries.

Guaranteed ride home — A survey of 1110 employee sites found that a guaranteed ride-home program was associated with a significant increase in average vehicle ridership [24]. Brownstone and Golob found that when combined with other incentives a guaranteed ride-home could significantly increase ride sharing. These programs address one of the often expressed concerns with switching from solo driving to an alternative transportation mode by assuring employees

that their transportation needs will be taken care of during an emergency [35]. Programs may compensate employees either partially or fully for the cost of a taxi fare, or company vehicles may be made available for employee use.

Guaranteed ride-home programs are typically inexpensive to operate [35, 36]. A six-month demonstration program in Seattle showed a 12 percent increase in the use of alternative modes of transportation though only between 2 to 4 percent of the maximum number of subsidized miles available to Guaranteed Ride-Home program participants were actually used [35].

Corporate support — Management commitment to alternative transportation modes and ride-reduction programs can be a strong positive motivation in encouraging employees to change their travel behavior [4, 24, 37].¹ A study of two very similar companies, both of which had virtually identical incentives for alternative transportation, found that in company "A," only half as many people participated in ride-share programs and two-thirds as many commuted by public transportation as in company "B." The one major difference was that company "B" was much more active in terms of corporate backing and promotion [6].

Leadership — A study on motivating commuting college students to reduce the number of miles they drove found that the presence of a leader was significantly related to a decrease in driving [27]. Though further study is warranted before clear conclusions can be drawn, these findings suggest that supervisors and managers in organizational settings should be incorporated into ride-reduction programs in order to motivate individual participation.

Other incentives — The option of an alternate work schedule can provide an incentive for adopting an alternate commute mode [33, 38-40]. Modarres reports that adjusted work hours and special benefits such as privileges in the company cafeteria or credit union can have a positive effect on the adoption of alternate modes of transportation [41].

Improved facilities can also reduce some of the barriers associated with alternative transportation modes and thus increase travel by those modes. This is especially true of non-traditional modes such as biking or walking. Fleetwood Enterprises, Inc. in California was able to increase the percentage of employees who regularly commute by bicycle from virtually 0 percent to 12 percent by installing on-site lockers and showers and by providing loaner bikes and a pick-up service for accidents or flats [4].

Preferential parking can also be viewed as an improvement in the facilities available to ride-share users. While Brownstone and Golob [25] report that

¹ It is worth noting that "corporate support" is an ill-defined term in much of the research. Studies often combine a wide variety of management and supervisory activities under this term, confounding attempts to identify the crucial intervention.

preferential parking is an important incentive, it may not be a significant factor in motivating people to continue to ride share once they have begun [23].

Coercion

Financial Disincentives

Financial disincentives may be more effective than financial incentives at changing travel behavior at least when imposed as a parking fee. Studies show that, generally, changes in transit fares have had less impact on transportation behavior than has the imposition of parking fees (typically between \$30-40 per month) [42]; having to pay for parking is a highly ranked motivation to switch to alternative modes of transportation [37].

Parking management strategies are the most common forms of employer-based disincentives, and can include: charging for employee parking; reduced or free parking for car pools and van pools; limited supply of parking for single occupancy vehicles; and preferential or closer parking for car pools and van pools. Further, the success of these strategies appear to depend largely on the relative disincentive they produce and the extent to which travel alternatives are available [39].

Several studies illustrate the effectiveness of financial disincentives in the form of parking fees. For example, in a study of six large medical institutions in San Francisco, California, a monthly charge for on-site parking was found to be the single most influential factor for determining the percentage of employees that drive alone to work. This factor alone accounted for 80 percent of the variability in the modes of travel [43].

A corporation in southern California ended employer-paid parking for single occupancy vehicles. Car poolers continued to park for free and bus riders continued to get free transit passes. The use of single occupancy vehicles fell from 42 to 8 percent while car pooling rose from 17 to 58 percent, and bus ridership declined from 38 to 28 percent (presumably, some former bus riders were invited into car pools) [44]. Also, a survey of large firms in southern California indicates that when free parking for all employees is the norm, direct ride-sharing incentives were not associated with an increase in ride sharing [33]. Again, this illustrates that financial disincentives can serve as an effective intervention particularly when implemented as a parking fee in situations where parking was previously free.

