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Response to Mathias and Nettelbeck on the Structure of Competence: Need for Theory-Based Methods to Test Theory-Based Questions

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In this paper, we respond to a 1992 study by Mathias and Nettelbeck in which, using exploratory factor analysis, they argued that the structure of intelligence in persons with mental retardation deviates from the model previously proposed by Greenspan. Applying the LISREL method of confirmatory factor analysis to Mathias and Nettelbeck's original correlation matrix, we found the Greenspan model (in which social and practical intelligence form separate factors) to be an equally plausible interpretation of their data as the single (Interpersonal Competence) factor found by Mathias and Nettelbeck. The findings are discussed with respect to (a) the importance of using theory-based methods when addressing theory-based questions and (b) the role of social intelligence in the ongoing controversy over the meaning of mental retardation.

In a paper published in this journal, Mathias and Nettlebeck (1992a) investigated a theoretical model of personal competence in persons with mental retardation proposed by Greenspan (1979, 1981). In their paper, they explored the

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factor structure of measures intended to tap various aspects of that model in an Australian sample of persons with mental retardation. Their findings were only partly supportive of the Greenspan model. The major area of difference is that Mathias and Nettelbeck found Practical Intelligence and Social Intelligence to form a single factor (Interpersonal Competence), whereas Greenspan (1979, 1981) postulated that they were two separate factors in a tripartite model of intellectual competence.

This question is of more than theoretical interest, as the recently revised American Association on Mental Retardation (AAMR) definition of mental retardation (Luckasson et al., 1992) utilizes a dual criterion of IQ and "adaptive skills," with the latter (according to the manual's theoretical chapter) based on Greenspan's notion of *adaptive intelligence* (which contains practical and social intelligence). As pointed out in two critiques by Greenspan and associates (Greenspan & Love, in press; Greenspan, Switzky, & Granfield, in press), however, the AAMR operationalization of adaptive skills is closer to the Mathias and Nettlebeck formulation than to the Greenspan formulation. Specifically, the list of competencies contained within the AAMR construct of adaptive skills does not differentiate between practical and social intelligence and, in line with the previous AAMR construct of "adaptive behavior," is much more heavily weighted with practical intelligence content than with social intelligence content. This is problematic, according to Greenspan et al. (in press), less for its lack of fidelity to the Greenspan model than for the very real possibility that a definition of mental retardation that fails to do justice to the role of social intelligence deficits may prove to be an inadequate basis for diagnosing a disorder that has historically been identified by naiveté in the area of interpersonal relationships (Greenspan & Shoultz, 1981).

In a subsequent study in the United States, using different measures, McGrew, Bruininks, and Johnson (in press) tested the relative merits of the separate-factors (Greenspan) or single-factor (AAMR/Mathias & Nettelbeck) models of the structure of competence in persons with mental retardation and other disabilities. Using confirmatory factor-analytic methods, McGrew, Bruininks, and Johnson (in press) found considerable support for Greenspan's assertion that Social and Practical Intelligence form separate factors in samples of individuals with both mild and moderate-to-severe disabilities. Additionally, a recent review by Widaman and McGrew (in press) of the factor-analytic literature on adaptive behavior and personal competence in persons with mental retardation found support for dimensions that correspond to the domains of the complete Greenspan model.

The current paper is intended to address more directly whether Mathias and Nettelbeck's finding of a single factor combining Practical and Social Intelligence was a valid interpretation of their own data. A major reason for thinking that it might not have been is that Mathias and Nettelbeck used exploratory factor analysis rather than more appropriate confirmatory methods. Exploratory factor analysis is best suited to the discovery of the dimensionality

among a set of variables when no a priori hypothesis, based on prior research or theory, is advanced about the underlying factor structure. Confirmatory factor methods (often referred to as the LISREL method) are more appropriate when prior research or theory suggests hypotheses about the underlying structure of a set of variables and where the goal is to evaluate and compare the relative fit of competing hypothesized models. (For a more thorough treatment of model-fit evaluation and comparisons, the reader is referred to Bentler, 1980; Byrne, 1989; Cole, 1987; Loehlin, 1987; Long, 1983).

A second problem with the Mathias and Nettelbeck finding, is that some of their data are inconsistent with one of the major assumptions of the exploratory model. Mathias and Nettelbeck used two scores (inference and error scores) from the Test of Social Inference (TSI; Edmonson, de Jung, Leland, & Leach, 1974) as separate variables in their study. Since the scores from these two variables are derived from the single administration of the same set of stimulus materials, correlated measurement error probably exists between the two scores. Exploratory factor-analysis methods assume no correlated error between individual variables (Long, 1983). It is not surprising that the two TSI variables were the primary indicators of Mathias and Nettelbeck's Accuracy of Inference factor. This factor is most likely a methodological artifact reflecting the correlated error between these two variables, in contrast to their interpretation of this as being a methodological factor due to a shared pictorial content of the variables. This is another reason why confirmatory factor methods would have been a better choice, as such methods allow a researcher to specify not only the relationship between latent factors and observed measures, but also the inclusion of correlated error parameters between observed measures in the specified models.

