Drivers’ perception of route alternatives

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ABSTRACT  
Although travel time is probably one of the most important attributes in route choice, the shortest time route is often not the preferred route according to several studies in the literature. This study tries to explain this finding by testing the hypotheses that choice makers may be able to estimate travel times correctly for routes they prefer, but that they are biased against alternatives even if these are faster. For a few choice sets of routes in the Dutch city of Enschede, respondents were asked to choose a route and provide their estimated travel times for both the preferred and alternative routes. These travel times were then compared with actual travel times. The comparison confirmed the hypotheses. In only 41% of the cases the shortest time route was chosen. Travel times were generally overestimated while respondents on average overestimated travel times of non-chosen routes more than the travel times of chosen routes. Besides, familiar routes, orbital routes and most direct routes were preferred even when they had a higher travel time. These results show that drivers are not able or do not want to evaluate routes objectively which has important implications for traffic management practices.

Keywords: route choice, travel time perception, survey
1. INTRODUCTION
In this paper we focus on the issue of perception of route alternatives. A more extensive discussion of the results presented here can be found in [1, 2]. Looking at route choice, there is evidence that drivers do not necessarily choose the shortest time route. Even in cases with non-trivial travel time differences between routes in the range of 2-5 minutes or 8-20% of the average travel time, such as shown in GPS surveys [3-6]. Many other attributes were found to be important in route choice, including directness, road hierarchy, number of intersections and turns, reliability of travel time, distance and maximum speed, information and weather, and the moment of congestion [5, 7-10]. However, due to the formation of habit, as a result of making the same choice over and over again, drivers become less attentive to changes in the route attributes and continue using the specific route even though it may not be the best one anymore [11]. In this paper we combine subjective data from interview surveys and objectively derived travel times to study the empirical relationship between perception of travel time, actual travel time and route choice.

To measure the error in drivers’ perception of route alternatives we adopt from cognitive science what is known as the ‘choice-supportive bias’. That is, people are more likely to attach positive feeling to options they choose and attribute negative features to options they reject [12]. In terms of route choice this suggests that driver have different perceptions of routes they frequently use than routes they hardly use. Therefore we distinguish four variables in the analysis of our study:

1. ATT+, the actual travel time of the used alternative
2. PTT+, the perceived travel time of the used alternative
3. ATT-, actual travel time of the non-used alternative
4. PTT-, perceived travel time of the non-chosen alternative

Based on the theory of choice-supportive bias and literature review three hypotheses were tested. An accepted hypothesis provides evidence that the choice-supportive bias exists in route choice. The three hypotheses are:

1. ATT+ ≈ PTT+. Travel times of chosen routes are perceived on average as being more or less what they actually are.
2. ATT- < PPT-. Non-chosen routes are perceived as being slower than they actually are.
3. PTT+ < PPT-. Chosen routes are generally perceived as being faster than non-chosen routes.

2. APPROACH
To assess drivers’ perception of route choice alternatives we compared perceived travel times with actual travel times. Perceived travel times were measured by means of multiple interview surveys while actual travel times were derived from a license plate survey and vehicle inductive profiles. Both surveys were held in the medium-sized city Enschede in the Netherlands, which has about 130,000 inhabitants. Although the city is rather small and compact in an international context, it can be considered a large city (13th in the Netherlands) in the Dutch context.

**Perceived travel time: interview surveys**
The surveys included multiple route choice situations for different origin-destination pairs. In each choice situation there were 2 choice alternatives. To study the effect of road hierarchy and directness on perceived travel times, orbital and center, and direct and indirect routes were mixed in a pairwise manner. Only routes for which reliable actual travel times were available were used. Four example of choice situations are shown in the figure below.
Respondents to the survey were recruited at parking areas on the university campus, or through personal invitation and the Enschede Facebook page. At the start of the survey a map was shown on which the choice situations were indicated (e.g. see figure above). The respondents were asked to imagine they had to make a trip from home to work or to a business appointment in morning peak hour traffic. First the respondents had to indicate their level of familiarity with each of the routes on a 4-point scale (very familiar, moderate familiar, used 1-2 time, never used). Next the respondents had to indicate which route they would choose after which they had to give an estimate of the travel time of both routes.

