ASSESSMENT OF THE VALUE OF TRAVEL TIME FROM STATED CHOICE SURVEYS: THE IMPACT OF LEXICOGRAPHIC ANSWERING

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1. INTRODUCTION

Stated Preference surveys have been conducted in many countries all over the world as an important tool to assess the value of travel time (VOT). Such surveys collect information about the travel behaviour as well as the socio-economic characteristics of the respondents. In some surveys the respondents are asked to express their preferences in terms of ratings or judgments (e.g. Richardson 2002), although Stated Choice surveys, where the respondents are asked to choose from a series of choice sets, are common practice (e.g. Caussade et al. 2005). These are often bi-optional and contain alternatives that are described with attributes like trip duration and monetary cost, compared to some reference trip (e.g. Burge et al. 2004).

Travel behaviour researchers commonly consider that choices that are not a consequence of a consistent trade-off of all alternatives should be disregarded in the VOT-assessment. For example, in the analyses of the Dutch VOT surveys the responses of subjects that chose the dominated alternative from a controlling choice set were disregarded (HCG 1990, 1998). The responses to VOT-surveys are generally analysed with logit-type discrete choice models based on the principles of Utility Theory (UT). The individual choices from the different choice sets are commonly treated as independent (e.g. AMR & HCG 1999). However, the outcomes may leave some puzzling questions behind with respect to the interpretation of observed choice behaviour, such as sign, size and time effects in monetary valuation (e.g. Gunn 2001, Mackie et al. 2001).

Recently, some authors investigated the consistency of the answers of people to stated choice surveys. Sælensminde (2001,2002) and Rouwendal and De Blaaij (2004) found that many respondents did not comply with the transitivity-principle according to UT. Van de Kaa (2005) showed that most car drivers in the 1988 and 1997 Dutch surveys also violated this principle. Excluding these respondents would leave a minority of the survey population for the VOT assessment. He demonstrated that a majority of the answering sequences could be explained by the consistent application of Prospect Theory (PT), while most remaining sequences could be explained by the consistent application of non-compensatory strategies.

Many surveys revealed that a considerable share of the respondents to stated choice surveys systematically selected those alternatives with the ‘best score’ on one attribute only (Sælensminde 2001, Arentze et al. 2003, Rizzi & Ortúzar 2003, Iragüen & Ortúzar 2004, Rouwendal & De Blaaij 2004, Van de Kaa 2005). Opinions differ as to the causes of this so-called strong lexicographic answering. Consequently, it is unclear whether they should be included in the
VOT-analysis. This decision has a strong impact on the resulting VOTs. Rizzi & Ortúzar (2003) and Iragüen & Ortúzar (2004) found a VOT that was approximately 20% lower when they were excluded, and Sælensminde (2001) a more than 50% higher one.

This paper aims to investigate whether lexicographic answering sequences from stated choice surveys should be included in VOT assessments. It compares the individual responses to the 1988 and 1997 Dutch national VOT-surveys (see Section 4) by following the principles of Extended Prospect Theory (EPT) (Van de Kaa, forthcoming) and demonstrates that the lexicographic answers should be included in the analysis. It also shows that the assessments with logit models underestimate the average VOT compared to an assessment based on the VOTs of those respondents that traded-off all alternatives in a consistent way.

Section 2 introduces EPT and compares it with the principles of UT. Section 3 discusses the choice behaviour that may give rise to strong lexicographic answering. The design and realization of the Dutch 1988 and 1997 national VOT surveys are summarized in section 4, together with the contents of the resulting choice behaviour database. Section 5 describes the choice behaviour strategy that was implicitly presumed in the final reports of the surveys (HCG 1990, 1998). Several non-trading choice behaviour strategies are described in section 6, where they are matched with choice sequences as found in the database. Section 7 identifies choice sequences from the database that may be based on consistent trade-offs of money and time expenses of the alternatives. A comparison of the frequency of employment of different choice behaviour strategies as observed in 1988 and 1997 is discussed in section 8. This demonstrates that the strong lexicographic answering results from a consistent trade-off of time and money expenses. Section 9 analyses the effect of the exclusion of lexicographic answering sequences on the VOT. Conclusions are formulated in section 10.

2. EXTENDED PROSPECT THEORY

The dominant paradigm of human choice behaviour in social sciences is Utility Theory (UT). In between 1979 and 1992 Prospect Theory (PT) was developed as a descriptive-behavioural alternative (Kahneman & Tversky 1979, Tversky & Kahneman 1991, 1992). A comparison of its premises and those of UT with empirical results from behavioural sciences, including travel behaviour research, showed that in almost all choice contexts only a minority of the subjects complied with UT’s premises, while a majority followed the PT premises (Van de Kaa, forthcoming). For an accurate description of the observed interpersonal diversity in choice behaviour, several premises of both UT and PT had to be adapted and some other premises were added. A selection, synthesis and extension might be appropriate as a generic functional-descriptive theory for human choice behaviour. In recognition of the impressive work of Kahneman and Tversky this is called Extended Prospect Theory (EPT). The comparisons of premises and empirical findings are extensively described in Van de Kaa (forthcoming), together with comprehensive foundations of EPT.
In the context of stated choice surveys without probabilistic or affectively salient attributes, the following three EPT premises differ the most from the corresponding UT ones:

i. EPT: Choice subjects frame alternatives context-dependent, as changes with respect to a reference state;
   UT: Context-independent, as post-decisional states.

ii. EPT: The majority of people demonstrate loss aversion in the valuation of the attributes of choice alternatives;
    UT: Sign independent/loss neutral valuation.

iii. EPT: Within a population, within-context differences in idiosyncratic decision rules (=evaluation-and-choice algorithms) may occur;
    UT: all people assess one (compensatory compounded) overall ordinal utility for each alternative and choose the alternative with the highest utility.

EPT assumes that most people use just one choice behaviour strategy (combination of decision frame, valuation principle and decision rule) during successive choices in the same context. This may be considered as a weak substitute for the complete, transitive and context-independent preference order of UT. In connection with this the following notions are crucial for the interpretation of this paper:

Choice behaviour strategy is the employment of a combination of framing, attribute valuation and evaluation-and-choice principles that are consistent with the subject’s interests in the particular context.

Choice sequence is a series of choices by that subject in that context, by the recurrent employment of the choice behaviour strategy in connection with the valuation of the attributes of the alternatives.

For recurrent operational choices, like the daily home departure time of commuters, EPT presumes that the choice behaviour strategies include feedback-based updating of the choice frame. If no feedback about the outcomes of choices is available, like in most stated choice surveys, people are presumed to follow just one strategy. One should realize, however, that changes in the character of the choice sets of a stated choice survey may also cause adjustment of the choice frame.

