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A Comparison of Full Profile and Hierarchical Information Integration Conjoint Methods to Modeling Group Preferences

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Abstract

This paper presents a comparative test of full profile (FP), original hierarchical information integration (HII-O), and integrated hierarchical information integration (HII-I) conjoint methods for modeling group preferences. It is hypothesized that in settings where groups need to decide about complex multi-attribute alternatives, HII-O will predict holdout profiles better than FP, and that HII-I will perform better than HII-O. The predictive ability of the three methods is tested for the case of housing preferences of housing co-ops, which are groups consisting of three to five people who jointly own a house. The results confirm that HII-I outperforms the other two methods and further suggest that FP and HII-O perform equally well. In addition, two variations of HII-I are developed. One of these provides independent estimates of the relative influence of group members on the decision outcomes, however at the expense of requiring larger designs. The two HII-I variations are also tested and found to be equivalent in predictive ability.

Key words: Conjoint analysis, hierarchical information integration, group preference modeling

A recurring issue in the literature on conjoint analysis is the problem of information overload and methods to cope with this. Recently, Pullman, Dodson and Moore (1999) presented results pertaining to different methods for handling large numbers of attributes in conjoint tasks. Their results suggest that full profile (FP) conjoint is surprisingly robust as FP performed equally well or even better than a series of alternative methods, including ACA and other hybrid methods in their study. One method that was not included in this comparison though was hierarchical information integration (HII). In HII, conjoint tasks are structured in a hierarchical fashion to support and better facilitate respondents to express their preferences for conjoint profiles. HII has been around for several years as an alternative way of handling larger numbers of attributes in conjoint tasks, but little research has been done to compare HII with other conjoint methods, including FP.

The present paper compares FP with two methods that both implement the HII framework. The first is the conventional method, as originally proposed by Louviere

(1984) and implemented by Louviere and Gaeth (1987), among others. The other is the approach using integrated experiments, as proposed by Oppewal, Louviere and Timmermans (1994). We denote the original approach as HII-O and the integrated approach as HII-I. Later in this paper we will recap the main features of these two methods.

Our study is the first to compare the predictive abilities of FP and HII-O/I. We know of only one previous study that compared FP and HII. This study (Van de Vijvere, Oppewal and Timmermans, 1998) compared a FP and HII-I choice design implementation in a residential choice application involving fourteen attributes. It was found that the aggregate preference structures as estimated in a choice model were equivalent for the FP and HII-I implementations, though the error variance was larger in the FP case. The study by Van de Vijvere c.s. however only compared the FP and HII-I approaches.

Our study also seems to be the first to apply HII to group settings. In fact, there are only very few applications at all in which conjoint designs were administered to groups instead of individuals. Notable studies are Dellaert, Prodiaglidad and Louviere (1998), Krishnamurthi (1988), Timmermans, Borgers, Van Dijk and Oppewal (1992), and Borgers and Timmermans (1993). However, consumer decisions about important products often involve more than one individual and often concern complex alternatives. For example, the purchase of household durables is often the result of a family decision making process, involving individuals with different preferences for different attributes (Buss and Schaninger 1987, Davis, Hoch and Ragsdale 1986, Menon et al. 1995). It is therefore highly relevant to study if and how conjoint methods can be applied to group settings. This paper explores the application of HII methods to modeling group preferences and develops two different implementations of HII-I. One of these provides independent estimates of the relative influence of each group member on the decision outcome, however at the cost of requiring larger designs.

The hypotheses to test in this paper are, first, that HI-O will better than FP predict preferences for holdout profiles if the application involves a fairly complex decision problem. The reasoning behind this hypothesis is that an increased task complexity leads to a decrease in response accuracy, either through a lack of respondent capabilities in handling the information or through a deterioration in respondent motivation to process the more complex task. Our application involves eight attributes, which is generally considered as a number that respondents can handle in a FP format. However, the respondents in our study are groups instead of individual respondents. We have groups of three to five people sitting together to jointly fill out a series of conjoint profiles regarding their joint or group preferences. This multi-person setting increases the task-complexity to the extent that one might expect that if HII were used instead of FP, this would help the group members to organize their discussion and joint deliberations to more easily and more consistently make their decisions about their joint response to each profile.

