

FACTORS IN THE JUDGMENT OF FACIAL EXPRESSIONS

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A set of 9 pictures posed to represent different facial expressions were used as stimulus objects and were presented to a group of 25 male graduate students by using the complete method of triads. Data thus obtained were analysed under Torgerson's multidimensional scaling technique. Three factors were extracted from B* matrix and were identified as Pleasantness-Unpleasantness, Attention-Rejection, and Tension-Sleep. The Three Dimensions Theory hypothesized by Schlosberg was shown to be quite sound. A way for further study by using the method suggested in this study was also emphasized.

In a study of Woodworth's scale of facial expression, Schlosberg (1941) asked each of his 45 subjects to sort three sets of 72 Fois-Wittmann pictures (Froit-Wittmann, 1930; Hullin and Katz, 1935) into the following 6 ordered categories: (1) Love, Happiness, Mirth; (2) Surprise; (3) Fear, Suffering; (4) Anger, Determination; (5) Disgust; (6) Contempt. Finding out the fact that, in some cases, pictures posed to express Category (1) were confused with those posed to express Category (6), he thought Woodworth's scale was not a *unidimensional* scale but rather a circular one with Category (1) and Category (6) near together. This meant that there were two factors involved in the judgment of facial expressions. And therefore he said, "It is possible that some other technique, such as a form of factor analysis, may eventually be of value in determining the axes, and the factors basic to the scale." (p. 507). Later, Schlosberg (1952) forced his subjects to sort a set of same pictures along a 9-point rating scale ranging from most unpleasant (1) to most pleasant (9) and then to sort on a scale from Rejection (1) to Attention (9). Facial expressions were judged in terms of *two dimensions*, that is, Pleasantness-Unpleasantness and Attention-Rejection. As a result, each picture was plotted on a roughly circular surface as shown in Fig. 1. Although he had predicted the use of factor analysis, he did not use this technique in his study. Two years later (1954), in the article named "Three Dimensions of Emotion", he suggested a third factor, Tension-Sleep, for the judgment of facial expressions. Fig. 2 shows his ideas. However, he did not undertake any experiment to prove his theory. *Three dimensions theory* remains to be a hypothesis only.

From what we have reviewed above, we know that Schlosberg assumed before his experiment that he had already known what factors were involved in the judgment of facial expressions, and then urged his subjects to sort pictures in terms of these unproved factors. His method was mainly deductive. The purposes of the present study are (1) to find out factors involved in the judgment of facial expressions in order to test the Three dimensions theory, and (2) to locate the scale positions for a set of 9 pictures by using Torgerson's Multidimensional Scaling technique.

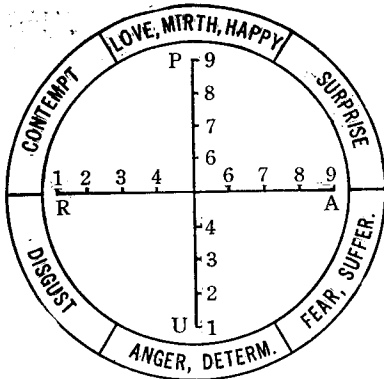


Fig. 1. Two Dimensions of Facial Expressions (Modified from Schlosberg 1952, p. 232)

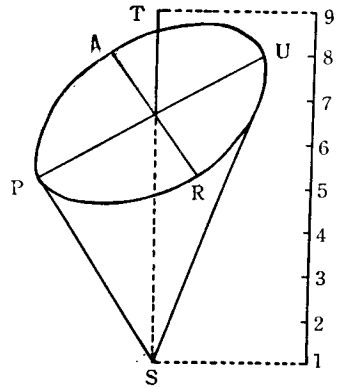


Fig. 2. Three Dimensions of Facial Expressions (Modified from Schlosberg (1954, p. 87)

The method used in this study is inductive rather than deductive. Factors involved are assumed to be unknown before experiment and are to be found out by the author.

