Heuristic Use of Mental Map INformation Gained from Behavioural Inspection of Routines in Daily activitieS (HUMMINGBIRDS)

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Abstract: This research project aims at identifying the critical spatial factors in an individual's mental map which influence daily activity travel behaviour in order to improve the agent-based modelling of activity travel behaviour by means of a computational process model. A qualitative travel survey and in depth interviews are used to identify the spatial factors that appear in the destination and travel mode choice heuristics of experts when discussing their activity space. Recorded interviews are processed through ATLAS.ti. First, the representative IF-THEN heuristics are identified and framed within the daily activity travel decision process and classified in a script network view. In addition the occurring spatial elements are indicated.

Keywords: activity-based modelling, spatial cognition, mental map, choice heuristics

1. INTRODUCTION

In essence travel is a representation of space-time behaviour. Not surprisingly, the relationship between travel characteristics (destination, mode and route choice) and attributes of space (regarding function and form) has proved to be a popular topic in geography, transportation planning and urban planning, both in practice and in research (see for instance Timmermans et al. (2003) and Stead & Marshall (2001) for reviews). From an agent based modelling point of view however, it is more important to grasp the interaction between the individual (agent), and space and travel. On an individual level, the relationship between travel decisions and spatial characteristics of the environment is established through the individual's perception and cognition of space. As an individual observes space, for instance through travel, the information is filed in the individual's mental map (spatial learning). Subsequently the mental map shapes – amongst others – the individual's travel decisions, since it reflects the individual knowledge and frame of mind concerning the environment and its transportation systems (spatial planning). While some recent research has contributed to this (Golledge & Gärling, 2003; Golledge & Timmermans, 1990), individual perception and cognition of space related to travel is less investigated than the measurable and objective representation of spatial and temporal patterns.

This research project therefore aims at identifying the critical spatial factors in an individual's mental map which influence daily activity travel behaviour in order to improve the agent-based modelling of activity travel behaviour by means of a computational process model (CPM). While a wide variety of modelling approaches and techniques have already been tested and applied in the past, the activity-based travel demand modelling paradigm is one of the most comprehensive approaches that is able to produce reliable and policy responsive forecasts. Within activity-based travel demand modelling, disaggregate rule-based CPM aim at establishing a true reproduction of behavioural processes underlying individual travel choices using IF-THEN heuristics. The prevalent paradigm of CPM originates from descriptive decision theory: starting from the finding that people do not typically behave optimally, the assumptions of perfect information and rationality are relaxed. Instead, more simple decision rules are focussed on, formalized as IF-THEN(-ELSE) heuristics.

One way to derive such decision heuristics is from data, for instance by means of data-mining techniques, e.g. ALBATROSS (Arentze & Timmermans, 2000). Another and more direct method to gain insight in the knowledge and methods of human decision making is to use domain knowledge, for instance elicited by means of the "think aloud protocol". This method is frequently used by psychologists and social scientists who want to know more about cognitive processes. It is also an important method for knowledge engineers whose goal is to build a knowledge-based computer system on the basis of human expertise (Van Someren et al., 1994). Since an application of the think aloud method in the strict sense is cumbersome, if not virtually impossible for the investigation of daily activity travel patterns established during a week – the expert would literally have to be followed everywhere by a researcher, continuously expressing his thoughts about his activity travel scheduling and execution –, this method is approximated to in this research project by conducting a structured pre- and post-interview with open ended questions about the activity travel scheduling and execution in a randomly chosen week.

A qualitative, explorative, descriptive and contextual research programme is utilised to conduct this research. The focus is to obtain a better understanding of the role of spatial cognitive factors within the general travel choice process, taking the context of daily activity patterns into account. The following research questions are at stake: are choice heuristics apparent in individual's activity travel decision process, in particular with regard to the destination choice decision and the mode choice decision (1); which elements in general occur in this propositional reasoning, to be conditions, restrictions, justifications or otherwise (2) and which spatial elements or mental map components in specific can be identified within these heuristics (3). Consistent with these research goals, this paper is structured as follows: first, the research methodology of the qualitative survey is explained. The next three sections present the results of the qualitative data analysis. Some general findings about the form and structure of the cognitive processes involved in activity travel decisions are explained. Next, the content of the decision process in general and the decision rules in specific are discussed. Within these sections special attention is paid to the spatial elements and mental map properties that appear in the decision process. To conclude, a general script network view presents an overview of the activity travel decision process, spatial determinants are indicated and future research plans are addressed.

2. METHODOLOGY

A one week activity travel survey and in depth interviews were used to identify the spatial factors that appear in the choice heuristics of experts when planning and

evaluating daily activity travel behaviour. During one week, 20 respondents reported their activity travel behaviour in standard activity travel diaries and they used a GPS enabled palm computer to record travelled routes. Respondents were interviewed twice: a 1 hour pre-interview took place before the start of the survey and consisted of an inquiry into the activity space and travel plans; a 45 minutes post-interview or feedback interview occurred after finishing the survey and included a comparison of the executed activity travel programme to the former planning.

To reveal as much determinants as possible and enable theory building, a selected sample of respondents was contacted, including extreme cases. Some important characteristics were taken into account that are known for causing variety in activity travel behaviour: age, sex, education, occupation, drivers licence, possession of car, marital status, household size, parenthood, residential location and mainly used transport mode. For each key characteristic as it is, at least 4 respondents were represented in the sample. This resulted in a total sample of 20 respondents, which is a typical sample size for qualitative research (Mehndiratta, 2003). Respondents were firstly selected from the wide circle of acquaintances of the researcher and then, according to the 'snowball method', attracted from the circle of acquaintances of acquaintances. Since the degree of motorization in Flanders (Belgium) is rather high with 1,17 private cars per household (FOD Economie, 2007), respondents without a driving licence and households without a private car were selected to start with. Income proved to be the most difficult variable to account for. All respondents can be situated in the lower or upper middle class, leaving decision strategies for very low and very high income groups a subject of further research.

