AN INVESTIGATION OF THE COMMON FACTOR SPACE OF SOME WELL-KNOWN QUESTIONNAIRE SCALES: THE EYSENCK EPI, THE COMREY SCALES AND THE IPAT CENTRAL TRAIT-STATE KIT (CST)

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Introduction

In the domain of measurement of personality by questionnaire, the last decade has been one of integration. At least among the designers of factored scales, if not among others, there have been attempts systematically to discover the common factor space and the relative standing of the various scales therein (Cattell, 1973; Comrey & Duffy, 1968; Derman & Harman, 1973; Eysenck & Eysenck, 1968).

The theory explicitly set out and documented in detail in Cattell's recent survey, (Cattell, 1973) is that if one starts with the most comprehensive of presently possible personality sphere item samplings from normal behavior one will finish with a dimensionality of 23 primary factors. With items covering also pathological behavior, the space goes up to 28 factors or more (as set out in the Clinical Analysis Questionnaire, Cattell & Sells, 1974). Secondly, the theoretical position supported by the data survey presented is that the normal primaries yield eight to ten secondaries (second order factors), according to whether 16 or 23 primaries are encompassed in the foundation. Thirdly, it states, regarding Eysenck (EPI) and Comrey factors, that the scales built for them are really approaches to second order factor measures. They are "approaches", not exactly to be aligned with the true second orders derivable from the 16 PF because they use the shortcut of underfactoring (Eysenck) or starting with variable scores that approximate to subjective definitions of the primary factors (Comrey). By neither of these approaches would one expect rotation to be able dependably to place the second order factors.

The twenty or more researches supporting the 23 primary, 8-10 secondary factor theory of structure have been fully collated elsewhere (Cattell, 1973). The bridging researches to Eysenck and Comrey scales, and the clarification of trait and

state factor relations in this area are set out in three articles, of which this is the first. (See Cattell & Barton). The present article responds to the questions: (a) When the 16 PF, Eysenck (EPI), and Comrey scales are factored together, is the factor indeed in the neighborhood of 23, as theorized above, or at three as Eysenck supposes, or nine as Comrey argues? (b) If so, do the EPI and Comrey scales come out as clear primaries, as their authors suppose, or are their loadings spread over several primaries as the above theory that they are second orders would require? The second article (Cattell & Barton) will then examine the relative validity, for measuring the second orders, of the EPI, the Comrey Scale, and the Core Trait-State Kit of Barton, which introduces scales for measuring all eight second orders in the 16 PF primaries.

Procedure

The Tests

The 16 PF Factors: The primary personality factors from Cattell's survey were each measured by two variables (forms A and B of the 16 PF)--two variables being the absolute minimum for defining a common factor if it should exist. In psychological meaning these primaries are factor A, affectia; B, intelligence; C, ego strength; E, dominance; F, surgency; G, super ego; H, parmia; I, premsia; L, protension; M, autia; N, shrewdness; O, guilt proneness; Q_1, radicalism; Q_2, self-sufficiency; Q_3, self-sentiment; and Q_4, ergic tension.

The EPI Factors: The EPI provides measures of E (extroversion), N (neuroticism) and L (a lie scale).

The Comrey Personality Scales: The CPS provides measures on the following ten scales: V (validity), R (response bias), T (trust), O (orderliness), C (social conformity), A (activity), S (stability), F (extroversion), M (masculinity), P (empathy), i.e. eight personality factors and two "distortion" scores.

The IPAT Adult Exvia-Invia (AEI) and the IPAT Adult Anxiety Scale (AAS): These were added to test the extent to which the stacking of the variables with several second order measures (there would now be three direct representatives of exvia: Eysenck's E, Comrey's E, and the IPAT Exvia scale) might or might not impede the anticipated resolution into pri-

maries. The IPAT anxiety scale in particular has been in use as a second order scale for years, and its second order validity in relation to other scales is well known (Spielberger, 1972). Furthermore, both of these IPAT scales have a trait and a state measure (20 items in each) which are relevant to the domonstration of the separateness of state and trait in the examination of the Core Trait State (CTS) Kit in the third article mentioned above (Barton & Cattell, 1974).

The Subjects

One hundred sixty-seven undergraduates at the University of Illinois volunteered to take the personality tests. These Ss were paid $2 per hour for their time and as an added incentive all were promised some feedback as to the nature of their scores.

Method

The battery of tests was given to each S over 3-1/2 one-hour sessions spaced over two days. Subjects were encouraged to complete the tests at a rate that was comfortable to them. With the exception of the state scales (which had to be fully completed during one session), Ss were allowed to leave before completing a whole test and to finish it at a later session. This procedure was adopted because the total testing time for all tests came to approximately 3-1/2 hours for most subjects.