METHOD

A set of 9 pictures posed by a same Caucasian woman were used as stimulus objects. (Fig. 3). These pictures were illustrated by N. L. Munn in his *Psychology* (1966, p. 194), by courtesy of H. Schlosberg. Each of these pictures was attached to a 8 cm.×10 cm. cardboard and was randomly numbered on the back. Twenty-five male graduate students from China, Japan, and Thailand served as subjects. (Caucasian, in the viewpoint of Oriental; Woman, in the viewpoint of men!) They were instructed to judge the pictures in terms of emotional expressions and by first impression. The pictures were presented to each subject by using the complete method of triads. One picture among each triads served as 'Target'. The subject must judge which one of the other two pictures was more similar to the target. His judgment, or choice, for every triads was recorded in the answer sheets by the experimenter. All 252 possible triads ($=3 \times C_2^9$) were presented to each subject in a random order as suggested by Ross (1934). At last, judgments by all 25 subjects were obtained. They were tabulated together to form 9 frequency matrices. The 9 frequency matrices were then turned into a scalar product matrix, B^* Matrix, by following Torgerson's *Multidimensional Scaling technique*. (Torgerson, 1958). This B^* matrix was used as basic data for factor analysis as well as Guttman-Lingoes' Small Space Analysis, SSA. (Lingoes, 1965). This was the first part of this study, and was followed by the second. After each subject had judged the whole 252 triads, he was asked to arrange the 9 pictures in terms of Pleasantness-Unpleasantness. At last, by the use of *Simplified Rank Order*, a linear scale was obtained, and its scalability tested.



Fig. 3. Pictures Used in This Study (from Munn 1966, p. 194, by courtesy of H. Schlosberg)

RESULTS

Fig. 4 shows the linear scale obtained. The order obtained was respectively Pictures 1, 6, 7, 3, 8, 5, 4, 2, and 9. Apparently the order was not 1, 6, 3, 7, 8, 5, 2, 9, and 4, as given by Munn (1966) in his textbook (p. 603). This meant that some

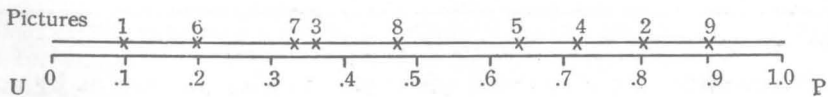


Fig. 4. A scale for nine pictures from most unpleasant to most pleasant by using the simplified rank order method,

pictures, especially Picture 4, were rather confusing to our subjects in one dimensional judgment. It was clear that our subjects had not judged in one dimension only. Factor analysis was therefore necessary. Then, from B* Matrix, Table 1, three factors were extracted by the help of computer program, BMDX72, using principal component solution and oblique rotation. The factor loadings of these three factors are shown in Table 2. The sum of squares of the elements of the B* Matrix, $\sum_j \sum_k b_{jk}^{*2}$, was 81.4, while the sum of squares of elements in \tilde{B}^* Matrix derived from the three factors, $\sum_j \sum_k \tilde{b}_{jk}^2$, was 78.5. These two sums were very nearly equal, therefore the process of factoring was stopped. (See Torgerson, 1958, p. 297). The loadings of each factor are plotted in Fig. 5(a) to 5(c). The intercorrelations show the degree of obliqueness between relevant factors.

Table 1. B* Matrix

	1	2	3	4	5	6	7	8	9
1	2.184	-1.110	-0.208	0.813	-0.576	1.279	0.318	-0.215	-2.469
2	-1.110	1.648	-0.738	0.673	0.519	-0.968	-0.938	-0.519	1.432
3	-0.208	-0.738	1.203	-1.711	0.628	0.135	0.488	0.456	-0.253
4	0.813	0.673	-1.711	2.939	-0.643	-0.192	-1.769	-0.893	0.783
5	-0.576	0.519	0.628	-0.643	0.312	-0.577	-0.158	-0.026	0.521
6	1.279	-0.968	0.135	-0.192	-0.577	1.257	0.629	-0.010	-1.552
7	0.318	-0.938	0.488	-1.769	-0.158	0.627	1.142	0.690	-0.400
8	-0.215	-0.519	0.456	-0.893	-0.026	-0.010	0.690	0.519	-0.003
9	-2.469	1.432	-0.253	0.783	0.521	-1.552	-0.400	-0.003	1.940

