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Further Evidence for the Validity of Assessment Center Dimensions: A Meta-Analysis of the Incremental Criterion-Related Validity of Dimension Ratings

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This study investigates the incremental variance in job performance explained by assessment center (AC) dimensions over and above personality and cognitive ability. The authors extend previous research by using meta-analysis to examine the relationships between AC dimensions, personality, cognitive ability, and job performance. The results indicate that the 7 summary AC dimensions postulated by W. Arthur, Jr., E. A. Day, T. L. McNelly, & P. S. Edens (2003) are distinguishable from popular individual difference constructs and explain a sizeable proportion of variance in job performance beyond cognitive ability and personality.

Keywords: assessment center, incremental validity, meta-analysis

Managerial assessment centers (ACs) continue to be a popular assessment method in both administrative and developmental contexts (Howard, 1997; Woehr, 2006). For administrative purposes, ACs have enjoyed continued use due in large part to their high fidelity (Cascio & Aguinis, 2005), strong criterion-related validity evidence (Arthur, Day, McNelly, & Edens, 2003), and a lack of subgroup differences in scores (Howard & Bray, 1988; Huck & Bray, 1976; Thornton & Rupp, 2006). Further, ACs have seen increasing use in management and leadership development programs largely because of their apparent objectivity relative to other alternatives (e.g., 360° feedback), more favorable applicant reactions in comparison with other predictors (Macan, Avedon, Paese, & Smith, 1994), and the positive impact on feedback acceptance (Cascio & Aguinis, 2005).

Although the AC method is popular and frequently used, the construct-related validity of the performance dimensions assessed continues to be perceived as its Achilles heel (Lance, in press). However, two recent meta-analyses have demonstrated relatively favorable validity evidence for AC dimensions. Specifically, Arthur et al. (2003) proposed that the myriad of espoused AC dimensions found in the literature could be reliably collapsed into a smaller, conceptually distinct set of seven dimensions. Using this

seven-dimension taxonomy, they provided evidence for the criterion-related validity of individual AC dimensions with respect to job performance as opposed to an overall AC rating (OAR), as is typical in previous criterion-related validity studies (e.g., Gaugler, Rosenthal, Thornton, & Bentson, 1987). Similarly, using the same seven-dimension taxonomy, Bowler and Woehr (2006) demonstrated that a model consisting of both dimension and exercise factors provided the best representation of AC dimension ratings and that exercise effects were only slightly larger in magnitude than dimension effects.

Another potential concern regarding the validity of AC ratings involves the extent to which they make an incremental contribution to the prediction of relevant criteria. Specifically, it has been suggested that variance in job performance explained by AC dimensions might be more economically captured via constructs measured in typical paper-and-pencil measures (Collins et al., 2003). Thus, the purpose of the present study is to extend the findings of Arthur et al. (2003), Bowler and Woehr (2006), and Collins et al. (2003) by providing a quantitative summary of (a) the degree of overlap between AC dimensions and external, non-AC constructs and (b) the extent to which AC dimensions explain variance in work performance beyond the Big Five personality dimensions and general mental ability (cognitive ability).

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A previous version of this article was presented at the 22nd annual conference of the Society for Industrial–Organizational Psychology, New York, April 2007.

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The Validity of AC Dimension Ratings

Despite the popularity of the AC method, a great deal of controversy continues to revolve around the construct-related validity of the performance dimensions assessed. Specifically, research on the structure of AC postexercise dimension ratings (PEDRs) has indicated that PEDRs reflect the effect of the exercises in which they were obtained to a greater extent than they reflect cross-exercise stability in candidate behavior on the dimen-

sions being rated. Large-scale quantitative reviews indicate that PEDRs reflect equal proportions of exercise and dimension variance (Lievens & Conway, 2001), that exercise effects were much larger than performance dimension effects (Lance, Lambert, Gewin, Lievens, & Conway, 2004), and most recently that exercise effects are only slightly larger than performance dimension effects (Bowler & Woehr, 2006).

Here it is important to note that research on the construct-related validity of AC dimensions has focused almost exclusively on PEDRs. However, this focus is largely an artifact of the requirements of the methods used to evaluate this form of validity evidence. Specifically, these studies have typically used multitrait-multimethod (MTMM) approaches to evaluate construct-related validity. That is, in the context of ACs, the MTMM approach is operationalized such that dimensions are viewed as traits and exercises as methods. Thus, ratings are required for each dimension within each exercise (i.e., PEDRs) to examine the magnitude of dimension and exercise effects. Here it is important to note that two primary evaluation approaches have been identified across ACs (Robie, Osburn, Morris, & Etchegaray, 2000; Sackett & Dreher, 1982; Woehr & Arthur, 2003). In the *within-exercise* approach, assessees are rated on each dimension after completing each exercise. In the *across-exercise* approach, evaluation occurs after all of the exercises have been completed, and dimension ratings are based on performance on all of the exercises. Common to both of these approaches, however, is the focus on postconsensus dimension ratings (PCDRs) as the ultimate measure of dimension-level performance. These dimension ratings represent the combination (either clinical or mechanical) of PEDRs into a summary representing dimension-level performance information across multiple exercises and/or raters. From a traditional psychometric perspective, PEDRs may be viewed as item-level information, whereas PCDRs represent scale-level information. The increase in reliability associated with the aggregation of item-level information sets a higher upper bound for the validity of the measurement. Despite the prevalence of the MTMM approach to examining the construct-related validity of ACs, recent attention has highlighted potential problems associated with the confirmatory factor analytic designs typically used in these studies (e.g., Lance, Woehr, & Meade, 2007). Others have argued that the MTMM model is not an appropriate approach for the assessment of AC construct-related validity (Arthur, Woehr, & Maldegen, 2000; Foster & Cone, 1995). Still others have argued that the findings with respect to larger than desirable method effects are not unique to the AC method and, in fact, rarely does the MTMM approach support construct-related validity regardless of the method(s) evaluated (Fiske & Campbell, 1992; Meier, 1994).

