Environment and Planning A 1999, volume 31, pages 1935 – 1947

Group-based versus individual-based conjoint preference models of residential preferences: a comparative test

E Molin, H Oppewal, H Timmermans
Department of Architecture and Urban Planning, Eindhoven University of Technology, PO Box 513, postvak 20, 5600 MB Eindhoven, The Netherlands;
e-mails: E.J.E.Molin@sepa.tudelft.nl; H.Oppewal@surrey.ac.uk;
M.v.Kasteren@bwk.tue.nl (Timmermans)
Received 1 December 1997; in revised form 3 August 1998; in re-revised form 8 February 1999

Abstract. The conjoint preference approach, measuring *individual* preferences, has a long history in the study of residential decisionmaking processes. Residential choice behaviour, however, is often the result of a group decisionmaking process. In this paper we investigate whether conjoint preference models derived from group responses are different from and predict better than conventional conjoint models derived from the responses of individuals who do not interact during the data-collection process. In particular, we propose a new approach to modelling group preferences for residential choice alternatives that extends previous work of Timmermans et al. The new approach is illustrated in an application among 193 families with children. The results confirm that preference structures of individual family members differ from group preference structures and that the proposed group-based model predicts family preferences for new residential environments better than do conventional models.

1 Introduction

The analysis and modelling of residential preferences continues to be a widely researched topic in urban planning. This interest reflects the concern of urban planning to study the relationship between environmental characteristics and people's behaviour. From an applied perspective, the increasing market orientation of the housing sector has led to a clear need for a better understanding of residential preferences of various socioeconomic segments.

An examination of the relevant literature suggests that researchers have typically examined *individual* residential preferences (Clark and van Lierop, 1986; Louviere and Timmermans, 1990; Phipps and Carter, 1984). For households consisting of more than one person, this practice thus assumes that individuals can provide valid and reliable responses that represent the preferences of the family as a whole. Surprisingly, this assumption goes largely untested in the residential choice literature.

The aim of this paper is twofold. First, we wish to test the hypothesis that responses obtained from individual family members predict family preferences equally as well as responses collected from the family as a whole. Second, because we expect to reject this hypothesis, we propose an improved modelling approach for modelling group responses.

To this end, the paper is organised as follows. First, we shall develop and explain the new, alternative modelling approach. Then, we present the application, focusing on the design strategy and measurement procedures, followed by a discussion of the results of the analyses. The paper will be concluded with a summary of the main findings.

2 Model development

2.1 Hierarchical information integration

To understand the contribution of this paper to the literature, it is important first to discuss hierarchical information integration (HII) theory and its application to group decisionmaking. HII is an extension of information integration theory (Anderson, 1981;

1982) to model complex decision problems. It has been developed to allow the inclusion of a larger number of attributes in conjoint tasks (Louviere, 1984; Louviere and Gaeth, 1987; Louviere and Timmermans, 1990). HII assumes that, if subjects have to evaluate a complex choice alternative involving many influential attributes, they first group or categorise the attributes into separate higher order decision constructs, form evaluations for these decision constructs separately, and then integrate their evaluations of the decision constructs to form a final, overall preference for the complex choice alternative. Thus, HII is a theory of how individuals reduce information overload. In addition, however, it also represents a modelling approach in that tasks constructed to measure preferences strictly follow theory. Thus, separate designs are constructed to measure individual preference for decision constructs, and in addition a bridging experiment is designed to measure how individuals arrive at an overall preference or choice by integrating their ratings for the decision constructs.

Timmermans et al (1992) proposed an extension of this approach in order to model multiperson decisionmaking. They assumed that individual family members first independently evaluate each decision construct as is assumed in HII. These construct evaluations of individual family members are then assumed to be integrated by the family to arrive at a family preference or choice. Thus, in theoretical terms, they added the group aspect to conventional HII. Their approach meant that designs were constructed to measure the family members' preferences for higher order decision constructs and a bridging experiment was conducted to measure how families arrive at an overall preference or choice by integrating the family member ratings for the decision constructs.

Despite their encouraging results, this approach has some potential limitations. First, it shares the limitations expressed about HII, on which it is based (Oppewal et al, 1994). In particular, the bridging experiment may encourage respondents to use simplifying (for example, averaging) heuristics in providing overall preference judgments because the profiles in the bridging experiment consist only of numerical preference ratings for the decision constructs. The underlying attributes are not explicitly mentioned. Second, as attribute effects are tested across only a limited range of values, there is no control over respondents' inferences about the values of other decision constructs. Third, the approach results in separate submodels (one for each subexperiment) rather than in a single integrated model. Fourth, the assumed hierarchical decision structure cannot be tested, but rather one must assume that the hierarchical structure is correct to concatenate the results of the separate experiments into an overall model of residential preference.