METHODS AND RESULTS

To test our view that confirmatory methods would have provided a more valid test of Greenspan's model of personal competence, we obtained a copy of Mathias and Nettelbeck's correlation matrix from the original doctoral dissertation by Mathias (1988) on which their article is based. We compared two alternative models. The *Mathias model* specified a two-factor model that included a Conceptual Intelligence factor and Mathias and Nettelbeck's Interpersonal Competence factor (a combination of Practical and Social Intelligence variables). The *Greenspan model* included the specification of separate Conceptual, Practical, and Social Intelligence factors. In both models, each factor was defined by those variables described by Mathias and Nettelbeck (1992a) as the intended indicators of the constructs (see Table 1 in their paper; Mathias & Nettelbeck, 1992a). No dual factor loadings were specified. Also, all latent factors were correlated (i.e., were oblique factors) in each model. More important, correlated measurement error between the two TSI variables was included in each model.

Based on a review of a variety of different model-fit statistics, both models were found to be equally plausible. For example, the goodness-of-fit (GFI) and parsimonious-goodness-of-fit (PGFI) values were identical (.82 and .58, respectively) for both models, and the adjusted goodness-of-fit (AGFI) values were .74 and .75. As expected, the TSI correlated measurement error parameter (.47 in both models) was significant. In fact, when the models were rerun without the correlated measurement error parameter, the LISREL modification indices indicated that the parameter should be added to the models. This supports our interpretation of the Mathias and Nettelbeck Accuracy of Inference factor as a methodological artifact due to the use of exploratory factor analysis methods with a set of variables that includes two variables with correlated measurement error.

Table 1 presents the parameter estimates for the two models. The 1.0 factor loading for the AAMR adaptive behavior community self-sufficiency variable (*Greenspan model*) and the low loadings for the AAMR adaptive behavior personal self-sufficiency variable (both models) is due to Mathias and Nettelbeck's report that the personal-self sufficiency variable was problematic due to a significant attenuation of range of scores on this variable. Their data set included only one good indicator of Practical Intelligence (community self-sufficiency). Three indicators are typically needed to represent factors adequately in exploratory and confirmatory factor analysis.

Of particular interest are the latent factor correlations in the two models. In the *Mathias model*, the Conceptual Intelligence and Interpersonal Competence factor correlation was .80. In the *Greenspan model*, the Conceptual and Social Intelligence latent factor correlation was .81, the Conceptual and Practical Intelligence correlation was .42, and the Practical and Social Intelligence correlation was .60. The .60 Practical and Social Intelligence correlation indicates that these are two related but separate constructs (i.e., they have approximately 36% shared variance). The .42 Conceptual and Practical Intelligence correlation also indicates related but separate constructs (18% shared variance).

The relatively high .80 and .81 latent factor correlations occurred whenever a separate Conceptual Intelligence factor was correlated with a factor that included the Social Intelligence indicators. This is most likely due to the fact that Mathias and Nettelbeck primarily used indicators of verbal abilities or crystallized intelligence to define Conceptual Intelligence (viz., Slosson, WISC-R Vocabulary, PPVT) and that the Social Intelligence measures used were "verbally demanding" (Mathias & Nettelbeck, 1992b). These high latent factor correlations most likely are due to common verbal or language demands across the Conceptual and Social Intelligence indicators. With the extant factor-analytic research literature converging on a broader definition of intelligence that includes such abilities as crystallized and fluid intelligence, visual and auditory processing, short-term memory, associative storage and retrieval, processing speed, and quantitative ability (Carroll, 1993; Horn, 1991), one would predict a lower correlation between Social and Conceptual Intelligence

TABLE 1
Factor Loading Parameters for Mathias and Greenspan Models

Variable	Mathias Model			Greenspan Model		
	Conceptual Intelligence	Interpersonal Competence	Social Intelligence	Conceptual Intelligence	Practical Intelligence	Social Intelligence
Stosson	.87	—	—	.87	—	—
Peabody	.80	—	—	.80	—	—
WISC-R Vocabulary	.81	—	—	.81	—	—
Coloured Progressive Matrices	.35	—	—	.35	—	—
ABS-SE Community Self-Sufficiency	—	.17*	—	—	.33	—
ABS-SE Personal Self-Sufficiency	—	.59	—	—	1.00	—
Role taking	—	.58	—	—	—	.58
TSI (inference score)	—	.64	—	—	—	.63
TSI (accuracy score)	—	.33	—	—	—	.33
Interpersonal understanding	—	.70	—	—	—	.70
Psychological causality	—	.84	—	—	—	.84
Moral reasoning	—	.65	—	—	—	.64
Referential communication	—	.40	—	—	—	.40
Means-ends problem solving	—	.78	—	—	—	.78

*Nonsignificant parameter ($p < .05$).

in studies where Conceptual Intelligence is defined by more than verbal or crystallized intelligence indicators.

