THE SIMULATION OF INDIVIDUAL PREDICTION IN AN "ALONE"- AND "GROUP"-CONDITION

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I. The Context and the procedure of the experiment.

This paper is part of a more general attempt to describe and predict the behavior of subjects in a simple decision situation. A second aspect of the same experimental setup has been treated in a paper on "Computer Simulation of Small Group Decision" (Prof. Hare, Richardson and Scheiblechner, 1968), where further informations on the purpose of the experiment and additional sources can be found.

The most surprising result of the former study has been, that group members, who first formed an individual opinion tended to pool their opinions into a common decision by taking the median of the distribution of opinions. This was exactly true in 56 out of 60 cases for the Vienna groups. When one observes the real process of pooling, a lot of influence attempts seem to go on, some individuals trying hard to change the decision in their direction. They are remarkably unsuccessful. Taking the median of the distribution means giving equal weight to all individual opinions independently of the amount of argument they are stated with. Why then does interaction take place at all? Is this ineffectiveness of the argument a seeming one and does the interaction influence some other aspect of behavior? It was supposed that such an influence exists and that it will show up in the next trials in the process of indiviual opinion-forming, causing convergence in the interpretation of more general features of the situation (namely of the structure of the test and S-person in question).

With this background in mind we now consider the actual process to be simulated. Five subjects, after having taken some personality and performance tests including the later mentioned value test are given the following "individual prediction task"; each gets some sheets of paper, where 15 items of the value test, the same they had previously taken themselves are typed. They are told, that some other not present person (called S-person, "stimulus-person", henceforth) has filled in this test. This person expressed it's attitudes towards the statements of the test on a scale ranging from 1 to 5. 1 means "strongly agree", 5 indicates "strongly disagree", category 3 is a neutral point standing for "undecided" and 2 and 4 beeing the respective "slightly" categories.

The answers of the S-person to the first five statements are given. Now each subject should write down on a prepared space his supposed predicition of the answer of the S-person to the sixth item without consulting the others. After that, the experimenter will announce the actual answer of the S-person which can be written on a space next to one's own predicition. This same procedure will be continued until item 15 terminates the task.

The value test in question consisted of a sample of a test developed by Prof. R. Reichardt. It contained five supposed areas of evaluation: the attitudes towards agression, particularism, sexual repression, contemplation and vitality. Each dimension was represented by three items (one of these beeing inverse scoring).

The answers of the S-person were not obtained from a real subject but constructed in the following way: the first five items were filled in with some irregular permutation of the numbers 1-5. These five items corresponded to the five dimensions. From the items 6-15 four were selected by chance. In these items the constructed response was equal to the answer to the item of the same dimension given in the first five statements plus or minus one. Extreme answers (1, 5) of course only could be changed in one direction and inverse scoring had to be taken into account. In the remaining 6 itmes the constructed response was exactly the same as given in trials 1-5. This procedure was supposed to exclude some simple response redundancies (as for example the predominant preference of one response category) and at the same time should guarantee a quite high amount of "consistency" of the S-person. The value test had not been analysed statistically before. Later it turned out that the items were intercorrelated in a manner not to be expected from the suggested names of the dimensions. Therefore we actually don't know, whether the S-person was "consistent" or not.

Then, after some additional tests the "group prediction task" was started. The general procedure was the same as in the above "alone-condition". Only now the subjects were seated around the common table and after having put down their individual predictions could discuss them and derive a common prediction. After this, each member of the five person group could write down a second private guess on his formular together with the group decision. Finally the correct response could be found in an envelope.

In the case of the group prediction task the "correct responses" were obtained from a real subject. But the answers of this S-person were adjusted more towards the extreme and answers to items of the same dimension were exchanged, so as to have all categories from 1-5 represented in the first five items. The resulting S-person was approximately as "redundant" and less "consistent" in the "group-condition" as in the alone condition. So both tasks were quite difficult for the subjects and they achieved only few more correct predictions than expected by chance (equiprobable responses from 1-5) in both situations. A crude estimate of task-difficulty is given in the following table 1 (30 subjects, predicting 10 items each or a total of 300 predictions).

Table 1

Task Difficulty: Number of subjects achieving a given number of correct predictions

	number of S's achieving x correct predictions				total number of correctly predicted items
	0	1	2	3 or more	
chance level	3,22	8,05	9,06	9,67	60
"alone"condition x)	0	3	8	19	92
"group"condition	0	7	9	14	74

x) The difference between chance and the "alone" condition is significant (χ^2 = 15,5 df = 3 p <,01)

II. Simulation-attempts for the "alone"-condition.

The basis for the first models was derived from a conjective by Prof. Hare. This conjective being as follows: Consider the answers of a subject to the items of a (value-)test. The process of answering divides the set of statements into disjoint subsets (equivalence classes) i.e. those opinions which the subject holds very strongly (say X_1), those to which he agrees slightly (say X_2) etc. until those which he refuses (say X_5). The items of one of those subsets should go together for this subject in some way, otherwise he would answer them differently. Therefore the reactions constitute a partition of the total set X of items into more homogenous subsets and this partition represents the structure of the test for this person. If this subject is instructed to predict the reactions of another person (S-person) to the same items, he will proceed as follows: first he will state to which equivalence class the current item belongs for himself. Then he will go through all previous items of the same equivalence class and collect the reactions of the S-person to this subject. Finally, by some pooling method of the obtained distribution he will make up his mind upon what the S-person should answer to the present item.

The procedure needs some complementation in case the equivalence class only contains the item in question and no previous reaction of the S-person. In this case Prof. Hare suggested to consider a neighboring class or the opposite class (e.g. if the conditional distribution pertaining to category 2 only has elements equal to zero, the distribution of 1 and 3 (neighboring) or of 4 (opposite) should be considered.) If these also should contain no elements one could predict neutraly (e.g. 3 in our case) for example.

Some advantages of a procedure like this are obvious:
First it contains an "ideosyncratic element" in a quite natural manner. Each individual and it's reasoning in this task are treated quite specifically. An alternative would be to use the factor-structure of the test. But this method does not take into account individual deviations and only is true in the "average" (for a large sample of subjects).

Second it offers an economic way to find clusters of items of the test, if no previous informations (factor structure, correlation-coefficient...) are available.

Under this assumption the programming of the first three simulation models is quite straightforward. It consists of the following steps:

1 - read in the "private opinions" IM (i.e. his personal answers) of the predictor to be simulated for the 15 items of the value test.
  - read in the answers of the S-person, IS.

2 - establish a matrix ISM, who's rows are the 5 response categories of the S-person and who's columns correspond to the answers of the predictor; allocate the first five pairs of answers of the S-person and private opinions in the proper place in this matrix (the first 5 reactions of the S-person were given as basic information to the predictor in the experiment).

3 - find the private opinion to the sixth item and the corresponding conditional column distribution in the above matrix ISM.

4 - apply some pooling method to this distribution of reactions of the S-person if it is not empty; if it is empty, use some other rule and information.

5 - output all reactions to this item (IM, IS) plus the actual and simulated prediction (IV, ISIM); update the above matrix ISM with the new information (pair of S-answer and private opinion).

6 - repeat steps 3 to 5 until the last (15^{th}) item.

