

Psychological Laboratory, University of Lund, Sweden.

THE FACTOR ANALYSIS METHOD OF STUDYING INTRACUTANEOUS SKIN REACTIONS

By

JASPER W. HOLLEY & KARIN WILLÉN

The purpose of the study reported in the present paper was to test the applicability of the method of factor analysis to problems related to the study of allergy. Thus its principal concern was with methodology. The present study, too, may be regarded as a follow-up of a previous investigation (*Andrews 1943, 1948*) in which the findings were not clear-cut. It should be pointed out, however, that both the method of factor analysis and the techniques of measuring skin reactions have improved since the first pioneering study.

MATERIAL AND METHODS

The reader will be spared a description of the method of factor analysis, and will instead be referred to a few of the sources for such information which are available (*Fruchter 1954*), (*Guilford 1954*), (*Thurstone 1953*).

The allergen extracts used in the present study conformed to the standards set by the Northern Society of Allergology. Specifically, the extracts yielded negative results in at least 18 out of 20 non-allergic subjects, with a concentration level of 1:1000 (weight/volume). In addition, it should be pointed out that every extract had been rigorously tested on persons with known allergies so that its positive results also could be evaluated in a proper manner.

The reactions of the patients were scored on the basis of a scale indicating their degrees of sensitivity. The first three units of the scale were based on the area of the skin reaction for allergen concentrations of 1:1000, while scores of four and above were used to indicate positive reactions to concentrations of 1:10,000, 1:100,000 etc. For two sets of tests, however, (specifically, dust and

mould allergens) the maximum score was only three, a range restriction which cannot be regarded as significantly influencing the factor pattern.

The records of the intracutaneous skin tests were taken from the files of the Allergy Laboratory, Lund, Sweden, which had been acquired from the examinations carried out between Jan. 1967—Nov. 1968, under the direction of Docent Bengt Arner. For the purposes of the present study, those cases were selected for analysis in which there was a minimum of one positive skin reaction for the standard series of allergen extracts. In addition, the tests selected were those in which at least 10 per cent of the patients reacted positively. The resulting set of intracutaneous skin tests is presented in Table 1.

TABLE 1
*Stimuli Applied to the Skin.**

1	House-dust	11	Horse epithelium
2	Dust A	12	Cat epithelium
3	Dust B	13	Cow epithelium
4	Dust C	14	Daisy-pollen
5	Bothrytis	15	Rape-pollen
6	Hormodendrum	16	Timothy-pollen
7	Mucor	17	Tree-pollen
8	Aspergillus	18	Reeds-pollen
9	Sheep's wool	19	Hazelnut
10	Dog epithelium	20	Shell-fish

RESULTS

The first step in the analysis was to compute correlational coefficients on the basis of the scores of the 100 persons with respect to the 20 stimuli given in Table 1. The resulting statistical indices are the values of Table 2.

The correlated values of Table 2 were factor analyzed, using the principal component method. Four factors were extracted and then rotated, using the varimax rotational system. All of such operations were achieved with the aid of electronic computers. The resulting "factor loadings" are given by the entries of Table 3. It might be helpful to point

* Crude extracts of dusts (A), (B), and (C) were fabricated at the Allergy Laboratory, Medical Clinic A., Lund, Sweden. The remaining extracts were fabricated at Vitrium AB, Stockholm, Sweden.

TABLE 2*
Correlation Coefficients.

Stimulus	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	--																			
2	20	--																		
3	33	51	--																	
4	12	48	64	--																
5	02	09	11	05	--															
6	09	06	06	09	67	--														
7	04	10	11	06	71	52	--													
8	00	00	00	16	46	43	33	--												
9	15	11	01	12	03	11	06	01	--											
10	00	08	03	11	02	01	06	03	38	--										
11	03	42	37	48	14	09	16	07	28	45	--									
12	20	32	06	24	06	01	09	11	11	45	47	--								
13	04	24	20	37	07	10	06	06	41	27	32	23	--							
14	13	03	04	07	03	01	09	04	00	04	08	05	21	--						
15	13	12	01	06	06	07	08	07	19	16	09	18	00	22	--					
16	12	05	03	05	02	04	09	03	01	02	02	10	11	13	08	--				
17	10	04	09	09	00	01	10	07	02	03	13	18	11	30	07	47	--			
18	15	14	05	10	03	01	05	01	05	12	01	11	15	26	36	55	31	--		
19	07	03	13	03	00	05	01	04	01	02	04	02	17	20	27	05	32	23	--	
20	21	31	31	17	09	13	11	08	05	12	01	13	12	05	31	18	15	05	09	--

* Decimal points omitted.

