The Invariant Component Structure of the Personality Assessment Inventory (PAI) Full Scales

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We investigated methodological and sample-based characteristics that might contribute to discrepancies in the structure of the 22-scale Personality Assessment Inventory (PAI; Morey, 1991, 2007). In Study 1, we used parallel analysis, Velicer's minimum average partial procedure, and random variables to determine the appropriate number of principal components to retain in a clinical sample ($N = 227$). We retained 3 oblique dimensions that broadly emphasized (a) general distress, (b) elevated mood and dominance, and (c) substance abuse and psychopathy. In Study 2, we applied the same uniform criteria and procedures to 5 previously published samples and conducted orthogonal vector matrix comparisons to determine how congruent 3- and 4-dimensional structures were across samples. Results suggested the PAI has 3 dimensions that are highly congruent across samples. Using Morey's normative sample, we provide the formulas needed to compute T scores for each component so they can be used in clinical work with patients. We discuss clinical implications and directions for future PAI research.

The Personality Assessment Inventory (PAI; Morey, 1991, 2007) is a frequently used measure of psychopathology that provides information regarding test-taking behaviors, affect, treatment considerations, and interpersonal characteristics. When developing the PAI, Morey (1991) reviewed historical and recent literature on each targeted clinical syndrome to ensure PAI items assessed the core components of each disorder. The PAI consists of 344 items that uniquely contribute to 22 scales (4 Validity scales, 11 Clinical scales, 5 Treatment scales, and 2 Interpersonal Style scales); 10 scales are composed of subscales, which evaluate more specific aspects of the parent construct (e.g., cognitive symptoms of depression). The PAI has adequate psychometric properties and has been used in a variety of clinical and nonclinical investigations (e.g., see Baity, Siefert, Chambers, & Blais, 2007; Boone, 1998; Hopwood, Morey, Rogers, & Sewell, 2007; Karlin et al., 2005; Kurtz, Shealy, & Putnam, 2007; Morey, 1991; Singh & Verma, 2007; Tasca, Wood, Demidenko, & Bissada, 2002; Walters, 2007).

Researchers' curiosity with the PAI factor structure or component structure is readily apparent from the published studies summarized in Table 1. Morey (1991) first reported in the PAI professional manual that a four-dimensional structure underlies the full set of scales in the normative sample and a heterogeneous clinical sample. The first 3 components were consistent across the two samples and emphasized (a) subjective distress and affective disruption, (b) behavioral acting out and impulsivity, and (c) egocentricity and exploitativeness in relationships. The fourth component in the clinical sample emphasized profile invalidity and carelessness, whereas in the nonclinical, sample it emphasized social detachment.

Boyle and Lennon (1994) claimed it was impossible to replicate the components reported by Morey (1991) using the data presented in the PAI professional manual. Although Boyle and Lennon's divergent results were largely due to different factor analytic decisions and a typographical error in the correlation matrix from the manual,[1] researchers have reported incongruent PAI structures in other clinical samples as well. For example, Tasca et al. (2002) investigated a sample of patients referred for eating disorder treatment and identified a fifth dimension that reflected interpersonal coolness and distance, which was not observed in other samples. Karlin et al. (2005) also reported a component structure that differed slightly from Morey's (1991). Karlin et al. found a unique dimension that emphasized the variance contained within the Drug Problems, Inconsistency (ICN), and Alcohol Problems scales. In briefly reported analyses, Frazier, Naugle, and Haggerty (2006) investigated all 22 scales using data obtained from patients undergoing neuropsychological evaluation. Frazier et al. extracted four components and reported their structure exhibited good congruence with Morey's (1991) four nonclinical dimensions (all rs > .86). However, Frazier et al. did not report congruence coefficients with the components obtained from Morey's (1991) clinical sample.

PAI dimensional structures reported across nonclinical samples have appeared to be more consistent with one another than those produced from clinical samples. Deisinger (1995) employed different factor analytic methods than Morey (1991) and found a four-factor structure that she believed was consistent with the nonclinical components reported in the manual. This conclusion was based on the similarity of pattern loadings across samples, although minor differences were observed on the fourth dimensions. Recently, Groves and Engel (2007) translated the PAI to German and in their normative sample found a four-component structure that was similar to Morey's (1991) nonclinical components.

We do not elaborate on the other studies presented in Table 1 because researchers did not analyze the complete set of PAI scales. However, a key observation is that discrepancies exist

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[1]The r between Negative Impression Management (NIM) and Positive Impression Management (PIM) in the clinical sample is −.45 not .45.

TABLE 1.—Characteristics of published PAI exploratory factor analytic investigations.