A second limitation of the approach is its limited opportunity for group interactions to take place. The procedure measures individuals' preferences before any group interaction; the interaction between the spouses serves only to measure the influence of each spouse on the final group outcome. Group interactions may, however, lead to preference changes as a result of information and normative processes (for example, Moscovici, 1985). The approach we propose in the next section allows for all such processes by simulating the group decisionmaking process.

2.2 A group model based on integrated HII experiments

In light of the above discussion, the goal of the present project was to develop an approach for modelling group preferences which overcomes these shortcomings. The particular approach that we suggest in this paper is (1) to construct so-called integrated subexperiments rather than conventional HII experiments, and (2) to ask groups (spouses, families, etc) to complete all experimental tasks jointly rather than using a mixture of individuals and groups to complete different tasks. The use of integrated subexperiments avoids the objections raised against HII. These experiments create profiles, which vary not only the attribute levels of the decision construct of interest, but also the construct evaluations of all other decision constructs. Consequently, the bridging experiment is no longer required. The specific advantage of this modification is, first, that profiles describe all dimensions relevant to the decision problem under investigation. Hence, respondents no longer have to infer values of missing dimensions. Dimensions are described either as hypothetical preference ratings or as profiles of attribute subsets. Second, the approach allows one to test the validity of the assumed hierarchical decision structure (for details see Oppewal et al, 1994). Third, data on the dependent variable of interest can be directly collected in each subexperiment, regardless of whether the researcher's interest focuses on ratings or choice data. Each subexperiment is a separate and independent conjoint experiment that can be analysed accordingly, even if the hierarchical structure should prove not to be valid.

The advantages of an approach based on integrated subexperiments also seems pertinent to the modelling of group preferences. In the present study, therefore, we explore these and potential other advantages of this design strategy to the modelling of group preferences. In particular, we suggest adding individualised construct evaluations of the remaining decision constructs to the profiles in each subexperiment, as shown in figure 1 for the case of two decision constructs.

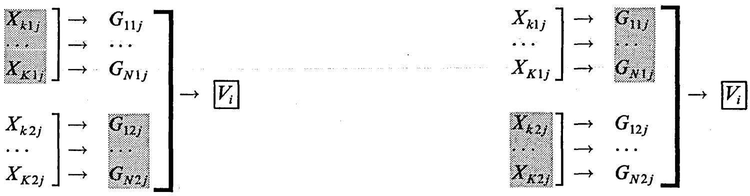

Figure 1. Experimental tasks of the proposed multiperson model. The shading indicates what is varied in the experiment.

Thus, we propose a model that includes parameters for the attributes belonging to a particular decision construct and, separately for each family member, parameters for the other constructs. These parameters can be interpreted as the relative influences of the family members on the joint decision. Note that individual family members can complete tasks identical in nature to these group tasks. In that case, the construct parameters can be interpreted as the extent to which the family member takes into account the preferences of his or her family members.

The model can be formally described as follows:

$$V_{ij} = \sum_{k \in K_i} \beta_{ik} X_{ijk} + \sum_{n \in N} \tau_{i'n} G_{i'jn} + \varepsilon_{ij}, \qquad i' \neq i,$$

where V_{ij} is the utility of alternative j as measured in subexperiment i; the X_{ijk} are the appropriately coded levels for attributes k, $k \in K_i$, K_i being the attribute subset varied in subexperiment i; the $G_{i'jn}$ are the coded levels of the remaining constructs i' $(i' \neq i)$ for group member n, $n \in N$, N being the set of group members; the β_{ik} and $\tau_{i'n}$ are the corresponding unknown parameters for subexperiment i; and ε_{ij} is an error term.

In the alternative approach suggested here, all tasks are completed by all group members in interaction. Hence, the responses are collected through a simulated group decisionmaking process. During this process, individual group members may reveal their preferences, attempt to influence other group members, change their preferences as a result of discussions with other group members, and finally reach a joint decision. As the estimated preference function is based on group decisions, the effects of group interaction are automatically incorporated in the model. Therefore, we hypothesise that this suggested alternative modelling approach will lead to potentially more valid models of group preference than will conventional models based on tasks completed by individual group members.