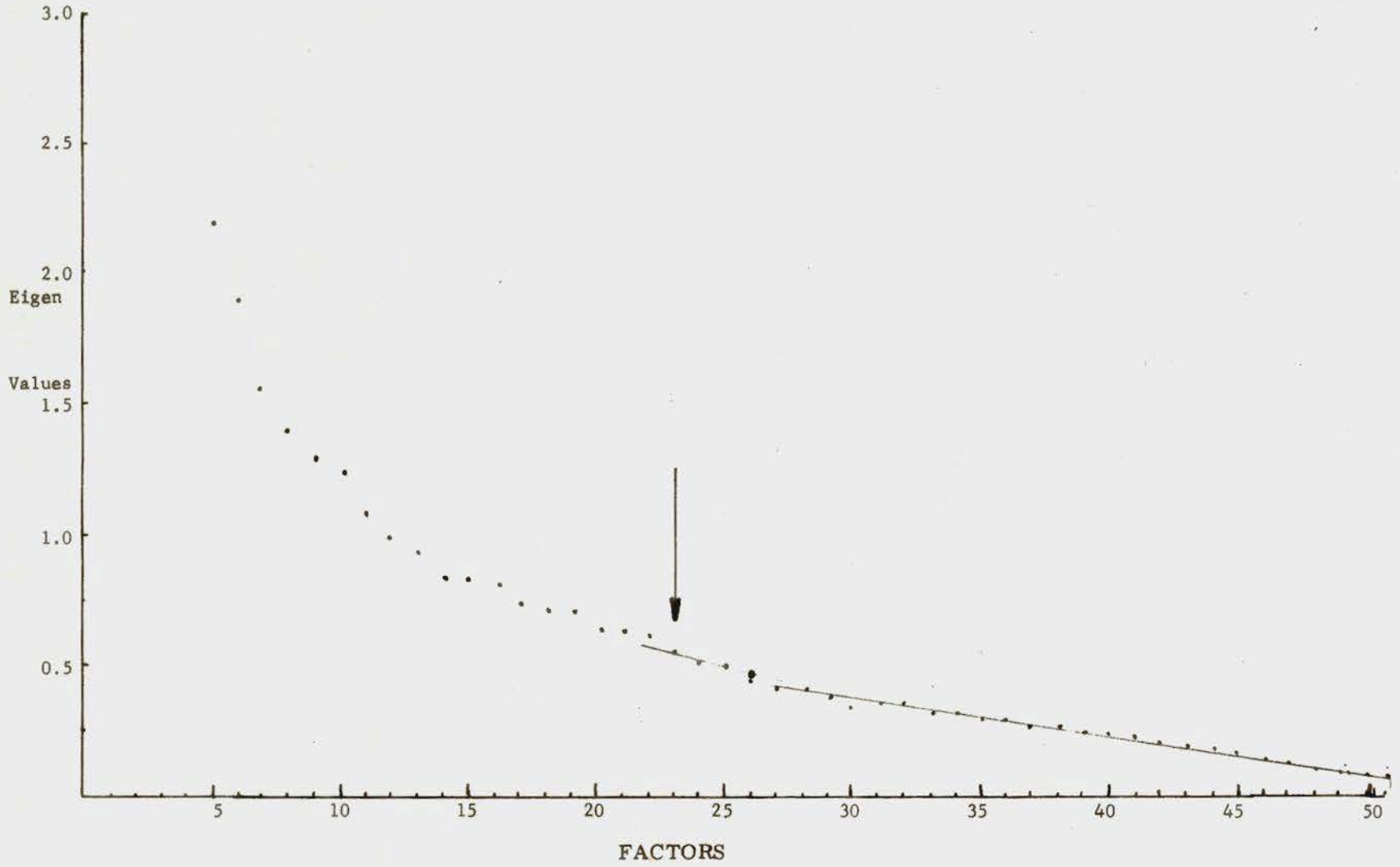
Following completion of the tests, all were scored according to their manual scoring descriptions, providing a total of fifty-one variables; 32 16 PF scores, 3 EPI scores, 4 IPAT AEIS scores, 2 IPAT AAS scores and 10 CPS scores.

These 51 scale scores were then intercorrelated. Unities were first inserted and the resultant latent roots (eigen values) plotted. A Scree test on this plot indicated pretty clearly that 23 factors should be extracted (see Figure 1). Incidentally, by no test we have tried (K-G, Joreskog) would the number of factors come anywhere near the 3 of Eysenck or the 8 of Comrey.