Despite these data, parking fees may not be a fail-safe method of promoting ride reduction. One study of suburban commuters found that the disincentive of high parking costs were not sufficient to attract riders to standard transit services. Enhanced service (e.g., guaranteed seating), however, provided an incentive for transit use and caused changes in travel behavior. This indicates that other non-financial factors need to be considered.

Another concern which has received little attention is that travel end-use (the mode by which commuters arrive at work) may not necessarily be indicative of travel behavior. Individuals who are coerced into using alternative modes of transportation may react by actually increasing their non-work automobile usage or by creatively circumventing the intent of the parking policy [3]. Analysis of a transportation management program at USWest, which used limited parking and parking fees as disincentives for driving alone, showed that, while car pooling was increased, many of the employees who car pooled drove to meet their car pool at a "Park and Ride" lot within one mile of the work site [3]. In cases such as this, the intent of the ride-reduction program is circumvented as employees find creative ways to avoid penalties.

Information

Information Campaigns

Data on the effectiveness of information campaigns on promoting changes in commuting travel behavior point to no clear conclusions. A survey of 1110 employee sites found that information programs (e.g., commuter information centers, commuter fairs, new-hire orientation) were not significantly associated with an increase in average vehicle ridership [24]. However, a study of the Yorkshire car-sharing scheme, which was implemented at four different sites, found that the rate of application to the program tended to increase with the intensity of the publicity campaign at each site [38]. Modarres reports that merely posting information does very little to modify the commuting behavior of employees and argues that an active, face-to-face approach is more successful [41].

One factor influencing the success of information campaigns may be the extent to which the information is personalized. Information campaigns concentrating on abstract or impersonal issues, such as social and environmental responsibility and problems related to the usage of automobiles, have generally been ineffective [45]. The mass media efforts during the fuel crisis in the mid-seventies which were directed toward changing individual commuting behavior, tended to focus on a broad set of shared goals for society (e.g., patriotism, social responsibility, saving fuel, and money). The public largely failed to respond to such pleas [46].

An intensive analysis of various transit information techniques in the 1970s concluded ". . . it was demonstrated that the information function does not appear to be a sensitive variable and therefore, will not influence people or change their attitudes one way or another toward utilizing public transit" [47, p. 161]. Other studies, however, conclude that information and education efforts have been significantly underutilized and have great potential for changing attitudes and behavior regarding the use of alternative modes of transportation [48]. Further research is needed to explore which specific types of information and styles of presentation are most effective.

Feedback

The use of feedback has been successfully employed to change travel behavior among individuals [28]. A study done by Hake and Foxx looked at the reduction of the number of miles driven by commuting college students [27]. Three groups were compared: 1) a control group, 2) a group which received monetary reinforcement scaled in terms of percent reduction in the number of miles driven, and 3) a group which received monetary awards only for keeping track of the number of miles driven, regardless of whether or not the miles were reduced. An average 10.4 percent reduction was found among the self-recording group (compared to a 22.5% reduction in the reinforcement condition) indicating that mileage reduction may be as much a result of feedback as of financial incentives. Caution must be used in interpreting these results, however, as the sample size was very small. A later study successfully employed public feedback and a contest to reduce vehicle miles traveled in an organizational setting [28].

STRATEGIES WHERE THE SOURCE OF CHANGE IS SELF-INITIATED

Very little research has been done on the role of less tangible and/or more personally initiated factors in changing travel behavior. In part this is understandable given the greater difficulty in externally manipulating such behavior change techniques. One cannot simply modulate (e.g., give, withhold) another's sense of duty or commitment. Nonetheless, these reasons for adopting a behavior can be discussed with program participants, the reasons themselves can be described as valid and worthy of attention, and the behavior setting can be structured so as to enhance their discovery. In this section we generalize from research done on other types of conservation behavior. This research suggests that further exploration in this area may be fruitful. The exception seems to be from what might be labeled "internally-mediated coercion" (e.g., pleas to one's sense of duty) which do not appear to promote changes in travel behavior. The studies in question, however, generally made appeals based on rather abstract issues such as general social and environmental benefits gained by switching to alternative modes of transportation. We speculate that more concrete and personalized pleas may be more effective.