In the next section we present an application of this alternative approach to modelling residential preferences. In this application, we will illustrate the suggested approach and test the hypothesis that models based on group responses outperform models that are estimated from responses of individual group members, even if these models are combined according to some averaging function.

3 Methodology

The substantive problem of interest concerns residential preferences of families, consisting of at least a father, a mother, and a child. The application of the suggested alternative modelling approach involves the following steps: (1) identification of the attributes assumed to influence the formation of residential preferences, including the categorisation of these attributes into decision constructs and the choice of attribute levels, (2) the construction of a design with integrated subexperiments, (3) the selection of respondents, (4) the choice of a measurement procedure, and (5) the estimation of the model and the interpretation of the estimated parameters. Details of these steps will be provided in the following (sub)sections.

3.1 Elicitation of attributes and attribute levels

The elicitation of the attributes and attribute levels used in the present study involved the following steps. First, on the basis of a literature search and some pilot interviews, the attributes influencing residential choice decisions were identified. Consistent with this literature, the selected attributes were assigned to one of two decision constructs: the *house* or the *location* construct. The assumption that these two constructs mediate the decision process is based on previous research on residential preferences (Clark and van Lierop, 1986; Hourihan, 1979; Louviere and Timmermans, 1990; Phipps and Carter, 1984). A further classification of these constructs in terms of decision sequences is not made here as our approach assumes a simultaneous choice process. The selected attributes and their levels are listed in table 1. The hypothetical construct-evaluations

Table 1. The selected attributes and their levels.

Housing	Location
Housing type	Building type in neighbourhood—mainly row houses or apartments [versus mainly (semi)detached]
flat or apartment	
row house	
semidetached dwelling	Frequency of public transport—once an hour (versus four times an hour)
detached dwelling	
Number of bedrooms	Travel time to work of father
three	5 mins
four	30 mins
five	55 mins
Size of bedroom for children—7.5 m^2 (versus 16 m^2)	Travel time to work of mother
Monthly costs	5 mins
Dfl 600	30 mins
Dfl 1000	55 mins
Dfl 1400	Travel time to school of children
Tenure–rent (versus own)	5 mins
	30 mins
	55 mins

were varied in terms of the values $5\frac{1}{2}$ and 8, with associated labels 'marginally sufficient' and 'good', respectively. These numerical figures correspond with typical grades given in the Dutch school system, the $5\frac{1}{2}$ suggesting that the evaluation is marginally sufficient.

3.2 Design construction

Having selected the attributes and their levels, the next step involved the construction of the design with integrated subexperiments. Because two decision constructs were identified, two such designs need to be constructed, one for the house and one for the location construct. Attribute profiles for the house construct were created by using an orthogonal fraction of the $4 \times 3^2 \times 2^5$ factorial design involving 16 treatments. The choice of an orthogonal fraction implies that unbiased estimates of the attribute effects can be obtained. In the case of the location subexperiment, an orthogonal fraction of the $3^3 \times 2^5$ factorial, also involving 16 treatments, was created. An example profile of the house subexperiment is provided in table 2. Three random orders of profiles were used to avoid any order effects. Families were randomly assigned to one of these order conditions. Within a family, the order was held constant between the various tasks.

Table 2. Example profile of the house subexperiment.

House	apartment rent 4 bedrooms bedroom child: 16 m^2 monthly costs: Dfl 1000	
Location	evaluation of location by father: evaluation of location by mother: evaluation of location by the children:	good (8) marginally sufficient ($5\frac{1}{2}$) good (8)

In addition to the profiles used for model estimation, two sets of hold-out profiles (not used in the estimation) were created for validation, using a different selection and ordering of the columns from the experimental design plans that were used for the construction of the experimental profiles. Thus, a second set of 16 profiles was constructed for the house subexperiment format and a second set of 16 profiles was constructed for the location subexperiment format. These profiles were randomly paired for each subexperiment, under the constraint that no alternative dominated any other in the resulting choice sets. Each family received two randomly selected hold-outs profiles and one randomly selected choice-set.

