Psychometric *g* Is Still Not Unitary After Eliminating Supposed "Impurities": Further Comment on Carroll

JOHN H. KRANZLER

University of Florida

ARTHUR R. JENSEN

University of California, Berkeley

The unity of psychometric *g* was tested after elimination of the chronometric and psychometric variables that Carroll (1991b) conjectures might be related to "impurities" in Kranzler and Jensen's (1991a, 1991b) analyses. Results of this analysis are again inconsistent with the hypothesis that *g* is unitary and further confirm the conclusions reached by Kranzler and Jensen, that psychometric *g* is a composite of a number of independent cognitive processes.

Carroll (1991a, 1991b) is steadfast in his belief that psychometric *g* is related to a unitary cognitive process, despite Kranzler and Jensen's (1991a, 1991b) presentation of data to the contrary. According to Carroll, our methodology simply cannot provide a suitable test of the unity of *g* because such a test requires an absolutely pure estimate of *g*, which is, of course, empirically unattainable. Carroll does, however, suggest that our methodology might successfully be employed after eliminating those psychometric and chronometric variables that seem to be the most likely source of the supposed "impurities." Carroll (1991b) argues that:

> Kranzler and Jensen might be able to do this with their presently available data, simply by eliminating from their prediction matrix those ECT [elementary cognitive task] variables that are, according to my factor analysis, most highly loaded with the second-order speed of movement factor. . . . It might be desirable to eliminate "impurities" on the side of the psychometric battery, too, . . . by eliminating tests in that battery having small but possibly significant loadings on the general speed factor, that is, making the estimate of *g* solely from the MAB Vocabulary and Similarities . . . (p. 453)

As a further test of the unity of g, Kranzler and Jensen's (1991a) data are reanalyzed after taking into account Carroll's (1991b) suggestions for a refinement in our methodology.

METHOD

Discussion of the apparatus, procedures, and descriptive statistics can be found in Kranzler and Jensen (1991a). Following Carroll's (1991b) suggestions, all of the ECT variables with their highest loading on the second-order speed of movement factor were eliminated. In addition, those ECTs with loadings equal to or greater than ±.30 on either of the two first-order speed of movement factors were also eliminated. This resulted in the elimination of the mean median reaction time measure for the Synonyms-Antonyms task and all of the movement time (MT) measures, with the exception of the intraindividual variability of MT (MTSD) for the Visual Search task. Even though the MTSD for the Hick 0-Bit condition did not meet these criteria, it too was eliminated because its highest loading was on one of the speed of movement factors. Also eliminated were the 10 ECT variables that Carroll (1991a) omitted in his factor analysis of the data because they did not meet Kaiser's (1981) measure of sampling adequacy. After the elimination of these variables, only 14 of the original set of 37 ECT variables

TABLE 1
Loadings of All Remaining Elementary Cognitive Tasks (ECTs)[a] on the
Three Principal Components

ECT Variable	Principal Components		
	1	2	3
IT	.233	.525	.350
HORTMDN	.628	.443	−.078
HORTSD	.421	.598	−.330
H3RTMDN	.818	.278	.062
H3RTSD	.499	.406	.263
ODRTMDN	.745	−.050	.469
ODRTSD	.521	−.238	.678
SDRTMDN	.759	−.226	−.114
SARTMDN	.725	−.289	.159
MSRTMDN	.845	−.166	−.191
VSRTMDN	.887	−.210	−.171
VSMTSD	.572	−.387	−.179
MSRTINT	.785	.035	−.314
VSRTINT	.812	−.022	−.179
% Variance	47	11	9

[a]ECT variable descriptions can be found in Table 1 in Kranzler and Jensen (1991a, p. 405).