Study	Sample (N; % Male)	Exclusion Criteria	Scales	Method	Rotation	Extraction Criteria	Dimensions
Morey (1991)	Normative (1,000; 48.0)	90.0% RR	22	PC	Orthogonal	Eigenvalue > 1	4
Morey (1991)	Clinical (1,246; 61.4)	90.0% RR	22	PC	Orthogonal	Eigenvalue > 1	4
Boyle and Lennon (1994)	Morey's (1991) normative sample	90.0% RR	22	PC	Orthogonal	Morey's four-factor model	4
Boyle and Lennon (1994)	Morey's (1991) normative sample	90.0% RR	22	ML	Oblique	Scree plot	5
Boyle and Lennon (1994)	Morey's (1991) clinical sample	90.0% RR	22	PC	Orthogonal	Morey's four-factor model	NA
Deisinger (1995)	Adult volunteers (183; 40.5)	Not stated	22	PAF	Oblique	Scree plot; Eigenvalue > 1; simple structure	4
Tasca, Wood, Demidenko, and Bissada (2002)	Eating disordered patients (238; 0)	Validity scales > 2 SD	22	PC	Orthogonal	Eigenvalue > 1	5
Karlin et al. (2005)	Chronic pain patients (432; 27)	PAI manual	22	PC	Orthogonal	Scree plot	4
Groves and Engel (2007)[a]	Normative (749; 47)	90.0% RR	22	PC	Orthogonal	Eigenvalue > 1	4
Boyle and Lennon (1994)	Mixed patient and nonpatient sample (211; 85)	Not stated	21[a]	ML	Oblique	Scree plot	5
Singh and Verma (2007)	Breast cancer patients (140; 0)	Not stated	20	PC	Orthogonal	Eigenvalue > 1	5
Schinka (1995)	Alcohol-dependent patients (301; 99.3)	PAI manual	20[b]	PC	Orthogonal	Not stated	4
Frazier, Naugle, and Haggerty (2006)	Patients referred for neuropsychological assessment (421; 49.0)	None	17[c]	PC	Oblique	Parallel analysis with Glorfeld's (1995) modification	4
Frazier et al. (2006)	Patients referred for neuropsychological assessment (421; 49.0)	None	17[d]	PC	Oblique	Parallel analysis with Glorfeld's (1995) modification	3
Morey (1991)	Normative (1,000; 48.0)	90.0% RR	11	PC	Orthogonal	Eigenvalue > 1	2
Morey (1991)	Clinical (1,246; 61.4)	90.0% RR	11	PC	Orthogonal	Eigenvalue > 1	3
Deisinger (1995)	Adult volunteers (183; 40.5)	Not stated	11	PAF	Oblique	Scree plot; eigenvalue > 1; simple structure	3
Karlin et al. (2005)	Chronic pain patients (432; 27)	PAI manual	11	PC	Orthogonal	Scree Plot	3
Demakis et al. (2007)	Head-injured patients (95; 82.1)	PAI manual	11	PC	Orthogonal	Eigenvalue > 1	3
Groves and Engel (2007)[e]	Normative (749; 47)	90.0% RR	11	PC	Orthogonal	Eigenvalue > 1	2
Hopwood, Baker, and Morey (2008)	Substance-dependent patients (722; 70)	PAI manual	11	PAF	Oblique	Eigenvalue > 1, scree plot, parallel analysis	2

Note. To limit the date presented in Table 1, a single investigation is listed more than once only if different samples and analyses are presented with corresponding factor matrices. Also, only studies that include multiple Personality Assessment Inventory (PAI) Clinical scales are included. RR = response rate; PC = principal components analysis; ML = maximum-likelihood procedure; NA = not available because of the typographical error in the PAI manual; PAF = principal axis factor analysis; Validity = Inconsistency (ICN), Infrequency (INF), Positive Impression Management (PIM), and Negative Impression Management (NIM). PAI manual = Based on Morey's (1991) protocol validity criteria, which was Item Omissions > 17, ICN T ≥ 73, INF T ≥ 75, NIM T ≥ 92, PIM T ≥ 68.
[a]Data for the ICN scale was unavailable. [b]Alcohol Problems and Drug Problems scales were not included in analyses because of the nature of the sample. [c]Based on 344 PAI items. [d]Based on 160 PAI items. [e]German version.

regardless of the number of scales investigated. For example, analyzing just the 11 Clinical scales, Morey (1991) reported a three-dimensional structure emphasizing (a) subjective distress and affective disruption, (b) behavioral acting out and impulsivity, and (c) egocentricity and exploitiveness in relationships for the clinical sample; whereas a two-dimensional structure that emphasized only subjective distress and affective disruption and behavioral acting out and impulsivity was observed for the nonclinical sample.

Thus, a review of the literature indicates dimensional structure discrepancies have been present across samples. There is reasonable correspondence for some dimensions across in-

dependent samples (e.g., Component/Factor 1, subjective distress and affective disruption), but it is equally clear that other dimensions differ in notable ways. For instance, Morey (2007) recently reviewed this literature and reported congruence coefficients across up to 13 investigations. Morey (2007) found considerable variability, with congruence coefficients that ranged from low values of .92, .70, .76, and .70 for Components/Factors 1 through 4, respectively. Although the PAI dimensional structure has been investigated numerous times, it is challenging to definitively describe it, and one may wonder if higher order PAI psychological constructs are similar across samples.

