Eliciting needs underlying activity-travel patterns and their covariance structure: results of multi-method analyses

Eliciting Needs Underlying Activity-Travel Patterns and Their Covariance Structure: Results of Multi-Method Analyses

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ABSTRACT

Modeling dynamic activity generation is high on the research agenda in activity-based transport demand modeling. The concept of dynamic needs has been put forward as such a mechanism. The aim of this paper is to investigate which needs underlie the generation of discretionary activities such as social, recreational and sports activities. Three surveys were conducted to elicit, establish and analyze the needs. We carried out qualitative face-to-face interviews based on a laddering technique to reveal need dimensions using an exhaustive classification of discretionary activities. Quantitative approaches were then used to determine which needs are equivalent in terms of their effects on activities and, hence, can be merged. Finally, a questionnaire-based survey involving a large sample of individuals is used to measure personal levels of the needs identified and to correlate these measures with socio-economic and behavioral characteristics. In total, six independent needs emerged from this research, namely Physical exercise, Social contact, Relaxation, Fresh air / being outdoors, New experiences, and Entertainment. Many-to-many relationships between activities and needs support the hypothesis that substitution relationships may play a significant role in activity generation. This implies that current practice in activity-based modeling of focusing on activities may produce biased results when developing dynamic models of transport demand. Furthermore, the results show that personal levels on these needs correlate with various socio-economic as well as behavioral variables.

INTRODUCTION

Although progress in activity-based models has been formidable and these models are now slowly but gradually moving to practice, there is still ample room for improvement. One of the issues requiring elaboration and further attention concerns the classification of activities. Several existing activity-based models are based on a simple classification of mandatory and discretionary activities (sometimes differentiating maintenance and social/leisure). Empirical results however indicate that these models are performing better for work and shopping activities than for social, recreational and leisure activities. In part, this may be because the motivators underlying these latter activities are more varied and because the choice options are both larger in number and more diverse, and hence more difficult to predict. However, relatively poor results may also be caused because these activities are partly substitutable because they satisfy common underlying needs. For example, both shopping and socializing mean a break from house-keeping duties. Shopping will also contain an element of meeting other people and hence will partly satisfy some general social needs.

Doherty (*1*) and Doherty and Mohammadian (*2*) also discussed the issue of classification of activities, albeit from a different perspective. Examining planning horizons, they found evidence that the process of planning activities is not congruent with commonly assumed hierarchical processes in activity-based models. They applied an ordered probit model to analyze the influence of a series of factors. Closely related to the problem of classification is the issue of activity generation. Mechanisms underlying activity generation are still poorly understood and not-well represented in current activity-based models (*3,4*). The notion that daily activities of individuals are driven by basic needs lies at the core of the activity-based approach since the pioneering work of Chapin (*5*) and is further emphasized by Miller (*6*) and Axhausen (*7*). Miller derived some elements of his framework for modeling short- and long-term household-based decision making from Maslow's hierarchy of needs. Meister et al. (*8*) partially implemented needs into their operational model of activity scheduling.

To incorporate possible substitutions between activities, Arentze and Timmermans (*9*) developed a need-based model. They defined the utility of an activity in terms of its contribution to the satisfaction of dynamically changing needs. So-called potentials describe relationships between activities and needs quantitatively. Potentials depend on the nature of the activity and on attributes such as duration, location, time-of-day, etc. The model predicts the timing and duration of activities in a dynamic longitudinal framework taking into account time budget constraints and needs at both household and person level. The results of numerical simulations supported the face validity of the suggested theoretical framework and modeling approach, demonstrating the possibility of incorporating substitution effects between activities and complex dynamic interactions between activities in general. To date, however, their approach lacks empirical validation.

The purpose of the study is to fill this gap. More specifically, the aim is to find a good classification of needs underlying activity generation and to examine the nature of the relationships between activities and underlying needs. In this paper, we describe the design and results of three related surveys carried out to elicit, establish and analyze the needs underlying activity-travel patterns of individuals. The first survey uses qualitative face-to-face interviews to find out which needs and other factors are responsible for the discretionary activities individuals conduct in daily life. This resulted in nine needs to be included in additional research. In the second survey subjects were asked to indicate to what extent they think the needs are influenced by 22 types of recreational, social, and sports activities. After looking at the similarities between

the needs and their influences on performing activities, the set could be reduced to six independent needs. The final survey is part of a larger questionnaire. In this survey, we use statements to measure by means of scale construction the general levels of these needs of the respondents and analyze the correlations of the levels with relevant socio-economic and behavioral characteristics.