TABLE 2
Summary of the Multiple Regression of _g_ Regressed on the Three Principal Components After Eliminating the Supposed "Impurities"

Component[a]	Multiple R	R	F	p
1	.308	.095	10.34	.001
3	.379	.144	5.44	.022

[a]Component entries are cumulative.

remained. In addition, all of the psychometric variables were eliminated, except for the Vocabulary and Similarities subtests of the Multidimensional Aptitude Battery (MAB). The estimate of _g_ was the average of the standard scores on these two subtests.

The 14 ECT variables were then submitted to a principal components analysis to derive orthogonal component scores. All of the principal components with eigenvalues greater than 1 were retained. Results of this analysis are shown in Table 1. These three components account for about 67% of the total variance in the 14 ECT variables. The principal component scores were then entered stepwise in a multiple regression analysis to predict the estimated _g_ scores. Results of this analysis, presented in Table 2, show that two of the three principal components (1 and 3) add significant increments to the multiple R^2. Principal Component 2 does not add significantly to the multiple R^2. The overall multiple R is .379 ($R^2 = .144$). After correction for the considerable restriction of IQ range in the university sample, the multiple R increase to .492.

DISCUSSION

Before discussing the results, it is important to reiterate that:

> The specific hypothesis addressed here is not whether _any_ of the principal components will add significantly to the prediction of _g_, as previous research (e.g., Vernon, 1983) suggests that this is likely, but whether _additional_ components _after_ the first principal component will add significantly to the prediction of _g_. If this is the case, then _g_ must be the result of separate processes, as the principal components are orthogonal. (Kranzler & Jensen, 1991a, p. 406)

The results of this analysis reject the hypothesis that the nature of _g_ is unitary, even after greatly reducing the number of chronometric and psychometric tests in the battery to eliminate the most likely sources of the supposed "impurities," as two of the three principal components do add significant increments to the prediction of _g_. Thus, the substantive conclusion of this study is the same as that reached by Kranzler and Jensen (1991a), namely, that multiple independent cognitive processes are significantly related to psychometric _g_.

Of course, it is possible to argue, as does Carroll (1991b), that "any components needed beyond the first [in the prediction of *g*] would be an indication that the analysis had not eliminated all the impurities" (p. 453). It is, nevertheless, altogether unclear what these "impurities" might be, especially after the selective elimination of numerous variables in this study (roughly two thirds of the original set of psychometric and chronometric variables). It is also difficult to imagine how the "impurities" could affect the outcome of the multiple regression analyses and not be apparent in Carroll's factor analysis. In sum, these results are still consistent with the conclusions reached by Kranzler and Jensen (1991a, 1991b), as well as the findings of recent replications of these studies (Miller & Vernon, 1992; Vernon & Weese, 1991), thereby adding further evidence that seems inconsistent with the hypothesized unitary nature of psychometric *g*.

REFERENCES

Carroll, J.B. (1991a). No demonstration that *g* is not unitary, but there's more to the story: Comment on Kranzler and Jensen. *Intelligence, 15,* 423–436.

Carroll, J.B. (1991b). Still no demonstration that *g* is not unitary: Further comment on Kranzler and Jensen. *Intelligence, 15,* 449–453.

Kaiser, H.F. (1981). A revised measure of sampling adequacy for factor-analytic data matrices. *Educational and Psychological Measurement, 41,* 379–381.

Kranzler, J.H., & Jensen, A.R. (1991a). The nature of psychometric *g*: Unitary process or a number of independent processes? *Intelligence, 15,* 397–422.

Kranzler, J.H., & Jensen, A.R. (1991b). Unitary *g*: Unquestioned postulate or empirical fact? *Intelligence, 15,* 437–448.

Miller, L.T., & Vernon, P.A. (1992). The general factor in short-term memory, intelligence, and reaction time. *Intelligence, 16,* 5–29.

Vernon, P.A. (1983). Speed of information processing and general intelligence. *Intelligence, 7,* 53–70.

Vernon, P.A., & Weese, S.E. (1991, April). *The effect of task complexity on the relationship between intelligence and speed-of-information processing.* Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.