The Role of Personality Factors in Repeated Route Choice Behavior: Behavioral Economics Perspective

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Abstract

This paper is based on an in-laboratory experiment and aims to explore the impact of various personality factors on route-choice behavior in the presence of partial pre-trip travel time information. Specifically, these factors are geographic ability, sensation seeking characteristics, and status-quo biases. The results show that while the variables related to perceived and realized travel times are important, the personality factors are also significant. Drivers with lower geographic abilities tended to use the main route more often and to switch their routes less often, compared to those with higher capabilities. Drivers who scored higher on sensation seeking tended to switch their routes more frequently, compared to other drivers.

Keywords: Route-choice behavior, Personality factors, In-laboratory experiment

1. Introduction

Advanced traveler information systems (ATIS) are rapidly penetrating all modes of transportation, and are recognized as the social trend that will have the greatest influence on future transportation systems (Wachs, 2002). ATIS, which provide pre-trip or en-route travel time information, have a significant impact on travel behavior by enabling drivers to make efficient travel choices (e.g., choose routes, modes and departure times). They are therefore regarded as an efficient means to achieving improved utilization of the transportation system (Koski, 2002; Bekhor et al., 2002; Bonsall, 2000; Emmerink et al., 1996). ATIS may be provided through different media and technologies, such as variable message signs (VMS), radio broadcasting, cell phones, navigation systems with Global Positioning System (GPS) technology, and real-time public transportation arrival time information.

A better understanding of the impact of information on travel behavior is a key issue for evaluating the performance of ATIS. Drivers' route choice behavior is a complex decision-making process, which incorporates multiple objectives and involves various factors. The mainstream approach to modeling this behavior focuses on variables related to the driver’s trip and socio-economic characteristics and route attributes (Polydoropoulou et al., 1994; Antonisse, 1989; Ben-Elia et al., 2008; Srinivasan and Mahmassani, 2000; Dia, 2002; Jan et al., 2000; Abdel-Aty et al., 1997). However, as asserted by the theory of Behavioral Economics, individuals do not faultlessly maximize their utility when making choices (see for example, Kahneman and Tversky, 1979; Simon, 1982; Kahneman, 2003). Instead, individuals use simple heuristics and sometimes make mistakes. As regards travel behavior models, this insight is traditionally dealt with by incorporating appropriate variables and complex error structures in random utility models (Prashker and Bekhor, 2004; Katsikopoulos et al., 2002; Chorus et al., 2007; Chorus, 2007, Prato, 2009).

This paper aims to explore the impact of various personality factors on route-choice behavior in the presence of partial pre-trip travel time information. Specifically, these factors are geographic abilities, sensation seeking characteristics, and status-quo biases. Our hypothesis is that these personality traits may also play a significant role in route choice behavior in the presence of information; therefore, they should be considered explicitly in route choice analysis. Particularly, we explore the impact of these personality factors on the likelihood of choosing the main route and on switching behavior. We also inspect the relationship between these variables and other well recognized factors, such as gender, and network familiarity.

The first factor, geographic ability, is usually described as a component of a more general characteristic, known as spatial ability, which may be defined as "a person's mental capability to learn, organize and recall spatial information" (Ramming, 2002). The nature of spatial ability was found in numerous studies to be influential in travel behavior (Golledge, 2001; Gärling et al., 1998; Freundschuh, 1992; Golledge, 1992). Geographic ability is mentioned in the literature as a trait which varies according to age and gender (Dabbs et al., 1998), and through its connection to cognition (Gärling and Friman, 1998; O'Neill, 1991). To the best of our knowledge, no efforts have been made to explicitly relate geographic ability to route choice behavior.