3. STRONG LEXICOGRAPHIC ANSWERING

When respondents in a stated choice survey systematically choose the alternative with the most profitable value on one attribute this is here called ‘strong lexicographic answering’. One example is the survey on the valuation of Chilean interurban road safety by Rizzi & Ortúzar (2003). Here, a large part of the 342 respondents chose the route alternatives with the lowest accident risk (21 %), travel time (17 %) or toll charge (6 %) from each choice set. Using similar survey designs, Iragüen & Ortúzar (2004) and Rouwendal & De Blaej (2004) reported similar percentages. Sælensminde (2001, 2002) even observed almost 75 % in a 4-set survey. Van de Kaa (2005) found only 15 % in a re-analysis of the responses of car drivers to the 1988 and 1997 Dutch VOT surveys. The frequency of strong lexicographic answering apparently diminishes with an increase in the number of choice statements (see Table 1).
Table 1 Frequency of strong lexicographic answering in stated choice surveys

<table>
<thead>
<tr>
<th>Source</th>
<th>Number of choice sets</th>
<th>% strong lexicographic answering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sælensminde (2001, 2002)</td>
<td>4</td>
<td>74</td>
</tr>
<tr>
<td>Sælensminde (2001, 2002)</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>Rizzi &amp; Ortúzar (2003)</td>
<td>9</td>
<td>44</td>
</tr>
<tr>
<td>Iragüen &amp; Ortúzar (2004)</td>
<td>9</td>
<td>39</td>
</tr>
<tr>
<td>Rouwendal &amp; De Blaeij (2004)</td>
<td>10</td>
<td>28</td>
</tr>
<tr>
<td>Van de Kaa (2005)</td>
<td>12</td>
<td>15</td>
</tr>
</tbody>
</table>

Three explanations are reported for observed strong lexicographic answering:

1. Consistent application of the strong lexicographic rule on any choice set, to express a strong lexicographic preference. Recent findings suggest that only a few people may exhibit such preferences, based on ethical convictions regarding life-threatening eventualities, species conservation etc. (e.g. Spash 2000, Rosenberger et al. 2003).

2. Consistent application of the strong lexicographic rule on any choice set, to simplify the choice task. Arentze et al. (2003) considered that the cognitive abilities of the choice subject in relation to the choice task complexity might influence the extent of lexicographic answering as a consequence of simplifying the decision rules but found no clear indications for this.

3. Consistent application of the weighted additive rule on choice sets that do not contain acceptable values for the ‘other’ attributes. It means that the extent of lexicographic answering would decrease with an increase in the range of values for the ‘other’ attributes of the choice sets. This was actually demonstrated for some ‘personal interest’ choices (Rosenberger et al. 2003, Cairns & Van der Pol 2004). More often than not this range will increase with an increase in the number of choice sets submitted. This may explain the decrease in the observed frequency of lexicographic answering in the VOT-assessment studies mentioned above (see Table 1).

One might consider that a consistent application of the strong lexicographic rule in a stated choice survey does not reveal a genuine value of travel time. Thus, answers based on such choice behaviour strategies should be excluded from the VOT assessment. However, if a strong lexicographic answering sequence is the result of consistent application of the weighted additive rule, they adhere completely to the premises of UT as well as PT and should be included in the VOT assessment.

A comparison of strong lexicographic responses in two VOT-surveys that differ in the scale extension of one of their attributes may reveal the choice
behaviour that causes it. Consider two surveys in which all monetary attribute levels in survey A are twice as high as in survey B, while all submitted travel times are the same. By definition, the choice sequences of all respondents that employ the strong lexicographic rule are the same in both surveys. However, if respondents consistently trade-off the money and travel time expenses of all alternatives, in survey A more people would choose all the alternatives with the lowest monetary costs compared to survey B, while less people would choose all the alternatives with the lowest travel time. Likewise, the frequency of other choice sequences that indicate a low VOT should be higher in survey A compared to survey B, while the opposite should hold for sequences implying a high VOT. The responses to the Dutch 1988 and 1997 VOT surveys provide such a base for comparison. The comparison is discussed in section 9 and shows that the observed lexicographic answering is the result of consistent trade-off behaviour.

4. DESIGN, REALIZATION AND RESULTS OF THE DUTCH VOT-SURVEYS

In 1988 and 1997, two large-scale SC surveys were held in the Netherlands to assess the VOT. The designs of both surveys were the same (HCG 1990, 1998). By courtesy of AVV Transport Research Centre, full documentation of both surveys was available for the current research, including the tabulated responses of the individual interviewees. These were excellently filed away and saved by HCG's successor Rand Europe.

The survey panel members were recruited while they were ‘on their way’ for business, commuting or other purposes. They were asked on the spot to answer questions about their actual trip, and whether they were willing to participate in a postal survey. A prize-draw was offered for travellers that completed and returned the follow-up questionnaire. The recruitment continued until a sufficient sample for nine trip purpose – travel mode combinations was attained.

Participants in the postal survey received a customized questionnaire, summarizing the information collected in the recruitment interview and allowing corrections to be made to this information. It further asked for information about the previous trip and about personal and household characteristics like gender and income. The core consisted of 12 bi-optional choice sets with time-cost trade-off questions and the actual ‘recruitment’ trip as a reference.

Four choice sets contained the reference trip and either a time loss/money gain or time gain/money loss alternative; one choice set contained a dominant alternative, added to check for the interviewees' understanding of the questionnaire. Depending on the duration of the reference trip, time savings and losses from 5 up to 40 minutes were submitted, along with cost increases and reductions. The nominal money values were the same in both surveys. As the guilder inflated by 24 % between the two surveys, the real values for trip cost levels submitted in 1997 were 80 % of those in 1988.
The response rates to different phases of the surveys are described in the final reports (HCG 1990, 1998). After checking, coding and classifying (and occasionally supplementing and correcting) the answers on the completed questionnaires, the data were entered and saved as SPSS-files. These files were recovered in 2005.

The data in the SPSS files of the 1988 and 1997 surveys differed in several respects. The 1997 database was more complete, and contained, amongst others, the literal rectifications by respondents of the information from the recruitment interviews. It appeared that 13 respondents received and completed a questionnaire that was customized for another transport mode than used during the recruitment interview. These records were removed. Where appropriate the files were rectified for the other remarks. Next, the survey year variable was added, measures and classifications of variables were made uniform and information that was not available in one of the databases was removed from the other. The remaining 7794 records were united in one database.