The communalities were now determined by iterating the factor analysis to give an exact 23 factor solution. Rotation was pursued by two methods, first, for speed, by a Procrustes solution targeting the first 16 factors as 16 PF factors

FIGURE 1

SCREE TEST



and secondly by a maxplane solution. In both cases we proceeded beyond the automatic program solution by a Rotoplot procedure (Cattell & Foster, 1963). They converged sufficiently for us to do the polishing on the former only, and on this, the usual improvement in the .10 hyperplane count was recorded until an unimprovable plateau was reached. This occurred after 18 hand rotations when the hyperplane count for the .10 range reached 80.05%. The statistical significance of this simple structure is by the Bargmann test $P<.03$, and by the new Cattell-Finkbeiner test $P<.05$.

Results

The factor pattern for the 23 factor-51 variable factor analysis is shown in Table 1. The intercorrelations of the 23 factors are shown in Table 2.

Except for the 16 primaries of the PF which in only one of the 32 scales fail to show the appropriate significantly loaded marker (oddly enough an intelligence scale) the structure of these scales is somewhat complex. Eysenck's E spreads across two factors (F and H, both appropriately primaries in the second order exvia factor), and his L scale across 5! Six of the ten Comrey scales have significant loadings on two or more primaries. The IPAT anxiety state scales fall on a factor other than the primaries involved in usual second order trait pattern (C-, H-, O, L, Q_3, Q_4). Eysenck's anxiety (neuroticism) scale seems to be largely the primary, O, guilt proneness, but it would be premature to conclude anything about its total validity against the full second order anxiety factor until the second order analysis of the present primaries is presented (Cattell & Barton).

Footnote 1

Use of a Procrustes target matrix has sometimes been criticized (Cattell, 1973) on the grounds that even when the "actual" structure is not similar to the target structure this program will impose the target structure anyhow. However, as Hakstian, Schoeneman, and others have shown, Procrustes is not capable of fitting any Vo to any Vrs, and when a far-fetched attempt is made the fact is evident from very large correlations among the factors. As Table 2 shows, the correlations among factors in this solution remain between small to moderate, thus indicating that our use of the Procrustean technique has merely shortened our rotation time without distorting the "true" structure.

