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Gregory J. Boyle
Bond University, Gregory_Boyle@bond.edu.au

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Schizotypal Personality Traits:
An Extension of Previous Psychometric Investigations

Gregory J. Boyle
Bond University

The author acknowledges the kind permission of Dr G. Claridge, Department of Experimental Psychology, Oxford University, in allowing the schizotypal traits data set to be reanalysed. This research was conducted while on sabbatical at the Department of Psychiatry, The University of Queensland.

Address for correspondence: Dr Gregory J. Boyle. Department of Psychology. Bond University, Gold Coast QLD 4229, Australia.

Abstract
In an exploratory scale factor analysis of the Combined Schizotypal Traits Questionnaire, Claridge et al. (1996) reported four schizotypal trait dimensions, which they labelled Aberrant Perceptions and Beliefs, Cognitive Disorganisation with Anxiety, Introvertive Anhedonia, and Asocial Behaviour. The present paper reports the findings of a further examination of both scale and item factor analyses, and proposes an alternative five-factor model. Positive and negative schizotypal trait factors emerged separately from general personality factors pertaining to extraversion, neuroticism, and psychoticism, showing that schizotypal traits cannot simply be reduced to the Eysenckian personality dimensions. The positive schizotypal factor also exhibited strong loadings on measures of delusions, suggesting that delusional cognition is a major component of schizotypal personality. The present five-factor model (supported by LISREL confirmatory factor analyses) may have important implications for future research into and clinical assessment of schizotypal personality traits.

Introduction
The psychometric measurement of schizotypal personality traits has received much attention in recent years, with the recognition that self-report screening may help to detect individuals "at risk" for developing a schizophrenic disorder (Boyle, 1998; Claridge, 1994, 1997; Claridge et al., 1996; Golden & Meehl, 1979; Raine, Lencz, & Mednick, 1994; Tyrka et al., 1995; Vollema & van den Bosch, 1995). Rawlings and MacFarlane (1994) have shown that schizotypal traits can be measured reliably even among young adolescents. Measurement of schizotypal personality traits may have benefits for detecting susceptible individuals, enabling possible preventative action (cf. Claridge & Beech, 1996; Lenzenweger, 1994).

Schizotypal personality traits appear to be normally distributed in the general population (Boyle, 1998; Ekselius, Lindstrom, von Knorring, Bodlund, & Kullgren, 1993; Raine, 1991), and are more frequently observed among the biological relatives of schizophrenic individuals (Kotsaftis & Neale, 1993). A continuum of severity is suggested, ranging from mild schizotypal traits, moderate schizotypal personality disorder or SPD (see Diagnostic and statistical manual of mental disorders (DSM-IV), American Psychiatric Association, 1994, p. 645), to fully-fledged schizophrenia (cf. Wolff, 1991). Unlike schizotypal personality traits, per se, SPD involves not only cognitive and perceptual distortions, but also positive and negative symptoms, also exhibited in fully-fledged schizophrenic disorders (see Charisiou et al., 1989a, 1989b; Vollema & van den Bosch, 1995). It is possible that either SPD or even schizophrenia might develop when an individual with elevated
Schizotypal traits suffer intense stress, in accord with a diathesis-stress model (cf. Grossarth-Matiek, Eysenck, & Boyle, 1994; McFall, Townsend, & Viken, 1995). Indeed, as reported in DSM-IV, a relatively small proportion of individuals with such elevated schizotypal traits do continue on to develop full-blown schizophrenia.

Some uncertainties surround the schizotypal personality trait and SPD constructs (Klein & Riso, 1993; Kotsaftis & Neale, 1993). For instance, the long-term stability (test-retest reliability) of measures of schizotypal traits is unknown (cf. Fernandez, 1990). According to Claridge et al. (1996), the most consistent finding has been the emergence of a schizotypal trait factor corresponding to positive symptoms (such as magical ideation, perceptual aberration, hallucinations, and delusions), another factor relating to perceptual-cognitive aspects (Raine & Allbutt, 1989), a factor corresponding to negative symptoms (e.g., lack of logical thought, lack of appropriate affect, physical and social anhedonia), and a factor relating to nonconformity or antisocial tendencies (Kendler & Hewitt, 1992; Muntaner, Garcia-Sevilla, Fernandez, & Torrubia, 1988; Raine et al., 1994; Venables & Bailes, 1994; Venables, Wilkins, Michell, Raine, & Bailes, 1990).