Commitment techniques, though not well explored in the travel behavior literature, may be effective means of changing behavior [see 21]. Literature in other areas of behavior change indicates that commitment techniques may be as or more effective than material incentives at changing behavior [49] and that these changes may be more durable than those realized by other techniques [50].

There is some indication that information gained through direct experience can be very effective at changing behavior [51]. Some companies have encouraged and facilitated direct experience as a means of allowing employees to get

acquainted with alternative transportation modes (e.g., Guest Pass Program in Connecticut, loaner bike programs of Fleetwood Enterprises, Inc. in California which allows employees to test out bicycle commuting without investing in a bicycle) [4, 36]. "Bike to Work" or "No-Drive" days or weeks are other means by which direct experience with alternative modes can be encouraged. Direct experience, however, is not always possible and there is the possibility that a negative experience is worse than no experience at all. Though substitutes for direct experience have been explored in other environmental domains and are promising strategies for behavior change [e.g. 52, 53], we can only speculate as to their effectiveness in the transportation domain. Research elsewhere indicates that appropriate substitutes for direct experience (e.g., the use of case studies) may be more effective than direct experience at initiating durable behavior change [53].

Psychological Considerations

This section includes studies that suggest effective behavior change strategies although the researchers did not actually test these strategies. Due to their speculative nature they are not listed in Figure 1. While the more tangible factors (e.g., commuting cost, trip length, availability of public transport, automobile availability) are often cited as the determining factors for who will switch to alternative modes of transportation, these factors alone are not powerful enough to accurately predict behavior [54]. Indeed, the perception of tangible factors themselves are influenced by psychological factors.

For instance, the actual influence of direct personal costs on transportation behavior is not clear. Though many studies on commuters willingness to car pool show that they consider the out-of-pocket costs of car pooling versus solo driving to be among the two or three most important factors influencing choice [42], replies to surveys indicated that many solo commuters are unable to give an estimate of the cost of commuting, and those who are able to, consistently underestimate the cost [55]. When people are made aware of the daily costs associated with solo driving, they may form negative attitudes toward the automobile as a viable mode of transportation, but will not necessarily reduce automobile usage [56]. During the gas crisis in the mid-seventies, numerous predictions were made that the use of the automobile, and in particular the single occupancy vehicle, would decline in parallel to a rise in the cost of gasoline. Even in those few periods of increasing real gasoline prices, this did not happen. Margolin and Misch reasoned that travel behavior must be sensitive to more than just economic considerations [31].

Travel time is another factor affecting modal choice, but the perception of travel time is complex [42]. Public transit users tend to estimate journey time by car the same as car users, and both groups tend to slightly overestimate real speed. Not surprisingly, car drivers are generally unable to give a realistic estimate of the time taken when traveling by public transportation. More surprising is

that public transportation users overestimate their own journey times by almost one-third [55]. Probably this discrepancy is due to the perception of "out of vehicle time" (e.g., time spent waiting for a bus transfer), which is overestimated as being two to three times as much as is time spent moving [42].

Attitudinal Factors

While perceived commuting costs and travel time are two important factors in commuting behavior, they are far from the only factors. Personal, psychological, and social issues such as perceived constraints on independence and requirements of semi-public behavior, also play a large role in the decision-making process regarding commuter mode choice [57].

To identify some of the other factors affecting modal choice, it is useful to look at the attitudinal differences between solo drivers and high occupancy vehicle (HOV) users. In general, solo drivers differ from HOV users in evaluations of the convenience, reliability, pleasure, comfort, and travel time associated with HOV use [57, 58]. The two groups generally do not differ significantly in their evaluations of the social benefits and problems associated with mode choice (e.g., air pollution, traffic congestion, energy use, noise levels, transportation system degradation) [57, 58]. This suggests that strategies based on appeals to civic-mindedness and tender-heartedness are likely to be ineffective at altering travel behavior while strategies addressing concerns such as convenience and reliability may be more effective. This is true whether dealing with actual or imagined problems. Intervention strategies could just as easily target perceived inconveniences and unreliability as the actual barriers that make alternate travel modes inconvenient or unreliable.