Unfortunately, however, the use of PCDRs does not allow the evaluation of internal construct-related validity in the form of typical convergent and discriminant validity coefficients. As a result, research examining ACs at the construct level (e.g., research examining AC PCDRs) has been somewhat sparse. Given that AC PCDRs represent a culmination of AC performance across exercises and are frequently used in applied settings, the failure to provide a comprehensive summary of the psychometric properties of PCDRs represents an important omission in the extant literature. Further, most of the studies on AC dimension construct-related validity have provided little evidence regarding the most appropriate way to define the actual constructs they evaluate. An inher-

ent flaw in this approach is the treatment of dimensions as generic constructs, and, without proper construct definition, these approaches have neglected an important step in evaluating construct-related validity (Arthur, Day, & Woehr, 2008). To obtain a more accurate view of the validity of constructs in ACs and the utility of the AC method, it is important to examine not only the pattern of internal relations among dimension ratings but also the degree of relationship among PCDRs and other non-AC assessed constructs (e.g., cognitive ability and personality), as well as the incremental criterion-related validity of consensus-based dimension ratings (over and above other common predictors).

A Taxonomy of AC Performance Dimensions

One of the primary problems in reviewing the psychometric properties of AC dimensions is the overwhelming number of dimensions found in the literature. Recent meta-analyses of the AC literature have reported identifying anywhere from 79 to 168 different dimension labels (Arthur et al., 2003; Bowler & Woehr, 2006; Woehr & Arthur, 2003). Although human behavior is certainly complex, it seems unlikely that 168 different dimensions are required to explain managerial performance. Thornton and Byham (1982) provided a somewhat more manageable list of 33 dimensions commonly used in ACs. Through a systematic content-sorting process, Arthur et al. (2003) found that the overwhelming majority of dimension labels found in the AC literature could be sorted into Thornton and Byham's list with a high level of reliability. Arthur et al. further proposed a core set of 7 skill dimensions into which nearly all dimension labels can be reliably reduced. These dimensions are problem solving, stress tolerance, influencing others, consideration/awareness of others, communication, organizing and planning, and drive. This classification system makes an important contribution to the literature by specifying a framework that can be used to provide a summary of the AC literature at the construct (dimension) level. Here it is important to note that the vast majority of the literature focusing on AC validity has simply ignored differences across dimensions. That is, all AC dimensions have largely been viewed as equivalent with respect to construct-related validity, whereas criterion-related validity has focused on an overall AC performance score. However, recent studies suggest that this generalization may not hold. Using this 7-dimension taxonomy, recent evidence indicates differential criterion-related validity and incremental validity of the 7 dimensions relative to an OAR (Arthur et al., 2003) as well as differential internal construct-related validity (Bowler & Woehr, 2006) across dimension constructs. Thus, any discussion of the validity of ACs must differentiate with respect to specific dimensions. Toward this end and in contrast with prior reviews focusing on OARs (e.g., Collins et al., 2003; Gaugler et al., 1987; Schmidt & Hunter, 1998), we used Arthur et al.'s taxonomy as a model for categorizing AC dimensions used in the existing AC literature.

Shared Variance With Non-AC Based Variables

The vast majority of research examining the relationships between AC ratings and other individual difference variables (including job performance) has focused on OARs. For example, Gaugler et al. (1987), in their meta-analysis of AC criterion-related validity, reported an OAR validity of .37. Other studies have

examined the relationship of OARs to other non-AC based variables (Collins et al., 2003; Scholz & Schuler, 1993). Scholz and Schuler meta-analytically examined correlates of OARs and demonstrated that OARs had differential relationships with cognitive ability ($\rho = .43$), Neuroticism ($\rho = -.15$), Extraversion ($\rho = .14$), Openness to Experience ($\rho = .09$), Agreeableness ($\rho = -.07$), and Conscientiousness ($\rho = -.06$). Collins et al. (2003) meta-analytically examined the covariation among OARs and a variety of individual difference constructs (i.e., the Big Five personality dimensions and cognitive ability). Their results indicated that the six individual difference constructs yielded a multiple correlation of .84 when regressed on OARs. On the basis of these results, the authors questioned whether ACs measure anything different from the constructs assessed with paper-and-pencil measures of individual differences, noting that “it may be possible to substitute standardized paper-and-pencil tests for more costly and lengthy assessment centers” (Collins et al., 2003, p. 25). Such results leave researchers and practitioners with the obvious question of whether the continued use of ACs is worthwhile.

Although the literature to date provides some insight with respect to the relationship of an aggregated AC rating and other measures, important questions remain unanswered. That is, previous research offers little or no insight as to the pattern of relations among different AC dimensions and the externally assessed constructs. More important, they may actually underestimate these relationships as a result of the loss of construct-level information (i.e., some dimensions may be more related to certain constructs than others). Here, validity is more appropriately examined at the construct (i.e., dimension) level.

Along these lines, Arthur et al. (2003) used meta-analysis to examine the relationships of individual AC dimensions to job performance. They effectively demonstrated that (a) specific AC dimensions were differentially correlated with job performance (ρ s ranging from .25 to .39) and (b) a regression-based composite consisting of four AC dimensions accounted for all of the criterion-related validity of AC ratings and explained 20% more variance in job performance than was reflected in previous estimates of the criterion-related validity of OARs. Hence, the results of their study provide support for the notion that construct-level information is meaningful in ACs, particularly from a criterion-related validity standpoint.