This paper is structured as follows. Each section is devoted to a survey. For each survey we briefly describe the questionnaire, the sample and the results. The paper closes with a summary and a discussion of the main findings of the study.

SURVEY 1: IDENTIFYING NEEDS

The purpose of the first survey is to identify which needs play a role in the generation of discretionary activities.

Approach

In order to elicit the needs and other factors underlying activity choice, qualitative face-to-face interviews were carried out. In the interviews an exhaustive set of 22 social, leisure and sports activities were taken into account (see Figure 1). This set was identified based on existing activity-diary data. Although a qualitative approach is used, the interviews had a fixed structure. It started with the question which of those activities the respondent never or rarely conducts. Only the activities that the subject conducts on a regular basis were included in the interview. Activity choice sets were generated by randomly selecting combinations of three activities such that all activities appear at least one time in a choice set. In actual practice it meant that the number of hypothetical choice sets varied between three and six, dependent on the number of activities the respondent conducts on a regular basis. For each choice set, a hypothetical scenario was presented of the following general form:

"Assume that on a day there is time available to conduct an activity and that you can choose between the following three activities:"

[the three randomly selected activities were shown]

A laddering technique (*10*) following similar logic of the so-called CNET method (*11,12*) was used to elicit the factors underlying activity choice. The following question was asked to the subjects:

"What are you considerations when choosing between the three activities?"

If a consideration was not clear or could not be identified as a need, the "*Why is that important to you?*" question, which is typical for laddering, was posed.

We used this method to get a broader view on the factors, not restricted to needs, that influence activity choice. Because this method is exploratory and free of theory, it is possible that unexpected needs or other factors occur. For every factor that does not correspond to a need we asked respondents to indicate the importance of that factor for making the decision (0= not

important, 1= somewhat important, 2= important, 3= very important). Furthermore, to obtain a first indication of the relationships between activities and needs, the subjects were asked to indicate for each of the 22 activities they conduct on a regular base, to what extent the activities satisfy the needs mentioned by them on a 5-point scale (1= not at all, 5 = to a large extent).

Sample

In total, eight different persons were interviewed. After the eight interviews we decided that we did not need to interview more subjects for the purpose of this phase. Convergence of responses suggested that the outcome would not be different if we interviewed additional persons. Although this is typically a convenience sample, care was taken to have a representation of diversity. Individuals from different stages of life and environments were included. Four respondents live in a city and the other four in a village. Three respondents have a fulltime job, one is a fulltime student, another one works part-time and the other three have a lot of discretionary time, because they are either retired or looking for a job. Two of the subjects have young children and two others have children that already left home. The age varies between 28 and 64 years old and 50% is female.

Results

A distinction was made between considerations that could be described as needs and other factors (e.g. weather, time-of-day).

Factors

Table 1 shows all factors that were indicated by the respondents, how often they were mentioned and the mean importance for making the decision (0= not important, 1= somewhat important, 2= important, 3= very important). The main factors that came out of the interviews were: the weather, the time of day, the duration of the activity/available time, the day of the week and if there is a particular reason for conducting the activity (e.g. need to buy something, there is something happening). The distribution of mean importance scores shows that the factors that are relatively important include goods/offerings, social obligation, there is something happening, need to buy something and dependent on the availability of others.

Needs

In this paper we will focus on the needs. Table 2 shows the needs mentioned by the subjects and how often they were brought up in the hypothetical scenarios. The need for social contact, relaxation and physical exercise were indicated by nearly all respondents. Other frequently occurring needs were: fresh air/being outdoors, maintaining relationships and new experiences. Furthermore, 50% of the subjects mentioned the need for information, nature, acquiring knowledge, rest and entertainment. Respondents with young children added the need to guide their child's development.

TABLE 1 Factors indicated by the respondents

Factor	# of respondents	Total frequency	Mean importance
the weather	7	19	1.78
time of day	6	16	1.73
activity duration/ available time	6	8	1.25
need to buy something	6	7	2.1
there is something happening	5	12	2.2
day of the week	4	4	1.67
dependent on the availability of others	3	10	2.08
costs	3	9	1.67
time elapsed since the previous performance	3	9	1.3
the range of goods (/offerings)	3	7	2.33
time of year	3	3	1.5
combining activities	3	3	0.84
social obligation	2	4	2.25
time pressure	2	3	1.25
available transport modes	2	2	2
with whom	2	2	2
distance	2	2	1.5
opening hours	2	2	1
mood	1	2	2
level of fitness	1	2	1.5
habit	1	1	1
entertainment value	1	1	1