Our second hypothesis is that under these same conditions HII-I will predict holdout profiles better than conventional approaches such as FP and HII-O conjoint. This is because, as argued by Oppewal et al. (1994), relative to HII-O, the integrated approach avoids the use of a separate bridging design. It also more completely describes each of the choice alternatives, and it directly links the attributes to the final dependent variable of interest, that is, preference or choice. Similar to HII-O, the advantage of HII-I over FP conjoint is that it presents respondents with a hierarchical structure or decision template to support their decision-making, however without requiring a separate bridging task. One thus can expect that HII-I will perform better than HII-O and FP in cases where respondents need to make complex trade-offs.

Our empirical tests are in the area of residential preferences, an area where group members typically have to make decisions about complex alternatives involving multiple attributes on which they potentially disagree. The results of our paper will show that, at least for this type of application, the HII-I approach outperforms the other two approaches, where these other two methods (FP and HII-O) are found to perform equally well in terms of predictive ability.

The organization of this paper is as follows. We first outline the ideas behind HII and discuss its possible extension to group settings. Next, we present the empirical application in which we test our hypotheses. The paper concludes with a discussion of results and issues for further research.

1. Hierarchical Information Integration (HII)

1.1. The idea of HII

In HII the respondent's evaluation and decision-making process is framed in a hierarchical structure to help the respondent in handling a large number of attributes. The hierarchical structure is researcher-defined and maps the large number of attributes onto a smaller number of perceptual dimensions, or as they are typically called, decision constructs (Louviere 1984). Each decision construct summarizes a particular subset of attributes. For example, the construct "product quality" could summarize quality-related attributes, whereas a separate construct "prices" could summarize various price-related attributes. Decision constructs are usually defined as numerical rating scales with anchors for example "1 = very poor quality" and "9 = very good quality" for a construct like product quality. Respondents rate the profiles of quality-attributes on this quality rating scale. In a similar fashion, they rate profiles of other subsets of attributes on other decision constructs. These summary or construct scores are next used as factors in a conjoint design.

In the originally HII approach (HII-O), the latter involves a separate design step. Each of the constructs is used as an attribute in a separate design to generate profiles that are only described by such summary ratings. One profile could thus be described as "product quality rated as 7" and "prices rated as 3", where the ratings are on the respective scales. Such a separate bridging task however seems rather artificial and prone to introducing biases, which is one reason why Oppewal et al. (1994) proposed the use of integrated designs (HII-I). In HII-I there is no separate bridging design. Instead, the constructs are included in the 'partial' profiles to guarantee that these profiles give the respondent information about all the dimensions that are relevant to the decision problem. Though this leads to an increase in the size of the partial profiles, this procedure is assumed to avoid that respondents too easily make biasing inferences about missing information.

1.2. HII applied to group decisions

The application of this framework to group preferences in principle is straightforward. Each group member is assumed to process the same information, that is, to map the same attributes onto constructs according to the hierarchical structure as provided in the conjoint task and to make trade-offs between attributes and/or constructs to derive the overall utility or preference for each alternative. The only complicating factor is that group members have to interact while completing the tasks. Each member not only has to process his or her own attribute perceptions and construct evaluations, but as a group the members also have to integrate these individual perceptions and evaluations into one overall preference judgment or choice. As argued above, this makes the task more complex, similar to having a larger number of attributes in the profiles.

The increased task load not only results from this multiplication of attribute numbers and group members, but also from the inter-personal conflicts that may arise when group members disagree on their evaluation of attributes. These conflicts need to be solved or accommodated when the group derives one overall evaluation of an alternative, thus further increasing the task complexity relative to when single persons complete a conjoint task.

During this process, group members will most likely differ in the influence they have on the outcomes. Many group decision researchers have taken an interest in measuring the differences in influence of group members on group outcomes, for example in order to use them when combining individual preference measures into group preferences. The simplest way of doing this is to average the individual preferences. However, this ‘equal weight strategy’ ignores the potential difference in influence. Strategies have been proposed to take these differences into account (e.g., Corfman and Lehman 1987) but it has remained unclear how to estimate influence, or potential influence, independently from the individual preferences. For example, in a study on MBA’s job choices, Krishnamurthi (1988) had MBA students and their spouses individually and jointly, as a couple, complete a conjoint experiment. To estimate an individual’s overall influence, Krishnamurthi regressed the joint rankings against the individual rankings and used the normalized beta weights, after adjusting for multicollinearity. This measure of observed influence thus depends on the observed preferences.