Despite the important contributions of their study, Arthur et al. (2003) did not examine the relationships between the AC dimensions and other key predictors of job performance, specifically cognitive ability and personality constructs. Also, they did not address the extent to which AC dimensions account for incremental variance in job performance over and above these more commonly used constructs (i.e., cognitive ability and personality), which are often assessed via paper-and-pencil methods. Researchers have begun to examine this question, and study results indicate that an OAR can explain incremental variance in criterion scores above cognitive ability (Dayan, Kasten, & Fox, 2002). This has been supported by additional studies, where OARs explained a moderate proportion of variance ($\Delta R^2 = .05$) in police evaluation scores above cognitive ability (Krause, Kersting, Heggstad, & Thornton, 2006). However, these results are not consistent across the literature. In another primary study, Goffin, Rothstein, and Johnston (1996) demonstrated that AC dimensions explained variance in performance above personality scores in total performance

($\Delta R^2 = .18$) as well as promotability ($\Delta R^2 = .13$). Quantitative summaries of these findings have reached somewhat different conclusions. Schmidt and Hunter (1998) found that ACs explained a smaller proportion of variance ($\Delta R^2 = .02$) in performance above cognitive ability; however, their examination also was not at the dimension level. Given the discrepancies among previous studies, we sought to reexamine this effect. Specifically, we sought to study the incremental variance in performance criteria at the AC dimension level, given the need to explore the multiple constructs that operate within ACs.

On the basis of the preceding discussion, our goal in the present study was to provide a quantitative summary of the AC literature that addressed two core research questions. These were as follows:

1. To what extent do AC dimensions (as represented in the Arthur et al., 2003, taxonomy) represent something other than cognitive ability and personality (i.e., how much commonality do the individual AC dimensions share with measures of cognitive ability and personality)?
2. How much, if any, incremental variance in job performance do AC dimension ratings account for over and above that accounted for by cognitive ability and personality?

Method

Literature Search and Criteria for Inclusion

To obtain data for inclusion in the meta-analysis, we conducted a literature search using a number of electronic databases (i.e., PsycINFO, Business Source Premier, and Web of Science) using the keywords *assessment center*, *personality*, *Big Five*, *general mental ability*, *cognitive ability*, *intelligence*, *performance*, *job performance*, and *performance ratings*. We also reviewed the reference lists of previous AC meta-analyses to locate studies that were not identified in the electronic searches. In total, our search resulted in 633 studies that were further reviewed for inclusion in the meta-analysis. Specific decision criteria were used to determine which studies were included. Studies had to (a) report final AC ratings at the dimension level (i.e., across-exercise or postconsensus dimension ratings); (b) report the sample size for each correlation presented; (c) report the correlations between the AC dimensions and either cognitive ability, personality variables, or relevant criteria; and (d) use AC dimensions that could be coded into Arthur et al.’s (2003) AC dimension taxonomy. Personality constructs must have been able to be coded into Barrick and Mount’s (1991) taxonomy for categorizing indirect personality variables into dimensions of the Big Five. Furthermore, performance ratings were only included if they were supervisor ratings of performance, as this is typical in criterion-related validity studies. Hence, performance ratings were excluded if they were based on peer, self, or subordinate ratings. When studies merely provided summary correlations (e.g., mean correlations across dimensions and or exercises) or partial correlation matrices, the authors were contacted in an attempt to obtain the full matrix.

Thirty-eight studies reporting 48 distinct samples, dating from 1969 to 2006, met the four inclusion criteria. Of the 48 samples, 23 were published studies, 17 were unpublished dissertations or manuscripts, 4 were conference presentations, and 4 were unpublished technical reports. The mean sample size was 1,100 ($Mdn =$

148, $N = 52,779$), the mean number of dimensions reported prior to recoding was 8.77 ($Mdn = 8$) and after recoding was 5.10 ($Mdn = 5$). Specifically, 27.08% of the studies presented data points for all seven of the Arthur et al. (2003) dimensions, 16.67% presented data points for six, 29.17% for five, 8.33% for four, 6.25% for three, 10.42% for two, and 2.08% for one dimension. Hence, 72.92% of the studies presented data that were able to be coded into five or more of Arthur et al.'s (2003) dimensions.

Dimension and Exercise Coding

Across the 48 samples included in the present study, we found 135 different AC dimension labels. Each dimension label was coded by two subject matter experts (i.e., trained and experienced AC assessors and researchers; SMEs) as belonging to one of the seven higher order dimension categories identified by Arthur et al. (2003). The coding of the dimension labels was facilitated by the fact that Arthur et al. (2003) provided a detailed listing of over 165 dimension labels extracted from the literature as well as the higher order dimension category each represents.

SMEs also coded each study with respect to the personality dimensions assessed. Specifically, personality variables were coded into Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness on the basis of Barrick and Mount's (1991) categorization scheme, which provides a well-established structure for collapsing indirect measures of the Big Five model into distinct dimensions. Only direct Big Five constructs and indirect constructs that were represented in the Barrick and Mount framework were included in the meta-analysis. Of the studies identified, 16 provided personality variables that could be classified into these dimensions. Cognitive ability measures were included if they represented either general mental ability or specific abilities (e.g., numeric or verbal ability), and 30 studies that met our inclusion criteria included cognitive ability. With respect to job performance, we coded both overall or general and task-specific supervisory performance ratings when they were presented. Of the studies identified, 21 provided job performance information.

