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Evaluation by Individuals of Their Travel Time to Work

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Modelers of transportation-related decisions have often drawn the distinction between "objective" measures of attributes used to describe the transportation system and individuals' perception and evaluation of these attributes. Only a few studies have been made, however, of the relation between these objective and subjective assessments. Individuals' satisfaction with the length of the work trip is examined, primarily with the aim of establishing the nature of the relation and its stability across different groups of travelers. The study is based on data collected in a home interview survey of residential location choice conducted in outer suburban Melbourne during 1978 and 1979. A number of broader issues are addressed, including implications for modeling and policy.

The ease with which people can participate in activities is influenced by the transportation system. A good transportation system may entice people to partake in certain activities, whereas a poor system may discourage such involvement. However, to ascertain what is a good or bad transportation system, it is necessary to investigate both objective and subjective measures of effectiveness. It may be that one individual views the separation between two activities in a much different light than another. Handicapped people, for example, are likely to view a trip to the corner shop as much more onerous than a neighbor who can walk without difficulty.

Transportation planners have often developed models of transportation choice or measures of accessibility that have assumed that individuals view the transportation system in the same manner. Car drivers are assumed to have the same satisfaction with a travel time of 10 min as those traveling by public transportation. Males and females are similarly assumed to have similar satisfactions with travel time. Yet these people experience quite different conditions and constraints. Moreover, most such models are calibrated by using data on existing travel patterns. This approach suffers from a major flaw--that all people clearly do not have the same sets of choices. Alternative choices must be built into the analytic procedure for evaluating spatial patterns before we can state firmly the nature of the relation (i.e., the shape of the curve) between satisfaction and journey length.

This paper explores individuals' perceived satisfaction with the length of the work trip. The primary aim is to establish the nature of the relation and its stability across different groups of travelers.

ATTRIBUTE EVALUATION

Evaluating attribute levels entails a number of steps (see Figure 1) (1):

1. Individuals must first have some estimate of the magnitude of the attribute in question (in this case, the length of the work trip). The relation between the actual length of journeys and travelers'

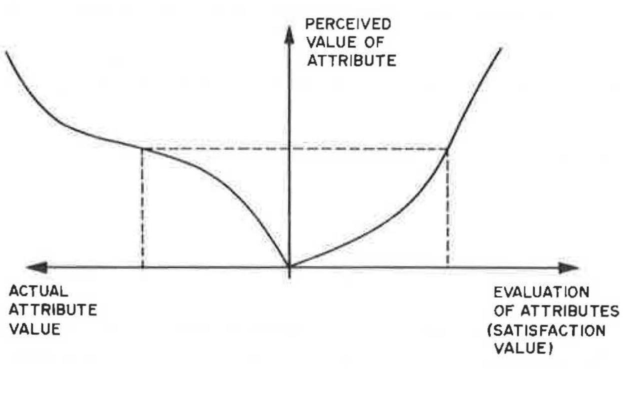
estimates is influenced by such factors as the traveler's level of familiarity with the trip, the purpose of the trip, time constraints (e.g., flexibility of arrival times), and conditions of travel. More often than not the relation is assumed to be monotonic.

2. Individuals must decide whether the particular attribute level is acceptable or not; that is, the perception of the attribute (trip length) must be transformed into a measure of satisfaction.

This two-stage process may not be the simple, one-dimensional transformation shown in Figure 1. Rather, it may take place in several dimensions, since the attribute may be evaluated on the basis of a number of characteristics. In the case of closeness to work, the individual may consider characteristics such as comfort, convenience, and ability to read the paper during the trip. There may also be a problem with being too close to work in that one is reminded of it during one's leisure time. The particular characteristics and the weighting given to each of them are closely tied to individual preferences.

This paper concentrates on the second part of the transformation shown in Figure 1. It is worth noting, however, that the findings may have wider applicability. Several studies indicate that the relation between perceived and objective measures of travel time--the first part of the relation--is in fact monotonic (1,2).

Figure 1. Transformation of individuals' attitude ratings from actual attribute level to satisfaction with attribute.



SURVEY METHOD

The information for this study was drawn from a survey of residential location choice conducted in three outer suburban areas of Melbourne, Australia, during 1978 and 1979. The three survey areas--East Burwood, Wantirna, and Belgrave (see Figure 2)--are in various stages of urban development. New residents in each area were asked, inter alia, to rate their level of satisfaction with closeness to their present workplace (see Figure 3), and then to evaluate a number of possible travel times to work (see Figure 4).