Two parts of the procedure outlined above are still free and need to be fixed: the pooling method and the complementary rules in case the corresponding conditional distribution is empty. Three pooling methods were used: the arithmetic mean, the median and the mode. (Reasons for doing this will be given later). If the column distribution was empty for an item the marginal column distribution of all previous reactions of the S-person (i.e. regardless of the corresponding private opinion) was used and the same parameters calculated. If the median did not coincide with one of the five response categories a linear interpolation was used. If the distribution had more than one mode, then the mode closest to the private opinion (IM) of the predictor was preferred, if this still was ambigous the mode related with the smaller numerical value of the category was prefered.

(example: distribution (1, 2, 4, 5) median 3, private opinion 3 → "mode" 2),

Before reporting the results of the 3 models, a more formal statement of the underlying assumption is given:

Hypothesis 1: In predicting the reaction of an S-person to an item of a (value-) test the subject will take into consideration only those previous items, which fall into the same opinion category (equivalence class) as the given one. The reaction of the S-person to these items will be (exclusively or predominantely) relevant for the prediction.

Table 2:

Results of the first 3 simulation-models (number of subjects who could be simulated with a given number of correct predictions).

	number of s's who could be simulated correctly a given number of times			total number of exact simulations
	less than 2	2	more than 2	
chance (equiprob. react.)	11,27	9,06	9,67	60
conditional mean	9	12	9	64
conditional median x)	5	9	16	73
conditional mode xx)	2	10	18	97 o)

x) this distribution deviates from chance $\chi^2 = 7,65$ $p < ,05$ df = 2

xx) this distribution deviates from chance $\chi^2 = 14,9$ $p < ,01$ df = 2

o) this total differs from chance $z = 5,5$ $p \ll ,001$

(the conditional mode distribution also differs from the conditional mean $\chi^2 = 9,27$ $p < ,01$ df = 2 and the totals of the mode and median simulations differ by $t = 2.29$ df = 58 $p < ,05$).

In a chance process of equiprobable responses we would expect an average of 2 correct simulations. The comparison with the resulting binominal distribution seems to show that the median and mode model were successful (the median primarily in avoiding less than two hits, the mode also in the higher classes, as can be seen from the totals). The mode again seems to be better than the other simulations (compare significance tests). The overall success is not very impressing (the chance level being quite favorable for the models).

These results don't tell us very much, they especially don't contain any information about hypothesis one. Therefore the next three models tried did not use the conditional distributions (depending on the private opinion of the predictor) but only the marginal distribution of all known eesponses of the S-person at any point of time. Now some reasons for the pooling methods will be given before presenting the results.

Pooling method 1: arithmetic mean (unconditional)

The arithmetic mean minimizes the sum of the quadratic deviations and the sum of simple deviations is zero. A predictor using the arithmetic mean holds the standpoint that he can't really tell what the S-person will say, but he can avoid a systematic error (favoring the agree or disagree side) and he can minimize his quadratic error (avoid a lot of gross errors) by this method.

Pooling method 2: median (unconditional)

The median minimizes the sum of the absolute deviations. An uninformed predictor evaluating his errors according to the simple distance between prediction and true answer can minimize his expected error by using the median.

Pooling method 3: mode (unconditional)

a) The mode maximizes the number of exact predictions (representing the most probable single value). A predictor using the mode classifies his success only in two categories: correct (difference IV-IS equal zero) - uncorrect (difference not equal to zero). He does not consider the amount of his errors and simply tries to maximize the number of his correct responses.

b) simple learning interpretation.
The mode being the most often heared answer of the S-person (announced after the prediction by the experimenter) at any moment has acquired the biggest reaction potential and consequently is most likely to ellicit the corresponding reaction.
(in case of the conditional mode: the paired assoziation (IS-IV) occured most often and given a certain IV the strongest learned reaction will be elicited).

All pooling methods represent some criteria of rationality for an uninformed predictor and the mode has an additional learning or reinforcement interpretation. The interpretation of the methods in the conditional case (first three models) is analogous.

Table 3
Results of the unconditional models.
(number of subjects simulated correctly in a given number of predictions).

	number of correct simulations			total items correctly simulated
	less than 2	2	more than 2	
unconditional mean	15	8	7	51
unconditional median	17	7	6	45
unconditional mode xx)	3	9	18	97 o)

xx) and o) as Table 2

Two of the models are worse than even the mild chance level used (compare Tab. 2, first row). But the unconditional mode is not different from the conditional one. In so far as the two very bad pooling methods are concerned hypothesis 1 receives some support (the two distributions of the median models being different at the ,01 level, $\chi^2 = 11{,}25$, df = 2). But just in the only adequate averaging process, the mode, there is no difference between considering the private opinion of the predictor (conditional) or not (unconditional).[1)]

So up to now the structuring of the test through the given answers (hypothesis 1) and the interpretation corresponding to the mode were confirmed to some extent.

These six models easily can be used for the data in the "group condition" too. If our very first impression initiating this work, namely that the observed interaction does change the process of prediction, were true, these models, if representing the "alone condition" correctly, should give very different results in application to the group data. Therefore, for purposes of comparisons, the results are presented below.

Table 4

Total number of items correctly simulated by models 1-6 in the "group condition":

	arithmetic mean	median	mode
conditional	53	59	54
unconditional	51	55	56

All totals are below chance (60) and the mode especially ceases to by an adaequate description of the process. This indicates that the subjects indeed use quite different methods of prediction in the two situations.

Next, the best simulation still being not very good (unconditional mode 97 exact predictions), some further methods and some modifications of the models used up to now were tried.

The rationale of these is as follows:

A. Further methods:

1. "Projection" or "Induction"

   It is assumed that the subject will predict the same answer for the S-person as he gave to the items himself.

This corresponds to a simple and very direct interpretation of "projection" in psychoanalytic theory. But there also exists a different interpretation:
The predictor not having sufficient information for his difficult task, would behave rationally if he considered himself an "average person" and concluded that other subjects did not deviate much from his own opinions. If the distribution of answers to any item were known for the population of the S-person, a maximum of correct predictions would result from using the modes of these distributions (i.e. the predictor abstracts from the individual S-person and instead judges the population of which the S-person is a member). These distributions being unknown the predictor considers his own opinion as the best estimate of some "average" of the distributions.
Therefore this procedure also could properly be called "induction".

2. Methods of maximal correlations.
Some of these methods are reported by Prof. A.P.Hare (Hare 1961). They consist in two steps: first the predicting subject will establish to which previous item(s) the current item is most similar and second the subject will predict as before. The most similar previous item can be determined in two ways: either intercorrelating the factor loadings of the present item with all previous ones or finding the highest positive or negative correlation among all previous items. Once this item is found, one could again predict the same way as the subject did before or one could insert the previous answer of the S-person (assuming that the subject has stored and learned it).

3. Linear Regression.
Having established the matrix ISM described above, the subject would be able to find a linear relationship between his own opinions and those of the S-person. For the current item the expected value can then be calculated knowing ones own opinion (the value of the independent variable). This should be more precise than the conditional parameters above, bacause at any time all previous informations (IS, IM) are used.

One modifiaction can be noted beforehand: if the linear dependence is very loose, the regression will be flat. A lot of simulated 3's can be expected. To prevent this, cutting points can be introduced that will result in more extreme answers. The regression value is calculated as usual, but hereafter is subject to a nonlinear transformation, e.g. if the cutting points are 1, 5 2, 9 3, 1 4, 5 5, 0 a value of the regression of 3, 2 will fall into the interval 3, 1-4, 5 and produce 4 as category of prediction.