Once all of the study variables were coded, each of the correlation values was assigned to the appropriate cell in a 14×14 summary correlation matrix (i.e., the correlations among each of the seven AC dimensions, five personality variables, cognitive ability, and job performance). To maintain independence of data points within each cell (i.e., each individual study contributed only one data point per cell), whenever an individual study contained two or more of the same dimensions after recoding, we averaged the corresponding correlations. For example, if an individual study contained the dimensions *analysis* and *judgment*, both were coded as belonging in the problem solving superordinate category, and the average correlation was used as one data point in the summary correlation matrix.

Sample-size-weighted average correlations were computed for each cell in the summary correlation matrix. When completed, the summary correlation matrix consisted of 14 variables with 91 unique intercorrelations (105 including unity diagonals). Table 1 presents the matrix in its entirety. With different individual studies contributing uniquely to different cells, each cell had a unique overall sample size. The average number of studies contributing to each cell was 10.82 ($SD = 6.17$, $min = 1$, $max = 25$; see Table 2) and the mean overall sample size across cells was 412.93. As recommended by Viswesvaran and Ones (1995), we used the harmonic mean (831) of the sample

Table 1
Uncorrected Meta-Analytic Intercorrelations Among Study Variables and Standard Error Estimates

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Cognitive ability	—													
2. Job performance	.30 (.02)	—												
3. Consideration/awareness of others	.17 (.03)	.19 (.01)	—											
4. Communication	.28 (.02)	.22 (.01)	.33 (.03)	—										
5. Drive	.21 (.03)	.13 (.03)	.36 (.03)	.38 (.03)	—									
6. Influencing others	.22 (.01)	.25 (.01)	.39 (.03)	.41 (.02)	.54 (.03)	—								
7. Organizing and planning	.29 (.02)	.28 (.01)	.27 (.03)	.39 (.02)	.40 (.03)	.48 (.03)	—							
8. Problem solving	.28 (.01)	.26 (.01)	.33 (.03)	.36 (.02)	.37 (.02)	.46 (.02)	.54 (.03)	—						
9. Stress tolerance	.22 (.03)	.14 (.04)	.48 (.04)	.39 (.02)	.42 (.04)	.50 (.02)	.35 (.03)	.36 (.03)	—					
10. Neuroticism	-.07 (.02)	-.10 (.07)	-.07 (.01)	-.08 (.02)	-.04 (.03)	.01 (.02)	-.07 (.02)	-.07 (.02)	-.07 (.03)	—				
11. Extraversion	.06 (.05)	.24 (.08)	.07 (.04)	.11 (.03)	.21 (.05)	.15 (.04)	.09 (.02)	.08 (.02)	.12 (.02)	-.01 (.03)	—			
12. Openness to Experience	.11 (.04)	-.02 (.00)	.06 (.02)	.12 (.02)	.06 (.06)	.08 (.03)	.09 (.02)	.11 (.03)	.11 (.03)	.00 (.04)	.18 (.05)	—		
13. Agreeableness	.12 (.06)	.10 (.00)	.05 (.02)	.09 (.04)	.09 (.05)	.08 (.03)	.02 (.03)	.06 (.02)	.06 (.03)	-.07 (.10)	.20 (.06)	.17 (.05)	—	
14. Conscientiousness	.20 (.06)	.24 (.04)	.09 (.03)	.09 (.05)	.10 (.05)	.09 (.06)	.05 (.03)	.13 (.04)	.12 (.07)	-.19 (.06)	.23 (.04)	.22 (.05)	.34 (.08)	—

Note. Values in parentheses are standard error estimates.

T1
T2

Table 2
Total Sample Size and Number of Studies on Which Correlations Are Based

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Cognitive ability	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2. Job performance	38,350 (5)	—	—	—	—	—	—	—	—	—	—	—	—	—
3. Consideration/awareness of others	6599 (21)	39,321 (15)	—	—	—	—	—	—	—	—	—	—	—	—
4. Communication	12,479 (20)	38,897 (11)	7,103 (25)	—	—	—	—	—	—	—	—	—	—	—
5. Drive	5,539 (18)	1,800 (10)	5,744 (20)	5,744 (20)	—	—	—	—	—	—	—	—	—	—
6. Influencing others	12,540 (21)	39,036 (12)	7,035 (23)	12,728 (23)	5,527 (18)	—	—	—	—	—	—	—	—	—
7. Organizing and planning	11,683 (15)	39,248 (14)	6,453 (19)	12,162 (19)	4,961 (14)	12,195 (18)	—	—	—	—	—	—	—	—
8. Problem solving	12,599 (23)	39,190 (14)	6,814 (24)	12,550 (24)	5,455 (19)	12,546 (23)	11,873 (18)	—	—	—	—	—	—	—
9. Stress tolerance	4,530 (12)	1,415 (6)	4,983 (15)	4,983 (15)	4,862 (14)	4,834 (14)	4,725 (13)	4,983 (15)	—	—	—	—	—	—
10. Neuroticism	7,25 (5)	106 (2)	537 (4)	740 (5)	690 (3)	983 (6)	967 (6)	740 (5)	1,095 (7)	—	—	—	—	—
11. Extraversion	1,166 (7)	174 (3)	1,235 (9)	1,321 (9)	1,373 (9)	2,054 (11)	1,594 (10)	1,438 (10)	1,284 (9)	1,032 (7)	—	—	—	—
12. Openness to Experience	1,156 (6)	60 (1)	1,119 (7)	1,694 (9)	910 (7)	1,672 (10)	1,990 (10)	1,847 (10)	929 (7)	986 (6)	1,428 (8)	—	—	—
13. Agreeableness	1,227 (7)	60 (1)	1,167 (8)	1,253 (8)	950 (6)	1,720 (11)	1,526 (9)	1,477 (10)	929 (7)	986 (6)	1,499 (9)	1,535 (9)	—	—
14. Conscientiousness	690 (4)	128 (2)	1,046 (7)	819 (6)	1,184 (7)	994 (6)	1,416 (7)	819 (6)	310 (3)	1009 (6)	1,495 (9)	1,536 (7)	997 (6)	—

Note. Values in parentheses are the number of studies on which correlations are based.

sizes for the individual mean correlations as the sample size for the subsequent analyses.