Positive motivations for changing travel behavior include: reducing the stress related to driving, reducing safety risks, and the opportunity for socializing [29, 37]. However, in general, solo drivers tend to be more concerned with the possible drawbacks to HOV use than they are with its benefits [31, 37]. This is in concurrence with studies done on the decision-making process which find that people generally will act more strongly to avoid something perceived as negative than they will to accrue some desirable benefit [59]. This has implications for the framing of HOV promotion efforts; it may be more effective to frame the advantages associated with HOV use in terms of avoiding the personal negatives associated with driving alone (e.g., highlight the stress associated with solo driving and offer transportation alternatives as ways to avoid that stress).

Cognitive Issues

Lack of information and the desire to avoid uncertain or unfamiliar situations also seem to play significant roles in the decision not to change from solo commuting to HOV use. Solo commuters often have misgivings about their ability to handle specific HOV-related problems (e.g., what to do about car pool

members who are late, how to handle finances in ride share situations) [29, 31]. One study found that solo commuters have a higher need for "mastery" or sense of control than do HOV users; they also tend to be slightly more conservative with their personal planning [45]. This suggests that solo commuters may need to be more confident about their ability to cope in a new setting before changing to an alternative mode of transportation.

The prospect of becoming involved in a difficult social situation can also deter people from switching to HOV use [31]. It is clear from surveys of solo commuters that people are not eager to become involved with others about whom they know nothing [29]. For instance, the desirability of car pooling has been found to decrease with an increase in the number of non-acquaintances in the car pool [60].

EVALUATION OF BEHAVIOR CHANGE STRATEGIES

Five dimensions of behavioral effectiveness have been proposed: reliability, speed of change, particularism, generalizability, and durability [8]. Reliability deals with how confident one is that a strategy can instigate behavior change. The issue here is both how well a strategy is at changing behavior the first time it is used as well as whether it is still able to effect change after many uses. Speed-of-change assesses how rapidly a strategy can effect change—either how quickly someone adopts a new behavior after being first presented with an intervention or how rapidly one improves performance of an existing behavior. The particularism dimension involves assessing whether a strategy can be designed for universal application or must instead be uniquely created or administered to subgroups. A more particularistic technique would be more costly to use since it would be context specific. Generalizability and durability move beyond the immediate and intended effect of an intervention and ask about unintended but beneficial side effects. Generalizability assesses the degree to which the increasing frequency of a target behavior "spills over" to related but untargeted travel reduction behaviors. It also deals with whether the individual receiving the intervention might encourage uninvolved others to adopt the behavior. In a sense, this dimension measures the tendency of a strategy to amplify effects. Finally, there is a need to effect changes in behavior in a way that can be maintained *without* repeated intervention. One places undue burden upon programs if they are required to perpetually intervene to maintain a single behavior change.

It is rare to find research studies that use a multi-dimensional approach to assess the effectiveness of a behavior change strategy. Furthermore, as shown in Figure 1, very few studies have been conducted on strategies employing internal or intangible approaches to behavior change. However, it is possible to draw from the literature some general comments about the effectiveness of the various categories of strategies for changing commuter travel behavior.

Positive tangible motivation generally results in initiating relatively rapid changes in commuting behavior. Financial incentives and corporate support also seem linked to behavior change. And while preferential parking and guaranteed ride-home programs may not be sufficient incentives for initiating behavior change they may play a role in the maintenance of the changed behavior. The implementation of alternative work schedules cannot be considered uniformly successful; results seem to depend on the type of schedule imposed and existing conditions in the workplace. The availability of ride-matching services seems to be a successful strategy only when the service is more particularistic (e.g., highly personalized).