The second factor, sensation seeking, is commonly used in behavioral science and is defined as "the need for varied, novel, and complex situations and experiences, and the willingness to take physical and social risks for the sake of such experiences" (Zuckerman, 1979). Several studies have suggested that sensation seeking is positively related to reckless driving behavior (Dahlen et al., 2005; Arnett, 1996; Zuckerman and Neeb, 1980). Within the context of route choice behavior, a recent study by Shiftan et al. (2010) demonstrated that a tendency to choose a route which is perceived as faster, but incurs larger travel time variance, can be predicted by sensation seeking.

The third factor, the status-quo bias, is a cognitive tendency to maintain current or previous decisions. In route choice behavior, this is generally represented by travel habits, which explains a significant part of the undertaken trip pattern (Bogers et al., 2005; Golledge, 2001; Mahmassani and Jou., 2000; Srinivasan and Mahmassani, 2000). Explanations for this bias are based on the ideas of Prospect Theory. The status-quo bias has been demonstrated in a variety of decision-making situations in diverse areas, such as Economics, Finance, Political Science and Industrial Organization (e.g., Samuelson and Zeckhauser, 1988; Kahneman et al., 1991; Chernev, 2004; Conesa and Garrige, 2003). In this paper, we attempt to explicitly introduce the impact of status-quo bias on route choice behavior. That is, we evaluate the effect of drivers' tendency to maintain their initial preference towards a specific route on repeated route choice behavior under information.

The rest of the paper is organized as follows: Section 2 presents the experiment design. Section 3 provides the results and describes the models estimations. Section 4 presents the conclusions.

2. Experiment Design

The experiment was comprised of two parts, which were presented to each participant: a route-choice assignment, and a questionnaire, designed to identify factors that influenced individual's behavior in the route-choice assignment. Both parts were conducted in a laboratory and presented on-screen. Data was recorded directly to a database. Participants took approximately 20-25 minutes to complete the experiment. The participants were 54 undergraduate students between the ages of 23-30 from the Technion – Israel Institute of Technology, all holding a driving license for 3-10 years. Most of the participants reported car availability; 16 out of 54 (30%) participants were female, which is close to their share of 35% of the undergraduate student population at the Technion.

2.1 The route-choice task

Participants were presented with a familiar, simple real-world network. However, the extent of familiarity varied among participants. The experiment was conducted in a laboratory environment. A review of the literature shows that due to very limited implementation of information technologies around the world, most studies in the area of route-choice behavior under information are not based on field studies. Instead, stated-preference surveys, the use of GPS-based data, as well as laboratory experiments based on simulation methods, were found to have validity and represent actual choice behavior; hence, they are commonly used (Li et al., 2005; Jan et al., 2000; Adler and McNally, 1994; Emmerink et al., 1996; Mahmassani & Jou, 2000; Chorus et al., 2007).

The network used in this study is located near the campus of the Technion in Haifa, Israel. Participants were asked to choose a driving route during the morning peak period from the main gate of the campus to a large employment center near the southern entrance to Haifa, for an important meeting. Two alternative routes, A and B, were suggested. Figure 1 illustrates the network**.**