3.3 Subjects and measurement procedure

Participants were 193 families of Eindhoven, The Netherlands, each family consisting of a father, mother, and at least one child older than 13. The families were recruited through the children's school or their previous participation in a study on consumer products. After receiving an introductory letter by mail, they were contacted by an interviewer who made an appointment for them to complete one of the following tasks:
(a) An *individual task* in which family members individually, without discussion or interaction with any other family member, completed a conjoint task. They expressed their preferences for each of the profiles on a 21-category rating scale, with the extremes labelled as 'very unattractive' and 'very attractive'.
(b) A *family task* in which family members jointly responded to both subexperiments, using the same response scale as the one used in the individual task. To provide these responses, family members had to discuss the profiles and solve possible preference disagreements.

Families were randomly assigned to one of these tasks. After one to two weeks, a second session was organised. As indicated in table 3, families who already had completed an individual task either again received an individual task or a family task. Families who completed a family task in the first session again received a family task in the second session. Note that the replications of the experimental tasks at t_2 were included to allow an assessment of the reliability of the models. These reliability analyses are, however, beyond the scope of this paper.

After another two weeks, all families participated in the *family hold-out task* in which family members were asked to express their joint preferences for two hold-out profiles on a rating scale and select the alternative they liked best from another pair of hold-out profiles. All these tasks were supervised by an interviewer. Before completing the experimental tasks, respondents familiarised themselves with the attributes and constructs varied in the experiment by rating six attribute profiles which were not part of the experimental design.

Table 3. Research design.

Experimental conditional	Time of measurement[a]		
	t_1: conjoint task 1	t_2: conjoint task 2[b]	t_3: hold-out task[c]
1	individual tasks: house (N_i = 72) or location subexperiment (N_i = 66)	individual tasks: house (N_i = 72) or location subexperiment (N_i = 66)	joint family task: two ratings and two choices in house (N_g = 22) or location format (N_g = 22)
2	individual tasks: house (N_i = 144) or location subexperiment (N_i = 153)	joint family task: both house and location subexperiments (N_g = 99)	joint family task: two ratings and one choice in both house and location formats (N_g = 85)
3	joint family task: both house and location subexperiments (N_g = 48)	joint family task: both house and location subexperiments (N_g = 48)	joint family task: two ratings and one choice in both house and location formats (N_g = 43)

[a] N_i indicates number of individuals, N_g indicates number of groups.
[b] Data from shaded tasks are not used in the analyses; condition 2 was tested for carryover effects which were found not to be significant.
[c] Lower response at t_3 is a result of panel attrition between t_2 and t_3.

4 Analysis and results

Central in this study is the hypothesis that conjoint models of residential preference based on group responses advance our understanding of residential preferences and outperform models derived from individual responses. The central hypothesis was tested in two ways. We first tested whether the model estimates derived from families' joint responses are significantly different from model estimates based on the individual or averaged responses of individual family members. Second, we tested whether the model derived from family responses better predicts preference judgments, expressed for hold-out choice alternatives. Before presenting the results of these tests, we shall first discuss the parameter estimates, in particular with respect to their interpretation in terms of the influence of individual family members on the outcome of the family decision. This discussion will demonstrate how the proposed approach potentially advances our understanding of residential preferences as none of the conventional approaches allows these kinds of interpretation.

4.1 Attribute effects

We started our analysis by estimating a model for each family and each individual family member [father, mother, child(ren)]. For each family, we also estimated a model by averaging the responses of individual family members, further referred to as an equal-weight model. Assuming that a simple main-effects-only model is able to represent a family's residential preferences, multiple regression analysis was used to estimate these preference models. The dependent variable in these analyses is the overall profile rating; the independent variables are the effect-coded attribute levels. Consequently, the estimated regression coefficients represent the part-worth utilities of the attribute levels expressed as deviations from the regression intercepts, which are equal to the mean overall profile evaluations. The equal-weight model was estimated from the profile ratings after averaging the profile ratings of the individual family members.

The results obtained from these analyses indicate that the simple main-effects-only model fits the observed preference ratings for the experimental residential profiles quite well: table 4 shows that the mean proportion explained variance is higher than 0.90 for all models. Tables 5 and 6 (see over) present the average part-worth utilities for the house and location subexperiments, as estimated for the various models.

Table 4. Goodness of fit of estimated models: proportion explained variance of observed profile ratings by estimated models.

