Measurement of Psychological Factors and Their Role in Travel Behavior

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Psychological factors are conceptualized as intervening variables linking system and user characteristics to transportation judgments and decisions. The information-integration approach of experimental psychology was used to measure and assess psychological factors by using simple rating scales and algebraic models of individual decision processes. Two simulation experiments were conducted to illustrate this approach. In the first, perceived safety of highway driving was measured on a bipolar rating scale and shown to vary as a simple algebraic function of factors, such as driving speed, time of day, weather conditions, and number of hours of continued driving. Other judgments involving continued-driving time and reducing driving speed were obtained and shown to be highly related to safety ratings. This supports the idea that psychological factors such as safety can be measured objectively and used to understand and predict traveler behavior. In the second experiment, the desirability of forming car pools was assessed as a function of the number of riders in the pool, the sex of each rider, and the acquaintanceship of the rider and the respondent. The acceptability of a given potential rider was a multiplicative function of sex and acquaintanceship; sex played an important role when the rider was a nonacquaintance. The desirability of a given car pool was an average of the desirability of individual riders, so that a desirable rider would compensate for undesirable riders. The implication of such results to policy makers is discussed, but the need for expanded research is stressed.

As has been pointed out (5, 8, 9, 11, 12, 13, 15, 16, 18), there is need to study individual decision-making processes and the role of psychological factors in traveler behavior. Ultimately, it is the individual who must judge the convenience of mass transit, the desirability of car pooling, and the safety of highway driving. However, measuring qualitative factors, such as safety and convenience, has been a central problem in research on this. This paper will illustrate how such factors can be measured and related to traveler behavior.

ROLE OF PSYCHOLOGICAL FACTORS

Our conceptualization of the role of psychological factors is illustrated in Figure 1, which uses one of the studies discussed in this paper as an example. System, user, and environmental characteristics are considered as independent (or input) variables that can be manipulated or categorized in simulated (laboratory) studies. Judgments and decisions related to traveler behavior are dependent (or output) variables to be measured and recorded. (Predicting actual, rather than simulated, judgments and decisions is, of course, the ultimate goal.) Psychological factors are considered as intervening variables linking the system, user, and environmental characteristics to the observable behavior. Their ultimate usefulness will depend on the extent to which a small number of psychological factors can be used to explain and predict a wide variety of behaviors. Thus, it is important to investigate both sets of linkages illustrated in Figure 1: the links between the characteristics on the left and the perceived values of the psychological factors and those between the perceived psychological values and the behavior on the right.

Two experimental studies are described. One considers perceived safety and safety-related behavior in highway-driving situations and investigates the factors illustrated in Figure 1. The other considers the relative desirability of car pools of varying personal composition. These studies use the methodology of the information-integration approach of experimental psychology. This approach is first described; then the two experimental studies are described and discussed.