Impacts of activities on needs

The results of this part were used to find out if some needs are basically the same and can be combined or one of them deleted. The average satisfaction rates across the activities can be determined to indicate an activity profile of a given need. From the point of view of activity generation, any two needs that have the same activity profile can be merged into a single need category, as they are equivalent and cannot be distinguished. Figure 1 shows the activity profiles for the pairs of needs Social contact and Maintaining relationships, Physical exercise and Staying fit, and Acquire knowledge and Information. Based on these results the following pairs of needs can be merged, because they show similar activity profiles:

- maintaining relationships and social contact
- staying fit and physical exercise
- information and acquire knowledge

For the other needs the similarities were not as clear as the ones named before. So, in the end nine important needs remained. They were mentioned by at least half of the respondents and include the following (in brackets the percentage of respondents mentioning it):

- Social contact, relaxation and physical exercise (100%)
- Fresh air/being outdoors, new experiences and information/acquire knowledge (63%)
- Nature, rest and entertainment (50%)

Combinations of these dimensions still showed considerable overlap in terms of their attribute profile. Whether these overlaps warrant a further reduction of the set could not be established with certainty due to the small sample size. Therefore, a second round using a larger sample was implemented to determine whether the set could be further reduced.

TABLE 2 Needs indicated by the respondents

Need	# of respondents	Total frequency
social contact	8	25
relaxation	8	24
physical exercise	7	20
fresh air/ being outdoors	5	9
maintain relationships	5	8
new experiences	5	8
information	4	8
nature	4	7
acquire knowledge	4	6
rest	4	5
entertainment	4	5
variety	3	5
personal development	2	5
curiosity	2	4
going out for a short time	2	4
stay fit	2	4
guide your child's development	2	2
flexibility	1	1
be occupied in a creative way	1	1
adventure	1	1
freedom	1	1
buying something new	1	1
make a social contribution	1	1
reflection	1	1
clear your mind	1	1
luxury	1	1
competition	1	1
enjoyment	1	1
being there for other people	1	1