There are a number of potential reasons why discrepant PAI dimensional structures may have been observed in the literature. We classify these explanations as sample-based and methodological differences. Sample-based considerations are characteristic of the participants (e.g., patient or nonpatient sample; single-gender or combined-genders sample). Methodological considerations pertain to decisions made regarding analyses (e.g., number of PAI scales, validity criteria, factor analytic techniques). Table 1 illustrates a number of the sample-based and methodological differences across studies. We address these issues in turn, highlighting how they might influence the structure of the full 22-scale PAI.

SAMPLE-BASED CONSIDERATIONS

It is possible that unique sample characteristics may lead to divergent dimensional structures. Some of the prior PAI factor analytic studies have included samples with only individuals experiencing a specific psychological difficulty (e.g., see Schinka, 1995 [alcohol dependency]; Tasca et al., 2002 [eating disorders]) or a range of psychological difficulties (e.g., Morey, 1991), whereas other studies have included nonclinical samples (e.g., see Deisinger, 1995; Morey, 1991) or samples that included a combination of individuals with and without psychological difficulties (e.g., Boyle & Lennon, 1994). Gender differences are also notable; Schinka (1995) included almost no women, but Singh and Verma (2007) and Tasca et al. (2002) had only examined women.

It has been suggested that normative and clinical samples may produce different dimensional structures (Morey, 1997; Morey & Glutting, 1994). Normative samples generally exhibit fewer symptoms than clinical samples, which corresponds with lower endorsement of items reflecting psychological problems. A potential consequence of this range restriction is that symptom scales may be less correlated and thus components/factors emphasizing psychological problems might be less likely to emerge. The opposite is true if the items conveying disorder-specific patterns of psychological problems are more frequently endorsed. To the extent that certain symptom scales have a more highly differentiated pattern of correlations, dimensions reflecting these patterns are more likely to be found. The PAI manual (Morey, 1991) provides mixed support for this belief. On one hand, a more differentiated component structure was observed when comparing the clinical sample to the normative sample across 11 scales, although when the full set of 22 scales were considered, four dimensions were observed in each sample. It is noteworthy, however, that these four dimensions were not equivalent.

O'Connor (2002) thoroughly investigated whether data from normative and clinical samples produce discrepant dimensional structures. O'Connor (2002) examined 37 measures of personality and psychopathology and concluded that dimensions are largely similar if appropriate retention guidelines are utilized (described following). Although normative and clinical samples have different item-endorsement levels (and thus different item means and standard deviations), the correlations between scales remain similar. Thus, it is unlikely that divergent PAI dimensional structures are the result of different sample characteristics.

Similarly, the literature has not suggested the structure of instruments differs in notable ways because of gender (e.g., see Byrne, Baron, & Balev, 1996; Byrne, Baron, & Campbell, 1994, 1993; Byrne, Baron, Larrson, & Melin, 1996). Although it is widely accepted that males and females endorse certain types of items differently, the correlations between items and scales remain similar. Thus, like with clinical and nonclinical samples, there is minimal support for the notion that sample differences in gender would produce discrepant dimensional structures.

Although we do not believe these sample-based factors contribute meaningfully to discrepant PAI dimensional structures, the literature contains some potential examples of sample-based differences contributing to inconsistencies. For example, Butcher (1994) reported the Minnesota Multiphasic Personality Inventory–2 (MMPI–2; Butcher et al., 2001) had discrepant four-dimensional solutions in a normative and airline pilot sample, which Butcher (1994) posited was because of the pilots' defensiveness. In this situation, however, it appears the seeming sample-based difference (pilots vs. the normative sample) was actually a methodological difference because the variance in the pilot sample was restricted relative to the normative sample.

METHODOLOGICAL CONSIDERATIONS

The number of scales analyzed can contribute to differences in component/factor structures across studies because changing the number of marker variables analyzed will change the pattern of correlations among variables. Generally, three or more marker scales are needed to define a distinct dimension (e.g., see Velicer & Fava, 1998), thus it would be very unlikely for an investigation of 11 PAI scales to produce a four- or five-dimensional structure consistent with those found underlying the full set of scales. In addition to needing a sufficient number of markers for each dimension, it is also the case that the nature of the scales included in the matrix is important; changing the composition of constructs may change the pattern of correlations among variables and thus the resulting dimensional structure. For instance, most researchers have followed Morey's (1991) example and included the validity scales in the component/factor matrix. Failing to do so provides an incomplete analysis of the PAI T score profile and may impair one's ability to define a relevant component/factor because of insufficient marker variables.

Investigators have used different guidelines to determine invalid PAI protocols (see Table 1). For instance, in the PAI professional manual, Morey (1991) included all profiles in the standardization sample as long as no more than 33 items were omitted. Other investigators have excluded profiles based on invalidity and excessive nonresponsiveness (e.g., Karlin et al., 2005; Schinka, 1995). This methodological difference may explain why Morey (1991) found a component emphasizing carelessness and profile invalidity in his clinical sample, but others have not.

