

## ON THE UNITARY NATURE OF EXTRAVERSION

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Studies of extraversion-introversion as a dimension of personality have raised two difficult problems (EYSENCK, 1960): is extraversion a *unitary* dimension of personality, and are extraversion and neuroticism *independent* dimensions of personality? CARRIGAN (1960) reviewed the evidence and concluded (a) that 'unidimensionality of extraversion-introversion has not been conclusively demonstrated', and (b) that 'a clear-cut answer cannot be given' with respect to the independence of these two dimensions of personality. In an earlier paper EYSENCK and EYSENCK (1963) have shown that one objection to the unitary nature of extraversion is not in fact tenable; sociability and impulsivity are not independent varieties of extraversion, but are significantly correlated with each other to form one supraordinate concept of extraversion. This finding has since been duplicated by SPARROW and ROSS (1964). The independence of E and N has been investigated in several large-scale factorial analyses, in which over 100 items previously found relevant to these two factors were intercorrelated and factor-analyzed, for 600 men and 600 women separately; the method of rotation used was developed in our laboratory to permit analytic oblique rotation and extraction of higher-order factors (HENDRICKSON and WHITE, 1964). Two higher orders factors, corresponding to E and N were found, and the angle between them did not deviate significantly from 90°, although the method of rotation did not prescribe independence of factors, but was determined entirely by the actual relationships obtaining within the data (EYSENCK and EYSENCK, 1967). There is thus some evidence of both the unitary nature of extraversion, as well as of the independence of E and N. In this paper both problems will be taken up from a rather different point of view, which may throw some new light on this controversy.

Consider the conception of a factor as in some sense an underlying cause of the observed correlations (EYSENCK, 1953). The correlation

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of any given test with that factor would then be an index of the degree to which that test measured that factor, i.e. its validity. If a criterion test could be found which correlated sufficiently highly with a given factor, i.e. which had sufficiently high validity as a measure of that factor, then it would be possible to use this test in a search for an answer to the two questions posed above. If the factor was unitary in nature, then the tests (or test items) constituting it should have correlations with the criterion which were *proportional* to their factor loadings, and if the factor was independent of another factor, then the criterion should not correlate significantly with any test (item) constituting this other factor.

The choice of the criterion test would of course be crucial in this argument. In the first place, the criterion should be chosen from a domain different to that from which the tests making up the factor were chosen. If the factor were determined by the intercorrelations between inventory items, then the criterion should not be an inventory item or a compound of inventory items. It could be a psychiatric diagnosis, as for instance in the studies using criterion analysis (EYSENCK, 1950, 1952), or it could be some objective behavioural test, or even some physiological reaction measure. Even more important is a second desideratum. The criterion should be chosen in such a way that it embodied a theory which predicted that it would be a good measure of one factor, but not of the other. Only by relating the criterion in some such way to explicit psychological (or physiological) theories about the nature of the factor in question can we hope to escape from the tautological arguments implicit in factor analysis.

The theory here chosen asserts that introversion is a product of cortical arousal, mediated by the reticular formation; introverts are habitually in a state of greater arousal than extraverts, and consequently they show lower sensory thresholds, and greater reactions to sensory stimulation. The theory in question has been discussed in great detail elsewhere (EYSENCK, 1967), as has the evidence regarding these and other deductions from it; on the whole the evidence, both physiological and psychological, appears to be in line with predictions made from the theory. The test used in the present investigation is the lemon test, so called because it measures the salivary reaction of subjects to the stimulus of having four drops of lemon juice placed upon the tongue for twenty seconds. The test was originally suggested by CORCORAN (1964), who has furnished data regarding its reliability and validity as a

measure of extraversion. The score on the test is the amount of salivation produced under lemon juice stimulating conditions, as compared with the amount of salivation produced under neutral conditions, i.e. when no lemon juice is present. Extreme extraverts show little or no increment in salivation, while extreme introverts show an increment of almost 1 gram; intermediate groups show intermediate amounts of increment. Eysenck and Eysenck (unpublished) have found a correlation of .71 on 50 male and 50 female Ss between increment scores and introversion, as measures by the EPI (EYSENCK and EYSENCK, 1965); the correlation with N was effectively zero. No sex differences were observed.