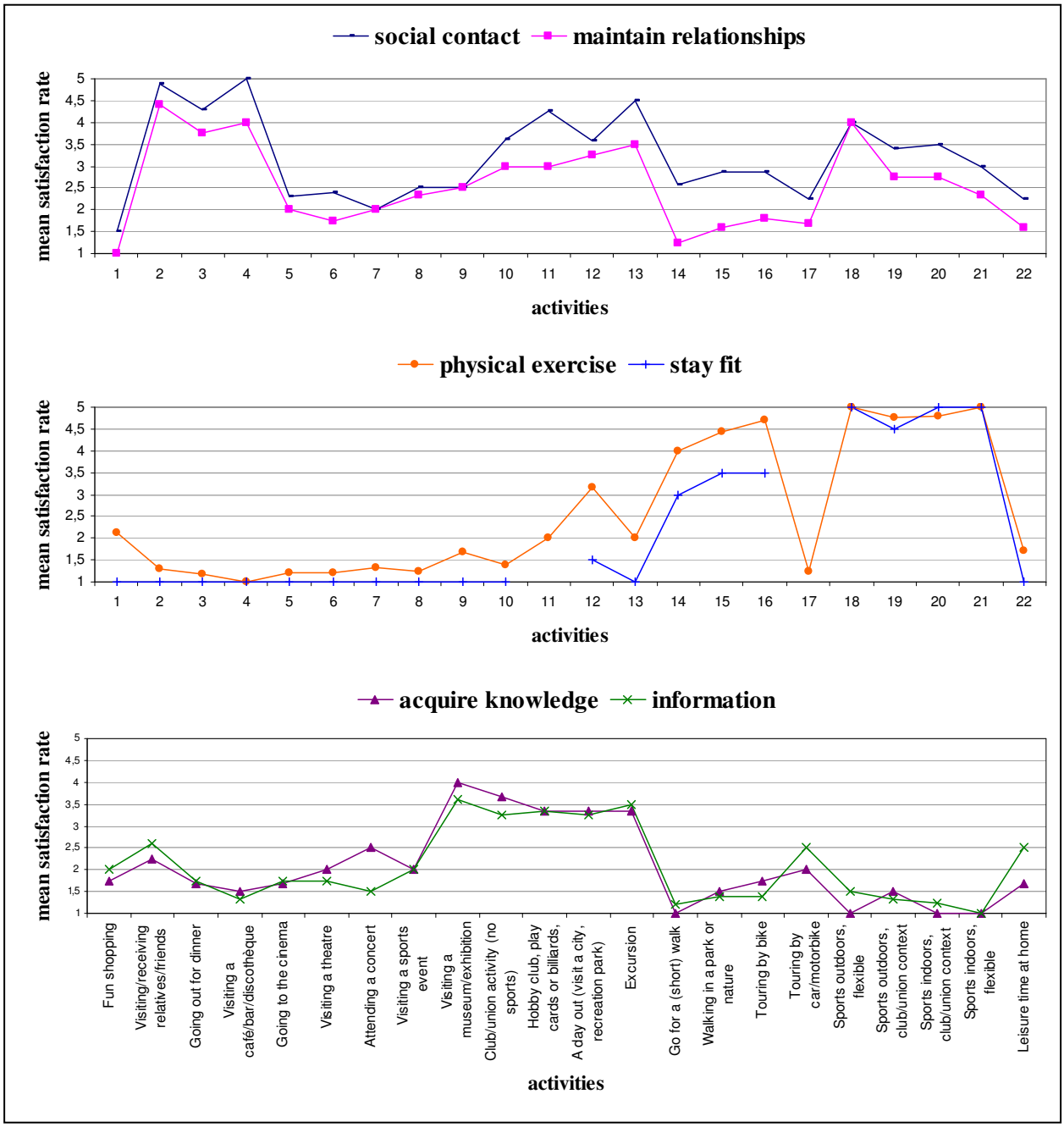

FIGURE 1 Comparisons of mean satisfaction rates Survey 1

SURVEY 2: ESTABLISHING NEEDS

In this section, we describe the next part of the data collection carried out to verify the independence of the needs identified in the previous phase. Similar to the approach used in the previous section, subjects were asked to indicate for each of the nine remaining needs and for the same list of 22 social, leisure and sports activities, to what extent the activity satisfies the need. An Internet questionnaire was developed to collect the data for a larger sample. The first part of the questionnaire consists of general questions about socio-economic characteristics. The second part showed for one need per page the list of activities and contained for every activity a field to fill out the satisfaction rate. Respondents could indicate n/a (not applicable) if they did not conduct the activity on a regular base.

Sample

For this Internet questionnaire about 45 acquaintances, students, and colleagues were approached by e-mail. The total sample consists of 41 persons. Three of them did not complete the questionnaire. The responses of the 8 respondents of the preceding face-to-face interviews were also included; however they only filled out the satisfaction rates for the needs they mentioned themselves. Table 3 describes the sample in terms of the distribution on some relevant socio-economic variables and for comparison shows the same distributions in the population at the national level. The table shows that the elderly (65+ years) and single-adult households are underrepresented and above-average educated groups are overrepresented.

TABLE 3 Composition of the samples

		sample survey 2 (%)	sample survey 3 (%)	population (%)
Gender	Female	51	53	50.5
	Male	49	47	49.5
Age	15 -< 25 yr	12	7	15
	25 -< 45 yr	58	48	37
	45 -< 65 yr	25	34	33
	65 -< 85 yr	5	10	16
Education	Below average	8	14	35
	Average	20	25	41
	Above average	72	61	24
Household composition	Single, no children	15	23	35
	Single, children	0	3	6
	Double, no children	54	38	29
	Double, children	29	33	29
	Multiple persons	2	1	1

Results

For every activity and each need the average satisfaction rate was calculated, resulting in an activity profile for each need. The results are shown in Figure 2. The activity profiles of social contact and physical exercise clearly deviate from the ones of the other needs. The need to rest follows the line of the need for relaxation. Apart from a difference in scale, rest has the same influence and therefore can be subsumed under relaxation. Moreover, relaxation was mentioned

