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An attempt to derive dimensional types using Q-factor analysis.

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AN ATTEMPT TO DERIVE DIMENSIONAL TYPES USING Q-FACTOR ANALYSIS

by

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ABSTRACT

A sample of 300 cases, for which both Differential Personality Inventory (DVI) and MMPI profiles were available, was randomly divided into two subsamples. The DPI profiles of each subsample were factor analyzed (Q-technique) and factors were designated as dimensional types on the basis of explicit criteria. Similarly, the core cases of each type were selected on the basis of criteria related to the magnitude of factor loadings. The mean DPI and MMPI profiles for core cases were computed. Analysis of the matrix of profile similarity coefficients between these mean DPI profiles revealed that only two of a possible seven types could be considered replicated across samples. The corresponding analysis of MMPI profiles provided little evidence for replicability. Strong evidence was found for type homogeneity but an analysis of the within-sample r_p coefficients between types indicated that a number of dimensions were significantly related. The results are discussed in terms of the error incurred in estimating dimensional types (i.e. ideal profiles) and a number of alternative procedures are considered.

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INTRODUCTION

Classification has been defined as "the ordering of organisms into groups (or sets) on the basis of their relationships (Sneath and Sokal, 1973, p. 3)". Although viewed here as a process, it should be noted that the term classification has also been used to refer to the end result of this same process, that is, the result of classification (i.e. process) is a classification (i.e. system). Any classification system is of course closely related to the general development of the science within which it is employed. More specifically, the predictions and scientific generalizations made feasible by appropriate classification both limit, and are limited by, the developments of scientific knowledge and techniques.

There are in fact many methods of classification and each varies in appropriateness as a function of the science within which it is applied. In recent years there have been numerous developments in the methodology of classification; for example, in the field of biology, Sneath (1964) has recently proposed a classification system based on the similarities of the recorded phenotypic characteristics of those organisms to be grouped. This scheme was proposed as an improvement over the traditional biological classification system based on nebulous evolutionary factors. Our present concern, however, is with the classification of psychological disorders.

Classification in Psychopathology

When viewed in the light of prevailing diagnostic procedures the existing classification system for psychological disorders - that of the American Psychological Association - must be regarded as largely inadequate. The system itself was not developed on the basis of any knowledge of etiology (Eysenck, 1970) or rigorous empirical documentation but rather emerged from prevailing schools of clinical thought (Lorr, 1970). As a result it is poorly co-ordinated as well as unreliable with characteristically low classification rates (Lorr, 1970) and shows little, if any, correspondence between diagnosis and treatment (Eysenck, 1970). The system's lack of validity (reflected by its' low reliability) has not been a major issue until recently due to a lack of concern with empirical testing of hypotheses related to diagnoses. In addition there has been a failure to state such hypotheses in an empirically testable manner (Eysenck, 1970).

Even on the basis of this brief critique it is apparent that the lack of a more strictly empirical approach in the field of psychopathology has led to what Eysenck (1970) succinctly refers to as ". . . a rather dismal picture in which unreliable, invalid, largely arbitrary tests are used to arrive at unreliable, invalid, largely arbitrary diagnoses which are irrelevant to the methods of treatment to be used, methods which in turn are quite ineffective (p. 170)". Such criticisms are of course not directed to the basic philosophy of classification but rather towards the shortcomings of the existing diagnostic system. As was mentioned with regards to the science of biology, alternative and hopefully more appropriate approaches to classification are rapidly undergoing development. Likewise in the realm of psychopathology there has been an increasing number of proposed diagnostic schemes (Mahrer, 1970). Morf and Krane (1973) have discussed the essential characteristics of such systems and it will prove useful to consider their analysis at this point. This will enable us to examine the alternative possibilities and to clarify the approach to classification which will be adopted for purposes of the present study.

Morf and Krane (1973) point out that any diagnostic system involves two main components; namely, classification and identification. The former is said to involve a set of personality dimensions or a set of categories or types while the latter is the method of assigning new cases. Each of these components in turn encompasses two steps, these being, 1) data gathering and 2) the application of a procedure of one sort or another to the data which will yield dimensions or categories, or in the case of the second component, patient assignments.

Each of the four steps characterizing any diagnostic system involves either a formal or informal procedure (Morf and Krane, 1973). (A formal procedure is defined here as one characterized by an explicit set of rules based on an explicit rationale). An example of a diagnostic scheme characterized by four informal steps is the traditional case where, for instance, a clinician might diagnose a patient as a 'paranoid schizophrenic' on the basis of his response using Rorschack ink blots. Procedures involving a combination of formal and informal steps, on the other hand, are exemplified by those diagnostic systems contrasted in the well documented clinical versus actuarial debate (eg. see Meehl, 1954; Sines, 1970). Finally, a recent study by Carlson (1970) provides a good illustration of an attempt to develop a diagnostic system involving four formal steps. Using DPI scores as input this author obtained categories based on the work of Guertin (1966) and assigned new cases using a set of discriminant functions.

Given these alternatives, which diagnostic system can be regarded as the most appropriate and why? It is apparent that the traditional and 'clinical' approach can be seriously questioned as far as reliability and validity are concerned (See Brody, 1972). The so-called 'actuarial' method on the other hand would appear to more closely approach a viable diagnostic system. There are in fact several presently available commercial programs (eg. Roche, MMPI Computerized Interpretation Service (Fowler, 1969); Institute of Clinical Analysis (Dunlop, 1966)) utilizing this approach to provide clinicians with diagnoses. The procedure employed here is formal in the sense that the MMPI - a test with known psychometric properties as well as a standard administration and scoring procedure - is used to form categories and assign new cases; the latter being performed on the basis of an explicit set of rules. The informal step in this procedure is to be found in the method employed in the formulation of diagnostic categories. These categories, at least with regards to those programs processing MMPI data, have emerged primarily from clinical theory. Because the procedure employed here is completely automated, diagnostic reliability cannot be questioned. It would appear, however, that the issue of validity has not been properly dealt with. This becomes quite apparent when one considers the low validity and reliability of the MMPI (eg. Cureton, 1950; Nunnally, 1967; Bentler, Jackson and Messick, 1970) as well as the variations of assessment printouts from different commercial programmes (Dahlstrom, Welsh and Dahlstrom, 1972).

It would appear that a completely formal procedure using psychometrically sound and rationally developed personality scales would be the most appropriate method to be employed. Such an approach to the problems of classification and identification has a number of advantages, namely,

1) the issue of diagnostic reliability is no longer of consequence, 2) the problem of diagnostic validity is taken into account and 3) as Morf and Krane (1973) propose, a formal approach permits one to utilize the sophisticated mathematical and computer technology now available.

As noted earlier, the viability of any classification system depends on the general level of development of the science within which it is found. It is hoped that the present study, through the utilization of more recently advanced psychometric, mathematical and computer techniques, will contribute to that body of research related to the development of a valid and reliable classification system for psychopathology.

The Categorical and Dimensional Models

Having selected a formal approach to classification, the choice remains as to which of two alternative models the system should be based on; specifically, should an attempt be made to derive categorical or dimensional types?

Historically, the categorical model can be traced to Hippocrates' theory of humours which led Kant (cited in Eysenck, 1970, p. 172) to propose his description of the four temperaments. These temperaments - the sanguine, melancholic, choleric and phlegmatic - were considered by Kant to be independent, categorical types into one of which any individual could be placed. The possibility of an alternative system of classification did not arise until 1903 when Wundt (cited in Eysenck, 1970, p. 172) proposed a quantitative dimensional scheme in which people could occupy any position and any combination of positions on two dimensions. Wundt's system was therefore distinctly non-categorical in the above sense and did not imply discontinuities and bimodal distributions.

In essence, Hippocrates, Kant and Wundt all appear to have proposed that if people are observed in some 'quantitative' manner it will be found that some combination of characteristics has a greater probability of appearing in the same individual than other combinations of characteristics. The categorical and dimensional models can therefore be considered to be "face and obverse of the same descriptive system (Cattell, 1970, p. 40)" as any object can be described through categorization or by listing measurements for it on a set of attributes.

In selecting a model for purposes of the present analysis, it will first be useful to briefly examine the opposing positions held by Cattell and Eysenck. Cattell, Coulter and Tsujioka (1966) argue that categories "accord with reality" in that nature creates modal combinations of characteristics particularly suited for adaptation and survival. Categorical or species types are defined by Cattell (1966) as "the central profile tendency found in a defined subgroup of a population which is measurable on certain dimensions (p. 290)". Species types are thus defined here in the sense that biologists use the term.

Cattell's (1966) main argument in favour of the categorical model rests on its superiority in the prediction of criterion variables. Specifically, psychopathological type membership is viewed as a moderator variable in the prediction of behaviour from a particular set of attributes. If this is in fact the case, then predictions from a strictly dimensional model will, by necessity, be more difficult and less precise.

Cattell (1966) sees polar or dimensional types as "the opposite extremes on a normal distribution of some defined trait (p. 289)". He suggests that no one is in fact found right at the extreme poles and even if this were the case, only two individuals could be designated as 'in' this type. The only alternative, Cattell (1966) argues, is to choose some arbitrary cut off point for inclusion in a type but he proposes that it would be more appropriate to simply assign individuals a score on the various dimensions.

Eysenck (1970), on the other hand, views the dimensional model as the most viable basis of a classification system. Within the context of Eysenck's scheme the term type is used not as a categorical sorting of people but rather as a "supraordinate concept implying empirical correlations between traits, which are the subordinate concepts (p. 173)". Eysenck (1970) feels that the categorical model does not accord with reality but has in fact become common in psychology due to a "slavish following of medical practice in a new and possibly different field (p. 172)".

In evaluating these opposing positions let us first list some of the more apparent disadvantages of the categorical model as advocated by Cattell. These are: 1) categorical types invite errors of classification (Zigler and Philips, 1961; Cattell, 1970), 2) they create the illusion that a person has been explained when he has been labelled (Szasz, 1957), 3) such labels change the patients self-perception and cause him to comform to the modal behaviour of the type assigned (Mead, 1954), 4) classification based on the categorical model forces one to keep a large number of types in mind (Cattell, 1970), 5) there exists the possibility of neglecting to recognize the individual's attribute deviations within the type itself (Cattell, 1970), 6) there is some difficulty in separating the pure abstract type concepts themselves from one another (Cattell, 1970), 7) the assumed equivalence of psychological and biological principals of adaptation and survival may not be justified.

Cattell (1966) has proposed that the accumulation and subsequent utilization of category-specific knowledge as well as the presumed importance of psychopathological type as a moderator variable in fact outweigh the disadvantages of the categorical approach. Most of the above criticisms, it is true, can or presumably will be dealt with adequately within the context of the model (see Morf and Krane, 1973). However, as will be discussed below, certain aspects of this approach are questionable and the dimensional model may in fact be more appropriate for the problem at hand.

First, can we correctly assume that the principles of adaptation derived from the science of biology exist and apply in the same manner in the realm of psychological disorders? In other words, can we assume that species types as described by Cattell exist and if so will this conceptual framework prove useful as the basis of a classification system?

The question of whether or not such species types exist in psychopathology is of course an empirical rather than philosophical one. The available research to date, although admittedly generally lacking adequate methodology, has in fact produced no clear cut evidence in favour of a categorical approach (Cattell, 1970). Furthermore, it must be remembered that in psychological disorders there is an absence of specificity (in sharp contrast to physical illnesses) and of distinct etiologies. In addition, it has not been established that different disorders require different treatments, (Szasz, 1961). All of these factors would appear to argue against the viability of the categorical model. It should also be noted here that the concept of a categorical type in the sense of a diagnostic grouping became prevalent in psychology as a direct consequence of the medical model. In the medical field, as opposed to the psychological, a disease usually involves a single major syndrome making it possible to establish a stable, workable model which can be applied uniformly. As Guertin (1966) notes, "psychologists must assume that a number of different models will be required to describe the members of a single diagnostic group . . . the notion of an isomorphic correspondence between psychiatric classification and symptom pictures may be a convenient simplification but it is unrealistic (p. 151)". While the dimensional model inherently renders the description of individuals and the prediction of criteria more complex (Cattell, Coulter and Tsujioka, 1966), it may in fact be more appropriate for classification in the field of psychopathology.

The categorical model is based on an Aristotelian mode of thought in the sense that any predictions of an individual's behaviour (i.e. behavioural symptom syndrome) are syllogistic; that is, they are based on group membership. In contrast, the dimensional model is Galilean as here behavioural predictions are made on the basis of the correlation of attributes. For example, in terms of the latter model one might predict a highly anxious response pattern on the basis of an individual's high score on a scale measuring 'neurosis'.

The Aristotelian approach has been criticized by Cassirer (1953) who argues as follows:

> ". . . if we call the number of properties of a concept the magnitude of its content, this magnitude increases as we descend from the higher concepts to the lower, and thus diminishes the number of species subordinate to

> the concept; while when we ascend to the higher genus, this content will diminish as the number of species is increased . . . the most general concepts we can reach no longer possess any definite content . . . and if the final goal of the method of forming concepts is entirely empty the whole process leading to it must arouse suspicion (p. 5-6)".

A categorical system then, by its very nature is to some extent indefinite and ambiguous. The latter stems from what cassirer refers to as "the neglect of the particular cases from which it starts and the annihilation of their peculiarity (p. 6)". It should be noted here that Cattell (1970) has recognized this problem with regard to categorical groupings of psychological disorders and has in fact recommended the dimensionalization of types once they have been established. As has been discussed however, there is no convincing reason to believe that psychopathological species types exist in the light of the available empirical evidence. It would appear, therefore, that the dimensionalization of subgroups derived on the basis of any one of a number of quantitative criteria (via clustering technique) may in fact lead to a very confusing state of affairs.

In the personality field, dimensionality rather than categorical type groupings has generally been accepted as nearer reality (Eysenck, 1970). With regard to psychopathological disorders, the factor analysis of attribute space has provided strong evidence (eg. see Trouton and Maxwell, 1956; Eysenck, 1960) for a two-dimensional (i.e. stability-neuroticism, stability-psychoticism) theory. A not so apparent alternative, also based on the dimensional model, is the factor analysis of 'people-space' which would yield a distinct, possibly more useful dimensional system. Rather than abstract variables serving as reference axes as in traditional factor analysis, the factor analysis of people-space would yield abstract patient types (i.e. 'ideal' profiles). This issue, however, will be discussed in greater detail at a later point.

In light of the above discussion, the present analysis was based on a dimensional model as applied to person rather than attribute space. Our main concern here related to the description of the types obtained as opposed to a description of individuals.

Selection of Input Variables

In order to derive psychologically meaningful dimensional types, it is apparent that careful consideration must be given to psychological variables selected for the analysis. In this regard, Morf and Krane (1973) point out that ". . . the domain to be sampled by input variables is that of psychopathological tendencies (p. 297)". They recommend that self-report inventories be employed, basing their preference on two factors, namely, 1) self-report measures are administered in a standard manner and can be mechanically scored and 2) because they are based on formal test theory one can evaluate validity and correct for acquiescence and social desirability. Morf and Krane (1973) specifically suggest the use of the DPI (Differential Personality Inventory), (Jackson and Carlson, 1973) and it is this measure which was employed in the present study.

The DPI has a number of characteristics which make it a good classificatory instrument. First of all, it was developed on the basis of recent research in personality assessment. The test itself was formulated through the utilization of a sequential method of scale construction with large, substantively defined item pools and a series of item analyses to increase the homogeneity of scales, reduce the effects of desirability response bias and to develop mutually independent trait scales. Secondly, the convergent and divergent validity of the DPI have been demonstrated as has scale reliability (Jackson and Carlson, 1973). Considering its method of construction it would appear the DPI establishes the domain of psychopathology and accounts for that domain in a parsimonious manner.

Selection of a Similarity Index

In order to derive the significant dimensions of people-space a quantitative index of the degree of similarity between cases must be employed. The basic element in this type of index is a series of differences $d_1, d_2 \ldots d_k$ between any two people on the k elements of a profile. In the present analysis we are interested in the degree of similarity between cases over the 13 scales which constitute the DPI profile.