The present analysis is concerned with results on the lemon test obtained from 45 men and 48 women, i.e. a total sample of 93 Ss; all these subjects formed part of the population of the above-mentioned study; 7 subjects were dropped because of failure to complete one question in the inventory. This inventory (the EPI Form A) contains 57 questions, of which 24 measure E, 24 measure N and the remainder constitute a Lie scale. The scores of the 93 Ss on the lemon test and the 57 questions of the EPI were intercorrelated, and the resulting  $58 \times 58$  matrix of product-moment correlations factor-analyzed by means of the principal components method, and rotated by means of the Promax Programme (HENDRICKSON and WHITE, 1964). The first factor to emerge was clearly identified as extraversion, the second as neuroticism. Table 1 gives the items used, the scoring key (E, N, and L; when a minus sign follows the letter then the 'no' answer is scored positively), and the factor loadings for the first two factors. Item 58 is the increment score on the lemon test. It will be seen that the lemon test score has a loading of  $-0.74$  on extraversion, and a completely insignificant one of  $0.01$  on neuroticism. The analysis was repeated for men and women separately; the factor loadings were  $-0.70$  and  $-0.60$  respectively on the E factor, and  $0.02$  and  $-0.06$  on the N factor. Factor-analytically, then, the lemon test seems to be a pure (univocal) measure of introversion.

If, as pointed out above, the lemon test may be regarded as a relatively pure criterion test of E, then (1) its correlations with the individual items of the E scale should be proportional to the factor loadings of that scale, and (2) its correlations with the individual items of the N scale should be effectively zero. Such a test might have been carried out on the factor loadings obtained in this study, and given

TABLE 1

1. Do you often long for excitement?	E	-0.48	0.33
2. Do you often need understanding friends to cheer you up?	N	-0.25	0.39
3. Are you usually carefree?	E	-0.36	-0.22
4. Do you find it very hard to take no for an answer?	N	-0.11	0.03
5. Do you stop and think things over before doing anything?	E-	0.40	-0.07
6. If you say you will do something do you always keep your promise, no matter how inconvenient it might be to do so?	L	0.07	-0.09
7. Does your mood often go up and down?	N	0.01	0.56
8. Do you generally do and say things quickly without stopping to think?	E	-0.57	0.12
9. Do you ever feel 'just miserable' for no good reason?	N	-0.02	0.49
10. Would you do almost anything for a dare?	E	-0.32	-0.05
11. Do you suddenly feel shy when you want to talk to an attractive stranger?	N	0.29	0.46
12. Once in a while do you lose your temper and get angry?	L-	0.22	0.19
13. Do you often do things on the spur of the moment?	E	-0.53	0.13
14. Do you often worry about things you should not have done or said?	N	0.17	0.61
15. Generally, do you prefer reading to meeting people?	E-	0.71	-0.02
16. Are your feelings rather easily hurt?	N	0.26	0.46
17. Do you like going out a lot?	E	-0.63	0.07
18. Do you occasionally have thoughts and ideas that you would not like other people to know about?	L-	0.09	0.28
19. Are you sometimes bubbling over with energy and sometimes very sluggish?	N	-0.17	0.57
20. Do you prefer to have few but special friends?	E-	0.40	0.06
21. Do you daydream a lot?	N	-0.05	0.66
22. When people shout at you, do you shout back?	E	-0.29	0.05
23. Are you often troubled about feelings of guilt?	N	-0.02	0.57
24. Are ALL your habits good and desirable ones?	L	-0.16	-0.00
25. Can you usually let yourself go and enjoy yourself a lot at a gay party?	E	-0.74	-0.00
26. Would you call yourself tense or 'highly-strung'?	N	0.08	0.07
27. Do other people think of you as being very lively?	E	-0.53	-0.27
28. After you have done something important, do you often come away feeling you could have done better?	N	0.20	0.50
29. Are you mostly quiet when you are with other people?	E-	0.62	0.21
30. Do you sometimes gossip?	L-	-0.07	0.07