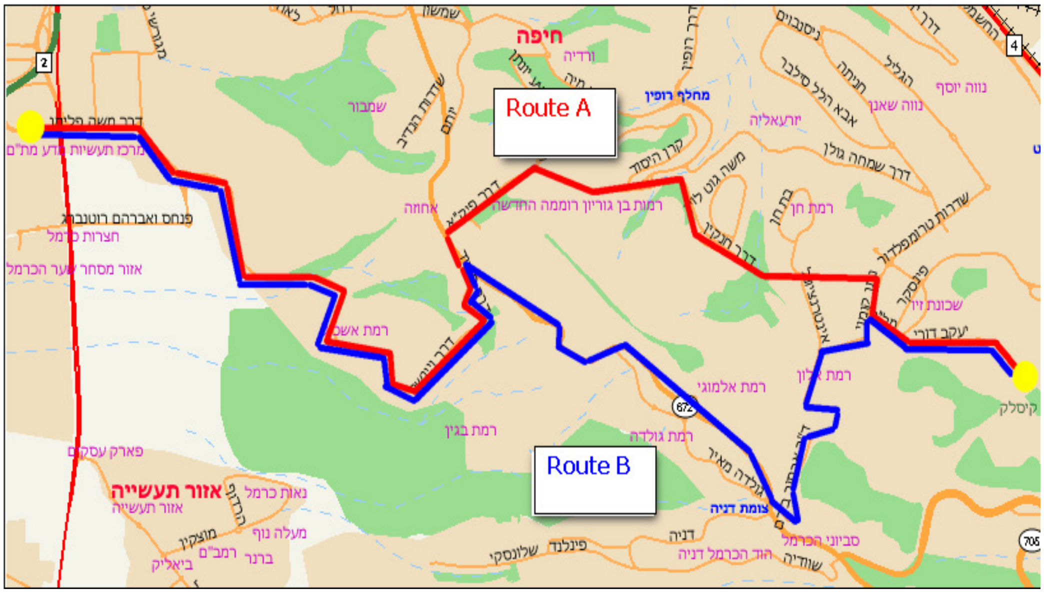
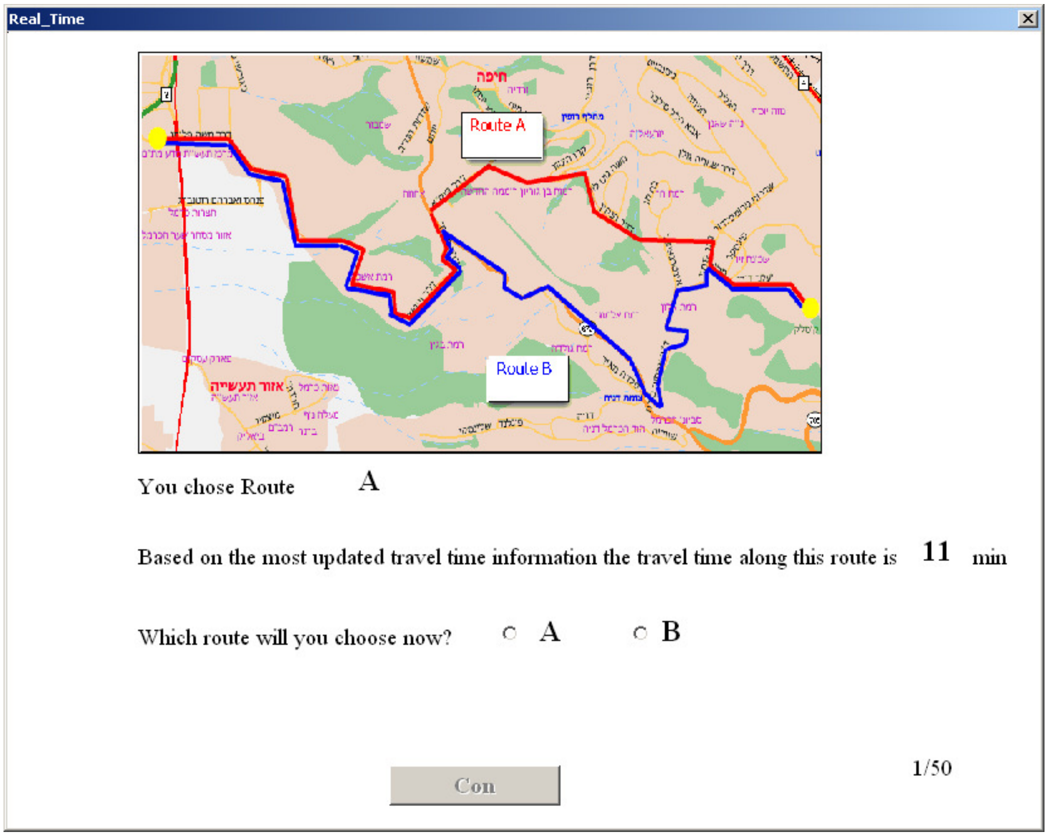


Figure 1. Network used in the experiment

Route A is the high road route for this trip. Road signs direct drivers to follow it to this destination. It is 9 kilometers long. Route B is 10 kilometers long. It is usually less congested and has some scenic views.