External coercion, particularly in the form of financial disincentives, was successful at initiating relatively rapid changes in travel behavior, perhaps even to a larger extent than the application of financial incentives. The most common form of financial disincentives is on-site parking fees. However, caution must be asserted along with the claims for success. Coercive strategies have been shown to produce negative reactions in individuals. When coerced, people exhibit an increased desire for a forbidden alternative or a decreased desire to do what they are being forced into doing [61, 62]. This effect seriously reduces the potential for coercive strategies to produce generalizable or durable behavior change.

It is worth noting that to some degree the distinction between incentives and disincentives is perceptual, based on experience and expectations. Because commuters have come to expect free parking at work, adding a charge for parking is seen as a disincentive. Because people expect to pay for rapid transit, free transit is perceived as a positive incentive. These perceptions can be altered with new experience. Once expectations change, a particular disincentive may cease being as effective. A rise in a parking fee where commuters expect to pay for parking may be less effective than the introduction of a parking fee where parking was previously free.

Finally, results on the use of external information in initiating changes in travel behavior are somewhat ambiguous. In general, pallid, relatively abstract information on the benefits of alternative modes of transportation and on opportunities for using these modes do not seem highly reliable or fast means of changing behavior. In contrast, specific, highly personalized information, such as that provided by on-site ride-sharing coordinators or by feedback mechanisms, does seem to be effective at quickly and reliably changing commuting behavior. The generalizability and durability of the changed behavior cannot be adequately assessed from the existing research.

Psychological studies on the differences between solo drivers and high occupancy vehicles (HOV) users suggest that there are two reasons why solo drivers won't switch to alternative modes of transportation. The first reason involves a lack of information on how to switch and how to deal with problems that may be encountered while using an alternative mode. Both of these could be a result of not providing sufficient procedural knowledge. The second reason involves the

negative perceptions of HOV use (e.g., seeing HOV modes as unreliable or inconvenient). These findings suggest that promotional efforts aimed at providing procedural knowledge and addressing specific concerns may be effective at increasing the reliability of strategies. Since attitudes regarding cost, energy use, and pollution associated with solo driving and HOV modes generally do not differ between solo drivers and HOV users, emphasis on these factors may not result in rapid or reliable behavior change.

CONCLUSION

A listing, by category, of the literature discussed (see Figure 1), shows a dearth of empirical research on the role of the self-initiated, less tangible factors in commuter behavior change. Not surprisingly, the research has followed the trend of behavioral change research in general by focusing on the application of external, tangible, motivation (either positive or coercive). To a lesser degree, attention has been given to the role of externally generated information in travel behavior change.

Ideally, programs designed to change employee travel behavior will 1) initiate significant changes in individual behavior, 2) will not cause unintended side effects such as increased driving during non-work hours, 3) will encourage the durability of changed behaviors without continual financial input, 4) will be cost effective, and 5) may result in a generalization of behavior to other realms (e.g., using alternative modes of transportation during non-work hours). The problems of durability and negative reactions associated with external motivations and coercion suggest that, if used in isolation, these techniques will be unable to realize the above goals; finding techniques which allow for and encourage the active involvement of individuals in their own behavior change is essential.

The most successful programs will likely utilize a combination of behavioral change techniques which are compatible both with employee needs and with the company environment. More research is needed to determine which strategies, and combinations of strategies, meet the above goals in which situations. The field of behavioral science, and specifically conservation behavior, is particularly suited to this research agenda.

REFERENCES

1. U.S. Department of Transportation, Federal Highway Administration, Ridesharing: Meeting the Challenges of the '80s, in *Urban Transportation Perspectives and Prospects*, H. S. Levinson and R. A. Weant (eds.), Eno Foundation for Transportation, Inc., Connecticut, pp. 194-202, 1982.
2. L. E. Keefer, Environmental Concerns Affecting Future Urban Transportation, in *Urban Transportation Perspectives and Prospects*, H. S. Levinson and R. A. Weant (eds.), Eno Foundation for Transportation, Inc., Connecticut, pp. 71-80, 1982.