Morey (1991) warned that there are several factor analytic decisions that also might produce inconsistencies across studies. In order of least to greatest potential to influence results, these decisions include whether to conduct factor or component analysis, the method of component/factor rotation, and the number of components/factors to retain. The decisions that previous researchers have made on these issues are summarized in Table 1, and we address each in turn.

Whether traditional factor analysis (principal axis factor analysis [PAFA]) or principal component analyses (PCA) are

conducted often makes little difference in the results (Fava & Velicer, 1992; Goldberg & Velicer, 2006; Velicer, Eaton, & Fava, 2000; Velicer & Jackson, 1990). PAFA extracts factors that explain shared or common variance among the set of variables, whereas PCA extracts components that explain all variance, including error. The evidence is mixed for the importance of this issue with the PAI. On one hand, Deisinger (1995) conducted PAFA and reported the four factors were largely consistent with components identified by Morey (1991) through PCA. However, Schinka (1995) found PAFA and PCA produced similar results for three dimensions but differences in a fourth in which PAFA produced a dimension with high Stress and Nonsupport loadings and the PCA solution emphasized the ICN scale. Differences between PCA and PAFA are most likely to emerge when component/factor definition is weak or when dimensions have been overextracted (Goldberg & Velicer, 2006; Velicer & Jackson, 1990) and Schinka's discrepant results may be due to these problems, as it is unclear what extraction criteria he applied. In general, different factoring techniques are not likely to be a major issue if robust dimensions are retained.

An additional decision that may contribute to seeming differences across PAI studies is whether dimensions were rotated orthogonally, which keeps them uncorrelated, or obliquely, which permits them to be related. In practice, choosing one over the other only makes a difference if there are substantial correlations between the latent dimensions. Most of the studies listed in Table 1 used orthogonal rotation. The exceptions were Boyle and Lennon (1994), Deisinger (1995), Frazier et al. (2006), and Hopwood, Baker, and Morey (2008). Boyle and Lennon criticized Morey's (1991) use of orthogonal rotation because they observed several large correlations between components (i.e., three $rs \geq |.53|$). Deisinger also observed large associations between the factors she retained, although her correlated factors appeared conceptually similar to Morey's (1991) orthogonal dimensions.

The remaining methodological issue involves criteria for identifying the correct number of dimensions to extract. Traditionally, retaining a dimension for each eigenvalue > 1.00 (Kaiser, 1960) or examining the scree plot to determine where the eigenvalues level off was thought to satisfactorily determine the number of substantial dimensions. The pervasiveness of these beliefs is readily apparent in Table 1. With the exception of Hopwood et al. (2008) and Frazier et al. (2006), each study has used one or both procedures. However, these procedures are problematic in several respects. First, retaining all dimensions with eigenvalues > 1.00 typically leads to overextraction because the number of dimensions suggested by this rule is more closely related to the total number of variables analyzed than the underlying structure of the data (e.g., see Velicer et al., 2000). Typically, the number of eigenvalues > 1.00 is equal to one fourth or one third of the total number of variables analyzed (Goldberg & Velicer, 2006).

The scree test is based on the belief that when eigenvalues are plotted, the point where the line breaks or levels off indicates the number of dimensions to retain. Eigenvalues above this point are identified as common factors, whereas those at and below represent error variance (e.g., see Velicer et al., 2000). Although the scree test is accurate with large samples and strong dimensions (Zwick & Velicer, 1982), it relies on a subjective decision to determine where the leveling off of the scree line occurs, which in turn can lead to different outcomes with no

strong rationale. As a result, the scree test is best used as an adjunct to more appropriate methods (Velicer et al., 2000).

THESE STUDIES

This investigation includes two studies. In the first, we examined the PAI structure in an outpatient sample using three alternative component retention procedures (described in detail following). In Study 2, we applied the same three retention procedures to the data from five previously published samples and investigated the congruence of structures across all six samples.

STUDY 1

Purpose

Given that prior analyses of the 22 primary scales failed to converge on a robust structure that replicated across samples (e.g., Morey, 2007), in a new clinical sample, we applied parallel analysis (PA), Velicer's (1976) minimum average partial (MAP) procedure, and the inclusion of random variables (Gorsuch, 1983) to determine the appropriate number of components to retain. We hypothesized that these procedures should lead to retaining more generalizable dimensions.

PA is an empirically supported retention procedure (e.g., see Hayton, Allen, & Scarpello, 2004). The procedure involves creating a series of random data matrices with the same number of columns (i.e., "variables") and rows (i.e., "participants") as the actual correlation matrix. One then compares the eigenvalues from the random data matrices against the genuine eigenvalues. For a component to be retained, the actual eigenvalue should be larger than the 95th percentile of the corresponding randomly generated eigenvalues (e.g., Glorfeld, 1995; Longman, Cota, Holden, & Fekken, 1989).