We used Arthur, Bennett, and Huffcutt's (2001) SAS PROC MEANS program to conduct the meta-analysis. This approach follows Hunter and Schmidt's (2004) validity generalization procedure and allows for the correction of statistical artifacts. Because we did not have reliability information for every data point, we constructed an artifact distribution that was applied to the predictors and criteria (the artifact values used are presented in Table 3). To generate the artifact distribution, we collected data on the reliability of the performance, personality, and cognitive ability variables across studies. These variables were corrected on the basis of the mean internal consistency estimates provided in primary studies. Although these values are typically used to correct for predictor unreliability, there is some debate as to the appropriateness of the use of internal consistency estimates with respect to job performance. We took this approach for two reasons. First, this is the approach used by Arthur et al. (2003) in their meta-analysis and our intent was to be as consistent as possible with previous examinations of AC dimension criterion-related validity. Our average reliability value for job performance (i.e., .90) was only slightly larger than what they found and what has been reported in the literature in general. Second, and more important, we believe that the issue of the appropriateness of using interrater reliability estimates is far from resolved in the literature. Although we recognize that the .52 value reported by Viswesvaran, Ones, and Schmidt (1996) has often been used in meta-analytic studies, we concur with opponents of using this value as an estimate of the reliability of job performance ratings. Specifically, we believe this value represents an underestimate of performance rating reliability and thus results in an overestimate of the true correlations of various predictors with job performance. We believe the best argument to date against the appropriateness of the .52 reliability estimate was made by LeBreton, Burgess, Kaiser, Atchley, and James (2003). They provided a compelling case that this value represents a downwardly biased estimate that has been severely attenuated because of restriction of range in job performance.

AC dimensions were corrected on the basis of the mean dimension intercorrelations: For example, if two primary study dimensions (e.g., *analysis* and *judgment*) were both coded into one of Arthur et al.'s (2003) dimensions (e.g., *problem solving*) and the correlation between these two dimensions was provided, the square root of this value was used as input to form an artifact distribution for the AC dimensions. In essence, this represents a type of alternate form reliability in that alternate measures of the same construct (i.e., within each of the seven AC dimensions) were used to assess reliability. This approach is not without precedent. Specifically, although our approach is not identical to that of Thornton, Tziner, Dahan, Clevenger, and Meir (1997), it is similar. In addition, consistent with Gaugler et al.'s (1987) reasoning that ACs show moderate to severe levels of range restriction, we corrected for this artifact. However, because range restriction values were not reported in any of the studies included in this meta-analysis and to be consistent with previous meta-analyses of AC criterion-related validity (e.g., Arthur et al., 2003; Gaugler et al., 1987), we used the range restriction value reported by Gaugler et al.

Table 3
Corrected Meta-Analytic Intercorrelations Among Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Cognitive ability	(.90)	.32	.20	.31	.23	.24	.32	.31	.25	-.07	.06	.11	.12	.20
2. Job performance	.34	(.90)	.22	.25	.15	.29	.33	.31	.16	-.10	.26	-.02	.11	.25
3. Consideration/awareness of others	.22	.24	(.80)	.37	.39	.43	.30	.36	.52	-.08	.08	.07	.05	.11
4. Communication	.35	.27	.44	(.86)	.41	.45	.42	.40	.42	-.09	.13	.13	.10	.10
5. Drive	.26	.16	.47	.48	(.86)	.58	.44	.41	.46	-.05	.24	.07	.10	.11
6. Influencing others	.28	.31	.51	.52	.67	(.87)	.52	.50	.54	.01	.17	.09	.09	.10
7. Organizing and planning	.36	.35	.36	.49	.49	.60	(.87)	.59	.38	-.07	.10	.10	.03	.06
8. Problem solving	.34	.32	.42	.45	.48	.56	.66	(.91)	.39	-.07	.09	.12	.07	.14
9. Stress tolerance	.28	.18	.63	.50	.56	.63	.44	.45	(.85)	-.08	.14	.12	.07	.14
10. Neuroticism	-.08	-.12	-.10	-.11	-.06	.02	-.09	-.09	-.10	(.79)	-.01	.00	-.07	-.19
11. Extraversion	.08	.29	.10	.16	.29	.21	.13	.11	.17	-.02	(.76)	.18	.20	.23
12. Openness to Experience	.13	-.02	.09	.17	.08	.11	.12	.14	.15	.00	.24	(.74)	.17	.22
13. Agreeableness	.15	.12	.07	.13	.12	.11	.03	.09	.09	-.10	.27	.24	(.73)	.34
14. Conscientiousness	.24	.29	.14	.12	.14	.13	.07	.17	.17	-.24	.31	.30	.47	(.74)

Note. Values on the diagonal in parentheses represent the artifact distribution for the variables that were used in the meta-analysis. Values above the diagonal are operational validity coefficients. Values below the diagonal are fully corrected coefficients.

Results

The sample-size-weighted mean correlations (i.e., the uncorrected effects) are presented in Table 1. The correlations presented in Table 1 were subsequently corrected for range restriction, criterion, and predictor unreliability. Corrected correlations are presented in Table 3 (correlations below the diagonal are fully corrected and correlations above the diagonal are only corrected for criterion unreliability and range restriction). To maximize consistency with previous studies, we conducted our primary analyses on the correlations corrected only for sampling error, range restriction, and criterion unreliability—that is, operational validity estimates.