3. EPA, *Transportation Control Measure Information Documents*, Office of Mobile Sources, U.S. Environmental Protection Agency, Ann Arbor, Michigan, 1991.
4. M. Malaspina, K. Schafer, and R. Wiles, *What Works: Air Pollution Solutions*, Report No. 1, The Environmental Exchange, Washington, D.C., 1992.
5. E. N. Schreffler and J. R. Kuzmyak, *Trip Reduction Effectiveness of Employer-Based Transportation Control Measures: A Review of Empirical Findings and Analytical Tools*, paper presented at the 84th Annual Meeting and Exhibition of the Air and Water Management Association, Vancouver, British Columbia, June 1991.
6. U.S. Department of Transportation, Federal Highway Administration, *Evaluation of Travel Demand Management Measures to Relieve Congestion*, Report No. FHWA-SA-90-005, 1990.
7. J. M. Brunso and D. T. Hartgen, Can Employer-Based Carpool Coordinators Increase Ridesharing? *Transportation Research Records*, 823, pp. 45-50, 1981.
8. R. De Young, Changing Behavior and Making it Stick: The Conceptualization and Management of Conservation Behavior, *Environment and Behavior*, 25, pp. 485-505, 1993.
9. S. W. Cook and J. L. Berrenberg, Approaches to Encouraging Conservation Behavior: A Review and Conceptual Framework, *Journal of Social Issues*, 37, pp. 73-107, 1981.
10. W. O. Dwyer, F. C. Leeming, M. K. Cobern, B. E. Porter, and J. M. Jackson, Critical Review of Behavioral Interventions to Preserve the Environment: Research since 1980, *Environment and Behavior*, 25, pp. 275-321, 1993.
11. E. S. Geller, L. D. Needleman, and K. Randall, Developing a Taxonomy of Behavior Change Techniques for Environmental Protection, in *Proceedings of the First U.S. Conference on Municipal Solid Waste Management: Solutions for the 90s*, Vol. III, U.S. Environmental Protection Agency, Washington, D.C., pp. 1261-1285, June 13-16, 1990.
12. E. S. Geller, Solving Environmental Problems: A Behavior Change Perspective, in *Psychology and Social Responsibility: Facing Global Challenges*, S. Staub and P. Green (eds.), New York University Press, New York, 1992.
13. D. B. Gray, *Ecological Beliefs and Behaviors: Assessment and Change*, Greenwood Press, Westport, Connecticut, 1985.
14. R. D. Katzev and T. R. Johnson, *Promoting Energy Conservation: An Analysis of Behavioral Research*, Westview Press, Boulder, Colorado, 1987.
15. P. C. Stern and S. Oskamp, Managing Scarce Environmental Resources, in *Handbook of Environmental Psychology*, D. Stokols and I. Altman (eds.), Wiley, New York, 1987.
16. P. C. Stern, Psychological Dimensions of Global Environmental Change, *A Review of Psychology*, 43, pp. 269-302, 1992.
17. K. L. Granzin and J. E. Olsen, Characterizing Participants in Activities Protecting the Environment: A Focus on Donating, Recycling, and Conservation Behaviors, *Journal of Public Policy and Marketing*, 10, pp. 1-27, 1991.
18. P. B. Everett, The Use of the Reinforcement Procedure to Increase Bus Ridership, *Proceedings of the 81st Annual Convention of the American Psychological Association*, 8, pp. 891-892, 1973.
19. P. B. Everett, S. C. Hayward, and A. W. Meyers, Effects of a Token Reinforcement Procedure on Bus Ridership, *Journal of Applied Behavior Analysis*, 7, pp. 1-9, 1974.