31. Do ideas run through your head so that you cannot sleep?	N	-0.25	0.35
32. If there is something you want to know about, would you rather look it up in a book than talk to someone about it?	E-	0.54	-0.13
33. Do you get palpitations or thumping in your heart?	N	-0.20	0.35
34. Do you like the kind of work that you need to pay close attention to?	E-	0.22	0.01
35. Do you get attacks of shaking or trembling?	N	-0.25	0.50
36. Would you always declare everything at the customs, even if you knew that you could never be found out?	L	0.12	0.13
37. Do you hate being with a crowd who play jokes on one another?	E-	0.49	-0.22
38. Are you an irritable person?	N	0.07	0.26
39. Do you like doing things in which you have to act quickly?	E	-0.39	-0.27
40. Do you worry about awful things that might happen?	N	-0.16	0.31
41. Are you slow and unhurried in the way you move?	E-	0.25	0.11
42. Have you ever been late for an appointment or work?	L-	-0.02	0.06
43. Do you have many nightmares?	N	-0.18	0.38
44. Do you like talking to people so much that you never miss a chance of talking to a stranger?	E	-0.25	0.02
45. Are you troubled by aches and pains?	N	-0.23	0.08
46. Would you be very unhappy if you could not see lots of people most of the time?	E	-0.40	-0.11
47. Would you call yourself a nervous person?	N	0.06	0.24
48. Of all the people you know, are there some whom you definitely do not like?	L-	0.07	0.04
49. Would you say that you were fairly self-confident?	E	-0.27	-0.51
50. Are you easily hurt when people find fault with you or your work?	N	0.35	0.36
51. Do you find it hard to really enjoy yourself at a lively party?	E-	0.65	-0.05
52. Are you troubled with feelings of inferiority?	N	0.01	0.73
53. Can you easily get some life into a rather dull party?	E	-0.48	-0.36
54. Do you sometimes talk about things you know nothing about?	L-	-0.08	0.20
55. Do you worry about your health?	N	0.04	-0.18
56. Do you like playing pranks on others?	E	-0.32	0.06
57. Do you suffer from sleeplessness?	N	-0.21	0.17
58. Lemon Test		-0.74	0.02

in table 1; however, it might have been objected that such a comparison capitalizes on whatever non-relevant factors were present on the occasion of this experiment and might have influenced both the EPI responses of the Ss and their lemon test scores. Consequently we have chosen to use factor loadings obtained in a different and much larger study, using 500 Ss, half men, half women, who had been given the same items printed in table 1, together with another 50 items (EYSENCK and EYSENCK, 1957). This whole matrix of  $107 \times 107$  items had been factor analyzed in the same manner as the matrix discussed above, i.e. by means of the principal components method, followed by Promax rotation. In this manner the scales are weighted against our hypothesis; not only are the factor loadings derived from a different population to that from which the item correlations with the lemon test are obtained, but in addition the factor analysis was carried out on a sample of items different from, and larger than, that used in our present experiment and factor analysis.