The most popular approach to the measurement of schizotypal personality traits has involved administration of self-report inventories to samples of ostensibly normal adults. However, the item content of such schizotypal trait measures varies considerably, leading to discussion about and research on the dimensionality of schizotypal traits. In order to address this issue, Bentall, Claridge, and Slade (1989), and Claridge et al. (1996) constructed a Combined Schizotypal Personality Questionnaire (CSTQ) comprising 18 self-report scales (including the Eysenckian personality dimensions), in order to ensure comprehensive coverage of the schizotypal domain (see Methods section). In factor analyses of the CSTQ scale inter-correlations (Bentall et al., 1989; Claridge et al., 1996), factors suggesting four higher-order schizotypal trait dimensions were labelled Aberrant Perceptions and Beliefs, Cognitive Disorganisation, Introvertive Anhedonia, and Asocial Behaviour, respectively. In the Bentall et al. study, a four-factor solution based on all 18 scales gave a better fit to simple structure criteria than did a three-factor solution based on only 14 scales (with the four delusion scales omitted). The results of this study remained speculative since the sample comprised only 180 subjects, and "little jiffy" (principal components plus orthogonal rotation) procedures were employed, resulting in factor solutions with less than optimal simple structure. In the Claridge et al. study, the sample comprised 1,095 subjects, so that more reliable factor solutions were obtained. The four-factor solution reported by Claridge et al. showed a considerable improvement in the ±.10 hyperplane count index of simple structure over that reported in the Bentall et al. paper. Not only was the sample size greatly increased but also, rather than using little jiffy procedures, Claridge et al. carried out iterative maximum-likelihood analyses, with extraction of factors followed by oblique (direct oblimin) simple structure rotation. Claridge et al. undertook their analyses on 14 of the 18 CSTQ scales (with the four psychotic delusions scales omitted), in view of Kelley and Coursey's (1992) rationale.

The Fould's delusional scales were omitted from the Claridge et al. (1996) study, not only because of Kelley and Coursey's (1992) reservations about the extent to which these measures actually pertained to the schizotypal trait domain, but also because of marked skewness in the distribution of the observed scores (a high level of assent to delusions would not be expected among normal population samples). Nevertheless, as Cattell (1978, p. 112) has pointed out, the inclusion of unrelated variables in a factor analysis ("hyperplane stuff") has the great advantage of delineating hyperplanes more precisely, so that the resultant factors are more clearly discernible. Consequently, all of the CSTQ scales (including Eysenck's measures) were retained in the present analyses to enable a comprehensive delineation of schizotypal trait dimensions.
The present paper, therefore, aims to extend the work of Claridge et al. (1996) by including all 18 of the CSTQ scales into the reanalyses, and by examining the possibility of a fifth higher-order personality factor - not previously reported, but expected on the basis of Cattell's (1978) Scree test (see Results section below). Separate factor analyses based on the item inter-correlations for all 420 items included in the CSTQ are also reported. In none of the previous papers by Claridge and his colleagues has an item factor analysis of the CSTQ been reported. Finally, LISREL confirmatory factor analyses (Joreskog & Sorbom, 1993) are reported for both the four-factor and five-factor solutions, to help determine which solution is the more acceptable.

**Method**

**CSTQ Scales**

Fourteen previously published scales measuring psychotic traits/symptoms such as schizotypal personality, borderline personality, hypomanic personality, anhedonia, hallucination tendency, perceptual aberration, and magical ideation, plus the four Eysenck Personality Questionnaire (EPQ) scales, and the four delusional states, comprised the Combined Schizotypal Traits Questionnaire (CSTQ). The EPQ was added into the CSTQ largely to include the P-scale, which although not a measure of "schizotypy" (cf. Meehl, 1990) in the narrow traditional sense, is a measure of psychosis-proneness in a more general sense, and therefore seemed worth having in, since at that time it was unclear what these various scales were myasuring. Inclusion of the remaining EPQ scales introduced items pertaining to extraversion and neuroticism, thereby providing "hyperplane stuff" (Cattell, 1978) to more clearly delineate factors that contrasted with such unrelated marker variables. Inclusion of hyperplane variables is an important consideration in undertaking valid exploratory factor analytic investigations (Gorsuch, 1983).