20. B. C. Deslauriers and P. B. Everett, Effects of Intermittent and Continuous Token Reinforcement on Bus Ridership, *Journal of Applied Psychology*, 62, pp. 369-375, 1977.
21. W. Bachman and R. Katzev, The Effects of Non-Contingent Free Bus Tickets and Personal Commitment of Urban Bus Ridership, *Transportation Research*, 16A, pp. 103-108, 1982.
22. T. Katzev and W. Bachman, Effects of Deferred Payment and Fare Manipulation of Urban Bus Ridership, *Journal of Applied Psychology*, 67, pp. 83-88, 1982.
23. H. E. Jacobs, D. Fairbanks, C. E. Poche, and J. S. Bailey, Multiple Incentives in Encouraging Car Pool Formation on a University Campus, *Journal of Applied Behavioral Analysis*, 15, pp. 141-149, 1982.
24. G. Giuliano, K. Hwang, and M. Wachs, *Mandatory Trip Reduction in Southern California: First Year Results*, unpublished manuscript.
25. D. Brownstone and T. F. Golob, The Effectiveness of Ridesharing Incentives: Discrete-Choice Models of Commuting in Southern California, *Regional Science and Urban Economics*, 22, pp. 5-24, 1992.
26. R. M. Foxx and D. F. Hake, Gasoline Conservation: A Procedure for Measuring and Reducing the Driving of College Students, *Journal of Applied Behavioral Analysis*, 10, pp. 61-74, 1977.
27. D. F. Hake and R. M. Foxx, Promoting Gasoline Conservation, *Behavioral Modification*, 2, pp. 339-368, 1978.
28. D. A. Reichel and E. S. Geller, Applications of Behavioral Analysis for Conserving Transportation Energy, in *Advances in Environmental Psychology, Vol. III: (Energy Conservation: Psychological Perspectives)*, A. Baum and J. E. Singer (eds.), Erlbaum Associations, Hillsdale, New Jersey, 1981.
29. J. B. Margolin, M. R. Misch, and M. Stahr, Incentives and Disincentives of Ride Sharing, *Transportation Research Records*, 673, pp. 7-15, 1978.
30. R. Booth and R. Waksman, Analysis of Commuter Ridesharing Behavior at Five Urban Sites, *Transportation Research Records*, 1018, pp. 33-40, 1985.
31. J. B. Margolin and M. R. Misch, *Incentives and Disincentives for Ridesharing: A Behavioral Study*, Federal Highway Administration, U.S. Department of Transportation, 1979.
32. W. R. Hershey and A. J. Hekimian, Measuring the Effectiveness of Personalized Ridesharing Assistance, *Transportation Research Records*, 914, pp. 14-21, 1983.
33. E. T. Ferguson, Evaluation of Employer-Sponsored Ridesharing Programs in Southern California, *Transportation Research Records*, 1280, pp. 59-72, 1990.
34. A. J. Hekimian and W. R. Hersey, Personalized Approach for Ridesharing Projects: Experience of Share-A-Ride in Silver Spring, Maryland, *Transportation Research Records*, 823, pp. 59-63, 1981.
35. E. Kadesh and L. Elder, Guaranteed Ride Home: An Insurance Program for HOV Users, *Transportation Research Records*, 1212, pp. 72-75, 1989.
36. M. A. Winslow, *Methods for Reducing Private Automobile Use*, Master's Practicum, School of Natural Resources and Environment, University of Michigan, Ann Arbor, Michigan, 1991.
37. C. D. Angell and J. Ercolano, *Southwestern Connecticut Commuter Transportation Study: An Analysis of Commuter Attitudes and Practices*, paper presented at the Transportation Research Board 70th Annual Meeting, Washington, D.C., 1991.