Table 2. Factor Matrix

Pictures	Factors		
	I (P-U)	II (A-R)	III (T-S)
1	1.53	-0.41	-0.19
2	-0.81	-0.67	0.08
3	0.22	0.28	0.96
4	-0.09	-1.01	-1.19
5	-0.24	-0.22	0.66
6	0.94	0.20	-0.14
7	0.15	1.04	0.08
8	-0.15	0.70	0.02
9	-1.56	0.11	-0.27

By BMDX72 computer program, using principal component solution & oblique rotation.

By a careful inspection of Table 2 and Fig. 5(a)~(c) as well as by arranging the pictures practically, the natures of factors were identified. It turned out to be that our results were nearly what Schlosberg (1954) had expected.

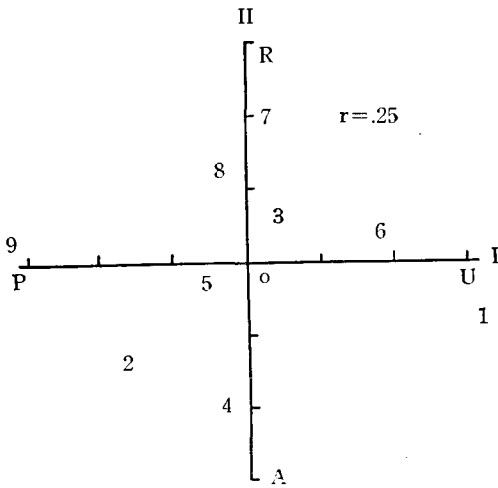


Fig.5(a). Factor loadings on Factor I and Factor II ($r=.25$)

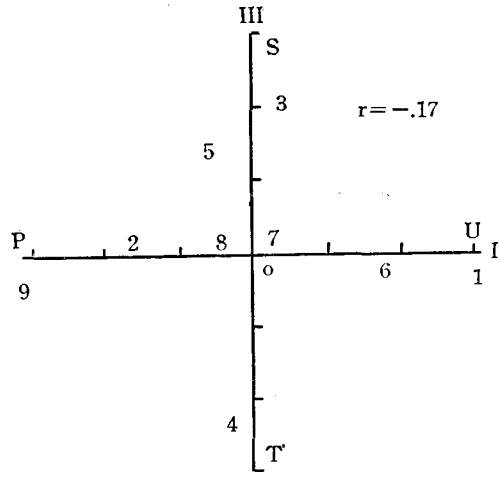


Fig. 5(b). Factor loadings on Factor I & Factor III ($r=-.17$)