B. Modification of the previous models: timefunction.

The success of the previous models could have been relatively small, bacause in reality not all informations pertaining to the S-person are weighted equally by the subject. The simplest differential weighting can be achieved by a linear (discrete) timefunction. The logic of this being, that for example the "first impression" is most decisive for all further predicitions. This can be done by entering the first informations in matrix ISM with greater weights. But also a "last impression" mechanism could be imagined (the timefunction having positive slope).

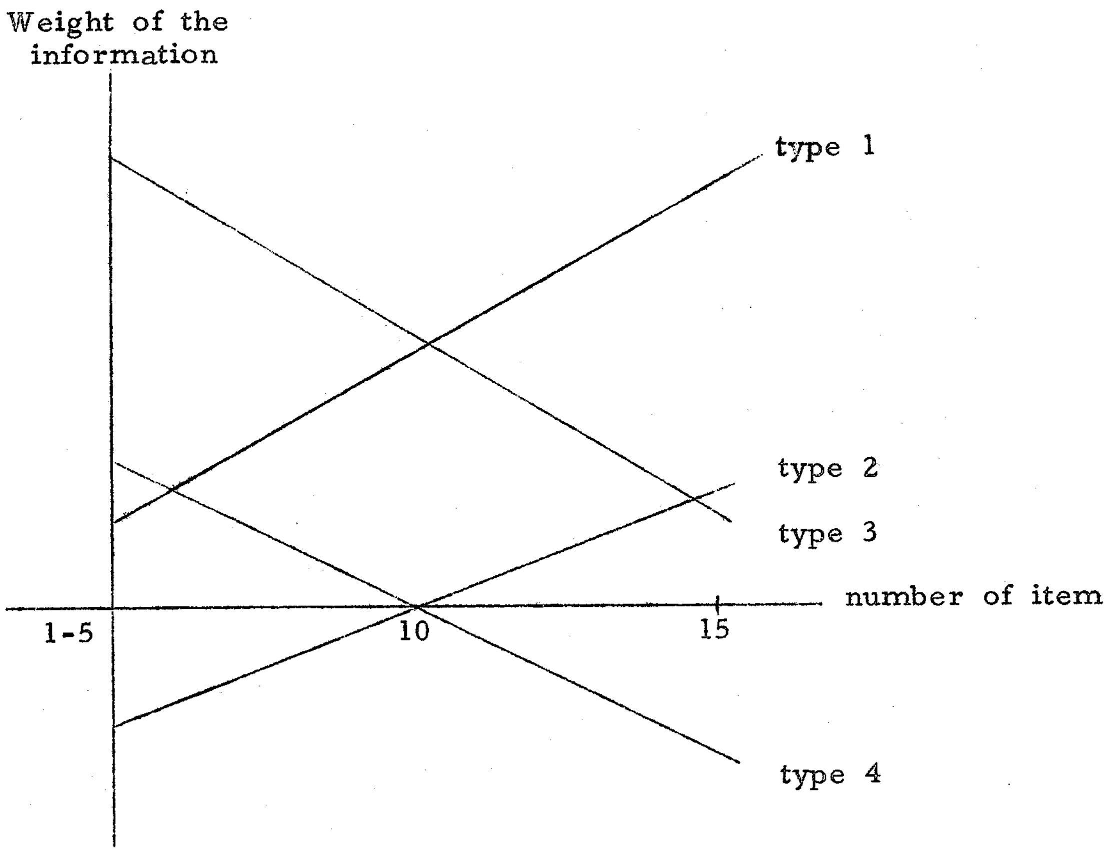
The results of the additional strategies are reported most easily:

- "projection" predicted correctly 98 itmes out of the 300 trials in the alone-condition (for the group condition it was successful 86 times).
- "methods of maximal correlations":
  The private opinions of our 30 predicting subjects were factor analyzed and the highest item to item correlations used for determining "the most similar previous item". [2)] Then inserting the corresponding previous predicition (IV) resulted in 73 and using the answer of the S-person (IS) in 97 correct simulations.

The first result tells us that the best use of the information contained in the private opinions can be made by the simplest mechanism as given by the "projection"-method. The second result shows, that not even taking into account much more information about the structure of the test improves the simulation substantially. The "unconditional mode" and the "projection"-mechanism demanding much less information than the maximal correlation method do as well and their achievement gains in weight.

The linear regression method and the timefunction were added to the previous simulation at the same time. Then some values for the linear, discrete timefunction were played through and the number of successes counted. The timefunction was one of the types of the following diagram. (Item 1-5 being given as basic information to the subject receive the same weight).

Fig. 1: Types of the time-function



Type 1: a "last impression" version (slope positive) with all positive impressions (and intercept positive)

Type 2: a "last impression" version (slope positive) but with negative first impression! (intercept negative)

Type 3: a "first impression" version (slope negative) with all positive impressions (value for item 15 still positive)

Type 4: a "first impression" version (slope negative)
with negative late impressions (last items negative weight)

All models were of course improved by adapting the time function (the previous simulation being the special case with slope 0 and intercept 1 (positive number)). The linear regression was not much mor e successful than the arithmetic mean previously.

Table 5
Sumarizes the results.

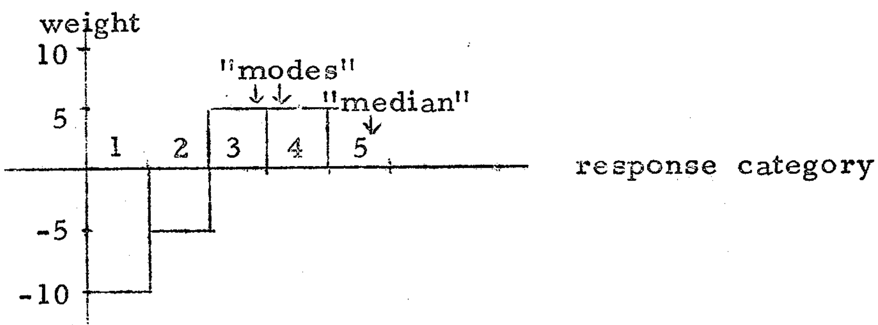
Method	lin. regr.	cond. mean	cond. median	cond. mode	uncond. mean	uncond. median	uncond. mode
Slope	1	-1	-2	0	posit.	2	0,4
Intercept	0,66	11	21	posit.	posit.	1	-1
maximal success observed	86	78	94	95[3)]	51	84	119
previous success (slope 0, intercept pos.)	72	64	73	97	51	45	97

For the linear regression and the mean models only functions of type 1 and 3 can be used, negative weights being not applicable in this context.

But the procedure of calculating the "median" and the "mode" still can be carried through with negative weights! An example should illustrate the point.

The terms "median", "mode", "distribution" used in the next paragraph are defined by the procedures used to calculate them and do not conform to customary statistical usage.

Fig. 2: "median" and "mode" in case of negative weights



The mode being the maximum of a "distribution" will be located at a category with positive weight and negatively weighted categories simply will not be chosen. If all are negative the "least negative" will be selected.