38. P. W. Bonswall, A. H. Spencer, and W. S. Tang, What Makes a Car Sharer? *Transportation*, 12, pp. 117-145, 1984.
39. Sierra Research, Inc., *Analysis of the Emission Benefits from Transportation Control Measures in San Diego County*, report prepared for the County of San Diego Air Pollution Control District, November 1990.
40. F. J. Wegmann and S. R. Stokey, Impact of Flextime Work Schedules on an Employer-Based Ridesharing Program, *Transportation Research Records*, 914, pp. 9-13, 1983.
41. A. Modarres, Evaluating Employer-Based Transportation Demand Management Programs, *Transportation Research—A*, 27A, pp. 291-297, 1993.
42. M. Wachs, Policy Implications of Recent Behavioral Research in Transportation Demand Management, *Journal of Planning Literature*, 5, pp. 333-341, 1991.
43. R. Dowling, D. Feltham, and W. Wycko, *Factors Affecting TDM Program Effectiveness at Six San Francisco Medical Institutions*, paper presented at the Transportation Research Board 70th Annual Meeting, Washington, D.C., 1991.
44. M. Surber, D. Shoup, and M. Wachs, Effects of Ending Employer-Paid Parking for Solo Drivers, *Transportation Research Records*, 957, pp. 67-76, 1984.
45. D. O. Nelson, Promotional Strategies for Ridesharing: Market Study for a Congested Major Urban Link, *Transportation Research Records*, 823, pp. 8-14, 1981.
46. J. L. Aho, Ridesharing: Carpools and Vanpools, *Transportation Working Paper 32*, Southeast Michigan Council of Governments, Detroit, Michigan, 1977.
47. S. Rosenbloom, Peak Period Traffic Congestion: A State-of-the-Art Analysis and Evaluation of Effective Solutions, in *Urban Transportation Perspectives and Prospects*, H. S. Levinson and R. A. Weant (eds.), Eno Foundation for Transportation, Inc., Connecticut, pp. 157-168, 1982.
48. U.S. Department of Transportation, *Evaluation of Carpool Demonstration Projects*, 1978.
49. R. Katzev, The Impact of Commitment in Promoting Consumer Energy Conservation, in *Consumer Behavior and Energy Policy: An International Perspective*, E. Monnier, G. Gaskell, P. Ester, B. Joerges, B. Lapillonne, C. Midden, and L. Puiseux (eds.), Praeger, New York, 1986.
50. P. C. Stern and E. Aronson (eds.), *Energy Use: The Human Dimension*, Freeman, New York, 1984.
51. R. Fazio and M. Zanna, Direct Experience and Attitude-Behavior Consistency, *Advancement in Experimental Social Psychology*, 14, pp. 161-202, 1981.
52. M. Monroe, *The Effect of Interesting Environmental Stories on Knowledge and Action-Taking Attitudes*, doctoral dissertation, School of Natural Resources and Environment, University of Michigan, Ann Arbor, Michigan, 1991.
53. M. Monroe and S. Kaplan, When Words Speak Louder Than Actions: Environmental Problem Solving in the Classroom, *Journal of Environmental Education*, 19, pp. 38-41, 1988.
54. R. F. Teal, Carpooling: Who, How, and Why, *Transportation Research A*, 21, pp. 203-214, 1987.
55. W. Brog, Psychological Determinants of User Behavior, in *Report of the 34th Round Table on Transportation Economics, Paris, European Conference of Ministers of Transport (ECMT), 1977, 1976*.

56. S. C. Hayward and P. B. Everett, *A Failure of Response Cost Feedback to Modify Car Driving Behavior*, paper presented at the Annual Meeting of the Midwestern Association of Behavioral Analysis, Chicago, Illinois, May 1-4, 1976.
57. N. Oppenheim, Carpooling: Problems and Potentials, *Traffic Quarterly*, 33, pp. 253-262, 1979.
58. A. D. Horowitz and J. N. Sheth, Ride Sharing to Work: An Attitudinal Analysis, *Transportation Research Records*, 637, pp. 1-8, 1978.
59. A. Tversky and D. Kahneman, Rational Choice and the Framing of Decisions, *Journal of Business*, 59(Part 2), pp. 251-277, 1982.
60. I. P. Levin and M. J. Gray, Evaluation of Interpersonal Influences in the Formation and Promotion of Carpools, *Transportation Research Records*, 724, pp. 35-39, 1979.
61. J. W. Reich and J. L. Robertson, Reactance and Norm Appeal in Antilittering Messages, *Journal of Applied Social Psychology*, 9, pp. 91-101, 1979.
62. S. Brehm and J. W. Brehm, *Psychological Reactance: A Theory of Freedom and Control*, Academic Press, New York, 1981.

Direct reprint requests to:

Raymond De Young
School of Natural Resources and Environment
430 East University Avenue
Ann Arbor, MI 48109-1115