	House subexperiment			Location subexperiment		
	mean	SD	*N*	mean	SD	*N*
Family members	0.95	0.06	216	0.90	0.11	219
Equal weight	0.98	0.02	72	0.93	0.07	73
Family	0.96	0.04	147	0.95	0.05	147

The estimated part-worth utilities for the *housing* attributes may be interpreted as follows. The part-worth utilities estimated for the housing type indicate that utility increases with the housing type becoming more detached. The part-worth utility is relatively low for apartments and, to lesser extent, also for row houses. Semidetached and detached dwellings are preferred, and the difference in utility between these two categories is relatively small. Utility increases almost perfectly linearly with an increasing number of bedrooms and with larger bedrooms for children. Owner-occupied dwellings are preferred over rented dwellings. Utility increases with decreasing monthly costs, and this relationship is almost perfectly linear.

The estimated part-worth utilities for the *location* attributes may be interpreted as follows. Neighbourhoods with mainly (semi)detached dwellings are preferred. Moreover, a higher frequency of public transport is preferred, although the difference in utility between low and high frequency is rather small, indicating that this attribute is apparently less important in forming residential preferences. Furthermore, utility increases with decreasing travel time to work or school. Children's travel time is considered more important by the family as a whole than fathers' and mothers' travel times. Mother's travel time is found more important than father's travel time. All estimated part-worth utilities are in anticipated directions, giving face validity to the estimated models.

4.2 Relative influence and power relations

We argued that the estimated construct parameters can be interpreted as measures of the relative influence of individual family members on a family's preference rating. An

Table 5. Preference structures estimated from the house subexperiment.

	Family	Father	Mother	Child	Equal weight
Housing type					
flat or apartment	−2.37	−3.01*	−2.79	−1.61*	−2.47
row house	−0.63	−0.61	−0.53	−0.23	−0.46
semidetached dwelling	1.36	1.77	1.52	0.74*	1.35
detached dwelling	1.64	1.85	1.80	1.10*	1.58
Number of bedrooms					
three	−1.22	−0.69*	−1.37	−1.22	−1.09
four	−0.01	−0.24	0.27	0.11	0.05
five	1.23	0.93	1.10	1.11	1.05
Size of bedroom for children 7.5 m^2 (versus $16m^2$)	−1.05	−0.66*	−0.66*	−0.88	−0.73*
Monthly costs					
Dfl 600	2.18	2.15	1.92	0.98*	1.69*
Dfl 1000	−0.32	−0.19	−0.15	0.00	−0.11
Dfl 1400	−1.86	−1.96	−1.77	−0.98*	−1.57
Tenure rent (versus own)	−0.55	−0.59	−0.70	−0.22*	−0.50
Evaluation of location					
father	−0.38	−0.59	−0.03*	−0.07*	−0.23
mother	−0.54	−0.03*	−0.34	−0.04*	−0.14*
child	−0.61	−0.32*	−0.28*	−0.81	−0.47
Intercept	9.56	9.38	8.54*	11.66*	9.86*
Number of cases	147	72	72	72	72

* Indicates significant difference with family model ($p < 0.05$).

examination of table 5 thus suggests that children have most influence on a family's preference rating for the location construct, as indicated by the range of the part-worth utilities of a particular attribute or construct. This perhaps unexpected result is, however, corroborated by the estimates for the location attributes, derived from family responses, listed in table 6, which shows that the family as a whole finds travel time to school more important than travel time to work. This seems consistent with the common knowledge that families are reluctant to move during the children's high school years. Moreover, as illustrated by the estimated models for the parents, both parents are more influenced by their children's preferences than by their spouses' preferences.

A further observation from table 6 is that the fathers have the highest influence with respect to the family's preference rating for the house construct. One may find this an unexpected result, arguing that mothers often spend more time at home (which is also the case in the present study) and thus have a higher interest in a good housing situation. However, as suggested by the theory of relative resources (for example, Davis, 1976), fathers may indeed have more to say about family resources, which should in part be spent to cover residential costs, as they contribute most to the family income. In 95% of our sampled families the father earned more than the other family members.

Such analyses about the influence of family members can be extended to the attribute level. Table 6 indicates that all family members attach most importance to those travel times that affect them most. Thus, fathers weigh travel times to their work more than the travel time to work of their spouse or travel time to school. There is also evidence of power relations. Mothers take the travel time to work for fathers more into consideration than vice versa. The evaluation of the house by mothers plays a lesser role in the evaluation by fathers than vice versa. Mothers, on average, apparently also take

Table 6. Preference structures estimated from the location subexperiment.