As mentioned before, the 12 choice sets submitted in the 1988 and 1997 surveys were identical in nominal terms. This meant that the same sequence of choices yields the same nominal value of time. However, in the united database that was used for the analyses presented in this article all nominal values were converted into € and inflated to real monetary values at a 2005-price level. The calculations were based on the annual price-index figures for Dutch households as published by Statistics Netherlands.

5. CHOICE BEHAVIOUR AS PRESUMED IN THE SURVEY REPORTS

The analyses presented in the final reports of the surveys were applied to a database from which the records with ‘erroneous information’ were removed. These concerned records with missing data about household income, age, sex, job and trip purpose; with one or more stated choice questions not filled in; and in which the interviewee chose a dominated\(^1\) alternative. Together they made up 15 to 20 % of the records. After these were removed, 6,168 records remained.

The remaining choice statements were analysed with logit models. In both surveys differences in utility between gains and losses were not considered, which means that they were essentially averaged. In concordance with Random Utility Maximization (RUM) theory, each choice statement was considered to express a preference for the alternative that offers the highest utility to the choice subject, in terms of the sum of a weighted value of travel time, a weighted value of monetary costs, and a random term to allow for unobserved characteristics of the choice context. This is identical to the weighted additive decision rule of Decision Theory (e.g. Payne \textit{et al.} 1993). According to this, the VOT of each individual equals the quotient of the weighted value of monetary cost and the weighted value of travel time, or the ratio of the travel time and travel cost coefficients in the utility function. However, the 12 choice statements of each individual were treated as stochastically independent, thus the VOT of the individual respondents was
not assessed. Segmentation factors in the model accounted for systematic differences in VOT between socio-demographic groups and travel circumstances. The models thus presumed an average VOT for segments of the survey population, with random variations to allow for interpersonal as well as intrapersonal deviations from a RUM-consistent choice behaviour strategy.

The VOT assessments in the final reports of the surveys thus presumed that all respondents followed one transitive, utility maximizing choice behaviour strategy or else provided unreliable choice statements.

6. ERRORS AND NON-TRADING CHOICE BEHAVIOUR STRATEGIES

For one reason or another, 7,794 persons took the effort to complete and return the questionnaire. The database does not provide information about their motives to do so, nor about the choice behaviour strategy that they followed. EPT presumes that each subject follows one of several feasible choice behaviour strategies consistently when she has to make successive choices in a particular context. But people may have made errors in doing so, which would result in choice sequences that cannot be explained by a consistent time-money trade-off of all alternatives. And several respondents might have rushed through the questionnaire inconsiderately, skipping or randomly answering several questions, maybe solely motivated by the prospect of the announced prize-draw.

This article starts with an analysis of choice sequences that may be caused by human errors. Next, the research is reported where several choice behaviour strategies were conceived that make sense for people who want to complete and return the questionnaire but wish to reduce the mental effort of doing so. Most of these are based on mental inertia\(^6\) rather than on a consistent trade-off of time and money costs for all choice alternatives. Some were discussed elsewhere (Van de Kaa 2005) from such respondents’ perspectives. Some of these were found by ‘cracking the code’ of frequently observed choice sequences. The choice sequences that follow from the employment of these strategies were determined. These were matched with the sequences as found in the database. In decision theory, this procedure is called the ‘structural’ or ‘outcome-oriented’ approach for the elicitation of choice behaviour strategies (e.g. Payne et al. 1993, Rieskamp & Hoffrage 1999). Obviously, the sequences that are not based on the systematic trade-off of time and money expenses should be excluded from VOT-assessment.

Random errors and inconsistencies
Even the most conscientious people make errors when they complete questionnaires. They may have marked the ‘wrong’ alternative in just one choice set, as a result of miscalculations, mistakes, a moment of inattention, or genuine inconsistencies. This may explain choice sequences that occur infrequently and differ, in one choice statement only, from frequently observed sequences. To assess the extent to which such errors might play a role, the 59 choice sequences that each occurred more than 13 times in the database were considered. For each of these, all choice sequences that differed in only one statement were determined and the frequency of their occurrence in the
database was assessed. Where one low-frequency, allegedly ‘wrong’ sequence could be related to several frequently occurring sequences it was proportionally allocated to these. One should note that this approach does not identify respondents’ errors in judgments that result in an ‘unintended’ choice sequence which coincides with a sequence that results from another choice behaviour strategy that is frequently employed by fellow respondents.

The 223 choices for the dominated alternative in choice set 8 of the surveys gives some clues for assessing the extent of random errors. It appears that 155 choice sequences coincide with more frequently observed sequences for the remaining 11 choice sets. Assuming chances of: <2 %; 2-4 %; 4-6 %; and 6-8 %, of one random error in each individual choice statement, explains 50; 29; 4; and 9 of the choice sequences with the dominated alternative. The same chances would explain 200; 259; 239; and 316 of the sequences that contained the dominant alternative. If the errors are random and 11 choice sets did not contain a dominated alternative, these numbers should be about 11 times the corresponding numbers of ‘dominated’ choice sequences. This apparently holds only up to a 4 % chance.

Rouwendal & De Blaeij (2004) found that as much as 15 % of their 1,055 respondents chose different alternatives from identical choice sets in a traffic safety-travel time-cost survey. When such a high percentage is representative for the error frequency in the surveys considered here, by far the most choice sequences would be the result of random errors and the frequency distribution of observed sequences would be much ‘flatter’ than observed in the database. Apparently this is not the case.

Using an upper limit of 4 % for the chance of marking the ‘wrong’ alternative in any choice set could explain 57 (30 %) of the 189 ‘unique’ sequences in the database and 382 (57 %) of the 666 sequences that were observed from two up to and including 12 times. Thus, compared to choice sequences that occurred between 2 and 12 times, a smaller share of the uniquely occurring choice sequences can be explained by random errors. This holds for the sequences that contained the dominant alternative as well as those that contained the dominated one. The corresponding average number of mistakes in each individual choice statement was 2 %, or a 25 % chance that an individual makes one random error in his choice sequence.

**Misunderstanding of the questionnaire**

The instructions for the completion of the stated choice questions asked to mark the preferred alternative in each choice set. When people are indifferent between the alternatives in a choice set they were apparently encouraged to mark one of the options randomly. But in several choice sets both alternatives may be unacceptable, for example if both alternatives are considered less attractive than the reference trip. In real life situations people would then opt for the status quo. In the survey they might leave such questions unanswered.

**Inertia-based skipping of choice questions**

One way to reduce the mental effort of completing the questionnaire is to skip questions. 244 respondents did not complete any of the 12 stated choice
questions and 89 filled in one, two or three questions, mostly the first ones, and missed out the rest. Another 130 respondents left out between 3 and 9 questions, of whom 32 just skipped the completion of a whole page with six choice sets. Finally, 31 respondents completed 10 and 137 respondents 11 stated choice questions.

