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ABSTRACT

Following the assumptions of ecological socialization research, adequate analysis of socialization conditions must take into account the multilevel and multivariate structure of social factors that impact on human development. This statement implies that complex models of family configurations or of socialization factors are needed to explain the variance in developmental paths and outcomes. This paper describes a method for exploring, describing, and constructing patterns of socialization conditions for human development. Socialization data from a longitudinal sample of 121 urban Icelandic children are used to illustrate how typical methodological problems (irregularities of shape, dispersion, multilinearity, multidimensionality) in socialization data can be solved by nonlinear multivariate analysis. The paper claims that such analysis optimizes the distribution of variables, reduces the complexity of data by minimizing loss of variance, and provides a successful exploratory analysis. Thus, central methodological problems that can arise from the measurement and the interference between socialization data can be solved. (EV)

Exploring pattern of socialisation conditions and human development by nonlinear multivariate analysis[1]

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Introduction

Following the assumptions of ecological socialisation research, adequate analysis of socialisation conditions must take into account the multilevel and multivariate structure of social factors that impact on human development (Garbarino 1992). This implies that complex models of family configurations or of socialisation factors are needed to explain the variance in developmental paths and outcomes. Empirically, these models are successful in so far as the complex structure of socialisation conditions is reduced to basic socialisation variables or risk factors (e.g. deprivation, divorce, attachment). On the other hand, the reduction to particular aspects of family socialisation variables does not allow to analyze complex family configuration influences as described in the ecological model. Thus, the analysis of social constraints on individual and personal development is reduced to single facets of family, school, or peer interactions without anchoring them in the macro- or exostructures of society. In addition, models of the multivariate and multilevel structure of socialisation conditions have often failed because of the methodological problems raised by different measurement levels and multivariations of the variables. In socialisation data normally neither the interval nor the order or linearity of the variable is given (for example, socio-economic status, region, sex, lifestyle,

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and rearing styles). Empirically, the interference of the socialisation variables leads to the often reported low correlations of single socialisation variables with dependent variables in general linear models (such as multiple regression). The paper describes a method for exploring, describing and constructing patterns of socialisation conditions for human development. Socialisation data from a longitudinal sample of 121 urban Icelandic children is used to illustrate how typical methodological problems (irregularities of shape, dispersion, multilinearity, multidimensionality) in socialisation data can be solved by nonlinear multivariate analysis (Gifi, 1990; Van de Geer 1993).

1. The problem

In socialisation research, theoretically it is assumed that the socio-economic milieu in which the child is growing up, defines the meanings of the socialisation conditions and therefore the childrens developmental opportunities. The macrostructural socialisation conditions indicated by the socio-economic status of the father should directly and indirectly affect children´s developmental opportunities. Directly because of the opportunities within the educational system given by the socio-economical status of the parents and the corresponding income, and educational aspiration of the parents. For example, a higher income and a higher educational and occupational status of the parents should increase the educational success of the children. Indirectly because of class- or milieu-specific cultural orientations and educational aspirations as well as family interaction styles, e.g. leisure activities and rearing practices. These different family socialisation conditions within socio-economic milieus should be important for the childs affective and cognitive development.

Empirical evidence for the influences of such macro- meso- and microsocial socialisation conditions on the childs personality development lead to the ecological socialisation model developed by Urie Bronfenbrenner. Bronfenbrenner suggested that indicators of the social background at the different levels of social organization have different meanings in and impacts on the socialisation process. These meanings and impacts does not differ only between socio-economic milieus but also between different aspects of the childs development (e.g. school performance, affective or cognitive development). In family socialisation research the hypothesis becomes empirically salient that social selection and family interaction influences define two different dimensions in the child life world experiences with different consequences for the childs development. Additionally, empirical findings in psychology suggests that in some kind developmental processes of cognitive development are independent of the social background in which the child is growing up. The hypothesis of different meanings of socialisation conditions for the different domains in personal and individual development was confirmed empirically in different studies: rearing styles of the parents for example are more important for the affective-cognitive development of the child while the educational aspirations of the parents are more important for school performance and educational achievement.

Empirically, the complex ecological model was partially confirmed, but not realized as a whole. The analysis of social constraints on individual and personal development is most often reduced to single facets of family, school, or peer interactions without anchoring them in the macro- or exostructures of society. This reduction to particular aspects of family socialisation variables does not allow to analyze complex family configuration influences on personality development as described in the ecological model. In addition,

models of the multivariate and multilevel structure of socialisation conditions have often failed because of the methodological problems raised by different measurement levels and multivariations of socialisation variables. Socialisation data normally fulfill neither the assumed order or interval of the categories of the variables (for example, socio-economic status, region, lifestyle, and rearing styles).