INFORMATION-INTEGRATION APPROACH

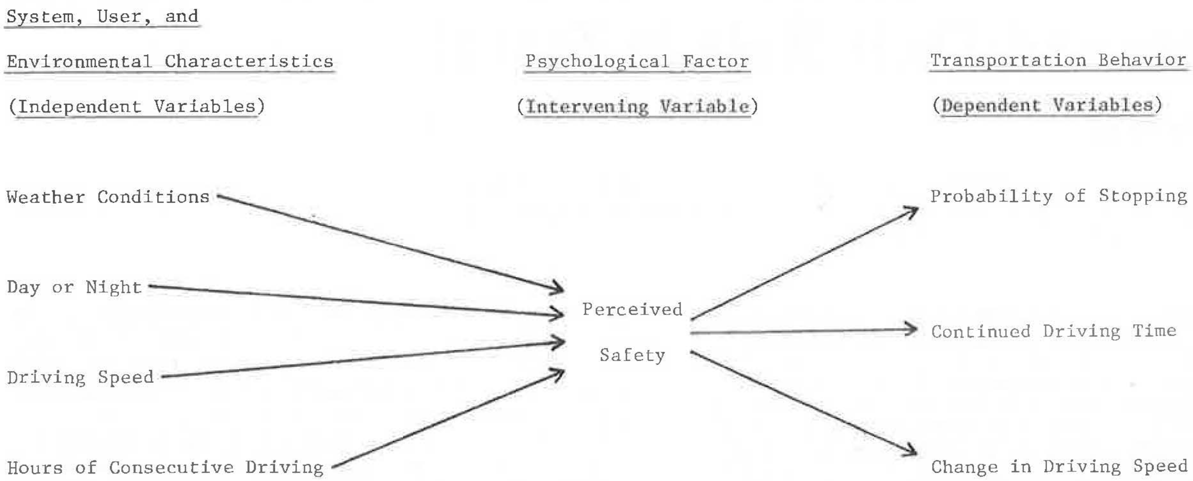
The primary goal of the information-integration approach is the analysis of how a variety of factors are combined or integrated to determine human judgments and decisions. The approach was developed by Anderson (2, 3) and has had a history of success in describing complex cognitive processes, including transportation modal choice (4, 11, 15, 16).

It is assumed that when a number of different factors have to be taken into account when making a judgment or decision, each piece of information can be characterized by two parameters: a scale value corresponding to the subjective evaluation of the information along the dimension of judgment [e.g., the perceived safety level of a highway driving speed of 88 km/h (65 mph)] and a weight representing the importance of the information for the judgment or decision to be made. The net effect of a given piece of information within a set of information is the product of its weight and scale value. The integrated judgment or decision is assumed to be represented by an algebraic function of the weights and scale values of the various pieces of information. For example, Levin has shown that the degree of preference for bus versus automobile can be described as a weighted average of time and cost factors (11).

Factorial experimental designs (complete or fractional) are typically used; each subject receives systematically programmed combinations of levels of stimulus factors and is asked to respond to each of the hypothetical situations thus formed. The responses are then analyzed to determine the relations between the informational variables and the subjective judgments or decisions. These relations are causal rather than circumstantial in the sense that they directly reflect the manipulation of factors in specified combinations, with extraneous factors controlled or balanced.

Goodness-of-fit tests are available through analysis of variance techniques to compare alternative models that describe the way in which the factors are integrated or combined (3). For example, lack of interaction between factors suggests an additive process of combining factors, and linear times linear interactions suggest a multiplicative relation between factors in which one factor acts as a modifier of the influence of other factors. Each of these processes will be seen in the experiments described below and should serve to illustrate the flexibility of the approach. Different models or parameters

Figure 1. Conceptualization of psychological factors as mediators of traveler behavior (safety example).



may apply to different homogeneous subgroups of decision makers. Levin has shown that automobile-biased and bus-biased individuals differ systematically in the weights they assign to varying levels of cost and time factors (11). In contrast, other modeling approaches that do not focus on individual decision-making processes make the a priori assumption that groups that are homogeneous with respect to socioeconomic characteristics will have similar decision-making processes.

Another feature of the information-integration approach that distinguishes it from other approaches is the use of simple rating scales to obtain numerical measures of subjective judgments. The recent technique in transportation research known as trade-off analysis has some of the features of the information-integration approach, but generates only rank-order data and transforms them to interval or ratio scales through conjoint measurement (6, 17). When someone ranks one particular set of mass transit characteristics higher than others, his or her absolute evaluation of that system may still be below his or her threshold for patronage. Furthermore, formal validity tests are generally lacking in such applications. In contrast, the data obtained in information-integration studies can offer information about the absolute as well as the relative rating of alternative systems, and the validity of the rating data is tested directly by the goodness-of-fit test of a given model. For example, an additive model will fit the data only if an additive rule describes the rating process, and the data form an interval scale.