**Actual travel time measurements**

Actual travel times were derived from a license plate survey and vehicle inductive profiles that were sampled by traffic light inductive loop detectors. Detailed information on survey characteristics, preprocessing of the data, error treatment and measurement results are available in [9]. Human monitoring stations were positioned in three concentric circle cordons, covering all main roads: a city center (starting with letter “C”), a city orbital (starting with letter “S”) and an outer city cordon (starting with letter “T”). Also see Figure 2. At in total 44 monitoring stations all car license plates and their time passage were registered during a Saturday and during the rush hour and off peak of a Tuesday.

Considering the vehicle inductive profiles; the system algorithm tries to match vehicle inductive profiles from loop detectors located at neighboring intersections and derive the actual travel time accordingly [13]. Hence, travel time sections run from signalized intersection to signalized intersection. In the city of Enschede all signalized intersections are covered by the system. For 5-minute intervals the system outputs the average, minimum and

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Figure 1. Route choice situations as used in the interview surveys
maximum travel time. AM-peak measurements (7:30 – 9:30) were used for this analysis. For each 5-minute interval an average was calculated based on data of 15 working days.

A route is defined as a sequence of consecutive stations/sections. Due to the large number of samples from both measurements, average travel times are quite accurate on most sections. By adding these average travel times, the travel time of the corresponding route was obtained.

![Monitoring stations in the license plate survey of Enschede. The thick lines are main roads (≥ 50 km/h), of which the dark ones represent the main road structure. The lines are residential streets (30 km/h).](image)

3. RESULTS
In total 51 respondents reliably completed the survey online and 214 respondents participated to the face-to-face interviews. The respondents represent a random sample of university employees, students and visitors. This response provided 828 valid choice situations as not all respondents completed all choice situations.

When looking at the choices and the actual travel times it becomes immediately clear that a substantial fraction of the respondents did not select the shortest time route. In only 41% of the cases the shortest time route was chosen. In comparison, about half of the respondents choose the route with the highest average speed, while a minority selected the route which is shortest in distance. On average, travel times were overestimated by 2.54 minutes in the online survey and 5.5 minutes in the face-to-face interviews, which equals about 19% and 40% respectively of the average actual travel time.

3.1 The difference between perceived and actual travel time
The meaning of average perceived travel time is ambiguous. Dependent on whether a route is often chosen or not, perceived travel times may vary. We therefore also considered estimates of respondents who selected a route (i.e. users) and those who did not (i.e. non-users) separately. Also see Figure 3. The figure shows the relation between actual and perceived travel times and suggests that the respondents overestimated low travel times more than high
travel times. As expected, a positive correlation between perceived travel times and actual travel times was found (correlation coefficient of 0.69 for PPT+ and 0.57 for PPT-).

![Figure 3. Perceived travel time versus actual travel time (minutes)](image)

The difference between PPT+ and PTT- shows that the respondents on average overestimated travel times of non-chosen routes more than the travel times of chosen routes. In the online survey this difference was 2.76 minutes, while in the face-to-face interviews this difference was 1.3 minutes. Due to the large variation in the perceived travel time and the relatively small sample size for some of the choice situations, this finding is only statistically significant on a limited number of routes. Interestingly, in the online survey the perceived travel times of users are on average just 0.89 minutes larger than the actual travel times, which is not statistically significant. This suggests that the perception of travel time of chosen routes is fairly accurate (i.e. hypothesis 1). Contrary, non-users significantly overestimated travel times systematically in both surveys (i.e. hypothesis 2).

In addition, results showed that the respondents were perceptually more optimistic about the travel times of the more direct routes. As a result, when these routes are chosen, estimates are considerably lower, not just for the chosen route but also for the non-chosen route. Aggregation on a route level supports this finding. Orbital direct routes were chosen relatively most often, followed by center direct routes. Also PTT+ of these routes is on average smaller than that of the alternative routes, and smaller than the actual travel times. Overall, 58% of the respondents choose orbital routes and 60% of the respondents choose the most direct route.

### 3.2 The perceived travel time for chosen and non-chosen routes

In Figure 4, we take a slightly different perspective. For each OD pair and each respondent, the difference between perceived and actual travel time is compared for the chosen and non-chosen routes. Each symbol in Figure 4 thus represents one respondent and one OD pair. The top figure shows the estimates from the online survey while the bottom figure shows the estimates from the interviews.
Figure 4. Per respondent and route pair, the difference between perceived and actual travel time for chosen and non-chosen route (top = online survey, bottom = interviews).