Furthermore, the different measurement levels and the multivariations of the variables often suppressed empirical relations of the variables in general linear models (such as multiple regression). An example for such supressed effects is Kohns study of class specific rearing styles. More salient is this problem in studies linking social structure to longitudinal measures in personel development. In small and theoretically guided data analyses the problem was not very important. But in complex data structures, including different measurement levels and data information from social as well as individual importance an exploratory technique is necessary. Refering to the theoretical assumptions of multidimensionality and multivariability of socialisation variables a methodological approach is suggested that allow to explore the multivariate and multidimensional structure of socialisation and developmental data. The nonlinear multivariate approach described in the GIFI Systems seems to be an adequate technique for such a complex analysis of socialisation and developmental variables as demanded in the ecological model. This technique make it possible to describe the shape of variables (e.g. centrality, dispersion, and irregulaties), to find out whether a set of variables is homogeneous or heterogeneous, to analyse the interference of the variables, and to describe the dimensionality of information given by the data (Heiser & Meulman 1994, pp. 182).

2. Data

The usefulness of nonlinear multivariate analysis for socialisations data shall be described by exploring the correspondence of socio-economic status as context information with family socialisation conditions and school performance and locus of control as developmental measures at age 7, 9, 12, and 15.

Accordingly, in the example two domains of personal development and socialisation conditions on different levels of social organisation are analyzed simultaneously as required in the ecological model.
The data are part of a longitudinal study on Icelandic children, that focusses on the relationship of social structure and individual development (Edelstein, Keller & Schröder 1990).

Table 1: Distribution of socialisation variables; number of cases; mean

N = 107; variables	categories	categories 1	2	3	4	5	6	7	no of missings
Set 1: social class									
- father's socio-economic status	low/middle	52	55						0
Set 2: family socialisation conditions									
- culturell social orientation	yes/no	68	38						1
- work centered social orientation	no, little, often	45	36	25					1
- supervision of schoolwork	no, sometimes, often	9	39	58					1
- number of activities with child	low - high	9	13	21	20	20	11	12	1
- punitive-restrictive rearing style	low - high	19	12	16	12	19	10	18	1
- verbal-overcontrolling rearing style	low - high	6	14	28	10	20	9	19	1
Set 3: grades									
- age 7	good - bad	41	36	18	12				0
- age 9	good - bad	44	49	12	2				0
- age 12	good - bad	49	42	13	3				0
Set 4: locus of control									
- age 7	internal-external	1	4	12	26	64			0
- age 9	internal-external	1	3	18	23	62			0
- age 12	internal-external	14	12	20	33	28			0
- age 15	internal-external	39	29	15	15	9			0

The variables used in the present analysis are classified into four sets for theoretical reasons described in ecological socialisation research. Socio

economic class (set 1) defines the macrostructural environment in which the family variables (set 2) form different meanings with specific influences on each of the two developmental aspects (set 3 and set 4).
Locus of control is measured by a short version of the Locus of Control Scale for Children developed by Nowicki & Strickland (1973). It measures the extent of how children believe that the consequences of their actions are influenced by themselves.
School performance is measured by the standardized mean of school performances (GPA) of the children in the main subjects (see table 1).

Individuals with missing values on all variables were excluded from the analysis. The missing values of the longitudinal variables were replaced by the median value obtained from the remaining subjects. All variables are treated as ordinal. The data analysis is done by the overals procedure in the categories module of SPSS.

3. Method

3.1. Some notes to nonlinear multivariate analysis

The rationale of nonlinear multivariate analysis is to explore the structure of a data matrix by linearization of the variables within the overall variance in the data space. In nonlinear multivariate analysis indicator matrices are used where the rows define the objects (individuals with their marks on the variables) and the columns define the variables. Table 2 gives an example of an indicator matrix for selected variables of the data.

Table 2: Example for an indicator matrixes G*k* for *n* objects in *k* sets

	set 1				set 2			grades 7			
	SES		culture		work						
objects	low	middle	no	yes	no	little	often	1	2	3	4
01	0	1	0	1	0	1	0	0	1	0	0
02	1	0	1	0	0	0	1	0	0	0	1
03	0	1	0	1	1	0	0	0	1	0	0
04	0	1	1	0	0	1	0	0	0	1	0
05	1	0	0	1	1	0	0	0	1	0	0
06	0	1	1	0	0	0	1	1	0	0	0
07	0	1	1	0	0	0	1	0	0	0	1
freq	2	5	4	3	2	2	3	1	3	1	2

The aim of the method is, similar to multidimensional scaling, to reduce the complexity of the data matrix by minimizing the loss of variance. Therefore the dispersion of objects (individuals) around the centrality of the categories of each variable (multiple categories) will be optimized (to single categories). Thus, this linearization process allowd to find out whether a set of variables is homogeneous or heterogeneous by describing the shape of variables (e.g.

centrality, dispersion, and irregulaties), the interference of the variables, and the dimensionality of information given by the data (Heiser & Meulman 1994, pp. 182).