The median dividing the "distribution" into two equal parts will be effected by negative weights in the following manner: the total sum of the weights and the half of it is reduced (-2,5 in the above example). Cummulating the weights from left to right a negative weight reduces the chance of reaching the midpoint, a positive increases it. Negative weights push away the median from them, positive weights attract it. (In the above example no cummulative weight is bigger than -2,5. Category 5 being the most extreme guess terminates the search for such a weight and is fixed as the "median").

Up to this point it has been argued only that the computer-routines still would work with negative weights. But this argument together with the previous learning interpretation indicate a way of giving sense to negative weights of categories in case of these parameters: negative weights can be thought of as negative reaction tendencies acquired in the learning process. The "mode" and the "median" represent two ways of defining a "maximal reaction tendency" (and of course have lost their proper statistical meaning).

From the above Tab. 5 we see that the conditional models tend to be first impression versions wheras in the unconditional models the last impression seems to be more important (pos. slope). There is no easy interpretation of this fact, it only reminds us that in arguments of this sort the context should not be overlooked.

Finally, the most successful strategy, the unconditional mode yielding 119 correct simulations, needs some comment. With these special parameters of the time function items 1-5 receive negative reaction tendencies, items 6 to 9 receive no weight and all reactions of the S-person starting with item 10 cause positive reaction tendencies. Therefore from item 6-10 all categories have weight -1 and all are "modes". In our program then the mode closest to the private opinion of the predictor is selected, i.e. the prediction is idential with the "projection" mechanism (yielding 51 correct simulations from item 6 to 10). The eleventh item is the first that has a true "mode" (depending on the reaction of the S-person to the 10^{th} item). Items 11-15 simulated by the mode yield 68 correct predictions. From the distributions of the actual predictions of the subjects we see, that no other parameters of the time function would yield more correct simulations, though many functions of type 2 result in about 106 to 116 correct simulations. 119 represents a true maximal value for that strategy (the "maxima" of the other strategies not being guaranteed because only relatively few parameters were tried). The negative starting weights in type 2 functions tell us that at the beginning of the process some vicarious trial and error seems to go on the avoiding to predict a category similar to the last answer of the S-person.

Looking at the items where correct predictions occured, two things seemed to be apparent:

1. for many subjects one of the simulation methods clearly seemed to do better than the others
2. some of the simulation methods seemed not to be correlated or only weakly correlated if for a pair of methods a table of contingency was established, where the numbers of items in which both were correct, one was false and the other was correct etc. were entered.[4)]

Therefore, if we know, which subjects would use which prediction methods or when in the series of predictions a change in method occurs we should achieve a substantial improvement in correct simulations: concerning the first point, one now could intercorrelate number of success with the various simulation methods with personality characteristics and single out the subjects accordingly. The second point can be taken care of by finding relationships between item-(position) numbers and methods of simulation. But the primary goal of this work being different, namely to exploit the redundancies of the reaction-series predominantely and not to rely on information-from outside the process itself, I proceeded in the following manner: the success of a prediction can be evaluated by its distance from the actual or true prediction of the subject.[5)] This value was computed for each item and each strategy and summed up and devided by the number of items simulated. At any point of time then the predicition of the method with the greatest "average" success was taken to be the "simulated prediction". If the success of more strategies was equal, the arithmetic mean of their predictions was taken. The methods joined together this way were: the conditional median and mode, the unconditional mode, linear regression and projection. Independent time functions for all methods and for the evaluation of success were added and any combination of the above process could be selected arbitrarily. This results in 17 free parameters (put into the program via typewriter) and this fact alone would make the evaluation of successes achieved a difficult task. The problem becomes less acute, if one considers the actual results reported in Tab. 6.

Table 6:

Total number of successful simulations with the selection of the "best strategy" of the following set of methods: conditional median and mode, unconditional mode, linear regression, projection:

Number of methods used	Number of total successes observed
5	102, 109, 112, 114
4	101
3	99, 107, 112
2	90, 96, 105, 106, 111
	86, 86, 98 98 x)

x) These are derived from items 7 to 15 instead of 6 to 15 as the others.

We observe that the maximal success could not be improved. The success does not even rise with the number of strategies used. The only improvement may be the "security level" of the simulation: Any combination of the methods yield at least approximately the same number as our best previous simple methods without timefunction (mode, projection, maximal correlation).

The reason for this being primarily the following effect: generally, the more exact simulations one of these methods yields, the greater relatively are the gross errors it makes, if it is wrong. [6] Therefore our measure of success does not select the "best method" very often, which also can be seen from the relative frequent use of the linear regression and conditional median (which were quite unsuccessful compared with the mode and projection). From inspecting the data one concludes that another measure of average success, e.g. a simple count of number of successes, would not select more properly among the strategies so that a second reason becomes apparent: for each person we have a total of 10 observations and the decision among our methods is based on 4,5 previous trials in the average. Therefore our series are much to short to allow for more refined methods of selection.

To conclude this chapter two other standards to evaluate the success of our models will be mentioned.

Standard 1: The S's all have answered the items of the value test for themselves prior to the prediction experiment. Therefore distributions of the reactions to the items are available (for n = 30 S's). The series of the modes of these distributions can be determined and interpreted as most probable predictions of the S's. The simulation based on this series is the same for all S's and would give a total of 100 [7] correct simulations in the "alone condition". The corresponding interpretation of the empirical prediction process would be the same as for the "projection-mechanism" but in addition to that it is assumed that the S's also have some feeling for their deviations from the norm. If they think themselves deviant they are able to change their prediction (private opinion) in the direction of the most frequent reaction.

Standard 2: One could ask for the optimal series of predictions, which remaining the same for all S's, would give a maximum of total correct simulations. This series is constituted by the modes of the actual predictions given by the S's. If this series is determined, one sees that it would result in a total of 122 correct predictions in the "alone-condition". This determines the upper limit for the success of all models which don't take into account individual deviations or ideosycracies of the process, but are able to construct the series based on perfectly correct and general a priori assumptions.

The best model (mode + timefunction) reached the "plafond" set by standard 2, but from trial 6-10 it was an "ideosyncratic process" which potentially could have resulted in much more correct predictions. Also the standard 1 forces us to be modest about the success of the models.

III. Simulation attempts for the "group condition"

The prediction process of the S's in the group-condition was conceived to be substantially different from that in the alone-condition. An indication that this is true can be gained from the just mentioned standards 1 and 2: for the group condition standard 1 is 92 and standard 2 is 165 correct predictions (as compared to 100 and 122 in the "alone condition"). Especially the high standard 2 shows that there is a lot of redundancy in the predictions of the S's which is due to some group-effect. The models to follow should be able to extract some of this redundancy.

The process in the alone condition can be conceived as one in which the S tries to establish some relationship or "similarity" between his own and the S-persons "cognitive system". The information available is the set of his own opinions (IM) and the correct answers of the S-person (IS) up to that item. From his prior predictions (IV) he gets some hints as to how this relationship could look like. These three sources are also available to the "simulator" of the above process, who in addition to that could also use some informations about the test (item-intercorrelations, assumed dimensions of items) and about the subject itself (personality variables). We confined ourselves to the first three kinds of data available and only for purposes of comparison used some test-information in two cases (method of maximal correlations, standard 1 above).