Table 1
Primary Factor Pattern*

Variables		- FACTORS - 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1 16 PF	A	.89	-01	-07	06	-07	00	05	>10	06	06	00	06	01	05	-09	-03	05	05	-.10	04	02	09	-05
2 Form A	B	-02	.90	02	.04	03	05	05	-01	05	-.10	05	04	-06	03	.01	04	01	08	04	-06	06	08	-01
3 "	C	01	03	.65	06	02	001	06	01	02	-.12	05	07	1.0	02	02	06	45	08	23	01	-02	07	09
4 "	E	08	08	06	.50	09	05	06	04	06	08	-06	-.0	01	03	04	-06	05	06	03	45	67	03	-.12
5 "	F	04	07	-05	.14	.45	07	05	.10	.22	.15	.01	-11	09	-01	01	.16	130	-90	10	12	.23	02	04
6 "	G	.12	07	.19	09	.10	.30	-01	001	03	-12	08	.18	-03	-07	.24	002	-02	-03	06	02	-.19	47	01
7 "	H	04	09	.24	.20	01	-09	.79	.22	-01	07	.03	04	07	-08	.13	-06	-02	03	01	07	04	-01	03
8 "	I	03	02	03	06	-07	09	.11	.85	00	-07	05	04	-07	08	09	-02	01	-07	02	-02	-05	01	.10
9 "	L	.24	03	-35	42	-05	-04	.12	-12	.24	.15	00	-06	07	05	03	-05	.13	001	-08	03	.32	06	-07
10 "	M	-03	06	-01	01	-.14	01	01	01	-08	.69	05	-01	.10	02	-05	06	-02	-00	01	.24	.13	-08	-06
11 "	N	00	05	.45	-14	-08	00	.32	06	04	02	.12	.13	.04	-44	.03	.20	.32	02	07	06	-02	05	06
12 "	O	-.11	-04	.34	-03	.32	-01	01	.11	08	-03	-05	.45	04	-10	.27	-05	.32	03	-.11	.07	-09	01	04
13 "	Q_1	07	04	04	-03	.14	01	01	04	02	.30	.12	.11	.64	05	09	-.13	05	08	-44	-03	.01	07	-01
14 "	Q_2	07	-03	-.14	07	-55	08	01	01	06	01	-.14	-.10	07	.71	08	.11	07	01	04	-03	05	-02	.26
15 "	Q_3	.11	-08	.22	07	-09	.12	02	.18	.15	.12	-03	.11	01	02	.45	.14	00	00	04	.13	09	42	05
16 "	Q_4	-.10	.16	-33	.10	.31	-.14	.08	-01	05	-.12	03	62	.15	03	06	.26	-02	-06	09	.16	-.13	08	.32
17 16 PF	A	.69	01	09	04	07	08	03	.12	.11	04	01	05	07	-01	.16	05	01	-01	.17	06	03	-.15	05
18 Form B	B	02	.09	04	09	-04	01	-02	-06	-.10	02	-03	-04	-02	00	-05	.10	-03	63	01	.12	-07	04	06
19 "	C	01	-.11	.21	04	01	07	03	-09	-.10	02	.11	-42	-.11	01	06	.16	02	02	-01	.11	02	-.13	02
20 "	E	-07	-04	07	.61	.18	-03	39	-02	.11	08	04	-05	.16	-04	02	05	01	02	02	06	-02	01	04
21 "	F	05	.10	.10	-05	.76	.11	07	09	-04	06	04	04	.12	04	02	-.10	02	03	-00	06	04	06	.13
22 "	G	-07	.17	.23	03	01	.25	.15	01	-.11	-45	07	.23	-04	04	.60	-.10	02	-.11	05	08	.10	-09	02
23 "	H	-09	07	07	06	.15	02	.76	05	01	-01	06	-.14	.14	07	.13	01	05	-05	.15	.12	04	-.10	04
24 "	I	-01	02	-09	01	-02	02	.14	.69	.14	07	02	-02	-09	-03	-07	02	03	.20	.15	.14	-48	05	00
25 "	L	-01	-05	03	04	01	02	-06	-03	.52	04	-08	.20	.12	-05	-.10	-02	07	-06	01	04	.19	.30	00
26 "	M	-04	09	-06	38	.22	-08	03	.16	-45	.27	-.16	-05	.12	-21	-01	-.31	04	.10	-02	.28	09	05	.21
27 "	N	.14	03	09	.15	.31	-45	04	04	02	06	.34	01	01	03	.12	00	08	-.10	03	08	-.13	06	40
28 "	O	-03	.10	01	-.16	04	.03	-03	00	-05	-08	-02	.83	.14	06	-27	04	-06	-07	.15	05	-03	-02	-03
29 "	Q_1	-.12	00	-08	-01	-.14	03	-04	-02	-47	.15	.10	-.10	.95	.14	-08	06	36	-.12	05	08	.10	07	03
30 "	Q_2	-21	-22	-04	.16	06	.10	-27	.13	.26	02	05	-.14	06	.29	-05	.13	01	.20	.23	.20	-22	-.11	.14
31 "	Q_3	-01	-01	.27	-00	-05	02	-.11	07	04	00	-08	-05	.43	-.12	.65	02	06	.09	03	-02	03	05	02
32 "	Q_4	.10	-09	-44	37	00	-01	-05	-05	-06	-05	-01	55	-.16	.10	.03	.37	03	03	-02	.00	.18	-09	02
33 EPI	E	-01	02	-.10	-.13	52	05	35	-00	01	-02	-.11	03	-06	05	01	-09	-01	09	04	00	.25	-.14	-.14
34 EPI	N	03	01	00	-.10	03	08	-01	-04	-04	07	-06	86	01	03	07	09	-.34	-02	02	.11	00	-08	07
35 EPI	L	.14	.24	42	07	00	04	-03	-06	.10	07	51	37	07	-03	05	-39	39	-04	.05	-06	02	05	-01