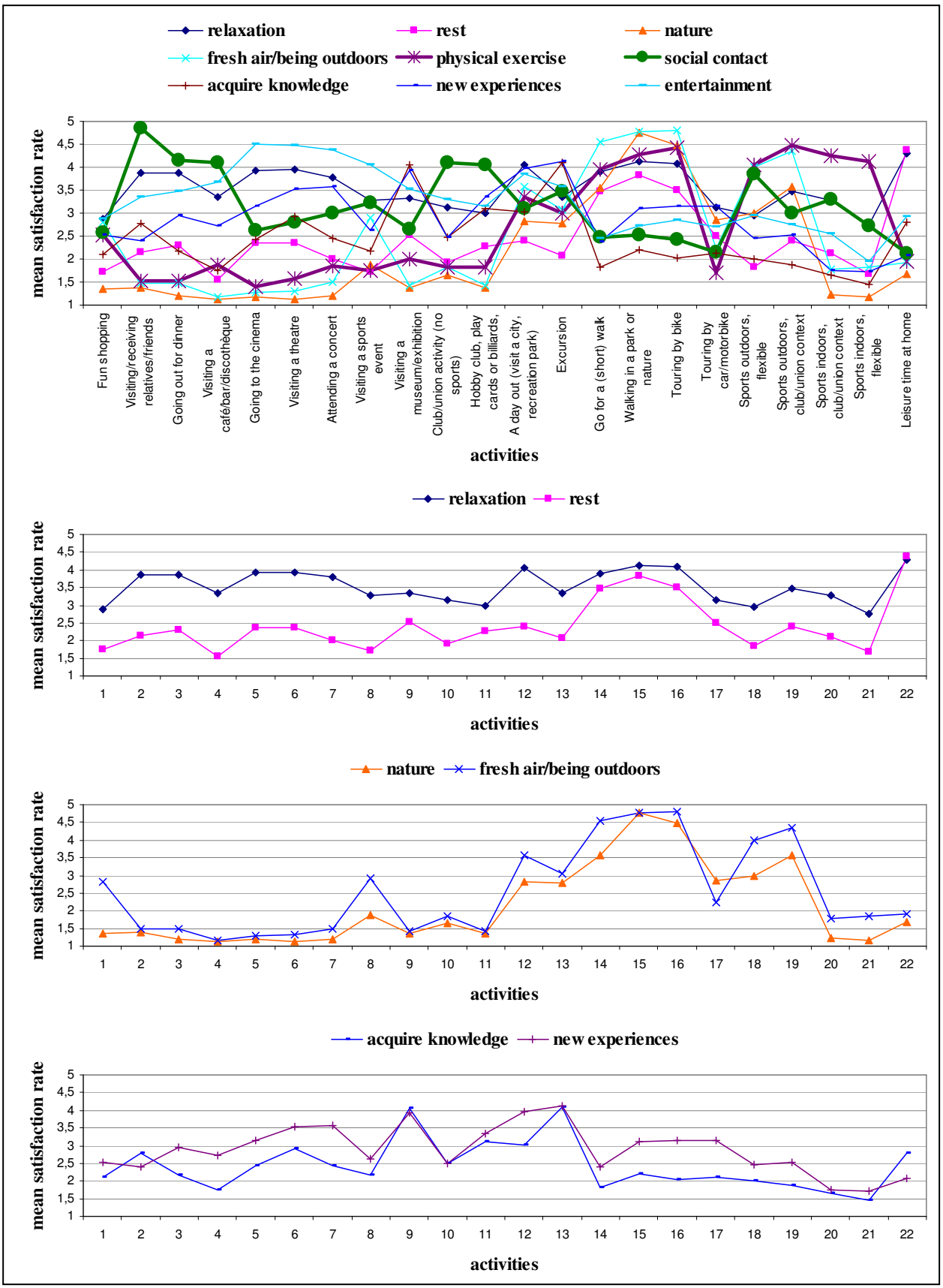

FIGURE 2 Comparisons of mean satisfaction rates Survey 2

by all subjects in the face-to-face interviews and rest by only half of them. So, all in all a need to rest cannot be distinguished from a need to relax when it comes to activity generation and, therefore, these two needs can be merged into a single category. The next graph of Figure 2 shows that the activity profiles of fresh air/being outdoors and nature are comparable too. In the first survey, fresh air/being outdoors was mentioned more often than nature, so we decided to leave nature out of consideration. The activity profiles for acquiring knowledge and new experiences are strongly alike as well. The satisfaction rates of acquiring knowledge exceed only four times the level of three units. Therefore acquiring knowledge will be subsumed under new experiences. In the end, the following six needs remain and will be included in the third-round survey:

- Social contact
- Physical exercise
- Relaxation
- Fresh air/being outdoors
- New experiences
- Entertainment

SURVEY 3: ANALYZING NEEDS

The purpose of this third round is to measure individuals' basic levels of the needs identified in the previous rounds and determine the extent to which these levels correlate with socio-economic and behavioral characteristics. In this main survey we use a much larger sample of individuals and incorporate the six remaining needs: Physical exercise, Social contact, Relaxation, Fresh air / being outdoors, New experiences and Entertainment. To construct a scale for each need, four statements were included in the questionnaire as indicators of the need: two of them were positively oriented and the other two negatively. The statements generally started with: "I think it is important to …", "I like to …" and "I have hardly any need for …". A complete list of the statements is shown in Table 4. The statements were mixed, so that the statements related to one need were not shown next to each other. Using Likert scales, subjects had to indicate to what extent they agreed with the statements (totally disagree, disagree, neutral, agree or totally agree).