The first set of information relates to observed travel patterns; such data are usually termed "market" data. The information obtained in the second approach is more accurately described as "experimental" data (in that the respondents are presented with alternative hypothetical travel times).

In later questions, the respondents were asked to record further details of their present work journeys, including the time spent traveling and the mode used. In addition, respondents were asked to indicate the importance they attached to closeness to work when deciding where to live (see Figure 5).

The survey took the form of household interviews, and information was collected for all major decision makers in the household. The usable sample of employed persons in this study was 1049.

Full details of the survey are given elsewhere (3,4).

SATISFACTION WITH THE JOURNEY TO WORK: COMPARISON OF OBSERVED AND EXPERIMENTAL DATA

The form of the relation between satisfaction and perceived length of work journeys is examined here by using both sets of data. The observed data were analyzed by using regression analysis, and the straight-line (AB) fit ($r^2 = 0.42$) is plotted in Figure 6. The experimental data were analyzed by calculating mean satisfaction ratings for the range of travel times presented; the resulting curve (OCD) is shown in Figure 6. Several nonlinear functions were fitted to the market data but without significant improvements in the level of explanation.

It can be seen that the straight line AB, which was fitted to the observed data, is a reasonable approximation to the curve OCD produced by the experimental data. However, theoretical interpretation of the relation between satisfaction and length of work journeys differs quite markedly, depending on which approach is adopted.

The relation AB is the classical distance decay function; this implies that satisfaction decreases directly with increasing travel time. By contrast, the curve OCD implies the existence of both "proximity" and "accessibility" thresholds; that is, people like to be close to work but not too close. Intuitively, this appears to be a reasonable finding. Close proximity to work may produce a stressful situation for households, through the noise, pollution, and congestion often associated with employment concentrations. Some amount of time spent traveling may also be necessary to achieve mental separation of work and home activities. On the other hand, poor accessibility may produce a stressful situation because of the large amount of time and energy spent traveling and the increased length of time spent away from home.

Empirical evidence from other studies also lends support to a curve of the form OCD. A series of studies undertaken at the University of Pennsylvania found that, for most services, people compromise between accessibility on the one hand and proximity considerations (e.g., noise, pollution, and congestion) on the other (5). By means of questionnaires, ordinal data were collected for a wide variety of public and private services for four distance categories: (a) on one's own block; (b) on a neighboring block; (c) within the rest of the neighborhood; and (d) within the neighboring community. Most curves were found to be of the form OC, although it has been suggested that extending the distance categories would probably produce an overall curve OCD with a distance from O to the peak C that varies for different services (6).

Redding (7) has also postulated a nonlinear relation between accessibility and locational valuation. This relation, as reproduced by Moore (8), is shown in Figure 7. Support for these ideas was provided in a study of four amenities (shopping center, elementary school, playground, and hospital) serving residents in Skokie, Illinois. It was found that most individuals had nearness as well as inaccessibility thresholds. The "inner" thresholds for these services were mostly from 0.25 to 0.5 block from the given amenity.

On both empirical and theoretical grounds, therefore, a nonlinear relation appears to be highly

Figure 2. Location of Melbourne outer suburban study areas.