Any two profiles may be considered to have separate degrees of resemblance in shape, elevation and scatter (Cattell, Coulter and Tsujioka, 1966). Although there has been some debate regarding the importance of each component as a function of diagnostic circumstance (see Guertin, 1966), it is now generally accepted that all three components must be taken into account in a classification procedure. There are two types of similarity indices (i.e. correlational and distance indices) and, at this point, the advantages and disadvantages of each will be considered.

As an index of profile resemblance the correlational coefficient would appear to be the logical choice. This measure has been criticized by a number of authors (eg. Cronbach and Gleser, 1953; Guertin, 1966), however, on the grounds that it takes into account only shape and neglects similarity reflected by elevation and scatter.

When one considers that a profile is in fact nothing more than a vector in mathematical terms, an alternative approach to the measurement of similarity becomes apparent. Specifically, one can consider the calculation of profile distance in a defined factor space based on Pythagoras' theorem. A number of distance measures have been proposed (eg. Sokal, 1961; Mahalanobis, 1936) but most indices of this type can be criticized on the grounds that they overemphasize the elevation component while being less sensitive to shape (eg. see Cronbach and Gleser, 1953; Guertin, 1966). This being the case, two profiles with opposite shape will yield a small d if they are at the same level and the variance is small. Most distance measures (eg. Sokals (1961) widely used taxonomic distance measure) have two additional disadvantages, namely, 1) the magnitude of d is not comparable across different scaling metrics for variables or factors and 2) they do not distinguish between oblique and orthogonal factors (Cattell, 1966).

In an attempt to circumvent a number of these difficulties, Cattell (1966) developed the distance measure r_p which for continuous orthogonal variables is computed as follows:

$$r_p(iy) = \frac{E_{\underline{k}} - \sum_{j}^{k} d^2\,(iy)}{E_{\underline{k}} + \sum_{j}^{k} d^2\,(iy)}$$

where: K = the number of dimensions involved in comparison

d = the difference in standard score units between the individual's i and j on each of the successive dimensions

E_k = twice the median chi-square value for k degrees of freedom

Cattell (1966) recommends the use of this coefficient as an index of similarity because 1) it takes account of the 'metric' and 'number of dimension' incomparabilities mentioned above, 2) it allows one to compare the obtained d with the magnitude to be expected by chance (see Horn, 1961) and 3) it behaves eg. as regards distribution, in basically the same way as the correlational coefficient and can therefore be evaluated in the same manner.

In the light of its numerous advantages r_p was chosen as a measure of profile similarity for purposes of the present analysis. Cattell (1966) has developed an extension of the r_p formula cited above which allows one to make allowances for 1) oblique variables, 2) differential weighting of variables and 3) unequal validity of the scales. The relative independence (Trott and Morf, 1972) and established validity of the DPI scales (Jackson and Carlson, 1969) as well as their rational basis of construction, however, permitted the computation of r_p in terms of equally weighted orthogonal variables.

It might also be noted here that r_p is non-Euclidean and as such the inter-profile distances cannot be handled by Pythagoras' theorem. This provides no real problems for the present analysis, however, as will be discussed at a later point.

Q-Technique Factor Analysis and Dimensional Types

Historically factor analysis is simply an elaboration of the underlying logical postulate of all correlational methods viz. Mills' method of "comcommitant variation". Via conventional factor analysis an effort is made to discover the dimensions or hypothetical factors which need to be postulated in order to account for the interrelationships among the variables being analyzed. The core features of the factor analytic model are a) any particular observed variable is usually to be considered accounted for by several factors and b) factors add up in their influence on a variable. This quantitative relation is explicitly stated in the specification equation:

$$a_{ij} = b_{j1} T_{1i} + b_{j2} T_{2i} \cdots b_{jk} T_{ki}$$

where: a_{ij} = score of individual i on variable j

b_{jk} = weight of factor k for variable j

T_{ki} = factor score of individual i on factor k

A particular individual's variable score, therefore, is a linear function of the weighted factor scores.

Conventional factor analysis, then, examines the correlations among variables, i.e. the correlations calculated between all possible pairs of columns with people serving as rows and variables as columns. Stephenson (1936) and Burt (1937) initially suggested the possibility of transposing the data matrix before computing intercorrelations and factor-analyzing them. The transposed rows thus become columns and the inter-correlations between columns are intercorrelations between people. This method has been variously referred to as transpose, inverted or Q-factor analysis and it serves to explicate individuals in people-space. Within the context of the linear factor model then "it is quite reasonable to conceive of 'person factors' as <u>ideal types</u> and the factor loadings as indices of relationship of individuals to several ideal types (Overall and Klett, 1972, p. 203)".

Burt (1943) has suggested that there is a high correspondence between the factors produced by conventional and Q-factor analysis while Guertin

(1971) proposes that the number and kind of trait and type factors will differ significantly. The latter author points out that corresponding factors will be found only when certain rigid conditions are initially imposed upon the correlation matrix. When considered in this light, Burt's (1943) proposal is mathematically interesting but of little practical importance in terms of the present analysis.

A number of authors (eg. Nunnally, 1967; Guertin, 1966; 1971; Overall and Klett, 1972) have recommended the use of Q-analysis as a method of grouping individuals in the categorical sense. Cattell (1966), on the other hand, suggests that Q-technique is properly a method of determining dimensions, a position based on the commonly held view of factor analysis as a structured, analytical and explanatory procedure (Morf and Krane, 1973). In line with Cattell (1966), Morf and Krane (1973) recommend the use of clustering procedures for determining categorical types on the grounds that this method "is taxonomic and descriptive in the sense that it does not proceed to a level more abstract than that of the data themselves (Morf and Krane, 1973, p. 299)".

Guertin (1971), arguing in favour of Q-technique as a categorical grouping method, claims that Cattell's criticisms may stem from his earlier work using this procedure in which he employed the correlational coefficient. In addition, Guertin (1971) suggests that Cattell may have over reacted to Stephenson's (1936) early, extravagent claims for Q-analysis. In support of his position Guertin (1971) reports the results of a factor analytic study in which four type-factors corresponding to four ship classes (i.e. carrier, destroyer, submarine and frigate) were found. The analysis itself was performed on the intercorrelations of 29 ships across

12 measures (eg. displacement, length) and yielded a correct type classification for all ships taking the highest of the type loadings as a basis.

Guertin's (1971) analysis would appear to support the notion that Q-technique is a viable procedure for determining categorical types if such types are clearly distinct and where type membership is of major importance in determining the observed variance pattern. In this study it is apparent that the experimental data employed lend themselves to an analysis producing a correspondence between factors and clearly defined categorical types. If the variables employed were those sampling the domain of psychopathology it is quite possible that the extracted 'person factors' would not necessarily serve to define the centroid of any such categorical group. Futhermore, if species types do in fact exist in psychopathology but are not of a truly distinct nature, the factor analytic approach might be criticized on the grounds that it serves to define types such that they are "more distinct from one another than cluster nuclei derived from other methods (Overall and Klett, 1972, p. 203)". The extent to which species truly overlap might therefore be more clearly discerned by the clustering technique recommended by Cattell (1966).

Overall and Klett (1972) have also recommended the use of Q-analysis for "the study of natural groupings among individuals (p. 201)". Although these authors do speak of 'clustering' individuals into groups in what might be regarded as the categorical sense, they clearly recognize the role of factor analysis in dimensionalizing people-space. In this regard they suggest, however, that "given a reasonable simple-structure solution, most individuals will relate primarily to only one ideal type (Q-type factor), although some individuals will be recognized as complex (p. 203)".

In the present analysis an approach similar to that advocated by these latter investigators (i.e. Overall and Klett, 1972) was adopted. No presumption was made here, however, that extracted factors correspond to categorical types.[1] Rather, types were regarded simply as 'person factors' which could be used to explicate an individual case.

<u>Q-Factor Analysis of the r_p Matrix</u>

The procedure of factor analyzing r_p coefficients has been criticized by Nunnally (1962) on the basis that any r_p matrix is non-Gramian. We shall attempt to illustrate here, however, that this position is unfounded and that the above procedure is in fact mathematically permissable.

A Gramian matrix is one which can be expressed as the product moment of a matrix (Horst, 1965); that is, S is a Gramian matrix if $S = P\Delta^2 P'$, where Δ is a diagonal matrix and P is an orthonormal matrix (i.e. where $P'P = I$). In terms of a factor analytic solution, because $XX' = P\Delta^2 P'$ (Horst, 1965) and $XX' = R_c$ (Harman, 1967) it is also true that $S = P\Delta^2 P' = XX' = R_c$ where S is the original correlation matrix, R_c is the reproduced, reduced correlation matrix, and X is the orthogonal factor loading matrix. It is important to note here that the above equation will hold in a factor analytic solution only when 1) communalities are found as the diagonal elements of S or 2) when unities constitute the diagonal elements of S (properly termed a principal components solution) but here $S = P\Delta^2 P' = XX' = R$ where R is the reproduced (not reduced) correlation matrix. The weakness of Nunnally's (1962) position becomes apparent when one considers the mathematically permissible procedure of factor analyzing a correlation matrix where communality estimates are employed as diagonal elements. In this case S is in fact a non-Gramian matrix and $S \neq P \Delta^2 P' \neq XX' \neq R_c$. In the light of this discussion it is clear that the factor analysis of an r_p matrix is permissible although one would not expect a mathematically elegant solution (Baumann, 1971) (i.e. where $\Delta^2 \geq 0$).

Selection of a Method of Factor Rotation

In order to obtain reasonably accurate descriptions of the derived dimensions, it was necessary to perform one of several possible rotations on the initially obtained factor matrix. The factors found in this initial matrix are of course extracted in their order of importance (via the principal axis method) and were not characterized by the high person loadings necessary for type interpretation. What was sought here then was a 'simple-structure' solution in the sense that there are certain individuals loading quite highly on each factor.

In choosing between the orthogonal and oblique methods of rotation one must consider that both methods lead to essentially the same conclusions about the number and kinds of factors. Because of its relative mathematical simplicity, however, the former was selected for use in the present analysis. The particular analytic method chosen was Kaisers' (1958) varimax solution which serves to maximize the sum of variances of squared loadings in the columns of the factor matrix. This method is widely used and has proven successful when employed as an analytic approach in obtaining an orthogonal rotation of factors (Nunnally, 1967).

Correction for Arbitrary Profile Elevation

As is the case for most psychological tests, the zero points of DPI scales must be regarded as arbitrarily fixed. This being the case, the raw-score profile elevation is also arbitrary and must be corrected to reflect true profile elevation.

In the present analysis profiles were standardized (for purposes of computing r_p) which in essence moves the origin of multivariate space to the person centroid (Overall and Klett, 1972). Although this procedure was suggested by Cronbach and Gleser (1953) as a method of correcting profile elevation it has one drawback; namely, it reduces the rank of the Q matrix (i.e. the r_p matrix) by 1 such that the number of ideal types defined by factor analysis is, in general, 1 less than the number of variables represented in the data (Overall and Klett, 1972).

It should be noted here that the number of profile elements corresponds to the maximum number of possible types which in turn represents the rank of the r_p matrix (Overall and Klett, 1972). In the present analysis, therefore, the rank of the r_p matrix was reduced to 12. It would appear reasonable to assume here, however, that 12 dimensions (rather than 13) would adequately account for the domain of psychopathology, thus justifying the procedure employed.

Skinner (1972) has suggested that the first factor extracted in such analysis will primarily reflect elevation and, as such, the variance of this factor should not be distributed across other factors via rotation. Incorporating this procedure within the context of the present analysis involved rotating only factor 2 - 13 and adjusting loadings on the first factor in terms of the proportion of variance accounted for. (First factor loadings were divided by two in light of the fact that this (unrotated) factor had an eigenvalue which was, on the average, four times as large as the eigenvalue of factors 2 - 13 following rotation.) Although this procedure shifts the origin of multivariate space to the person centroid (thus resulting in the loss of one possible type), it would appear to limit the effects of arbitrary elevation in determining types.

Criteria for Selecting 'Core' Profiles

Overall and Klett (1972) point out that "factor variates in the usual R-type analysis are defined as the weighted functions of the original multiple measurements, by direct analogy the 'ideal types' can be defined as the weighted averages of profiles for individuals (p. 203)". The problem of defining dimensional types can of course also be approached (although somewhat less elegantly) by simply computing the mean profiles of 'core' cases; that is to say, those individuals with relatively high loadings on a particular factor type and relatively low loadings on irrelevant factors.

In accord with a formal approach to classification, individuals must be 'included' within a particular type on the basis of certain explicit criteria. The set of criteria employed within the context of the present analysis were as follows:

1) Each subject was included in a particular type on the basis of the highest factor loading obtained, if, and only if, this loading was greater than or equal to .30.

2) Each subject was included in a type, if, and only if the difference between the squared loadings on the relevant factor (i.e. the highest loading factor) and the most significant irrelevant factor (i.e. the second highest loading factor) was greater than or equal to .09 (the latter representing a proportion of the variance corresponding to a correlational coefficient of .30).

3) A factor was designated as a type, if, and only if it included 5 or more core cases.

In order to clarify how these criteria were utilized, a description flow-chart is presented in Appendix A.

The Description of Types

Q-analysis of DPI profile with orthogonal rotation was expected to generate factors such that individuals loading highly on each would exhibit similar personality characteristics which differed from the characteristics of those individuals loading highly on other factors. Such factors of course represent ideal types and the aim of the descriptive process to establish the 'ideal profile' for each type. Accordingly, once the 'core' cases were selected an estimate of the ideal profile was obtained by averaging the DPI profiles of these individuals.

An additional step in the description of types was to investigate the effects of sex, age and a number of other intra-sample variables (eg. inpatient vs. outpatient, therapy vs. non-therapy) as related to high type loadings.

Dimensional Type Replicability and Homogeneity

In addition to being descriptive, factor analysis is inferential in either the psychometric or statistical sense (Kaiser and Caffrey, 1965). In the present analysis statistical inference is of importance; specifically, we wish to determine the extent to which the dimensions derived using the present sample apply to the population of individuals characterized by psychological disorders. The confidence with which such inferences can be made is contingent on the degree to which factor type replicability and homogeneity are established.

As Horn (1965) points out, rotated factors are even more likely than unrotated factors to reflect "a pseudo-structure due to chance". This view has been supported in a number of investigations (eg. Jackson and Morf, 1973) where random data were factor analyzed and appeared to yield 'meaningful' results. Considering the nature of the present analysis, it is clear that any set of derived dimensional types may appear as a function of chance factors. If factor type replicability over two samples can be demonstrated, however, the role of such factors is less likely to be of importance.

Replicability was evaluated by computing the r_p of mean DPI and MMPI core profiles between samples and subsequent inspection of this matrix. A particular factor was regarded as replicated if it correlates highly with only one other factor of the alternate sample.

Dimensional types can be regarded as homogeneous if the profiles of the core cases are more similar than are profiles in general. Homogeneity was therefore evaluated by comparing the mean r_p of core profiles to the mean r_p of all profiles in each sub-sample.

Method

Subjects

The patient sample consisted of 78 adult inpatients of the Windsor Western Hospital Centre and 222 students who have attended the University of Windsor psychological clinic for study help, counselling or therapy.

Materials

Differential Personality Inventory (DPI) (Jackson and Carlson, 1973) scale scores were used as input data for computing the resemblance coefficients between subjects. In addition, subject profiles were obtained using the Minnesota Multiphasic Personality Inventory (MMPI)

Form R (Hathaway and McKinley, 1967). As discussed, these profiles were used (in addition to the DPI) to evaluate factor replicability. One important reason for employing the MMPI was to permit an additional evaluation of the role of chance factors in determining dimensional types derived on the basis of DPI profiles.

Procedure

Administration of Personality Inventories

The hospital inpatients were tested in groups averaging ten in number. The testing was conducted two days a week on the hospital ward with the DPI administered first, followed by the MMPI. It was expected that the majority of subjects would complete both inventories in the same session and there were only minor deviations in the testing procedure. These irregularities were recorded for possible use in examining factor types, however. The test results of the students which were used as input data were collected by the university clinic.