TABLE 3*
Rotated Factor Matrix.

Stimulus	Factor			
	I	II	III	IV
1	—08	—02	—17	<i>42</i>
2	39	04	14	<i>57</i>
3	29	07	—03	<i>70</i>
4	51	—08	—04	<i>53</i>
5	03	88	00	05
6	04	74	—02	—11
7	15	73	10	02
8	—10	53	—06	—06
9	35	04	—01	08
10	<i>61</i>	—02	—09	—18
11	73	08	08	18
12	<i>67</i>	—07	13	—14
13	47	05	—24	20
14	—07	00	<i>43</i>	—01
15	—23	—08	37	31
16	06	06	<i>61</i>	—11
17	16	01	<i>60</i>	—06
18	—05	02	<i>71</i>	01
19	—02	—04	<i>41</i>	—05
20	—11	—12	—07	<i>54</i>

* Decimal points omitted.

out that a factor loading may be regarded as an approximation of the correlation of skin-reaction test with a factor.

It may be observed that the highest value for each test in Table 3 has been italicized.

The manner in which the skin reactions cluster can be seen in the illustrations of Figs. 1 through 4, which follow. The most important measures comprising the factorial groupings have been circled.

It may be seen from the graphic illustrations of Figs. 1 through 4 that the allergy reactions cluster together, and, as we shall see later, in a meaningful manner. Such clusterings would indicate that the correlations between the tests

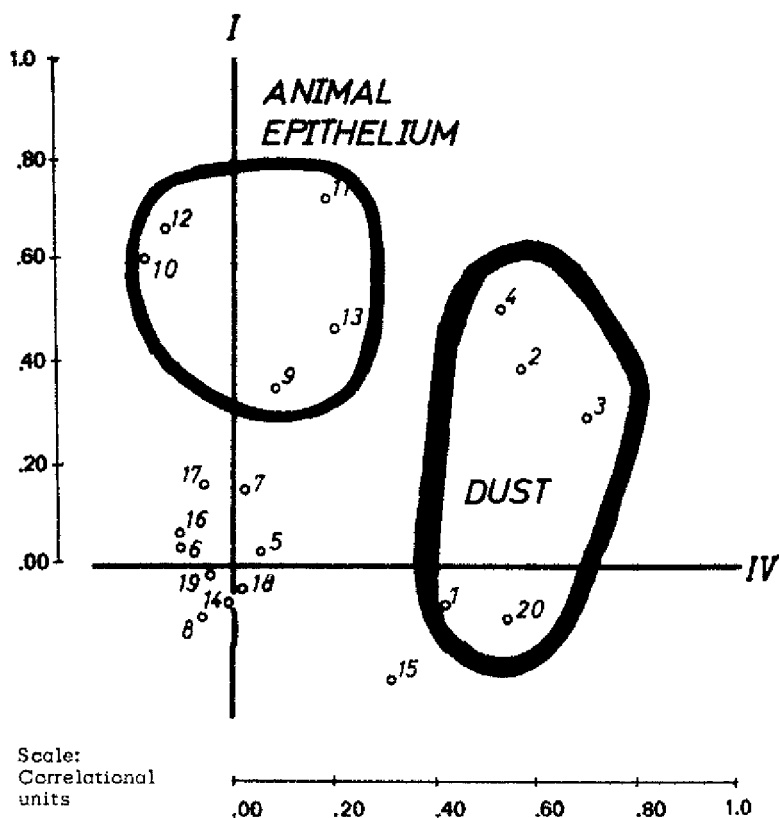


Fig. 1.
Factors of Animal Epithelium and Dust.

in each factor grouping tend to be high, as compared with their correlations with other tests. Thus, the factor groupings would indicate clusters of tests which are correlated with one another to a relatively high degree.

We may now consider an interpretation of the factors obtained in the study. In this connection it should be pointed out that the meanings of the factors are determined by the qualities which are common to the tests constituent to the factors. For the first factor, for example, the tests with the highest loadings are given in Table 4.