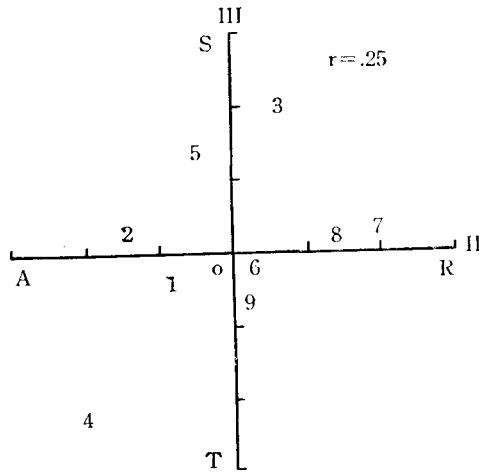
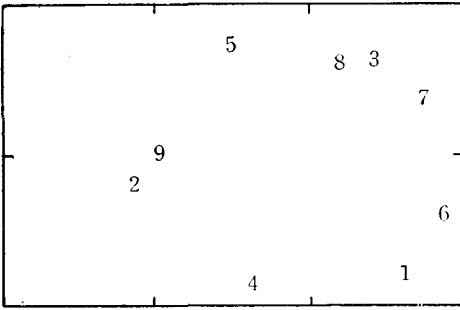
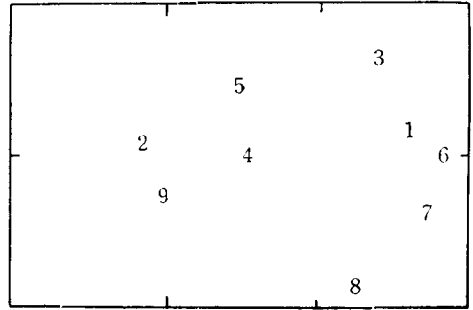
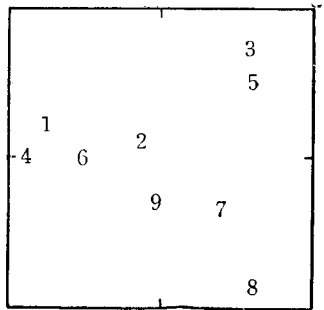


Fig. 5(c). Factor loadings on Factor II & Factor III ($r=.25$)

The results obtained by using Guttman's SSA are also presented here. It is appropriate to represent the configuration of our 9 points by 3 dimensions, owing to the fact that the two conditions, *monotonicity* and *fewest possible dimensionality*, might be met. (See Guttman, 1968, p. 471). The coefficient of alienation for 3 dimensions is .06, showing a very satisfactory goodness of fit. Fig. 6(a)~(c) show the space diagrams. The distances among points represents the similarities among pictures. One can easily see that results are basically similar to those obtained by using factor analysis. The differences may be due to the theoretical differences between metric and nonmetric approaches.

It seems to me that three factors were involved in the judgment of facial expressions. Therefore, the following discussions were based on this viewpoint.

Fig. 6(a). $X=1, Y=2$ Fig. 6(b). $X=1, Y=3$ Fig. 6(c). $X=2, Y=3$

DISCUSSION

Now, let us take a look at Fig. 5(a). The abscissa represents Factor I and ordinate, Factor II. Pictures 1 and 6, which express anger and unpleasantness, have highly negative loadings on Factor I. At the opposite extreme of the same axis, Pictures 2 and 9, which represent happiness and mirth, have highly positive loadings. The pictures on this axis show the degree to which a facial expression presents feelings of pleasantness or unpleasantness, therefore, Factor I can be easily identified as *Pleasantness-Unpleasantness*. (abbreviated as P-U Factor). This is a major factor, owing to the facts that its eigenvalue contributed 48% to the total variance, and that most of our subjects could tell this factor after experiment. On Factor II, Picture 4 has a highly negative loading, while Pictures 7 and 8 have a fairly high positive loadings. Picture 4, representing surprise, is characterized by wide opened eyes and open mouth. On the contrary, Pictures 7 and 8, representing disgust, suggest "an aloofness, an effort to shut out stimulation." (Schlosberg, 1941, p. 506). The Pictures on this axis show the degree to which a facial expression presents attention or rejection to the external stimuli. Therefore, Factor II may be identified as *Attention-Rejection*, or A-R Factor, as named by Schlosberg. From Fig. 5(a), we may see that the points representing nine pictures form a roughly oval surface, with P-U axis longer than A-R axis. This fact was also found in Schlosberg's study (1952, p. 234). The intercorrelation between these two factors is .25,

showing that the two axes are not orthogonal (Guilford, 1954, p. 512). The obliquity is about 15° , or $\angle ROU=75^\circ$, with the R end near to the U end and the A end near to the P end. This means that Pictures 7 and 8 are similar to Pictures 6 and 1 in some degree, whereas Picture 4 is similar to Pictures 2 and 9 in some degree. In his paper, Schlosberg (1952) said, "There is also the question as to whether or not the two axes are perpendicular; the difficulty some Ss experienced in distinguishing between rejection and unpleasantness suggests that the included angle is somewhat less than 90° ." (p. 236). His question is quite reasonable and is now answered. Fig. 5(a) may be considered as a circular scale with scale position for each picture already being located. It is interesting to compare Fig. 5(a) with Fig. 1 at this moment. With the obliquity of the axes in mind, we may find out that the relative positions of these nine pictures are so similar to those of the pictures represented in Fig. 1 that the 9 pictures can be fitted very well into the appropriate categories.