Two major parts of the interviews could elicit IF-THEN destination and travel mode choice heuristics: the description of the activity space on the one hand and the explanation of the activity travel planning and execution on the other hand. The first interview part consisted of questions about the perception and the extent of the individual's activity space. During this part of the interview, two main sets of open ended questions were posed. The first set refers to the destination choice and the perception of distances in the activity-space: "*Where do you perform [activity type]? Is that far away? How far is it? In distance? In time?*" Activity types taken into consideration are: work, school, social visit, daily shopping, non-daily shopping and services. The second set of questions regarding the activity space concerns the activity-related reach of the respondent using different transport modes: "*Which activities do you execute by [transport mode]? Regularly? Occasionally? How far is that? In distance? In time?*" Transport modes mentioned, are: foot, bike, bus, train, motor(cycle) and car. It is important to note that in this interview section no explicit questions were asked to reveal decision heuristics. Respondents often referred to circumstances and reasons for destination and travel mode choices spontaneously. In contrast with this first interview section, during the interview sections regarding the scheduling and evaluation of scheduled activities, the reasons, circumstances and choice options for the destination, mode and route choice were explicitly interrogated. With regard to activities away from home, respondents were asked to specify where it took place, what the distance to the activity location was both in qualitative and in quantitative terms, why they had chosen that place, whether they had been there before and whether they used to chose that location frequently or considered other options as well. With regard to travel mode choice, respondents were asked why they had chosen that particular mode of transport, whether they used it frequently to reach that destination, whether they could and would consider other transport modes and what their general appreciation of the accessibility of that activity space was.

Interviews were taped, transcribed verbatim and processed with ATLAS.ti. The use of

such a specialized CAQDAS (Computer Assisted Qualitative Data Analysis) software package is considered to be a useful instrument to improve not only the pace and flexibility of data processing in specific, but also the consistency and internal reliability of qualitative research in general (Maso & Smaling, 1998; Seale, 1999). A cross-case analysis was undertaken for the activity space interview parts. Initial reading and re-reading was followed by indexing and free coding the text, which involves assigning conceptual labels to topics and refining them through repeated inspection. Bearing the research questions in mind, all mentioned travel decisions were indexed manually in ATLAS.ti according to their activity, mode and destination type. References to the choice process and IF-THEN heuristics were indicated and coded. For every new instance, the similarity with previous cases was considered according to the constant comparative method (Glaser & Strauss, 1967). ATLAS.ti facilitated the selection, retrieval and display of coded quotations to a great extent. If no proper existing label could be assigned, a new code was created and previous interview passages were checked anew for missed cases. While coding progressed, ideas about different perspectives and relationships between codes and overarching categories were developed and provisionally conceptualized in memo's, codes and code families. Secondary coding involved the elaboration of these preliminary ideas, further code classification and the examination of relationships between labels and categories. Final inspection and selective coding of the data lead to an understanding of the interrelationship between categories and their properties and the integration into central categories with regard to the activity travel decision process. Finally, this data-driven analysis resulted into the descriptive phase and the construction of theories. Thus, theory *emerged* directly from the data according to the principles of "Grounded Theory" (Glaser & Strauss, 1967), while *theoretical sensitivity* was shown in the initial selection of the respondents (cf. supra) and in the classification of the assigned codes. In addition, these theories – the classified concepts and ideas that individuals associate with daily activity travel choices and their relationship – were represented in "script network views" using the software's graphic tool. These results from the interview data analysis of respondents' discussion about their daily activity spaces are presented in the following section. Selected typical quotations, translated as naturally as possible, are added for the sake of argumentation and illustration.

3. RESULTS

3.1 General Form and Structure of Activity Travel Decisions

Two main observations dominate the analysis of the general form and structure of the cognitive process involved in daily activity travel decisions: the execution of daily activity schedules is principally automatic and seldom preceded by much deliberation (1) and the individual's daily activity travel execution seems to start from a default setting, and is completed with additional heuristics (2). A striking finding during the interview administration was the fact that, generally speaking, the different dimensions of the daily activity-travel planning and execution in general and the mode and destination choice in specific does *not* appear to be sequential stages within the decision process. Although often modelled that way, the travel related decisions in an everyday activity schedule are in fact perceived of and handled as being part of an integrated problem where certain interconnected solutions are triggered simultaneously without much consideration, not to mention the systematic weighing of different alternatives by its attributes which is assumed in most classic utility based choice models. Activity, destination and travel mode are set in fixed mental scripts that are cued by certain situations. It is automated routine behaviour,

often performed mindlessly. This was not only spontaneously stated by a respondent:

17: "Now I'm giving it some thought. That is not what one normally does."

This hypothesis is also shown by the fact that respondents often stated travel times to certain locations without mentioning the travel mode or having referred to it before.
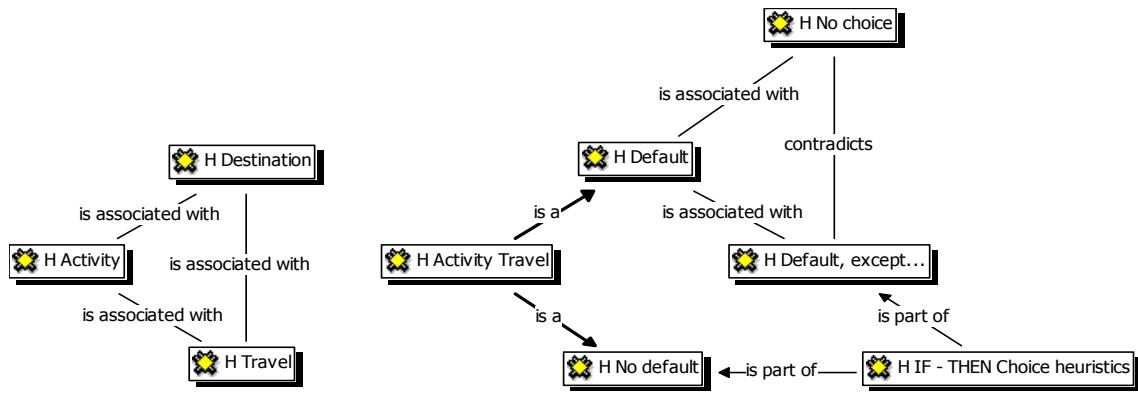