It would appear that mental inertia was the most important driving force behind the skipping of some questions as 126 (57%) out of the 223 respondents who completed the first four questions but missed some or all of the others systematically chose for the reference state. The omission of some or even most other choice statements suggests that these ‘status quo’ preference statements might be based on a simplifying heuristic instead of a consistent trade-off of loss aversive valued monetary and time gains and losses (Mackie et al. 2001, Van de Kaa 2005). Therefore, all sequences with one or more choice statements missing are considered as unreliable.

**Random choice**

A small but significant number of the choice subjects may have applied the Random Decision Rule of Decision Theory (e.g. Johnson et al. 1993) as a consequence of inertia, indecision or lack of interest. This implies that a choice subject selects the alternatives at random from the choice sets. If a group of respondents applied this rule consistently in the VOT surveys, their individual responses in terms of choice sequences can be conceived as stochastically independent.

Basic statistical rules can be used to assess the extent to which choice sequences might be a consequence of the application of this rule. Starting with the most frequently encountered choice sequence (k records) one might apply a null hypothesis that all respondents choosing choice sequences with a frequency up to and including k used the random rule. If the null hypothesis is rejected, the number of random choosers is reduced with these respondents. When this procedure is repeated until p(k) is significant it appears that the null hypotheses has to be rejected for all choice sequences in the database that occur more than twice. Only a few twofold chosen sequences might be a consequence of the consistent application of the random rule, together with any uniquely chosen sequences.

A consequence of consistent application of the random rule is that the chance that the dominated alternative is chosen from choice set 8 should be equal to the chance that the dominant alternative is selected. Excluding the sequences that may be caused by random errors, 87 of the unique choice sequences contained the dominant and 45 the dominated alternative. This supports the low frequency of employment of the random rule. Taking into account the unique choice sequences that are most probably caused by random errors, about 1.5 % of the respondents might have applied it. The unique and twice-observed choice sequences are further considered as inapt for the VOT assessment as they might be a consequence of either the random rule or random errors.
“Stick to the left-hand side”
Several interviewees may have followed a less drastic easy strategy than either skipping questions or completing the questionnaire at random. One way may be to choose the alternatives at the left hand side of the questionnaire unless they do not meet a ‘satisficing’ threshold level with respect to money and/or time, in which case the right-hand side is considered and chosen if the threshold level is met. Using ‘no money loss’ as cut-off criterion yields 17 choice sequences for the left-hand side strategy and two sequences for its right-hand side alternative. No time loss as cut-off criterion explains four sequences for the left-hand side strategy and none for its right-hand side alternative. Similar inertia-based strategies, like “fixed order” responses (like A-B-A-B-A-B …or A-A-B-B-A-A-…) were not encountered in the database.

Status quo bias combined with other inertia-based strategies
After excluding respondents who did not complete all twelve stated choice questions, 32 % chose the reference state from all four choice sets that contained it. Mackie et al. (2001) considered that the choice for the reference state, which could explain the difference in the valuation of positively and negatively experienced changes of equivalent size by car drivers in a UK VOT survey, was caused by mental inertia. Van de Kaa (2005) showed that this was highly unlikely, as only a small part of the car drivers that did take part in the Dutch surveys combined a preference for the reference state from the four sets that contained it with random choice, fixed order responses or strong lexicographic answers to the remaining eight stated choice questions. Examination of the choice sequences in the complete database confirms this finding. Obviously, one cannot rule out the possibility that some of the 76 (1 %) “status quo” choosers who combined this with lexicographic answering exhibited an inertia bias. However, a non-compensatory two-stage strategy starting with an attribute-based elimination rule drawing on loss aversion, resulting in an empty choice set for eight stated choice questions, followed by a compensatory re-evaluation of the initially rejected options, would do the same job.

Combinations of the status quo bias combined with other inertia-based strategies may explain several sequences that contain a choice for the dominated alternative. For example, two sequences were chosen 10 and 5 times respectively, much more frequently than can be explained by random answering. They might be the result of a choice for the status quo from the first four choice sets, followed by the choice for the right-hand side alternative unless this implied no monetary gain or a monetary loss, in which case the left-hand side alternative was chosen as long as it implied no money loss. More puzzling is a sequence that was completed 18 times and contained the dominated alternative. These respondents might have started with a choice for the reference state from the four choice sets on the first page of the stated choice game, followed by a choice for the alternative that promised a shorter travel time from the two remaining sets on that page that compared alternatives with money and time gains and losses. The second page had no choice sets in which the reference alternative could be chosen, but contained the dominant alternative at the left hand side of the page. From this page, these respondents might have chosen the right-hand side alternative as far as
this implied no money loss and only considered and chosen the left hand side alternative to avoid a loss of money. This explanation evokes the question of what caused the apparent shift in strategy from one page to the other. An alternative explanation is a relatively high random error in a sequence that occurred 191 times. Whatever gave rise to this choice sequence, it is obvious that this and the preceding sequences are not the result of a consistent trade-off of monetary and temporal consequences.

**Strong lexicographic decision rule**

As described in section 3, respondents who follow the Strong Lexicographic Rule (SLR) systematically choose the alternative with the most profitable value on one attribute. As all alternatives in the stated choice survey contained two attributes and the levels of the attributes differed between the alternatives submitted in each choice set, consistent employment of SLR yields two choice sequences. The choice sequence that implied that the alternative with the lowest travel cost was chosen from each choice set (SLR-money) occurred 135 times in the database, the one implying a choice of the alternative with the lowest travel time (SLR-time) was observed 659 times.

**Summary**

About 10% of the choice sequences might have been caused by the consistent application of the strong lexicographic rule. In the remaining part of this article we will consider whether or not these should be better attributed to a consistent trade-off of time and money expenses.