	Family	Father	Mother	Child	Equal weight
Building type in neighborhood mainly row houses or apartments [versus mainly (semi)detached]	−0.52	−1.01*	−1.02*	−0.71	−0.92*
Frequency of public transport once each hour (versus four times)	−0.25	−0.17	−0.06	−0.31	−0.18
Travel time to work of father					
5 mins	0.64	1.78*	0.38	0.16*	0.77
30 mins	0.25	0.23	0.25	0.32	0.27
55 mins	−0.89	−2.01*	−0.63	−0.48*	−1.04
Travel time to work of mother					
5 mins	1.03	0.04*	1.14	−0.10*	0.36*
30 mins	0.11	0.15	0.15	−0.01	0.10
55 mins	−1.14	−0.19*	−1.29	0.11*	−0.46*
Travel time to school of children					
5 mins	1.25	0.36*	0.53*	2.00*	0.96
30 mins	0.40	0.05*	−0.09*	0.33	0.10*
55 mins	−1.65	−0.41*	−0.44*	−2.33*	−1.06*
Evaluation of house					
father	−0.75	−0.30*	−0.07*	−0.01*	−0.13*
mother	−0.52	0.09*	−0.03*	−0.07*	−0.00*
child	−0.65	0.08*	0.07*	−0.43*	−0.09*
Intercept	9.05	9.87*	8.98	10.60*	9.82*
Number of cases	149	73	73	73	73

* Indicates significant difference with family model ($p < 0.05$).

the evaluations by their children more into consideration than fathers do. Thus, in the present sample, fathers still seem to have most power and are less inclined, on average, to incorporate the value judgments of their spouse and children. Similar effects can be observed in table 5.

4.3 Comparing preference structures

To investigate whether the estimated preference structure of the various models differ significantly, we tested for differential regressions between models. To that effect, the observations were pooled and codes, representing contrasts between models, were added to the design matrix. First, a model was estimated without the contrast parameters as explanatory variables, and then the model was reestimated by including the contrast parameters. A partial F-test was applied to test whether the set of contrast parameters contributes significantly to the explained variance. This test statistic can be expressed as follows:

$$F_{\text{change}} = \frac{R^2_{\text{change}}(N-p-1)}{q(1-R^2)},$$

and follows a $F_{(q,N-p-1)}$ distribution. R^2_{change} represents the additionally explained variance due to the contrast parameters, N is the total number of observations in the pooled samples, p is the total number of parameters, and q is the number of contrast parameters. If the F_{change}-value is significant, one can proceed by examining the t-values of the contrast parameters to identify which attributes are responsible for the differences between the two models.

Table 7. *F*-values calculated for contrast parameters between family-member categories and family preferences.

	House subexperiment					Location subexperiment				
	N	p	q	F_{change}	p-value	N	p	q	F_{change}	p-value
Father	3504	25	13	4.06	0.000	3552	23	12	19.02	0.000
Mother	3504	25	13	6.22	0.000	3552	23	12	11.06	0.000
Child	3504	25	13	31.08	0.000	3552	23	12	22.95	0.000
Equal weight	3504	25	13	3.43	0.000	3552	23	12	14.57	0.000

N = number of observations, p = total number of parameters, q = number of contrast parameters, p-value = level of significance.

The results of the F-tests presented in table 7 show that, across families, the family model is significantly different from the individual member models and also from the equal weight model. That is, the preferences of fathers, mothers, and children as measured in the individual tasks are all significantly different from the family preferences expressed in the joint family tasks. Moreover, family preferences are different from averaged individual preferences, indicating that preference differences between family members do not balance out at the aggregate level. These results thus confirm our assumption that group interactions play a role in the joint family task. Individual family members may exert a different influence on the outcome of the group decision and members may change their preferences as a result of informational and normative processes (for example, Chandrashekaran et al, 1996; Moscovici, 1985).

It is interesting to look at which attributes are responsible for the differences between fathers, mothers, and children. Tables 5 and 6 present the part-worth utilities estimated for the house and location subexperiments for the family as such and each family member separately. If a contrast parameter is significant ($t > 1.96, p < 0.05$), then the corresponding part-worth utility is marked with an asterisk. Hence, these tables indicate which of the estimated part-worth utilities of the family-members model and equal-weight model differ significantly from the family model. Table 5 illustrates that fathers evaluate apartments significantly lower than children do. In fact, children appear to have a significantly different preference function for most housing-type attributes. Although the preference ordering is the same for fathers, mothers, and children, children differentiate less between extremes, suggesting they care less about housing type.