Figure 1 ATLAS.ti Script Network View: General Activity Travel Decision Process

The script network view above which has been constructed based on the interview data, shows that within these *activity-destination-mode* scripts both destination and travel mode appear to have some sort of standard norm or *default* setting for most of the everyday activity episodes. This default setting can be completed by some additional *exceptions*, expressed as IF-THEN heuristics. However, there are some situations where either the destination or the transport mode or both attributes have *no default* setting and where two or more choice options are considered until the point of departure. In these cases, IF-THEN heuristics appear to explain the circumstances or reasons for the consideration of choice options. The content of these default settings and these IF-THEN heuristics is discussed further in this paper.

3.2 Content of Default Settings in Daily Activity Spaces
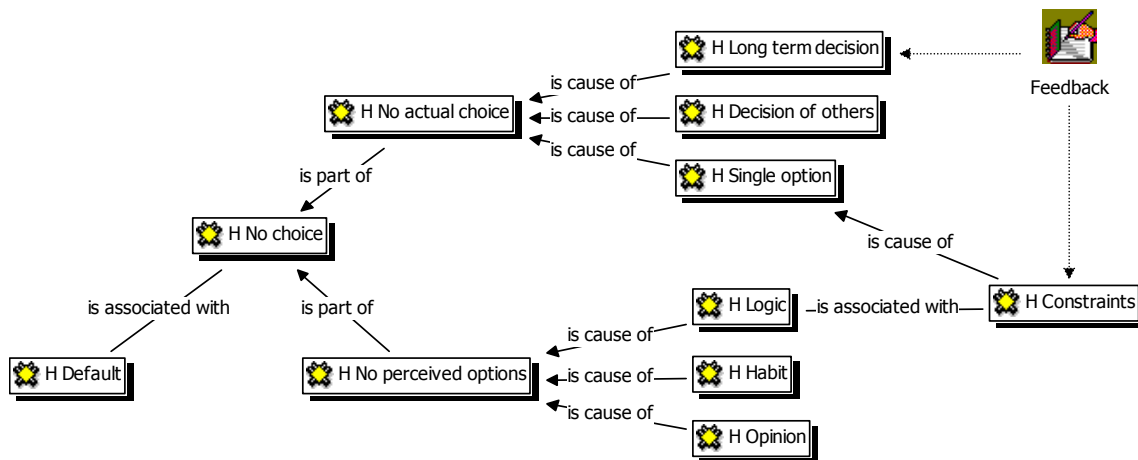

Figure 2 ATLAS.ti Script Network View: Default Settings in Daily Activity Spaces

In case of a *default* setting, it is often referred to as a *no choice* situation in two ways: either there is *no actual choice* within the daily activity context or there are *no perceived choice options*. The first situation can be caused by the fact that the choice at stake was part of a *long term decision*, by the fact that *others made the decision* or by the fact that there was actually *only one single choice option* (within existing and accepted constraints such as space-time constraints, coupling constraints or institutional constraints). Besides the occurrence of no actual choice, there can be *no perceived choice options* as well. Respondents' explanations in this situation refer to the *logic* of the solution (again, within given constraints), the fact that it is a *habit* or they expose some *opinion*, which relates to attitudes and beliefs.

3.2.1 Destination Choice Default Settings

First, the categories indicated in Figure 2 are illustrated for the destination choice. In daily activity travel patterns, destinations are fixed for a lot of activities. There is no actual choice at the time of the everyday activity travel planning and execution. *Long term decisions* such as where to live, where to work and where to go to school determine travel destinations of mandatory activities. Leisure activities such as sports or other hobbies are generally considered to be discretionary activities. The long term decision to join a club however, can fix the destination of leisure travel in everyday life. As a result, such activities become much less flexible in activity schedules. Therefore it can be stated that long term decisions add to the constraints of daily life.

The daily destination choice of travel to execute social activities (family and friends) is obviously determined by a (long term) location *decision of others*.

11: "And going to friends, well, it is in fact indeed … a lot of people did actually move outside [respondent's hometown, red.], now I'm giving it some thought, yes."

Besides that, for all sorts of discretionary activities where others are involved the activity location decisions can be made by other respondents as well. These others usually are members of the household, but destination decisions made by others outside the household also occur, for example when going out with friends. A special case of this situation consists of bring/get activities.

Finally, destination choices can be determined by the fact that there is actually *only one choice* option. When there is only one post office in the area for instance, you'll be obliged to buy your parcel-post package over there. Remarkable in these cases is not only the fact that the amount of destinations available in the choice set is defined by the specificity of the wanted product or specialization of the needed service, but also by the fact that there is a commonly accepted spatial assumption present in the statement: "in the area". Theoretically speaking more options can be available (e.g. the post office in the neighbouring area), but in case of a large difference in (actual and perceived) distance between two equally valued alternatives, proximity within the space-time settings of the daily activity schedule can restrict the actual choice set.