1.3. Measuring individual influence

Steckel and O’Shaughnessy (1989), who used group members’ preferences as factors in a conjoint design, overcame this limitation. They defined three levels for each group member: the group member likes, dislikes, or is neutral to a choice alternative. These hypothetical preferences were varied by design, hence, the extent of disagreement or conflict potential in the groups was experimentally controlled and the procedure allowed the efficient and independent estimation of the impact of each group member’s preference on the joint decision. The parameters estimated for these individual specific factors can be regarded as independent estimates of the influence of individual group members if influence is defined as the effect that an individual has on the choice outcome (cf. Corfman and Lehmann 1987). Steckel and O'Shaughnessy administered their task however to only one person for each group, so their measures are based only on this representative's view of the decision process. Also, their approach does not allow one to establish the relation between the attributes of alternatives and the individuals or group's preferences.

To amend these problems, Timmermans et al. (1992) and Borgers and Timmermans (1993) developed an HII approach that obtains a mapping of attributes onto individual utility functions and then combines individual utilities into group preferences. Based on Louviere (1984)'s HII-O approach, they use a series of subexperiments and a separate bridging task to derive the overall utility function. Their method is a hybrid of individual and group HII in that they use individual tasks for the first step but administer the bridging task in a group setting. In the group task, the members receive information about how each member would rate an alternative on each of the decision constructs and they are asked as a group to rate the total attractiveness of the alternative. This bridging task is somewhat similar to Steckel and O'Shaughnessy (1989)'s setup but with the difference that it is a task that all group members jointly complete. The studies by Timmermans c.s. thus extent the work by Steckel and O'Shaughnessy (1989) and also involve the first attempts to apply HII to group settings. Note however that these group tasks only involved an HII-O bridging task. As argued earlier in this paper, this kind of task is suspected to lead to biased outcomes. Dellaert et al. (1998) developed a similar, what they call "two-stage" conjoint approach, to separately measure individual preferences and joint family preferences. Their approach however focuses on measuring the discrepancies between individuals' own preferences and the preferences that other group members project onto them.

1.4. Individualizing group HII-I tasks

Thus, previous work has shown how to experimentally control the level of conflict in a group and infer the influence that each group member had in deriving the final outcomes. That is, by specifying how each group member would evaluate a certain attribute or decision construct, the researcher can arrange the extent to which these hypothetical evaluations are different or similar. In theory one can define a hypothetical rating for each group member and for each attribute. In practice however this is quite cumbersome as the number of hypothetical attribute ratings easily becomes very large. Using individualized HII construct scores by specifying a hypothetical construct evaluation for each individual group member in the task seems a good compromise in attaining this.

In our study we therefore specify for each group member how he or she would score the alternative on the particular constructs. In this way the researcher controls respondents' inferences about how each of their fellow group members rates the remaining decision constructs and controls the level of conflict induced among group members. Similar to Steckel and O'Shaughnessy (1989) and Dellaert et al. (1998), the parameters estimated for the separate group members can be interpreted as the influence on the group members on the final group outcome. In our case however, influence parameters can be derived for each separate construct, we thus obtain more detailed diagnostics than these previous studies.

We implement this approach by specifying the construct scores for each separate group member and including all of these as factors in the designs. Clearly, this will often lead to larger designs than those required if constructs are not made individual-specific. In our study we implement this method, which we call individualized HII-I and compare it to a 'regular' implementation of HII-I to measure group preferences in a group task.

2. Method

2.1. Subjects

Our hypotheses are tested in a study on residential preferences of housing co-ops. Co-ops are groups of typically 3 to 5 young people with lower incomes who live together in their collectively owned property. Their dwellings consist of a room for each individual, while other facilities such as bathroom, kitchen, backyard and sitting area are shared. Co-op members jointly decide which house to buy. Thus, residential choices of co-ops are a good example of high-involvement durable good purchases of small groups in which all group members jointly have to make the purchase decisions. The 73 groups (co-ops) participating in this study were randomly assigned to one of the four methods (FP, HII-O, HII-I and individualized HII-I, resulting in 11 to 20 groups observed for each method.

2.2. Design

Based on the housing choice literature (Borgers and Timmermans 1993; Clark and Van Lierop 1986; Hourihan 1979; Louviere and Timmermans 1990; Phipps and Carter 1984; Timmermans et al. 1992) and additional pilot research among co-ops, we defined eight attributes as shown in Table 1. These eight attributes were placed into two groups, one defining the *house* construct, the other defining the quality of the residential *environment*, as shown in Table 1.