From Figure 4, we draw the following conclusions. The perceived travel time estimates vary widely with respect to the actual travel time as users both overestimate and underestimate travel times. In particular, some respondents clearly overestimated travel time. However, for the online survey the median difference between perceived and observed travel time is only 0.1 minutes which is in line with hypothesis 1 and literature: people’s estimates of chosen routes are on average fairly accurate, but individual estimates vary widely.

Not surprisingly, there is a clear correlation between the rate of overestimation of travel time of chosen and non-chosen routes. Both figures confirm the third hypothesis: that respondents that overestimate the travel time of the chosen route tend to overestimate the travel time of the non-chosen route even more. In fact, the relation between PTT- - ATT- and PTT+ - ATT+ can be well described as: \( PTT^- - ATT^- = PTT^+ - ATT^+ + x \text{ minutes} \). In other words, when correcting for differences in actual travel time (or when assuming the same actual travel time), the perceived travel time of the non-chosen route is on average \( x \) minutes longer than that of the chosen route. In this case and based on Figure 4, \( x \) equals 3.77 minutes for the online survey and 2.05 minutes for the face-to-face interviews. Interestingly, a vast majority of the respondents intentionally chose the route which they perceived as being shortest. Based on
their perceptions these choices are perfectly logical. The remaining choices can only be explained by the influence of non-observed factors.

4. FAMILIARITY
For each of the routes, respondents were asked to indicate their level of familiarity on a 4-point scale (very familiar, moderate familiar, used 1-2 time, never used). Results showed that the vast majority of respondents were equally familiar with both route alternatives (78% of the cases). Most respondents were very familiar or moderately familiar with the route alternatives. Figure 5 shows the perceived travel times of four routes and clearly reveals that the perceived travel times of the least familiar respondents were lower than those of the most familiar drivers. This finding is statistically significant (95% confidence interval) for orbital indirect, orbital direct and the average. Differences between the other familiarity levels are not systematic. In addition, differences between the PTT+ and PPT- of different familiarity levels were not statistically significant, which shows that the results presented earlier are independent of the level of familiarity.

For comparison four actual travel times are indicated in Figure 5: Minimum TT = lowest travel time recorded in AM peak, Average TT = average travel time in AM peak, Peak ATT = travel time at the busiest moment of the AM peak and Maximum ATT = highest travel time recorded in AM peak. Considering that travel times were generally overestimated as mentioned earlier, the estimates of the least familiar drivers were among the most accurate. Similarly, the estimates of the most familiar drivers approximate the Peak ATT and Maximum ATT. These findings suggest that drivers initially are fairly positive about new routes, but that over time actual usage of these routes makes them increasingly pessimistic, or perhaps realistic. This might be explained by bad experiences that inevitably occur and make drivers cautious not to rely on average travel times alone but also on the travel time reliability. Along that same line of thought, the minimum ATT and maximum ATT show that the travel time range of the orbital direct route is larger than the range of other routes. Hence, relatively low travel times were measured too. This can be explained by the fact that the direct route passes the most signalized intersection. Perhaps respondents anticipate to this gamble.

![Figure 5. Perceived Travel Time versus familiarity](image-url)
To better understand the findings from Figure 5, choice and perceptions figures of the four familiarity levels are shown in Table 1. Since only the difference between ‘very familiar’ and ‘used never’ are statistically significant it is most interesting to examine these two outer cases. Row 1 shows that most respondents were very familiar or moderately familiar. There are no major differences between in the choices of perceived non-shortest time routes (row 2) and the choices of actual non-shortest time routes (row 3). The rows 4 to 9 suggest that the least familiar respondents choose orbital and direct routes more frequently than very familiar respondents did. This again implies that an a priori preference based on hierarchical and directness principles exists, even when such routes are not the shortest in travel time.