Of course, the latter example is also related to the default settings in daily activity location choice where there are *no perceived choice* options. Daily grocery shopping, shopping for non-daily goods, consulting services and discretionary leisure activities all have multiple destination possibilities. Nevertheless, even when there is no official commitment to certain locations and there are a number of possible destinations, explanations that can be categorized as "logic", "habit" and "opinions" are mentioned in the interviews as the driving force in the establishment and maintenance of default destination settings. *Logical arguments* refer to the position of the actual destination in the entire activity schedule and the various applicable constraints. Given the circumstances, some places are just the most logic place to go. Time and distance

minimization in specific and cost minimization in general are important driving forces.

07: "She [daughter, red.] also does everything there, so, eum, her hobby's are there too, so eum. And currently I go to the gym, the Horizon, to use the Power Plate but that is currently also when driving back from eum, from school. Generally. I try to."

Besides logic, *habit* can be a strong driving force as well, even overruling the logic of distance minimization. Personal relations or semi-official commitments for services such as a bank or the family doctor enhance this habitual destination choice. Besides, it is considered rather unusual to change certain activity locations once a choice is made and the result proved to be satisfying, even under changing circumstances. Due to the interpretation of habitual forces by respondents, the concept of "habit" in this theory differs from the usual meaning of habitual travel choice behaviour in transportation literature. In that, the term "habit" is often used to indicate all travel choice behaviour without explicit intention and no or little deliberation (Gärling & Axhausen, 2003). Here, "habit" is used to explain apparently illogical default settings.

18: "The hairdresser is in Vosselaar still [previous place of residence, red.]" … "yes yes yes so, that is those 5 kilometres again"… "that's an old habit, I shall say."

Finally, *opinions* about destination choices in general and about attributes of theoretically optional activity locations can shape the default destination settings. The first mentioned type is related to general problem-solving strategies and attitudes. The second sort of opinions about attributes of theoretically optional activity locations is related to preferences, often shaped after unsatisfactory experiences. There is a default setting because (all) other options are perceived as being insufficient. The benefit of the outcome can overrule the logic of minimizing distance.

09: "But say, we buy everything here in the vicinity… if something is broken, we can go back there immediately." … "And the service is good as well, so it is stupid wanting to buy it somewhere else if it's a little bit cheaper?"

14: "You have got a small supermarket over here, but we don't like to shop there. Most of the times, we go to the Delhaize [supermarket, red.]."

A last remark that can be made about the default destination settings in daily activity travel patterns is the fact that for shopping activities (small groceries, clothing and the like), the default setting often is a general area which still holds a few possibilities instead of one specific activity location. From a mental map's point of view, this spatial generalization of the destination choice set into functional area's is related to Kevin Lynch's concept of "districts" (1960).

3.2.2 Travel Mode Choice Default Settings

The impacting factors for the default settings of mode choices are similar to those of destination choices. First of all, *long term decisions* with regard to the possession of vehicles (purchase of a bike, motor or private car) and the ability to drive them (learning how to drive a bike, passing one's driving test) is an important predictor for the use of individual modes of travel, as is the acquisition of public transport season tickets and reduced fare passes for the use of bus or train. Moreover, people seem to organize their lives from the perspective of the available modes of transport as well: they buy a car to get somewhere but the fact that they have a car, makes them chose destinations that they would not have considered if they would not have owned a car.

08: "But in in Antwerp or in eum Ghent, and … that might be good to mention, I actually own a bus season ticket for the entire regional bus network from the Lijn and that also partly constitutes an argument to catch the bus or tram more easily in Antwerp or in Ghent or the like because I, yes, I have a public transport season ticket, so…"

In certain circumstances the default setting of travel mode experienced as a no choice situation in the daily activity travel pattern is a mere consequence of *the decision of others* in favour of a certain mode of transport.

06: [Car, red.] "Eum, yes, going to the shop. But, hey, I don't drive in that case but I go along with my parents."

A third "no actual choice" situation occurs when the modal choice set is limited to only *one choice option*. This is obviously the case for activities such as "walking the dog", "run around the block" or "making a bicycle trip". Besides that, this situation also arises when there is a limited individual modal choice set to start with (no car, no bike, inability to walk due to a physical problem), when public transport supply does not fit the spatial or temporal demand or when destinations are chosen that can only be reached one way within a reasonable period of time.

05: [Car, red.] "But at night, there are no busses and then they bring me back to Hasselt that way, so. Otherwise, I don't drive along with a car. But it is the case when I have no alternative."

In addition to *no actual choice* situations, *no perceived choice* situations also occur in default mode settings. The first type of arguments for the existence of certain default mode settings appears to be *logic* within situational constraints. Because different modes of transport have different properties (speed, flexibility, cost, needed physical effort, availability, loading capacity…), they all have a different perceived logical use.

07: [Car, red.] "If you walk out the hairdresser's door, your hairdo is fine, and then I think, if it rains then or the like or in the winter, I think in fact, I think it's a shame, so."

As mentioned before, activity, destination and mode are intimately tied in everyday activity travel scripts. Because a lot of destinations in the activity space are fixed or appear to have a strong default setting, the resulting distances that have to be travelled are fixed as well. Certain distances and destinations are automatically associated with certain suitable transport modes. Choosing the fastest travel mode is a common logical choice strategy serving the benefit of time minimization, unless there is some other benefit experienced from travel with a slower mode.

08: [Bus, red.] "Time, sure, that surely plays an important part for me… because I with regard to my job, eum, I experience it as loss of time… but I do carry on… because I, just because I take the bus and on the bus I can do something else then when I'm behind the wheel myself eum and can do nothing else but eum minding the traffic."

As for destination default settings, *habit* is of strong influence in the maintenance of default travel mode settings. Moreover, a (chosen or forced) habit to use a certain transport mode to reach certain activity locations can be so strong that it becomes a general default travel mode setting for nearly all activity travel in everyday life. In that case, activity scheduling follows the functional logic of the travel mode at stake.