Experimental profiles were created using a separate statistical design for each conjoint method. An overview of the designs that were used is provided in Table 2. Note that the models require up to three different designs, one for each sub-experiment. Construct factors were included where appropriate with levels described as values '2', '4', '6' or '8' of the 10-category rating scale that respondents used to evaluate the constructs in the sub-experiments. It was however not in all cases possible to use all four levels because we wanted to ensure that all models could be estimated for each group separately. Further details about the experimental designs are available upon request.

2.3. Procedure and measurements

Interviewers contacted the groups and arranged that first a questionnaire was delivered containing separate conjoint tasks for all individual co-op members. After one week, at an

Table 1. Attributes and levels defining the constructs house and environment

House	Housing environment
size individual rooms	*travel time by bike to city-center*
12 m^2	0 minutes
16 m^2	10 minutes
20 m^2	20 minutes
24 m^2	30 minutes
monthly living costs	*building period neighborhood*
Euro 110	before 1950
Euro 150	between 1950 and 1980
Euro 190	after 1980
Euro 230	
garden	*type of neighborhood*
available	mainly (semi-)detached houses
not available	mainly houses in a row/apartments
joint sitting area	*traffic in street*
available	destination traffic only
not available	heavy traffic

Table 2. Overview of the designs used in the four conjoint approach conditions

Conjoint approach	Type of experiment	Full factorial	Fraction used	Number of profiles
Full profile	Full profile experiment	$2^4 * 3 * 4^3$	1/96	32
Original HII	House subexperiment	$2^2 * 4^2$	1/4	16
	Environment subexperiment	$2^2 * 3 * 4$	1/3	16
	Bridging experiment	3^2	1/1	9
Integrated HII	House subexperiment	$2^2 * 4^3$	1/16	16
	Environment subexperiment	$2^2 * 3 * 4^2$	1/12	16
Individualized	House subexperiment	$2^7 * 4^2$	1/128	16
Integrated HII	Environment subexperiment	$2^7 * 3 * 4$	1/96	16

appointed time, the interviewer came to collect the individual tasks and administer a group task. The interviewer gave instructions and monitored the group process but did not interfere. Profiles had been printed on separate index cards and group members were asked to gather round a table such that they could all read the index cards. It was left to the co-op members to discuss the profiles, solve their possible preference disagreements, and come to a joint response for each profile.

The joint group task involved that a group first ranked all profiles in terms of overall preference as a place to live. Next, the group rated each experimental profile on a 100-category rating scale, ranging from ‘extremely unattractive’ (1) to ‘extremely attractive’ (100). In the HII-O sub-experiments a 10-category rating scale was used to collect the construct ratings. Each conjoint task contained one additional, holdout profile. After completing their tasks the groups completed more hold-out profiles, one for each type of experiment that they had completed earlier. These holdouts were in the same format as in the corresponding previous experimental tasks. Finally, all groups in all conditions completed one additional full-profile holdout. This means that in total there were three holdout conditions: one in which holdouts of the same format as the experiment were administered *during* the experiment, a second in which holdouts of the same format as the experiment were administered *after* the experiment, and a third in which all groups filled out a FP profile after concluding all the their tasks. In the analyses, the first holdout condition serves to assess the reliability in each condition, the second and third serve to assess the predictive validity and are the basis for our hypothesis tests.

Our measure of predictive ability is the mean absolute difference between observed and predicted hold-out ratings. To make the number of HII holdout measures comparable to the FP holdout measures, in the HII conditions we averaged for each group the absolute difference that was observed for the two holdouts from the separate sub-experiments.

3. Analysis and results

3.1. Model estimation

O.L.S. regression was used to estimate a main-effects-only preference model for each separate group. Dependent variables are the overall profile evaluations; independent variables are effect-coded indicators of the attribute and construct levels, where appropriate. The fit of the models was satisfactory: the mean R^2 between the observed and predicted ratings is .94; the mean R^2 for the separate models are all larger than .91. The reliability of the models is assessed from the mean absolute error observed for the holdouts that were administered during the experimental tasks. These reliabilities are shown in the first columns of Table 3. These data suggest that FP is the most unreliable (MAE = 9.5) and the individualized HII-I is the most reliable (MAE = 8.1) method, however, the differences are not statistically significant.

