Commentaries

All General Factors Are Not Alike

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In their focal article, Ree, Carretta, and Teachout (2015) argue that a large general factor (DGF), defined as the first component of an unrotated principal components solution, is characteristic of many different domains. In their view, ignoring the DGF in assessment and prediction in industrial and organizational (I-O) psychology is counterproductive. They readily acknowledge that the existence of a DGF does not preclude the existence of distinguishable specific factors. Their message is simply that the general factor (unrotated) frequently accounts for over half the reliable variance, and rather than ignore it, the reasons for it and the usefulness of it should be investigated. Further, the general factor is a construct, and all constructs must be supported by the various kinds of evidence that demonstrate construct validity. The DGF is no exception.

I think virtually everyone would agree with the statements made in the above paragraph. The difficulties arise because all general factors are not alike, and assessment of the specific components can be done for various measurement purposes. For example, Borsboom, Mellenbergh, and van Heerden (2003) and others (e.g., Diamantopoulos, Riefler, & Roth, 2008; Edwards, 2001) make a distinction between two kinds of general factors. The DGF of the *first kind* is intended to represent an actual latent variable that determines (i.e., "causes") individual differences on any number of observed measures. This kind of DGF can be modeled with a bifactor model (e.g., see Wiernik, Kostal, & Wilmot, 2015) that may include latent specific factors that also play a causal role in determining individual differences on observed measures.

The DGF of the *second kind* posits that individual differences on the general factor are *caused* by specific latent factors that produce additive

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effects. With this model, the DGF is simply a sum score of individual components and does not represent a single latent variable. If individual differences on several specific measures are produced, at least in part, by a similar set of specific latent variables, a principal components analysis of their intercorrelations will produce a general factor of some magnitude, but the general factor itself is not a latent variable. Borsboom et al. (2003) refer to these two kinds of general factors as a *true latent variable* versus a *sum score*. Edwards (2001) uses the terms *superordinate* factors versus *aggregate* factors. Diamantopoulos et al. (2008) refer to them as *reflective* and *formative* factors.

General Factors of the First Kind

Several of the examples described in the focal article do seem to represent a general factor of the first kind. For example, although its specification is not made explicit by Ree et al., general mental ability (GMA) most likely constitutes a single latent variable that has several distinguishable subfactors (Johnson, Nijenhuis, & Bouchard, 2008). That is, it fits a bifactor model, and the general factor is indeed large. The focal article implies that the DGF for mental ability is not verbal ability, quantitative ability, or spatial ability. The implication is that it is something else that explains most of the variance in all three. What then is it? If the DGF is modeled as a single latent variable then it is necessary to produce a substantive specification for what the general factor is. Without any substantive specification, DGF construct validation is difficult. Much of mainstream intelligence research characterizes the DGF as a general capacity to reason and comprehend novel complex ideas, regardless of their specific content (Gottfredson, 1997). A summary of the existing explanations for GMA as a factor of the first kind is given by Reeve, Scherbaum, and Goldstein (2015), who also make a strong case that the specific latent variables, controlling for GMA, can be very useful in many different prediction situations. In their judgment, Ree et al. take too narrow a view of the criterion space, and they argue that sometimes there are important differential predictions that reflect more than *g*. A reasonable expectation is that future research will produce a neuroscience-based characterization of the latent variable(s).

Job attitudes in general, and job satisfaction in particular, could be modeled either as a single, general latent variable plus specific factors corresponding to satisfaction with compensation, supervision, coworkers, the work itself, and so forth or as a set of specific factors that sum to an overall satisfaction score (Judge, Hulin, & Dalal, 2012). Currently, the former seems more likely (Dalal & Credé, 2013), and the general factor can be defined simply as how positive or negative you *feel* about your "job." This does not preclude the existence of specific latent factors as well (see Wiernik et al., 2015).

It might also be the case that a general latent variable (the "Big One") exists in descriptions of personality. However, this example has certain complexities. Currently, the definitive confirmatory factor analysis work, based on the most recent and most comprehensive meta-analyses, is reported by Davies, Connelly, Ones, and Birkland (2015). If method variance (in this case attributable to the specific inventory used) is at least partially controlled by comparing DGFs obtained by factoring the Big Five intercorrelations obtained *within* specific inventories to factoring intercorrelations computed *between* inventories, the variance accounted by the general factor drops from approximately 50% to approximately 25%. That is, when controlling for specific inventory (i.e., method) effects, the general factor is no longer dominant. Substantively, the resultant general factor seems to represent an individual's general self-evaluation of whether they are a "good" person. These general evaluations appear to be specific to each rater. The general factors obtained from self-ratings and from other ratings (i.e., from a single observer) of the same items are essentially uncorrelated, and the variance accounted by the observer general factor is less. If item intercorrelations are based on different observers, the general factor essentially disappears (Chang, Connelly, & Geeza, 2012). This is consistent with saying that the general factor of personality is of the first kind and represents an individual's overall self-evaluation. Interestingly, observer ratings are somewhat more predictive of external variables than are self-ratings (Connelly & Ones, 2010).

The General Factor in Job Performance Assessment

Ree et al. seem to have misconstrued this DGF as a general factor of the first kind, which it is not. Certainly, factor analyses of performance data will usually yield a general factor, particularly when supervisor or peer ratings are the measurement method. However, no one, including Ree et al., has produced a substantive content specification for the general factor. That is, if general job performance is a latent variable, what are the content specifications for this construct?

