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RADEX STRUCTURE OF JACKSON'S BASIC PERSONALITY INVENTORY

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Summary—The sub-scale structure of Jackson's Basic Personality Inventory (Jackson, *Manual for the Basic Personality Inventory*, 1989) has been explored in a number of different investigations. The chief conclusions are that: (1) the sub-scales of the BPI are three-dimensional; (2) the three factors are Psychiatric Symptomatology, Social Symptomatology, and Depression; (3) this structure is invariant over the populations studied to date. Conclusions made about structure, however, are a function of the technique employed. Conclusions (1)–(3) were reached via the traditional factor/component analysis program of investigation. In the present study facet analysis and multidimensional scaling were used in a reanalysis of BPI data from nine different samples. The results indicated that the BPI is more satisfactorily portrayed as a two-dimensional radex (Guttman, *Educational and Psychological Measurement, 17*, 391–407, 1957). Cross-sample invariance was still obtained. The discovery of the radex structure of the BPI suggests links to other circular characterizations of Personality and Psychopathology variables, several of which were discussed.

INTRODUCTION

The Basic Personality Inventory (BPI) is a 12 sub-scale Psychopathology inventory constructed according to Jackson's construct-oriented approach (Jackson, 1971, 1989). The sub-scales have been shown to have sound psychometric properties (Jackson, 1989; Kroner, Reddon & Beckett, 1991; Holden, Reddon, Jackson & Helmes, 1983). Given that the psychometric properties of the scales are acceptable, one may turn to an examination of the structural characteristics of the inventory at the sub-scale level, and, in addition, its structure in different populations of respondents. These secondary issues have been explored in a number of studies. Chrisjohn, Jackson and Lanigan (1984) studied high school normals, psychiatric patients and juvenile delinquents, Austin, Lescheid, Jaffe and Sas (1986) studied young offenders, and Bjorgvinsson and Thompson (1994) studied Icelandic high school normals. A number of conclusions have been reached from these studies. First, the sub-scales of the BPI are three-dimensional. Second, the three dimensions are Psychiatric Symptomatology (Hypochondriasis, Persecutory Ideas, Anxiety, Thinking Disorder, Deviation), Social Symptomatology (Interpersonal Problems, Alienation, Impulse Expression), and Depression (Depression, Social Introversion, Self Depreciation). Third, this structure is invariant over the populations studied.

A theme that runs unavoidably through analyses of structure, however, pertains to the choice of analytic strategy. The task in structural analysis is representation and, significantly, there are many ways of representing the relationships among a set of variables. It is noteworthy that in this capacity the factor analytic programme of investigation is the usual choice. This programme typically involves the factor, or component, analysis of a correlation matrix, the application of a set of statistical or heuristic tests to decide on the dimensionality, the rotation of the solution to simple structure, and the interpretation of the results in terms of the structural relations of variables to each of the factors (see e.g. Gorsuch, 1983). This is, for the most part, the approach taken in past analyses of the structure of the BPI.

There are a number of reasons why this traditional program may not always be the most useful. First, factor analysis demands a linear mapping of solution space coordinates (i.e. the factor loadings) into proximities (i.e. the correlations). This mapping is not the only reasonable mapping, and may in fact generate a higher dimensional solution space than necessary. This may, in turn, militate against the detection of interesting structures, since it is more difficult to examine a higher dimensional representation than a lower one. Second, no guidance is provided as to what the investigator should

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expect from the variables. What should one expect of the dimensionality of the variables, and, just as importantly, their arrangement in the k-dimensional solution space? Without prior guidance in this matter, the investigator enters an investigation with little idea of what a 'good' representation might look like (Guttman, 1971; Borg & Lingoes, 1989). This can foster an unnecessary dependence on non-substantive, piecemeal tests and heuristics. Simple structure, for instance, is not a substantive criterion, but an expedient to overcome the inherent rotational indeterminacy of the model, while piecemeal tests and heuristics to decide on dimensionality (e.g. roots greater than one, scree test) are decidedly non-substantive. Third, the practice of dimensional interpretation militates against the detection of interesting regional structures because important manifolds in the solution space are not always evident when loadings are examined one factor at a time (Shye, 1978). In addition, the number of dimensions must be taken to be equal to the dimensionality of the representation (Borg & Lingoes, 1989). In scale analysis there is a long tradition of failing to distinguish between the dimensionality of the euclidean embedding (solution) space, and the intrinsic dimensionality of the point manifolds found in these spaces. While it may seem that confirmatory factor analysis overcomes certain of these problems (e.g. in the statement of prior hypotheses and the use of a formal test dimensionality) it still involves a linear mapping, higher dimensional solutions, and standard dimensional interpretations.

The pairing of Guttman's facet analysis with non-metric multidimensional scaling is an alternative to the standard program. Guttman and his colleagues have shown this approach to be a fruitful means of analysing the structure of a set of variables, with applications to many domains, including wellbeing (Levy & Guttman, 1981), intelligence (Guttman, 1957), and attitudes toward aspects of work (Elizur & Guttman, 1976). Dancer (1985) employed this technique in a revealing analysis of the Rosenberg Self-esteem scale. In facet analysis, one constructs a facet definition for the items or sub-scales of a test. The facet definition describes the way in which the variables should be related empirically. Specifically, it provides for an hypothesis as to the dimensionality and arrangement of a set of variables, thus providing *a priori* guidance to the investigator in regard to the representation of the variables. These hypotheses are, in addition, often more restrictive than those typically seen in confirmatory factor analysis. Guttman and his associates have established the types of empirical structure to be expected from a number of different types of facet definition. Famous examples include the simplex, radex, multiplex, and circumplex (see Shye, 1978). The other member of the pair, multidimensional scaling, demands only a monotonic mapping of distances (based on the solution space coordinates) into proximities. As a result, a smaller dimensionality (as compared to factor analysis) is typically adequate to represent a set of variables. Thus, it is easier to assess whether the solution space contains the structure hypothesized by the facet analysis. It is well known, however, that in the event that the best monotonic mapping is a linear one, the dimensionalities and representations generated by factor analysis and multidimensional scaling are roughly the same (Schlesinger & Guttman, 1969). In this paper we employ the facet analysis/multidimensional scaling pair in a re-analysis of BPI data from nine different populations.