As for the number of bedrooms, fathers discriminate least, mothers most. In contrast, children weigh the monthly costs less, whereas this is an important attribute for fathers. A similar result is obtained for tenure. Children in general have provided higher evaluation scores. The individual evaluations of location are significantly different as indicated earlier.

Table 6 demonstrates that fathers and mothers care more about the kind of neighbourhood. As expected and discussed in connection with power relations, there is evidence of significant differences in the evaluation of the travel-time attributes. Thus, it can be concluded that such comparisons shed interesting light on the power relationships within families.

4.4 Predictive ability

A corollary to the central hypothesis in the present study was that family models outperform family-member and equal-weight models in predicting family preferences and choices for new residential alternatives. In this study, new residential alternatives were represented by family ratings for hold-out profiles and family choices between pairs of hold-out profiles, as observed about two weeks after the second task (time t_3 in table 3).

Table 8 shows how the predictions of the family-member, equal-weight and family models differ from the observed family ratings for the constructed hold-out profiles of residential environments. It shows that the mean absolute difference is significantly smaller for the family models than for family-member and equal-weight models, at the 95% probability level.

Table 9 presents the percentage of correctly predicted choices of the family-member, equal-weight, and family models. It shows that the proportion of correctly predicted choices is larger for the family models than for the family-member and equal-weight models. One-sided t-tests indicate that the differences between the family model and the family-member model for the choice of the location are significant at the 95% probability level. The differences between the family model and the equal-weight model are significant at the 90% probability level. The differences for the house-format choices are not significant.

We thus find that model performance improves from individual measurement of residential preferences to group measurement in the case of location attributes. This could be a result of the conflict that is generated by the travel-time attributes. No such conflicts are apparent in the house subexperiment, which suggests that family models outperform family-member models in particular when there is considerable conflict of interest between family members.

Table 8. Absolute differences between predicted and observed family hold-out ratings.

Model	House format			Location format			Total		
	mean	SD	N	mean	SD	N	mean	SD	N
Family-member (M)	3.98	3.40	384	4.67	3.36	360	4.31	3.40	744
Equal-weight (EW)	3.01	2.88	128	3.70	2.80	120	3.35	2.86	248
Family (F)	2.10	1.72	256	1.81	1.61	228	1.97	1.67	484
t-test	diff.	t	p^a	diff.	t	p^a	diff.	t	p^a
M versus F	1.88	9.20	0.000	2.86	13.81	0.000	2.35	16.09	0.000
EW versus F	0.91	3.29	0.001	1.89	6.82	0.000	1.38	7.01	0.000

Note: diff. difference.
[a] One-tailed p-value.

Table 9. Percentage correctly predicted choices for pairs of family hold-out profiles.

Model	House format			Location format			Total		
	%	SD	N	%	SD	N	%	SD	N
Family-member (M)	65.9	47.5	258	59.0	49.3	261	62.4	48.5	519
Equal-weight (EW)	68.6	46.5	86	63.2	48.5	87	65.9	47.5	173
Family (F)	68.8	46.5	128	73.4	44.3	128	71.1	45.4	256
t-test	diff.	t	p^a	diff.	t	p^a	diff.	t	p^a
M versus F	−2.9	−0.56	0.288	−14.4	−2.91	0.002	−8.7	−2.91	0.008
EW versus F	−0.2	−0.02	0.491	−10.2	−1.57	0.059	−5.2	−1.13	0.130

Note: diff. difference.
[a] One-tailed p-value.

5 Conclusion and discussion

In this paper we proposed a new method for modelling group preferences for complex choice alternatives, such as residential environments. Critical for the suggested approach is that group members complete an experimental preference task in which choice alternatives are described in terms of a set of relevant attributes, describing the choice alternatives, and the preferences of other group members for the alternatives. The theory, design strategy, measurement tasks, and model estimation of this alternative approach have been developed in this paper and illustrated in the context of residential preferences of families. This approach can help to improve our understanding of residential preferences as it not only allows a direct assessment of the effects of attributes, describing the house and the location, on group preferences but in addition also gives insight into the relative influence of individual group members on the outcome of the group-decision process and potential sources of conflict within groups. In this study, it was empirically investigated whether the proposed conjoint preference model, derived from group responses to experimental profile descriptions of residential environments, results in different preference functions from those obtained in conventional conjoint preference models, which are derived either from individual responses only, or from a combination of individual responses. In addition, the hypothesis that group-based models outperform individual-based models was examined.