Inclusion of the four Foulds delusional scales (Foulds & Bedford, 1975) also provided markers against which to contrast the structure of schizotypal personality traits, in accord with Cattell's (1978) recommendations concerning hyperplane variables. The Foulds scales are not schizotypy/psychoticism/psychosis-proneness scales in the same, normal individual-differences sense as most of the other scales included within the CSTQ. Foulds designed them as patient assessment scales, not intended for assessing trait-like features in normal populations. These delusional scales were excluded from the analyses undertaken by Claridge et al. (1996), but are included in the present reanalyses primarily as hyperplane variables.

The CSTQ consisted of 420 dichotomously scored items. It included the E, N, P, and L scales from the EPQ (Eysenck & Eysenck, 1975); Claridge's Schizotypy Questionnaire (STQ), combining both Schizotypal Personality (ST A) and Borderline Personality (STB) scales (Claridge & Broks, 1984); Physical (PhA) and Social Anhedonia (SoA) scales (Chapman, Chapman, & Raulin, 1976); Perceptual Aberration (PAb) scale (Chapman, Edell, & Chapman, 1980); Magical Ideation (MgI) scale (Eckblad & Chapman, 1983); Hypomanic Personality (HoP) scale (Eckblad & Chapman, 1986); Launay-Slade Hallucination (LSHS) scale (Launay & Slade, 1981); Schizophrenism (NP) scale (Nielsen & Petersen (1976); MMPI Schizoidia scale (Golden & Meehl, 1979); and the Delusions Symptoms States Inventory, including Delusions of Grandeur (DG), Disintegration (DD), Persecution (DP), and Contrition (DC) (Foulds & Bedford, 1975). The psychometric properties of these various scales have been well-documented (e.g., Chapman, Chapman, & Miller, 1982; Claridge & Hewitt, 1987; Claridge, Clark, & Beech, 1992; Enright, Claridge, Beech, & Kemp-Wheeler, 1994; Hewitt & Claridge, 1989; Jackson & Claridge, 1991; Obiols, Domenech, Garcia-Domingo, & de Trincheria, 1992; Rawlings & MacFarlane, 1994; Lenzenweger, 1994; Vollema &
Clearly, the various scales comprising the CSTQ covered a wide heterogeneous range of "schizotypal" features, thereby allowing comprehensive assessment of the dimensionality of schizotypal personality traits (cf. Tyrka et al., 1995).

Subjects and Procedure

The large total sample comprised 1,021 non-psychotic individuals (682 females, 339 males) whose mean age was 40.01 years ($SD = 16.78$ years). Further details of the sample composition are provided in Claridge et al. (1996) for some 1,095 subjects. Briefly, though, samples from previous studies (Bentall et al., 1989; McCreary, 1993) were combined ($N = 180$ and $N = 695$, respectively), comprising undergraduates from Oxford university, Liverpool University, and the Liverpool Polytechnic, together with subjects who had been recruited from the Oxford Subject Panel ($N = 220$) as student or health professional volunteers. The largest subset of subjects ($N = 408$) was obtained through a media appeal (see Claridge et al., 1996, for details).

Results And Discussion

Exploratory Scale Factor Analyses

The $18 \times 18$ product-moment inter-correlation matrix for the CSTQ scales was subjected to an iterative maximum-likelihood estimation procedure, together with extraction of factors based on the Scree test (Cattell, 1978), and oblique (direct oblimin) simple structure rotation, in accord with recommended procedures (see Gorsuch, 1983). Since the item responses to the four delusional scales were noticeably skewed, a square root transformation was undertaken in order to reduce the skewness. Even with the transformed Foulds scale included in the analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was .89, and Bartlett's test of sphericity was 9,775.50 ($p < .0001$), indicating that the inter-correlation matrix was suitable for factor analysis. In the present study, the Scree test (cf. Cattell, 1978; Hakstian, Rogers, & Cattell, 1982) suggested a fifth higher-order factor - the fifth eigenvalue lying at the top of the Scree line (with a large drop in magnitude between the 4th and 5th eigenvalues - see Child, 1990, p. 38). The eigenvalues for the 18 unrotated principal components were as follows: 6.69, 2.31, 1.51, 1.27, 0.87, 0.76, 0.65, 0.62, 0.56, 0.50, 0.45, 0.36, 0.32, 0.29, 0.26, 0.22, 0.21, and 0.16, respectively. The resulting five-factor solution is presented in Table 1.