METHOD

Subjects

Data from nine different populations were analysed: adult psychiatric patients ($N = 404$) (Chrisjohn *et al.*, 1984), adult normals ($N = 182$) (Chrisjohn *et al.*, 1984), male ($N = 278$) and female ($N = 538$) high school normals (Smiley, 1977), male ($N = 245$) and female ($N = 279$) delinquents (Smiley, 1977), mixed (male/female) high school normals from Alberta ($N = 1444$) (Reddon, 1980), and male ($N = 268$) and female ($N = 341$) high school normals from Iceland (Bjorgvinsson & Thompson, 1994).

Facet definition

A facet definition was derived for 11 of the sub-scales of the BPI. The denial scale was excluded from the analysis (see Chrisjohn *et al.*, 1984; Bjorgvinsson & Thompson, 1994). The facet definition is provided in Fig. 1.

There are two facets which jointly characterize the sub-scales of the BPI. Facet A is a primary classifier since it is the primary basis for assessment, and corresponds to the Depression/Social Symptomatology/Psychiatric Symptomatology distinction of past research on the BPI. Each sub-scale

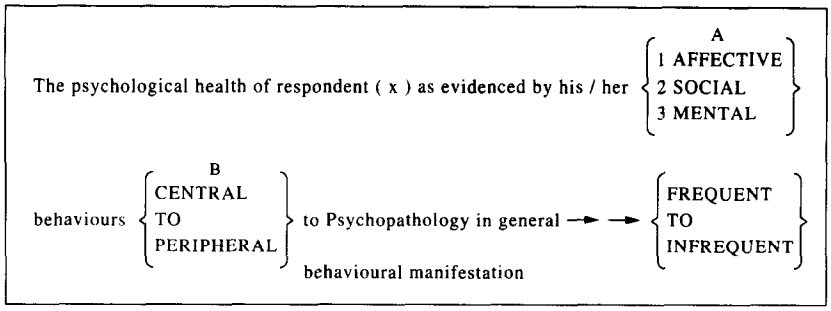

Fig. 1. Facet definition for the BPI sub-scales.

of the BPI involves behavior from one of these modalities. Depression, for instance, falls in the affective category. Facet B, on the other hand, is a modifying facet, since it merely clarifies facet A. The idea is that certain types of behavior, e.g., thinking disorder, play less of a role in the definition of Psychopathological syndromes than others (e.g. depression). It is suggested, therefore, that BPI sub-scales represent types of behavior that vary in terms of how frequently they conjoin with other types of behavior to produce Psychopathological syndromes. Facet A also happens to be a polarizing facet, there being no order implied by the relationships among its elements. Facet B, on the other hand, is a modulating facet since the central to peripheral modifiers are clearly ordered, with 'central' playing the role of an origin for the items. Each respondent is assigned a total score on each sub-scale, thus mapping types of Psychopathology (characterized jointly by facets A and B) into a frequency measure.

By choosing an element from each of the two facets, each sub-scale is described by a two element 'structuple' (an ordered description of the sub-scale in terms of the facets). For example, Persecutory Ideas is described by element 3 of facet A (i.e. it belongs to the domain of mental problems), while Depression is characterized by element 1 of facet A. However, we were not able to arrive at a complete hypothesis of ordering for the second facet. The sub-scales were, therefore, classified only in terms of the first facet, with the effect of the second facet left as an exploratory issue. The structuples associated with each sub-scale are given in Table 1.

The fact that the BPI sub-scales are described by one polarizing and one modulating facet provides grounds for the hypothesis of a two-dimensional radex (Guttman, 1957; Canter, 1985). In a two-dimensional radex items are arranged regionally according to their assigned structuples. That is, items with the same structuple are located in the same region of the solution space. The polarizing facet divides the space into conical regions emanating from a common origin, the number of these regions being equal to the number of elements in the polarizing facet. The modulating facet further divides the space by the super-imposition of concentric circles about the origin, the number of circles being equal to the number of elements in the modulating facet. In effect, the radex is generated by the pairing of a circumplex and simplex ordering inherent in the items (Shye, 1978). The result is a partition of the two-dimensional solution space into $p \times q$ regions, where p and q are the number of elements in the polarizing and modulating facets, respectively.

Table 1. BPI sub-scales and associated structuples

Sub-scale	Structuple
Hypochondriasis	a3b?
Depression	a1b?
Interpersonal Problems	a2b?
Alienation	a2b?
Persecutory Ideas	a3b?
Anxiety	a3b?
Thinking Disorder	a3b?
Impulse Expression	a2b?
Social Introversion	a1b?
Self Depreciation	a3b?
Deviation	a3b?