The prediction process of the S in the group condition is based on the same kind of information but now some additional knowledge can be gained from one's partners in the group: the prior predictions (IV) of the partners are all known, all previous group decisions are known and also the private opinions (IM) of one's partners are known to some extent, because sometimes they are stated explicitly in comparison to the S-person and sometimes they are implicit in an argument for a special group decision. Also the test-items are discussed themselves so that some naive test-information is supplied. With this new data available the process no longer is one of establishing a relationship between two cognitive systems (S and S-person) but rather an interplay of six cognitive organizations (the S-person given by its reactions IS and five S's discussing this person and thereby revealing their own systems by the series of IV and eventually IM produced). Also now the single subject faces a decision problem as to which information he should use to what extent and which variable of the situation he should maximize. Concerning the first problem of usage of informations under the assumption that S will try to maximize his number of correct predictions we would expect that S would rely heavier on informations most useful up to that point. If he for example finds a satisfying relationship between his own opinions and the S-persor there is no reason not to continue to follow some mechanism of "projection". If he is unsuccessful with this method, an alternative, for example to try to estimate one's partners opinions and from these estimates to construct one's prediction IV, could be more promising. This raises the question of weighting all available informations properly in our models of the process. On a priori grounds we could assume that the amount of participation will contain some clues to the weighting problem.[8)] But we not even can ssume that S tries to maximize his number of correct predictions without any restrictions. An alternative would be for example to guess in such a way, that the expected amount of disagreement between S and his partners is minimized. This would imply still other strategies.

A number of quite difficult aspects of the situation have been mentioned now. The first exploratory models tried were quite simple with respect to the above description. The primary goal of the first models was to get some idea of the most important variables. The components of the simulations were the following:

1. basic strategy: The basic processes were the conditional mode, the unconditional mode and "projection" as in the alone condition. But now <u>two</u> matrices were established for each subject: one matrix SM of rows IS and columns IM of its own opinion.
   A second matrix SMG of rows IS and columns IM of <u>all</u> group members (i.e. the sum of all SM's).

In both matrices for each item the corresponding IS-IM pair(s) was entered with some weight derived from the participation in that trial. The components of the participation weight were:

a) number of emitted acts by S for that trial
b) number of received acts by S for that trial

c) one fifth of the acts received by the total group, where no specific receiver was recorded

d) an additive constant. [9)]

The four components were collected additively and each could be weighted seperately. For the individual matrix SM the varying weight causes varying influence of the trials, the items with most participation being most important in determining the mode. For the identical group matrix SMG this procedure also effects varying influence of the group members according to their participation.

2. The information contained in the subjects own prior predictions IV and in those of it's partners was collected in a vector of cutting points. A frequency count of the subjects and the total groups prior predictions continually was updated and the total interval of the response categories (1-5) was devided proportionally according to these frequencies. These division points then served as cutting points to transform any continuous parameter calculated in component 1 above into an integer simulated prediction category. Two vectors of cutting points were obtained: V for the specific individual and VG, which is the same for all members of the group. The observations again are weighted with the same participation weight.

These two components contain the most important informations available which one feels a model of the situation should include (IS, IM, IV of all group members). They can be combined by first calculating the corresponding parameter (cond. or uncond. mode, projection) and then comparing with the cutting points and stating the interval in which it is contained. The simulated answer then is the number of this interval. Combinatorically then models arise, whose fit can be seen from Tab. 7 for some values of the free participation parameters:

Table 7:

Success of the ten strategies for the group condition under some values of the free participation parameters.

Weights of components of participation				Individual cond. mode		matrix SM uncon. mode		Group matrix SMG cond. m.		Group matrix SMG uncond. m.		Projection	
emitted acts	received acts	acts to total group	constant	V	VG	V	VG	V	VG	VG	VG	V	VG
				1	2	3	4	5	6	7	8	9	10
1	1	1	1	48	51	72	79	49	44	58	62	87	94
1	1	1	0	62	59	79	81	58	57	76	78	88	85
0	9999	9999	1	59	49	75	75	55	55	61	72	85	82
1	0	0	0	52	56	77	82	58	57	72	71	83	82

V... cutting points derived from prior predictions of the subject

VG.. cutting points derived from prior predictions of <u>all</u> subjects of the group

strategies 1 and 2 refer to 253 trials and 5 and 6 to 297 trials simulated (the conditional mode not being defined if the distribution is empty).

From Table 7 the general poor fit of the models can be seen. Nevertheless some regularitites may be stated. The mode strategies 3, 4 and 7, 8 are clearly more adequate than the mode procedure of the alone condition (which resulted in 54 and 56 correct predictions). Therefore considering the prior predictions IV and weighting IV and IS (known answers of the S-person) according to the amount of participation occured, must have added valuable information. The effect of considering IV also may be seen from the "projection" strategies 9, 10. The projection mechanism of the alone condition resulted in 86 correct predictions. The following rank-ordering of the strategies holds:

$9, 10 \succcurlyeq 4 \succcurlyeq 3 \geqslant 7, 8 \succcurlyeq$ all others

Only the first four of them actually are worth considering.
The comparable conditional and unconditional mode strategies exhibit clearly the superiority of the unconditional mode. Therefore the idea expressed in hypothesis 1 will not be considered further in the group condition. The cutting points VG derived from all group members prior predictions tend to produce more correct predictions than the purely individual vector V, especially in the more valuable strategies. Finally, with the exception of the 4^{th} and 10^{th} column participation is best used by equally weighting all components (row 1 1 1 0).

Then some modifications of the ten strategies were tried which allowed time dependence of the influence of the amount of participation. Now not a weighted sum of the components of participation was entered in matrices SM, SMG and in the V, VG vectors, but a linear function of this sum depending on the trial number was used. Again of course all strategies were improved, but the improvement was not large (for example strategies 4 and 8 now being successful 95 times). In addition to that two new strategies were tried, namely simply to take the mode of all privious individual predictions IV or of all group members previous predictions. This resulted in 100 correct simulations in both cases. Therefore all additional information used in the previous ten strategies did not add to the accurancy but even subtraced valuable hints contained in IV!

Also instead of using the SM and SMG matrices it was tried to use VM and VMG matrices which were defined analogous but used IV instead of IS. This again changed very little in the fit of the models. The essence of these last trials was: the most important informations for the group process are contained in IV, some information still is available through IS, IM and the participation-rate but to use these data properly a totally different kind of model would be needed.

In the new approach the situation is conceived as an additive process, in which each of the (five) response-categories possesses some subjective probability or reactive strength derived from various sources. Once the reaction tendencies are fixed the biggest of them will be realized. The components of reactive strength are the following:

1 a) the prior predictions of the subject, IV; the probability of predicting a certain category in an actual trial is a function of the frequency of this category in previous trials. More precisely the "extremeness" of the

prediction-category in such a function. If S has some preference for undecided predictions (category 3) he will continue to prefer the same kind of reactions and analoguosly if some preference for medium (category 2 and 4) or extreme (1 and 5) reactions should exist.

b) the same as a) but now the distribution of the IV's of the subjects partners determines the preferences. This sort of adaption is the expression of some conformity or group-influence.