Given that the correlations in the matrix were aggregated across independent data sets, the appropriateness of using these values in subsequent regression analyses is a potential concern (Cheung & Chan, 2005; Viswesvaran & Ones, 1995). Consequently, we examined the variability of the correlations that were aggregated within each cell of the 14 × 14 matrix relative to the total variability across all correlations. Aggregating values is appropriate if the within-cell variance is small both in absolute terms and relative to the between-cell variance. An examination of these values showed that the within-cell variance of the correlations was 0.011 and the variance across all of the correlations was 0.037, indicating that the within-cell variance is small in absolute terms and relative to the between-cell variance (it reduces the overall variability substantially). As the within-cell and between-cell variance values met these criteria, we concluded that it would be appropriate to use these aggregated values in subsequent analyses.

To address Question 1 (i.e., To what extent do AC dimensions represent something other than cognitive ability and personality [i.e., how much commonality do the individual AC dimensions share with measures of cognitive ability and personality?]), we examined the correlations (presented in Table 3) between AC dimensions and job performance, cognitive ability, and personality dimensions. We also used the correlations in Table 3 as input into a set of regression analyses. We regressed cognitive ability and each of the five personality dimensions on the full set of seven AC dimensions. Correlations between the seven AC dimensions and

cognitive ability ranged from .20 to .32 (mean $\rho = .27$), indicating that all of the AC dimensions were moderately correlated with cognitive ability. In addition, regressing cognitive ability on all of the AC dimensions resulted in a multiple correlation of .40, indicating that the total shared variance was approximately 16%. Correlations between the seven AC dimensions and the five personality dimensions ranged from $-.09$ to .24 (mean $\rho = .07$). In addition, regressing each of the five personality dimensions on all of the AC dimensions indicated that the AC dimensions were most strongly associated with Extraversion ($R = .25$) followed by Conscientiousness ($R = .18$), Openness to Experience ($R = .16$), Neuroticism ($R = .16$), and Agreeableness ($R = .13$). Similarly, regressing each of the seven AC dimensions on all five personality dimensions indicated that personality as a whole was most highly related to drive ($R = .25$) followed by stress tolerance ($R = .20$), communication ($R = .20$), influencing others ($R = .19$), problem solving ($R = .18$), consideration/awareness of others ($R = .15$), and organizing and planning ($R = .15$). Finally, we looked at the relationship of each of the AC dimensions with both cognitive ability and all of the personality dimensions. Results indicated that, taken together, cognitive ability and personality were most strongly related to communication ($R = .35$) and organizing and planning ($R = .34$) followed by drive ($R = .33$), problem solving ($R = .33$), stress tolerance ($R = .30$), influencing others ($R = .29$), and consideration/awareness of others ($R = .23$). In sum, these results suggest that although the AC dimensions are related to both cognitive ability and personality, the magnitude of this relationship is modest at best. That is, none of the AC dimensions shared more than 12% common variance with cognitive ability and personality.

We next turned to Question 2 (i.e., How much, if any, incremental variance in job performance do AC dimension ratings account for over and above that accounted for by cognitive ability and personality?) and examined the criterion-related validity of the seven AC dimensions with respect to job performance as well as the incremental validity over and above cognitive ability and personality. We first regressed job performance on the seven AC dimensions. Results indicated that the AC dimensions accounted for approximately 16% of the variance in job performance ($R =$

.40). It should be noted that this value was quite close to the multiple correlation of .45 found by Arthur et al. (2003) in their examination of the criterion-related validity of the AC dimensions.

To examine the incremental proportion of variance in job performance accounted for by the AC dimensions, we again used the correlations in Table 3 as input into a series of hierarchal regressions (all regression results are presented in Table 4). First, we regressed job performance on cognitive ability and then on cognitive ability and the five personality dimensions. Results indicated that both cognitive ability and personality were significantly and uniquely associated with job performance. In the final step, we entered the seven AC dimensions. Results indicate a significant increase in the variance accounted for in job performance from 20% to 30% (i.e., $\Delta R^2 = .10$).

We conducted two supplemental regression analyses to compare the operational results with those of uncorrected and fully corrected models. In the uncorrected series of regressions, we used the sample-weighted mean correlation values presented in Table 1 as input. These results were very similar in the contribution of each predictor block and only varied slightly in magnitude: Cognitive ability $R^2 = .09$, the personality variables $R^2 = .18$ ($\Delta R^2 = .09$), and the AC dimensions $R^2 = .24$ ($\Delta R^2 = .06$). The results of analyses using a fully corrected model were also quite similar with respect to the relative ΔR^2 by the addition of each predictor block: Cognitive ability $R^2 = .12$, the personality variables $R^2 = .24$ ($\Delta R^2 = .12$), and the AC dimensions $R^2 = .35$ ($\Delta R^2 = .11$).

Finally, we sought to address the relative contribution of each of the AC dimensions to the incremental validity of ACs over and above cognitive ability and personality. Here we used a forward selection approach to the entry of each of the AC dimensions in the hierarchical regression. Specifically, we first regressed job performance on cognitive ability and the five personality dimensions. Next, we entered the AC dimension most highly correlated with job performance (i.e., organizing and planning, $\rho = .33$). In the subsequent steps, we entered the AC dimension with the highest partial correlation (i.e., controlling for the other variables in the model) with job performance. Results (also presented in Table 4) indicate that six of the seven AC dimensions accounted for a

significant and unique proportion of variance in job performance at $p < .05$ or less. The dimension with the largest impact was organizing and planning ($\Delta R^2 = .053, p < .001$) followed by influencing others ($\Delta R^2 = .013, p < .001$), drive ($\Delta R^2 = .009, p = .001$), problem solving ($\Delta R^2 = .009, p = .002$), stress tolerance ($\Delta R^2 = .007, p = .006$), consideration/awareness of others ($\Delta R^2 = .005, p = .021$), and communication ($\Delta R^2 = .003, p = .086$).