Because homogeneity analysis suggests useful transformations by considering equivalent forms of the variables, and then selecting preciseley those objects that yield a distribution with mimimal dispersion, socialisation data can be explored and optimized by a) defining multiple and single coordinates of categories within the data space b) reducing dispersion of variables by optimal transformation processes, c) locating quantified variables (centroids) in the multidimensional data space, and d) describing the distances of object scores to the quantified categories[2]. Figure 1 gives an example of the transformation process for multiple, single, ordinal, and numerical quantifications for one variable. The smaller the dispersion around the object points, the greater the homogeneity. The loss of information depends on the transformation of categories on the assumed measurement level.

Graph 1b about here
(optimal transformations at different measurement levels)

Figure gives a short overview of the different transformations needed by single and multiple nominal data, ordinal and metric measurement levels.

[2]Note: Depending on the assumed measurement level, the interference, and the dimensionality of the variables, nonlinear multivariate analysis show similar results as correspondence analysis, principal component analysis, multiple regression analysis and multivariate analysis of variance. The results can be interpreted in terms of the mutual correlations of the variables (and lead to similar results as Cronbach's α).

3. 2. Analytical steps

Transformation

Because homogeneity analysis suggests useful transformations by considering equivalent forms of the variables, and then selecting precisely those objects that yield a distribution with minimal dispersion, socialisation data can be optimized by linearization of the dispersions. In figure 1 the transformation plots gives an impression of the dispersion and possible computations of the variables by minimal loss of information (or variance). The quantifications are plotted on the vertical axis, categories on the horizontal axis. In the present data I assume that all variables are ordinal.

Figure 2 about here
(transformation plots for all variables)

As shown in graph 2, most of the variables need a transformation. In the analysis the variable "punitive-restrictive" rearing style, for example, is used as a dichotomous variable. It also can be recoded for further analysis without losing information or variance.
The dispersion of the locus-of control variable at age 7 and 9 due to a measurement error. Children at age 7 and 9 obviously were not able to understand the items indicating an internal control belief. In the analysis this variable will get exactly that status it empirically has. The transformation corrected for the worse differentiation of information in the variable.

The fit of the data and the loss of information from the empirical data by transformation is given by the multiple and single fit for each variable and each dimension. It results from the distances of objects to the category

centroids of a variable (multiple fit) or to a straight line defined by the categories (single fit).

Table 3: Sum of multiple fit, single fit, and single loss for each variables over two dimensions

	multiple fit	single fit	single loss
Set 1: social class			
- father's socio-economic status	.435	.435	.00
Set 2: family socialisation conditions			
- culturell social orientation	.068	.068	.00
- work centered social orientation	.358	.349	.009
- supervision of schoolwork	.083	.082	.001
- number of activities with child	.456	.409	.047
- punitive-restrictive rearing style	.106	.073	.033
- verbal-overcontrolling rearing style	.076	.063	.013
Set 3: grades			
- age 7	.778	.777	.001
- age 9	.111	.106	.006
- age 12	.622	.613	.008
Set 4: locus of control			
- age 7	.287	.267	.02
- age 9	.132	.116	.016
- age 12	.408	.390	.017
- age 15	.388	.373	.015

Multiple fit indicates the selectivity of categories within the multivariate data space, single fit inform about the loss of variance by linearization. If single loss - a difference between multiple and single fit - is high, linearization restricts the empirical distribution, and the variable is better treated as multiple nominal. As in the example all variables show little loss, the assumption of ordinal structure can be maintained.

Interference of the data

After this short description of the variables the socialisation pattern and developmental variables can be described.

The interference of the variables is described by the component loadings as shown in table 3:

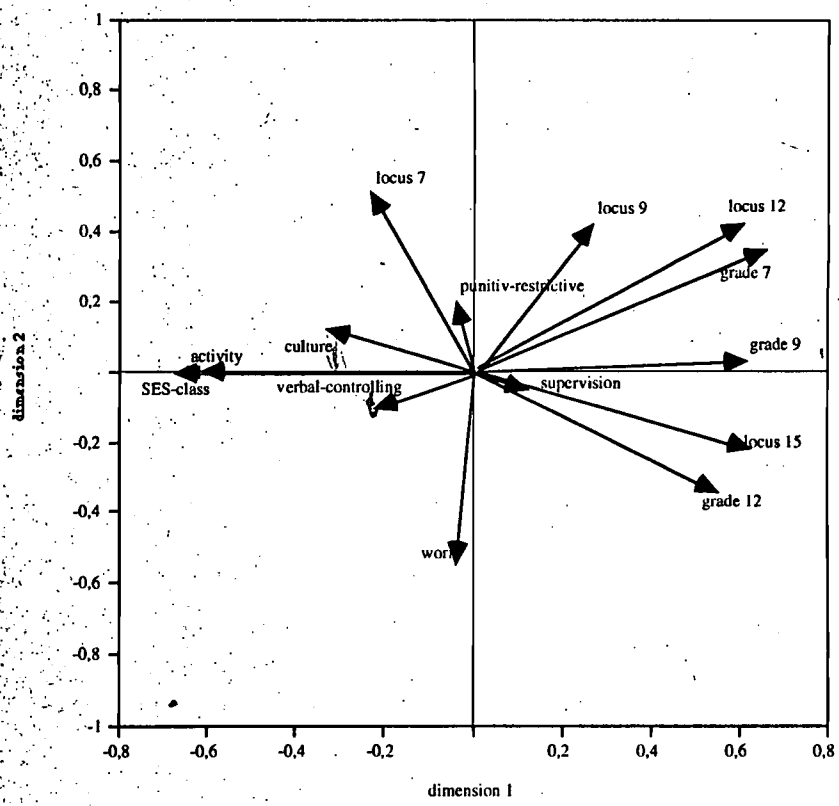
Table 2: Component loadings for two dimensional solution

	dimension 1	dimension 2
Set 1: social class		
- father's socio-economic status	-.659	-.005
Set 2: family socialisation conditions		
- culturell social orientation	-.331	.125
- work centered social orientation	-.049	-.559
- supervision of schoolwork	.127	-.061
- number of activities with child	-.630	.003
- punitive-restrictive rearing style	-.042	.201
- verbal-overcontrolling rearing style	-.234	-.094
Set 3: grades		
- age 7	.605	.417
- age 9	.601	.029
- age 12	.564	-.320
Set 4: locus of control		
- age 7	-.234	.514
- age 9	.272	.424
- age 12	.622	.339
- age 15	.583	-.233
Eigenvalue	.522	.406

- The first dimension is defined by the socioeconomic status of the father, the number of activities with the parents on the one pole, the general educational succes indicated by the high loadings of the school performance variable "grade" and locus of control up to age 12 on the other.
- The second dimension is defined by the development of school performance from age 7 to age 12 as well as a work centered social orientation of the parents, indicated by the variable "work". On the first view, it seems that school performance is highly correlated with the socialisation conditions. But it is important to realize, that the second dimension is defined by the deveopment of school performance, while on the first dimension school success in general play an important role.

The scatterplot of the component loadings for the two dimensions (graph 3) makes the structure of the multiple data space more visible.

Graph 2: Scatterplot for component loadings in the first and second dimension



The plot shows very impressingly the meaning of the first and the second, the socialisation and developmental dimension:
The first dimension underlines the social selection hypothesis: Children from middle class families and with parents who share more activities with the

children tend to have better developmental opportunities within the school career. Children from lower socio-economic class reversely have a higher risk for school failure in general. If we would interpret the component loadings in terms of correlations, SES correlates - loosely spoken - highly positively with the number of activities parents share with the child, and with the cultural orientation of the parents. Likewise this constellation obviously correspond with better school performances in general but does not influence the school career itself. This result corresponds with the assumptions of lifestyle research in the tradition of Bourdieu and underline the hypotheses in ecological socialisation research, that the meaning of the families socio-economic status is reflected by the cultural orientations and activities with the child.

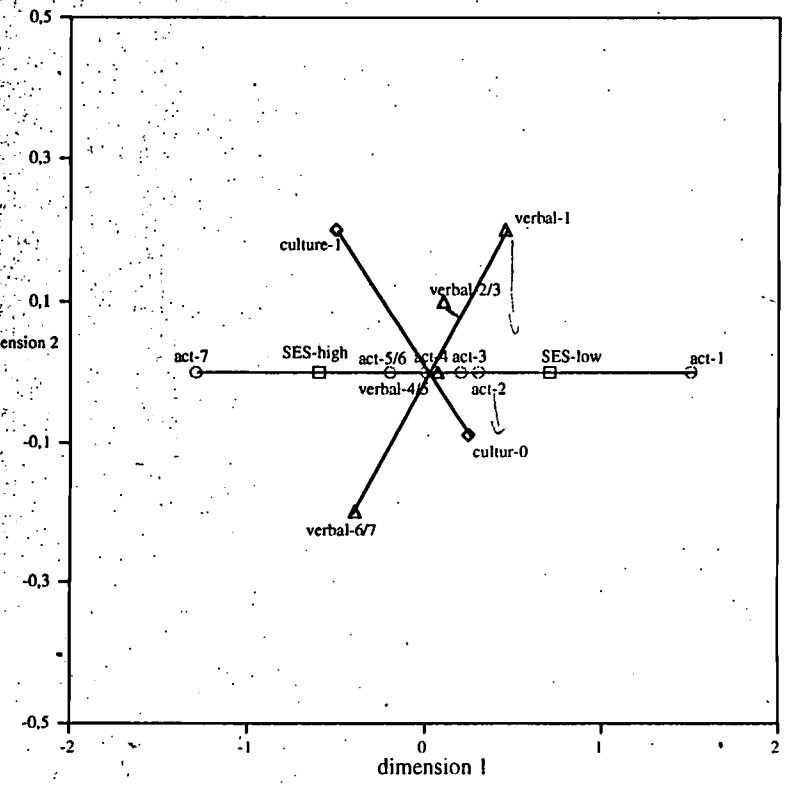
The second dimension indicates a developmental process of school performances that is relatively independent of the anayzed socialisation conditions. In contrast, the development of locus of control seems to be influenced by the socialisation variables.