The scales were part of a larger questionnaire consisting of six different parts. For validation of the scales we focus on three of them, namely the statements, socio-economic and demographic variables and the standard week pattern of the respondents. In the standard week pattern the respondents had to indicate, for every day of the week, which of the given activities they normally (phrased as 'almost always') conduct on that day. For each selected activity the subjects had to specify the usual duration and travel time. We included 18 activities in this part, like work, education, bring/collect child(ren), grocery shopping and some sports, leisure and social activities. The decision to use the latter ones was based on frequencies of those activities indicated by respondents in the Amadeus survey (*13*). If only a very small percentage of the 1600 respondents conducted the activity at least once a week, we decided not to include the activity.

TABLE 4 Statements used in the third survey

Physical exercise
1. I think it is important to practice a sport much.
2. I am not fond of practicing a sport.
3. I like to exercise much.
4. I have hardly any need for physical exercise.

Fresh air/being outdoors
1. I prefer to travel by bike or by foot.
2. I prefer to stay indoors as much as possible.
3. I think it is important to do activities outdoors.
4. I have hardly any need for fresh air.

Social contact
1. I like to have people around me.
2. I have hardly any need for social contact.
3. I think social contacts are important.
4. I like to be alone.

Relaxation
1. I think time for myself is very important.
2. I have hardly any need for relaxation.
3. I think leisure time is very important.
4. I like to be busy.

Entertainment
1. I like liveliness around me.
2. I have hardly any need for entertainment.
3. I like to be entertained.
4. I rather go for a walk or cycling than going to the movies, the theatre or a concert.

New experiences
1. I think it is important to gain new experiences.
2. I avoid situations unknown to me.
3. I am inquisitive in nature.
4. I have hardly any need to do new things.

Sample

Respondents were selected from a sample of neighborhoods in the Eindhoven region. In the last two weeks of June 2009, 4000 invitation cards were distributed to households in the selected neighborhoods. Furthermore, individuals who in an earlier survey (*14*) had indicated their willingness to participate again in an Internet survey were approached by e-mail. In this way, approximately 400 individuals were invited additionally to participate in the survey. As an incentive, twenty vouchers of 50 Euros were allocated to respondents through a lottery. In total, 408 individuals started and 270 of them completed the main questionnaire.

Table 3 describes the sample and the Dutch national population with regard to some relevant socio-economic variables. The sample is reasonably representative except that above-average educated groups are overrepresented. This bias is typical for Internet surveys in general (*15,16*). The elderly (65+ years) and young persons (< 25 years) are somewhat underrepresented and households consisting of two persons (married or living together) are a little overrepresented.

Results

The 270 respondents that completed the main questionnaire were included in the scale analysis. The four statements for every need, as shown in Table 4, were used to construct a scale for each need. To determine the reliability of each scale, we calculate Cronbach's alpha. Furthermore, we carry out a factor analysis to check whether the scale is homogeneous, i.e. relates to a single dimension. Note that the factor analysis was conducted only for the purpose of checking whether a single factor can explain the shared variance in the four statements that were included to represent the need, rather than to identify the joint factors (needs).

TABLE 5 Results Cronbach's Alpha and factor analysis

	Physical exercise	**Social contact**	**Relaxation**	**Fresh air / being outdoors**	**New ex-periences**	**Entertain-ment**
Cronbach's Alpha						
Alpha	0.834	0.748	0.287	0.526	0.692	0.602
Alpha without:						
Statement 1	0.758	0.652	0.018	**0.570**	0.564	0.587
Statement 2	0.783	0.623	0.102	0.311	0.671	0.444
Statement 3	0.808	0.643	**0.297**	0.406	0.667	0.457
Statement 4	0.806	**0.812**	**0.460**	0.514	0.602	**0.623**
Factor analysis						
Eigenvalues:						
Component 1	**2.700**	**2.307**	**1.525**	**1.748**	**2.104**	**1.882**
Component 2	0.542	0.853	**1.026**	0.984	0.795	0.916
Component 3	0.495	0.486	0.902	0.720	0.606	0.648
Component 4	0.263	0.354	0.547	0.548	0.495	0.554
New eigenvalues:						
Component 1		**2.152**	**1.525**	**1.626**		**1.708**
Component 2		0.488	0.921	0.817		0.735
Component 3		0.360	0.555	0.557		0.557