Job performance is not a trait. It is a "state" that has been defined by virtually everyone (see Campbell & Wiernik, 2015) as things that people do at work for the purpose of advancing the organization's goals. Performance itself (i.e., what we actually do in a work role, with varying levels of proficiency) should be distinguished from the determinants of performance (e.g., abilities, skills, motivation) and from the outcomes of performance (e.g., sales) *if* the outcome is substantially influenced by other factors. The things we do, in the name of performance, have been sorted into categories of similar content (e.g., technical tasks, peer leadership, etc.) by using various methods and by developing actual measures of many different performance facets (see Campbell & Knapp, 2001). Identifying the most meaningful

categories of performance requirements has been what modeling performance is all about. Our own best effort to synthesize all previous categorizations is recounted in Campbell and Wiernik (2015), who deal with modeling performance content, performance dynamics, performance assessment, performance goals, and performance adaptability, among other things. Many of these same issues are discussed in Campbell (2012) and Campbell (2013).

If general job performance *is* a latent variable and should be utilized as such, but no specifications for it exist, how then would the following issues be addressed?

- How would training on the DGF be designed? What would be the substantive training goals? What would be the training content?
- How would performance problems be diagnosed? Saying, "your DGF needs improvement," when we can't specify what the DGF is, is counterproductive.
- How could people be coached on how to improve their DGF?
- What should be done with technically proficient scientists and engineers who become dysfunctional "leaders"?
- What would be the substantive content of performance feedback?
- What would be the procedure for identifying the performance requirements for jobs? (i.e., what would a job analysis designed to specify the DGF for a job's performance requirements look like?) The focal article criticizes the Fleishman, Quaintance, and Broedling (1994) taxonomy for not dealing with a general factor. However, the Fleishman et al. taxonomy does not deal with performance itself. It deals with the knowledge, skill, and ability (KSA) determinants of performance. For many domains of KSAs, a general factor of the first kind may indeed be operative and may indeed have neurological or physiological substrates. Unfortunately, the I-O psychology literature is replete with confusions between performance itself and both its determinants and outcomes. For further discussion of this issue, see Campbell (2013).

Again, there is usually a large general factor when correlations among a set of performance measures are analyzed. However, given the way performance must be defined, it is simply not possible to specify the DGF as a general factor of the first kind. The question of what are the specifications for the underlying latent variable cannot be answered in any sensible way. It is a general factor of the second kind and must be dealt with as such. Overall performance (i.e., the general factor) can only be defined as the sum (weighted in some fashion) of performances on a specified number of facets or components. Consequently, the authors of the focal article took my assertion that there is no general job performance factor out of context and put it in a different (incorrect) context. Relatedly, there are also a number of

incorrect citations in the focal article. For example, the Project A data produced five factors for first term enlisted performance, not eight. Please see Campbell and Knapp (2001) and Campbell (2012) for a full account.

If the DGF is a general factor of the second kind, what produces it? Some of the reasons could be the following. The focal article discusses some of them.

- The individual performance measures that are intended to capture individual differences on different categories (i.e., factors) of performance requirements (e.g., technical performance, peer leadership performance, etc.) could have common determinants. The obvious suspects are GMA, certain personality factors, and the characteristic level of effort an individual usually invests. Such a set of common determinants could produce correlations between performance factors that have very different content but that yield a general factor of the second kind.
- Common method variance in general (e.g., the use of the rating method) and the special case of using the same rater to estimate performance levels on each performance factor can produce substantial intercorrelations among variables.
- Various measurement biases such as halo, leniency, overgeneralization of negative information from one dimension to other dimensions, relative liking of the ratee by the rater, impression management by the ratees, and the implicit performance model held by the rater, which may not correspond to the model used to construct the rating scales, are all potential measurement artifacts that can inflate the intercorrelations among criterion variables.
- Use of outcome measures as performance criteria, individual differences on which may be due to factors not under the individual's control (e.g., such as amount sold or even ratings of productivity or work quality), could produce spurious intercorrelations of various kinds. Nowhere is this more tragic than in the use of "value added" models of changes in students' achievement test scores to assess the performance of K–12 teachers (see Haertel, 2013).

Considerations such as the above can, and certainly do, produce a general factor. However, virtually by definition, an overall performance measure must be a sum or aggregate score (weighted or unweighted) of a set of individual measures of performance itself, not the determinants of performance. The aggregation can be done explicitly or left up to the implicit theory of the rater or judge. Aggregate scores, controlled for method variance and measurement artifacts, are in fact needed for many different kinds of personnel

decisions (Schmidt & Kaplan, 1971), but this does not mean they reflect a substantive latent factor.

In general, I-O psychology has neglected research on the specification and measurement of our dependent variables (Campbell, 2013). It is our collective shortcoming. Ree et al. seem to share this view. Remedying this deficiency is our collective responsibility, particularly with regard to performance itself. The word "performance" is probably misused even more than the word "leadership," and the body politic is the worse for it. We simply need to know much more about what performance is, how we actually make performance judgments, and how performance can best be assessed.

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Estimating the Strength of a General Factor: Coefficient Omega Hierarchical

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Relying on work described by Jackson (2003), Ree, Carretta, and Teachout (2015) recommended researchers use the first unrotated principal

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