Another distinctive feature of the information-integration approach is that known as functional measurement (2). Rather than rating factors in isolation, as is sometimes done in attitude assessment in transportation research (7), ratings of stimulus combinations are obtained to directly determine the trade-off between competing factors. The relative influence of each of several factors estimated in a multifactor information-integration task is the weight that is functional in the decision-making process. This takes into account the range of values of each factor, as well as the number of factors to be considered. In a similar manner, the psychophysical function relating subjective to actual values of each factor is also obtained directly from the multifactor judgments. This function is obtained empirically, rather than a priori by assuming linear functions, as is sometimes done.

The major features of the information-integration approach and their consequences for transportation research are summarized below.

Feature	Consequence
Experimental manipulation of stimulus factors	Causal relations between system characteristics and judgments or decisions
Simulated judgments and decisions	Predict effects of changes in system characteristics
Factorial designs	Goodness-of-fit tests for alternative integration models
Within-subject designs	Identification of homogeneous subgroups of decision makers
Simple rating scales	Absolute as well as relative measures of preference
Functional measurement of weights and scale values	Determination of relative importance of factors and determination of the relation between subjective and actual system values

EXPERIMENT 1: PERCEIVED SAFETY AND SAFETY-RELATED BEHAVIOR IN HIGHWAY DRIVING

This study uses the information-integration approach to examine the role of the psychological factor safety (more correctly, perceived safety) in highway driving. The independent variables shown on the left side of Figure 1 were manipulated factorially to form 48 unique combinations. In one experimental condition, each respondent was asked to rate how safe or unsafe he or she perceived each combination to be. This is our way of measuring safety, i.e., determining the relation between the manipulated factors and the safety ratings. In other experimental conditions, the respondents were asked how they might behave under situations described by the various combinations of factors. The relations between these behavior measures and the safety ratings tell us about the potential usefulness of the psychological factor safety as an explanatory mechanism for highway driving behavior.

Method

The respondents were told to consider that they were taking a vacation trip from Iowa City to San Francisco driving on I-80. They were presented a number of hypothetical situations of varying driving conditions. In all of the experimental conditions, each respondent received all combinations of the following factors describing the driving conditions: weather [clear skies, winds gusting to 56 km/h (35 mph), moderate to heavy rain, or no information about weather], automobile speed [80, 88, or 105 km/h (50, 55, or 65 mph)], time (daytime or after dark), and hours of continued driving

(3 or 8 h of previous driving). Each of the resulting combinations was described on a different page of a response booklet (the actual booklets expressed speeds in U.S. customary units only). In addition to the 48 combinations described above, each respondent received 12 practice and filler trials that included other stimulus levels, some of which were more extreme than those used in the main 4 × 3 × 2 × 2 experimental design (e.g., wind and rain).

The respondents were divided into three groups, each of which was required to respond differently to the information presented. All respondents were undergraduate students at the University of Iowa. The respondents in the safety-rating group (n = 17) were asked to rate each hypothetical situation by placing a mark somewhere along a 15-cm (6-in) line labeled very unsafe at the left end and very safe at the right end. The position of their mark indicated their safety rating for each situation. The responses were recorded to the nearest 0.5 cm (0.2 in), with 0 being the lowest level of safety and 15 being the highest level of safety.

The respondents in the continued-driving-time group (n = 20) were asked to indicate how much longer they would continue to drive under each of the given conditions.

The respondents in the changed-driving-behavior group (n = 22) were asked to indicate the following for each condition: (a) Would you alter your driving speed? (b) If your answer to the previous question is yes, in what way would your speed be altered—increased, decreased, or would you stop for the day? (c) If you would increase or decrease your speed, give the amount of change in miles per hour. All respondents in all groups worked through their response booklets at their own pace.

Results and Discussion

Safety Ratings

The mean responses for the safety-rating group are shown in Figure 2. The safety ratings were higher for 3-h consecutive driving than for 8; they were higher for day than for night, for clear weather than for wind and for wind than for rain; they were very nearly equal for clear weather and unknown weather, indicating a Pollyanna effect when weather conditions were not specified, and decreased as the speed increased. In the 4 × 3 × 2 × 2 analysis of variance, each of these factors represented a significant source of variance, with the following rank-ordering of importance (in terms of the proportion of the variance contributed by each factor): hours of continued driving, weather, time (day versus night), speed.