Table 2. Intercorrelations of the BPI subscales

	Hypo	Depr	IntP	Alie	Pers	Anxi	Thin	ImpE	Soci	Self	Devi
Adult Psychiatric Patients (N = 404)[a]											
Hypo	1.000										
Depr	0.430	1.000									
IntP	0.214	0.332	1.000								
Alie	0.249	0.263	0.531	1.000							
Pers	0.471	0.496	0.406	0.519	1.000						
Anxi	0.513	0.692	0.347	0.206	0.530	1.000					
Thin	0.549	0.412	0.314	0.352	0.630	0.543	1.000				
ImpE	0.398	0.480	0.513	0.503	0.515	0.543	0.486	1.000			
Soci	0.210	0.550	0.270	0.340	0.368	0.395	0.275	0.272	1.000		
Self	0.359	0.731	0.263	0.319	0.476	0.590	0.469	0.474	0.607	1.000	
Devi	0.575	0.616	0.403	0.492	0.618	0.588	0.617	0.588	0.474	0.618	1.000
Mixed High School Normals (N = 1444)[b]											
Hypo	1.000										
Depr	0.462	1.000									
IntP	0.139	0.228	1.000								
Alie	0.112	0.226	0.467	1.000							
Pers	0.455	0.552	0.352	0.365	1.000						
Anxi	0.476	0.410	0.175	0.021	0.405	1.000					
Thin	0.509	0.384	0.153	0.224	0.467	0.430	1.000				
ImpE	0.225	0.211	0.436	0.399	0.255	0.214	0.278	1.000			
Soci	0.106	0.382	0.110	0.176	0.219	0.066	0.116	−0.012	1.000		
Self	0.323	0.592	0.205	0.230	0.408	0.318	0.376	0.240	0.457	1.000	
Devi	0.502	0.509	0.272	0.390	0.518	0.357	0.598	0.308	0.249	0.466	1.000
Male High School Normals (N = 278)[c]											
Hypo	1.000										
Depr	0.500	1.000									
IntP	0.270	0.310	1.000								
Alie	0.300	0.410	0.420	1.000							
Pers	0.460	0.580	0.380	0.430	1.000						
Anxi	0.490	0.420	0.260	0.160	0.420	1.000					
Thin	0.430	0.360	0.230	0.210	0.440	0.360	1.000				
ImpE	0.280	0.370	0.440	0.480	0.390	0.270	0.330	1.000			
Soci	0.300	0.480	0.220	0.260	0.340	0.240	0.070	0.150	1.000		
Self	0.340	0.650	0.140	0.400	0.430	0.280	0.270	0.330	0.500	1.000	
Devi	0.550	0.600	0.370	0.520	0.540	0.370	0.560	0.470	0.190	0.490	1.000
Male Delinquents (N = 245)[c]											
Hypo	1.000										
Depr	0.450	1.000									
IntP	0.190	0.330	1.000								
Alie	0.190	0.270	0.450	1.000							
Pers	0.470	0.490	0.330	0.320	1.000						
Anxi	0.460	0.440	0.150	0.080	0.370	1.000					
Thin	0.470	0.460	0.130	0.220	0.430	0.510	1.000				
ImpE	0.240	0.400	0.480	0.420	0.360	0.310	0.270	1.000			
Soci	0.450	0.510	0.210	0.160	0.360	0.300	0.380	0.200	1.000		
Self	0.440	0.660	0.360	0.300	0.410	0.440	0.440	0.420	0.520	1.000	
Devi	0.560	0.480	0.280	0.360	0.520	0.480	0.570	0.360	0.480	0.540	1.000
Adult Normals (N = 182)[a]											
Hypo	1.000										
Depr	0.507	1.000									
IntP	0.227	0.338	1.000								
Alie	0.145	0.274	0.341	1.000							
Pers	0.367	0.532	0.309	0.404	1.000						
Anxi	0.475	0.539	0.345	0.112	0.462	1.000					
Thin	0.343	0.347	0.091	0.232	0.566	0.397	1.000				
ImpE	0.219	0.300	0.396	0.403	0.416	0.379	0.386	1.000			
Soci	0.246	0.364	0.225	0.225	0.323	0.325	0.122	0.115	1.000		
Self	0.309	0.420	0.142	0.082	0.353	0.463	0.395	0.214	0.423	1.000	
Devi	0.450	0.541	0.292	0.473	0.618	0.460	0.564	0.523	0.263	0.314	1.000
Female Delinquents (N = 279)[c]											
Hypo	1.000										
Depr	0.530	1.000									
IntP	0.390	0.380	1.000								
Alie	0.270	0.350	0.530	1.000							
Pers	0.420	0.500	0.450	0.330	1.000						
Anxi	0.490	0.440	0.250	0.080	0.450	1.000					
Thin	0.620	0.440	0.330	0.350	0.480	0.430	1.000				
ImpE	0.330	0.430	0.550	0.460	0.320	0.300	0.420	1.000			
Soci	0.330	0.510	0.200	0.230	0.330	0.260	0.300	0.180	1.000		
Self	0.400	0.720	0.370	0.350	0.410	0.290	0.400	0.440	0.540	1.000	
Devi	0.640	0.620	0.470	0.410	0.480	0.460	0.610	0.460	0.370	0.510	1.000