The MAP procedure considers the average partial correlation matrix after sequentially extracting individual components in a PCA. The appropriate number of components to extract is identified when the average of the squared partial correlations reaches a minimum value (Velicer, 1976). When an extracted component removes common variance from a correlation matrix, the average of the partialed correlations among the variables decreases. However, when a component removes unique variance, the average of the remaining partial correlations in the matrix increases, which signifies the component should not be retained.

Although PA and MAP procedures are more optimal than interpretation of the scree plot or Kaiser's (1960) rule to determine an appropriate number of dimensions to retain (e.g., Hubbard & Allen, 1987; Velicer et al., 2000; Zwick & Velicer, 1982, 1986), an alternative strategy is to include random variables in the genuine data. Overextraction is indicated when a component is defined by one or more random variables (e.g., see Gorsuch, 1983; Wood, Tataryn, & Gorsuch, 1996). A component defined by significant loadings from a random variable indicates the dimension is capitalizing on a pattern of correlations that are due to nonreplicable sampling error.

Method

Participants and procedure.   We obtained the sample from the University of Toledo Training Clinic, which provides a range of psychological services to individuals, couples, and families. Individuals are administered the PAI as part of the routine Clinic

intake procedure and periodically during the course of treatment. We used 248 full PAI protocols obtained during intake interviews. Consistent with Morey's (1991) recommendations for clinical practice, protocols were considered invalid if more than 17 items were unanswered or the four Validity scales were elevated to atypical levels (ICN T $\geq$ 73; Infrequency [INF] T $\geq$ 75; NIM T $\geq$ 92; PIM T $\geq$ 68). After applying these criteria, 227 individuals remained in this study, which represents 92.0% of the tests administered at intake. This is a higher percentage of valid profiles than has been found in previous studies that have used similar criteria (e.g., Tasca et al., 2002, 82.0%; Karlin et al., 2005, 84.7%; Schinka, 1995, 85.8%).

The participants were 17 to 59 years old (M = 27.28; SD = 9.57), and most were White (76.7%; 12.8% African American), female (59.1%), and single (71.4%; 17.6% married; 8.8% divorced). Nearly half of the individuals (47.1%) were seeking assessment services only. For those who received therapy, the average number of sessions was approximately 9. However, this number is positively skewed, as 85.0% of those in therapy received $\leq$ 10 sessions.

Consistent with Morey (1991), the intercorrelation matrix for the raw scores on the 22 PAI full scales served as the basis for PCA. Although evidence indicates components and factors can be considered interchangeable with well-structured data (Goldberg & Velicer, 2006), we refer to our PCA dimensions as components rather than factors. We based component retention on three different criteria: (a) PA, (b) MAP, and (c) component definition from 12 random variables (M = 50, SD = 10). We used O'Connor's (2000) syntax to conduct PA and MAP procedures. We selected oblique (oblimin) rotation because it is widely accepted that psychological constructs are typically correlated with one another (e.g., see Byrne, 2005). It is notable that we obtained very similar results when T scores were analyzed rather than raw scores and also when varimax or promax rotation was selected over oblimin.

Results and Discussion

PA results suggested retaining three components (see Figure 1); it is clear that the third eigenvalue is larger than the 95th percentile for the third randomly generated eigenvalue (actual = 1.75; 95th percentile PA = 1.48), but the 95th percentile for the fourth randomly generated eigenvalue is larger than the actual eigenvalue (actual = 1.18; 95th percentile PA = 1.41). The MAP also suggested it would be appropriate to retain three components because the average squared partial correlation reached the lowest value after the third root was extracted. However, there was indeterminacy between the third and fourth roots (see Figure 2), with the average of the squared partial correlations differing by just .00006, suggesting a four-component solution may be reasonable to consider too. We next investigated three- and four-dimensional solutions in combination with 12 random variables. The three-dimensional solution did not have meaningful pattern loadings from any random variables,[2] whereas the four-dimensional solution had random variable pattern loadings of |.53|, |.49|, |.43|, and |.42| on the fourth dimension. All of these coefficients were higher than those for any of the actual
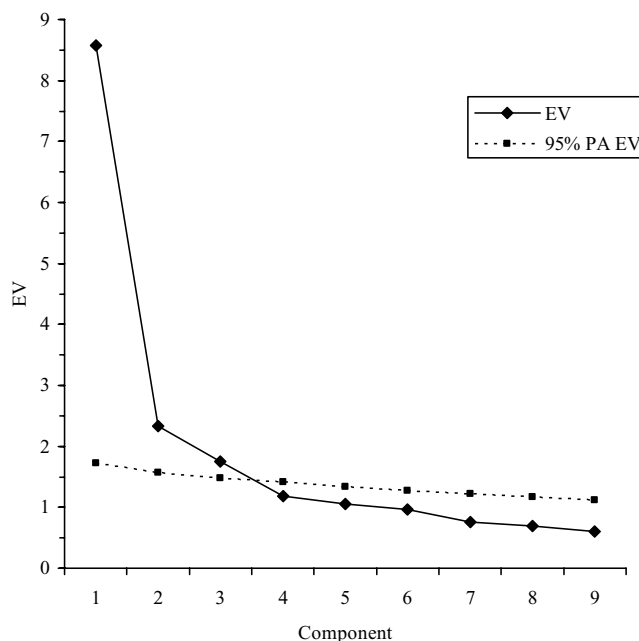

FIGURE 1.—Parallel analysis (PA) results for Study 1. EV = eigenvalues; 95% PA = 95th percentile of randomly generated eigenvalues. Based on the analysis of 500 random data sets.

scales; the largest two were INF (.40) and ICN (.29). Collectively, the results suggested it was appropriate to extract three, not four, components from the data.