Random errors (up to 4% in each individual choice statement), skipping of questions as a consequence of misunderstanding or mental inertia, the Random Decision Rule and several more strategies that draw on mental inertia, together may explain over 15% of the choice sequences. These are not based on a consistent trade-off of the monetary and time costs of the alternatives in all choice sets. They included almost all choices for the dominated alternative and almost all sequences that occurred up to 13 times, but hardly any sequences that occurred more than 17 times. Moreover, only six of these sequences could also be a consequence of the consistent application of one of the ‘trading’ choice behaviour strategies considered in the next section. Therefore, all but these six choice sequences, including the remaining sequences that contain a choice for the dominated alternative of choice set 8, were considered as unreliable and unsuited for VOT assessment. The files that contained these sequences were removed from the database that will be used for further analysis. Together they comprised about 17% of the original database, about the same percentage that was disregarded for the original VOT-assessments – though there are some distinct differences in the removed files (HCG 1990, 1998). This left 6465 records for further analysis.
7. CHOICE BEHAVIOUR STRATEGIES BASED ON THE TRADE-OFF OF TRAVEL TIME AND MONETARY COST CONSEQUENCES

Extended Prospect Theory (EPT) presumes that each subject follows one of several feasible choice behaviour strategies consistently when she has to make successive choices in a particular context. Experience shows that most people complete stated choice questionnaires conscientiously and trade-off the costs and benefits of alternatives to the best of their knowledge. Those respondents that did so might have employed several choice behaviour strategies, e.g. combinations of a reference state, characterization of the alternatives, attribute valuation principle and decision rules. Some of them may be very averse to any increase in travel costs while others do not care, for example because they get any increase reimbursed. Several choice behaviour strategies were conceived that make sense from different respondents’ perspectives. The same procedure was followed as described in the previous section to assess these strategies and to identify the choice sequences in the database that comply with them.

**Transitive compensatory strategy in conformity with UT**
The transitive choice behaviour strategy in conformity with UT (UT-comp for short) is defined here as the consistent application of the weighted additive rule in connection with the maximization of loss-neutral utility assessment. Taking into account interpersonal differences in attribute values this results in a limited number of choice sequences. In surveys with bi-optional choice sets and two attributes per alternative, each choice statement yields one inequality that defines an upper or lower boundary for VOT. Solving these for the 12 choice sets (including one with a dominant alternative) submitted in these surveys yielded 12 choice sequences and corresponding VOT-classes that satisfy the transitivity principle. Allowing for random choice from sets with alternatives that are equally valued might have added some sequences that define a particular VOT instead of a bandwidth, but these were not encountered when UT-comp was applied to the questionnaires of the Dutch surveys.

The choice sequence that corresponds with a very low or zero VOT is identical to that following from SLR-money, the one that corresponds with a very high to infinite VOT coincides with that caused by SLR-time. The other ten choice sequences that comply with UT-comp have intermediate VOTs. Together these 12 sequences were identified in 2199 records. One might consider that all other sequences in the database violate the transitivity principle.

**Loss aversive valuation in accordance with PT**
The survey design offered the interviewees a choice frame in conformity with Prospect Theory (PT). The ‘reference state’, with its strong emphasis on a real-life (reference) trip was clearly circumscribed. The alternatives were characterized by increases and decreases relative to the reference trip, which might have boosted a change-oriented choice behaviour even for people not inclined to it. The instruction in the questionnaire to imagine that the trip is made in the interviewees’ own time and that the travel expenses are at their
own expense will probably have incited most of them to consider increases in both travel time and monetary cost as losses. The limited complexity of the choice task facilitates the employment of a compensatory decision rule.

For different degrees of loss aversion, different choice sequences may be found that satisfy the consistency principle. The loss aversion factors 1.5, 2.0 and 2.5 were applied to all attributes. For evaluation-and-choice, the same Weighted Additive rule was employed as for UT-comp. Also the calculations were the same. This yielded 15 consistent choice sequences for $\lambda_{\text{time}} = \lambda_{\text{cost}} = 2.0$, including six that were found by presuming random choice from sets with alternatives that are equally valued and thus characterized by a unique VOT instead of a bandwidth. The calculations with $\lambda_{\text{time}} = \lambda_{\text{cost}} = 1.5$ and $\lambda_{\text{time}} = \lambda_{\text{cost}} = 2.5$ each yielded just 12 consistent sequences that each represents a VOT-band. Three of the six sequences indicating a unique VOT as found for $\lambda_{\text{time}} = \lambda_{\text{cost}} = 2.0$ were also revealed for $\lambda_{\text{time}} = \lambda_{\text{cost}} = 1.5$, but now indicating a VOT-bandwidth. The other three were amongst the 12 sequences found for $\lambda_{\text{time}} = \lambda_{\text{cost}} = 2.5$. These findings are in agreement with an average $\lambda = 2.0$ (standard deviation $\sigma = 0.4$) as assessed from 20 published simple trading experiments (Van de Kaa, forthcoming). For the prediction of choice behaviour it seems advisable to take this variance into account.

For the present paper, only the VOTs found for $\lambda_{\text{time}} = \lambda_{\text{cost}} = 2.0$ are considered. The choice behaviour strategy to which they comply is in this article abbreviated ‘PT-two-two’. This strategy covers the choice sequences of 3601 respondents. Obviously, these included both choice sequences in conformity with the application of the strong lexicographic rule. They also included all but 75 sequences that could be explained by the application of a transitive choice behaviour in conformity with UT.

**Loss aversive valuation with shifted reference**

Though the questionnaire incited people to evaluate the submitted cost and travel time variations as if they affected the interviewee’s interests, several people might have considered the travel costs of the submitted alternatives as routine expenses. This would mean that they are framed in the ‘gain domain’, which implies a loss neutral valuation (e.g. Tversky & Kahneman 1991). With $\lambda_{\text{time}} = 2.0$ and $\lambda_{\text{cost}} = 1.0$ this yields the PT-two-one strategy. The same calculations as described above revealed 15 consistent choice sequences, completed by 2878 respondents. Of these sequences, 1627 also comply with UT-comp, and 2504 with PT-two-two.

**Travel time saving at an acceptable price-per-minute**

People may aim to ‘buy’ the alternative with the lowest travel time as long as the price for it is acceptable. A choice behaviour strategy that suits this aspiration is to start each choice process with the assessment of the alternative with the shortest travel time and to compare it with the reference trip. If the duration of this ‘fastest trip’ is shorter than or equal to that of the reference trip, and the extra money expenses per minute time gain are below an acceptable level, then it is selected. If not, both alternatives are compared with the weighted-additive value rule, applying a loss aversion factor for time losses relative to the reference trip, and the alternative with the highest value
is chosen. Monetary expenses are considered as ‘normal’ everyday market transactions and thus valued loss neutral. This strategy is further referred to as SAVE-time.

This strategy is essentially a lexicographic evaluation of travel time, in combination with a ‘satisficing’ elimination principle, followed by a loss aversive, compensatory evaluation when the submitted choice sets do not allow application of the first rule. It allows for the assessment of an idiosyncratic VOT value. The 2245 observed choice sequences that comply with this rule include those in concordance with SLR-time, 509 other sequences that comply with UT-comp as well as PT-two-two, and 288 more sequences that comply with PT-two-two. Except for the sequences that can be explained by SLR-time there exists no overlap with sequences explained by PT-two-one.