—continued opposite

Table 2—*continued*

	Hypo	Depr	IntP	Alie	Pers	Anxi	Thin	ImpE	Soci	Self	Devi
					Female High School Normals (N = 538)[c]						
Hypo	1.000										
Depr	0.510	1.000									
IntP	0.270	0.330	1.000								
Alie	0.280	0.390	0.550	1.000							
Pers	0.500	0.590	0.380	0.420	1.000						
Anxi	0.500	0.440	0.310	0.250	0.530	1.000					
Thin	0.470	0.390	0.230	0.280	0.480	0.390	1.000				
ImpE	0.390	0.390	0.510	0.480	0.400	0.350	0.370	1.000			
Soci	0.230	0.420	0.170	0.210	0.340	0.320	0.110	0.050	1.000		
Self	0.400	0.640	0.280	0.380	0.510	0.460	0.340	0.420	0.470	1.000	
Devi	0.540	0.540	0.370	0.430	0.540	0.430	0.580	0.480	0.220	0.490	1.000
					Icelandic Male High School Normals (N = 268)[d]						
Hypo	1.000										
Depr	0.380	1.000									
IntP	0.210	0.170	1.000								
Alie	0.220	0.350	0.490	1.000							
Pers	0.410	0.530	0.350	0.450	1.000						
Anxi	0.430	0.440	0.270	0.270	0.470	1.000					
Thin	0.360	0.290	0.310	0.310	0.380	0.280	1.000				
ImpE	0.290	0.300	0.450	0.560	0.460	0.360	0.350	1.000			
Soci	0.070	0.420	0.060	0.170	0.230	0.190	0.100	0.080	1.000		
Self	0.290	0.610	0.170	0.280	0.460	0.410	0.250	0.300	0.380	1.000	
Devi	0.480	0.450	0.410	0.510	0.510	0.390	0.550	0.500	0.160	0.390	1.000
					Icelandic Female High School Normals (N = 341)[d]						
Hypo	1.000										
Depr	0.470	1.000									
IntP	0.410	0.300	1.000								
Alie	0.320	0.360	0.410	1.000							
Pers	0.560	0.590	0.350	0.440	1.000						
Anxi	0.510	0.470	0.360	0.280	0.540	1.000					
Thin	0.510	0.330	0.300	0.360	0.520	0.420	1.000				
ImpE	0.320	0.280	0.460	0.440	0.390	0.300	0.430	1.000			
Soci	0.140	0.450	0.070	0.150	0.260	0.210	0.100	0.040	1.000		
Self	0.340	0.670	0.220	0.370	0.540	0.350	0.250	0.300	0.540	1.000	
Devi	0.560	0.570	0.410	0.430	0.590	0.450	0.600	0.470	0.180	0.400	1.000

Note: Hypo, Hypochondriasis; Depr, Depression; IntP, Interpersonal Problems; Alie, Alienation; Pers, Persecutory Ideas; Anxi, Anxiety; Thin, Thinking Disorder; ImpE, Impulse Expression; Soci, Social Introversion; Self, Self Depreciation; Devi, Deviation.

[a]From Chrisjohn *et al.* (1984).

[b]From Reddon (1980).

[c]From Smiley (1977).

[d]From Bjorgvinsson and Thompson (1994).

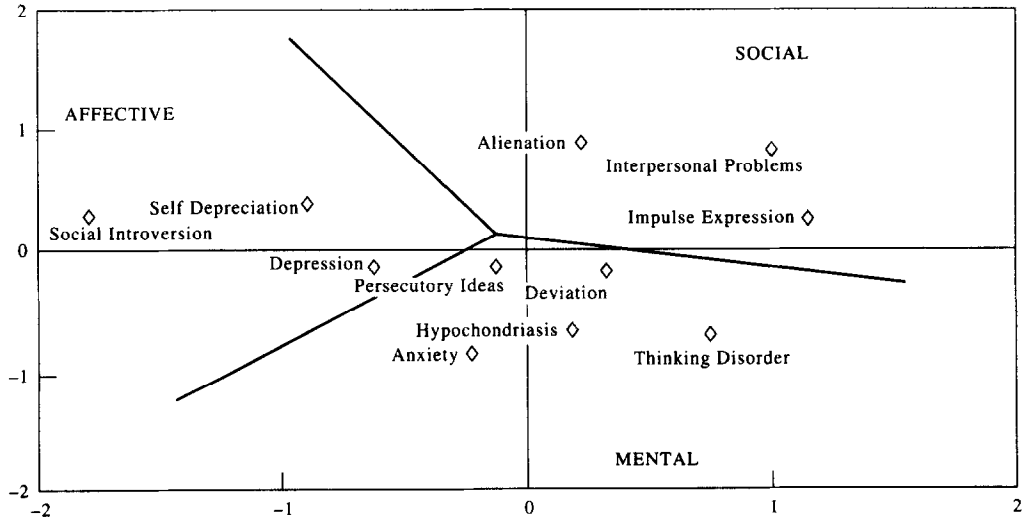

Fig. 2. Two-dimensional solution for adult psychiatric patients. Note: stress = 0.108.

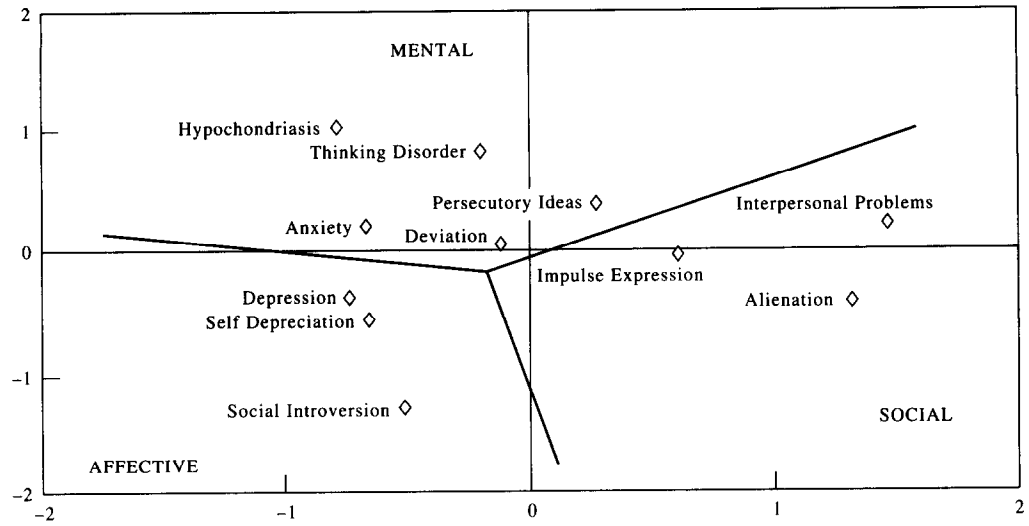

Fig. 3. Two-dimensional solution for male high school normals. Note: stress = 0.188.