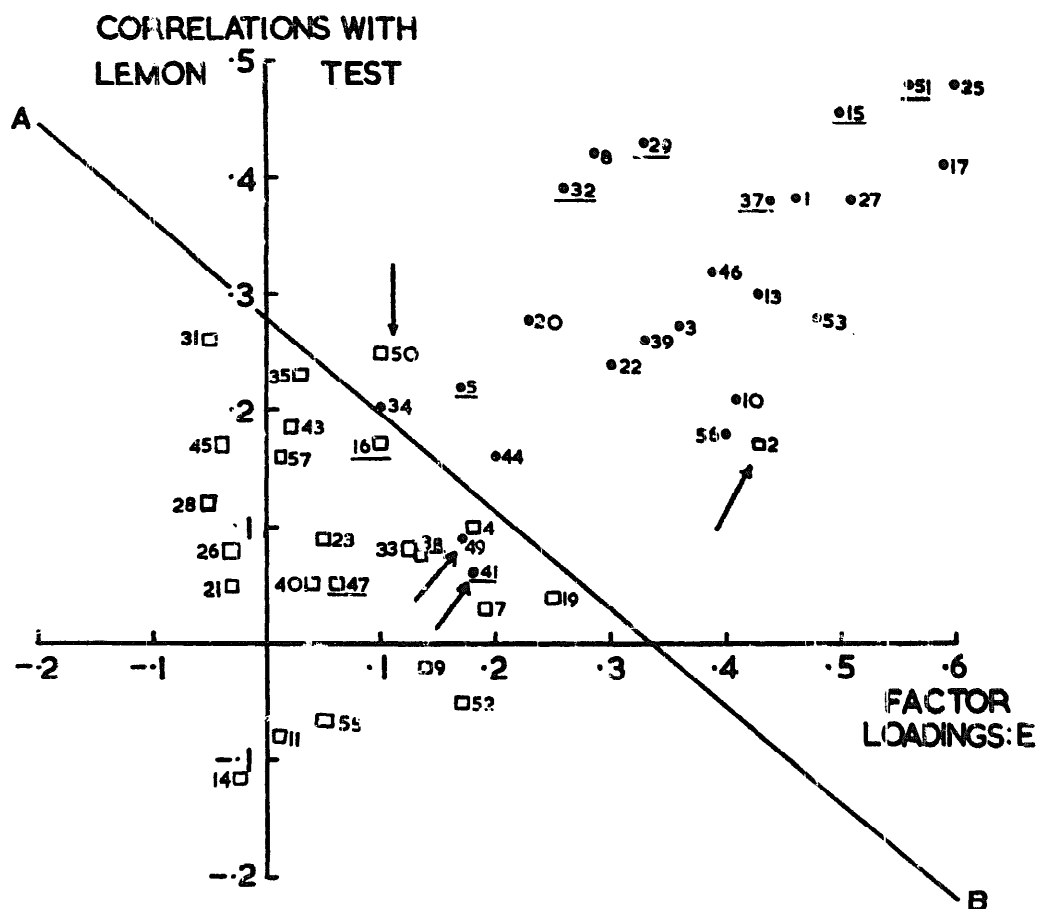


Fig. 1. Factor loadings on extraversion (abscissa) and correlations with lemon test (ordinate) of neuroticism items (squares) and extraversion items (circles).

Results are shown in fig. 1, where factor loadings have been plotted along the abscissa, the item correlations with the lemon test along the ordinate. Items constituting the E scale have been printed as dots, items constituting the N scale, as squares. L scale items, being irrelevant to this comparison, have been omitted in order not to confuse the picture. Items with negative loadings larger than 0.10 have been reversed in sign (multiplied by  $-1$ ); these items have been indicated in the Figure by underlining. It will be seen that practically all the E items have both high factor loadings on the extraversion factor and reasonable correlations with the lemon test, whereas N items have low loadings and low correlations. The line A-B has been drawn at the (arbitrary) level approximating a correlation value of .3, to divide the diagram into two parts; to the right (i.e. in quadrant I) are the high loading - high correlation values; to the left are the low loading - low correlation values.<sup>1</sup> The former should be E items, the latter N items; it will be clear that in fact this is so. There are only two N items to the right of the line, and two E items to the left; arrows have been inserted to point to these four values. It will be seen that for all items (both E and N) having loadings of 0.20 or above, correlation with the lemon test are 0.15 or higher; at loadings below 0.15, only three are above 0.20. There is thus a remarkable correspondence between the two sets of values.

It is obvious to the eye that the correlation values are roughly proportional to the factor loadings for the E items; a correlation was made both with and without regard for signs. Both correlations are positive, with the former of course much larger; the actual values are 0.97 and 0.71. Both are sufficiently larger to allow us to say that the predicted proportionality is in actual fact found, thus supporting the view that the items of the EPI extraversion scale measure a factor which is, as far as this experiment is concerned, unitary. This outcome is particularly reassuring in view of the fact that the criterion test used was chosen on the basis of quite specific theories regarding the psychological and physiological nature of extraversion and introversion;

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<sup>1</sup> The line is actually slanted towards the right because the average size of the factor loadings is greater than the average size of the correlations in the ratio of 6/5; in order to compensate for this, the intercepts of the line on abscissa and ordinate have been changed from .3 to be in roughly the same proportion.

only by thus extending the circular arguments of broader coverage can we bring together the psychometric and experimental approaches.

#### SUMMARY

Scores of salivary reactivity to lemon juice were intercorrelated with 57 personality questionnaire items for 45 men and 48 women, and the matrix of correlations factor analyzed. Two factors corresponding to extraversion and neuroticism were extracted; the lemon test score had a loading of  $-0.74$  on the former, and of  $0.02$  on the latter, confirming theoretical predictions. It was also shown that questionnaire items having high loadings on E were also highly correlated with the lemon test score, while items having low loadings had low correlations. The implications of these findings were discussed for the unidimensional nature of extraversion, and for the independence of extraversion and neuroticism.

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