**Money savings at an acceptable price-per-minute**

As in the previous strategy, people treat travel costs as loss-neutral money expenses, and aim to minimize their travel expenses as long as the money ‘earned’ per minute time loss is above an acceptable level. Each choice process starts with the assessment of the alternative with the lowest travel cost and compares it with the reference trip. If this ‘cheapest’ alternative implies expenses equal to or smaller than the reference trip time, and the extra travel time has a value per minute time loss that is below an acceptable level, then it is selected. If not, both alternatives are compared with the weighted-additive value rule, applying a loss aversion factor for time losses relative to the reference trip, and the alternative with the highest value is chosen.

The 1674 observed choice sequences that comply with this strategy include the SLR-money sequences and 178 more sequences that can be explained by UT-comp as well as PT-2,2. 863 more sequences coincide with PT-2,2. Most of the remaining 498 sequences are also explained by PT-2,1. There is no overlap with the previous rule.

**Attribute-based elimination followed by Prospect Theory**

Most choice sequences that follow from the application of UT, PT or and/or SAVE strategies can also be explained by elimination of alternatives with losses above an acceptable attribute threshold, followed by a compensatory evaluation. Such a two-stage evaluation-and-choice process is frequently reported from many different fields, including stated choice surveys of VOT (e.g. Cantillo and Ortúzar 2005). Respondents may also evaluate the alternatives first according to the weighted additive value rule, to find out that, even when they applied loss aversion to both monetary and time changes, the selected alternative implies a non-acceptable increase in either monetary expenses or travel time. Rejection of those unacceptable alternatives and still choosing the alternative with the higher VOT will result in identical choice sequences. From a functional-descriptive perspective both two-stage strategies are equivalent. Here, only combinations of Attribute-Based Elimination with a Compensatory evaluation according to the PT-two-two strategy are considered (ABEC for short). The elimination is either applied to
alternatives that imply (most often high) additional monetary expenses compared to the reference state (ABEC-money) or to all alternatives implying an unacceptable increase in travel time (ABEC-time). In addition to the choice sequences that were explained above, 688 more could be the result of the application of ABEC-money and an additional 39 sequences might be the result of ABEC-time.

**Summary**

Seven different choice behaviour strategies have been identified and described. These choice behaviour strategies, the employment of which will be compared in the following section with each other and with the strong lexicographic rules (SLR-money and SLR-time), are:

- The transitive compensatory strategy in conformity with UT (UT-comp);
- Loss aversion in accordance with PT, $\lambda_{\text{time}} = \lambda_{\text{cost}} = 2$ (PT-two-two);
- PT with shifted reference, $\lambda_{\text{time}} = 2$ and $\lambda_{\text{cost}} = 1$ (PT-two-one);
- Maximization of travel time savings at an acceptable price (SAVE-time);
- Maximization of money savings at an acceptable VOT (SAVE-money);
- Elimination of alternatives implying unacceptable money losses followed by compensatory loss aversive evaluation (ABEC-money);
- Like ABEC-money, but elimination of time losses (ABEC-time).

All cover one or both of the two sequences that might also result from the application of the strong lexicographic rule discussed in the previous section. They employ the weighted additive decision rule and/or the strong lexicographic rule, sometimes in combination and/or together with elimination principles and almost all relying on some kind of loss aversive valuation. All of these might be consistent with the interests of the choice subjects that employed them during the completion of the stated choice questionnaire. Together these explain 88% of all choice sequences. One should realize that a host of non-compensatory decision strategies are described that may explain the remaining, less common sequences, while many of these might also be explained by other combinations of loss aversion factors, compensatory, lexicographic and elimination principles than those considered in the seven strategies above.

**8. FREQUENCY DISTRIBUTION OF CHOICE BEHAVIOUR STRATEGIES**

The differences in the relative frequency of the 1988 and 1997 answering sequences might show whether or not the different strategies are based on a reliable trade-off of the alternatives with respect to their travel time and cost outcomes. If a significant segment of the survey population employs the Strong Lexicographic rule (SLR) to express lexicographic preferences or to simplify the choice task, there is no reason to expect that this segment would increase or decrease between 1988 and 1997, as the questionnaires are identical. If a significant segment of the population demonstrated a small VOT (below a low upper limit) as a consequence of a consistent trade-off of the alternatives, and another segment a high one (above a high lower limit, as a consequence of SLR-time), inflation of the value of money would cause both limits to shift down. Thus the segment that demonstrated a low, upper bound
VOT would decrease in size between 1988 and 1997, while the segment demonstrating a high VOT would increase.

To test which one of the explanations is true, a null hypothesis was formulated that there is no association between the variables ‘Choice behaviour strategy’ and ‘Year’. The first variable may, for example, contain two categories of choice sequences: all strong lexicographic ones and all other ones. The second variable contains the years 1988 and 1997 that only differ by 24% in the real values of all the monetary attribute levels, all other things being equal. If the null hypothesis has to be rejected (p < 5%) the two variables may be considered as related, thus the frequency of strong lexicographic answering changes with the real values of the submitted travel costs. Consequently, strong lexicographic answering may be considered to be the consequence of consistent trade-off behaviour. If the null hypothesis is accepted (p > 5%) the strong lexicographic rule might be considered as a choice behaviour strategy that was employed by a significant and stable part of the population in both years. This may be a consequence of a shift from the ‘SLR-money’ to the ‘SLR-time’ segment as a consequence of deliberate trade-off behaviour, while the total number of strong lexicographic choosers remains the same. One might test the null hypothesis successively for the distribution over these two ‘rules’ and the ‘other strategies’, or use a nominal VOT-class distribution and/or both underlying choice sequences as controlling variables. If the null hypothesis has to be accepted again, this is considered as convincing evidence that lexicographic answering should be excluded from the VOT because it is evidently not based on a consistent trade-off of time and money expenses. If it is rejected, this is considered as evidence that the strong lexicographic answering sequences are a consequence of consistent trade-off behaviour and should be included in the VOT assessment.

The same analysis can be applied to each of the seven other choice behaviour strategies discussed above and to combinations of them, as well as to the individual choice sequences that may be attributed to them. Choice behaviour strategies for which the null hypothesis is rejected should not be considered as independent strategies with a relatively stable employment frequency in similar contexts but as aggregates of choice sequences that might better be explained by the application of different choice behaviour strategies. If, after controlling, the null hypothesis still has to be accepted, these strategies and the resulting choice sequences are considered as an unreliable basis for VOT assessment. Strategies for which the null hypothesis is accepted, but has to be rejected after controlling for nominal VOT classes or individual choice sequences, can be considered as (aggregates of) strategies with a relatively stable employment frequency in contexts similar to the stated choice surveys. After valuation of the attributes they are presumed to yield choice sequences that offer reliable VOT values, based on a consistent trade-off of travel time and cost consequences.