It is hypothesized that the 11 BPI sub-scales analysed here will conform empirically to a two-dimensional radex. Specifically, the 11 sub-scales will be partitioned in a two-dimensional solution space into three conical regions according to their assigned values on facet A. Hence, the mental, affective, and cognitive sub-scales should each occupy one conical region. Ignoring the modulating facet (which here plays an exploratory role), and assuming the solution space to be two-dimensional, the probability of this structure arising by chance is approx. 0.00011 (assuming a random sampling of sub-scales into regions). Thus, the radex hypothesis clearly places non-trivial restrictions on the empirical structure of the BPI sub-scales.

RESULTS

The correlation matrix for each sample is provided in Table 2.

Non-metric multidimensional scaling (primary approach to ties, stress formula 1) was applied to each. Adequate two-dimensional representations were found for all data sets (stress ranging from 0.102 to 0.188), and these are displayed in Figs 2–8.

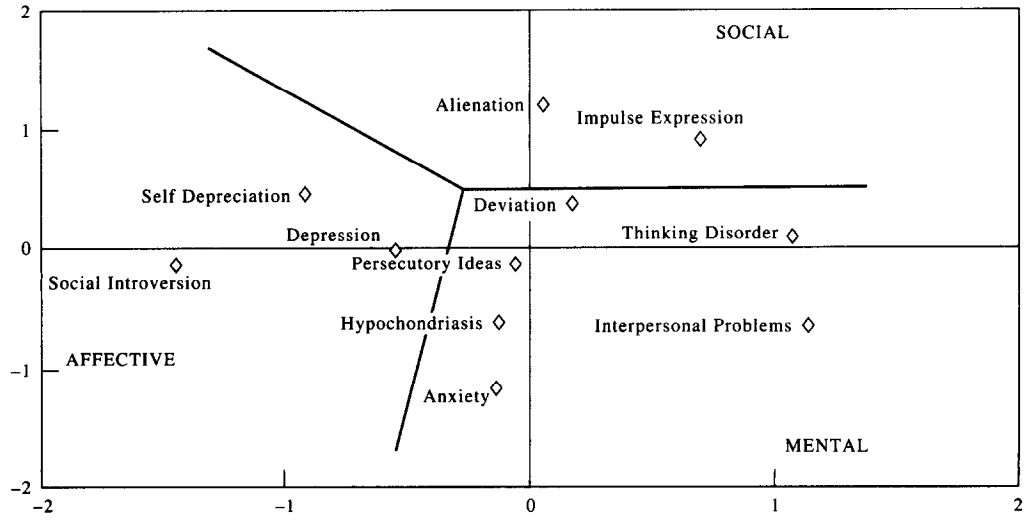

Fig. 4. Two-dimensional solution for adult normals. Note: stress = 0.132.

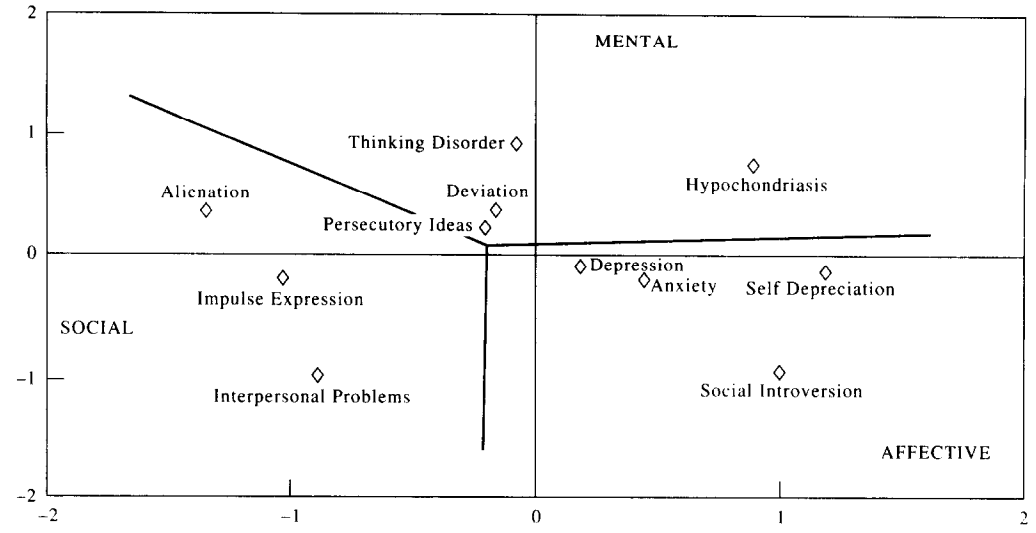

Fig. 5. Two-dimensional solution for male delinquents. Note: stress = 0.103.

The hypothesized radex structure described all of the samples, with several minor exceptions. First, for the adult normals, Anxiety was located marginally inside the region of the Affective sub-scales. Second, for the male high school normals, Interpersonal problems was located in the region of the mental sub-scales. Finally, for the female high school normals and Icelandic male high school normals, facet A behaved in an axial, rather than a polarizing, fashion. An axial facet is a facet with ordered elements (Shye, 1978). Here the mental/affective/cognitive distinction of facet A was ordered in the solution space from affective to mental to social. There is no clear explanation for this ordering, but, at a descriptive level, affective and social problems were less likely to coincide in these samples than mental and social, or mental and affective problems. Hence, for these samples the circumplex ordering implied by the polarizing facet did not obtain.