Analysis of constellations

A more detailed insight into the structure of the data is possible by scatterplots of the projected category centroids of the transformed variables.

As an example: The projected centroids in graph 4 show the location for the variables SES, activities, culture and the rearing style verbal-overcontrolling. The lines combine the category points of the variables whereby the controversial location of variables in the two-dimensional data space becomes obvious.

Graph 3: Plots for the projected centroids for SES, activities, culture and verbal-controlling

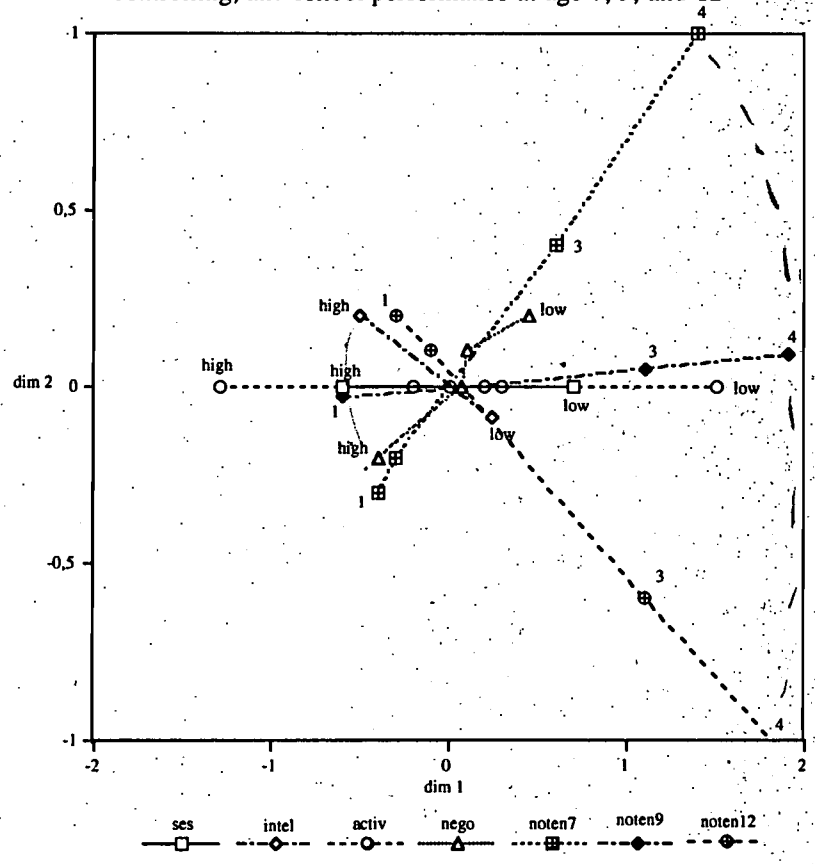


The plot shows the correlation of the socio-economic status and the activity variables as indicated by the high component loadings in table 3. The smaller correlations of cultural orientation of the parents has to do with its location on the second dimension.

The controversial structure of the data becomes evident by including the developmental patterns of school performance and locus of control in the plot

In graph 4 the same information is given as in Graph 3 but it includes the measurements of school performance at age 7, 9, and 12.