Treatment of Data

Once the DPI and MMPI were administered to each of the 300 subjects in the manner described, they were treated as follows:

1) The total sample was randomly divided into two sub-samples of 150 cases in such a manner that students and hospital inpatients were equally represented in each.
2) The r_p coefficients were computed for the DPI profiles of each sub-sample.
3) Each r_p matrix was factor analyzed (Q-technique) separately. The communality estimates of a preliminary analysis were used as diagonal elements.

4) A varimax rotation was performed on the resulting factor matrices.

5) 'Core' cases (as described) for each type of each sub-sample were selected on the basis of explicit criteria.

6) The mean profiles (DPI, MMPI) of the core cases were determined followed by the computation of the r_p coefficients between them over sub-samples. This permitted an evaluation of factor reliability (i.e. type replicability).

7) The mean r_p of core case profiles (DPI) were compared with the r_p of all profiles in each sub-sample in order to evaluate type homogeneity.

8) On the basis of the mean profiles (DPI) of core cases - in conjunction with an evaluation of the contribution of other variables (eg. age, sex) - a description of each dimensional type was devised.

RESULTS

Identification of Core Cases and Factor Types

As described earlier, the core cases of each factor type were selected on the basis of certain explicit criteria. The procedure used involved a 'differential validity index' which was defined as the difference between the squared highest and second highest factor loadings. Appendix B presents the relevant factor loadings, differential validity index and, where applicable, the type designation for each case in Sample A and Sample B.

Factors were designated as dimensional types if they met certain criteria (i.e. if they included 5 or more core cases). Table 1 presents the mean differential validity index for each type as well as the number of cases in each type for Sample A and Sample B. These results allow an evaluation of the viability (in terms of the accuracy of estimating the 'ideal' profile) of each type.

Homogeneity and Independence of Factor Types

The homogeneity of each factor type was evaluated by computing the mean r_p between the core case DPI profiles of each type and comparing these values with the mean r_p of the corresponding sample. Table 2 presents the factor type mean r_p values as well as the means for Sample A and Sample B.

Although orthogonal factors were extracted, the manner in which core cases were selected necessitates an evaluation of the independence of factor types. Specifically, because no particular case would be expected to load solely on one factor a certain degree of overlap between

TABLE 1

Mean Differential Validity Indices for Factor Types in

Sample A and Sample B

Sample A			Sample B		
Type	DVI[†]	N	Type	DVI	N
1	.31	11	1	.26	15
2	.24	13	2	.30	5
3	.23	5	3	.18	11
4	.18	5	4	.28	8
5	.21	6	5	.29	5
6	.23	6	6	.18	8
7	.24	9	7	.36	5
8	.24	5			
9	.20	9			

[†] Mean difference between the squared loadings on factor types and the highest loading on an irrelevant factor for N cases.

TABLE 2

Mean r_p's for Samples and Factor Types (DPI)

Sample A (Mean r_p = .04) Type	Mean r_p	Sample B (Mean r_p = .04) Type	Mean r_p
1	.48**	1	.35**
2	.34*	2	.63***
3	.33*	3	.31*
4	.10	4	.45**
5	.31*	5	.42**
6	.40**	6	.38**
7	.42**	7	.45**
8	.42**		
9	.37**		

Because unities were employed as diagonal elements in the calculation of sample mean r_p's, the latter would tend to be slightly elevated. Tests of significance were therefore made assuming mean r_p = .00.

* $r_p \geq .29$, $p < .10$

** $r_p \geq .35$, $p < .05$

*** $r_p \geq .50$, $p < .01$

types would be expected. The degree of overlap observed will of course permit an additional evaluation of the error incurred in the estimation of 'ideal profiles'. Table 3(a) and 3(b) presents the r_p's between types (for mean DPI profiles) for Sample A and Sample B. Corresponding results for mean MMPI profiles are presented in Table 4(a) and 4(b).

Replicability of Factor Types

In order to evaluate type replicability across samples, the r_p values between the mean profiles in Sample A and Sample B were computed. Table 5(a) and 5(b) present these results for DPI and MMPI profiles, respectively.

Factor types were considered to be replicated if the difference between the squared highest and second highest r_p values was greater than or equal to .25 for DPI profiles. (It was felt this value would reflect a significant convergence between corresponding types as well as a significant divergence between non-corresponding types.) Tables 5(a) and 5(b) present these values for DPI and MMPI profiles.

On the basis of the above criteria, two factor types were considered replicated across samples; these being, Type 3 (Sample A) x Type 2 (Sample B) and Type 8 (Sample A) x Type 1 (Sample B) which will be referred to as Type A_3B_2 and Type A_8B_1, respectively.

Factor Type Description

Mean DPI profiles for replicated factor types were entered on profile sheets and interpreted using the scale definitions of elevated scores (Jackson and Carlson, 1973). Figure 1(a) presents the DPI mean profiles for factor type A_8 and type B_1 and Figure 1(b) the mean profile

TABLE 3(a)

r_p Values for Sample A Factor Types (DPI)

		Types								
		1	2	3	4	5	6	7	8	9
	1	1.00	.03	.13	.17	.24	-.13	.60**	.02	.22
	2		1.00	.33	.60**	.30	.33	.31	.24	.22
	3			1.00	.31	.36*	-.08	.27	.15	.15
	4				1.00	.27	.31	.41*	.29	.23
Types	5					1.00	-.06	.43*	.23	.10
	6						1.00	.17	.05	.34
	7							1.00	.33	.36*
	8								1.00	-.06
	9									1.00

* $r_p \geq .35$, $p < .05$
** $r_p \geq .50$, $p < .01$

TABLE 3(b)

r_p Values for Sample B Factor Types (DPI)

		Types						
		1	2	3	4	5	6	7
	1	1.00	.26	.12	.11	.27	.21	.31
	2		1.00	.22	.25	.14	.10	.21
	3			1.00	.25	.10	.02	-.16
Types	4				1.00	.34	.47*	.21
	5					1.00	.44*	.17
	6						1.00	.36*
	7							1.00

** $r_p \geq .50$, $p < .01$
* $r_p \geq .35$, $p < .05$

TABLE 4(a)

r_p Values for Sample A Factor Types (MMPI)

		Types								
		1	2	3	4	5	6	7	8	9
	1	1.00	.08	.26	.49*	.49*	-.03	.51**	.56**	.26
	2		1.00	.65**	.47*	.45*	.43*	.55**	.31	.72**
	3			1.00	.41*	.48*	.30	.49*	.42*	.61**
	4				1.00	.84**	.24	.82**	.51**	.68**
Types	5					1.00	.10	.68**	.39*	.61**
	6						1.00	.39*	.05	.51**
	7							1.00	.68**	.83**
	8								1.00	.47*
	9									1.00

* $r_p \geq .35$, $p < .05$
** $r_p \geq .50$, $p < .01$

TABLE 4(b)

r_p Values for Sample B Factor Types (MMPI)

		Types						
		1	2	3	4	5	6	7
	1	1.00	.26	.19	.37*	.54**	.54**	.51**
	2		1.00	.25	.56**	.47*	.45*	.80**
	3			1.00	.68**	.65**	.68**	.23
Types	4				1.00	.92**	.78**	.61**
	5					1.00	.89**	.62**
	6						1.00	.56**
	7							1.00

* $r_p \geq .35$, $p < .05$
** $r_p \geq .50$, $p < .01$

TABLE 5(a)

Factor Type Replication Across Samples Using r_p (DPI)

		Sample B 1	2	3	4	5	6	7	r_{p_1}	r_{p_2}	$r_{p_1}^2 - r_{p_2}^2$
Sample A	1	.09	.09	.23	.48	.60	.71	.10	.71	.60	.14
	2	.57	.36	-.05	.26	.23	.18	.50	.57	.50	.08
	3	.15	.68	.09	.20	.19	.14	.19	.68	.20	.42
	4	.60	.35	.02	.14	.44	.30	.36	.60	.44	.17
	5	.28	.53	.49	.65	.21	.26	.10	.65	.53	.14
	6	.50	-.01	-.25	-.09	-.02	.13	.59	.59	.50	.10
	7	.56	.29	.27	.43	.58	.65	.28	.65	.58	.08
	8	.60	.33	.31	.03	.09	-.01	.01	.60	.33	.25
	9	.17	.15	-.19	.23	.20	.60	.61	.61	.60	.01

r_{p_1} = largest distance measure, r_{p_2} = second largest distance measure

TABLE 5(b)

Factor Type Replication Across Samples Using r_p (MMPI)

		Sample B							r_{p_1}	r_{p_2}	$r_{p_1}^2 - r_{p_2}^2$
		1	2	3	4	5	6	7			
	1	.19	.21	.84	.71	.71	.73	.27	.84	.73	.18
	2	.60	.67	.13	.36	.39	.40	.70	.70	.67	.04
	3	.44	.67	.30	.49	.45	.42	.68	.68	.67	.01
	4	.60	.51	.48	.75	.84	.87	.60	.87	.84	.05
Sample A	5	.39	.67	.44	.78	.73	.75	.63	.78	.75	.05
	6	.77	.09	-.09	.10	.23	.22	.40	.77	.40	.43
	7	.76	.44	.55	.65	.79	.88	.57	.88	.79	.13
	8	.38	.31	.78	.50	.54	.66	.29	.78	.66	.17
	9	.75	.56	.29	.47	.59	.69	.72	.75	.72	.04

Differential Personality Inventory Form L

PROFILE SHEET
MALE and FEMALE

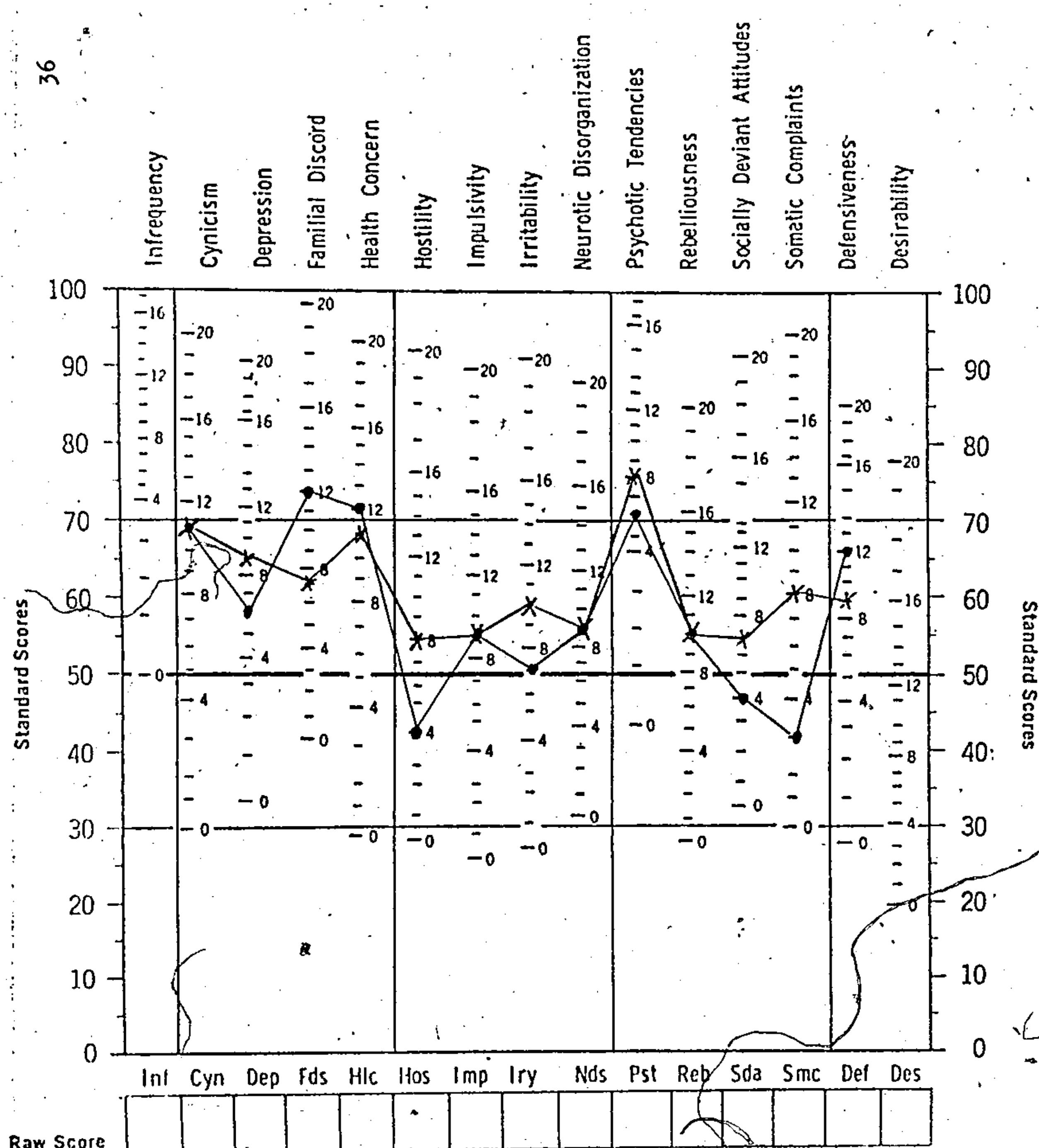

Figure 1(a)

DPI Mean Profiles for Type A_8 and Type B_1

A_8 ●——●

B_1 ×——×

Differential Personality Inventory Form L

PROFILE SHEET
MALE and FEMALE

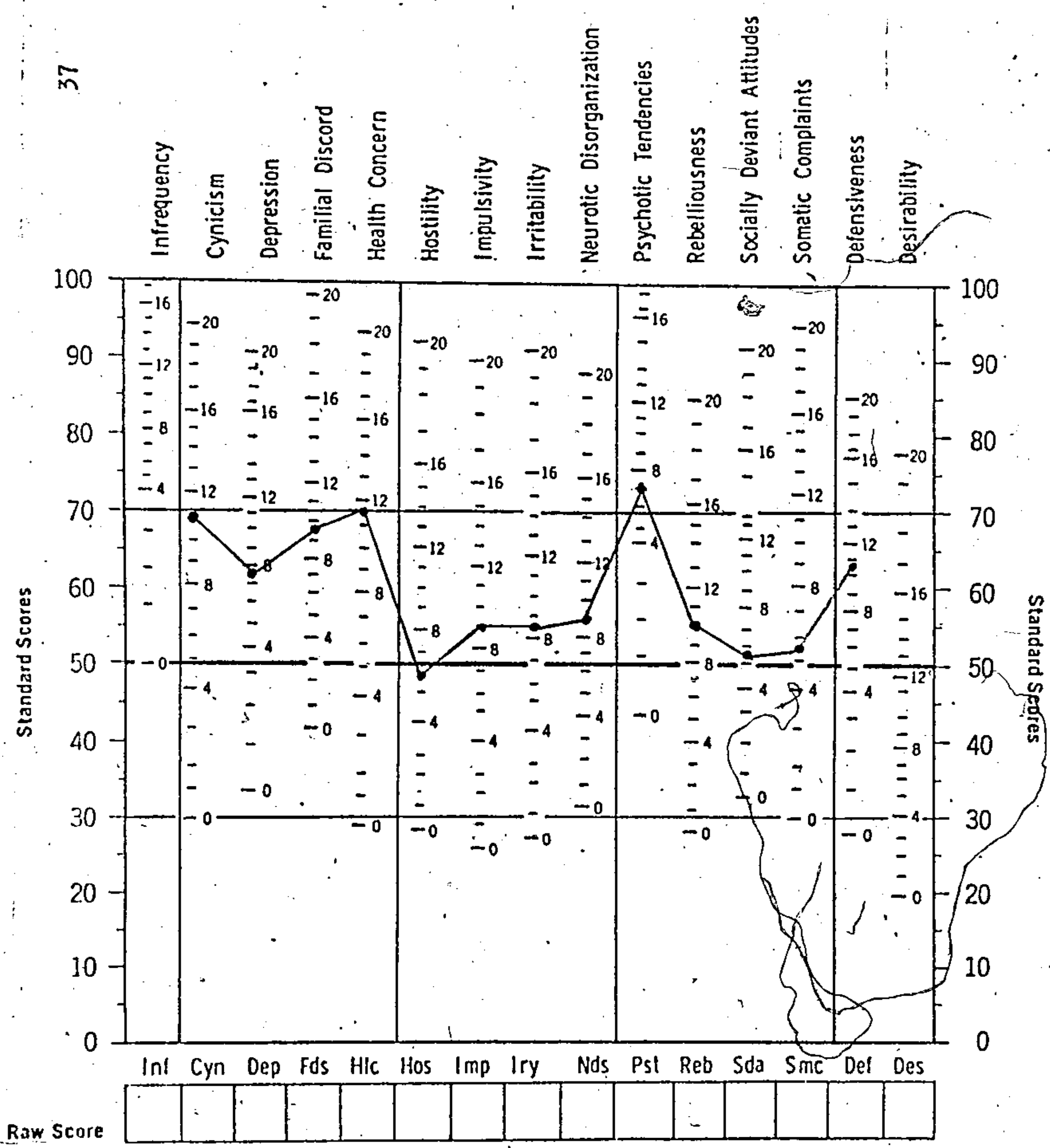

Figure 1(b)

DPI Mean Profile for

Combined Type A_8B_1

for the combined type A_8B_1. Figures 2(a) and 2(b) provide the same information for factor types A_3, B_2 and A_3B_2. Following each figure is a description of the type based on 1) mean DPI profiles, 2) sex and number of core cases and 3) treatment institution attended.