2 a) actual projection tendency of the individual subject: if in the immediately preceeding trial the true reaction of the S-person (IS) and the private opinion (IM) of the subject were close together, a tendency to predict one's own opinion for the S-person will be reinforced. If the two opinions were opposite this discrepancy will inhibit the projective tendency.

b) cumulative individual projection tendency: this mechanism operates as a), but <u>all</u> previous trials will now be considered (the sum of the "simularities and dissimularities" having occured)

c) actual projection tendency relative to the group: again as a) but now the total group will decide whether the S-person can be seen similar or dissimilar to the individual opinion (the sum of the discrepancies over all individuals except the subject himself). The rationale of this mechanism is, that if for example the private opinion of all group members were close to the S-persons in the trial before, the communication between S's will have expressed some acceptance of the S-person and a belief in his "rational" behavior. The interaction will have been opposite if big discrepancies occured.

d) cumulative group-related projection tendency: as c) but now again all previous trials are summed up assuming that a cummulative impression will have been formed.

The components 1 a and b are similar to the previous cutting point mechanism (V and VG). Only now the frequencies are "symmetrized" (e.g. cat. 2 also counted with cat 4 etc) and not converted into width's of intervals but into probabilities interpreted as reaction tendencies.

The component 2 a, the actual individual projection tendency is calculated from the following expression:

$(2-|IM-IS|) \cdot |2-|IM-IS||$ IM...private opinion of S
IS ... answer of S-person
$|\;|$ .. absolute value

The difference between two opinions can range from 0 to ± 4. If the difference is smaller than 2 the S-person will be considered similar and "positive" projection will take place. If it is greater than 2 "negative" projection will set in, i.e. the reaction-tendency of the category corresponding to IM (and its surrounding) will be diminished. The projection mechan in this model operates along a "gradient of projection" that is not only the precise category given by IM but also the neighbouring categories will be affected to a lesser degree (usually).

Gradient of Projection:

private opinion IM	effects on categories
5	5: g_1 4: g_2
4	4: g_1 5: g_2
3	3: g_1 2,5: g_3
2	2: g_1 1: g_2
1	1: g_1 2: g_2

g_1, g_2, g_3 are chosen "linearly" i.e. $g_2 = 1/2 g_1$, $g_3 = 1/4 g_1$ usually.

The component 2 b to 2d operate analogously.

The reaction tendency for each category now is a sum of the six above components (if all parameters are different from 0) and the category having the maximal value of reaction tendency will be predicted. If now one of the components varies to a much higher degree than the others, the outcome primarily will be determined by this component. It would be desirable therefore that all components vary in the same range approximately and then can be added after being weighted with parameters typed in on the typewriter. These parameters then gave a hint as to the importance of each process in question.

The solution of this problem was tried by deriving the mean and variances of the six components. Some assumptions on the basic variables (IM, IV, IS) were made and then the usual standardisation was applied on the components. [10] (Finally the six components could be weighted with the amount of participation having occured in that trial, but this possibility actually never was used). Table 8 summarizes the fit of this model for three sets of parameters.

Table 8

Number of successes of the additive model for reaction tendencies (for all runs the gradient of projection was 1,0 0,5 0,25)

Weights of components						Number of successes
1a indiv. pred.	1b partners pred.	2a actual indiv. proj.	2b cum. indiv. proj.	2c actual group proj.	2d cum. group proj.	(out of 300)
1	1	1	1	1	1	100
1	1	1	0	1	0	102
1	0	1	1	0	0	92

The fit of the model was comparatively good to start with, but some deficiencies were apparent:

Concerning components 2a to 2d: negative projection occured much too often compared with the real data. The correlations (from each individual) between kind of projection observed (or concluded from the data) and simulated were close to 0.

Concerning all components: the means and variances were not estimated properly. The range of variation and mean of the components did not behave as standardized variables with mean 0 and variance 1 (especially assumption 2 of the derivation of footnote 9 is not valid with respect to the responses of the subjects to the test items-there are strong correlations in the data).

The deficiency in the sign of projection can be removed by replacing the distance (IS-IM) with the distance (IV-IM), that is, we fix the sign of projection by considering the relationship between own opinion and prediction for the S-person in the last trial (the initial projective tendency still being determined by (IS-IM). For the first two parameter constellations of Tab. 8 above we now get 107 and 105 correct simulations. To see whether projection now contributes to the fit the model was run with the parameters 1 1 0 0 0 0 (i.e. projection excluded) and 95 correct obtained.

There also existed the impression that negative projection works different than in the first model- it does not inhibit the category corresponding to IM (and surrounding) but it reinforces the category on the opposite side of the reaction continuum (if IM is 3 in case of negative projection 1 and 5 are reinforced). The reinforcement procedure remaining as before otherwise, 110 correct predictions were obtained in the first parameter constellation (cf. Tab. 8). Runs of the model, which used only one of the projection components of a time gave around 72 and the distribution components taken simply (1a and 1b) gave about 95 correct predictions. So each component did contribute to the fit.

It is a much more difficult problem to remedy the different amount of variation of the six components. The reaction tendencies computed from the individual and group distribution of predictions (IV) simply can be normed so that the biggest of them is 1 and the smallest 0 and this operation is theoretically meaningful. But for the projection components it is not desirable to do so, because one could magine in the real process that under certain circumstances the influence of projection could totally vanish or on the other hand become the only one operating mechanism. The empirical amount of variation was much larger than computed from the assumptions in footnote 9 and moreover showed irregular dependencies on groups and trial numbers, so no general solution seemed possible. Some runs with standardized components 1a and 1b but unchanged projection mechanism generally resulted in lower success than without standardization (because previously there was some positive covariance between projection and components 1 and 2 serving for some amount of "self correction" of the relative strengths of the components). The best fit obtained was 112 correct predictions, when the projection mechanisms were given small weights (which shows that the version before this one would have been more accurate than 112 correct simulations under the same circumstances). An empirical solution of the projection problem would be possible by actually computing all tendencies and determining the parameters empirically, but the theoretical gain would be low.

Finally with the same model, a weighting of the components according to the success of the last trial was added.[11] This assumed that only trials in which the subject was successful (came near the S-persons answer) would have a tendency to influence the following strategy in subsequent trials.

This again resulted in a somewhat better fit than under comparable conditions before.

From these modifications of the program we could conclude that by adding all useful ones together we would arrive at about 120 correct predictions but not much more. In general I got the impression that by estimating all components of a model like this "qualitatively" that is in a 0-1 fashion (for operating or not) instead of the quantitative procedures actually used, one probably can get a better fit simply because one does not run into the problem of disproportional and uncontrolled variation of the components.

Instead of more thoroughly putting the components together or changing them to qualitative variables as suggested above, the next modification tested the value of a source of information not considered up to that point. Now the "structure" of the value test as it was perceived by it's constructors was taken into account. The new part in the program rested on the following assumptions:

Assumption 1: In predicting and discussing the reactions of the S-person to the items of the value test the S's will collect items together in a manner very similar to that of the test constructors. If the test-constructor qualifies two items as measuring the same supposed dimension (i.e. states the "face validity" of the items, e.g. "agression") then the discussion of the S's will result also in establishing a " "logical" or "psychological" relationship between the two items. The analogue will happen for items with reverse scoring.

Assumption 2: If an item of a certain dimension appears for the first time in the prediction process, the S's prediction will be identical with the S-persons answer to the item of the same dimension found among the first 5 items. If the same dimension appears a second time, the S's prediction will be identical with the actual (empirically obtained) prediction of the former instance (adjustments due to inverse scoring being performed if necessary).