I: "Yes. And how do you go to the station?" 07: "by car… (Laughter) everything by car". … I: "and what is in fact too short as distance for you, to travel by car?" 07: "yes, what, what actually… the village centre… but I still do that anyway" … "regularly eum during the summer eum we try to make it a habit to to go to SACHICO [sports centre, red.] for instance by bike."

Finally *opinions* about travel modes and the properties of the environment in which they are of use influence the fact that certain modes are not perceived or considered as a choice option. General attitudes, beliefs, bad experiences, lack of knowledge or a sufficient degree of satisfaction from other travel modes feed this category.

13: [Car, red.] "But like the Alma [supermarket, red.], things like that. The Aldi [discount supermarket, red.] I would walk to if it wasn't such a busy road, but it is far too busy so… I think it's even dangerous by bike."

A final remark about the observed appearance of "logic" for the development and maintenance of default destinations and travel mode settings regards the fact that this "logic" in itself could be translated into logical decision rules or IF – THEN heuristics. It might be clear that in the above mentioned quotations, such rules were often implicitly present. To make them more explicit, stated data from a thorough questioning of destination and mode choice in default settings could elicit such logical decision rules. At least, as far as people are aware (which is often not the case for default settings, as is shown above) and as far as they are able to articulate the complex relationships between influencing factors. In addition, logic does not have to be a synonym for rationality in human reasoning. Further analysis of the activity travel scheduling and evaluation part of the interviews will illustrate this.

Within the destination and travel mode default settings, the influence of space and spatial cognitive factors is at most apparent in the perception of distances and the subsequent distance minimizing strategies. Besides that, the generalisation of possible activity destinations into functional areas is significant. A third element of spatial factors influencing destination and travel mode decisions is the appreciation of the suitability and accessibility of travel environments with certain travel modes. For slow modes this can involve the presence of suitable infrastructure and motorized traffic. For car driving, respondents refer to congestion levels and parking facilities.

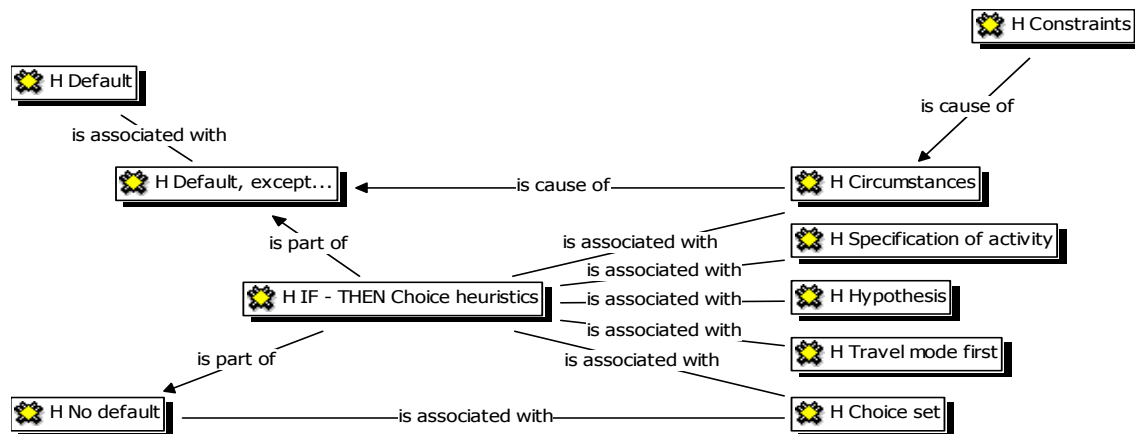### 3.3 Content of IF–THEN Heuristics in Daily Activity Spaces

Figure 3 ATLAS.ti Script Network View: IF–THEN Choice Heuristics

3.3.1 IF–THEN Destination Choice Heuristics

Destination choice appears to be fixed for most daily travel activity decisions. Some few explicit IF–THEN heuristics occurred in the activity space related interview part. As explained above, the activity categories "work", "school" and "social visits" are fixed due to long term decisions or decisions of others. Activity categories "services" and "leisure" usually comprise some fixed locations due to certain commitments. For other destinations related to "services" and "leisure" and for destinations related to "grocery shopping" and "shopping for non-daily goods", few if any options are perceived or considered in everyday life.

Figure 3 shows that a first set of heuristics was used to explain the *circumstances* or situations in which other than usual choices appear. Certain situational constraints, such as exceptions due to institutional constraints, household task allocation and

space-time constraints, can cause deviations from the destination default setting. Quite remarkable is the fact that these exceptional problems and subsequent solutions as they are seem to be part of fixed scripts. This reasoning shows the existence of a "destinations repertoire" or mental map which comprises a set of standard alternative solutions for rather exceptional situations in everyday life.

17: "If, possibly the department store here nearby is not open, and and then we go somewhere else sometimes to the GB or to, what is it called? the Delhaize [supermarket, red.] or so."

A second appearance of explicit heuristics has to do with the categorization of activities. Apart from work and attending school which usually comprises only one destination, each activity category is an aggregation based on presumed similarities in behaviour within the activity category. However, most respondents spontaneously mentioned meaningful *specifications* and typical subcategories, expressed as: "IF [activity subcategory] –THEN [destination and/or mode choice]". Conditional on the subcategories of *daily and non-daily shopping*, destinations are either defined in terms of generalized activity location areas (e.g. small daily groceries) or exact locations (e.g. comprehensive weekly groceries). When a certain activity subcategory only occurs infrequently (e.g. shopping for furniture), possible destinations are not fixed and referred to in general terms. Within the quite diverse activity category *leisure* a distinction between daily and weekly routines with principally fixed and near destinations on the one hand, and seasonal activities (e.g. cycling) and occasional leisure trips on the other hand, seems possible. The occurrence of "leisure shopping trips" also shows that a mere functional categorization of activities has its limitations.

08: "…For what shopping is concerned, if I need clothing or something like that, then I always try to buy that in Geel, eum, in the city centre of Geel, eum, so I go, I travel very little distances for shopping elsewhere."