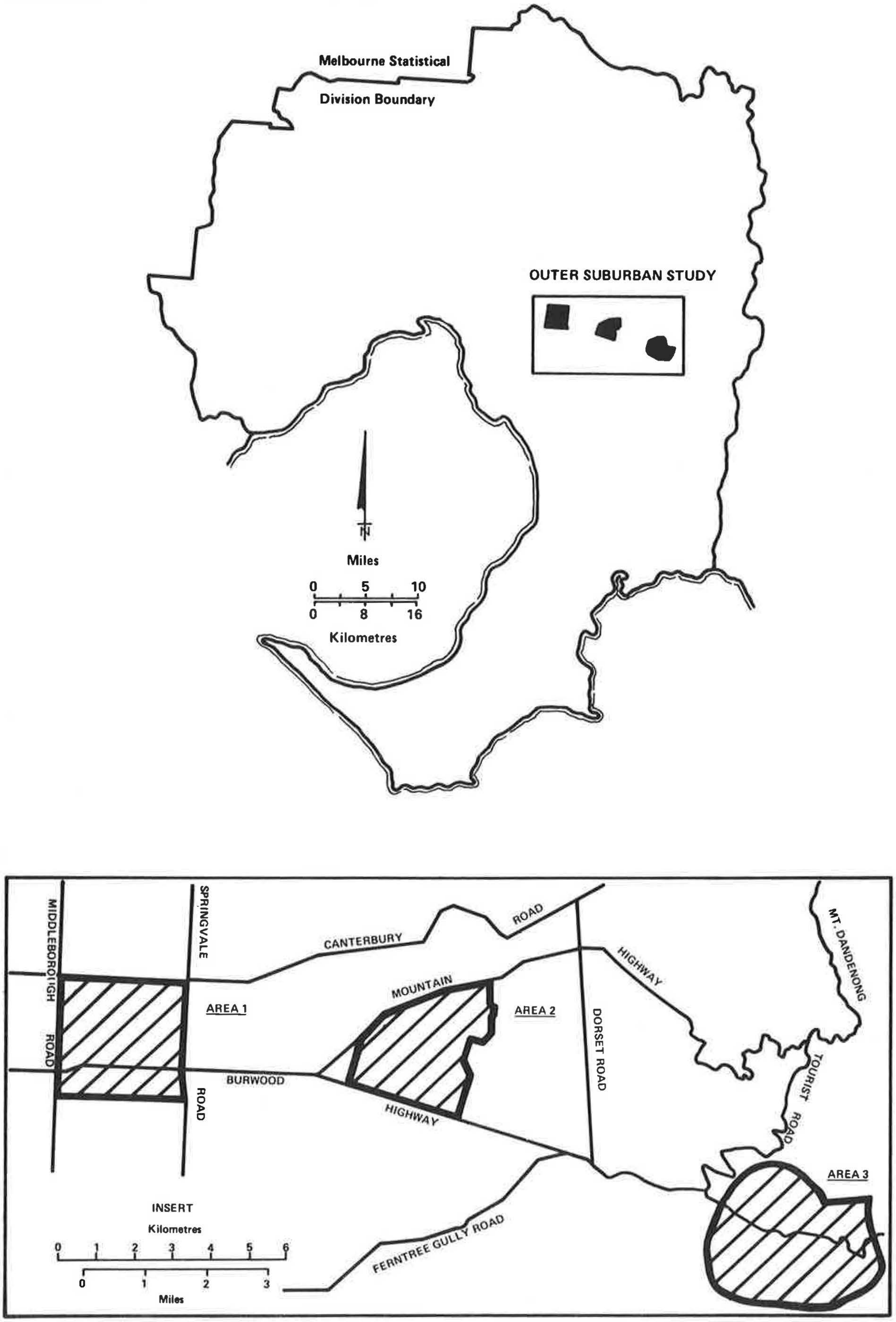


Figure 3. Question and measurement scale used to obtain satisfaction ratings for closeness to present workplace.

Q. *In this study we are interested in knowing how well you THINK particular suburbs would satisfy your needs. The areas we are studying are shown on the attached map. We now have a series of questions which aim at finding your impression of these areas. Could you please mark a cross (x) on the scale to indicate how you rate such locality for each of the following factors. If you have no view of what the area offers in respect to a particular factor, leave the appropriate scale blank.*

e.g. EAST BURWOOD

EXTREMELY BAD — EXTREMELY GOOD

	1	50	100
Closeness to present workplace			

Figure 4. Question and measurement scales used to obtain satisfaction ratings for hypothetical alternative work journeys.

Q. *People travel different distances to work. For each of the travel times below could you please mark how satisfied you would be with this separation between home and work?*

EXTREMELY BAD — EXTREMELY GOOD

TRAVEL TIME TO WORK (MINUTES)	1	50	100
0			
10			
20			
30			
40			
50			
60			
70			
80			
90			

Figure 5. Question and measurement scales used to obtain importance ratings for closeness to present workplace.

Q. *We are now interested in knowing how important these factors were in your choice to live in this area. Could you please mark a cross on the scale to indicate how important you feel each factor was in this decision. If any of these factors were not considered please leave them blank.*