The near parallelism of the lines in each panel of Figure 2 suggests that the factors weather and speed are additive. The analysis of variance confirmed that these two factors did not interact. Furthermore, none of the factors weather, speed, and time interacted with each other, indicating that all of them combine additively in affecting safety ratings. However, the factor hours of continued driving tended to interact with the other factors; the hours times weather and hours times speed interactions were statistically significant, but the hours times time interaction did not reach statistical significance at the 0.05 level. All of these interactions with hours of continued driving were similar; the effects of weather, speed, and time were all less after 8-h continued driving than after 3. For example, it can be seen by comparing the left and right panels of Figure 2 that the lines for different weather conditions are closer together (i.e., represent smaller changes in safety ratings) at 8 h than at 3 h.

In other words, the factor hours of continued driving modified or multiplied the effects of the other factors, whereas the effects of the other factors were independent of each other. The pattern of results for safety ratings (R) can be described by a model of the following form:

$$R = H(W + S + T) \quad (1)$$

where H, W, S, and T represent subjective scale values for levels of hours of continued driving, weather, speed, and time respectively.

Continued-Driving Time

The mean responses for the continued-driving-time group are shown in Figure 3. The pattern of results is very similar to that of the safety-rating group (Figure 2). The relative importance of the four factors was about the same in each group. The main difference is

Figure 2. Mean safety ratings for each condition of experiment 1.

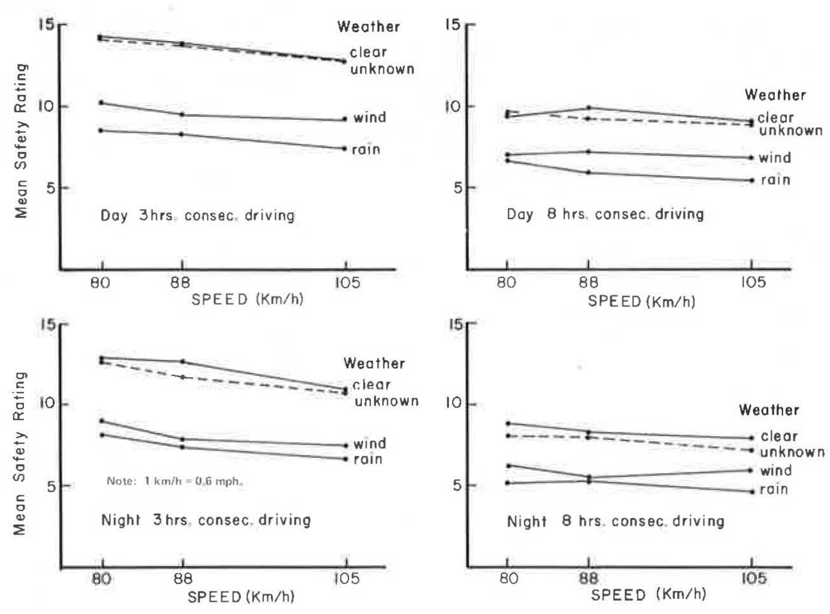
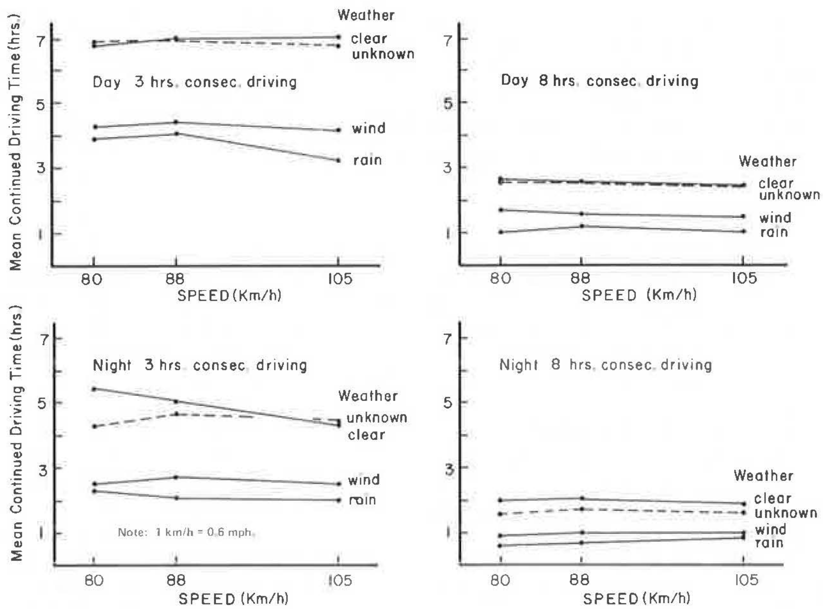