A fairly well-shaped circle, with points independent of the origin of the coordinate system, formally called a *circumplex*, can be found from SSA data as shown in Fig. 6(a). The points around the circle are not well-stepped, showing that some pictures, say, Pictures 2 and 3, could be eliminated and some pictures be added to construct a good circular scale. This suggests that we may use SSA to check whether or not the steps of a circular scale are appropriate. Now, it is interesting to note that if we start from Picture 1, and respectively order the pictures along the circumference of this circle in a counterclockwise direction, we would get an order of 1, 6, 7, 3, 8, 5, 9, 2, and 4. This order is very similar to the answer given by Munn in his textbook. Fig. 6(a) is also interesting if we compare it with Fig. 1. All of these 9 pictures can be put into Woodworth's 6 categories without changing their relative positions. We may probably say that since the results of these two studies are exactly the same in this point, there is a high degree of objectivity in the judgment of facial expressions both by the Oriental and by the Caucasian.

Next, let us look at Fig. 5(b). The abscissa still represents the P-U factor, but the ordinate represents a new factor now. The pictures which have high loadings on this new factor are Pictures 3, 5, and 4. Pictures 3 and 5 at the one hand suggest the relaxation of sleep and Picture 4 at the other hand presents feelings of high excitement. The former looks not easily to be activated, whereas the latter looks very easily to be activated. They show different degree of tenseness, *levels of activation*. Apparently, it is the third factor hypothesized by Schlosberg (1954), and was therefore identified as *Tension-Sleep*. In the earlier paragraph, we noted that Picture 4 had high loading on Factor II and was used to represent surprise. Here we see that it has high loading on Factor III and is used to represent tension. This needs further descriptions. The intercorrelation between Factor I and Factor III is $-.17$. It means that the two factors are not independent and that a 10° of obliquity with the U end sloping towards the T end, or the P end sloping towards the S end is shown ($\angle SOU=100^\circ$). This has something important to do with Schlosberg's

Three dimensions hypothesis. We may see from Fig. 2 that the top surface was a little sloped, showing that "anger and fear can reach higher levels of activation than can contempt". (Schlosberg, 1954, p. 87). His hypothesis is shown to be true. Still further informations may be obtained by an inspection of Fig. 5(c).

In Fig. 5(c), Factor II is plotted against Factor III, that is, A-R against T-S. Their intercorrelation is .25. The A end slants 15° to the T end and the R end slants 15° to the S end. ($\angle SOR=75^\circ$). This may also mean that Attention can reach higher levels of activation than can Rejection. This is quite true in daily life. Combining these two facts together—the U end slopes towards the T end, and the A end also slopes towards the T end, we may imagine that the surface constructed by the P-U axis and the A-R axis looks like a sloped "wheel" turning around the T-S "axis", with both the U end and the A end always sloping towards the T end. This means that in a state of unpleasantness or attention, people are more easily to be activated. The nature of Picture 4 can be seen more clearly from Fig. 5(c). It was plotted between the A end and the T end, far away from Pictures 3 and 5, or, Pictures 7 and 8. This characteristic was also well described in Fig. 6(c). When surprised, people are both tense and attentive.

SUMMARY AND CONCLUSION

1. Schlosberg's Three dimensions theory was shown to be very sound in the present study. A three dimensional structure for the judgment of facial expressions may be represented in a space as shown in Fig. 7.

2. A scale constructed by choosing pictures from appropriate positions in this space will be possible to obtain. And the method suggested in this study may serve for this purpose.