In sum, these results indicated that the seven AC dimensions (a) were moderately correlated with, albeit quite distinct from, cognitive ability and personality; (b) accounted for a significant proportion of the variance in job performance; and (c) accounted for a significant proportion of the variance in job performance over and above cognitive ability and personality. Further, six of the seven dimensions were each significantly and uniquely associated with job performance.

Discussion

AC ratings demonstrate high levels of criterion-related and content-related validity but troubling levels of construct-related validity. Few would question that this statement best summarizes the AC literature to date. However, although there has been a tremendous emphasis on dimensions in the AC construct-related validity literature, this emphasis has been somewhat generic. That is, rather than focusing on the specific content domain represented by AC dimensions, researchers have tended to talk about dimensions in general. Statements such as “dimension effects are small relative to exercise effects” or “AC ratings do not reflect the dimensions they were intended to measure” are commonplace and have the effect of collapsing the full content domain reflected in AC dimensions into a generic, monolithic AC dimension. Indeed, reviews of the literature to date have highlighted that the number of espoused constructs assessed in ACs is overwhelming (Arthur et al., 2003; Woehr & Arthur, 2003). So it is not altogether surprising that researchers have tended to ignore more careful examination and delineation of the AC dimension construct domain. Most AC research is woefully deficient in the description of specific construct explication and development. AC dimensions are more often

Table 4
Job Performance Regressed Onto Cognitive Ability, Personality Variables, and Assessment Center (AC) Dimensions—Operational Model

Model	R	R ²	ΔR ²	Sig. F change
Hierarchical regression by block of predictors				
1. GMA	.320	.102		.000
2. GMA + NEOAC	.445	.198	.095	.000
3. GMA + NEOAC + 7 AC dimensions	.543	.295	.097	.000
Forward selection of individual AC dimensions ^a				
3a. GMA + NEOAC + organizing and planning	.501	.251	.053	.000
3b. GMA + NEOAC + problem solving	.509	.259	.009	.002
3c. GMA + NEOAC + drive	.518	.268	.009	.001
3d. GMA + NEOAC + influencing others	.530	.281	.013	.000
3e. GMA + NEOAC + consideration/awareness of others	.535	.286	.005	.021
3f. GMA + NEOAC + stress tolerance	.541	.293	.007	.006
3g. GMA + NEOAC + communication	.543	.295	.003	.086

Note. GMA = cognitive ability; NEOAC = a block containing Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness.

^a Each variable was entered in a forward selection sequence, such that each model contains the AC dimension listed in addition to the dimensions in previous steps, where GMA and NEOAC were held constant.

than not simply what one says one is measuring in ACs. Recently it has been argued that this lack of careful and systematic construct delineation may be a large contributing factor to the troubling findings in many primary studies with respect to AC dimension construct-related validity (Arthur et al., 2008).

Researchers examining the criterion-related validity of AC ratings have largely circumvented construct-related problems by focusing on overall measures of performance (i.e., OARs), subsequently ignoring the specific constructs assessed by ACs. Yet such studies confound construct and method issues. To date, only one study has provided a large-scale review of the criterion-related validity of specific AC dimension ratings (i.e., Arthur et al., 2003). Thus, our primary goal in the present study was to build on the findings of Arthur et al. (2003). Specifically, in addition to studying the criterion-related validity of specific AC dimensions, we sought to examine (a) the extent to which AC dimensions represent something other than cognitive ability and personality (i.e., how much commonality do the individual AC dimensions share with measures of cognitive ability and personality?) and (b) the extent to which AC dimension ratings account for incremental variance in job performance over and above that accounted for by cognitive ability and personality variables.

In general, our results present a favorable picture of the criterion-related validity of AC dimension ratings. As expected, our results regarding the general criterion-related validity of AC dimensions were quite consistent with those of Arthur et al. (2003). That is, both studies indicate that, as a set, the AC dimensions in Arthur et al.'s (2003) seven-dimension taxonomy share approximately 18% common variance with measures of job performance. These findings suggest that the AC dimension ratings are one of the most valid selection tools. Further, in comparison with studies conducted at the OAR level of conceptualization, these results indicate that multiple dimensions uniquely contribute to the prediction of job performance.

The results of the present study also extend previous findings and suggest that AC dimension ratings do not substantially overlap with paper-and-pencil measures of cognitive ability and personality. As might be expected, both cognitive ability and personality contribute to AC performance. This contribution clearly varies with respect to the specific dimension(s) assessed. However, the relationship between personality, cognitive ability, and the AC dimensions is relatively small. Thus, AC dimension ratings clearly reflect something other than cognitive ability and personality. Also, as expected, our results differed from those of previous meta-analytic studies examining the relationship of an OAR with measures of personality and cognitive ability (Collins et al., 2003; Scholz & Schuler, 1993). Specifically, although our composite of AC dimensions related to cognitive ability in a similar way as OAR, as reported by Scholz and Schuler (1993), we generally found stronger relationships between personality variables and a regression-based composite of the seven AC dimensions than they did with OARs. It should be noted that most of the studies in our analysis collected both paper-and-pencil measures of personality and cognitive ability as well as AC dimension ratings. However, only one provided an explicit indication as to whether assessors were aware of or incorporated assessee scores on these measures prior to rating the AC dimensions. Thus, there is no way to evaluate the extent to which the AC ratings may have been contaminated by the other measures. However, if such contami-

nation did occur, it would serve to attenuate the incremental contribution of the AC dimensions with respect to job performance. So, it is possible that our results underestimate the actual incremental validity of AC dimension ratings.