Figure 3. Mean continued-driving time for each condition of experiment 1.



that the effect of speed did not reach statistical significance in the analysis of continued-driving time.

The interaction effects were also similar in each group. Hours of continued driving interacted with weather and with time in the analysis of continued-driving time. As with the safety ratings, these interactions were due to smaller effects of weather and time after 8-h continued driving than after 3-h continued driving. With the exception of a small and nonsystematic interaction between weather and time, the other factors were additive.

A model of the same basic form would thus describe both the safety ratings and the estimates of continued-driving time. The correlation between the two measures is 0.94. Safety ratings are thus excellent predictors of how driving time will vary as a function of the factors manipulated in this experiment. Furthermore, the extremely high correlation with hours of continued driving time suggests that the safety ratings have interval scale properties.

Changes in Driving Behavior

The responses of the group who indicated changes in driving behavior were more complicated. The speed factor had a significant influence on the number of respondents who indicated that they would stop driving for the day. The greater the speed, the larger the number of respondents who indicated that they would stop. The mean change in speed for those respondents who did not indicate that they would stop was also affected by the designated driving speed. These effects can be interpreted as follows: Respondents adopt an optimal driving speed for each combination of weather, time, and hours of continued driving. For example, with clear weather, daytime, and 3-h continued-driving time, virtually all respondents indicated that they would continue driving, and the mean optimal driving speed was about 97 km/h (61 mph) [i.e., 9.5 km/h (6 mph) over the speed limit]. This means an upward adjustment for speeds of 80 and 88 km/h (50 and 55 mph) and a downward adjustment for speeds of 105 km/h (65 mph). Another example is rain, nighttime, and 8-h continued-driving time, where over half of the respondents indicated that they would stop, but the mean driving speed for those continuing was about 85 km/h (53 mph), which means an upward adjustment for a speed of 80 km/h (50 mph) and a downward adjustment for speeds of 88 and 105 km/h (55 and 65 mph).

Hours of continued driving had a smaller effect on mean speed change than on any other dependent measure; however, this factor had a large effect on the number of respondents who indicated that they would stop driving. Otherwise, the effects of the manipulated factors on mean speed changes were similar to those observed with the other dependent measures.

Taken together, the indicated changes in driving behavior suggest the effects of perceived safety plus another intervening factor that we might designate as desire to reach destination. As perceived safety decreases, respondents are more apt to indicate that they would stop; however, if they indicate continuing driving, it is apt to be at the same speed as before.

Summary of Results

The safety ratings varied systematically as a function of the manipulated factors, and the analysis of variance supported a simple model for describing how the factors combine. Establishing the integration rule relating the manipulated factors to the safety ratings is our way of measuring the psychological factor perceived safety.

Continued-driving time was shown to be related to the manipulated variables in much the same fashion as safety ratings. This establishes the link between perceived safety and other behavioral indicants and supports the conceptualization illustrated in Figure 1 that psychological factors can be used as intervening constructs to explain and predict traveler behavior.