The results (Table 5) suggest that the indicators of the needs Physical exercise, Social contact, New experiences, Fresh air / Being outdoors, and Entertainment have a single dimensionality (i.e., only one component has an eigenvalue > 1). On the other hand, the statements related to the need for Relaxation are not homogeneous according to this criterion. The first section of the table shows the Cronbach's Alpha values. The 'Alpha without' value for each item shows the Alpha value that would result if the item was removed from the set. Printed bold are cases where 'Alpha without' is larger than the current value. The Cronbach's Alpha values suggest that the indicators for Physical exercise, Social contact and New experiences are to a satisfactory extent reliable. For some needs the Alpha can be increased by deleting one statement (value Alpha without is higher

than the overall Alpha for the need). However, a number of 3 statements is considered an absolute minimum for constructing a scale. In the cases of Social contact, Fresh air / being outdoors and Entertainment one indicator (based on the level of Cronbach's Alpha if item deleted) was deleted to increase the reliability. For Relaxation we left out one of the statements as well. Nevertheless the Cronbach's Alpha for this need is still too low (an Alpha value of 0.70 or larger is generally considered satisfactory). For Social contact we deleted Social contact-statement 4 ("I like to be alone"). In case of Fresh air / being outdoors statement 1 ("I prefer to travel by bike or by foot") was excluded from further analyses. For Entertainment we left Entertainment-statement 4 ("I rather go for a walk or cycling than going to the movies, the theatre or a concert") out of the final score-variable and in case of Relaxation, statement 4 ("I like to be busy") was deleted.

A new variable for each need can be constructed by summing the scores of the indicators, where totally disagree is counted as 1, disagree as 2, neutral as 3, agree as 4, and totally agree as 5. Consequently, the summary variables have a minimum of 3 (if one indicator was deleted) or 4 (if all four statements were included) and a maximum of 15 or 20.

To find out whether there are correlations between the sum scores of the needs, on the one hand, and some socio-economic variables and the time spent on activities in the standard week pattern, on the other, we calculated correlation coefficients. Nominal and some ordinal variables were dummy coded. The variables of the standard week pattern were computed by taking the sum of the durations of each time the activity was selected. If the activity was not selected in the week pattern, the value 0 was assigned. Thus, the variables represent the total amount of time normally spent by the respondent on the activities every week and whether they conduct the activity on a weekly basis or not. Table 6 shows how the needs are related to the other needs and subsequently to the time spent on several activities in the week pattern and to other general variables (e.g., gender, age). The correlation coefficients (Spearman's rho) that are significant at the 0.01 level are identified with two asterisks, and those significant at the 0.05 level are identified with a single asterisk. The values higher than 0.2 are shown in bold. Some variables that did not show significant and/or high correlation coefficients, were not included in the table. For example, household composition, car ownership/availability, age youngest child, and dwelling types (other than detached).

The results show that several needs are somewhat correlated. Especially, the need for social contact is related to entertainment, new experiences, and fresh air/being outdoors. Furthermore, the need for fresh air/being outdoors is correlated to the need for physical exercise. In all cases the needs are positively interrelated, this means that in general some subjects tend to give high scores for all needs and conversely, others indicate relatively low rates.

If we look at the standard week pattern, we see that if the amount of hours a week spent on paid work and education is higher, the need for physical exercise, new experiences and entertainment increases. The need for social contact is higher when respondents spend more time on visiting/receiving relatives/friends and visiting a café, bar or discothèque. In case of students, the need for relaxation grows when the time spent on doing their homework for school/study increases. Persons who exercise frequently show a higher need for physical exercise, entertainment, and fresh air/being outdoors. Finally, the need for entertainment is somewhat positively correlated to the time spent on visiting a café, bar or discothèque, visiting/receiving relatives/friends and fun shopping.

In addition to the behavioral variables, socio-economic factors have several impacts as well. Older age groups display lower needs in general. In particular, the needs for social contact and entertainment decrease when persons age. Similarly, if subjects are retired their need for

entertainment is lower. If the number of children in the household is higher, the need for fresh air/being outdoors is lower and the more often individuals work from home, the less time they need for relaxation. Furthermore, Females tend to have higher needs for physical exercise, new experiences, and entertainment. Respondents living in a detached house display a higher need for physical exercise and fresh air/being outdoors. Finally, the need for fresh air is higher in case of having a driver's license.

TABLE 6 Correlation coefficients (Spearman's rho)