Type A_8B_1 The primary scale of importance with regards to the description of the combined type A_8B_1 is clearly (see Figure 1(b)) the extreme elevation of both types A_8 and B_1 on the psychotic tendencies scale. Both types also show relatively high elevations on defensiveness, health concern, family discord, depression and cynicism. The core cases of type B_1 would appear to be more severly disturbed, however, judging from their relatively lower score on the defensiveness scale and their higher psychoticism score. The higher defensiveness score of the core cases of type A_8 (as compared to that of type B_1) as well as their low scores on somatic complaints and hostility, on the other hand, would appear to indicate the formers' more effective use of defense mechanisms in coping with psychologically stressful phenomena.

The core cases of type B_1 consisted of 8 females and 7 males, while type A_8 consisted of 1 female, 3 males, and 1 case whose sex was unidentified. Twelve of the 15 core cases of type B_1 were from I.O.D.E. hospital and 3 from the university clinic, while the core cases of type A_8 consisted of 1 subject from I.O.D.E. and 4 from the university clinic. The predominance of psychiatric in-patients with regard to type B_1 supports the notion that the latter represents a more aberrant dimension of people-space than type A_8.

Type A_3B_2 Although type A_3 shows generally more extreme scores than type B_2, Figure 2(a) illustrates the high degree of correspondence between

Differential Personality Inventory Form L

PROFILE SHEET
MALE and FEMALE

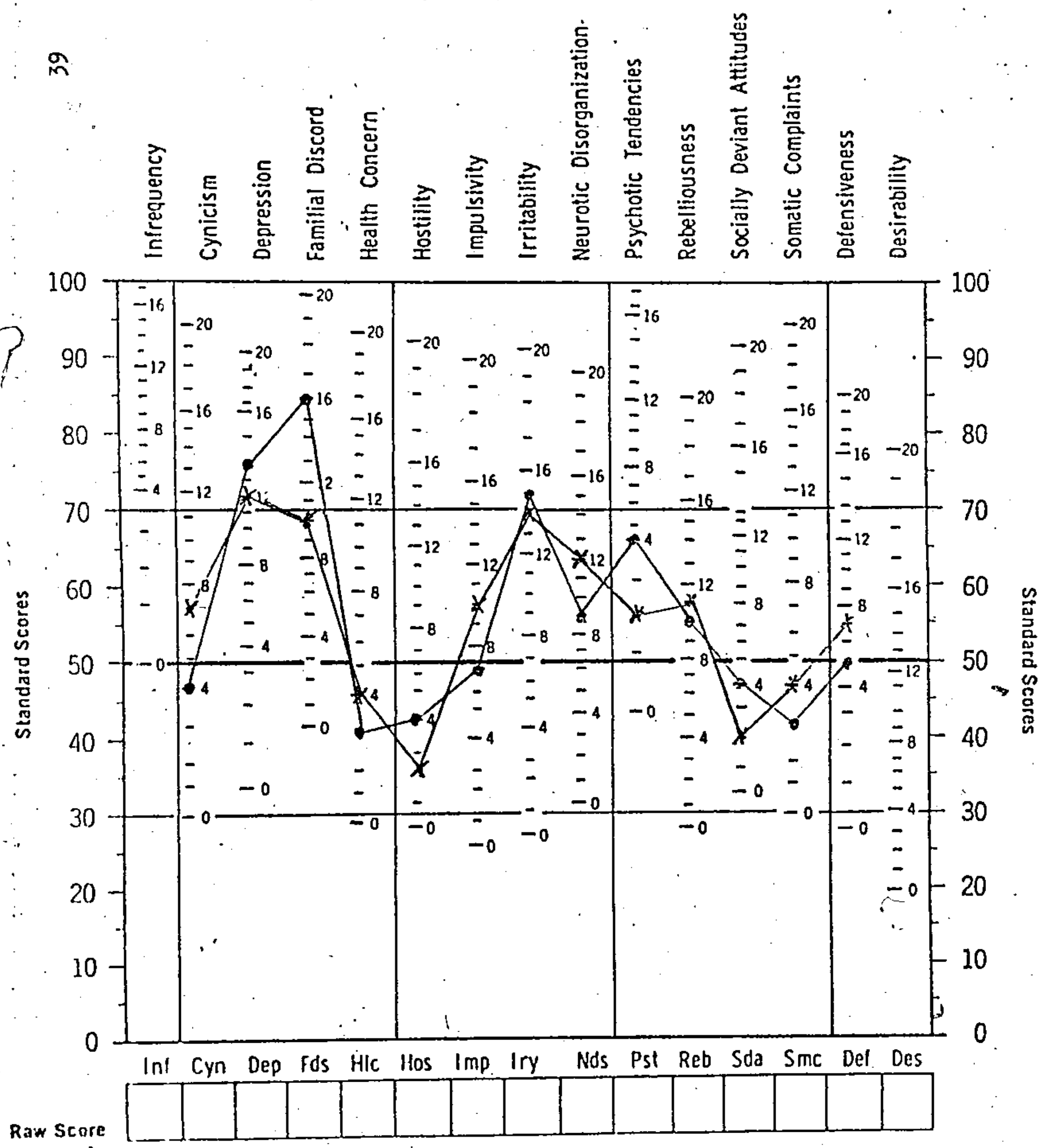

Figure 2(a)

DPI Mean Profiles for

Type A_3 and Type B_2

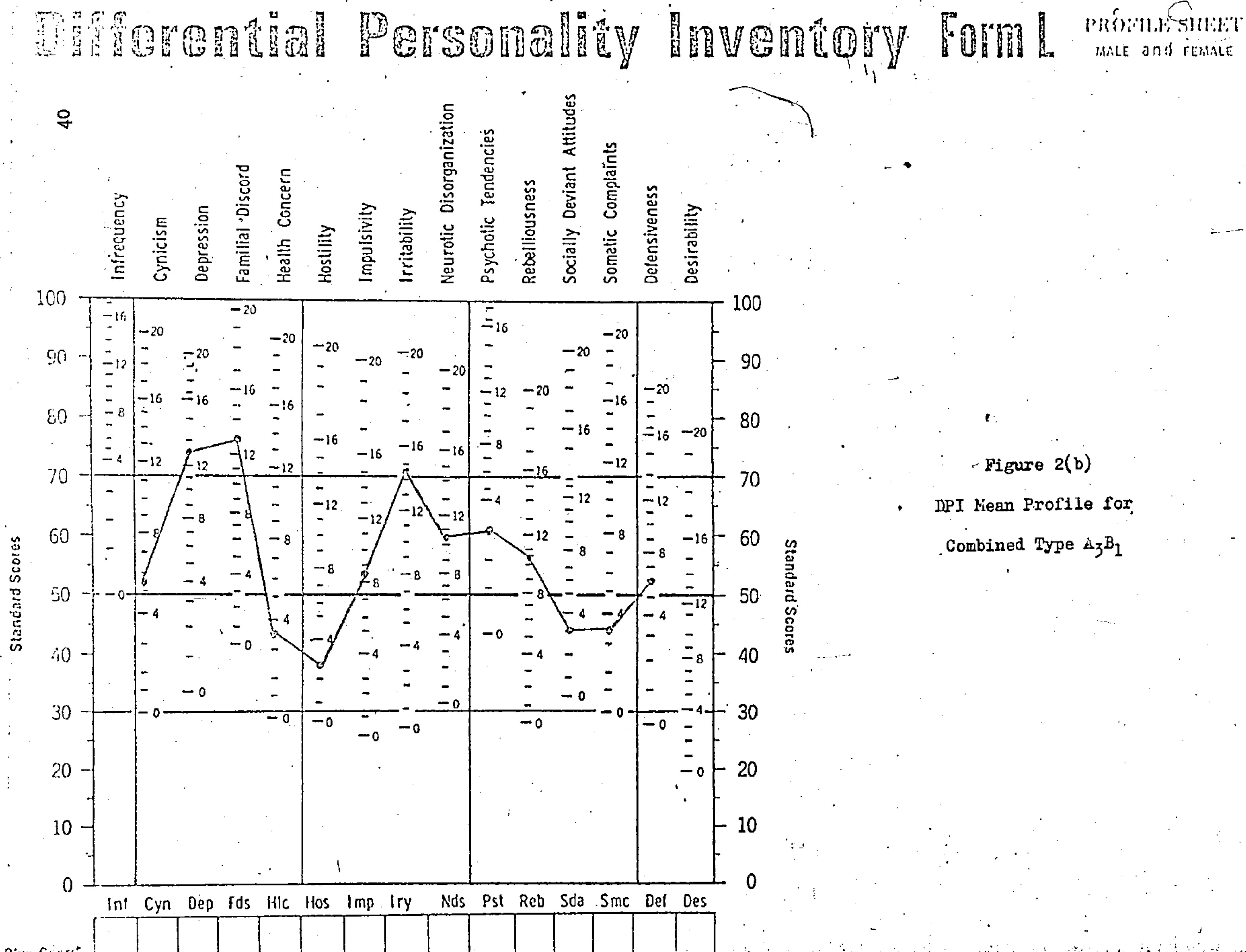

Figure 2(b)

DPI Mean Profile for

Combined Type A_3B_1

the two with regards to the shape and scatter of DPI profiles. Both types show extreme or very high elevations on Depression, Family Discord and Irritability as well as relatively high scores (although not as extreme as the former) on Neurotic Disorganization and Psychotic Tendencies. In addition, both type A_3 and type B_2 exhibit relatively low scores on Hostility, Socially Deviant Attitudes, Health Concern and Somatic Complaints. These low scores would suggest the tendency to repress or deny events threatening to the individual which in turn leads to certain disruptions in cognitive processes (as reflected by elevated scores on the Depression, Neurotic Disorganization and Psychotic Tendencies scales) and interpersonal relations (as reflected by elevated scores on the Family Discord and Irritability scales.

The core cases of type A_3 consisted of 3 females and 2 males, while those of type B_2 were 4 females and 1 male. Of these 10 cases, all were from the university clinic; 2 were receiving therapy, 1 was a non-therapy case and 7 were of unknown theraputic status.

Unreplicated Factor Types

At this point those factor types not considered replicated but which reached a score of .14 on the replication criterion (i.e. those types for which $r_{p_1}^2 - r_{p_2}^2$ .14 in Table 5(a)) will be briefly described. This will serve to illustrate the relationship between the above types and those which were replicated and, in addition, will further clarify the manner in which factor types (once homogeneity and replicability are established) could be employed in dimensionalizing people-space.

Combined unreplicated types will be described on the basis of their three most elevated scales. These scales (in descending order of elevation) for the types in question were: 1) Psychotic Tendencies, Irritability, Cynicism (Type A_4B_1) 2) Irritability, Socially Deviant Attitudes, Family Discord (Type A_1B_6) 3) Impulsivity, Neurotic Disorganization, Psychotic Tendencies (Type A_5B_4). Figure 3(a) presents the DPI mean profiles for factor type A_4 and type B_1 and Figure 3(b) the mean profile for the combined type A_4B_1. Figures 4(a), 4(b) and 5(a), 5(b) provide the same information for type A_1B_6 and type A_5B_4, respectively.

For comparison purposes it should also be noted that the corresponding scales for replicated types were as follows: 1) Family Discord, Depression, Irritability (Type A_3B_2) 2) Psychotic Tendencies, Health Concern, Cynicism (Type A_8B_1).

As would be expected type A_8B_1 and type A_4B_1 (replicated) are highly similar (since both contain type B_1) and would appear to represent a dimension of psychopathology characterized by a strong tendency to psychosis and cynical attitudes. Type A_5B_4, on the other hand, is primarily denoted by elevations on the Impulsivity and Neurotic Disorganization scales indicating it specifies a lack of control with regards to both behavioural and cognitive functioning. Although type A_5B_4 shows some elevation on the Psychotic Tendencies scale, the deviation is not nearly as large as that of replicated types A_8B_1 and A_4B_1 suggesting it represents a less aberrant dimension of people-space than the latter.

Types A_3B_2 (replicated) and A_1B_6 would also appear related to some extent in that both are characterized by high elevations on the Family Discord and Irritability scales. These types do appear distinct, however,

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MALE and FEMALE

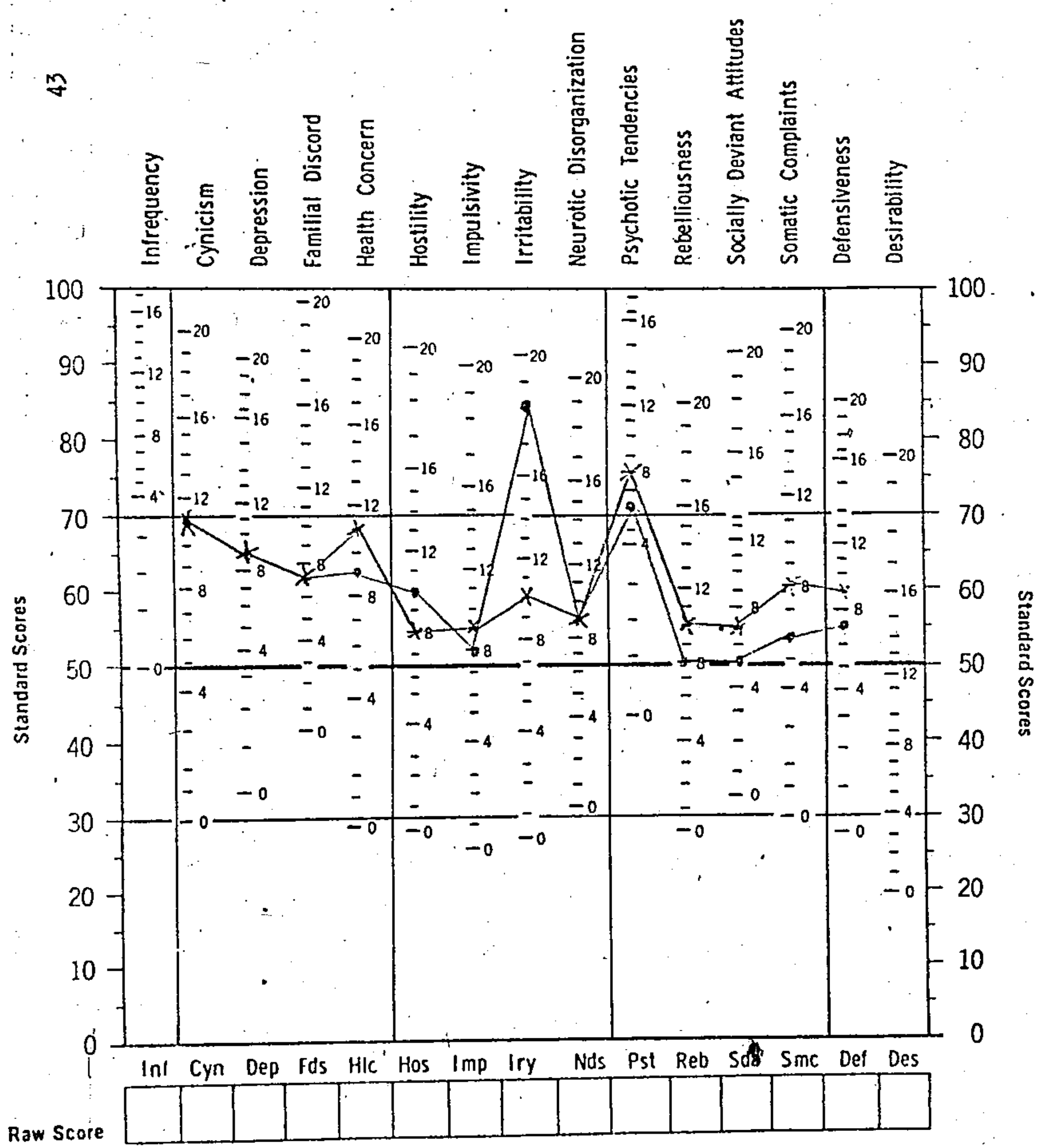


Figure 3(a)