The relation between safety ratings and changes in driving behavior was more complex, but perceived safety—in conjunction with another psychological factor—was a useful explanatory mechanism for the observed data.

EXPERIMENT 2: DESIRABILITY OF CAR POOLS OF VARYING PERSONAL COMPOSITION

This experiment used the information-integration approach to further study how psychological factors may influence traveler behavior by examining how the desirability of car pools varies as a function of personal—as opposed to the usual time, cost, and distance—factors. The factors include the sex of each rider and whether or not the rider is a prior acquaintance of the respondent.

Method

Nineteen female and 16 male undergraduate students at the University of Iowa participated in this experiment. They were instructed to assume that they lived 16 km (10 miles) from school in an area having many other students with whom car pools could be formed and were asked to rate the relative desirability of a series of hypothetical car pools varying in the number of riders, the sex of each rider, and whether each rider is an acquaintance or a student whom they do not know.

Each page of the response booklet contained a description of a different car pool. Below each description was a 15-cm (6-in) line labeled very undesirable at the left end and very desirable at the right end. The respondents were instructed to mark this line at a place that indicated their personal rating of the desirability of each hypothetical car pool. As in the first experiment, the responses were measured and recorded; 0 represented the low end of the scale and 15 represented the high end of the scale.

Car pools with one rider (in addition to the respondent) were described by the sex of the rider and whether or not the rider was an acquaintance of the respondent. There are thus four combinations with one rider: male acquaintance (MA), female acquaintance (FA), male nonacquaintance (MNA), and female nonacquaintance (FNA). Car pools with two and three riders were described by the sex of each rider and whether or not each rider was an acquaintance of the respondent. Ordinarily this would be represented by 16 combinations for two riders and 64 combinations for three riders. However, not all of these combinations are unique—e.g., if rider 1 is a male acquaintance and rider 2 is a female nonacquaintance, this is the same as if rider 1 is a female nonacquaintance and rider 2 is a male acquaintance. There are 10 unique combinations with two riders and 20 unique combinations with three riders. There are thus 34 different car-pool descriptions; each respondent received them in a different order of presentation. Six practice trials using some of the same descriptions used later were given at the beginning. The rating task was self-paced.

Results and Discussion

The results are summarized below.

	Mean Desirability Rating	
Car-Pool Combination	Male Respondent	Female Respondent
One rider		
MA	10.06	12.50
FA	10.47	12.32
MNA	7.00	3.29
FNA	9.50	6.53
Three riders		
3 Acquaintances	10.76	12.15
2 Acquaintances and 1 nonacquaintance	9.70	10.84
1 Acquaintance and 2 nonacquaintances	9.03	7.69
3 Nonacquaintances	8.16	3.49

The data for one rider show that both male and female respondents gave the lowest ratings to MNAs. For both sexes, car pools with a female rider were rated higher than those with a male rider, and car pools were rated higher when the rider was an acquaintance than when he or she was a nonacquaintance. Furthermore, the difference in ratings between female and male riders was much greater for nonacquaintances than for acquaintances. Statistically, this corresponds to an interaction between sex and acquaintance versus nonacquaintance. This interaction was statistically significant for female respondents and approached significance for male respondents. In simple terms, this relation means that if the rider is an acquaintance, the sex of the rider is of little consequence, but if the rider is not an acquaintance, males prefer a rider of the opposite sex and females prefer a rider of the same sex.

Although not shown above, the same general trends were seen for two riders and three riders. In each case, the lowest rating occurred when all riders were MNAs. These ratings for car pools with all MNAs become more extreme (i.e., lower) as the number of riders increases. This corresponds to the common set-size effect in information integration (1, 10), which is explained by assuming that information values are averaged with each other and with a neutral initial impression. However, when one rider was designated as an acquaintance, the ratings increased considerably, even if the other riders were MNAs. For example, female respondents gave a mean rating of 2.37 (which is very low on an absolute as well as a relative basis) for a car pool of three MNAs, but a mean rating of 7.95 (which is slightly above the neutral point on the desirability scale) for the combination of two MNAs and one MA. Even when a moderately negative-stimulus person (e.g., a FNA for female respondents) is combined with a MNA, the ratings are slightly higher than for all MNAs. This argues for a compensatory or averaging process in combining the desirability levels of different riders.