Initially, in the opening trial, the participants were asked to estimate the travel time for both routes and to choose one of them. These a-priori perceived travel time estimates were needed, as they served as benchmarks in the experiment. Next, participants were asked to choose one of the two routes in 50 recurring trials. A numerator was presented on-screen, indicating the trial number. After each choice was made, the participant was provided with the travel time information for his or her chosen route. In order to probe the impact of partial travel time information, no information on the alternative route was provided. An example of a screen-shot used for the route-choice task is presented in Figure 2.



You chose Route A

Based on the most updated travel time information the travel time along this route is 11 min

Which route will you choose now? ○ A ○ B

Figure 2. Example of a screen presented in the in-laboratory experiment

The travel time information in the recurring trials for each participant was drawn from a distribution that depended on the perceived *a-priori* travel time estimates, which the specific participant provided for the two routes. This increased the reliability of the route-choice task, as each participant would received travel time values which he or she would consider to be practical. The realization of travel time information for each participant was made using uniform distributions with ranges that were constructed as described in Table 1.

$tt^0(A)$ and $tt^0(B)$ are the perceived *a-priori* travel time estimates provided by a participant for routes A and B, respectively. The perceived *a-priori* travel time difference (TTD) between the two routes was defined by:

$$TTD = tt^0(B) - tt^0(A) \tag{1}$$

	Distribution of Travel Time	
Condition	Route A	Route B
TTD>0	$[tt^0(A)-0.5TTD,\ tt^0(A)+2TTD]$	$[tt^0(B)-TTD, tt^0(B)+0.5TTD]$
TTD<0	$[tt^0(A)+TTD,\ tt^0(A)-0.5TTD]$	$[tt^0(B)+0.5TTD,\ tt^0(B)-2TTD]$
TTD=0	$[0.8\ tt^0(A),\ 1.2\ tt^0(A)]$	$[0.9\ tt^0(B),\ 1.1\ tt^0(B)]$

Table 1. Ranges of uniform travel times distributions

As regards these definitions, three conditions may apply, as presented in Table 1. Regardless of the condition, this distribution confirms that although the mean travel time is shorter on the route which was perceived to be shorter, the travel time variance is higher. Furthermore, these distributions ensure that in the recurrent trials the probability that one route is shorter than the other is exactly 0.5. That is, each participant had no incentive to prefer one route over another as regards travel time.

2.2 The questionnaire

The main purpose of this part of the experiment was to identify the impact of personality traits and characteristics on route choice behavior. In order to probe this impact, the general frame of the well known Sensation Seeking Scale (SSS), form V (Zuckerman et al., 1978), was used. This scale measures sensation seeking in the following four domains:

- Thrill and Adventure Seeking (TAS) - in the area of sports and physical activity. It can be summarized as a positive answer to “I sometimes like to do things that are a little frightening”.
- Experience Seeking (ES) - in the sensory and cognitive domain. An example of a question expressing sensation seeking in this domain: “I like to explore a strange city or town by myself, even if it means getting lost.”
- Disinhibition (DIS) - seeking sensation in the social and sexual domain. This can be represented as a positive answer to “I like to have new and exciting experiences even if they are a little unconventional or illegal.”
- Boredom Susceptibility (BS) - represents intolerance for repetition and routine of any kind (e.g., work). An example of a question expressing sensation seeking in this domain: “The worst social sin is to be a bore”.