DPI Mean Profiles for

Type A_4 and Type B_1

A_4 ●——●

B_1 ×——×

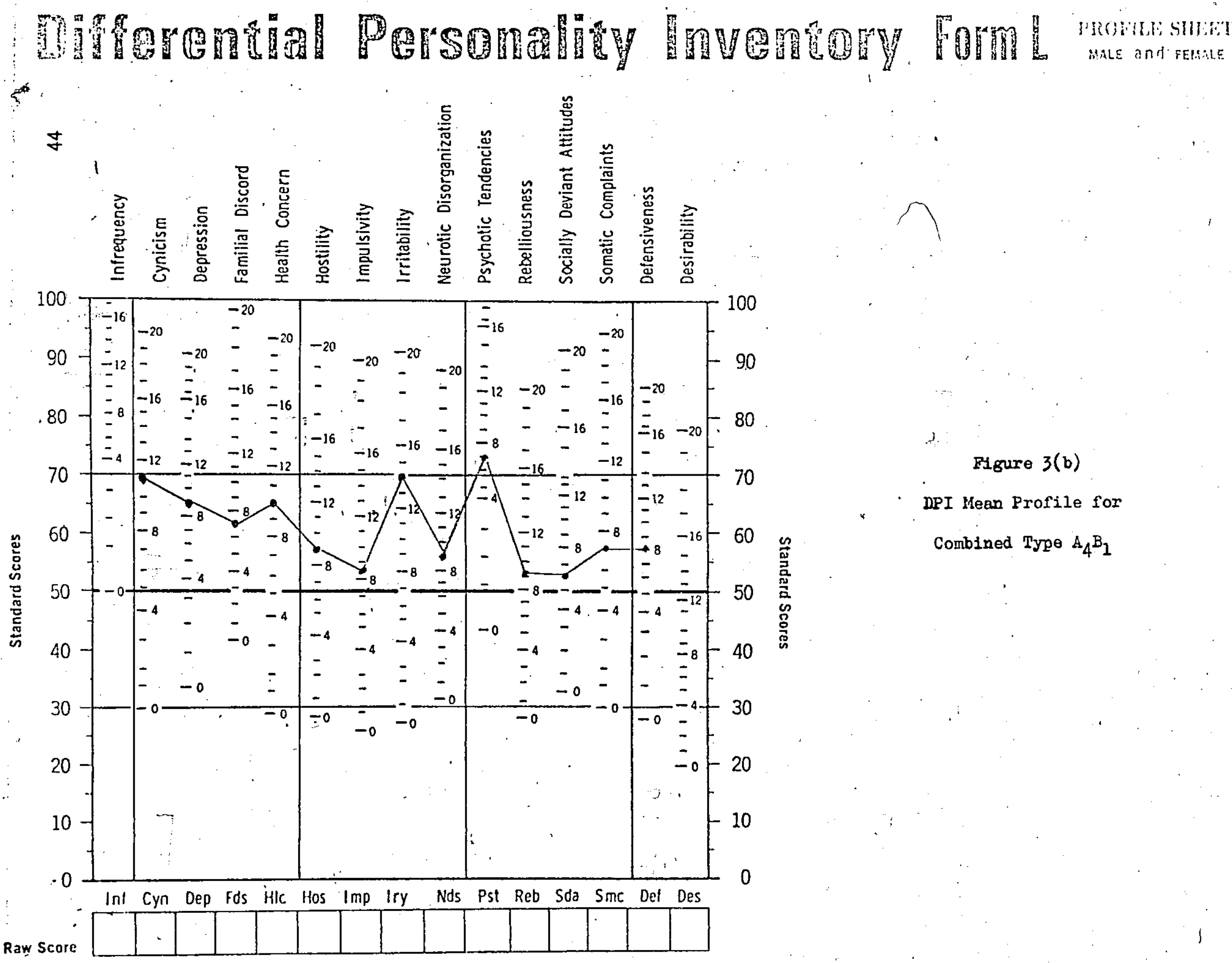


Figure 3(b)

DPI Mean Profile for

Combined Type A_4B_1

Differential Personality Inventory Form L

PROFILE SHEET
MALE and FEMALE

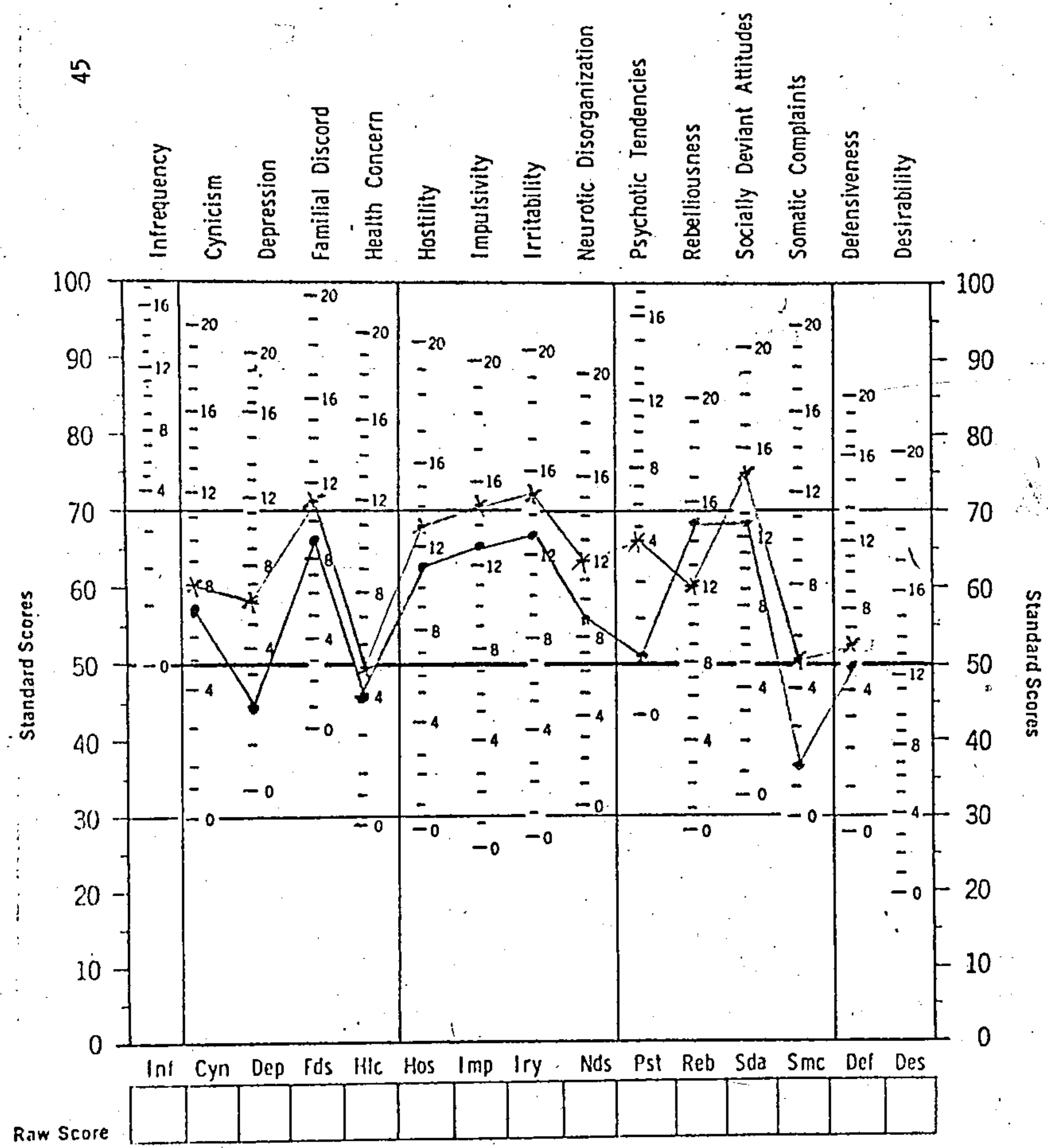


Figure 4(a)

DPI Mean Profiles for

Type A_1 and Type B_6

A_1 ●——●

B_6 ×——×

Differential Personality Inventory Form L

PROFILE SHEET
MALE and FEMALE

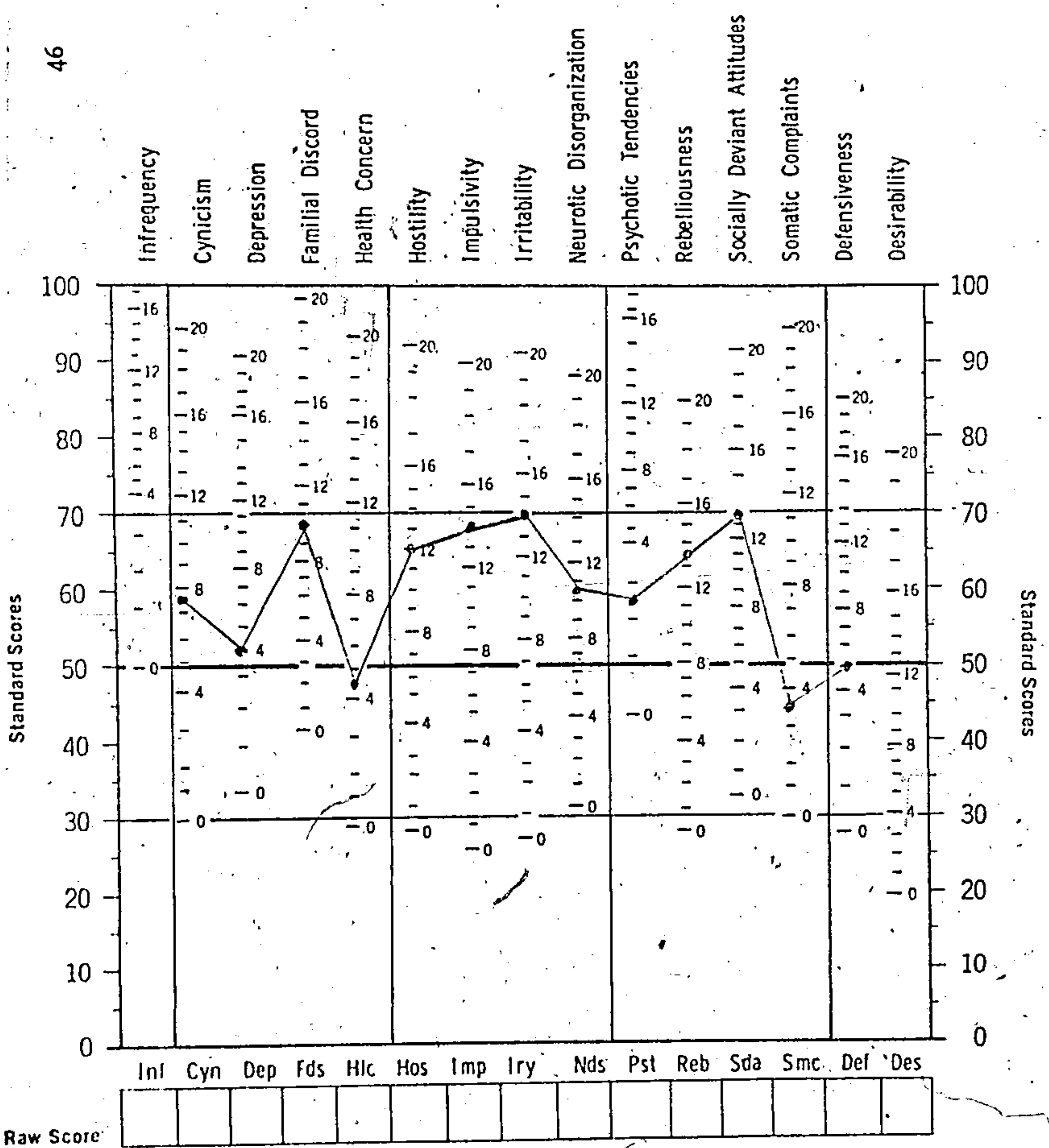


Figure 4(b)

DPI Mean Profile for

Combined Type A_1B_6

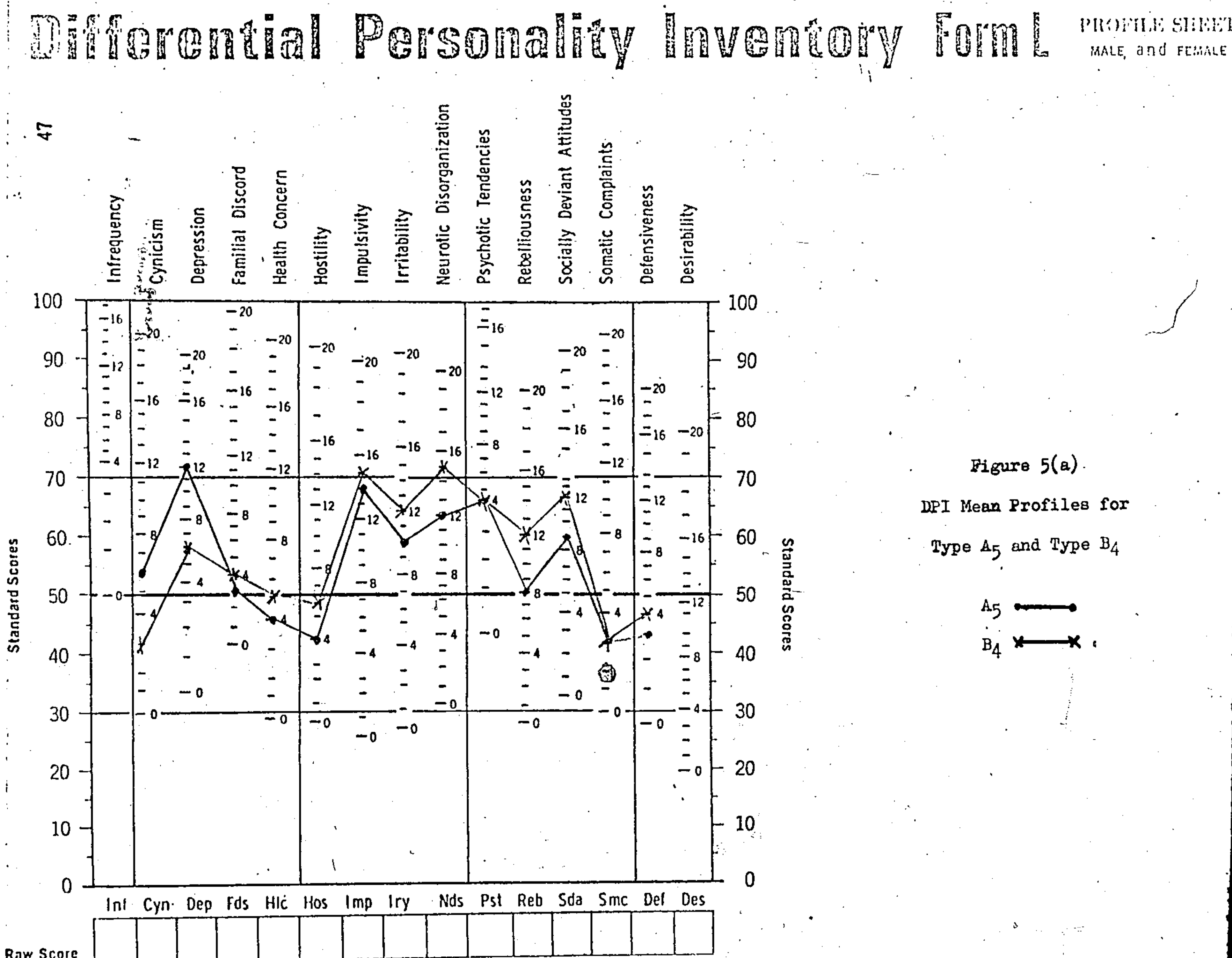


Figure 5(a)