With respect to the exploratory issue of the ordering of the sub-scales in the modulating direction, the following was evident. In general, Depression, Deviation, and Persecutory Ideas defined the origin of the radex structure in the samples. This suggests that these are most central or most common to Psychopathological problems in general. Depression, for example, is drawn to the centre of the structure because it enters into a wide range of syndromes involving mental and social behaviours, as well as other affective behaviours. Anxiety was located near the centre only for adult normals and psychiatric patients. Within the region of the Affective sub-scales, the sub-scales were ordered (from

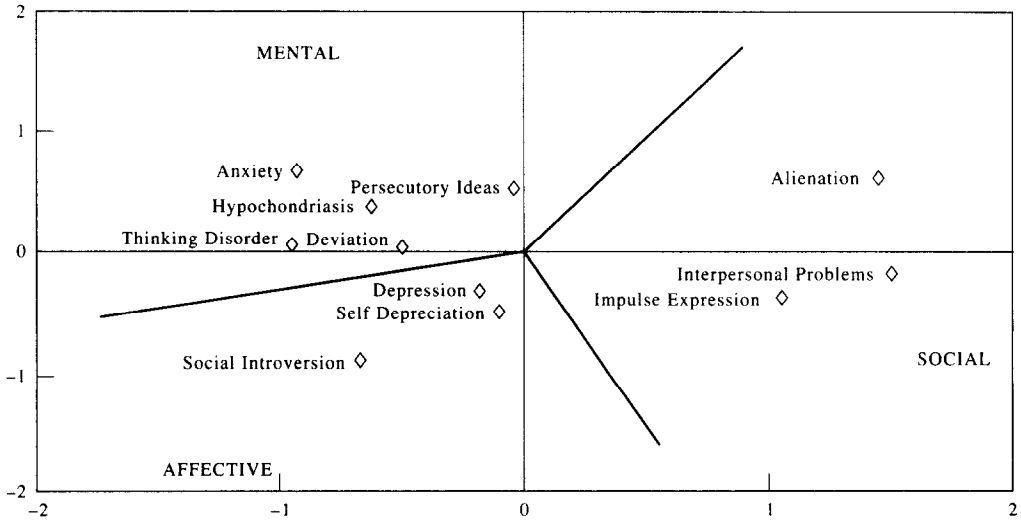

Fig. 6. Two-dimensional solution for mixed high school normals. Note: stress = 0.107.

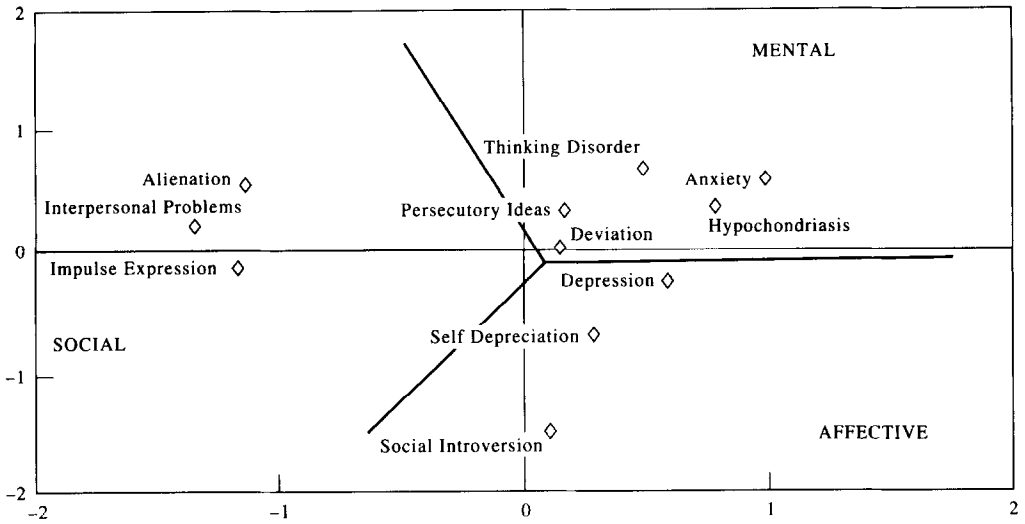

Fig. 7. Two-dimensional solution for female high school normals. Note: = 0.132.

the origin out) Depression, Self-depreciation, and Social Introversion in six of the nine samples. Self-depreciation and Depression exchanged positions in the adult psychiatric, mixed high-school normal, and female delinquent samples. Within the region of the Mental sub-scales, Persecutory Ideas and Deviation were closest to the origin in all of the samples. Finally, there was not a consistent ordering within the region of the Social sub-scales.

DISCUSSION

The use of facet analysis in conjunction with multidimensional scaling reveals that the sub-scales of the BPI have a highly articulated, meaningful, low dimensional radex structure. This finding is in keeping with other lines of research (Wiggins, 1982; Kiesler, 1983; Romney & Bynner, 1992), that have found circular orderings to be fundamental to the domains of Personality and Psychopathology. In fact, the radex structure of the BPI might have been hypothesized according to the following line of reasoning. First, the affective, social, and mental elements of facet A of the BPI are very similar