The SSS is estimated on the basis of a questionnaire that includes 40 items (10 for each domain), presented in a random order in the format of a "forced choice". In accordance with the goal to identify personal traits that might explain route choices, the tendency to switch routes, and compliance with information, we made two adjustments to this form: First, the "forced choice" scale, which is occasionally criticized in the literature (see for example, Arnett, 1994), was replaced with a finer Liker-type format. That is, for each item, participants were asked to indicate the extent to which they agree with the stated item on a scale of 1 to 5, where 1=strongly disagree and 5=strongly agree. Second, we replaced the ten questions relating to the DIS domain with ten questions about Geographic Ability (GA), which according to our hypothesis might be relevant to route choice behavior. An example of an item reflecting GA is "Judging where north is in an unfamiliar city is extremely easy for me". The GA items were based on questions to elicit geographic abilities, as presented in Ramming (2002).

Other items which were included in the questionnaire were: socio-economic items (e.g., gender, age), questions about the subject’s extent of familiarity with the study network, and car availability.

3. Results

All the participants reported that the tasks were clear. Most of them mentioned that they actually often face this choice in real life, while traveling within the area.

3.1 Route choice- general description

In the opening trial, only 3 participants out of 54 (5.5%) chose the route they had estimated as having the longer travel time. The average a-priori perceived travel time estimates provided by participants were 24.3 minutes for route A and 23.3 minutes for route B, indicating that these two routes are noticeably interchangeable for participants, as regards travel time. In this initial trial, 32 out of 54 participants (59%) chose route A (the main road), while 22 participants (41%) chose route B.

In the experiment, a general pattern of shifting towards route B was noticeable, as illustrated in Figure 3, which shows the fraction of drivers choosing route A in blocks of ten trials. It should be noted that shares for route A and route B hardly differ between Block 1 and Block 5. This may indicate that participants tended to return to their initial route choice. In the first 20 trials, more than 55% of participants chose route A; the fractions of drivers choosing this route were lower in the later trials.

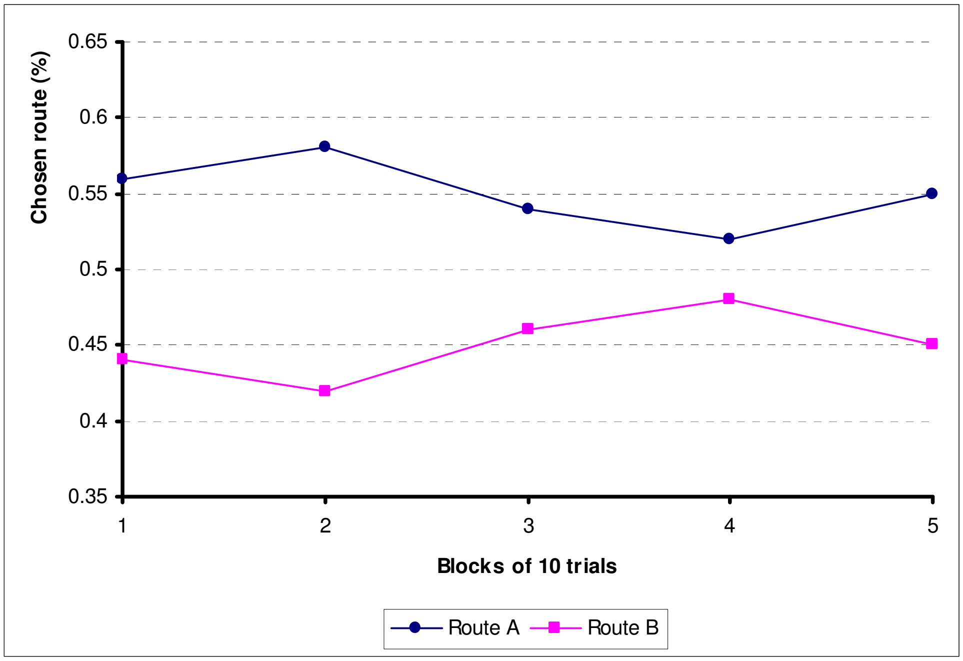


Figure 3. Route chosen (in fraction form) throughout the experiment

3.2 Correlations among factors

In the experiment, data was compiled based on route choices, *a-priori* perceived travel times, realized travel times, and also on factors associated with sensation seeking (TAS, ES, BS), and geographic ability (GA). In addition, data were also collected on participants' gender, and their extent of familiarity with the network.