Several observations can be made about the data presented above. The first is that the ratings decrease as the relative number of acquaintances to nonacquaintances decreases. Another is that while male and female respondents show a similar pattern of rating responses, females give much lower ratings to car pools with all nonacquaintances.

Taken as a whole, the pattern of results for this experiment suggests a two-stage integration process in evaluating the desirability of a potential car pool. The characteristics of a given person (sex and whether or not the person is an acquaintance of the respondent) are combined multiplicatively to determine the desirability of that person as a potential car-pool rider, where the importance of sex depends on whether the person is an acquaintance or a nonacquaintance. The overall desirability of a given car pool is then the average of the desirability levels of the individual riders.

An integration model such as described above, when considered in light of the finding that male nonacquaintances are rated as undesirable car-pool riders, suggests the following policy for forming car pools of at least moderate desirability: Use a chaining approach in which rider 1 supplies the name of a rider 2, rider 2 supplies the name of a rider 3, and so on. In that way, every rider has at least one acquaintance to offset the undesirability of forming car pools with male nonacquaintances. The use of a continuous response scale enabled us to show that the overall desirability of a car pool may be slightly positive even when two out of three riders are seen as undesirable.

CONCLUSIONS

The experiments reported in this paper were designed to illustrate how the effect of psychological factors on traveler behavior could be studied by using the information-integration approach of experimental psychology. The first experiment showed that the psychological factor, safety, could be measured by asking subjects to rate the safety of a series of highway driving situations described by varying levels of weather, driving speed, time, and hours of continued driving. These ratings could be described by a relatively simple integration model. Continued-driving time was shown to follow an analogous model and was highly correlated to the safety measure, thus showing the linkage between the psychological factor and a relevant dependent measure of driving behavior. Another dependent measure showing intended changes in driving speed was also related to perceived safety. It would appear fruitful to continue the search for a relatively small number of psychological factors that underlie a variety of traveler behaviors. The present methods could be of value in such a search.

The second experiment studied interpersonal factors in car pooling that are of considerable interest and importance, but have largely been neglected because of their qualitative nature. The present methods led to an operationalization and quantification of the effects of these factors on the desirability of car pooling. An extension of these methods might show that interpersonal factors have similar effects on the desirability of other multiple-occupant transportation modes.

A number of features of the information-integration approach were illustrated in these studies; these are summarized below.

1. Experimental manipulation of factors in simulated judgmental tasks: We obtained judgments for situations that may not have actually occurred in a given respondent's history, but could conceivably be of future importance—for example, driving at night in the rain after 8 h of continued driving, and considering joining a car pool with one prior acquaintance and the others strangers.
2. Definition of additive and nonadditive processes: We determined that weather conditions, driving speed, and time of day all had independent (additive) effects on perceived safety, but in judging the desirability of a given car-pool rider, whether or not the person was a prior acquaintance modified the effect of the rider's sex. (Procedures such as additive conjoint measurement would have found difficulty in detecting such effects.)
3. Use of simple rating scales: We showed that subjective ratings of safety were highly related to hours of continued driving and thus that the rating scale has interval properties; a continuous measure of car-pool desirability allowed us to identify situations where changes produced shifts from the negative to the positive side of the neutral point.
4. Functional measurement: We developed a method for measuring the psychological factor, safety, and determined that the relative influence of factors was very nearly the same for continued driving time as for safety ratings; we developed a method for measuring the effects of interpersonal factors in car pooling. A recent extension of this study has shown that interpersonal factors had an effect comparable to the more traditional cost and time factors (15).