The extended solution reported in Table 1 gave a closer approximation to simple structure than did the corresponding four-factor solution (also based on the inter-correlations of all 18 CSTQ scales, with the Foulds scales corrected for skewness), since the ±.10 hyperplane count (Cattell, 1978) was 16% higher. This five-factor solution provided an expanded picture of that previously described by Claridge et al. (1996).

Factor 1 (accounting for 37.1% of the unrotated principal components variance) loaded highly on MgI, DD, PAb, LSHS, STA, DG, HoP, and DP, respectively, and might be labelled Positive Schizotypal Traits. This factor is essentially the same as that labelled by Claridge et al. (1996) as "Aberrant Perceptions and Beliefs". With inclusion of the Foulds delusional scales into the reanalysis, a new finding is that Factor 1 loads strongly on the delusional scales, suggesting that delusional cognition contributes to positive schizotypal personality traits. Factor 2 loaded highly on Extraversion (E) and HoP vs. SoA. Since the highest loading was on E (-.83), an appropriate label for this extended factor might be Extraversion Personality Traits. In the Claridge et al. analysis, all four factors loaded significantly on E, preventing a simple structure solution from being obtained. Factor 3 loaded highly on Neuroticism (N), NP, STB, ST A, and MMPI scales respectively. Since the highest loading was on N (-.95), this factor might be labelled Neurotic Personality Traits. This factor is similar to that labelled less succinctly by Claridge et al. as "Cognitive Disorganisation with
Anxiety”. Factor 4, which loaded on PhA, SoA, and to some extent on Psychoticism (P), was termed "introvertive anhedonia" in the Claridge et al. paper, but is clearly labelled here as Negative Schizotypal Traits. Factor 5, which loaded strongly on Eysenck's P vs. L scales, is similar to the Claridge et al. factor labelled "Asocial Behaviour", and might appropriately be labelled as Psychotic Personality Traits. However, since the P scale has been regarded as a measure of psychopathic characteristics (Zuckerman, 1989) and, given the significant loading on STB, this factor might alternatively be labelled as Psychopathic Personality Traits.

The approximation to simple structure was substantially greater for the five-factor solution than for the four-factor solution, suggesting that extraction of all five factors was justified. Although the starting point for these factor analyses was the matrix of scale inter-correlations, separate item factor analyses of the CSTQ data set had not previously been reported. Consequently, item factor analyses were carried out in addition to those above, to provide a further check on the validity of the above five putative factors.

**Exploratory Item Factor Analyses**

The 420 x 420 matrix of product-moment item inter-correlations was subjected to an iterative maximum-likelihood procedure, together with oblique simple structure rotation. Only six iterations of initial communality estimates were required, indicating that the un-rotated factor matrix was relatively stable. The KMO measure of sampling adequacy was .86, while Bartlett's test of sphericity was 193,797.52 (p < .0001), indicating that the correlation matrix was suitable for factor analysing.

Five factors were extracted for comparative purposes (cf. Williams, 1994). Factor 1 loaded predominantly on Perceptual Aberration (PAb), and to a lesser extent on Magical Ideation (MgI; cf. George & Neufeld, 1987). The label "Aberrant Perceptions and Beliefs" portrays dimension as Positive Schizotypal Traits. For Factor 2, most significant loadings were on either Extraversion (E) or Hypomanic Traits (labelled Extraversion Personality Traits). Factor 3 loaded highly on Neuroticism (N), STA, and STB items. Although interpreted by Claridge et al. (1996) as a cognitive disorganisation factor, this factor might be better labelled as Neurotic Personality Traits. Factor 4 loaded mainly on Physical Anhedonia, and to a much lesser extent on Social Anhedonia, indicative of Negative Schizotypal Traits, while Factor 5 loaded predominantly on the EPQ L-scale, suggesting that unreliable responding is "in the hyperplane", forming an entirely separate Response Inconsistency factor. Thus, aside from the fifth factor, the first four factors from the above scale analyses have clearly emerged also from factoring the item inter-correlations.