Assumption 1 asserts that the discussion will reveal the face-validity of the items for each member, i.e. in judging another persons reactions the S's seem to know what is measured by the test. It would be interesting to know whether they gain the same insight into the purposes of the test if they fill it in individually. Assumption 2 asserts that first the S's are "S-person centered" that is after the logical analysis of the items they state a predicition derived from the S-persons prior reactions. After some trials they get so involved in the above mentioned logical analysis that they forget about the S-person and get "predictions centered", i.e. they are consistent with their own prior predictions and don't learn much additional bits of the S-person.

Some runs withthe new subroutine added were performed. The new subroutine operating alone (all other parameters set 0) gave 118 correct predictions. In this case the distribution of the correct predictions over the trials is interesting and is given in table 8.

Table 8

Number of correct simulations over trials 6 to 15 under the assumption of a "content-structure".

item No	6	7	8	9	10	11	12	13	14	15	$\sum$
supposed "Dimension"	A	T^x	K^x	T	P	K	B	A	B	P	
S-person or own prior prediction	S	S	S	IV	S	IV	S	IV	IV	IV	
Reaction of S-person	5	3	1		2		4				
Grp. 1	0	0	3	3	5	1	2	1	2	4	21
Grp. 2	0	0	3	1	5	1	4	1	3	5	23
Grp. 3	0	0	3	2	3	2	1	1	2	1	15
Grp. 4	1	0	0	3	3	2	3	1	4	1	18
Grp. 5	0	0	3	3	4	1	1	1	3	4	20
Grp. 6	1	0	4	2	4	0	3	3	1	3	21
$\sum$	2	0	16	14	24	7	14	8	15	18	118

x inverse scoring

S prior answer of S-person inserted

IV prior prediction IV of subject inserted

The total sums for the groups are very homogenous so that the assumed process is quite general. But the sums over the items differ greatly, thus one may say that the "dimension" is not equally well perceived. For dimensions A and T (totals of 10 and 14 correct) there is no gain (chance level 12) but for the other dimensions there is a big improvement in prediction. Some qualifications of this last statement will follow later. If for the second appearence of an item of the same dimension the reaction of the S-person to the first item were inserted, we would get 47 correct predictions instead of 62 in the corresponding 5 items. If the last reaction of the S-person were taken, only 38 correct simulations would occur. Therefore the S's actually get "prediction-centered" as was expected in Assumption 2 above.

Now the same "generalization"-mechanism previously used in the projection routine was used again with the structure-subroutine. That is, not only the category obtained was reinforced but also its "surroundings" as given in the table for the projection gradient.[12] The prior projection and prediction distribution mechanism now could be added to the structure operation. Generally more than 118 correct were achieved. This was especially due to the prediction distribution routine (component 1 a and 1 b above) which adjusted the simulations for extremeness of the reactions. If for example from the structure we would predict 5, then according to generalization 4 also is reinforced, usually to a lesser extent. If now the subject predicted 2 and 4 very often prior to that trial than 4 gets additional reinforcement and can overrule 5. This adjustment operation resulted in about 10 additional correct predictions. By flattering the generalization gradient of the structure routine so that the adjoining category is equaly reinforced as the obtained one again 10 additional correct predictions could be won. Both manipulations resulted in greater probabilities of twos and fours and the maximal success achieved was 136 correct (compare footnote 7). The biggest improvement occures in trials 6 and 7 so that the big difference between dimensions in table 8 vanishes to a large degree. A loss on the other hand happens in trial 8, where more subjects actually predict one instead of 2. Finally a modification of the projection components (2a - 2d above) was tried which meets some of the criticisms mentioned in connection with it. The strength of the projection tendencies was measured as before but now the value of it was compared with two parameters typed in on the typewriter. If the value exceeded some upper bound positive projection was assumed to go on, if it was less than a lower bound negative projection was initiated and if it was in between no projection took place at all (this is the transformation into a qualitative variable suggested above). The amount of reinforcement through projection then did not longer depend on the strength of the underlying tendency but only on the corresponding values of the projection gradient (g_1, g_2). With this the amount of variance produced by the projection mechanism comes under control. Some runs with this modification generally gave about the same results as with the structure and prediction distribution (1 a and 1 b) routines above. So our maximum achieved could not be improved. If however the structure routine was excluded and projection and components 1 a and 1 b were operating alone somewhat more correct predictions could be obtained than with the elder version. Some further runs in which the trials and subject's responses were weighted not equally as in all versions above but corresponding to a linear function of the components of participation occured (sending acts, receiving acts, total group reception) revealed no significant changes in the outcomes. So participation or interaction, although they did not worsen the fit of the model, could on the other hand not improve it either.

Therefore for this last type of cumulative- (additive) reaction-tendencies - model we can conclude:

- that it is more adequate than the types considered before
- that projection and prediction distribution mechanism well complement each other
- that the structure routine also can be improved by generalization and the distribution mechanism
- but that all other information added can not contribute anything to a better fit of the model and in the best case does not worsen it.

To see whether the differences in the prediction process of the alone- and group-conditions still are appearent, the same structuring of the test was applied to the data of the alone-condition also.

Three rules were tried:

1 - if an item of a certain dimension appears for the first time in the prediction task, the simulated prediction is set equal to the answer of the S-person to the item of the same dimension in the five given ones. If it appears for the second time, the simulated answer is set equal to the actual empirical prediction of the subject in the preceeding item of the same dimension (this is exactly the procedure of the group condition).

2 - first appearence as before, second appearence again first answer of the S-person

3 - first appearence as before, second appearence set equal to the last answer of the S-person to an item of the same dimension.

The number of hits were 75, 77 and 102 for the three procedures. If "generalization" was applied (replacement of categories as footnote 7) the number of hits was 90, 101 and 107 (with replacement 3→2: 93, 106, 102). Therefore the test-structure is also important in the alone condition and generalization is again a useful supplement. But their success is markedly lower in the alone condition and most important, no "prediction-centeredness" can be seen as expressed for the group condition in assumption 2 above. Instead of becoming centered on the prediction itself the subjects remain concentrated on the S-person (method 3 above) and actually seem to learn more about it in the alone condition.

Our initial puzzle, which was one of the most prominent motives of this investigation, now can be answered in the following (incomplete) manner:

- the ongoing interaction and attempts to convince one's partners dont influence the outcome of the group prediction for the current item: in this case some social norm or rationality principle (least absolute error) is operating that determines the decision to be the median of the individual predictions,
- the interaction does have influence on the group members way of obtaining their individual predictions: the discussion leads
  a) to a common interpretation of the test which probably is closely related to the face validity of the items

and b) leads to the preference of some prediction categories (2 and 4 in our groups) which again have some rational or strategic meaning: the prefered categories convey information (they dont correspond to a withdrawal, cat. 3) but at the same time protect against extreme errors (to which cat. 1) and 5) are susceptible) and against extreme deviations from the other group members opinions. [13)]

and finally c) one could mention that in our models it was not possible to relate sheer amount of participation to the amount of influence of certain members over the others or to the amount of reliance placed on one's own or the group members opinions.

IV. Summary

30 subjects had to predict a stimulus persons reactions to the items of a value test. They were given 5 answers of the S-person among which each of the five assumed dimensions of the unnormed test was represented. Then 10 additional answers had to be predicted. After each prediction the true answer of the S-person was announced (by the experimenter) or could be found in an envelope. The same 30 subjects were run with the same value test but 2 different S-persons (one constructed, the other a modified empirical person) first in an "alone condition" where the prediction was given without interaction and then in a "group condition" where the 5 members first fixed an individual prediction each and then discussed these and derived a group prediction item by item.