Graph 4: Plots for the projected centroids for SES, activities, culture, verbal-controlling, and school performance at age 7, 9, and 12



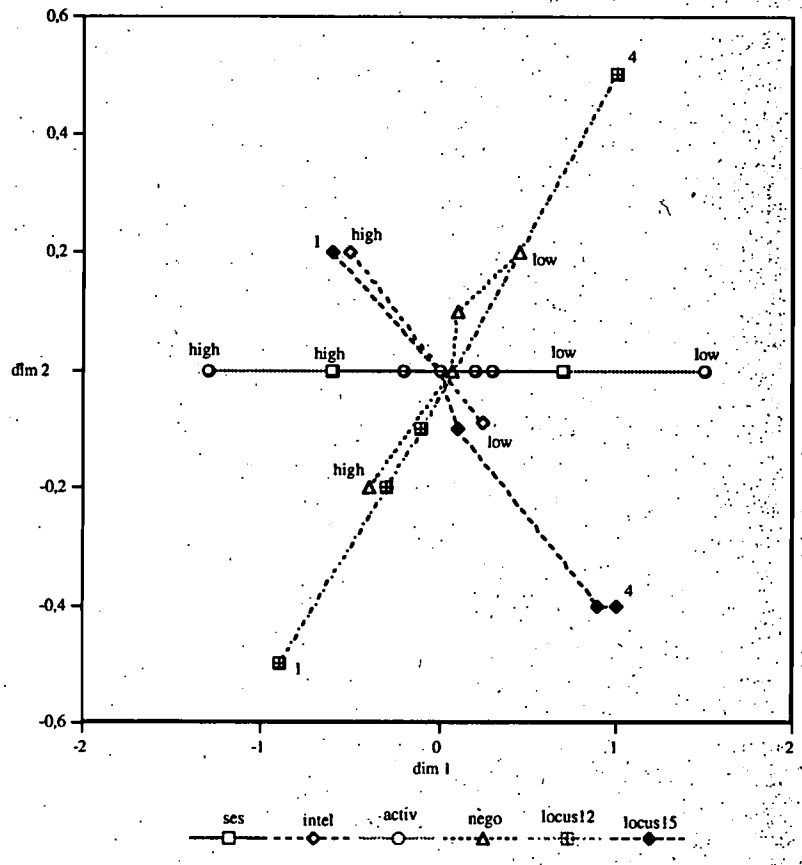
The scatterplot shows the impressive correspondence of high school performances with the positive, high categories of the socialisation variables SES, activities, cultural orientation, and rearing style. Interestingly, the

rearing style seems to be most important at earlier age (corresondence with school performance at age 7) while the cultural orientations become important in later childhood. In the case of children from families with a lower socio-economic status, with parents without cultural orientations and only little activities with the child the school performance of the children is lower. Furthermore, only these children differentiated over the school career. The risk of school failure indicated by lower school performance increases with the age of the children.

We find a similar trend for the development of control beliefs between age 12 and 15. In the example shown in Graph 6 an obvious correspondence between the socialisation conditions and control belief is illustrated: Children from lower socio-economic class (and who are, for example, not experienced activities with the parents) are more likely to develop an external control belief than children from upper socio-economic class.

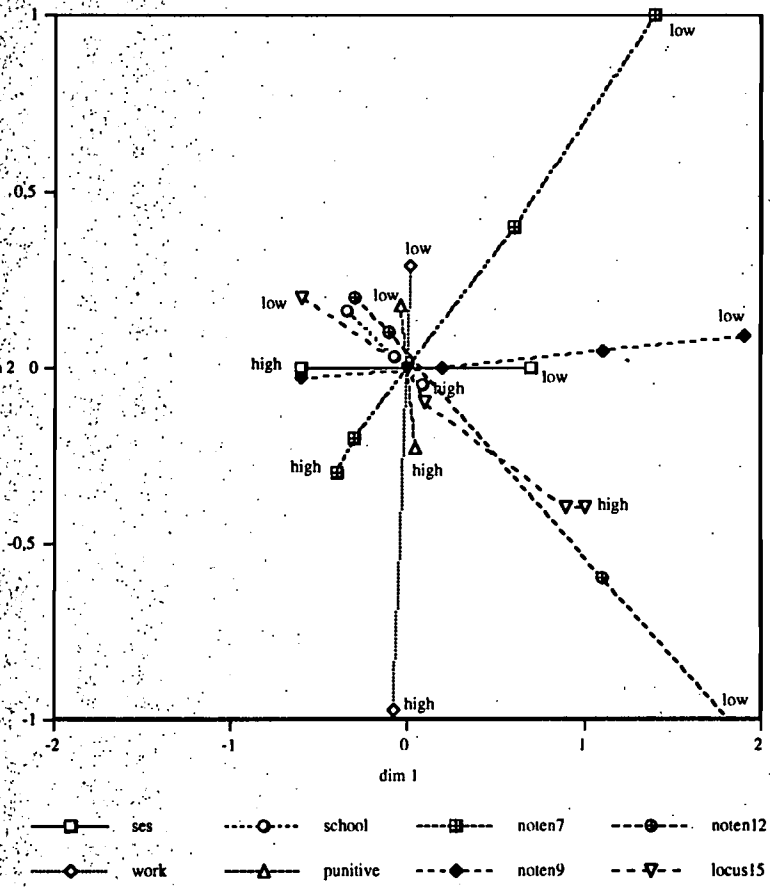
Both examples leads to the conclusion, that the socialisation conditions seems to indicate an family climate that promote the development of autonomy, self efficacy and other abilities to solve developmental tasks on the one hand or, reversely increasing the risk of school failure in lower class families where these socialisation pattern were not found.