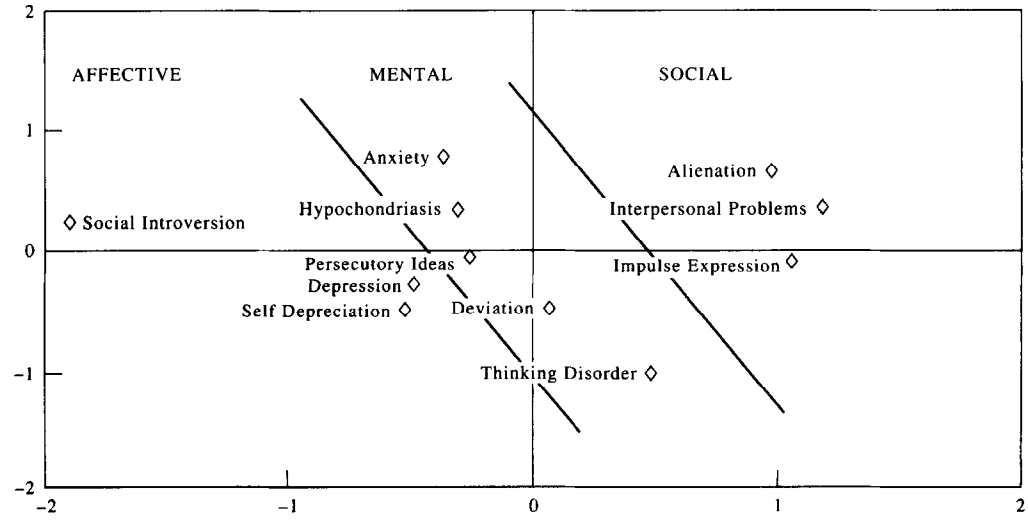

Fig. 8. Two dimensional solution for female delinquents. Note: stress = 0.124.

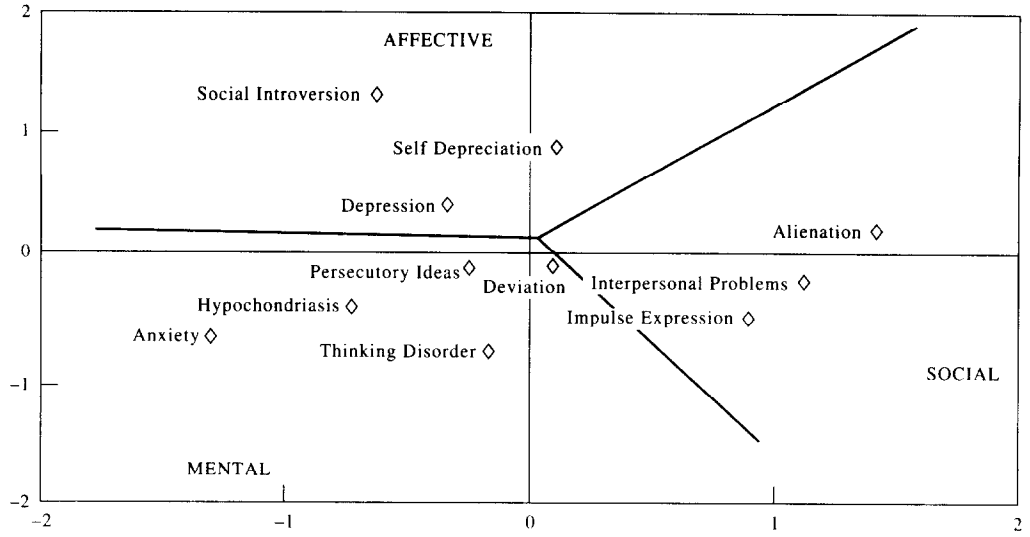

Fig. 9. Two-dimensional solution for Icelandic male high school normals. Note: stress = 0.118.

to Eysenck's (1981) Introversion/Extraversion, Psychoticism, and Neuroticism dimensions, respectively (Bjorgvinsson & Thompson, 1994). Second, Goldberg (1981) has shown that Eysenck's three dimensions fit within the framework of the Big Five model of personality (Fiske, 1949; Norman, 1963). Specifically, Eysenck's Psychoticism is represented jointly by the Big Five's Agreeableness and Conscientiousness dimensions, Eysenck's extraversion dimension by the Big Five's Extraversion dimension, and Eysenck's Neuroticism dimension by the Emotional Stability dimension of the Big Five. Finally, many of the variables characterized by the Big Five have a circumplex structure (Wiggins, 1982; Romney & Bynner, 1992; Hofstee, de Raad & Goldberg, 1992). Thus, on these grounds the circumplex component of the BPI radex is not surprising.

What of the simplex ordering that corresponds to the modulating facet? Widiger and Frances (1985, p. 621) stated that "the interpersonal circle might fail to adequately represent all the cognitive and affective variables that are integral to the concept of personality disorder." In studying a sub-set of the 11 DSM-III personality disorders, Romney and Bynner (1992) found that indeed those with a cognitive component (e.g. compulsive and passive–aggressive disorders) did not fit onto the circumplex of personality disorders. They instead found that these cognitive disorders had a distinct

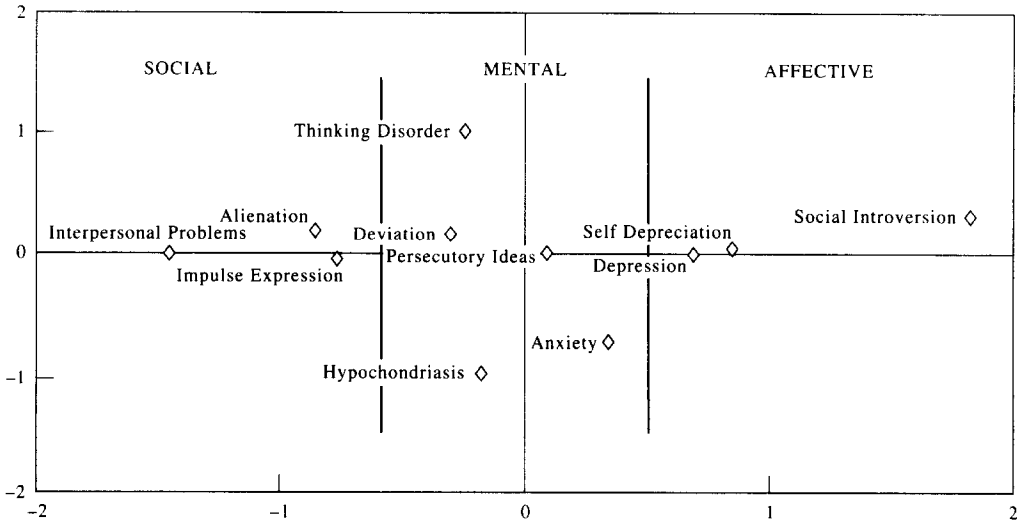

Fig. 10. Two-dimensional solution for Icelandic female high school normals. Note: stress = 0.102.