Table 3. Mean absolute prediction errors for the four conjoint methods in three holdout conditions

		During Experiment		After Experiment		FP format holdouts after experiment	
	N	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
FP	20	9.52	1.38	15.34	3.94	13.49	3.04
HII-O	11	8.60	2.20	10.44	1.18	16.67	3.54
HII-I	14	9.32	1.61	8.84	1.02	9.85	2.92
HII-I-ind	14	8.09	.87	8.17	1.39	10.32	2.40
Total	59	8.96	.74	11.18	1.44	12.47	1.52

3.2. *Hypothesis tests*

We test the hypotheses by comparing the models' prediction success for the two types of holdouts that had been administered after the groups completed all their tasks. The predictive results for these holdout conditions are shown in the right-hand columns of Table 3 for each of the four conjoint approaches. To test the hypotheses we set up three contrasts for the "Conjoint Method" factor in an ANOVA on the average absolute deviation between the predicted and observed score across the two holdouts for each subject group. The first contrast tests the difference between FP and HII-O, the second the difference between HII-I and individualized HII-I, and the third tests the difference between FP and HII-O on the one hand and the two HII-I approaches on the other hand.

The results for these three contrast tests are shown in Table 4. They show that the test-statistics for the first two contrasts are not significant, hence we retain the null hypotheses that FP and HII-O predict equally well and we also conclude that HI-I and individualized HII-I predict equally well. Our second hypothesis is however confirmed: the null hypothesis that the HII-I variants predict equally well or worse than FP or HII-O is rejected at the alpha is 5 percent level.

4. Conclusion and discussion

The aim of this paper was to test the predictive ability of various implementations of Hierarchical Information Integration (HII) when applied to model group preferences and make comparisons with the case where Full Profile (FP) conjoint is used to model group preferences. We argued that group settings such as studied here make the decision task more complicated than when single respondents need to complete a conjoint task. We therefore expected that the original HII method (HII-O; Louviere 1984) would predict a set of holdout profiles better than would a FP implementation on the same attributes. This hypothesis however was not confirmed. It should be noted however, that this study only included eight attributes. It remains to be seen to which extent HII-O will predict better if the number of attributes increases. We leave this as an issue for further research.

We secondly expected that the HII method that uses integrated experiments (HII-I) will perform better than the previous two methods, mostly because this method supports the decision-making process without requiring a separate bridging task. Our data supported this hypothesis. The HII-I methods were found to consistently perform better than the FP

Table 4. Contrast tests

Contrast	Value of Contrast	Std. Error	t	df	Sig. (2-tailed)	Sig. (1-tailed)
1 FP vs. HII-O	.4393	1.1644	.377	55	.707	.304
2 HII-I vs. indiv. HII-I	.2391	1.1724	.204	55	.839	.420
3 (HII-I = indiv HII-I) vs. (FP = HII-O)	−3.2450	1.6524	−1.964	55	.055	0.28

and HII-O conditions, even though the holdouts that were used to test the hypothesis favored FP because most holdouts were in a FP format.

Thirdly, we devised two possible implementations of this HII-I approach, one of which involves that respondents come to know each group member's rating for constructs that describe major dimensions of each alternative. We found no difference in predictive ability between these two methods.

The implication of these results is that if one is interested in obtaining the best possible predictions of group preferences for relatively complex alternatives, one should preferably design joint group tasks according to one of the two HII-I approaches. The individualized HII-I approach has the advantage that insight can be obtained in the relative influence of each group member on the group preferences. In this approach the parameters estimated for the individual specific construct evaluations can be interpreted as the relative influences that group members had on the group preferences as demonstrated by Steckel and O'Shaughnessy (1989). The 'regular' HII-I approach however has the practical advantage that it involves smaller profiles and that one design fits all possible group sizes.

Further research could focus on two important topics. Firstly, further validity tests of hierarchical information integration should be performed as only very little research has been performed in this area and our research suggests that integrated HII performs better than the more conventional methods for accommodating large attribute sets. As our application involved a particular type of group (co-ops) and decision problem (residential preferences), it is for example relevant to study the performance of HII in different settings Further research into the effects of different definitions of the hierarchical structure would also be worthwhile.

Secondly, with respect to the study of group preferences, further research could be undertaken to investigate to which extent group tasks such as studied here lead to different, and possibly more valid results than if single persons are taken as a representative of a group. If it were found that group tasks lead to better results than tasks for individuals, it would also be relevant to investigate if a subgroup that represents the whole group could be used instead of the whole group to attain these improved results.

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