Most important, and the key contribution of the present study, is that the results clearly demonstrate that although there may be some overlap between cognitive ability, personality, and AC ratings, AC dimensions do explain incremental variance in job performance above and beyond these other constructs. A regression-based composite of the seven AC dimensions predicts a significant proportion of the variance in job performance ratings over and above that associated with cognitive ability and personality. This finding runs directly counter to the conclusions reached by Collins et al. (2003) that cognitive ability and personality share an overwhelming portion of variance with AC ratings and thus AC ratings, at least at the OAR level, are unlikely to add to the prediction of job performance. Two key differences between our study and that of Collins et al. should be noted. First, Collins et al. did not include job performance in their study. Rather, they focused exclusively on the relationship of AC ratings with cognitive ability and personality. Thus, they did not present direct evidence pertaining to incremental validity. Second, Collins et al. used an OAR as their measure of AC ratings whereas we focused on specific dimension ratings. However, as demonstrated by both our findings and those of Arthur et al. (2003), a regression-based composite significantly adds to the prediction of job performance ratings.

Another key finding of the present study was that six of the seven AC dimensions accounted for a significant unique proportion of the variance in job performance. This finding presents a somewhat different picture than that presented by Arthur et al. (2003). Specifically, they found that only four dimensions (i.e., problem solving, influencing others, organizing and planning, and communication) were needed to account for all of the variance shared with job performance. Here it should be noted that although we found that six of the seven dimensions added statistically significant variance to the prediction of job performance, effect sizes of five of these dimensions were quite small (i.e., $\Delta R^2 < .01$). Of interest, however, were both the consistency and the inconsistency between our findings and those of Arthur et al. (2003) with respect to the top three dimensions for predicting job performance. Both studies found that problem solving and organizing and planning were two of the three most important dimensions. Arthur et al. (2003), however, found influencing others to be the second most important dimension, whereas we found it to be the fourth most important overall. Alternately, drive did not add significant variance in the Arthur et al. (2003) study but was among the top three in ours. Here it is important to note that our results are based on partialing out cognitive ability and personality prior to examining the impact of AC dimensions. It is quite likely that the importance of variables such as drive increases after controlling for cognitive ability, whereas the importance of variables like influencing others decreases after controlling for some of the personality variables.

Implications

The results of the present study have several implications for operational ACs. First and foremost, our results suggest that AC

dimensions are correlated with but distinct from other popular individual difference constructs. In contrast to the results of previous studies that have suggested that ACs could be replaced with paper-and-pencil tests of cognitive ability and personality (e.g., Collins et al., 2003), the results of the present study suggest that the degree of relationship among AC dimensions and external constructs is modest at best and offers compelling evidence that the constructs measured via these methods are not interchangeable. Further, the results of the current study suggest that AC dimensions explain a sizeable proportion of unique variance in job performance. More specifically, AC dimensions predict actual job performance over and above other commonly used predictors (i.e., paper-and-pencil measures of cognitive ability and personality).

Despite suggestions that the AC method may not be worthwhile given its expense relative to paper-and-pencil cognitive ability and personality tests, the results of the current study suggest the contrary. Previous reviews have consistently emphasized that ACs are one of the most expensive tests used in personnel selection (Howard, 1997; Thornton & Byham, 1982). Thus, the costs of ACs must be justified through their incremental impact above other (less expensive) predictors. Certainly, cost is only one factor in the potential utility of AC ratings; however, on the basis of our findings, we think these costs are justified. The incremental variance in job performance explained by AC dimensions above cognitive ability and personality clearly supports the continued use of ACs. Together with the numerous other advantages associated with ACs, including high levels of face validity and positive user reactions (Macan et al., 1994), their usefulness as a developmental tool (Thornton & Rupp, 2006), decreased levels of subgroup differences compared with other predictors (Thornton & Rupp, 2006), and accompanying applications to job settings where subgroup differences are heavily scrutinized (e.g., police officers; Dayan et al., 2002), we believe that the benefits associated with the AC method far outweigh the costs.

A broader implication of the present study pertains to the debate concerning the overall validity of AC dimensions. Recent reviews have posited that ACs do not, in fact, measure the dimensions they intend to measure and thus dimensions should be abandoned (e.g., Lance, in press). Contrary to this position, however, three recent meta-analyses have demonstrated relatively favorable construct validity evidence for AC dimensions after collapsing the myriad of dimensions found in the literature into a more parsimonious, conceptually distinct set of dimensions. Specifically, using Arthur et al.'s (2003) seven-dimension taxonomy, these meta-analyses provide evidence for the criterion-related validity of AC dimensions (Arthur et al., 2003), the impact of dimension factors (Bowler & Woehr, 2006), and the differentiation from and incremental criterion-related validity of AC dimensions over cognitive ability and personality (present study). Thus, it would seem that these studies provide evidence in support of the construct validity of the core set of AC dimensions posited by Arthur et al. (2003). Perhaps the solution to the AC construct-related validity paradox is not the abandonment of dimensions but rather more careful conceptualization, delineation, and application of the dimensions assessed.

Summary and Conclusions

Our primary purpose in this study was to provide additional validity evidence for AC ratings at the dimension level. Only a

small portion of variance is explained in Arthur et al.'s (2003) seven dimensions by personality and cognitive ability variables, providing support for the distinctness of the constructs measured using these disparate methods. Finally, our results demonstrate that AC dimensions explain incremental variance in job performance ratings above cognitive ability and personality variables, supporting the validity and utility of AC dimensions.

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