NOT IMPORTANT — VERY IMPORTANT

	1	50	100
Closeness to present workplace			

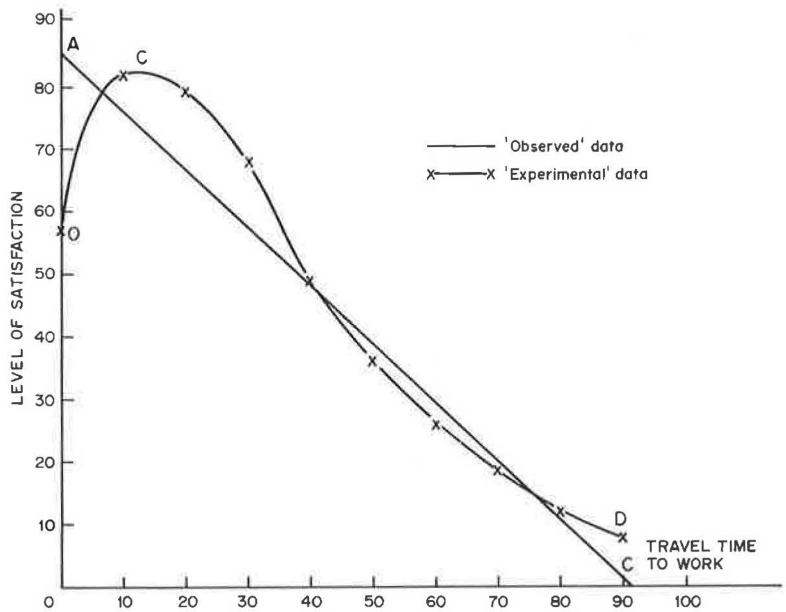


Figure 6. Comparison of observed and experimental relations for evaluation of travel time.

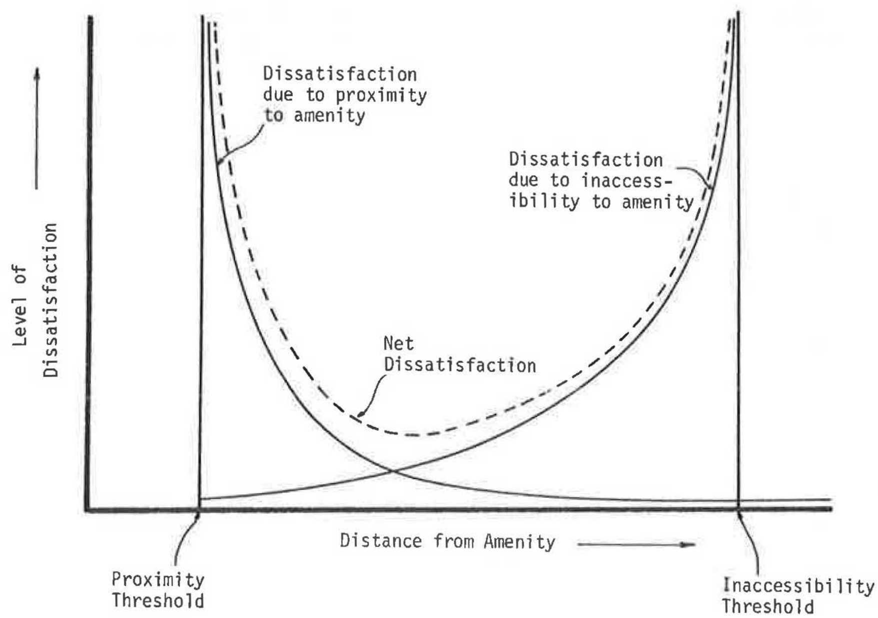


Figure 7. Relation between dissatisfaction and accessibility to amenity.

plausible. Of course, it might be argued that at this level of aggregation the observed data provide a reasonable empirical approximation. However, the choice of approach becomes more critical when the stability of this relation is examined across different population groups.

STABILITY ACROSS MARKET SEGMENTS

Perceived satisfaction with both existing work journeys and hypothetical travel times was examined further by segmenting the sample into a number of groups. The groups were based on a number of variables commonly used in transportation studies (age, sex, travel mode, and occupation), plus two others that relate to the perceived importance of closeness to work and respondents' present travel times.

In comparing the observed and experimental approaches, however, there are a number of problems. The observed data pertain to only one travel time for each individual--i.e., their present travel time--whereas the experimental data yield satisfaction ratings for a range of travel-time values for each individual. It follows, therefore, that present travel time is a meaningful basis for testing the stability of travel-time evaluation only in the case of experimental data.

Comparison of the two approaches is also complicated by differences in the methods of analysis. Between-group differences in observed behavior were tested by using regression analysis and standard statistical tests (see Table 1). However, a somewhat simpler method was used for the experimental data, given the nonlinear form of the relation. The test developed here essentially compares the degree of overlap between the distributions of mean satisfaction (i.e., the OCD curves) calculated for the various subgroups. The method is capable of handling only two subgroups at a time. No overall test of significance is available, but the method is

Table 1. Perceived satisfaction with closeness to current workplace among population subgroups: regression analysis of observed data.