Apart from the specifications of the activity categories, some of the relevance of the perception of distance in the destination choice within different activity travel categories was also illustrated. However, the travelled distance seems more related with the frequency of the activity performance and the attractiveness of the destination than with the actual activity related purpose of the trip. Besides actual occurring choices in daily activity space, respondents mentioned *hypothetical choice situations* as well in the interview conversation. Since these heuristics do not reflect actual performed travel behaviour of the past but only reflect suspicions about possible future behaviour, they are not discussed further.

03: "Yes,… if tomorrow a new department store opens in the neighbourhood, then I will shop in the vicinity…"

A fourth sort of heuristics illustrates the fact that *mode choice can precede* the choice of the activity location. Apart from that, all travel modes are associated with a certain reach. In a no travel mode choice situation, destinations are obviously also chosen within the possibilities of the single available travel mode.

09: [Daily travel by bike, red.] "Eum, if it is within half an hour, let's say, within an hour then…" I: "Then it is feasible, yes?" 09: "Let's say, for me, yes."

Finally, in the *no default* choice situation the destination *choice set* in everyday life's activity travel comprises several considered opportunities. In these cases, destinations are valued equally and the actual established choice appears to depend on scheduling logic, situational circumstances and coincidence. Further analysis of the activity travel scheduling and evaluation of the established choices at the end of the recording week is needed to gain more insight into this process.

18: "Yes yes. But hé, I never have to make a long detour here. Really, I run into at least four bakeries."

3.3.2 IF–THEN Travel Mode Choice Heuristics

In contrast with the IF–THEN destination choice heuristics, mode choice heuristics were far more numerous in the interviews. This might be due partly to the interview questions, but it also indicates that people perceive more choice options with regard to mode choice than with regard to destination choice and that variety in mode choice occurs more frequently than variety in destination choice. Within these heuristics, the classes of occurrence (*circumstances*, *specifications*, *mode first* and *choice set*) of Figure 3, can be recognized for each travel mode.

WALKING – First of all, walking as a travel mode is a choice in *exceptional situations* when circumstances are optimal and general space-time constraints are relaxed: nice weather and a lot of time are typically mentioned as being favourable conditions. Relatively short distance to the activity location proved to be a prerequisite. However, in exceptional situations with constraining circumstances, walking can also be a (perceived) single remaining option. Examples of this are weather (snow), incidents, kids, cargo... Moreover such conditions can result into different destination choices.

06: "Eum, sometimes to the bakery, if it has snowed or something like that, then I do go by foot to the bakery or."

As for destination choice heuristics, IF–THEN mode choice heuristics for daily walking occasions are used in the interviews to *specify* mode choice options within certain activity categories clustered by location type or activity type. Again, distance is an important factor, together with prism constraints such as the company of children and the transportation of purchases.

18: "yes, you know, if I eum, take for instance, go to buy drinks. Bottles, but that is by foot as well. And I think that is not as convenient by bike… yes that is in fact, those are practical concerns… and such a crate with bottles.."

Walking can be chosen *previous to the destination* because of the benefit of walking as pastime or as part of a leisure activity. These cases are less distance sensitive.

19: "yes, what happens is that we walk to den Bruun [village pub, red.] on a Sunday afternoon, drink something and walk back." I: "but that is if you have a lot of time then?" 19: "yes."

Walking and cycling are sometimes considered as equal alternatives in the *choice set* to cover short distances. Revealed decisive factors are time constraints and practical concerns; the bike is faster, but reliable storage is desired.

08: [Walking, red.] "Eum, well, it could be the trip to the station, because I'd rather not leave my bike over there, and it could be just"… "It depends on the time, eum, so at the beginning I did it far more easily by foot as well, but eum, now it is very often because of the kids and the lot that eum, let's say the fuss in the morning and so on that I am sometimes obliged to take the bike to get to the train on time, so eum…"

A final remark about walking is the fact that more than one third of the respondents indicated to hardly ever walk to any activity location. Besides the noted reasons of time saving and health reasons the main explanatory factor is the fact that they tend to live in low density sprawl dwelling area's where distances are larger and walking accommodation is poor; walking is simply not a perceived option in these area's.

CYCLING – Like walking, here weather *conditions* and time are often mentioned as favourable (pre)conditions. However, more often than walking, cycling is used to replace car travel for short to medium distances because of its speed and reach.

12: "to go to the bank eum,… to the bakery, eum, yes… things if the weather is nice and I've got some time, then I use my bike."

Specifications of IF– HEN bike heuristics also appeared in the interviews. In this case the breakdown does not only occur on the level of the activity but also on the level of location type, travel time and travel distance, illustrating the close coherence of activity, destination and travel mode choice.

08: "Services, yes, yes, of course if I have to go to the post office for instance I won't take the car, there I always go by bike. Yes. That's the same radius of action, in fact, because that is all grouped in the centre, you know, eum. Regularly travel further away, yes, it depends on where exactly I have to be, eum. If it, if it is Geel, then it is by bike, you know, so and then it is possibly a bit further away, you know, because, eum, It's like I say, if I have to go to Bel, Yes, then I go by bike, you know, or to Zammel or whatever…"

For some daily activity routines, there is a standard mode *choice set*. Respondents answered the question: "How do you go to [activity]" with at least two possible travel modes. Again, revealed decisive factors are time constraints and practical concerns.

02: "Well, it's just a matter of, like the weather, yes, then I will take eum the bike, but if I go shopping, yes, then I usually take the, eum, the car you see. You've got a lot of stuff with you in that case, you see... Like to the butcher or something like that. Yes, every time I can I go by bike, you see." I: "Yes, if you don't have to bring too much." 02: "To park over there, where I go to the butcher, well, there is no parking place and then I'd rather go by bike."