	Physical exercise	**Fresh air / being outdoors**	**New ex-periences**	**Social contact**	**Relaxation**	**Entertain-ment**
Needs						
Physical exercise	1.000	**0.468****	**0.244****	**0.318****	0.166**	**0.304****
Fresh air / being outdoors	**0.468****	1.000	**0.374****	**0.426****	0.185**	0.166**
New experiences	**0.244****	**0.374****	1.000	**0.436****	**0.218****	**0.289****
Social contact	**0.318****	**0.426****	**0.436****	1.000	**0.330****	**0.463****
Relaxation	0.166**	0.185**	**0.218****	**0.330****	1.000	**0.227****
Entertainment	**0.304****	0.166**	**0.289****	**0.463****	**0.227****	1.000
Week pattern (hours a week)						
Paid work	0.178**	0.029	0.153*	0.119	0.086	0.169**
Work + education	**0.238****	0.044	0.194**	0.117	0.106	**0.235****
Homework	**0.221**	**0.381**	-0.033	-0.110	**0.516***	0.057
Physical exercise	**0.651****	**0.230****	0.161**	0.183**	0.168**	**0.273****
Walking/cycling	0.107	**0.273****	0.060	-0.034	0.023	-0.030
Café/bar/disco	**0.211****	0.080	0.171**	**0.226****	0.082	**0.330****
Visiting/receiving relatives/friends	0.110	0.071	0.092	**0.245****	0.114	**0.303****
Fun shopping	-0.094	-0.008	0.119	0.182**	0.137*	**0.255****
General variables						
Gender (1=female)	-0.171**	-0.015	0.087	0.118	0.093	0.060
Age	-0.118	0.066	-0.147*	**-0.208****	-0.179**	**-0.318****
Income	0.034	0.051	0.136*	-0.098	-0.023	-0.022
Education level	0.072	-0.044	0.073	-0.136*	-0.013	-0.065
Dominant activity						
Paid work	0.014	0.014	0.120	0.035	0.125*	0.103
Education/study	0.012	-0.085	0.018	0.069	0.057	0.126*
Retired	-0.028	0.040	-0.098	-0.070	-0.182**	**-0.227****
Num of children	0.130	**-0.225***	0.113	-0.055	0.026	0.059
Detached house	0.166**	0.124*	-0.085	-0.006	-0.014	-0.065
Driver's license	-0.005	0.183**	0.055	0.065	-0.013	0.015
Work from home	0.094	-0.046	-0.072	-0.013	**-0.255***	-0.173

DISCUSSION AND CONCLUSIONS

Several authors in the area of activity based modeling argued that the generation of activities should be based on needs (*6,7,9*). However, systematic empirical research on which needs exactly are responsible for which activities individuals conduct in daily life has not been carried out so far. In this paper a first attempt was made to elicit the needs underlying activity programming of social and leisure activities. After conducting qualitative face-to-face interviews based on cognitive mapping techniques (*10, 11, 12*) and subsequently an Internet questionnaire to find out which needs are similar and/or do not have that much influence, six needs remained that are distinct in terms of their relationships with activities. The needs are: Social contact, Physical exercise, Relaxation, Fresh air/being outdoors, New experiences, and Entertainment. The activity profiles of these needs confirm the hypothesis that many-to-many relationships exist between activities and needs which give rise to substitution relationships between activities. In the third survey statements were included and measurement scales were developed for every need. The scores on the scales for needs were correlated with characteristics of the respondents and the activities they usually conduct every week. The analysis shows intuitive and interesting results. For instance, individuals having a higher need for social contact spend more time on social activities like visiting relatives/friends and going to a café, bar or discothèque. Elderly tend to have lower needs in general.

In summary, some important findings are that 1) a substantial part of factors underlying activity choice can be interpreted as needs, 2) the set of these needs is limited and 3) complex relationships between activities and needs exist and may give rise to negative generation effects between activities. Furthermore, the contribution of the paper to activity-based modeling is twofold. First, it represents the next step in developing a needs-based model of activity generation. This approach may find wider explanation in both cross-sectional activity-based models and in the further development of dynamic activity-based models. Secondly, it provides evidence of the relationship between activities and underlying needs, increasing the complexity of previous analyses and models of activity programming and duration choices. In future research, we plan to further analyze the data collected in the main questionnaire and to estimate the parameters of a need-based model.

We should also point to some limitations of the study that suggest ways for future research. First, a replication of in particular the first survey is needed to verify completeness of the needs identified or whether additional dimensions play a role. Second, the present study focused on the nature of activities only, whereas other facets and, in particular, location may have influences on relationships between activities and needs as well. For example, the extent to which a given activity influences a need for experiencing fresh air and green environment, obviously, will also depend on attributes of the location. Third, future research could focus on the extent to which travel-mode and route choices for trips influence needs and, hence, interact with activities at locations. For example, using the bike may satisfy needs for physical exercise and being in open air and have a negative generation effect on recreation activities. Fourth, attributes of the residential location may have an influence on needs underlying activities which was considered only in a limited sense in the present study. For example, attributes of the residential location may satisfy or induce needs and, thus, have an impact on activity choices. Finally, we note that also reverse relationships may exist between activities and needs in the sense that an activity can induce rather than satisfy a need. Clearly, such relationships are important as well as they give rise to positive generation effects between activities. To cover also this aspect, an extension of the survey instrument is needed.

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