Category	r^2	N	Intercept	Standard Error	Slope	Standard Error
Total	0.42	1019	85.6	1.35	-0.93	0.0342
Sex						
Male	0.39	671	84.9	1.72	-0.91	0.0437
Female	0.48	347	86.6	2.15	-0.97	0.0546
Mode						
Car	0.42	845	89.0	1.50	-1.09	0.0438
Public transportation	0.34	149	82.7	5.40	-0.76	0.1880
Age (years)						
24	0.56	226	89.7	2.41[a]	-1.01	0.0597
25-29	0.37	343	82.8	2.50[a]	-0.87	0.0611
30-39	0.45	290	87.9	2.49[a]	-0.98	0.0644
40	0.27	154	80.6	4.02	-0.83	0.1238
Perceived importance[b]						
Unimportant	0.20	173	60.3	4.75[a]	0.61	0.0945
Relatively important	0.30	256	71.0	2.89[a]	-0.68	0.0642
Important	0.37	327	87.1	2.13[a]	-0.85	0.0614
Very important	0.38	219	94.3	4.74[a]	-0.92	0.1163
Occupation						
White collar						
Upper level	0.45	342	86.3	2.1	-0.98	0.0603
Lower level	0.38	348	87.2	2.7	-0.94	0.0705
Blue collar	0.39	299	91.4	6.27	-0.94	0.1647

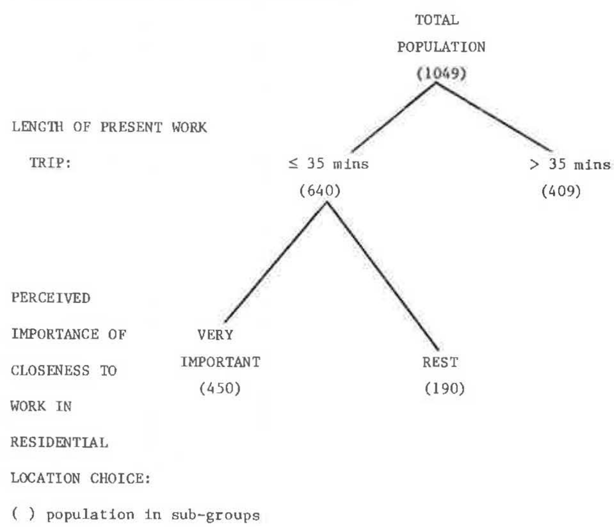
[a] Denotes significant differences with at least one other subgroup at the 5 percent confidence level.
[b] Derived on the basis of natural breaks in the frequency distribution of responses. The corresponding importance ratings are 1-18, 19-51, 52-84, 85-100.

Table 2. Differences in travel-time evaluation among population subgroups: sums of squares of differences in mean satisfaction ratings.

Category	Subgroup Comparison	Step 1 Grouping	Step 2 Grouping[a]
Sex	Male with female	131	128
Mode	Car with public transportation	466	200
Age (years)	≤24 with 25-29	31	52
	≤24 with 30-39	47	65
	≤24 with ≥40	119	82
	25-29 with 30-39	33	50
	25-29 with ≥40	54	70
	30-39 with ≥40	82	127
Importance	Very important with rest[b]	492	296
Occupation	Upper-level white collar with lower-level white collar	48	104
	Upper-level white collar with blue collar	34	36
	Lower-level white collar with blue collar	31	33
Perceived travel time to work (min)	0-15 with 16-35	265	265
	0-15 with 36-55	836	
	0-15 with ≥56	1597	
	16-35 with 36-55	381	
	16-35 with ≥56	986	
	36-55 with ≥56	216	
	0-35 with ≥36	723	

[a] Those whose current travel time is >35 min.
[b] Subgroups unimportant, relatively important, and important have been combined into a group called "rest".

Figure 8. Breakdown of population subgroups with significant differences in travel-time evaluations (experimental data).



capable of detecting localized differences between the subgroups.

Specifically, a simple t-test was used to determine whether the subgroups differed significantly (at the 5 percent level) in the mean satisfaction ratings assigned to each travel time. A measure of the total difference between the respective distributions was subsequently obtained by summing the squares of the differences in their average ratings. This measure is analogous to the between-group variance in analysis of variance. The grouping that produced the largest sum of squares of differences in the means was deemed to have the largest variance in evaluation and formed the basis for subsequent steps in the analysis. This process of dividing the sample into two groups and then investigating the lower-order groupings is similar in nature to the clustering program referred to as the Automatic-Interaction Detector (9). Segmentation of the experimental data continued until there was no significant difference between the average evaluation ratings for any of the travel-time values (this step is analogous to the within-group variance produced in analysis of variance). Table 2 and Figure 8 summarize the results of this analysis.