The pattern coefficients for the three dimensions are presented in Table 2. Pattern coefficients are regression weights that predict scales from the components taking into account the associations between components. The pattern matrix differs from the structure matrix, which indicates the actual correlation between scales and components, disregarding the correlation between components. The first component is a heterogeneous dimension with high positive coefficients for the Depression, Anxiety-Related Disorders, Borderline Features, Anxiety, Schizophrenia, NIM, Paranoia, Nonsupport, Somatic Complaints, Stress,

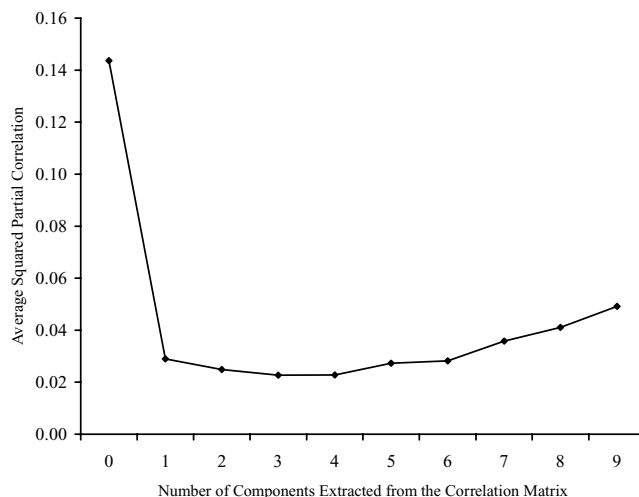FIGURE 2.—Results for the minimum average partial procedure in Study 1.

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[2]The average absolute value of pattern matrix loadings for these random variables was |.09|, and the three highest loadings were |.26|, |.21|, and |.20|, respectively.

TABLE 2.—Rotated pattern matrix for 22 Personality Assessment Inventory scales in Study 1.

Scale	Component 1	Component 2	Component 3	h^2
Inconsistency	.17	−.14	**.55**	.39
Infrequency	−.15	−.24	**.42**	.23
Negative Impression	**.78**	−.02	.05	.62
Positive Impression	**−.60**	−.38	−.07	.60
Somatic Complaints	**.67**	.03	−.18	.43
Anxiety	**.81**	−.09	−.08	.62
Anxiety-Related Disorders	**.83**	.05	−.15	.66
Depression	**.91**	−.18	−.03	.81
Mania	.19	**.77**	.01	.67
Paranoia	**.76**	.13	−.08	.60
Schizophrenia	**.78**	−.01	.18	.71
Borderline Features	**.82**	.21	.14	.85
Antisocial Features	.11	**.54**	**.60**	.72
Alcohol Problems	−.04	.23	**.73**	.57
Drug Problems	.06	.12	**.73**	.58
Aggression	.34	**.50**	.26	.53
Suicidal Ideation	**.57**	−.10	.13	.38
Stress	**.66**	.06	.00	.45
Nonsupport	**.68**	−.11	.04	.48
Treatment Rejection	**−.71**	−.11	−.07	.57
Dominance	−.36	**.81**	−.09	.72
Warmth	**−.51**	.30	−.29	.47
Variance explained (%)[a]	35.39	9.54	12.19	
R between components				
Component 2	.13			
Component 3	.26	.02		

Note. Loadings ≥ .40 are bolded for emphasis. h^2 = communalities.
[a]Percent of variance explained after oblique rotation.

and Suicidal Ideation scales. Not surprisingly, it has high negative coefficients for the Treatment Rejection, PIM, and Warmth scales. Thus, the dimension is one of general distress and symptomatology, with depression being the prime marker.

The second component provides high positive coefficients for the Dominance, Mania, and to a lesser degree, Antisocial Features and Aggression scales. This dimension emphasizes energetic dominance, inflated self-esteem, and to a lesser extent stimulus seeking and aggressiveness; it appears to reflect the dimension of agentic surgency that is often found in the personality literature.

The remaining component has high positive coefficients for the Alcohol Problems, Drug Problems, Antisocial Features, ICN, and INF scales. It can be considered an "anticonscientiousness" dimension that emphasizes externalizing problems, including aggressive impulsivity, rule breaking, substance abuse, and carelessness or disregard for tasks.