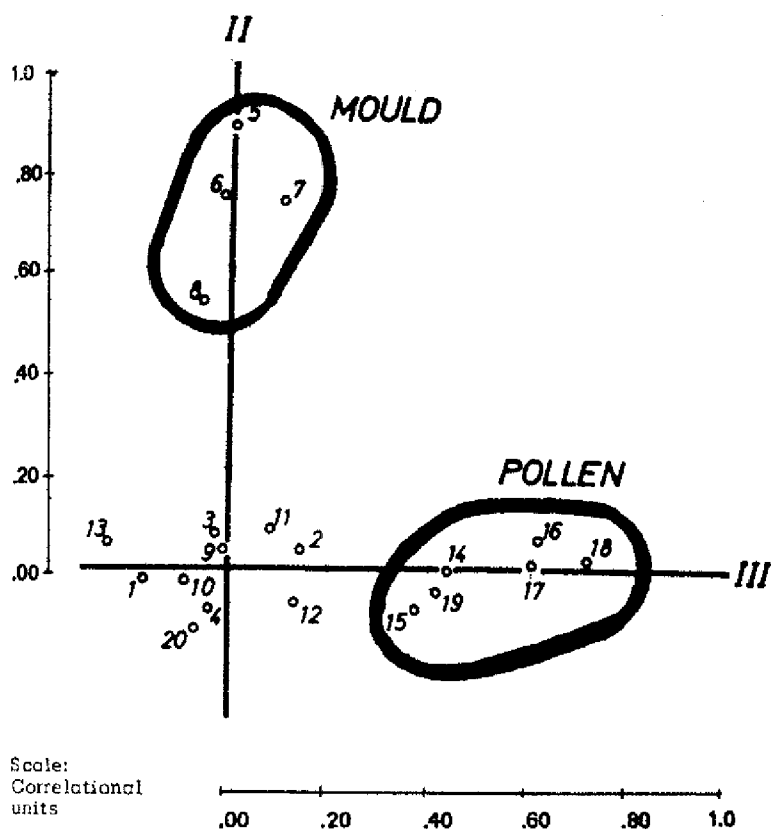


Fig. 2.
Factors of Mould and Pollen.

TABLE 4
Items of Factor I.

Stimulus Number	Description	Factor Loading
11	Horse epithelium	.73
12	Cat epithelium	.67
10	Dog epithelium	.61
4	Dust (C)	.51
13	Cow epithelium	.47
2	Dust (A)	.39
9	Wool	.35

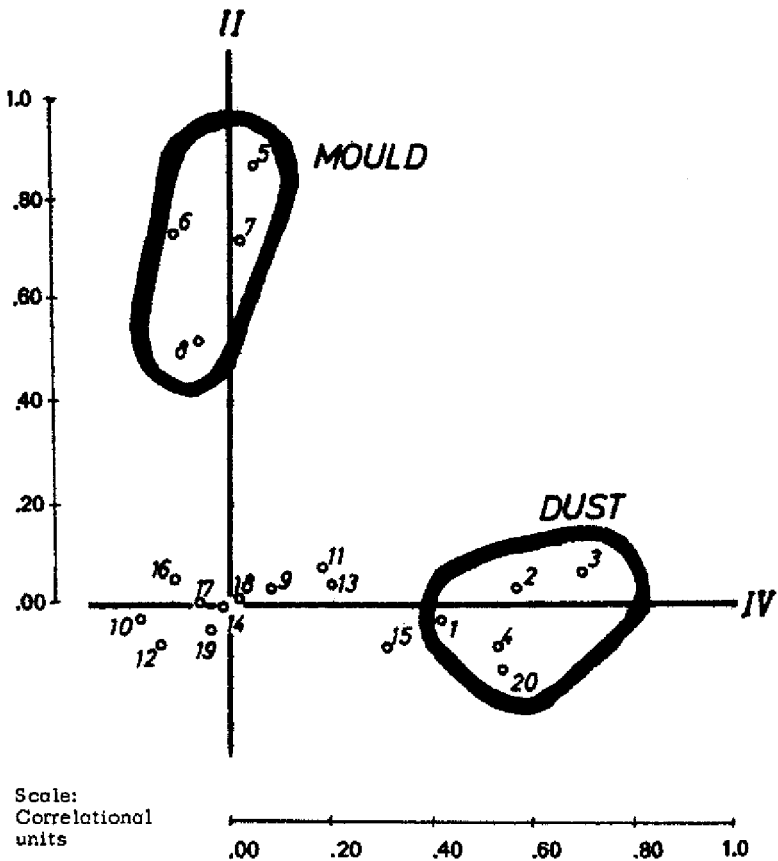


Fig. 3.
Factors of Mould and Dust.