COMPARISON OF RESULTS

First, in the results of the regression analysis (Table 1) there appear to be very few differences between the subgroups in their observed behavior. The variation in the slopes of the lines is not significant (at the 5 percent confidence level) for any of the groupings. The intercepts do, however, show some variation, which indicates some differences in their evaluation of low travel times. For example, those who feel closeness to work is relatively unimportant rate low travel times somewhat lower than the other groups.

Figure 9. Evaluation of hypothetical travel times by those currently traveling less than and those traveling more than 35 min to work.

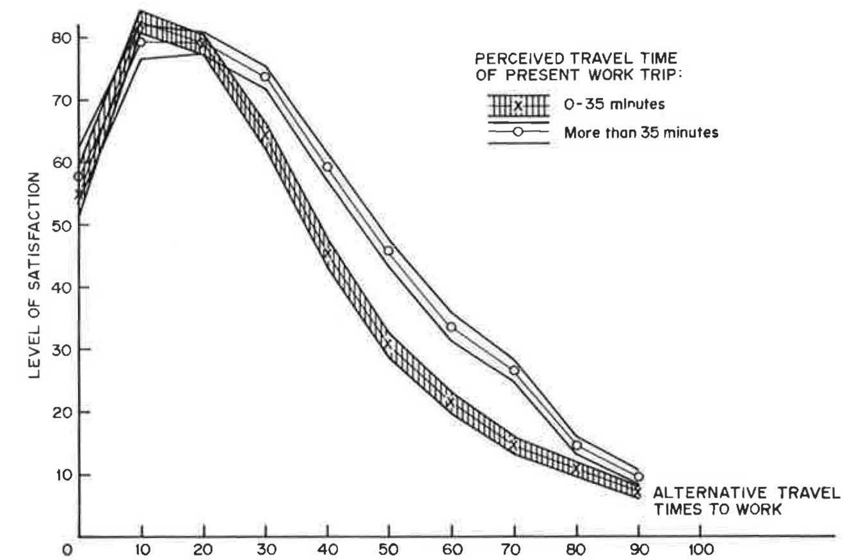
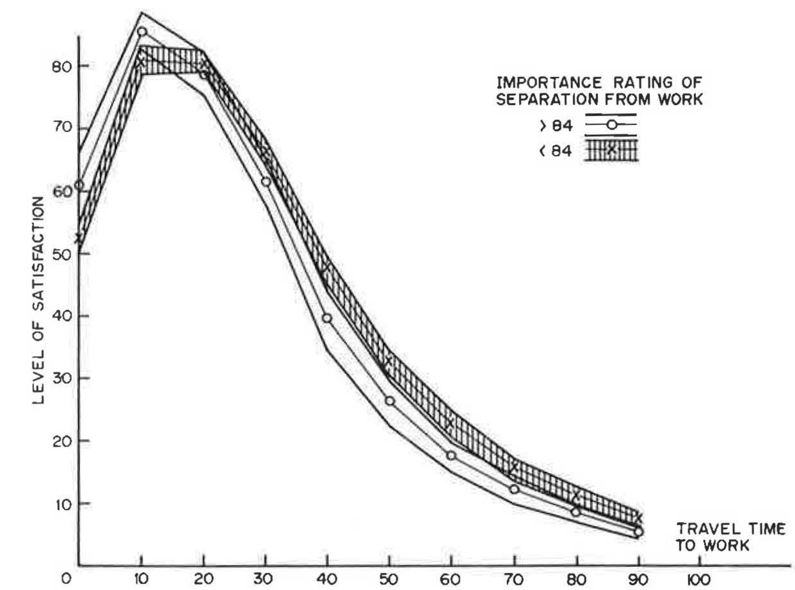


Figure 10. Evaluation of hypothetical travel times by perceived importance of closeness to work for subpopulation traveling less than 35 min to work.



Analysis of the experimental data, however, indicates that existing patterns of behavior impart a significant bias to travel-time evaluation (Table 2). By far the greatest difference in the preference distributions occurs when the population is grouped according to the perceived length of their work trips. Mode of travel and subjective ratings of importance also appear to be significant discriminators. But, as will be seen later, these show systematic relations with existing travel times.