As noted previously, it would have been reasonable to use orthogonal rather than oblique rotation because there were not substantial correlations between the dimensions (rs ranged from .02 to .26; see Table 2). These findings also indicate that the pattern coefficients in Table 2 are quite similar to the structure coefficients. However, because oblique rotation was used, we calculated the percentage of variance accounted for by each component after rotation by summing the squared pattern matrix loadings and dividing by the total number of variables (Tabachnick & Fidell, 2001). Component 1 accounted for about 35% of the variance, whereas the remaining components accounted for substantially less (see Table 2). The three components combined to account for 57.66% of the PAI total variance after rotation.

Although no other investigation of the 22 PAI scales has retained only three dimensions, there are notable similarities between the dimensions reported in Table 2 and those that have been reported in the literature. For example, the second and third dimensions identifying mania/dominance and substance abuse are conceptually consistent with prior investigations (e.g., Deisinger, 1995; Groves & Engel, 2007). One notable difference between our results and others in the literature is that a dimension emphasizing Paranoia, Nonsupport, and Warmth (e.g., Karlin et al., 2005; Tasca et al., 2002) was not differentiated from our first dimension of general distress.

STUDY 2

Purpose

In Study 2, we aimed to clarify whether there is a common and replicable PAI dimensional structure across samples after holding constant four methodological features: the number of scales examined, the method of analysis, the criteria for component retention, and the rotation of component axes. Using the sample in Study 1 and data from five other samples, we examined all 22 scales using PCA as the method of analysis. We also uniformly applied the three component retention procedures used in Study 1. Finally, using methods described following, we determined the extent to which the extracted dimensions defined a similar multidimensional space across samples.

The rotation of components in multidimensional space can be indeterminate (e.g., for a circumplex model, two orthogonal dimensions located in any position provide an equivalent representation) or affected by sample-specific peculiarities (e.g., a clustering of scales), either of which may result in two samples using different axes to represent the same multidimensional space. As a result, seemingly different dimensional solutions may in fact represent very similar or identical regions in multidimensional space. Because nonsubstantive rotational differences will obscure fundamental similarities across samples, it is necessary to examine congruence after one complete *m*-dimensional orthogonal solution has been brought into optimal alignment with another complete *m*-dimensional orthogonal solution. Barrett (2005) referred to this procedure as orthogonal vector matrix comparison or maximally congruent orthogonalized factor comparison, and he provided a software program for the analyses.

The extent to which the dimensional structure for an instrument replicates across samples has been investigated fairly extensively for an array of different inventories (e.g., see Barrett, Petrides, Eysenck, & Eysenck, 1998; Hendriks et al., 2003; McCrae, Zonderman, Costa, Bond, & Paunonen, 1996; Paunonen & Ashton, 1998; Terracciano, 2003; Terracciano, McCrae, & Costa, 2003). When an investigator has raw data from multiple samples, the invariance of dimensional structures is often examined using confirmatory factor analysis (CFA; e.g., Boyle & Lennon, 1994; Boyle, Ward, & Lennon, 1994). However, quantitative indexes of dimensional structure invariance also can be obtained from exploratory factor analytic (EFA) procedures, including principal components analysis (see Barrett et al., 1998; McCrae et al., 1996). In a number of respects, quantitative EFA procedures can be more optimal than CFA procedures for inventories like the PAI that possess scales with complex loadings or non-normal distributions. Under these conditions, CFA models

have incorrectly rejected robustly replicated dimensional solutions, at times even when cross-factor loadings as low as .20 were specified in the analytic model (see Aluja, García, García, & Seisdedos, 2005; McCrae et al., 1996; Terracciano et al., 2003).

Quantitative EFA procedures are not subject to the same sensitivities as CFA methods. Quantitative EFA relies on congruence coefficients to assess component/factor invariance across samples. Congruence coefficients range from -1.0 to 1.0 and evaluate the extent to which a fixed set of items or variables have identical component/factor coefficients from one solution to the next.

Barrett's (2005) program allows researchers to examine congruence between either unadjusted target and comparison component/factor matrices or what he termed *Procrustes-adjusted matrices,* which are "row-normalized" such that the row-based component/factor coefficients across all dimensions are equalized in the target and comparison matrices (i.e., the sum of the squared coefficients for a variable across all components/factors equals 1.0 regardless of their initial size). Unfortunately, the term *Procrustes* has not been used consistently in the literature. Barrett's (2005) unadjusted analyses (i.e., his non-Procrustes analyses) correspond to the type of analyses that typically have been used by investigators examining dimensional structure invariance for personality tests (e.g., Aluja et al., 2005; Barrett et al., 1998; Hendricks et al., 2003; McCrae et al., 1996; Paunonen & Ashton, 1998; Terracciano, 2003; Terracciano et al., 2003). However, the latter authors have referred to their approach as a Procrustes analysis. To avoid confusion, we do not use the term *Procrustes.*

Both unadjusted and row-normalized procedures simultaneously rotate the full complement of orthogonal components/factors in a comparison matrix into maximal alignment with a specified target matrix. Optimal alignment is determined by the least squares criterion such that the program seeks to minimize the sum of squared deviations between the component/factor coefficients in the comparison and target matrixes. Components/factors are not aligned one by one; rather, a fixed orthogonal structure is maintained across all dimensions. The rotational method does not distort the original data or artificially align dimensions in the absence of genuine congruence, and Terracciano (2003) noted several examples in which dimensional solutions failed to replicate after subjecting a target and comparison matrix to maximal orthogonal alignment (e.g., Ball, Tennen, & Kranzler, 1999, with the Temperament and Character Inventory [Cloninger, Svrakic, & Przybeck, 1993]; Helmes & Nielson, 1998, with the Center for Epidemiological Studies-Depression Scale [Radloff, 1977]; and Gosling & John, 1998, with the Five-factor model in nonhuman animals).