DISCUSSION

Mathias and Nettelbeck (1992a) gathered very important data that can help to evaluate the validity of different models of personal competence. Although they offered appropriate cautions about their results due to the small size of their sample and the use of only one good indicator of Practical Intelligence, we believe a more significant problem was the failure to use confirmatory factor analytic methods. The use of exploratory methods was inconsistent with their major goal of testing theory-based hypotheses and with the nature of their data (i.e., the existence of correlated measurement error between two variables). Theory-based research methods (i.e., confirmatory factor analysis, often referred to as the LISREL method) should be used to test theory-based hypotheses.

Reanalysis of Mathias and Nettelbeck's (1992a) data with confirmatory methods did not support their conclusion that Social and Practical Intelligence form a single construct (which they labeled Interpersonal Competence) rather than the separate theoretical constructs postulated by Greenspan (1979, 1981). Model-fit comparisons indicated that the Greenspan model of personal competence, a model that suggests separate Conceptual, Practical, and Social Intelligence constructs, is an equally plausible interpretation of their data. In fact, we would argue that the relatively moderate latent-factor correlations found between the Social and Practical Intelligence factors (.60) and the Conceptual and Practical Intelligence factors (.42) support the contention that these are theoretically distinct constructs.

In contrast to Mathias and Nettelbeck's focus on the Practical and Social Intelligence distinction, our analysis suggests that the biggest area of concern with their data is the Conceptual and Social Intelligence distinction. We offer the hypothesis that the less-than-clear distinction between Conceptual and Social Intelligence that emerged in their data is due to their narrow operational definition of *Conceptual Intelligence* as verbal or crystallized abilities, thus tapping verbally based skills that were also required in the Social Intelligence measures that they used. Support for this hypothesis, as well as for the complete Greenspan model, can be found in a recent study in which *Conceptual Intelligence* was defined more broadly to include indicators of the major domains of intelligence (McGrew, Bruininks, & Johnson, in press).

As indicated in the introduction, this debate has implications not just for theoreticians but for practitioners who are interested in the way in which mental retardation is defined, diagnosed, and assessed. Over the past 75 years, a number of scholars (e.g., Gardner, 1983; Guilford, 1967; Sternberg, 1988; Thorndike, 1920) have argued for the utility of a multiple-intelligences perspective that includes the construct of social intelligence as something separate from and equal in importance to IQ (or what Sternberg has termed *academic intelligence*).

Nevertheless, recent conceptions of mental retardation, including the 1992 revised AAMR definition, give primary emphasis to Conceptual Intelligence (IQ) and secondary emphasis to Practical Intelligence (daily living skills) and virtually no emphasis to Social Intelligence as a separate and equal component.

The failure to take Social Intelligence seriously is attributed (where commented on) to the inadequacy of existing measures (Ford, 1979; Shanley, Walker, & Foley, 1971) and the lack of empirical evidence supporting its independence from IQ (Thorndike & Stein, 1937). One could reply, to paraphrase Goodnow (1986), that it makes no more sense to require empirical validation of an obviously important attributed personal limitation as "social stupidity" than it does to require validation of such other obviously important attributed personal limitations as "shyness" or "ugliness." Nevertheless, it would be mistaken to assume, as does S. R. Reiss (personal communication, April 1993), that there is no empirical support for the existence of social intelligence as a separate construct, or to use that assumed lack of support as justification for continuing to give that construct short shrift in current efforts at redefinition and measurement. In fact, there are numerous research measures of social intelligence (see Bryan, 1991 for a recent review) and growing validation support for the importance of this construct (Greenspan & Love, in press).

We certainly support the call for improved measures of social intelligence, but need to point out that there is growing factor-analytic support for the notion that social intelligence should be viewed as a theoretical construct separate from either conceptual or practical intelligence. While factor-analytic research by itself is not necessarily a sufficient basis for deciding how mental retardation should be conceptualized, it is an important aspect of any attempt at construct validation. For this reason, it is important to point out that utilization of less-than-optimal statistical methods, and the use of too narrow a range of measures, may have contributed to Mathias and Nettelbeck's concluding (prematurely we believe) that social intelligence should not be viewed as a separate aspect of personal competence in persons with mental retardation.

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