Figure 9 compares the preference distributions for those who spend between 0 and 35 min and those who spend more than 35 min traveling to work. Generally, those who travel the shorter distance are less satisfied with travel times of more than 30 min than those who currently spend the longer time traveling.

Taking this as the second stage in the grouping, there are no significant differences in any of the possible groupings of the people who travel more than 35 min to work. Those who travel less than 35 min can, however, be grouped into (a) those who feel closeness to work is very important in the decision to live where they do and (b) the remainder of the population. Figure 10 shows that those who feel closeness to work is very important are less satisfied with longer travel times than the remainder of the subpopulation.

It is of interest to note, however, that grouping individuals who travel less than 35 min to work by importance produces only a slightly larger difference in the two distributions than would have resulted had the grouping used those who travel 0-15 min and those who travel 16-35 min (Table 2). Moreover, similar results using observed data and travel distance have been documented elsewhere (10).

The tendency of subpopulations to rate their existing travel time higher than the rest of the population may result from several factors:

1. The individual may adapt to a particular travel time once it has become part of his or her regular routine.
2. The individual may go through a process of rationalization in which, in order to accept certain decisions, he or she must be convinced that the

required travel distance is satisfactory.

3. The possible influence of other mediating factors should not be ruled out. For instance, a large proportion of those who use public transportation spend more than 35 min traveling to work (see Table 3). Moreover, users of public transportation tend to be less dissatisfied with these longer travel times (see Figure 11). This may partly reflect a greater opportunity to use the time spent traveling more productively (e.g., reading the paper and talking to friends).

4. The individual may in fact prefer the said travel time.

There is no clear evidence as to the degree of influence each of the above considerations has on the differences shown in Figures 8-10.

The findings of the experimental approach clearly highlight a major problem in using observed data. The observed-behavior approach implicitly assumes attribute evaluation to be independent of existing choices and conditions; that is, people are assumed to rate their existing travel time in the same way as would other individuals who travel different distances to work.

The second difficulty with the observed-behavior approach lies in the distribution of travel times at which people live from work. Figure 12 shows that the majority of the total sample live between 10 and 30 min of work, few people live within 5 min of work, and only a small number live more than 65 min from work. The small proportion of ratings in these areas means that they will only have a small influence on the regression line, which, in turn, is less representative of these travel times.

Table 3. Relation between mode use and perceived travel time to work.

	Mode of Travel			
	Car		Public Transportation	
Perceived Travel Time from Home to Work (min)	Number	Travel-Time Distribution (%)	Number	Travel-Time Distribution (%)
0-15	251	27.4	6	3.7
16-35	377	41.1	19	11.7
36-55	204	22.2	48	29.6
>55	85	9.3	89	54.9
Total	917	100.0	162	100.0

Figure 11. Comparison of observed and experimental relations for car and public transportation users.

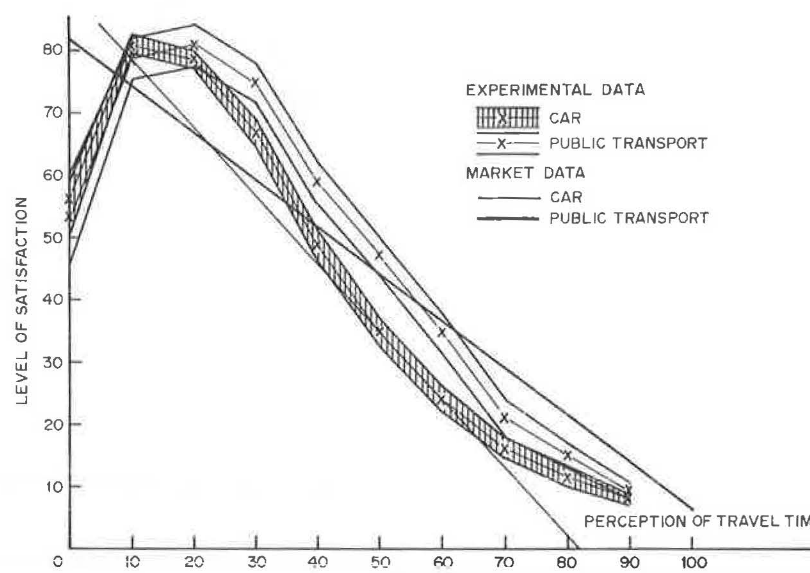
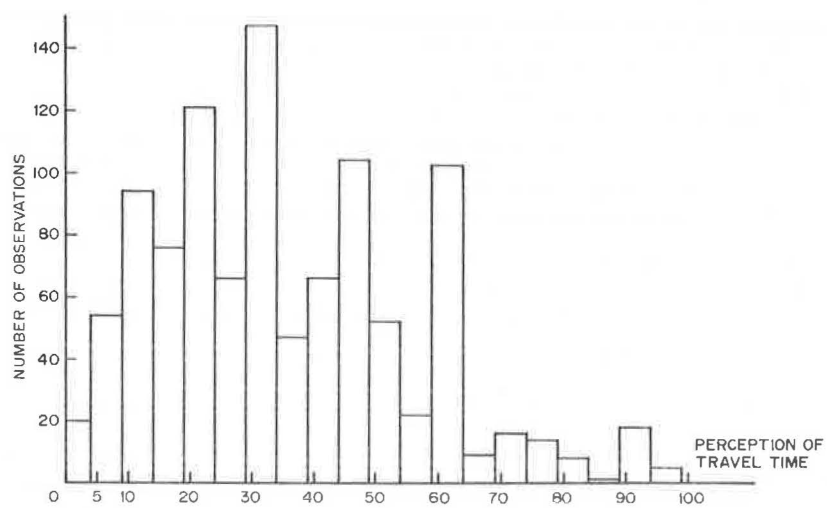