Table 2 presents the correlations among the factors that were collected in the questionnaires and the results of the route-choice task experiment.

The results show that the sensation seeking factors are significantly correlated among themselves. Gender is correlated with TAS; TAS is higher for males, in line with the literature (Zuckerman, 1994). Only GA is significantly correlated with the route choices, where drivers with higher geographic ability tend to use the main route (route A) less frequently. Weaker correlations also exist between the sensation-seeking factors, in particular experience seeking, and the number of route switches in the experiment.

The a-priori choice of route and the a-priori perceived travel time difference between the two routes, are correlated among themselves (drivers who indicated route A was shorter, tended to select it a-priori) and with both the fraction of choices of route A and the number of route switches in the experiment. The number of switches is also correlated with the trip frequency, i.e., drivers that make this trip more frequently tended to make less switches in the experiment. The number of switches is also negatively correlated with the fraction of choices of route A. This implies that drivers who chose the main route (route A) more, were less likely to switch routes.

	Gender	Years in Haifa	Route frequency	A-priori choice	TAS	ES	GA	BS	Choices A	Switches	TTD	Absolute TTD
Gender	1	0.049	0.118	0.075	-0.297*	-0.100	-0.147	-0.252	-0.015	0.019	-0.009	-0.028
Years in Haifa		1	-0.417**	0.217	0.030	0.065	0.002	-0.130	-0.054	-0.117	-0.117	0.066
Trip frequency			1	0.026	-0.254	-0.059	-0.077	-0.124	-0.010	0.301*	0.110	-0.009
A-priori choice				1	-0.022	0.062	0.032	0.053	-0.551**	0.338*	-0.660**	0.220
TAS					1	0.459**	0.302*	0.112	-0.042	0.148	-0.031	0.358**
ES						1	0.295*	0.301*	-0.130	0.210	-0.074	0.069
GA							1	0.144	-0.295*	0.159	-0.013	0.253
BS								1	-0.187	0.149	-0.132	0.023
Choices A									1	-0.279*	0.230	-0.102
Switches										1	-0.247	0.264
TTD											1	-0.409**
Absolute TTD												1

* significant at the 0.05 level
** significant at the 0.01 level

Table 2. Correlations among factors in the experiment

3.3. Model estimation

Based on the experiments, two models were formulated and evaluated: A route choice model and a route switching model.

3.3.1 Route Choice Model

Table 3 presents the estimation results of a model that predicts the fraction of choices of route A in the 50 trials using a logistic regression model. The model structure is given by:

$$\ln\left(\frac{P(A)_i}{1-P(A)_i}\right)=\beta X_i+\varepsilon_i \tag{2}$$

$P(A)_i$ is the fraction of route A choices for driver i. X_i is a vector of explanatory variables for the driver. β is the corresponding parameters. ε_i is a random error term.

Parameter	Estimated value	t-statistic
Constant	6.233	13.69
A-priori choice (route B=1)	-2.814	-17.13
Perceived travel time difference (TTD)	0.3135	5.34
Perceived travel time difference percentage (PTTD)	0.2392	4.47
Travel time standard deviation difference (TTSTD)	1.335	7.03
Travel time change percentage difference (TTCPD)	0.2652	4.52
GA	-0.07401	-9.61
BS	-0.07163	-5.55
Gender (female=1)	-0.3740	-3.62
Haifa newcomer dummy	-0.7568	-5.37
Frequent trip dummy	-0.3698	-3.51