The results of the present study confirm that preferences of different family members differ from family preferences. Consequently, common practice to select one family member as a representative in housing surveys to provide responses that are supposed to reflect family judgment is unlikely to result in valid and reliable measurements of residential preferences. The results of the analyses confirm that the family model predicts family preferences for new residential alternatives better than family-member models, again suggesting that our understanding of residential preferences can be improved if a group-based approach is used. Furthermore, as for the prediction of choices as opposed to preferences, this study suggests that the family model outperforms the family-member and equal-weight models in predicting choices for new residential choice alternatives in the location subexperiment, but not in the case of the house subexperiment. This may suggest that the advantage of group-based conjoint preference models is highest if there exists a considerable degree of conflict or disagreement among family members in terms of their preference for a particular attribute. It is not surprising that in these kinds of cases our understanding of residential preferences may be significantly improved as conventional individual-based conjoint models do not allow one to draw any conclusions about the influence of group members on the final outcome of the group-decision process. Moreover, as there is no interaction between group members, the preference ratings expressed by a single, representative group member are based on his or her impression of the judgments of all other group members and will not change as a result of interaction or discussion. Thus, only if there is a high degree of agreement among the preferences of group members, or at least highly monotonic relationships between the preferences of group members, are conventional conjoint preference models likely to predict well. In all other cases, they are likely to perform less well than group-based conjoint preference and choice models.

The extent to which particular attributes are indeed sources of conflict between individual group members can be assessed by the proposed approach. In addition, it can be used to measure the relative influence of individual group members on the outcome of the group-decision process. In the present study, we found that the influence of children on the location decision was relatively high, suggesting that parents are reluctant to move when their children are still strongly oriented on their immediate environment. In addition, we found evidence of both fathers and mothers being more influenced by their children's judgments than by their spouses' preferences. Also, fathers seem to play a dominant role in the preference formation for attributes of the house, which might illustrate the relative resources theory.

In conclusion, then, we feel that the suggested approach has potential value in measuring preferences for choice alternatives in situations where the decisions are in principle made by a group rather than by an individual. Further methodological and applied research is needed, however, to appreciate better the potentials and limitations of the suggested approach.

References

Anderson N H, 1981 *Foundations of Information Integration Theory* (Academic Press, New York)

Anderson N H, 1982 *Methods of Information Integration Theory* (Academic Press, New York)

Chandrashekaran M, Walker B A, Ward J C, Reingen P H, 1996, "Modelling individual preference evolution and choice in a dynamic group setting" *Journal of Marketing Research* **33** 211 – 223

Clark W A V, Van Lierop W F J, 1986, "Residential mobility and household location modelling", in *Handbook of Regional and Urban Economics* Ed.P Nijkamp (Elsevier, Amsterdam) pp 97 – 132

Davis H L, 1976, "Decision making within the household" *Journal of Consumer Research* **2** 214 – 260

Hourihan K, 1979, "The evaluation of urban neighbourhoods. 2: Preference" *Environment and Planning A* **11** 1355 – 1367

Louviere J J, 1984, "Hierarchical information integration: a new method for the design and analysis of complex multiattribute judgement problems", in *Advances in Consumer Research, Volume 11* Ed. T C Kinnear (Association for Consumer Research, Provo, UT) pp 148 – 155

Louviere J J, Gaeth G J, 1987, "Decomposing the determinants of retail facility choice using the method of hierarchical information integration: a supermarket illustration" *Journal of Retailing* **63** 25 – 48

Louviere J J, Timmermans H J P, 1990, "Hierarchical information integration applied to residential choice behaviour" *Geographical Analysis* **22** 127 – 145

Moscovici S, 1985, "Social influence and conformity", in *Handbook of Social Psychology* Eds G Lindzey, E Aronson (Random House, New York) pp 347 – 412

Oppewal H, Louviere J J, Timmermans H J P, 1994, "Modelling hierarchical conjoint processes with integrated choice experiments" *Journal of Marketing Research* **31** 92 – 105

Phipps A G, Carter J E, 1984, "An individual-level analysis of the stress-resistance model of household mobility" *Geographical Analysis* **16** 176 – 189

Timmermans H J P, Borgers A, Van Dijk J, Oppewal H, 1992, "Residential choice behaviour of dual earner households: a decompositional joint choice model" *Environment and Planning A* **24** 517 – 533