In summary, the present exploratory factor analyses undertaken on both the CSTQ scale and item inter-correlations highlight the distinction between positive and negative schizotypal personality traits, showing them to be distinct from the Eysenckian personality dimensions (in contrast to Eysenck & Barrett's, 1993, claim that schizotypal trait factors could be subsumed within the E, N, and P dimensions), thereby providing a clearer delineation of schizotypal trait dimensions within the normal population.
Table 1
Oblique Five-factor Maximum-likelihood Solution for CSTQ Scales

<table>
<thead>
<tr>
<th>CSTQ Scale</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>$h^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-Extraversion</td>
<td>.02</td>
<td>-.83</td>
<td>.09</td>
<td>-.06</td>
<td>.02</td>
<td>.74</td>
</tr>
<tr>
<td>N-Neuroticism</td>
<td>-.09</td>
<td>-.04</td>
<td>-.96</td>
<td>-.05</td>
<td>.02</td>
<td>.81</td>
</tr>
<tr>
<td>P-Psychoticism</td>
<td>.13</td>
<td>-.01</td>
<td>.07</td>
<td>.29</td>
<td>-60</td>
<td>.52</td>
</tr>
<tr>
<td>L-Lie Scale</td>
<td>.11</td>
<td>-.02</td>
<td>.05</td>
<td>.20</td>
<td>.65</td>
<td>.44</td>
</tr>
<tr>
<td>Claridge ST A Scale</td>
<td>.59</td>
<td>.02</td>
<td>-.48</td>
<td>-.20</td>
<td>-.04</td>
<td>.83</td>
</tr>
<tr>
<td>Claridge STB Scale</td>
<td>.11</td>
<td>-.14</td>
<td>-.58</td>
<td>.05</td>
<td>-.37</td>
<td>.76</td>
</tr>
<tr>
<td>SoA-Social Anhedonia</td>
<td>.25</td>
<td>.41</td>
<td>.06</td>
<td>.38</td>
<td>.02</td>
<td>.46</td>
</tr>
<tr>
<td>PhA-Physical Anhedonia</td>
<td>-.22</td>
<td>.18</td>
<td>-.07</td>
<td>.59</td>
<td>.08</td>
<td>.44</td>
</tr>
<tr>
<td>Mgl-Magical Ideation</td>
<td>.86</td>
<td>-.09</td>
<td>-.04</td>
<td>-.03</td>
<td>.05</td>
<td>.78</td>
</tr>
<tr>
<td>PAb-Perceptual Aberration</td>
<td>.81</td>
<td>.10</td>
<td>-.02</td>
<td>-.10</td>
<td>-.11</td>
<td>.66</td>
</tr>
<tr>
<td>HoP-Hypomanic Personality</td>
<td>.42</td>
<td>-.47</td>
<td>-.23</td>
<td>.18</td>
<td>-.14</td>
<td>.77</td>
</tr>
<tr>
<td>DC-Delusions-Contrition</td>
<td>.22</td>
<td>-.01</td>
<td>.29</td>
<td>.27</td>
<td>-.10</td>
<td>.37</td>
</tr>
<tr>
<td>DG-Delusions-Grandeur</td>
<td>.45</td>
<td>-.18</td>
<td>-.03</td>
<td>.26</td>
<td>-.10</td>
<td>.44</td>
</tr>
<tr>
<td>DP-Delusions-Persecution</td>
<td>.38</td>
<td>-.07</td>
<td>-.01</td>
<td>.21</td>
<td>-.08</td>
<td>.27</td>
</tr>
<tr>
<td>DD-Delusions-Disintegration</td>
<td>.82</td>
<td>.03</td>
<td>.08</td>
<td>.00</td>
<td>.05</td>
<td>.58</td>
</tr>
<tr>
<td>LSHS-Hallucination Scale</td>
<td>.75</td>
<td>-.05</td>
<td>-.21</td>
<td>-.16</td>
<td>.04</td>
<td>.71</td>
</tr>
<tr>
<td>NP-Schizophrenism Scale</td>
<td>.06</td>
<td>.22</td>
<td>-.73</td>
<td>.00</td>
<td>.02</td>
<td>.64</td>
</tr>
<tr>
<td>MMPI Schizoidia Scale</td>
<td>.11</td>
<td>.00</td>
<td>-.42</td>
<td>.29</td>
<td>-.03</td>
<td>.39</td>
</tr>
</tbody>
</table>