Quite remarkable is the fact that a quarter of the respondents did not possess a bike at the time of the interview. The majority lives in built up area's near public transport services and has no direct access to private cars or no drivers licence. However, income levels show that this is not a matter of poverty. Those respondents simply live close enough to various facilities to fulfil their daily needs by foot or public transport.

BUS – Busses are often used by daily cyclists to replace the bike in *exceptional situations*, such as bad weather conditions. Busses can also replace certain train trips, especially late at night when accessibility by train in certain area's drops. Busses are far less likely to be an alternative for car travel because of their association with longer travel times and their (equal) sensitivity to traffic chaos. Only if time constraints permit and if no other option is available or another benefit is experienced from travelling by bus, people will opt for the bus instead of the car.

I: "yes. And to Turnhout. You do that sometimes by bike, and sometimes by bus as well. When…" 20: "Mostly by bike and sometimes by bus". I: "and when by bus? Can you". 20: "if we don't feel like…" I: "(laughter) yes?" 20: "after a night out it could happen or if it's bad weather it could occur as well."

Some *specifications* of the situations in which busses are used in terms of activity type and distance or area also appear as IF-THEN mode choice heuristics.

08: "Eum… Not easy, or at least… Now I really have to think carefully. I, eum, what happens now and again is, for instance if I eum have to be in Ghent because of business, then it could that I take a bus over there.…"

For some trips busses are part of the standard *choice set*. High transportation supplies with frequent busses to various destinations at low cost are favourable conditions for the occurrence of this choice situation.

15 [Chess club, red.]: "sometimes walking, sometimes by bike and sometimes by bus" I: "o, yes, by bus. That's easy from here". 15: "Yes, because there are busses, I think, every 10 minutes". I: "And, when when would you go by bike and when by bys? And when would you walk? It depends on what?" 15: "Hm… How I eum… by eum… my bike was not fixed yet that time, you know"… "Otherwise I have to walk then, but you have to be there at a certain time, if not, you loose anyhow"… "But my wife has to work then, so I have to take care that she arrives and that I can leave immediately then, and if that just not works out, well, then I have to catch the bus, because in that case it is quicker than walking".

TRAIN – Only one typical "IF [activity] – THEN default [other mode], EXCEPT [circumstances] THEN Train"- heuristic could be recognized in the interviews. The train is not often used as a travel mode to replace default travel modes in *exceptional situations* in daily activity travel. It is however a vehicle that is highly associated with typical exceptional activities to certain typical destinations at medium to far distances like occasional leisure trips to the seashore or to city centres and occasional work trips to the Central Business District of large cities

04: [Train, red.] "To Antwerp, that is". I: "regularly or?" 04: "No! Now and then. If there is a, you know, a musical."

07: [Train, red.] "To grandpa and grandma to, at least to Bruges when grandpa and grandma give a party in Bruges (laughter). Because, because we don't have to mind the alcohol then."

Sometimes, principally for leisure trips, the choice of the travel mode train occurs before the destination choice (cf. supra). In the interviews, the train was never mentioned to be part of a travel choice set in a no-default mode choice situation. Moreover, for more than half of the respondents both bus or train are simply never considered in daily activity travel.

CAR – As said before, cars are typically used for all distances. In *exceptional cases*, they are believed to replace rather short trips that can be executed by feet or by bike whenever weather conditions are considered too bad. Furthermore, cars are used to replace another default travel mode when time constraints are high or when public transport is not longer available, for instance during the night.

08: "Normally, normally I take the bus, if I so, if I, if I can be flexible with my working hours, that is to say, if I haven't got in the morning, let's say about nine or something like that, if I haven't got a meeting or don't have to teach or the like, eum, then I just take the bus, if I, if I can't afford it to, let's say, arrive at work at 9:30… In other cases if I have to start earlier or if I stop eum later, if I have something to do in the evening that overruns it's time, and then I take the car. But mostly I take eum the bus."

Distinctive *specified activities* that are most likely to be undertaken by car are activity travel tours and weekly or monthly grocery shopping. Even most respondents who didn't own a car or had no drivers licence indicated to execute grocery shopping that way. They either borrow a car for these occasions or drive along with members of the household, relatives or friends. Only respondents from very small households stated not to need a car; they simply increase the frequency of their grocery shopping.

11: "… eum, now and again, eum, to go to the shop, if we have to do a lot of groceries… the Colruyt is very near, but then we do take the car… to buy drinks and stuff."

Finally, with regard to spatial characteristics and spatial cognitive factors influencing destination choice and mode choice in daily activity travel IF–THEN heuristics, no other elements than already mentioned in the default reasoning section have to be addressed. Here too, the importance of perceived distances, perceived accessibility by various transport modes and the cognitive representation of destination choice sets in generalized areas of opportunities is significant.

The weather is a variable environmental factor that is able to trigger the execution of different scripts in people's mental maps. For people who are used to cycling a lot, bad weather conditions are typically mentioned as an exceptional situation. In these cases, they usually take the bus. However, for people who are used to travel by car, bad weather is often used as an excuse for not choosing the bike and nice weather is typically seen as an exceptional situation; perhaps cyclists are born optimists, unlike car drivers?

The explanation of such difference lies within the long term organization of the individual's daily life based on the availability and accessibility of travel modes and in the *feedback* mechanisms between long term decisions and daily activity constraints. On the one hand, car drivers have (unconsciously) chosen daily activity destinations in a habitual activity travel schedule from the car's perspective: daily activity travel schedules are space extensive and time intensive. As a consequence only few destinations can actually be reached by other modes, unless their habitual daily activity schedule is thoroughly reconsidered. They have developed a car dependent lifestyle. Their mental map, full of automated car related scripts, is uni-modal and biased. Spatial determinants are thus more important in the occurrence of travel poverty than vehicle ownership.