Pearson’s Chi-square significance test was employed to test the null hypothesis for several distributions of potential choice behaviour strategies. Some core findings are presented in table 3. The hypothesis is rejected for SLR, and in all tests in which SLR-money and SLR-time are considered as
choice behaviour strategies on their own. It is also rejected for all other
considered potential strategies and combinations of strategies from which the
SLR-sequences are excluded. The choice behaviour strategies for which the
null-hypothesis is accepted are: UT-comp; PT-two-two; PT-two-two
supplemented with other strategies that rely on loss averse principles; and a
combination of both SAVE-strategies. All include both SLR choice sequences.

<table>
<thead>
<tr>
<th>Distribution of potential choice behaviour strategies</th>
<th>Pearson’s Chi-square asymptotic significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Sect. 6) compared with survey year</td>
<td></td>
</tr>
<tr>
<td>SLR (SLR-money + SLR-time); Other strategies</td>
<td>&lt;0.05 %</td>
</tr>
<tr>
<td>UT-comp (incl. SLR); Other strategies</td>
<td>41.9 %</td>
</tr>
<tr>
<td>UT-comp (excl. SLR); Other strategies</td>
<td>4.8 %</td>
</tr>
<tr>
<td>SLR-money; SLR-time; other UT-comp; Other strat.</td>
<td>&lt;0.05 %</td>
</tr>
<tr>
<td>PT-two-two (incl. SLR); Other strategies</td>
<td>17.8 %</td>
</tr>
<tr>
<td>PT-two-two (excl. SLR); Other strategies</td>
<td>&lt;0.05 %</td>
</tr>
<tr>
<td>SLR-money; SLR-time; other PT-two-two; Other strat.</td>
<td>&lt;0.05 %</td>
</tr>
<tr>
<td>PT-two-one (incl. SLR); Other strategies</td>
<td>&lt;0.05 %</td>
</tr>
<tr>
<td>SAVE-time + SAVE-money; Other strategies</td>
<td>15.9 %</td>
</tr>
<tr>
<td>SAVE-time; SAVE-money; Other strategies</td>
<td>&lt;0.05 %</td>
</tr>
<tr>
<td>SLR+PT-two-two+PT-two-one+ABEC-money+ABEC-time; Other strat.</td>
<td>41.3 %</td>
</tr>
<tr>
<td>41 Identified individual choice sequences</td>
<td>&lt;0.05 %</td>
</tr>
</tbody>
</table>

Table 1 Association between potential choice behaviour strategies and
survey years

When the individual choice sequences that are consistent with one or more of
the previous strategies are arranged in increasing nominal VOT-order, they
show a clear association with the survey year. Moreover, the frequencies of all
sequences indicating a low nominal VOT (including SLR-money) decrease
between 1988 and 1997, while all sequences indicating high VOTs (including
SLR-time) increase. This is exactly what one might expect as a consequence
of the inflation in the intervening years.

Summarizing, the hypothesis that observed strong lexicographic answering
sequences in the Dutch stated choice VOT surveys are the result of non-
trading behaviour has to be rejected. These sequences should not be
considered as a consequence of lexicographic preferences and/or choice task
simplification but as the result of consistent trade-off behaviour. They should
be added to other sequences to form a consistent choice behaviour strategy
that holds for a stable segment of the population and allows for idiosyncratic
differences in VOT. Other valuation approaches, like loss neutral valuation of
money expenses in combination with loss averse valuation of time changes
(PT-two-one), and several combinations of lexicographic and attribute-based
elimination strategies (SAVE-time; SAVE-money; ABEC-money; ABEC-time)
might also yield VOTs based on a consistent trade-off of money and time
expenses. Like SLR they do not yield choice behaviour strategies on their own
that can be attributed to population segments that are stable within the context
of stated choice surveys. There might be some optimal distribution of the UT-,
PT-, SAVE and CUTOFF strategies over the survey population that is stable.
in different stated choice surveys but the elicitation of such a distribution goes beyond the scope of this paper.

9. EFFECT OF LEXICOGRAPHIC ANSWERING ON VOT ASSESSMENT

The employment of a choice behaviour strategy by an interviewee, combined with her valuation of the attributes, results in a particular choice sequence and a corresponding VOT-interval. The values of the upper and lower bounds of the interval indicated by the same choice sequence differ, depending on the presumed choice behaviour strategy. The purpose of this section is not to assess a ‘best’ or ‘most reliable’ VOT value. The aim is to test the sensitivity of the average VOT of the survey population for different assumptions about the employment of choice behaviour strategies. A baseline for the comparison is offered by the average VOTs for the 1988 and 1997 survey populations, as assessed by HCG with the conventional logit-modelling approach (HCG 1990, 1998).

In view of the many choice sequences and corresponding VOT-intervals that are discerned within each choice behaviour strategy, the middle of each interval might be used as a fair approximation of its average VOT. For the calculation of an average VOT over the survey population this requires the assessment of an approximate upper boundary for the highest, half-closed, VOT interval. To allow for a rough-and-ready assessment of this upper boundary, figure 1 shows the cumulative frequency distribution of VOT values as assessed according to different choice behaviour strategies. Extrapolation of all four distributions in figure 1 indicates an upper boundary of the highest VOT interval of about 31.0 €/h or above.

![Figure 1 Cumulative frequency distribution of the VOT of survey population segments](image-url)
Figure 1 also shows that the 1997 VOTs surpass the corresponding 1988 values all along the line. One should note that this yields no indication of the temporal development of real-life VOT appraisal. It may be explained, for example, by the lower share of ‘other purpose travellers’ in the 1997-survey compared to 1988, as these, on average, revealed a much lower VOT than the commuters and business travellers. The vertical arrangement of frequencies for some VOT values explained by the PT-two-two strategy is a consequence of evaluating only one loss aversion factor, \( \lambda = 2.0 \), instead of a random variation around this mean value (see section 7). What is remarkable is the low number of respondents that might have applied UT-comp in the VOT-ranges from 4-8 €/h (1997) and 5-10 €/h (1988). The underlying choice sequences are the only ones that cannot be explained by the application of PT-two-two as well. This might be considered as an indication that in both surveys very few interviewees followed the UT-comp strategy.

Using 31 €/h as an upper VOT limit, the average VOTs for the 1988 and 1997 surveys were calculated for different choice behaviour strategies. For each strategy only the choice records were taken into account that could be explained by the consistent employment of that strategy. The results are presented in table 2.