Figure 12. Frequency distribution of travel times reported by respondents to present journey to work.



Even with these apparent differences, however, a comparison of the relations obtained from the observed and experimental approaches shows marked similarities. Figure 11 is fairly representative of the level of correspondence between the results. Both approaches suggest that car users are less satisfied with longer travel times than are those who travel by public transportation. But, as has been emphasized earlier (Table 3), users of public transportation generally have longer travel times. Consequently, the regression coefficients are likely to produce less reliable estimates at the lower end of the travel-time range.

The general spread of data points in the observed-data approach and its inability to relate people's perceptions to their existing conditions cast doubts on its validity. The experimental approach appears to overcome some of the problems outlined, although it too has its limitations. One key unresolved issue is whether people are able to respond accurately to hypothetical attribute levels. It is also unclear whether the processes of travel-time estimation and evaluation are indeed independent as conceptualized in Figure 1. Even assuming this to be the case, it may be unrealistic to expect individuals to evaluate a given attribute in isolation from other considerations. The latter is more an argument for extending the experimental approach to a multifactorial design than a fundamental criticism of the method itself. Work along these lines has been carried out in other contexts under the guise of functional analysis (11,12).

IMPLICATIONS

The relations and procedures investigated in this paper have implications for both modelers and those who collect the data.

In regard to data-collection procedures, this paper provides some evidence for questioning the suitability of basing comprehensive data sets solely on observed patterns of behavior. The very nature of the urban system means that not all possible variations in choice and attribute levels will be available. Models based on observed data may be appropriate for predicting changes within a similar environment or range of experience, but as soon as one steps outside that environment the observed data and the models thus derived become less reliable. Experimental data such as those presented here would seem to provide a sounder basis for building models, by providing for greater control over attribute levels.

The general form of the relation between perceived satisfaction and travel time also has implications for modeling and for the development of accessibility measures. Most commonly, the impedance to travel is assumed to be (a) constant across groups of people and (b) a monotonically decreasing function of travel time. However, the evidence presented in this paper indicates that a monotonic relation does not hold for all people; there is a general tendency for individuals to be less satisfied with living close to work than with living 10-20 min from work. The exact form of the relation must await more refined analyses.

CONCLUSIONS

Two approaches for investigating the relation between individuals' evaluations of travel time and their perceptions of travel time were investigated. The observed-data approach used only information on existing travel patterns, whereas the experimental approach collected information on a number of hypothetical travel times. Although the observed-data approach provided relations similar to those provided by the experimental approach, it did so with an unrepresentative set of data points. Less reliance could, therefore, be placed on these results.

The experimental approach showed that the respondents tended to prefer a 10- to 20-min separation between home and work. Lower and higher travel times were found to provide a lower level of satisfaction. Although this general distribution held for all groups of individuals studied, there were variations between some subpopulations. These variations were most marked between those groupings of people who actually spent different amounts of time in traveling.

In closing, this paper questions the assumption made in many models and accessibility measures that individuals' satisfaction with temporal separation from the workplace decreases with distance. More realistic measures could result if the distributions discussed in this paper were incorporated.

ACKNOWLEDGMENT

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