simplex structure (Romney & Bynner, 1992). These points, in conjunction with the present findings, suggest that a joint representation of the personality disorders of the DSM-III, may well exist in the form of a radex. The reason for this is that the simplex ordering that is nested within each circumplex region of a radex may accommodate the simplex structuring that certain of these sets of Personality variables (e.g. the cognitive disorders) seem to require. Interestingly, Leary's (1957) original 'circumplex model' of disorders is, in fact, a radex, since he posited a circular ordering around a common centre, and an ordering from the centre (mild forms of the trait) to the extremes (severe forms of the trait). The present research indicates that this theoretical structuring describes very well the BPI's characterization of Psychopathology.

The radex structure of the BPI was highly invariant over the nine samples studied. This invariance is remarkable, for the radex is a more refined structure than a three-factor factor analysis solution. The additional level of invariance found in the present work involves the central to peripheral ordering within circumplex regions. For example, it was found that depression, deviation, and persecutory ideas consistently had central positions in the samples. Thus, it appears that these three disorders define the core of psychopathology as characterized by the BPI. Anxiety was also near the centre for the adult normals and psychiatric patients. The latter result makes sense given the central role of anxiety in many commonly occurring psychopathological syndromes. Finally, the ordering of the sub-scales in the affective region was invariant over eight of the samples.

It is of interest to compare these results with the factor analytic results of past studies. These factor analyses, of course, recovered the polarizing facet (i.e. the mental/affective/social distinction) in three dimensions. Other characteristics of the BPI, however, were not portrayed. As previously noted, one oversight was the simplex ordering arising from the modulating facet (i.e. the central to peripheral ordering). A second was the circumplex ordering of the sub-scales arising from the polarizing facet. The result of these oversights was a mischaracterization of the BPI, and, interestingly, difficulties in modelling the structure of the sub-scales. For example, in both the Chrisjohn *et al.* (1984) and Bjorgvinsson and Thompson (1994) studies, questions were raised about the factors on which certain of the sub-scales loaded. Deviation and Persecutory Ideas tended to load on both Psychiatric Symptoms and Social Symptoms. The discovery of the radex structure of the BPI parsimoniously explains this cross-loading. Specifically, the circumplex ordering of a radex corresponds to sub-scale association that 'goes in a circle' (i.e. the circular pattern of correlations) (Shye, 1978). Hence, a variable in one region of the radex may be most highly correlated with variables in another, rather than with variables in its own region. Hofstee *et al.* (1992), among others, suggest that a portrayal of personality variables as mixes of basic types may in general be more appropriate than a portrayal based on the assignment of variables to single dimensions. The variables in a radex structure have a continuous membership value in the regions (or types) that comprise the circumplex. In fact, variables could in theory be sampled from a population of BPI sub-scales until the two-dimensional radex was 'full', and the regional boundaries thoroughly blurred. Figures 2–8 indicate that Deviation and Persecutory Ideas are typically located at the border of the mental and social regions of the radex. Hence, in a factor analytic sense, they load highly on both. Several of the other sub-scales are similarly located near regional boundaries, and this is one of the reasons that a factor analytic dimensional interpretation misrepresents the BPI: a regional interpretation is more appropriate. This may also explain the questionable fit of the orthogonal confirmatory factor analysis model in Bjorgvinsson and Thompson (1994).

One might inquire as to the usefulness of the radex structure to other aspects of investigation. Several avenues available for exploitation have already been mentioned. As with any empirical result, further investigation is of course required to fully articulate the place of the radex finding in theory, and as a predictive tool. However, a number of preliminary points can be made. In the first place, the discovery of the radex structure in the samples studied is properly seen as support for *existing* theory. This theory [e.g. as in Leary (1957)] characterizes personality variables jointly in terms of two factors: (1) kind or type; and (2) level, centrality, or extremity. The facet definition provided in the present work embodies this theory, and therefore is a structural theory (Guttman, 1971). The radex of the present work is in keeping with this theory, since within each circumplex region (i.e. affective, social, and mental types of disorder), there is a simplex ordering in terms of centrality to psychopathology in general. Historically, circular orderings of personality variables have played important roles in both predictive and theoretical contexts [see e.g., Leary (1957), Lorr & McNair (1963), and Wiggins

(1982)]. The results of the present study suggest that the radex might in addition play a useful role in the integration of distinct theories. Specifically, the simplex theory for cognitive personality disorders (Romney & Bynner, 1992) might be reconciled with the circumplex theory for other types of disorders within the context of the radex.

Since the representation of empirical results interacts with the development and testing of theory, the most adequate representation should always be favoured. Inappropriate representations can potentially mislead efforts to theory construct. Consider, for example, a theory that specifies that a collection of p dichotomous variables are ordered on a single continuum. If linear factor analysis is chosen as the tool of representation, then a multidimensional representation will be the result (Gorsuch, 1983). The choice of this inappropriate representation might then lead to incorrect conclusions about the adequacy of the theory. It is noteworthy that the radex structure of the BPI, while psychologically rich, is nevertheless a parsimonious representation of the data. Just as one may speak of the BPI as having been simplified in terms of three factors, one may speak of the BPI as having been simplified as a radex (a *particular* two-dimensional structure). However, the radex is a greater simplification since only 22 numbers (i.e. the coordinates) are required to represent 55 pairwise relationships, while the three-factor structure requires 33 numbers (i.e. the loadings).

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