Graph 5: Plots for the projected centroids for SES, activities, culture and verbal-controlling and locus of control at age 12, and 15



But al least, what do we find in families, in which a more restrictive family climate occur, e.g. the parents have a work centered social orientation, a punitive rearing style and tend to control the activities of the child such as learning for school at home? Such socialisation pattern typically associated to lower class families!

Graph 6: Plots for the projected centroids for SES, restrictive family climate, and the development aof school performane and locus of control



In graph 6 we find no evidences for correspondences with the developmental variables and these restrictive socialisation conditions. The restrictive socialisation conditions seems to have only little to do with the development of

school performances and locus of control at age 15. Moreover, the work centered social orientation of the parents is highly associated with the punitive rearing style, but not with the socio-economic status of the parents. Therefore hypothesis about class specific family interaction and there influences on the childs development can not be maintained for both socio-economic milieus analyzed here. An adequat analysis of socialisation pattern and developmental outcomes within socio-economical, e.g. macrostructural socialisation conditions need a very close sight into the data structure.

Summary

The examples I gave should show the relevance of exploratory analysis for the understanding of the different meaning of family socialisation conditions within and between cultural contexts and developmental outcomes. It also should illustrate the complex correspondences between the different types of variables that are typically for socialisation research. The linearization approach appears to be an adequate method for exploring the structure of socialisation data as a first step of multiple data description. The analytical steps in nonlinear multivariate analysis allow to identify irregularities of shape of a distribution, multidimensionality and intercorrelations of socialisation-, context-, and developmental variables (Heiser & Meulman 1994, p. 188). Nonlinear multivariate analysis optimizes the distribution of variables, reduces the complexity of data by minimizing loss of variance and provides an succesful explanatory analysis. Thus, central methodological problems that arise by the measurement and the interference between socialisation data can be solved. For socialisation research two methodological aspects makes the GIFI system to a favourable analytical technique:

1. the possibility of simultaneus analysis of socialisation and developmental variables with different measurement levels,with different status of information and with a complex interference of the data and
2. the possibilities of a detailled insight into the data structure by testing the qualities of information given by the data, by describing the correspondence of the variables and the multidiemsnionality of the data.

This salient qualities allow to test basic hypothesis in socialisation research that until now are not empirically proved.

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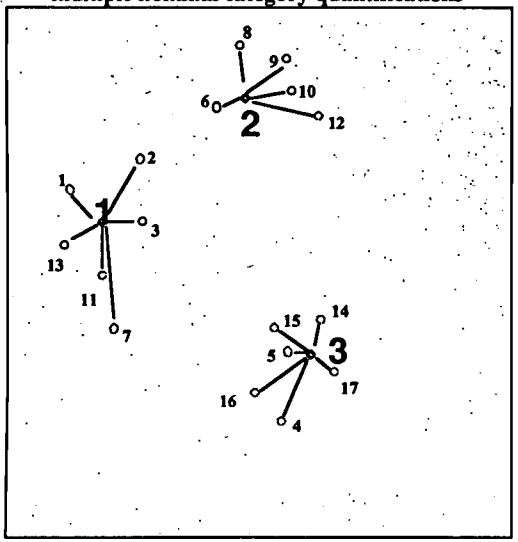
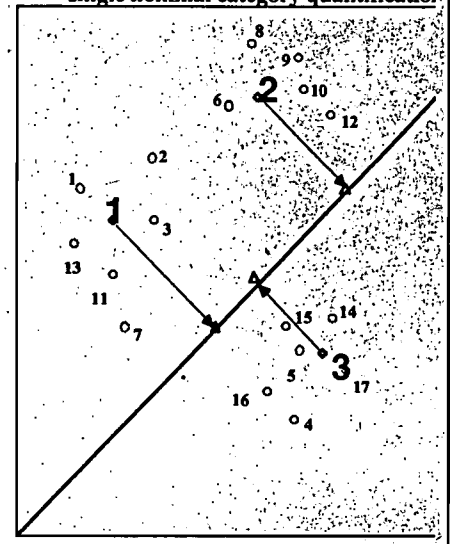
Figure 1: Optimal transformation and linearization by measurement levels