3. It is suggested that more subjects of both sexes and more pictures be used in further study, and that the limitation of this method be noted if more pictures are used.

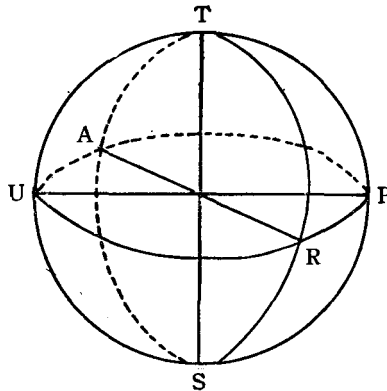


Fig. 7. A Three Dimensional Space for Facial Expressions

REFERENCES

- (1) COOMBS, C. H., A method for the study of interstimulus similarity, *Psychometrika*, 1954, **19**, 183-194.
- (2) DIXON, W. J. (editor), Biomedical Computer Program (p. 169. BMD03M, General Factor Analysis), University of California press, 1967.
- (3) EDWARDS, A. L., Techniques of Attitude Scale Construction, N. Y.: Appleton-Century-Crofts, 1957, pp. 246-247.
- (4) FROIS-WITTMANN, J., The judgment of facial expression, *J. exper. Psychol.*, 1930, **13**, 113-151.
- (5) FRUCHTER, B., Introduction to Factor Analysis, Princeton: D. Van Nostrand, 1954.
- (6) GUILFORD, J. P., Psychometric Methods, N. Y.: McGraw-Hill, 1954.
- (7) GUTTMAN, L., A general nonmetric technique for finding the smallest coordinate space for a configuration of points, *Psychometrika* 1968, **33**, 469-506.
- (8) LINGOES, J. C., An IBM 7090 program for Guttman-Lingoes smallest space analysis— I, *Behavior Science*, 1965, **10**, 183-184.
- (9) MUNN, N. L., Psychology (5th ed), N. Y.: Houghton Mifflin, 1966.
- (10) ROSS, R. T., Optimal orders in the method of paired comparisons, *J. exper. Psychol.*, 1939, **25**, 414-424.
- (11) SCHLOSBERG, H., A scale for the judgment of facial expression, *J. exper. Psychol.*, 1941, **29**, 497-510.
- (12) SCHLOSBERG, H., The description of facial expression in terms of two dimension, *J. exper. Psychol.*, 1952, **44**, 229-237.
- (13) SCHLOSBERG, H., Three dimensions of emotion, *Psychol. Rev.*, 1954, **61**, 81-88.
- (14) STAKE, R. E., *et al.*, Sampling Distributions of Error in Multidimensional Scaling, University of Nebraska, 1962.
- (15) TORGERSON, W. S., Multidimensional scaling: I. Theory and method, *Psychometrika*, 1952, **17**, 401-419.
- (16) TORGERSON, W. S., Theory and Methods of Scaling, N. Y.: Wiley, 1958.
- (17) WOODWORTH, R. S., Experimental Psychology, N. Y.: Henry Holt, 1938.
- (18) WOODWORTH, R. S. & H. SCHLOSBERG, Experimental Psychology, (rev. ed.), N. Y.: Henry Holt, 1954.
- (19) YOUNG, P. T., Motivation and Emotion, N. Y.: John Wiley & Sons, 1961.

面部表情之判斷的因素

(摘 要)

林 清 山

利用三張一組法 (the complete method of triads) 將一套九張畫有代表各種不同面部表情的相片呈現給 25 名受試。受試須自兩張相片之中選擇最接近第三張相片的一張相片。再利用 Torgerson 的多度空間量表法 (multi-dimensional scaling technique) 將如此所得的資料加以因素分析。結果自 B* 矩陣 (B* matrix) 中抽得愉快-不愉快, 注意-拒絕, 和緊張-睡覺等三個因素。這結果顯示可以支持 Schlosberg 有關情緒的三度空間學說 (three dimensions theory)。