DPI Mean Profiles for

Type A_5 and Type B_4

Differential Personality Inventory Form L

PROFILE SHEET
MALE and FEMALE

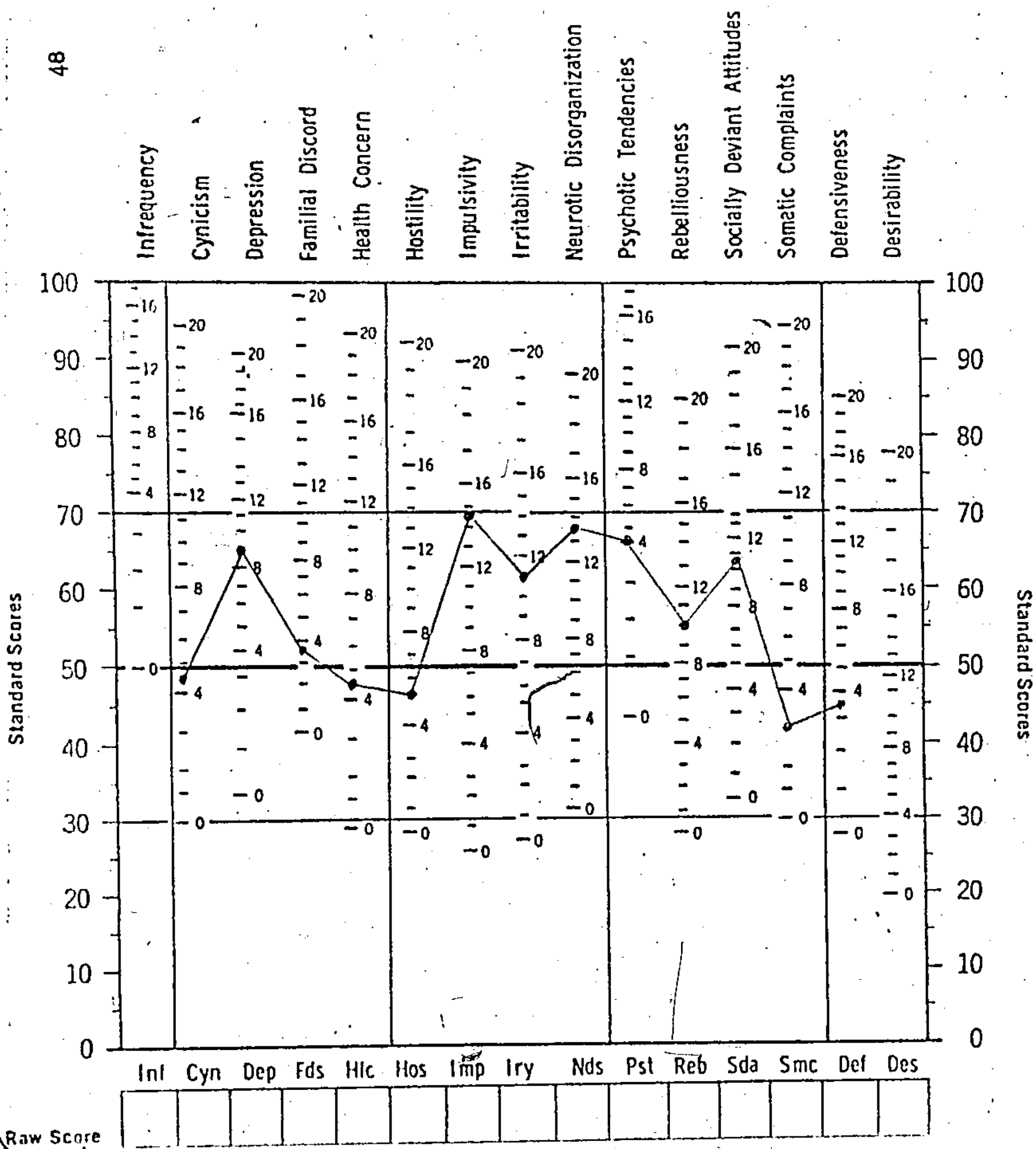


Figure 5(b)

DPI Mean Profile for

Combined Type A_6B_4

with regards to the third scale of significant elevation which for type A_3B_2 (replicated) is the Depression scale and for type A_1B_6 is the Socially Deviant Attitudes scale. On the basis of these latter elevations, certain inferences might be made regarding the general pattern of adaptation characterizing and distinquishing these types; for example, type A_3B_2 (replicated) might be considered to reflect an 'inner-directedness' and type A_1B_6 'outer-directedness'.

DISCUSSION

Homogeneity and Independence of Factor Types

Of the sixteen types generated in the present analysis, 11 were significantly different from the sample as a whole with respect to the similarity of DPI profiles (see Table 2). Of the 5 types not reaching statistical significance in this regard, 4 were significant at the .10 level. With one exception (Type A_4) therefore, the dimension types obtained can be regarded as exhibiting an acceptable degree of homogeneity.

In evaluating the independence of factor types two issues must be considered; first, how do types compare with regards to orthogonality, in light of the criteria for selecting core cases and second, to what extent are the types actually related? Table 1 permits an evaluation of the first of these questions and it would appear that all types are well above the DVI criterion set for core case designation (a criterion, it should be noted, which specifies the acceptable degree of similarity between core cases and hence between types). The DVI range for the types of Sample A was .18-.31 and for those of Sample B was .18-.36 compared to the criterion of .09.

Inspection of the between type r_p values for Sample A and Sample B as presented in Tables 3(a) and 3(b), however, reveals that a number of factor types are significantly related with regards to DPI profiles. Tables 4(a) and 4(b) which present similar results for MMPI profiles also indicate a pattern of highly related types. Although the latter findings might be expected in light of the fact that the MMPI is a psychometrically weak test, the DPI results are not so easily explained.

As was mentioned earlier, the dimensional types obtained would not be expected to be precisely orthogonal due to the manner in which core cases were selected. More specifically, types which are similar to some extent would be expected simply because "factors can be orthogonal, i.e. factor variates can be defined so that they are statistically independent, even though the clusters of variables that they represent are not completely independent of one another (Overall and Klett, 1972, p. 131)".

In the present analysis, therefore, one would expect that the core cases of relatively orthogonal types would have fewer intermediate loadings on irrelevant factor types than highly related types. To illustrate this point, the factor type loadings of selected core cases which were greater than or equal to .15 but less than the second highest loading were examined. Two types were selected from each sample such that one was not significantly related to any other type while the other was similar to at least one other type. For Sample A, types A_6 and A_5 were selected (type A_6 was not significantly related to any other type while type A_5 was related to types A_3 and A_7) since both included 6 core cases. The core cases of type A_6 were found to have 12 intermediate factor type loadings while the core cases of type A_5 had only 7 such loadings. For Sample B, the 5 core cases of types B_2 and B_5 (B_2 was not significantly related to any other type while type B_5 was related to type B_6) were examined in a similar fashion. The same pattern of loadings was discerned here with type B_5 having 7 intermediate factor type loadings while type B_2 had 4 such loadings.

These factor loading patterns would suggest that the high degree of similarity between certain types was primarily a function of error incurred in the estimation of ideal profiles. The criteria used to select core cases would appear to yield orthogonal types only when applied to specific loading patterns; that is, those patterns characterized by relatively few intermediate loadings. This being the case, neither the DVI nor the number of core cases in a type would be expected to relate to type orthogonality. An examination of the relatively orthogonal types (i.e. types A_6, A_8, B_1, B_2, B_3 which were not significantly related to any other type) supported this. The number of core cases in these types were 6, 5, 15, 5 and 11 respectively, indicating that the number of core cases per se was of little importance in this regard. (It is also noted here that for those types which were significantly related, the number of core cases varied from 5 to 13.) Similarly, the average DVI for 'orthogonal' types was 24.2 which was actually below the mean DVI (24.5) of all types generated.

It is apparent, therefore, that the procedure of selecting core cases and averaging their profiles at best provides a rather crude estimate of ideal type profiles. It would also appear that the primary difficulty here arises with regards to the appropriateness of the criteria used to select core cases. Had an attempt been made here, however, to modify the selection criteria - such that those core cases exhibiting a large number of intermediate factor type loadings were deleted - another problem might have arisen. Specifically, additional criteria would most probably have significantly reduced the number of core cases such that the computed ideal profiles (i.e. the average core case profiles) remained poor approximations of the dimensions in question.

Fortunately, alternative methods are available which permit one to circumvent the difficulties related to the selection of core cases and, at the same time, yield much more exact estimations of ideal profiles. A number of these alternative procedures will be discussed in a moment.

As a final point here, it should be remembered that factors were extracted from the non-Gramian r_p matrix. In addition to yielding certain negative roots, this procedure may have generated factors which were characterized by minor deviations from orthogonality (Overall and Klett, 1972, p. 141). Some degree of similarity between types (possibly non-significant), therefore, may have resulted as a function of the similarity index employed.

Replicability of Factor Types

Using the criteria discussed earlier, only two types (A_3B_2; A_8B_1) were considered replicated. However, in the light of what appear to be rather crude estimates of the ideal profiles, such results must be viewed as at least tentatively supporting the notion that replicable dimensional types exist in the domain of psychopathology.

An Evaluation of Alternative Approaches

The major issue of concern in the present analysis was the error incurred in the estimation of ideal profiles. Several methods of computing such estimates are discussed by Overall and Klett (1972) one of which involves the following computation:

$$Z = S' W D$$

where: S' = the transpose of the standardized person x variable matrix

W = a zero-one transformation matrix in which a single non-zero element in each row corresponds to the factor with which a particular individual has the highest relationship

D = a diagonal scaling matrix containing the reciprocals of the column sums in the matrix W

Z = a matrix whose vectors are estimates of ideal profiles

This method, however, would in all probability incur a greater degree of error then the procedure employed in the present analysis. This becomes clear when one considers that the above formula represents no more then the computation of the unweighted average of individual profiles designated to types on the basis of their highest factor loadings. The results of the present analysis (where more refined criteria were employed) suggests that such a procedure is unlikely to produce meaningful results.

As mentioned, it is possible to avoid the problems associated with the designation of individuals to particular types and the necessarily crude estimations of ideal profiles which are generated using this procedure. At this point, therefore, an alternative method adopted from the work of Overall and Klett (1972) and Skinner (1972) will be considered. The former authors point out that,

> "Since the observed profile vectors can be represented, apart from the error component, as the weighted average of pure-type profiles, the reciprocal relationship requires that it is possible for pure-type profiles to

> be estimated as simple weighted averages of the individual profile vectors. The pure-type profiles can be approximated be simple weighted functions of the individual profiles even though no individuals in the population are actually pure-types themselves (Overall and Klett, 1972, p. 219-220)".

The 'weight averages of the individual profile vectors' referred to here is simply the factor scores of the variables in a Q-factor analysis. It is apparent that the degree of error incurred in the estimation of ideal profiles using factor scores will be considerably less then that of any procedure attempting the same via core case designation.

An alternative solution, therefore, would initially involve the extraction of principal components[2] from a matrix of profile similarity indices (r_p is recommended) and the subsequent computation of the variable factor scores. The latter (i.e. the factor scores representing ideal types) would be computed according to the formula $X = F^{-1} Z$ (Harman, 1960) where: X is the factor score matrix, F^{-1} is the inverse of the factor loading matrix (i.e. the person x factor matrix) and Z is the standardized person x variable matrix. As was discussed, if the DPI is employed, the factor scores of only the first 13 factors (corresponding to the 13 DPI scales) should be computed and only when a reasonable approximation of optimum profile elevation has been achieved. It is important to note that only under the latter condition will this analysis yield types which 1) correspond to each dimension (i.e. profile cluster) represented in the data and 2) pass through the centre of profile clusters (Overall and Klett, 1972).

Having computed 26 ideal profiles (13 from each of two samples) r_p coefficients between the latter could then be computed. This r_p matrix would then be subjected to a principal components analysis (with a varimax rotation) which would yield what will be referred to as 'hypothetical' ideal types. (Each of the 26 ideal types will of course have loadings on each hypothetical ideal type.) In order to refine the ideal types, a Procrustean rotation would then be performed based on this factor loading matrix.

The Procrustean method involves the transformation (i.e. rotation) of an initial factor matrix to the best possible (least squares) fit to a target matrix. In terms of matrix, algebra one solves for Vrs' in the equation:

(1) $Vo\ x = Vrs'$

where: Vo = the original factor matrix

x = a transformation matrix

Vrs' = the closest possible fit to Vrs which is the target matrix

Hurley and Cattell (1962) have developed a solution for determining x according to the matrix equation $x = (Vo'Vo)^{-1}Vo'Vrs$ which when normalized as to columns can be substituted into the above equation to solve for Vrs'.

In terms of the analysis under discussion, a target matrix (Vrs) could be developed on the basis of the ideal type x hypothetical ideal type factor loading matrix (Vo). It would be constructed by setting the factor loadings of ideal types to 1.00 on only one hypothetical ideal type and setting all other loadings to 0.00. The ideal type x hypothetical ideal type matrix (Vo) would then be rotated to a least squares fit (Vrs') to the target matrix. The best fit solution would then be compared to that expected via chance factors using one of the methods suggested by Hurley and Cattell (1962).

Once the least squares solution matrix (Vrs') has been computed, refined ideal types can be generated by determining the factor scores of the variables (i.e. the ideal types). This would be done according to the formula $X = F^{-1} Z$ or in terms of the present notation, $X = Vo^{-1} Z$, where X is the factor score matrix, the vectors of which represent the refined ideal types, Vo^{-1} is the inverse of the ideal type x hypothetical ideal type matrix, and Z is the ideal type x variable matrix.

There are many different approaches to the problem of determining dimensional types using a procedure involving the computation of factor scores. For example, one could first extract components from the initial r_p matrix and then, on the basis of the unrotated factor loading matrix (i.e. the person x factor matrix), perform a Procrustean rotation. Following this ideal profiles could be generated by computing the factor scores of the variables of the least squares solution.

Future research, employing the Q-analysis technique as a method of investigating psychopathology, should be primarily concerned with establishing the dimensions (if they exist) of people-space. If such dimensions are established (with regards to both homogeneity and replicability) the theraputic utility of such a classification system would then arise as an issue of primary importance. Hopefully, however, this system derived using advanced mathematical techniques will in itself provide new insights into the nature of psychopathology.

FOOTNOTES

1.

