A NOTE ON A PROVISIONAL FACTOR ANALYSIS OF LINEAR POTTERY WARE

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Introduction

The sherds analysed here, were excavated at Hienheim, Bavaria. Directed by prof. dr. P. J. R. Modderman of the Institute of Prehistory at Leiden University, teams of graduates, undergraduates and labourers have been digging there from 1965 on (Modderman 1966, 1971). In a discussion on Linear Pottery and Stroke Ware decoration, the problem arose whether on the basis of internal evidence alone, a typology might be converted into a chronological order. When I proposed to make an attempt to answer the question by statistical means, prof. Modderman offered to describe the decoration on a trial sample of Linear Pottery sherds from Hienheim. Seven undisturbed pits, each attributable to a different house, were selected. None of the sherds in the sample being sufficiently large to hold a complete motif, the elements or smallest recurrent units of decoration had to be employed in the analysis. In the sample different elements or categories plus an additional rest group could be defined. Every incidence on the sherds was separately scored. The resulting catalogue is presented here as table 1.

Method

From the simplicity of the desired answer in relation to the relatively complicated nature of the data, it follows that a multivariate method is indicated (Geer 1967, p. 91). More specifically, if positioning on a scale is considered an ordering or ranking operation, some form of factor analysis is appropriate (Hodson 1969a, 1969b):

'. . . (these methods) enable us to see whether some underlying pattern of relationships exists such that the data may be 'rearranged' or 'reduced' to a smaller set of factors or components that may be taken as source variables accounting for the observed interrelations in the data'. (Nie 1970, p. 209).

Among the several ways to factor analyse[1] I prefer the Principal Components method because of its deductive characteristics; factors are defined through mathematical (linear) transformations of the observed data only. In practice, the input data (table 1) are first transformed into a correlation matrix (table 2); then linearly combined into a factor matrix, which is finally rotated to the best interpretable solution (table 3).

Although special care was taken to select undisturbed pits, it is probably impossible to exclude contamination of the fillings. To improve the reliability of the present analysis, the input data (table 1) were subjected to a number

[1] For a discussion of the relative merits of the various techniques jointly known as factor analysis, the reader is referred to Geer 1967 or Harman 1967; less technical summaries are given in Hodson 1969a and Nie 1970.

Table 1. Hienheim. The occurrence of elements of decoration on a restricted sample of sherds in closed deposits.

Elements of decoration:		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	(23)
House	16	1	1	1	5	–	–	13	–	1	2	–	–	1	–	–	–	1	–	–	–	–	–	–
House	20	4	2	–	11	–	1	9	–	31	3	3	4	15	–	–	–	–	–	–	–	–	–	–
House	27	20	8	2	18	2	24	18	11	9	14	7	8	18	2	6	4	3	4	–	–	2	–	–
House	31	7	9	3	5	3	3	16	–	–	63	6	4	4	–	–	–	2	1	1	1	1	–	5
Pits	526/562	4	1	2	2	–	1	5	1	6	7	19	4	2	1	–	–	–	–	–	–	–	–	–
Pit	721	1	5	–	6	–	4	7	–	–	65	–	2	3	1	–	2	–	–	–	–	1	1	–
House	13	2	2	1	3	–	17	10	6	–	20	–	3	4	–	–	–	–	–	–	–	–	–	–

Table 2. Hienheim. Correlations between the several groups of decorated sherds, based on the data in Table 1.

	House 16	House 20	House 27	House 31	Pits 526/562	Pit 721	House 13
House 16	1.000						
House 20	0.510	1.000					
House 27	0.169	0.614	1.000				
House 31	0.265	0.585	0.963	1.000			
Pits 526/562	0.144	0.328	0.286	0.328	1.000		
Pit 721	0.163	0.561	0.983	0.977	0.239	1.000	
House 13	0.368	0.544	0.792	0.731	0.174	0.737	1.000

of special transformations, following which the same analysis was applied:

1. the original data, as presented in table 1, were routinely factor analysed; cf. tables 2 and 3.
2. on the supposition that contamination, if any, will occur in small numbers, from each entry in table 1 (arbitrarily) two units were subtracted.
3. a present/absent dichotomy was used; this should provide a qualitative approach.
4. a combination of the 2nd and 3rd attempts: a category was listed present only when it was tallied thrice at least; otherwise it was assumed absent.

Notwithstanding these transformations, the results were very stable as regards relative positions on the first three factors, except in the 4th case, where the deviations were unimportant, however.

Results and discussion

As shown in table 3, the first three factors represent 61%, 16% and 13% of the variation, respectively; the remaining 10%, being distributed over several factors, may be labeled 'noise'. If the sherds in the sample were produced by a population not restricted to a vanishingly small segment of time, one of the factors should be related to time: habits constantly change. However, there are no internal reasons to prefer one factor to the other, and considerations alien to the data at hand should provide an answer:

1. no data indicative of qualitative social change have been found at Hienheim (Modderman, pers. comm.)
2. regarding alternatives, an ecological model indicates two major, non-diachronic sources of variation in the culture of a Linear Pottery population: social stratification and kinship determinants (Velde 1973).
3. in more extensive, similar analyses of other cultures, a time factor accounts for 40 to 50% of the variation (Clarke 1970, p. 26; Hodson 1969, p. 300, 315).

It may be argued then that the first factor is somehow related to time. As regards the direction of this factor, if it is accepted that cultural variation increases with time (Clarke 1968, p. 256–257) then by comparing tables 3 and 1 it is seen that the number of categories of decoration decreases from Pit 721 to House 16. Consequently, the former should be the youngest

Table 3. Hienheim. Varimax rotated factor matrix, based on the data in Table 2. Arranged according to loadings on factor I.

Factors:	I	II	III	IV
Pit 721	0.953	−0.008	0.089	0.233
House 27	0.951	0.014	0.127	0.262
House 31	0.924	0.089	0.182	0.226
House 13	0.833	0.382	0.016	0.031
House 20	0.398	0.334	0.161	0.827
Pits 526/562	0.140	0.060	0.982	0.108
House 16	0.089	0.952	0.061	0.211
% of variation	61.2	16.0	12.8	5.6 = 95.5 %

group in the series, and the latter the oldest one[2].

Without an extension of the present analysis, especially to include groups that have been dated, it would be logically false to assume that the problem has been solved; yet the results encourage further investigation.

[2] Incidentally, this result is in accordance with the chronological ordering of the elements of decoration on Dutch Linear Pottery: elements nrs 14-22 are attributed to the later phases there (Modderman 1970, p. 120-140).

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