Table 3. Estimation results for the route choice fraction model

The estimation results show that while the variables related to a-priori perceived and realized travel times are the most important in the model, the personality factors which capture participants' characteristics are also valuable. Everything else being equal, participants strongly prefer the main route A, to the alternative route. Newcomers to the city (living in Haifa for less than 1 year), participants who undertake the trip frequently (at least once a month), and females tend to use route B more, compared to others. One of the sensation-seeking factors (boredom susceptibility) and geographic ability are significant in the model. The estimated values of these parameters indicate that participants with higher geographic abilities tend to use route B more, compared to those with lower capabilities. Similarly, participants with higher intolerance for repetition and routine also tended to use route B more frequently. These results seem plausible, as route A is considered the main route.

Participants who a-priori indicated that route A was shorter chose this route significantly more, compared to participants who did not. This impact is captured by three variables: the *a-priori* chosen route, the perceived *a-priori* travel time difference between the two routes (this variable was defined in Equation (1)), and the difference in the perceived travel times between the two routes expressed as a percentage of the travel time on the shorter route. This latter variable is defined by:

$$PTTD = 100 \times \frac{tt^0(B) - tt^0(A)}{\min[tt^0(B), tt^0(A)]} \tag{3}$$

The realized travel times during the experiment were drawn from the distributions described above, which depend on the *a-priori* perceived travel times. The construction of these distributions is such that the mean realized travel times are equal for the two routes, but the standard deviation is different. The estimation results show that participants tend to prefer the route with the lower realized travel time variability. The travel time standard deviation difference is measured as:

$$TTSTD = \sigma_{tt}(B) - \sigma_{tt}(A) \tag{4}$$

The travel time change percentage difference variable captures the difference in the change between the perceived travel times and the means of the distributions in the two routes (*tt(B)* and *tt(A)*), as a percentage of the travel times. It is defined as:

$$TTCPD = 100 \times \left[\frac{tt(B) - tt^0(B)}{tt^0(B)} - \frac{tt(A) - tt^0(A)}{tt^0(A)} \right] \tag{5}$$

3.3.2 Route switching model

Table 4 presents a model that predicts the fraction of switches between the two routes in the 50 trials using a logistic regression model. The model structure is given by:

$$\ln\left(\frac{P(S)_i}{1 - P(S)_i} \right) = \beta X_i + \varepsilon_i \tag{6}$$

$P(S)_i$ is the fraction of choices in which driver i switched the chosen route (from A to B or vice versa). X_i is a vector of explanatory variables for the driver. β are the corresponding parameters. ε_i is a random error term.

Two of the sensation-seeking factors (TAS and BS) are significant in this model. Participants who scored higher on the TAS and BS factors all tended to switch their routes more frequently. Geographic ability is also significant in the model. Participants who scored higher on the GA tended to switch their routes more frequently. These results seem plausible, as route switching behavior might be triggered when drivers have more geographic abilities and are sensation seekers.

Variables that are related to the participant's familiarity with the trip also affected the frequency of switching. Participants who took the trip more frequently tended to switch their routes less, compared to those who traveled it less frequently. Participants living in Haifa between 1 and 4 years switched routes less frequently, compared to those who are newcomers to the city (under 1 year), as well as those who have been in Haifa for more than 4 years. Based on this, the extent of familiarity seems to be negatively correlated to route switching. This result is in line with previous studies showing that an unfamiliar population tends to switch a lot, compared to a familiar population (Lotan, 1997 and references there).