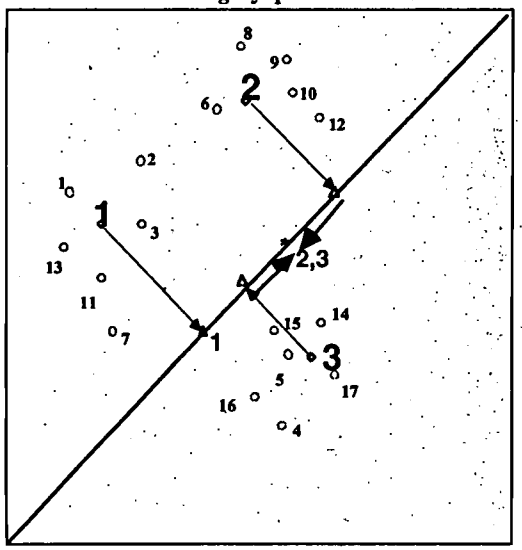
multiple nominal category quantifications



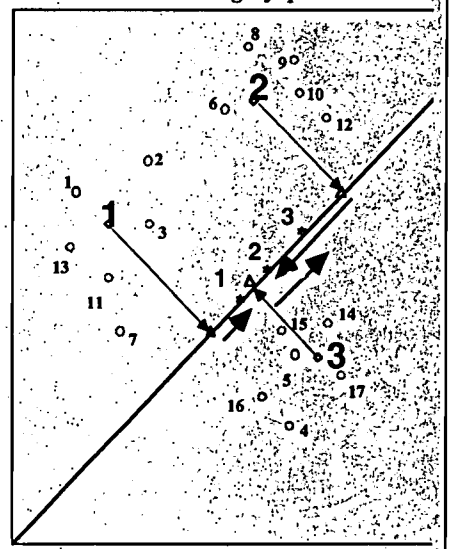
single nominal category quantification



ordinal category quantifications

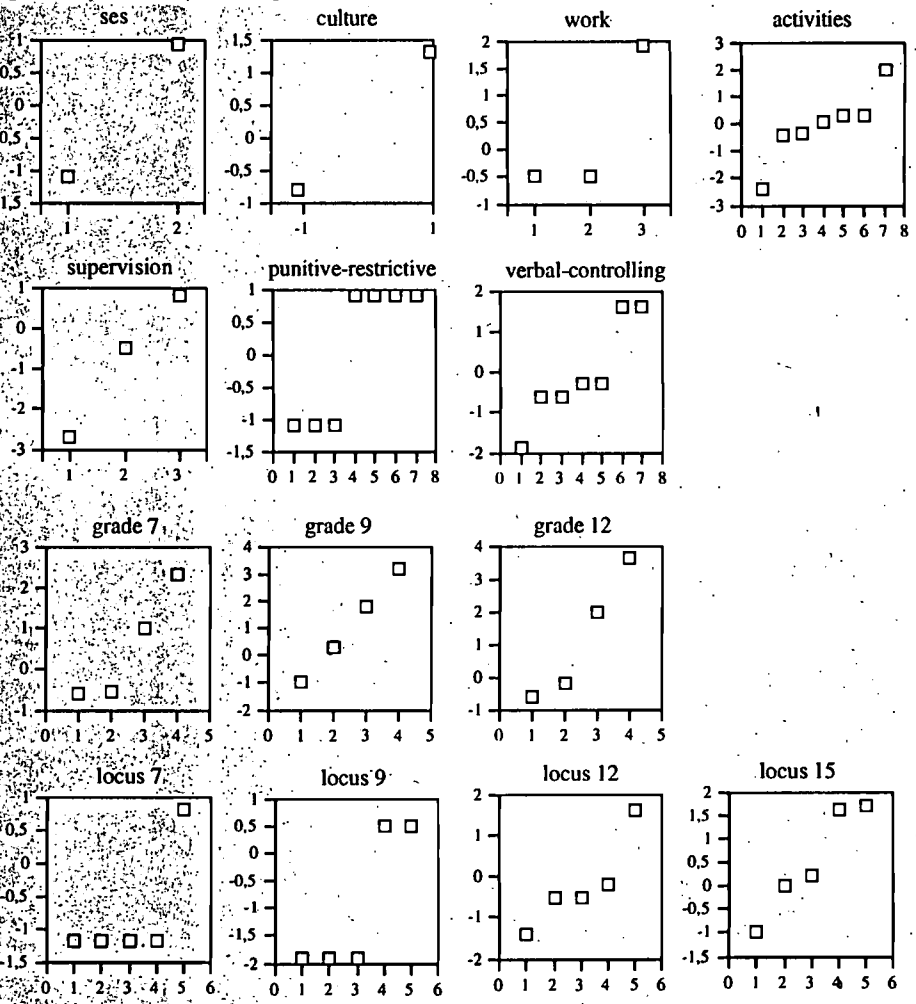


interval category quantifications



Note: ○ = object
1 = multiple category coordinates
△ = single category quantifications
★ = quantification

Figure 2: Transformation plots for all variables.



Note: Quantifications are plotted on the vertical axis, categories on the horizontal axis.

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