All of these findings were achieved at the cost of substituting simulated behavior for actual driving behavior or car-pooling decisions. We recognize the need to extend our studies to larger and more representative samples of real-world behavior. However, there is reason to be optimistic about the ability to generalize laboratory studies such as described here. For example, recent studies using the information-integration approach defined a behavioral measure of individual decision processes in modal choice that accurately predicted travel mode to work, especially when individual situational constraints were included in the prediction model (11, 15). The results of the present car-pooling study are consistent with field research findings concerning car-pooling behavior of various population segments in the Washington, D.C., metropolitan area (14). The present study showed that female respondents, in particular, assigned low desirability to nonacquaintances as potential riders. It was observed in the field research study that women in particular are resistant to telephoning a stranger to discuss a possible car pool. The present methods can extend the field results by developing a simple model that has direct policy implications (e.g., the chaining procedure described above). One way of testing the validity of this modeling approach would be to recalibrate the model with a specified target population, implement the policy strategy suggested by the model, and evaluate the effectiveness of the policy. This is the object of current work in our laboratory.

While extensions to real-world behavior are important to an integrated research program, laboratory studies such as those described in this paper can continue to be useful in opening the investigation of traveler behavior to include psychological factors and descriptions of individual decision-making processes that may underlie traveler behavior in a wide variety of real-world situations. The work reported here is part of a continuing series of studies applying the information-integration approach to problems in transportation research.

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Comparative Analysis of Determinants of Modal Choices by Central Business District Workers

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The role of individuals' perceptions and preferences in traveler decision making is a growing and active area of theoretical and empirical research. This study was designed (a) to quantify the relation between perceived system attributes and modal choice, (b) to compare the magnitude of this relation to that of the alternative relations of sociodemographic and network time and cost data and modal choice, and (c) to determine whether the linkage between perceived system attributes and modal choice is dependent on the relations of sociodemographic and network data to modal choice. The sample was composed of Los Angeles central business district workers who live within approximately 3.2 km (2 miles) of a freeway that feeds radially downtown. Models were calibrated for three dependent-variable criteria; these were monthly differences in use for (a) automobile versus bus, (b) automobile versus car pool, and (c) bus versus car pool. The multiple coefficients of determination for modal choice as a function of perceived system attributes were statistically significant at the 0.001 level for all dependent-variable criteria. The coefficients ranged from 0.265 to 0.125, but the analogous coefficients for sociodemographic or planning data ranged from a low of 0.004 to a high of only 0.054. The effects of perceived system attributes on the dependent variables were not diminished by the other types of independent variables. Tests of significance for the individual components of combined models with these types of data showed the perceived-system-attribute data to be significant at beyond the 0.001 level in all cases. However, sociodemographic and network data appear to be influenced by the addition of perceived-system-attribute data to the degree of becoming nonsignificant in some cases. The overall conclusion is that perceived system attributes can be a statistically significant correlate of modal choice over and above any influence by network or sociodemographic variables or both.

The potential relevance of individuals' perceptions of and preferences for transportation modes and their service attributes to traveler decision making makes these topics active areas of theoretical and empirical research. Golob (1) and subsequently Golob and Dobson (2) have reviewed consumer-behavior models derived from market research and psychology and discussed their applicability to urban travel issues. An organizational structure has emerged from a conference on behavioral travel-demand that specifies the relation of perceived system attributes to traveler behavior (3). The perceptual models developed here are consistent with this organizational structure.

From an empirical perspective, the role of perceptions and preferences in traveler decision making is mixed. Hartgen (4) found that attitudes accounted for only 10 to 20 percent of the explained variation in traveler modal choices while situational variables, e.g., income and automobile ownership, accounted for 80 to 90 percent of the explained variance. A similar finding was reported by Dobson and Kehoe (5), who did not find a statistically significant correspondence between view of system attributes and actual modal choices, although they did find substantial correlations between perceptual measurements of transportation system attributes and anticipated satisfactions with innovative urban transportation modes. Thus, neither of these investigations offers strong support for perceptions or preferences as determinants of modal choice.