Parameter	Estimated value	t-statistic
Constant	-3.810	-7.57
A-priori choice (route B=1)	0.8246	5.33
Perceived travel time difference (TTD)	-0.1085	-4.74
Perceived travel time difference percentage (PTTD)	-0.2723	-4.33
Absolute perceived travel time difference (ATTD)	0.4078	3.67
Absolute percentage perceived travel time difference (APTTD)	-1.397	-4.15
Travel time standard deviation difference (TTSTD)	-1.351	-3.61
Absolute travel time change percentage difference (ATTCPD)	-0.3214	-4.62
TAS	0.01988	2.57
GA	0.04084	4.32
BS	0.07051	4.85
Haifa 1-4 years dummy	-0.4028	-3.54
Weekly trip dummy	-2.324	-9.90
Monthly trip dummy	-1.316	-7.11
Yearly trip dummy	-1.023	-6.19

Table 4. Estimation results for the route switching fraction model

As with the route choice model, the a-priori perceived travel times are important as regards switching behavior. Participants who indicated the main route (route A) was shorter and chose it a-priori switched routes less frequently, compared to those who indicated the alternative route (route B) was shorter. Participants make less switches when the differences in the perceived travel times are larger, in absolute values and as a percentage of the travel times, compared to when they are smaller. Similarly, they also make less switches when the differences in the standard deviations of travel times are smaller, compared to when they are larger. Moreover, they also make less switches when the difference between the perceived travel times and the mean of the realized travel times are smaller, compared to when they are larger.

4. Conclusion

This paper describes a laboratory experiment intended to probe the impact of personality factors in the analysis of route choice behavior, on route choice behavior in the presence of partial pre-trip travel time information. Specifically, the factors studied are sensation seeking, geographic ability, and status-quo bias. We also examine the relationship of these variables with other well recognized factors, such as perceived travel time, gender, and network familiarity. The route choice and the route switching models show that while, as confirmed in early studies (e.g., see Chorus et al., 2006 and the references there), familiarity and variables related to perceived and realized travel times are very important, sensation seeking factors, geographic ability and the a-priori choices are also significant in making routing decisions. The results confirm our hypothesis that personality factors also play a role in route choice behavior in the presence of information and consequently, route-choice analysis may benefit from explicitly discussing these personality factors.

Sensation seeking, which is recognized in other studies as being positively related to reckless driving behavior, was found relevant to route choice behavior in the presence of partial travel time information. Drivers who scored higher on sensation seeking tended to switch their routes more frequently, and to use the alternative route more often than the main route. Drivers with higher geographic ability tended to use the alternative route more than those with lower capabilities. They also tended to switch their routes more often. The route choice model demonstrated the impact of the a-priori choice, which may reflect travel habit in this real world network, and therefore represents the status-quo bias. In other words, drivers who a-priori chose the main route (route A) and indicated it was shorter, chose the main route significantly more and switched their route less, compared to drivers who a-priori chose the alternative route (route B) and indicated it was shorter. This switching behavior indicates that it takes a few trials, after which the driver may start switching, as it seems that at the beginning drivers are 'stuck' in their *a-priori* choice. It should be noted that participants had no incentive, as regards travel time, to change the route chosen a-priori, as the probability that the travel time information indicated one route is faster is 0.5.

The traditional variables used in route choice analysis were found to be important in the switching model presented here. The extent of familiarity factor was found to be negatively related to both the frequency of switching routes and to the fraction of the main route choices. The difference in perceived travel times was found significant as regards switching behavior, and affected the route choice. That is to say, drivers made less switches when the differences in the perceived travel times were larger, in absolute values and as percentage of the travel times, compared to when they were smaller. Similarly, they also made less switches when the differences in the standard deviations of travel times were smaller, compared to when they were larger. Moreover, they also made less switches when the difference between the perceived travel times and the mean of the realized travel times were smaller, compared to when they were larger.

As noted above, the results presented in this paper are based on a laboratory experiment comprised of a fairly homogenous population and a simplified travel network. Therefore, the results obtained cannot be considered very robust, and more studies based on the real world (rather than a laboratory) should be performed. Nevertheless, the notion of sensation seeking, geographic ability and status quo bias are novel within the context of route choice behavior. Therefore, this paper points out that personality factors are relevant in the decision-making process and may improve the modeling of route choice behavior. As for information provision via different technologies, it may indicate a utilization of features associated with these personality factors (such as landmarks).

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