Table 1. Aggregated choices versus familiarity

<table>
<thead>
<tr>
<th></th>
<th>Very familiar</th>
<th>Moderate familiar</th>
<th>Used 1-2 times</th>
<th>Used never</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Percentage (N = 624)</td>
<td>43%</td>
<td>27%</td>
<td>13%</td>
<td>17%</td>
</tr>
<tr>
<td>(2) Choices perceived non-shortest time route</td>
<td>12%</td>
<td>14%</td>
<td>10%</td>
<td>12%</td>
</tr>
<tr>
<td>(3) Choices of non-shortest time route</td>
<td>59%</td>
<td>47%</td>
<td>63%</td>
<td>65%</td>
</tr>
<tr>
<td>(4) Choices Orbital Indirect (vs. Orbital Direct)</td>
<td>43%</td>
<td>41%</td>
<td>35%</td>
<td>29%</td>
</tr>
<tr>
<td>(5) Choices Center Indirect (vs. Center Direct)</td>
<td>51%</td>
<td>40%</td>
<td>56%</td>
<td>31%</td>
</tr>
<tr>
<td>(6) Choices Orbital Indirect (vs. Center Indirect)</td>
<td>49%</td>
<td>77%</td>
<td>33%</td>
<td>50%</td>
</tr>
<tr>
<td>(7) Choices Orbital South (vs. Orbital Direct)</td>
<td>68%</td>
<td>60%</td>
<td>57%</td>
<td>75%</td>
</tr>
<tr>
<td>(8) Choices Direct route (vs. Indirect route)</td>
<td>53%</td>
<td>59%</td>
<td>55%</td>
<td>70%</td>
</tr>
<tr>
<td>(9) Choices Orbital route (vs. Center route)</td>
<td>58%</td>
<td>68%</td>
<td>45%</td>
<td>63%</td>
</tr>
</tbody>
</table>

As mentioned before, only 22% of the respondents indicated different levels of familiarity for both route alternatives. In 5% of the cases they were very familiar with one alternative and moderately familiar with the other. The remaining 17% of the cases are randomly spread resulting in too low samples for analysis. Based on the results shown in Table 2 it appears that the respondents choose routes which they were most familiar with. While in case of equal familiarity, orbital routes and direct routes were chosen more often. It seems that, apart from travel time, familiarity is the primary route choice determinant, followed by road hierarchy (i.e. orbital or center), while directness (i.e. indirect or direct) comes third. This is in line with earlier findings.

Table 2. Choices versus familiarity

<table>
<thead>
<tr>
<th>Familiarity – chosen route (vs. route alternative)</th>
<th>Very familiar</th>
<th>Moderate familiar</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Very familiar - Orbital Indirect (vs. Orbital Direct)</td>
<td>43%</td>
<td>57%</td>
</tr>
<tr>
<td>(2) Moderate familiar - Orbital Indirect (vs. Orbital Direct)</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>(3) Very familiar - Orbital Indirect (vs. Center Direct)</td>
<td>49%</td>
<td>51%</td>
</tr>
<tr>
<td>(4) Moderate familiar - Orbital Indirect (vs. Center Direct)</td>
<td>14%</td>
<td>86%</td>
</tr>
<tr>
<td>(5) Very familiar - Center Direct (vs. Orbital Direct)</td>
<td>32%</td>
<td>68%</td>
</tr>
</tbody>
</table>

5. CONCLUSION
To assess drivers’ perception of route choice alternatives we compared perceived travel times with actual travel times. Perceived travel times were measured by means of interview surveys, while actual travel times were derived from a license plate survey and vehicle inductive profiles. Based on three hypotheses this study aimed to determine whether or not the choice-supportive bias exists in route choice, and to quantify perception bias.
The study results presented in this paper provide evidence in favor of the choice-supportive bias in route choice. The following conclusions can be made.

- \( ATT^+ = PTT^+ \). Travel time perceptions of chosen routes are fairly accurate, although widely variable. On average, travel times are overestimated, but there is no evidence that specifically chosen routes are perceived as being better than they actually are. At best, perceptions of chosen routes are accurate.
- \( ATT^- < PTT^- \). Non-chosen routes are perceived as being worse than they actually are. Travel times of non-chosen routes are considerably overestimated.
- \( PTT^+ < PTT^- \). Chosen routes are perceived as being significantly better than non-chosen routes. In addition, route familiarity, road hierarchy (i.e. orbital over center routes) and the directness of routes are important determinants of route choice.
- Perceived travel times of the least familiar respondents were lower than those of the most familiar drivers, which suggest that with more experiences of a particular route drivers become increasingly pessimistic or perhaps cautious.

These findings have important implications for traffic management practices. Consider for example the case of route guidance and traffic information. When drivers have a negative perception of a particular route, it may require considerable effort to persuade such drivers to use that route. Presumably, the incentive (e.g. monetary or travel time reduction) to switch to a non-chosen route must at the least compensate for the perception bias.

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