On the other hand, individuals without a driver's licence or private car have probably organized their lives in short term and long term decisions bearing a necessary spatial proximity and temporal deceleration in mind. Their reflected repertoire of daily activity scripts typically shows a great variety of travel modes. Although the radius of action might be more limited in distance, such individuals surely show more flexibility regarding travel mode choices. In a prevailing car-oriented society, these respondents also proved to be very aware of their somewhat unusual way of life.

09: "For us nothing is far away. But for those who have cars, everything is far away. That is in fact really strange, no?" I: "yes, you will have to explain that a bit, because…" 09: "We are used to the fact that it always takes a long time before we get anywhere, for us it is not far away…"

Of course, the above painted pictures of car drivers versus non-car drivers are quite extreme. In reality, several mixed situations occur. Driven by attitudes and opinions, some people deliberately choose to use the car more consciously. This way, they are less dependent on this travel mode. Others can only be forced to make other travel mode choices if habitual daily activity travel schedules become untenable (e.g. due to external conditions such as congestion).
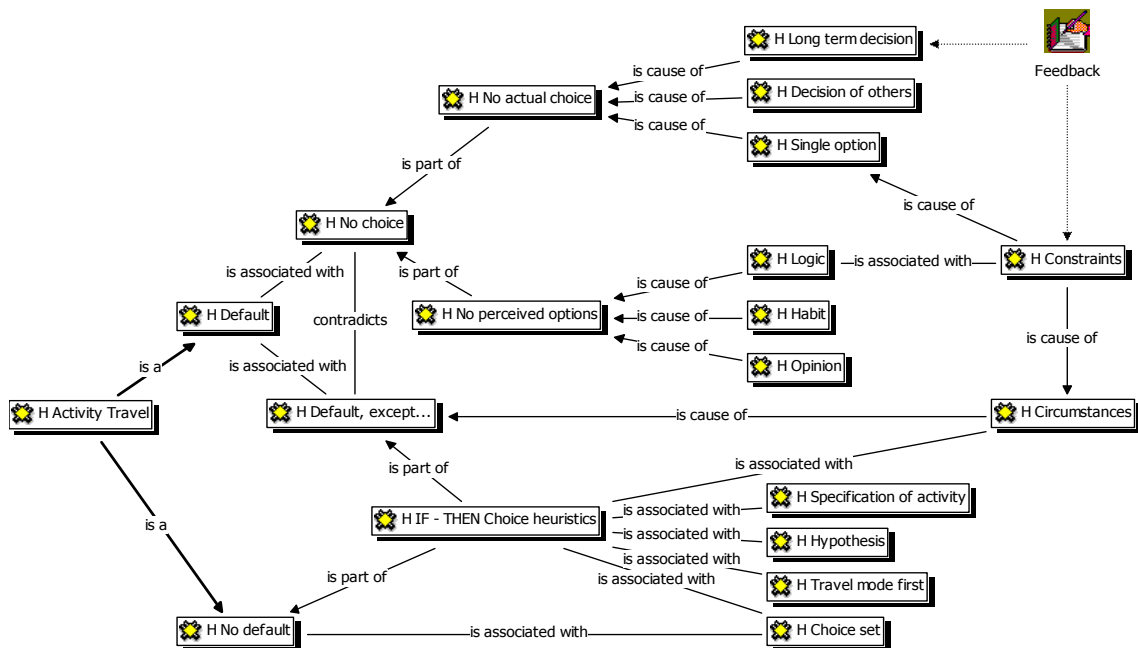
4. CONCLUSION AND FUTURE RESEARCH

Figure 4 ATLAS.ti Script Network View: Scripted Daily Activity Travel Execution

A general overview of the developed theory of scripted daily activity behaviour based on the activity space interview excerpts is shown in Figure 4. An activity-travel repertoire with rather fixed scripts comprising default settings and IF–THEN heuristics is apparent in individual's daily activity travel execution, in particular with regard to the destination and the travel mode choice decisions. Actual and perceived choice sets are very limited and choices are typically restricted and justified by long-term decisions, decisions of others, logical reasoning, habits and opinions. The driving force behind the logical reasoning are various conditional constraints experienced in everyday life. Within these heuristics, reasoning concerning accessibility in general and distances in time and space in particular plays an important role. Thus, the individual's mental map comprises a repertoire of possible activity travel scripts including travel modes and activity destinations, structured as exact locations or functional areas. Elements in this opportunity set are connected to an – often imperfect – perception of accessibility with various transport modes which influences the reasoning process in daily activity travel decision making.

Some more research in this area is needed to refine the content of the human logic behind the establishment and preservation of default settings and the decision strategies for activity travel decisions without a default setting. Moreover, the circumstances in which particular parts of people's repertoire are applied and the conditions causing variety in activity travel behaviour deserve future attention, as well as the circumstances and conditions which can force sustainable changes in scripted activity travel behaviour. Further analysis of the interview parts in which the scheduling and execution of an actual activity travel agenda for a week was questioned will probably offer additional clarification. Moreover, current use of IF–THEN heuristics in existing agent based computational process models need to be sorted out and compared to the findings in this HUMMINGBIRDS project before implications for modelling can be addressed in detail. A clear example of the applicability of this qualitative research for modelling practice with regard to the activity categories is the distinction which should be made between "weekly groceries" and "small daily grocery shopping" because of the specific characteristics of the destination choice set and the possible difference in mode choice set.

With regard to the integration of the mental map concept into the agent based modelling of activity travel behaviour, special attention must be paid to the perception of distances and the perception of accessibility of activity locations and activity areas with various travel modes. This aspect of spatial cognition clearly influences reasoning in destination and mode choice and it will be a special point of attention in the future analysis of the gathered data of this explorative research. This research will allow for a comparison of qualitative and quantitative distance estimations from the stated data in the interviews with revealed travelled distances from GPS-tracks.

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