Table 1 (cont.)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
36 AES A S	-22	00	-12	-10	.11	-03	61	-03	05	04	07	-17	-01	-15	-19	01	.13	-02	-05	09	49	08	-02
37 AES A T	-17	03	-10	-21	36	08	52	-04	.13	.22	03	04	-05	09	06	-05	.17	05	.10	06	.22	08	01
38 AES B S	-05	02	07	-14	02	-00	49	-03	01	-02	.12	.13	-01	-23	01	01	06	03	-02	-05	46	.17	05
39 AES B T	01	-01	.10	-10	08	03	63	.16	05	-07	09	07	.10	-01	09	-16	01	.32	-01	.10	02	08	-82
40 AAS A S	-10	.13	.10	04	06	.11	-01	01	07	-04	-10	.14	06	04	.19	02	01	-02	.10	-08	01	08	-83
41 AAS B S	06	06	.15	-02	06	-08	05	-08	00	09	05	.14	00	03	-10	03	02	-01	-09	07	-06	00	-84
42 Validity	07	02	-05	.27	.13	-07	04	01	-02	05	.11	-10	04	06	-05	-57	-03	02	39	03	-03	-16	03
43 Response	-03	-04	-02	.11	.13	04	03	04	.18	-62	76	-14	06	.10	-13	-14	02	04	07	-10	-01	00	.11
44 Trust	-01	-09	-03	05	05	-03	-10	.11	-31	02	.18	-12	-08	04	06	-02	.31	-02	-38	03	-07	-37	.10
45 Orderliness	-03	09	06	03	05	.18	.15	.17	06	07	07	05	-03	01	65	-02	01	03	-18	.33	02	42	.16
46 Social Conf	.14	03	.10	.10	.11	01	02	.30	.21	-25	-18	.12	-46	-06	.25	-07	04	-02	-08	.18	.12	09	04
47 Activity	01	-08	44	.16	.14	.15	39	-12	07	.25	03	01	-18	.10	06	04	00	-06	-17	.21	.12	09	04
48 Stability	05	-13	04	07	03	06	04	.19	-15	-07	-21	-67	.03	.00	-03	.16	.29	-03	-09	.05	-09	06	-05
49 Extroversion	04	06	07	.10	-12	.14	96	01	08	05	-21	03	00	.27	07	06	-08	-02	02	-03	-07	03	-07
50 Masculinity	-38	.13	38	.18	-12	08	.20	04	00	02	-04	-09	.15	-02	-06	-01	-26	00	-04	-42	07	.11	04
51 Empathy	.20	.10	04	05	-01	49	06	.34	.14	09	06	.13	-02	.15	06	06	03	-11	08	-00	-14	.10	.17

*Except for putative variables only loadings $\geq .35$ are reported.

Table 2
Intercorrelations Among the 23 Factors*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	1.0	12	04	-42	37	14	51	36	-14	01	11	-08	-01	-33	11	29	05	-10	18	02	18	-01	06
2		1.0	08	-11	-12	-01	-16	08	-15	15	02	-15	-21	13	05	36	14	33	-26	22	-05	-06	19
3			1.0	00	12	37	32	-15	-27	44	24	-64	-19	-14	15	18	05	18	00	-10	11	02	49
4				1.0	00	01	-16	-37	27	16	-11	16	36	04	-28	-10	-25	08	00	-09	11	-01	-01
5					1.0	19	50	05	-19	12	-15	-16	-04	-17	-20	23	18	03	06	-23	37	-01	12
6						1.0	30	-02	-21	31	32	-32	-16	-26	-01	06	19	13	-26	05	-07	00	30
7							1.0	17	-24	32	10	-33	-06	-32	02	21	06	-03	13	-11	25	-04	22
8								1.0	-27	09	03	10	00	-03	-26	14	07	-09	-10	33	03	-18	-13
9									1.0	-15	-20	30	37	08	-09	-17	-27	-17	04	01	05	-03	-16
10										1.0	30	-36	08	-07	-21	12	-15	20	01	-14	02	-31	21
11											1.0	-16	-15	-11	20	07	-20	12	05	01	-12	14	-04
12												1.0	31	03	-18	-20	-10	-10	10	20	-06	13	-53
13													1.0	14	-48	-04	-45	06	17	24	26	-13	-29
14														1.0	-11	-19	-01	-14	-24	05	17	02	-13
15															1.0	11	22	-08	02	-17	-26	25	04
16																1.0	04	23	09	13	20	06	20
17																	1.0	02	-18	-07	-16	06	22
18																		1.0	-07	02	10	04	31
19																			1.0	-06	05	-03	-08
20																				1.0	-21	07	-20
21																					1.0	-01	17
22																						1.0	-08
23																							1.0

*Decimal points omitted.

Conclusions

(1) The dimensionality needed for the general personality sphere as represented by the 16 PF, EPI, and Comrey Scales is best estimated as 23, though with any significant loadings, the EPI covers only about 7 and the Comrey Scales about 13.

(2) Within this space, the first 16 factors are recognizable, i.e., clearly marked by marker scales for, as the usual 16 PF factors, and both the EPI and Comrey scales have virtually all of their loadings within the 16PF space.

(3) Just what the patterns of the latter loadings mean in terms of coincidence with the second order factors in the 16 PF cannot be concluded until the second order analysis of Table 2 is presented, but the Comrey scales seem at this stage to have more intelligible structure as first order factors and might not be second orders as we had hypothesized.

(4) The IPAT state scales for anxiety and exvia-invia require factors for their description different from those for the traits, though in the case of exvia-invia part of the state variance proves to be trait variance.

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