Eigenvalue: 6.69  2.31  1.51  1.27  0.87
% Variance: 37.1  12.8  8.4  7.1  4.8

Notes. Factor loadings shown to two decimal places only; factor loadings >.35 shown in bold.
F I correlates .23 with F2, -.47 with F3, .24 with F4, and -.28 with F5. F2 correlates -.09 with F3, .20 with F4, and -.26 with F5. F3 correlates -.19 with F4, and .30 with F5. F4 correlates -.08 with F5

Confirmatory Factor Analyses
To further test the adequacy of the four-factor versus five-factor solutions, confirmatory factor analyses were undertaken via LISREL 8, based on the scale inter-correlations (with "noisy" variables loaded significantly by two or more factors being removed from the analyses). These analyses were not undertaken with the intention to cross validate the findings from the exploratory analyses above (in which case, a new data set based on an independent sample would be required), but merely to help decide on the more appropriate number of schizotypal trait factors measured within the CSTQ for the same large data set (cf. Cuttance & Ecob, 1987; Mason, 1995).
For the four-factor solution, the chi-square was 1,227.83 ($df= 59$, $p < .0001$), the adjusted goodness-of-fit index (AGFI) was .77, the root mean square residual (RMR) was .10, the non-normed fit index (NNFI) was .74, and the comparative fit index (CFI) was .80, suggesting a relatively inadequate fit of the model to the empirical data. Thus, the four-factor model was not strongly supported, despite the removal of only five of the noisy scale variables from the analysis. For the five-factor solution, the
chi-square was 556.30 (43 df), the corresponding AGFI was .86, the RMR was .08, the NNFI was .84, and the CFI was .86, indicating a better fit to the data. That the five-factor model provided a better fit was also supported by a statistical difference test (see Hayduk, 1987, pp. 163-167). There was a significant improvement in the five-factor model over the four-factor one (chi-square = 671.53, 16 df, p < .001).

CONCLUSIONS
A series of exploratory and confirmatory factor analytic studies of a wide array of personality-disorder and psychosis-proneness scales has supported the validity of both positive and negative schizotypal trait dimensions. Schizotypal personality traits (and associated behaviours and experiences) are of interest in part as they are thought to be possible precursors to schizophrenia (cf. Grossarth-Maticek et al., 1994). Given the large sample size and the comprehensiveness of the test battery, these findings provide some support for the existing literature (e.g., Charisiou et al., 1989a, 1989b) pertaining to positive and negative symptoms of schizophrenia (cf. Vollema & van den Bosch, 1995).

The present analyses based on the inter-correlations of all 18 of the CSTQ scales (with the Foulds delusional scales corrected for skewness) add to those of Claridge et al. (1996) in a number of important ways, providing a clearer delineation of positive and negative schizotypal trait factors, and showing that such traits cannot be subsumed within the Eysenckian personality dimensions (which emerged as three separate factors). Thus, in the Claridge et al. analysis (p. 110), all four factors loaded significantly on Extraversion (E) whereas, in the present reanalysis, only Factor 2 loaded on E, in accord with simple structure criteria (see Child, 1990). Another new finding was that the positive schizotypal trait dimension loaded highly on the Foulds scale (especially on Delusions of Disintegration), suggesting that delusional cognition is a major component of schizotypal personality.

In conclusion, five distinct factors emerged based on the Scree test, and the simple structure of the factor pattern (indexed via the ±.10 hyperplane count) was significantly increased over that obtained with the corresponding four-factor solutions. LISREL confirmatory factor analyses tested the goodness-of-fit of the four-factor versus the five-factor model, providing further support for the validity of the present interpretation of the CSTQ structure—as comprising two major schizotypal factors, alongside three general personality dimensions (cf. Boyle, Stankov, & Cattell, 1995).

Footnote
1. The hyperplane count is the proportion of trivial, non-significant factor loadings – usually ≤.10 in bandwidth (see Cattell, 1978). The higher the hyperplane count, the greater is the degree of simple structure as proposed by Thurstone (see Child, 1990, pp. 48-49).

References