<table>
<thead>
<tr>
<th>Choice behaviour strategies</th>
<th>1988</th>
<th>1997</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of records</td>
<td>Mean VOT (€/h)</td>
</tr>
<tr>
<td>Logit-model (HCG, 1990)</td>
<td>2060</td>
<td>7.5</td>
</tr>
<tr>
<td>Logit-model (HCG, 1998)</td>
<td>2060</td>
<td>7.7</td>
</tr>
<tr>
<td>UT-Comp excl. SLR</td>
<td>493</td>
<td>9.1</td>
</tr>
<tr>
<td>PT-two-two excl. SLR</td>
<td>994</td>
<td>12.6</td>
</tr>
<tr>
<td>UT-Comp incl. SLR</td>
<td>709</td>
<td>12.4</td>
</tr>
<tr>
<td>PT-two-two incl. SLR</td>
<td>1211</td>
<td>15.6</td>
</tr>
<tr>
<td>41 explained sequences</td>
<td>1883</td>
<td>12.3</td>
</tr>
</tbody>
</table>

Table 2 Average VOT of the survey populations for different choice behaviour strategies and considered survey population segments

Exclusion of the strong lexicographic answering sequences appears to lower the average VOT. Obviously, the extent of this shift depends on the presumed choice behaviour strategy. It may also vary considerably between different survey designs, particularly depending on the number and extent of the attribute levels that are considered (see section 3). The high average VOT for the PT-two-two strategy is caused by averaging the VOTs for travel time gains and losses. If only the average values for travel time gains are assessed, these are clearly below the corresponding values of UT-comp. Other consistent strategies that employ combinations of compensatory, lexicographic and attribute elimination rules indicate a lower VOT.

Most remarkable at a first glance is that any inference of VOTs for individual respondents, followed by aggregation over survey populations, yields much higher average VOTs than assessments based on logit models. One should note, however, that the logit model disregards the intrapersonal consistency of choice statements and lumps intrapersonal random errors and taste variations
with interpersonal heterogeneity in preferences in one Gumbel-distributed error term. Hensher (2001) showed convincingly that the multinomial logit model underestimates the VOT compared to assessments with less restrictive models that bear the aforementioned phenomena in mind. In a stated choice survey among long-distance car drivers regarding their demand for high-speed rail connections he found that models that at least allow for the simulation of intra-individual homogeneity in taste/VOT revealed a 1.5 to 2.0 times higher VOT than with a MNL model. Taking into account that the deterministic VOT-assessment as discussed in the previous sections also relies on intra-personal homogeneity and that random errors are excluded from the assessment, they corroborate Hensher’s (2001) findings.

10. CONCLUSIONS AND RESEARCH AGENDA

A comparison of the individual choice sequences observed in the Dutch 1988 and 1997 stated choice surveys, based on the premises of Extended Prospect Theory, showed that:

- The strong lexicographic answering sequences in these surveys should be considered as the result of a consistent trade-off of time and money expenses;
- Exclusion of these responses from the assessment of the Value of Travel time might result in a serious underestimation;
- Even after subsuming these responses under a transitive linear-additive choice behaviour strategy in conformity with Utility Theory this explains less than 35 % of all responses;
- The average VOT for this segment of the survey population, as inferred from their individual choice sequences, is 60 to 70 % higher than the one found from logit-based analyses; this may be because the logit model disregards the intrapersonal homogeneity/consistency in judgment/VOT during the stated choice game; the observed difference is of the same order-of-magnitude as found in earlier studies (Hensher 2001).
- A loss aversive strategy ($\lambda_{time} = \lambda_{cost} = 2$) in conformity with Prospect Theory (PT-two-two) explains, after subsuming the strong lexicographic responses, over 55 % of all responses;
- The average VOT for this segment of the survey population, as inferred from the individual choice sequences, is more than twice the VOT found from logit-based analyses; the value of travel time gains is still 40 % above the logit-model results;
- Several loss aversive combinations of compensatory, lexicographic and elimination principles can explain some 33 % of all responses in addition to the ones explained by PT-two-two;
- The choice sequences explained from these additions to the PT-two-two strategy indicate lower VOTs than those according to PT-two-two but higher than inferred from the logit analyses;
- The reliability of the assessment of VOTs from stated choice surveys, based on the EPT- premise of consistent application by most people of one choice behaviour strategy out of several that are employed within the survey population, might be improved by the inclusion of these intransitive responses.
The Dutch VOT-survey database contains much more information about idiosyncratic valuation and choice behaviour strategies that have thus far not been explored. The following additional analyses might increase the understanding of the traveller’s choice behaviour with respect to travel time:

- Investigation of the character and extent of intrapersonal deviations of choice behaviour strategies as a consequence of taste variations, unobserved attributes, judgment errors and random inconsistencies and choice errors;
- Investigation of the stability of the distribution of different choice behaviour strategies over the survey population as a whole and within several segments (travel mode, trip purpose, household income, …);
- Assessment of the main factors that determine idiosyncratic VOTs for revealed ‘stable’ choice behaviour strategies;
- Formulation and parameter estimation of discrete choice model structures that might fit with the observed heterogeneity in idiosyncratic VOTs and with the character and extent of human taste variations, errors and/or choice inconsistencies.

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**Bibliography**


Notes

1 Choice set 8 contained a ‘dominated’ alternative, with a longer trip duration and higher monetary travel costs than the other, the ‘dominant’ alternative.
2 Transitive choice behaviour means that a subject should always choose A over C when she chooses A over B and B over C. Sælensminde (2001) and Rouwendal and De Blaaij (2004) call such behaviour ‘consistent’. However, there is ample evidence for conditions where ‘consistent and predictive intransitivities can be demonstrated’ (Tversky 1969: 31).
3 Strong lexicographic answering may be a consequence of the Strong lexicographic rule which selects the alternative with the highest value on the most important attribute or, in the case of a draw, the next important one (e.g. Foerster 1979).
4 The Weighted Additive rule assumes that the subject expresses the importance of each attribute in a subjective attribute decision weight, independent of the attribute values. The attribute values are multiplied with the relevant attribute decision weights, and these products are added for each alternative. The alternative with the highest Weighted Additive value is chosen (e.g. Foerster, 1979).
5 The amounts were in Dutch guilders but are systematically converted and inflated to 2005-price levels.
6 Mental inertia is a ‘dissinclination to act or exert oneself’ (SOED 2002).
7 The loss aversion factor for a good is defined as the ratio of the Willingness to pay for its acquisition and the willingness to accept compensation for giving it up; the loss aversion factor for the attribute of a choice alternative is defined as the ratio of the psychological value of a gain relative to the reference state in a positively experienced attribute characteristic and the psychological value of a loss relative to the reference state of equivalent size.