A parallel analysis employing a clustering technique was carried out on the sample used in the present study (C. Miller, Unpublished Masters Thesis, University of Windsor, 1974). If a high correspondence is found between the types yielded by both methods of analysis, this result could be interpreted as evidence in favour of a categorical model. That is, a high correspondence between types would indicate that the factoring procedure has in essence reduced to a cluster search yielding categorical type groupings rather than abstract underlying dimensions of another nature. Such a finding would appear to indicate the importance of species types in accounting for the common variance among cases. No correspondence between types over analysis, on the other hand, could be taken as evidence against the utility of the categorical model, or alternatively, may indicate the use of an inappropriate clustering technique.

2.

In Q-principal components analysis unities are employed as the diagonal elements of the correlation matrix and, by definition, each component which is extracted is a linear compound of the observed profiles. As such, the factor scores of variables can be exactly computed (apart from error) according to the formula $X = F^{-1} Z$ (Harman, 1960) where X is the factor score matrix (the vectors of which represent the ideal profiles), F^{-1} is the inverse of the factor loading matrix (i.e. the person x factor matrix) and Z is the standardized person x variable matrix.

In Q-factor analysis, on the other hand, communality estimates are employed as the diagonal elements of the original correlation matrix and as a consequence the extracted factors are theoretically independent of any unique variable variance. As such, because factors are not simple linear compounds of the observed profiles, the factor scores of variables must be estimated (rather than exactly computed as in a principal components analysis) by one of several methods. One formula used in estimating factor scores is $X = F^{1} R^{-1} Z$ (Harman, 1960) where X is the factor score matrix, R^{-1} is the inverse of the person x person r_p matrix, Z is the standardized person x variable matrix.

In an analysis designed to generate dimensional types it would appear questionable whether there is any real purpose served in extracting factors such that the unique variance of the profile variables is defined on the basis of the factor analytic model. Research in this area is still in a rudimentary state and the refinement of dimensional types in this manner would appear to be somewhat premature. In addition, a factor analytic procedure inherently renders the computation of factor scores more complex, less precise and certainly more controversial. For these reasons then, it is suggested that a principal components analysis is most appropriate for the problem at hand.

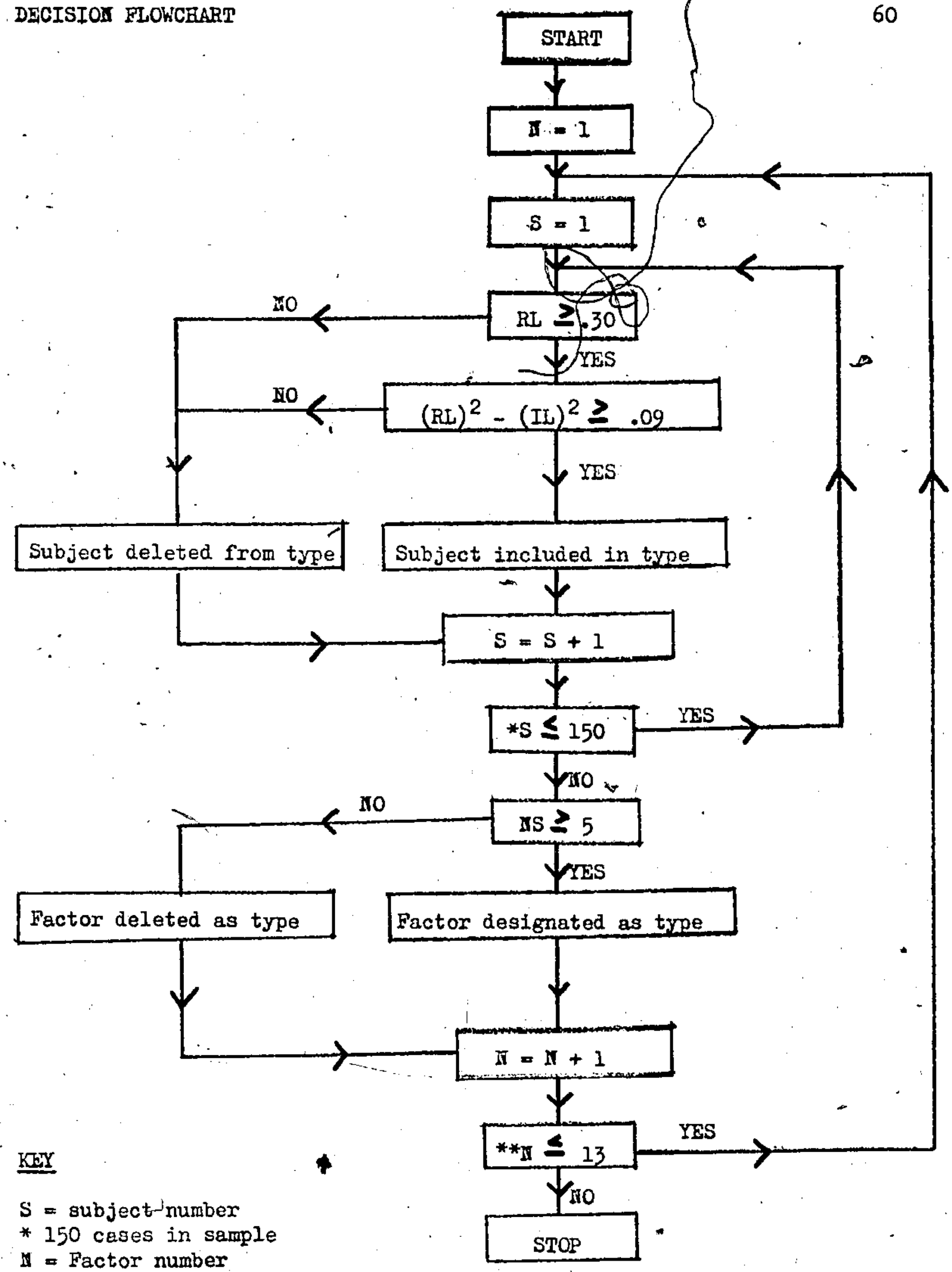
APPENDIX A

A Decision Flowchart

For the Selection of

'Core' Profiles and Factor Type Designation

DECISION FLOWCHART



KEY

S = subject number
* 150 cases in sample
N = Factor number
** assuming 13 'significant' factors
RL = Subjects' highest factor loading
(i.e. relevant loading)
IL = Subjects' second highest factor loading
(i.e. irrelevant loading)
NS = number of subjects assigned to each type

APPENDIX B

Relevant Factor Loadings, Differential Validity Indices and Type Designations for Sample A and Sample B

SAMPLE A

Case	Highest Loading†	Second Highest Loading	Difference of Squares (DVI)	Type†† Designation
1	-.59 (VII)	-.26 (I)	.28	6
2	.36 (III)	-.27 (XIII)	.06	-
3	-.41 (II)	-.33 (VIII)	.06	-
4	-.37 (IV)	-.36 (VI)	.01	-
5	.52 (II)	.29 (V)	.19	-††††
6	.45 (XII)	.42 (II)	.02	-
7	-.34 (VI)	.32 (I)	.02	-
8	-.53 (VII)	.29 (IX)	.20	6
9	.54 (III)	-.34 (VII)	.17	2
10	-.55 (VII)	-.32 (I)	.20	6
11	-.55 (XII)	-.25 (I)	.24	9
12	.53 (III)	.32 (V)	.19	2

†- factor number

††- factors II, III, IV, V, VI, VII, X, XI, and XII of Sample A correspond to types 1, 2, 3, 4, 5, 6, 7, 8, and 9, respectively.

†††- case was not designated within a type because the number of cases loading 'significantly' on the same factor did not exceed 5.

††††- case was not designated within the type because 1) the polarity of the highest factor loading was opposite to that characterizing the majority of cases (minimum of 5) designated as belonging to the type and 2) the number of cases loading in the same direction as this case were not sufficient (i.e. ≥ 5) to designate the type as bipolar.

Case	Highest Loading	Second Highest Loading	Difference of Squares (DVI)	Type Designation
13	.49 (XI)	-.33 (VII)	.13	8
14	-.45 (XII)	.31 (XI)	.10	9
15	.56 (XI)	-.33 (IV)	.20	8
16	-.62 (X)	.29 (XI)	.30	7
17	-.40 (IX)	.28 (V)	.08	-
18	.48 (III)	.28 (I)	.15	2
19	.37 (IX)	-.26 (I)	.07	-
20	.46 (II)	-.36 (VI)	.08	-
21	-.68 (VII)	.17 (III)	.43	6
22	.53 (III)	-.34 (IX)	.16	2
23	.39 (V)	-.37 (IV)	.01	-
24	.39 (XI)	-.39 (VI)	.00	-
25	.49 (V)	.31 (IX)	.14	4
26	-.42 (VII)	-.28 (I)	.10	6
27	-.54 (VII)	-.37 (VIII)	.15	6
28	.42 (III)	.35 (II)	.06	-
29	.52 (III)	-.39 (VII)	.12	2
30	.37 (II)	-.26 (VIII)	.07	-
31	.52 (III)	-.29 (XII)	.19	2
32	-.44 (XII)	.34 (I)	.07	-
33	.68 (III)	-.21 (VII)	.42	2
34	.30 (XII)	-.27 (XIII)	.02	-
35	-.44 (VI)	.35 (II)	.07	-

Case	Highest Loading	Second Highest Loading	Difference of Squares (DVI)	Type Designation
36	.49 (XII)	.45 (II)	.04	-
37	-.61 (X)	-.35 (II)	.25	7
38	-.43 (XI)	.36 (I)	.05	-
39	.52 (IV)	.37 (III)	.13	3
40	-.46 (VIII)	.23 (I)	.16	-†††
41	.48 (VI)	.36 (VIII)	.10	5
42	-.59 (XII)	-.37 (VIII)	.16	9
43	-.64 (IX)	.24 (V)	.35	-†††
44	-.52 (II)	-.31 (III)	.17	1
45	.50 (II)	-.45 (III)	.05	-
46	-.37 (V)	.34 (I)	.02	-
47	.51 (IV)	.26 (XIII)	.19	3
48	.44 (III)	-.27 (I)	.12	2
49	.64 (VI)	.19 (I)	.37	5
50	-.70 (IX)	.25 (III)	.43	-†††
51	-.45 (III)	.36 (II)	.07	-
52	-.43 (XI)	.26 (I)	.11	-††††
53	-.69 (II)	-.31 (X)	.38	1
54	.35 (I)	-.25 (VI)	.06	-
55	.66 (III)	.17 (II)	.41	2
56	.62 (V)	.26 (I)	.31	4
57	.37 (V)	.36 (I)	.01	-
58	-.68 (II)	.27 (I)	.39	1

Case	Highest Loading	Second Highest Loading	Difference of Squares (DVI)	Type Designation
59	-.41 (X)	-.31 (II)	.07	-
60	-.45 (XII)	-.34 (IX)	.08	-
61	-.41 (XII)	.40 (III)	.01	-
62	.51 (VIII)	-.23 (II)	.19	-
63	.60 (III)	.29 (VI)	.28	2
64	.41 (V)	.39 (IX)	.04	-
65	.57 (VI)	-.26 (II)	.25	5
66	-.58 (II)	.32 (XI)	.24	1
67	.48 (IX)	-.31 (VIII)	.14	-
68	-.51 (XII)	.34 (IV)	.14	9
69	-.42 (X)	.30 (I)	.09	7
70	-.48 (IX)	.28 (III)	.15	-
71	-.67 (II)	-.28 (XII)	.37	1
72	-.69 (II)	-.31 (X)	.38	1
73	.39 (I)	-.17 (VI)	.12	-
74	-.47 (XIII)	.45 (II)	.02	-
75	-.45 (XII)	.36 (V)	.07	-
76	-.71 (II)	-.19 (V)	.46	1
77	.45 (III)	-.37 (V)	.06	-
78	-.53 (XII)	.32 (VII)	.18	9
79	-.41 (X)	-.39 (II)	.02	-
80	.60 (XI)	-.22 (VI)	.31	8
81	-.56 (XII)	-.28 (I)	.23	9

Case	Highest Loading	Second Highest Loading	Difference of Squares (DVI)	Type Designation
82	-.60 (XII)	-.22 (I)	.31	9
83	-.42 (XIII)	.32 (XII)	.08	-
84	.59 (XI)	-.26 (IX)	.28	8
85	-.58 (II)	-.35 (X)	.22	1
86	-.40 (XII)	.34 (IV)	.04	-
87	.70 (IV)	.22 (VII)	.44	3
88	.38 (VIII)	-.37 (II)	.00	-
89	.39 (III)	.27 (IX)	.08	-
90	.38 (II)	.32 (IV)	.04	-
91	.37 (I)	.31 (VI)	.04	-
92	-.40 (III)	-.31 (XI)	.06	-
93	-.38 (II)	.32 (I)	.04	-
94	.45 (V)	.26 (I)	.13	4
95	.34 (I)	.30 (X)	.03	-
96	.52 (IV)	.31 (XI)	.17	3
97	-.35 (V)	.27 (VI)	.05	-
98	-.48 (X)	.44 (IV)	.04	-
99	.54 (VI)	-.24 (IV)	.23	5
100	-.42 (IV)	.34 (VI)	.06	-
101	-.41 (VIII)	-.36 (VII)	.04	-
102	-.39 (III)	.32 (X)	.05	-
103	-.37 (V)	-.34 (III)	.02	-
104	-.77 (X)	-.18 (XII)	.56	7

Case	Highest Loading	Second Highest Loading	Difference of Squares (DVI)	Type Designation
105	.47 (IV)	-.38 (XII)	.08	-
106	.50 (V)	.30 (XIII)	.16	4
107	.35 (I)	-.27 (V)	.05	-
108	.46 (XIII)	.31 (I)	.11	-
109	-.37 (II)	-.32 (V)	.04	-
110	.53 (VI)	-.40 (VIII)	.12	5
111	.48 (III)	-.48 (VIII)	.00	-
112	-.46 (V)	.28 (I)	.13	4
113	.48 (II)	-.35 (III)	.11	-
114	.32 (I)	-.29 (VI)	.02	-
115	.55 (VI)	.35 (IV)	.20	5
116	-.54 (XII)	-.30 (II)	.20	9
117	.56 (IV)	.29 (I)	.23	3
118	.40 (I)	-.24 (VII)	.10	-
119	.56 (III)	-.33 (XII)	.20	2
120	-.59 (XII)	.34 (III)	.23	9
121	-.48 (V)	.36 (XI)	.10	4
122	.70 (III)	.29 (IV)	.41	2
123	.32 (I)	.28 (VIII)	.02	-
124	.63 (III)	.32 (XII)	.30	2
125	-.59 (X)	.27 (VI)	.28	7
126	-.63 (II)	-.20 (IV)	.36	1
127	-.55 (X)	-.28 (VII)	.22	7

Case	Highest Loading	Second Highest Loading	Difference of Squares (DVI)	Type Designation
128	-.47 (VI)	.27 (II)	.15	-
129	-.53 (X)	-.33 (XII)	.17	7
130	-.36 (X)	.29 (I)	.05	-
131	-.35 (V)	.31 (XI)	.02	-
132	.59 (XI)	-.26 (IX)	.28	8
133	.43 (III)	.33 (VIII)	.07	-
134	-.44 (IX)	.28 (I)	.11	-
135	.37 (VI)	.31 (I)	.04	-
136	-.52 (X)	-.33 (II)	.16	7
137	-.48 (X)	.36 (I)	.10	7
138	.52 (XIII)	.22 (I)	.22	-
139	.36 (III)	.32 (XIII)	.03	-
140	-.49 (VIII)	-.47 (II)	.02	-
141	-.41 (II)	.38 (VIII)	.03	-
142	-.38 (II)	.29 (VIII)	.06	-
143	-.29 (IV)	.27 (I)	.01	-
144	-.60 (II)	.24 (I)	.30	1
145	.44 (IV)	-.20 (I)	.15	4
146	-.39 (XI)	.29 (IV)	.07	-
147	.45 (XII)	-.35 (VI)	.08	-
148	-.33 (VII)	.30 (IV)	.02	-
149	.32 (I)	.29 (IX)	.02	-
150	-.48 (II)	-.33 (X)	.12	1

SAMPLE B

Case	Highest Loading	Second Highest Loading	Difference of Squares (DVI)	Type Designation ††
1	-.72 (XIII)	.22 (II)	.47	7
2	-.41 (V)	.33 (II)	.06	-
3	.38 (VI)	.29 (IX)	.06	-
4	.60 (XII)	.26 (II)	.29	-
5	.30 (XII)	.28 (VI)	.01	-
6	.74 (II)	-.20 (VII)	.51	1
7	.46 (V)	-.33 (IV)	.10	3
8	.68 (II)	.22 (IX)	.41	1
9	.54 (II)	-.36 (X)	.16	1
10	.46 (II)	.33 (I)	.10	1
11	.32 (IX)	.31 (XIII)	.00	-
12	-.48 (XI)	-.39 (X)	.08	-
13	-.52 (XIII)	.50 (II)	.02	-
14	-.41 (I)	.29 (VIII)	.09	- †††
15	.47 (II)	.30 (IX)	.13	1
16	.66 (II)	-.30 (VII)	.35	1
17	.46 (II)	.22 (XIII)	.16	1

††- factors II, IV, V, VI, VII, XI, and XIII of Sample B correspond to types 1, 2, 3, 4, 5, 6, and 7, respectively.