The most dominant element in the first factor would appear to be a reaction to animal epithelium. It may be observed, however, that two test variables, numbers 4 and 2, received substantial loadings, .51 and .39 respectively, on this factor. But such findings are consistent with clinical observations of a relatively high degree of relationship between these skin-reactions, a relationship, frequently speculated, for which objective evidence, as offered by the findings of the present study, has been lacking. An examination of the con-

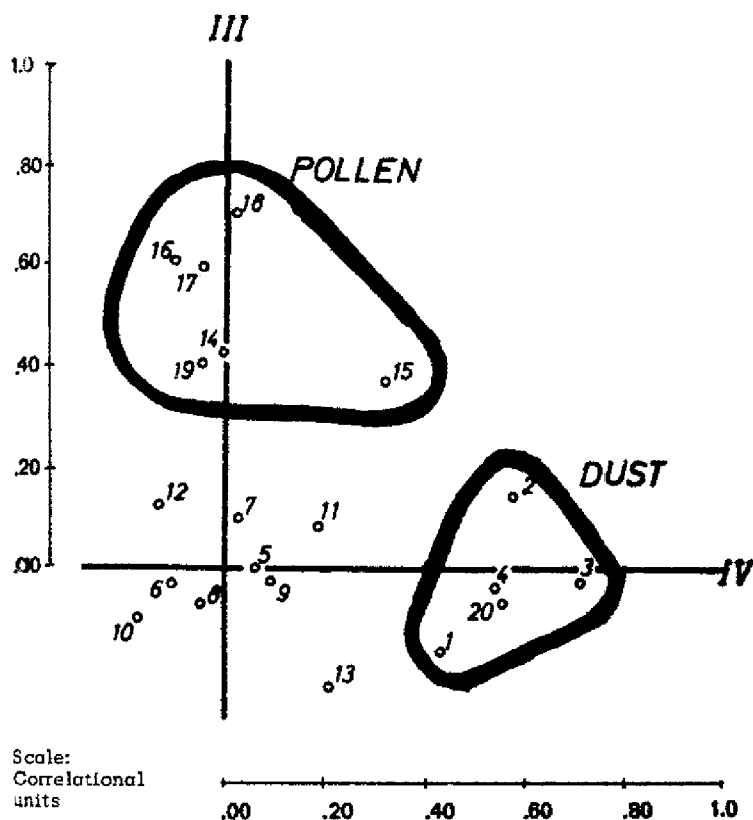


Fig. 4.
Factors of Pollen and Dust.

TABLE 5
Items of Factor II.

Stimulus Number	Description	Factor Loading
5	Bothrytis	.88
6	Hormodendrum	.74
7	Mucor	.73
8	Aspergillus	.53

figuration of Fig. 1, also, points out that while the loadings of the dust variables are high on the first factor, they are even more closely related to the other dust variables of the fourth factor, a factor which will be discussed subsequently.

The items of the second factor are presented in Table 5.

The skin-sensitivity responses of the second factor were all reactions to various types of mould. These variables are markedly in variance with those of the three other factors.

The items comprising the third factor are presented in Table 6.

TABLE 6
Items of Factor III.

Stimulus Number	Description	Factor Loading
18	Pollen, Reed	.71
16	Pollen, Timothy	.61
17	Pollen, Tree	.60
14	Pollen, Daisy	.43
19	Hazelnut	.41
15	Pollen, Rape	.37

The third factor apparently, is a reaction to pollen, and certainly may be regarded as clear-cut.

The items of the fourth factor are given in Table 7.

TABLE 7
Items of Factor IV.

Stimulus Number	Description	Factor Loading
3	Dust (B)	.70
2	Dust (A)	.57
20	Shell-fish	.54
4	Dust (C)	.53
1	House dust	.42

Certainly the fourth factor is a "dust sensitivity" factor. The high correlation (.54) for shell-fish should not be a cause of distress. It should be pointed out that the chance variations with a population sample of only 100 persons and with only 20 test variables, as in the present study, can well explain its position, a location that might well be expected to shift in subsequent analyses. It should be added, too, that the possibility that the shellfish variable shares at least some amount of common variance with the dust stimuli cannot be disregarded at the present time.

These writers would view the findings of the present investigation with satisfaction, and would suggest that further research beyond the limits of the pilot study be continued.

They would point out that the type of "family grouping" which can result from a study such as that reported in the present paper, if properly followed up and verified, can provide a convenient frame of reference for the entire area of allergy reactions, based on measures which are objective and quantitative.

SUMMARY

The present paper reports a pilot study on the feasibility of applying factor analysis techniques in allergy. The analysis of intracutaneous skin reactions, taken from clinical records, resulted in the four clear-cut factors of pollen, animal epithelium, dust, and mould. The continuation of research, along the lines of the present study, was recommended.

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