In the group condition the amount of individual interaction seemed to have no influence on the immediate outcome of the group decision (almost without exception [56 out of 60 cases] the median of the individual predictions was chosen). It therefore was supposed that the interaction might have some influence on the group members individual solution process for the subsequent trials.

To prove this assumption some models to simulate the indivual prediction process were constructed. In the alone condition a variety of programs which assumed that for the first trials "projection" will take place (i.e. predict one's private opinions for the S-persons) and that then a learning process, which leads to a preference for the most often heard category of the S-persons answers, will take over, were the models with the best fit (119 maximal correct predictions out of 300). These models did very bad in the group condition. In this situation models which assumed the summation of reaction tendencies and the realization of the biggest one were much more appropriate. The most important summands of the reaction potential were the "content structure" of the test itself (the face validity of the items presumably) and some preferences for not too extreme but yet information-conveying response categories (maximal success achieved was 136 correct predictions out of 300).

The prior anwers of the S-person were important only for the first trials and then ones own and the partner's prior predictions became predominately important. Also the projection mechanism or one's private opinion to the items was much less important in the group than

in the alone condition. The dissimilarities between the solution process in the alone-condition and the group-condition are exhibited by the simulation models which best describe each of the two situations. To obtain more perfect fit in both situations the consideration of personality variables and information on the test items and of verbal content of interaction in the group situation seems quite inevitable. Only the second of the three kinds of information necessary was used to a small extent in our models, the primary goal of the investigation being to exploit the redundancies in the S's reactions and to compare the two kinds of redundancies in both situations considered.

FOOTNOTES

1) In the conditional models the unconditional parameters were used if the conditional parameter was not defined. This was the case in 47 of the total of 300 simulations. Therefore the relatively small gain considering the private opinions (conditional) is not due to the rare use of conditional values in fact.

2) An n of 30 is much to low for a reasonable factor-analysis. In addition to this we should not have used just the same sample for the factor analysis and the simulation at the same time. We were forced to do this because of lack of information about the value test which has not been item-analysed by Prof. Reichardt before.

3) If one of the parameters did not exist, the same prediction as in the item before was used (e.g. the conditional distribution was empty).

4) Some informations to that point are for example:
- the coefficient of contingency between conditional mode and projection is CC = 0,14 (positive relationship, $p < ,05$) and between unconditional and conditional mode is much higher, CC = 0,42 (positive, $p < 0,01$), both without time function. Therefore projection can supplement very well the mode strategies for example.
- the following table gives numbers of subjects best simulated with the strategies (without time function).

	conditional			unconditional	Projection
	mean	median	mode	mode	
No S's	4	6	11	10	15

(does not sum up to 30 because for some S's more than one method yields maximum correct).

5) The actual function of the distance was:
$(N-1-|ISIM-IV|)^2$ .... N number of response categories
ISIM simulated prediction
IV actual prediction of the subject

In addition to that this value of the success again could be modified by a linear time function-for example, such that successes long ago would not count very much etc.

6) Compare Hare, Richardson & Scheiblechner 1968, page 14.

7) In one item there are 2 and in another 3 modes of private opinions. In these cases the mean of expected correct predictions was taken. If corresponding to a later suggested "generalization" argument the following transformations of predictions are performed:
prediction transformation:

prediction	transformation
1	2
2	2
3	3
4	4
5	4

106 correct simulations are obtained. If 3 → 3 is changed into 3 → 2 107 hits and if in the case of ambiguity the most often implied category is selected 111 correct simulations result.

8) Not only sheer amount of participation of the S's but especially quality of participation should contain valuable hints on the influence of each person and on the underlying processes. All experimental sessions were Bales-protocolled, but there are two reasons not to expect much of the protocols in this context.
   1- the average amount of participation for one individual in one trial is very low
   2- the Bales-protocollers were not well trained before (this part of the experiment being mainly for teaching purposes).

9) This additional constant was necessary because at some trials for some indivuduals all other components of participation were zero. In this case the corresponding observation would have been lost in the weighting procedure. The zero participation was due to coding and punching errors.

10) Distribution of the projection tendencies:
   2a- actual individual projection tendency:
   Assumption 1: All answers to all items are distributed equiprobably

x:	1	2	3	4	5	mean $\mu = 3$
p(x):	1/2	1/5	1/5	1/5	1/5	variance $\sigma^2 = 2$

Assumption 2: The answers of different subjects (the S-person and the predicting subject S especially) are independent.

If x is the answer of the S-person and y the answer of the predictor, then the variable $|x-y|$ can take on values 0-4 and is distributed with mean $\mu = 1,6$ and variance $\sigma^2 = 36/25$

Then $2-|x-y|$ is distributed with $\mu = 0,4$, $\sigma^2 = 36/25$ and finally $(2-|x-y|)\,|2-|x-y||$ has mean $\mu = 0,64$ and variance $\sigma^2 = 4,51$

2b - cumulative individual projection tendency:

Because of assumption 2, (independence of x and y) the cumulative measure $\sum_{i=1}^{n} (2-|x_i-y_i|)\,|2-|x_i-y_i||$ (i= number of preceding trials) is distributed with mean and variance

$\mu = n.0,64$

$\sigma^2 = n.4,51$

2c - actual grouprelevant projection tendency.

This being the sum of 4 subject's act. indiv. projective tendencies is distributed as $\mu = 4.0,64$

$\sigma^2 = 4.4,51$

2d - mean $\mu = 4.n.0,64$

$\sigma^2 = 4.n.4,51$

Distribution of the "symetrisized" prediction frequencies: for one trial x will produce (assumption 1)

distribution y: 1	2	3	4	5	with probability
0	0	1	0	0	1/5
1/2	0	0	0	1/2	2/5
0	1/2	0	1/2	0	2/5

This reaction tendency can take on the values 1, 1/2, 1 and the mean of this variable is $\mu = 0,2$

and its variance is $\sigma^2 = 0,08 = 2/25$

For two trials the estimates of these reaction tendencies are based on a sample of size n = 2 and their mean is $\mu = 0,2$ and their variances $\sigma^2 = 1/2 . 2/25 = 1/25 = 0,04$.
Generally, for n trials: $\mu = 0,2$ $\sigma^2 = 1/n . 2/25$
The same holds for the reaction tendencies based on the four partners predictions (assumption 2): $\mu = 0,2$
$\sigma^2 = 1/4 . 1/n . 2/25 = 1/n . 1/50$

11) The reinforcement weight of a trial being calculated from $(16 - (IV-IS)^2)/16$

12) In case of a negative projection tendency and an indivudual private opinion of 3 now categories 1 and 5 were reinforced most (g_1) and categories 2 and 4 less (g_2).

13) This statement taken for granted and the preferences for categories 2 and 4 estimated from the data we should simulate 160 fours and 140 twos. Then 110,47 correct simulations could be expected. The 136 achieved in our optimal constellation still would be better than this standard of chance.

LITERATURE

A. P. Hare, Computer Simulation of Interaction in Small Groups. Behavioral Science, Vol. 6 No. 3, July 1961.

A. P. Hare, R. Richardson, H. Scheiblechner, Computer Simulation of Small Group Decisions. Research Memorandum No. 13, Institute for Advanced Studies, Vienna, February 1968.