Case	Highest Loading	Second Highest Loading	Difference of Squares (DVI)	Type Designation
18	.51 (XIII)	.36 (XI)	.13	-††††
19	.68 (II)	.25 (XII)	.40	1
20	-.44 (XIII)	.38 (II)	.05	-
21	.58 (II)	.20 (III)	.30	1
22	-.33 (XI)	.26 (X)	.04	-
23	.36 (VI)	-.33 (IV)	.02	-
24	-.38 (VII)	.32 (VI)	.04	-
25	.41 (II)	.35 (XI)	.05	-
26	.40 (VIII)	-.35 (XI)	.04	-
27	.37 (II)	-.30 (XIII)	.05	-
28	.55 (II)	-.34 (XIII)	.18	1
29	.40 (VI)	.26 (IX)	.09	-††††
30	.45 (VI)	-.33 (IV)	.09	-††††
31	.32 (I)	-.27 (III)	.03	-
32	.55 (II)	.27 (X)	.23	1
33	.79 (II)	.19 (III)	.58	1
34	-.43 (X)	.35 (VI)	.06	-
35	.46 (IX)	.30 (XII)	.12	-†††
36	-.58 (XI)	-.26 (XIII)	.27	6
37	-.50 (VII)	-.40 (V)	.09	-†††
38	.45 (IX)	-.32 (V)	.10	-†††
39	.33 (I)	.30 (VI)	.02	-
40	-.39 (XI)	-.38 (XIII)	.01	-

Case	Highest Loading	Second Highest Loading	Difference of Squares (DVI)	Type Designation
41	.39 (IV)	-.32 (XI)	.05	-
42	-.35 (IV)	.32 (V)	.02	-
43	-.41 (IX)	-.28 (VIII)	.09	-
44	-.36 (XIII)	.28 (IV)	.05	-
45	-.41 (IV)	.40 (I)	.01	-
46	.38 (VII)	.32 (VI)	.04	-
47	.59 (V)	.29 (VIII)	.27	3
48	.38 (V)	.36 (IX)	.01	-
49	.39 (VII)	.28 (XII)	.07	-
50	.33 (I)	.30 (VI)	.02	-
51	.44 (VII)	.28 (I)	.11	-
52	-.51 (XI)	.30 (VIII)	.17	6
53	-.46 (V)	.38 (III)	.07	-
54	-.38 (III)	-.36 (IX)	.01	-
55	.30 (III)	-.29 (VIII)	.01	-
56	.52 (IV)	-.29 (XIII)	.19	2
57	-.34 (XII)	.30 (VIII)	.03	-
58	.33 (IX)	-.31 (II)	.01	-
59	-.41 (XIII)	-.41 (V)	.00	-
60	-.50 (VI)	.27 (I)	.18	4
61	-.33 (IX)	-.31 (VI)	.01	-
62	-.65 (VII)	.21 (II)	.38	-
63	-.52 (VII)	-.20 (XI)	.23	-

Case	Highest Loading	Second Highest Loading	Difference of Squares (DVI)	Type Designation
64	.37 (XI)	.33 (I)	.03	-
65	-.37 (V)	.29 (VIII)	.06	-
66	-.48 (VI)	-.32 (II)	.13	4
67	.38 (VI)	-.35 (IV)	.02	-
68	-.53 (XI)	-.44 (VI)	.09	6
69	-.30 (XI)	.28 (VI)	.01	-
70	.37 (I)	.24 (VIII)	.08	-
71	-.62 (XIII)	.34 (IV)	.26	7
72	-.63 (XIII)	-.25 (I)	.34	7
73	.73 (IV)	.15 (I)	.51	2
74	.44 (IV)	.31 (I)	.09	2
75	-.41 (XIII)	-.38 (XII)	.02	-
76	.56 (VIII)	.25 (I)	.25	5
77	.51 (II)	.39 (III)	.11	1
78	.48 (VIII)	.32 (III)	.13	5
79	-.49 (VI)	-.41 (IX)	.07	-
80	-.44 (IX)	-.33 (XII)	.08	-
81	-.31 (I)	-.25 (XIII)	.04	-
82	-.60 (XIII)	-.27 (V)	.29	7
83	.38 (VII)	.36 (III)	.02	-
84	.26 (I)	.25 (X)	.01	-
85	-.62 (IX)	-.24 (VI)	.32	-
86	-.63 (VI)	-.42 (IX)	.22	4

Case	Highest Loading	Second Highest Loading	Difference of Squares (DVI)	Type Designation
87	.48 (V)	-.34 (II)	.11	3
88	-.32 (XI)	.32 (IV)	.00	-
89	.45 (VI)	-.42 (V)	.02	-
90	.35 (V)	-.28 (IV)	.04	-
91	-.42 (XI)	.35 (VIII)	.06	-
92	.55 (II)	-.40 (IX)	.14	1
93	-.54 (XI)	-.43 (VI)	.11	6
94	-.34 (IX)	.34 (IV)	.00	-
95	.65 (VIII)	-.30 (XI)	.33	5
96	.34 (IX)	.33 (I)	.01	-
97	-.42 (XIII)	.42 (X)	.00	-
98	.41 (V)	.28 (VIII)	.09	3
99	-.33 (I)	.28 (VIII)	.03	-
100	-.47 (XII)	.40 (IV)	.04	-
101	.55 (V)	.44 (VI)	.11	3
102	-.63 (VI)	.18 (V)	.37	4
103	.67 (IV)	.24 (VII)	.39	2
104	.59 (XII)	.27 (I)	.28	-
105	.44 (IV)	.43 (X)	.01	-
106	.60 (V)	.24 (I)	.30	3
107	.61 (VIII)	-.22 (IX)	.32	5
108	-.42 (VII)	-.4[illegible] (XI)	.02	-
109	.53 (V)	.28 (I)	.20	3

Case	Highest Loading	Second Highest Loading	Difference of Squares (DVI)	Type Designation
110	.62 (V)	-.26 (VIII)	.31	3
111	.46 (V)	.31 (I)	.11	3
112	-.61 (VI)	.20 (XIII)	.33	4
113	.65 (IX)	-.20 (V)	.38	- †††
114	-.44 (XI)	-.41 (IX)	.02	-
115	.52 (V)	.30 (I)	.18	3
116	.34 (X)	-.32 (VII)	.02	-
117	-.45 (V)	-.40 (IX)	.04	-
118	.74 (XII)	.20 (VII)	.51	- †††
119	.62 (III)	.30 (IV)	.28	- †††
120	-.39 (V)	.30 (VI)	.06	-
121	-.49 (VI)	-.31 (IX)	.14	4
122	-.74 (VI)	.15 (II)	.53	4
123	-.47 (III)	-.25 (V)	.15	-
124	-.34 (V)	.31 (XII)	.02	-
125	.47 (IX)	.31 (I)	.12	- †††
126	-.63 (XI)	-.29 (IX)	.32	6
127	.35 (III)	.30 (XIII)	.03	-
128	.36 (VI)	-.32 (X)	.03	-
129	-.36 (VII)	-.33 (XI)	.02	-
130	.62 (IV)	.26 (I)	.31	2
131	-.62 (XI)	-.29 (IX)	.30	6

Case	Highest Loading	Second Highest Loading	Difference of Squares (DVI)	Type Designation
132	.68 (VIII)	.21 (I)	.42	5
133	.40 (IV)	-.31 (XII)	.06	-
134	.51 (II)	-.41 (IX)	.09	1
135	.35 (XI)	.31 (I)	.02	-
136	-.40 (V)	.31 (VIII)	.06	-
137	-.49 (XI)	-.39 (IX)	.09	6
138	-.36 (VI)	-.33 (XIII)	.02	-
139	.47 (V)	-.29 (III)	.14	3
140	-.39 (IV)	.32 (I)	.05	-
141	.33 (VI)	-.26 (X)	.04	-
142	-.39 (IV)	.28 (I)	.07	-
143	-.40 (IV)	.39 (V)	.01	-
144	-.46 (VII)	.27 (X)	.14	-
145	-.47 (XI)	-.33 (XIII)	.11	6
146	-.42 (IX)	.37 (VI)	.04	-
147	-.55 (V)	.27 (I)	.23	-
148	-.66 (VI)	-.25 (III)	.38	4
149	-.71 (XIII)	-.26 (I)	.43	7
150	.42 (IV)	.38 (III)	.04	-

References

Baumann, U. Psychologische Taxonomie. Bern: Verlag Hans Huber, 1971.

Bentler, P. M., Jackson, D. N. and Messick, S. The identification of content and style: A multi-dimensional interpretation of acquiescence. Psychological Bulletin, 1971, 76, 186-204.

Brody, N. Personality research and theory. New York: Academic Press, 1972.

Burt, C. L. Correlations between persons. British Journal of Psychology, 1937, 28, 59-96.

Burt, D. L. Factors of the mind. London: University of London Press, 1940.

Carlson, K. A. A multivariate classification of reformatory inmates. Unpublished doctoral dissertation, University of Western Ontario, 1970.

Cassirer, E. Substance and function and Einstein's theory of relativity. New York: Dover, 1953.

Cattell, R. B. (ed.) Handbook of multivariate experimental psychology. Chicago: Rand McNalley and Company, 1966.

Cattell, R. B., Coulter, M. A. and Tsujioka, B. The taxonometric recognition of types and functional emergents. In R. B. Cattell (ed.) Handbook of multivariate experimental psychology. Chicago: Rand McNalley and Company, 1966, 288-329.

Cattell, R. B. The integration of functional and psychometric requirements in a quantitative and computerized diagnostic system. In A. R. Mahrer (ed.) New approaches to personality classification. New York: Columbia University Press, 1970, 9-52.

Cronbach, L. J. and Gleser, G. C. Assessing similarities between profiles. Psychological Bulletin, 1953, 50, 456-473.

Cureton, E. E. Validity, reliability and baloney. Educational and Psychological Measurement, 1950, 10, 94-96.

Dahlstrom, W. G., Welsh, G. and Dahlstrom, V. MMPI Handbook. Volume 1 Minneapolis: University of Minnesota Press, 1972.

Dunlop, E. (ed.) Essentials of the automated MMPI: A compendium of clinical information. Glendale, California: Institute of Clinical Analysis, 1966. (O. K. Buros (ed.) Seventh mental measurements yearbook, 1972, 253-255).

Eysenck, H. J. (ed.) Experiments in personality. London: Routledge and Kegan Paul, 1960.

Eysenck, H. J. A dimensional system of psycho-diagnostics. In A. R. Mahrer (ed.) New approaches to personality classification. New York: Columbia University Press, 1970, 169-207.

Fowler, R. D., Jr. Automated interpretation of personality test data. In J. N. Butcher (ed.), MMPI: Research developments and clinical application. New York: McGraw-Hill, 1969, 105-126.

Guertin, W. H. The search for recurring patterns among individual profiles. Educational and Psychological Measurement, 1966, 26, 151-165.

Guertin, W. H. Typing ships with transpose factor analysis. Educational and Psychological Measurement, 1971, 31, 397-406.

Guilford, J. P. and Hoepfner, R. Comparisons of varimax rotations with rotations to theoretical targets. Educational and Psychological Measurement, 1969, 29, 3-22.

Harman, H. Modern factor analysis. Chicago: University of Chicago Press, 1960.

Hathaway, S. R. and McKinley, J. C. Minnesota Multiphasic Personality Inventory Manual. New York: The Psychological Corporation, 1967.

Horn, J. L. Significance tests for use with r_p and related profile statistics. Educational and Psychological Measurement, 1961, 21, 363-370.

Horn, J. L. On subjectivity in factor analysis. Educational and Psychological Measurement, 1967, 27, 811-820.

Horst, P. Factor analysis of data matrices. New York: Holt, Rinehart and Winston, 1965.

Hurley, J. R. and Cattell, R. B. The Procrustes Program: Producing direct rotation to test a hypothesized factor structure. Behavioural Science, 1962, 7, 258-262.

Jackson, D. N. and Carlson, K. A. Convergent and discriminant validation of the differential personality inventory. Journal of Clinical Psychology, 1973, 29, 214-219.

Jackson, D. N. and Morf, M. E. An empirical evaluation of factor reliability. Multivariate Behavioural Research, 1973, 8, 439-460.

Kaiser, H. F. The varimax criterion for analytic rotation in factor analysis. Psychometrica, 1958, 23, 187-200.

Kaiser, H. F. and Caffrey, J. Alpha factor analysis. Psychometrica, 1965, 30, 1-14.

Lorr, M. A typological conception of the behaviour disorders. In A. R. Mahrer (ed.) New approaches to personality classification. New York: Columbia University Press, 1970, 101-116.

Mahalanobis, P. C. On the generalized distance in statistics. Proceedings of the National Institute of Science of India, 1936, 2, 49-55.

Mahrer, A. R. (ed.) New approaches to personality classification. New York: Columbia University Press, 1970.

Mead, G. H. Mind, self and society: From the standpoint of a social behaviourist. Chicago: University of Chicago Press, 1934.

Meehl, P. E. Clinical versus statistical prediction. Minneapolis: University of Minnesota Press, 1954.

Morf, M. E. and Krane, W. R. A strategy for developing automated assessment systems. Behavioural Science, 1973, 18, 294-306.

Nunnally, J. C. Psychometric theory. New York: McGraw-Hill, 1967.

Overall, J. E. and Klett, C. J. Applied Multivariate analysis. New York: McGraw-Hill, 1972.

Sines, J. O. Actuarial versus clinical prediction in psychopathology. British Journal of Psychiatry, 1970, 116, 129-144.

Skinner, H. A. Development of a Multivariate Personality Taxonomy for Alcoholic Patients. Unpublished Masters Thesis, University of Western Ontario, 1973.

Sneath, P. H. A. New approaches to bacterial taxonomy: use of computers. Annual Review of Microbiology, 1964, 18, 335-346.

Sneath, P. H. A. and Sokal, R. R. Numerical taxonomy. San Francisco: W. H. Freeman and Company, 1973.

Sokal, R. R. Distance as a measure of taxonomic similarity. Systematic Zoology, 1961, 10, 70-79.

Stephenson, W. The inverted factor technique. British Journal of Psychology, 1936, 26, 344-361.

Szasz, T. S. The problem of psychiatric nosology: A contribution to a situational analysis of psychiatric operations. American Journal of Psychiatry, 1957, 114, 405-413.

Szasz, T. S. The myth of mental illness. New York: Hoeber-Harper, 1961.

Trott, D. M. and Morf, M. E. A multimethod factor analysis of the differential personality inventory, personality research form, and Minnesota multiphasic personality inventory Journal of Counselling Psychology, 1972, 19, 94-103.

Trouton, D. S. and Maxwell, A. E. The relation between neurosis and psychosis. Journal of Mental Science, 1956, 102, 1-21.

Zigler, E. and Phillips, L. Psychiatric diagnosis: A critique. Journal of Abnormal and Social Psychology, 1961, 63, 607-618.

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