Using this approach, we investigated the congruence of the component structure reported in Study 1 with structures extracted from five additional samples. Morey (1991), Tasca et al. (2002), and Karlin et al. (2005) graciously provided raw score correlation matrices for further investigation. Additionally, Groves and Engel (2007) reported the raw score correlation matrix for the German translated PAI.[3] Thus, it was possible to

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[3]The German PAI includes a revised ICN scale that is composed of the same number of items as the original PAI. However, it includes different items.

TABLE 3.—Recommended number of components to extract from the 22 Personality Assessment Inventory scales across six samples based on alternative retention procedures.

Study	Dimensions Originally Retained	Components to Retain by Alternative Criteria		
		PA	MAP[a]	RV
Morey (1991) clinical	4	4	3, possibly 4	4
Morey (1991) normative	4	3	3	3
Tasca, Wood, Demidenko, & Bissada (2002)	5	4	2, possibly 3	3
Karlin et al. (2005)	4	4	4, possibly 3	4
Groves & Engel (2007)[b]	4	4	4	4
Study 1	3	3	3, possibly 4	3

Note. PA = parallel analysis; MAP = minimum average partial procedure; RV = random variable. PA results based on the analysis of 500 random data sets.
[a]There was indeterminacy in some solutions, so values within .0006 of the minimum are provided. [b]German version.

apply PA, MAP, and random variable procedures to these five data sets. Given that the same methodology will be applied to each sample, resulting component congruence coefficients will shed light on whether robust dimensions are observed.

Method

Participants and procedure. In Study 2, we made use of the sample described in Study 1 as well data from three clinical samples and two nonclinical samples. Tasca et al.'s (2002) and Karlin et al.'s (2005) clinical samples are characterized as eating disordered ($N = 238$) and chronic pain patients ($N = 432$), respectively. Morey's (1991) clinical sample ($N = 1,246$) is diverse with the largest diagnostic group being affective disorders (22.2%). The nonclinical samples consisted of Morey's (1991) adult normative sample from the United States ($N = 1,000$) and Groves and Engel's (2007) adult normative sample from Germany ($N = 749$).

We used PA, MAP, and random variables to determine the appropriate number of components to retain (see Table 3). Based on these results, we then conducted PCAs in each sample. Because the components in Study 1 were minimally correlated (rs from .02 to .26) and because it is necessary to compare orthogonal dimensions across samples, we used varimax rotation and Barrett's (2005) Orthosim program to conduct maximally congruent orthogonalized component structure comparisons across samples.

Results and Discussion

Although the three alternative component retention guides produced results that were somewhat ambiguous (i.e., did not clearly suggest a x-dimensional structure over a y-dimensional structure), the findings suggest that there was probably some overextraction in previous studies (see Table 3). In general, the three retention procedures supported extracting three or four components from each sample. Thus, we extracted three and four components from each sample. Despite knowing it was inappropriate to extract four components from our sample, we did so for comparison purposes.

We next investigated whether these dimensions might represent similar or identical regions in multidimensional space. Congruence coefficients for the four-dimensional solutions are

TABLE 4.—Personality Assessment Inventory four-dimensional congruence coefficients across samples.

	Target Matrix																							
Aligned	Morey (1991) Clinical				Morey (1991) Nonclinical				Karlin et al. (2005)				Tasca, Wood, Demidenko, and Bissada (2002)				Groves and Engel (2007)				Study 1			
Sample	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4
MC					.98	.90	.96	**.76**	.97	**.72**	.96	**.81**	.98	**.72**	.94	**.87**	.96	.95	**.77**	**.83**	.99	.95	**.89**	**.87**
MN	.98	**.86**	.91	**.75**					.98	.97	.96	**.89**	.98	.90	.92	**.88**	.99	.99	.97	.94	.98	.97	.95	**.75**
K	.98	**.88**	.92	**.41**	.98	.91	.96	.97					.98	.91	.94	.96	.98	.96	.98	.97	.99	.96	.91	.90
T	.99	**.88**	**.89**	**.51**	.98	.90	.93	**.88**	.98	.92	.95	.96					.98	.93	.91	.96	.99	.95	.92	**.89**
G–E	.99	**.89**	**.89**	**.49**	.99	.94	.92	**.76**	.99	.98	.95	.96	.99	.90	.91	.97					.99	.96	.93	**.87**
Study 1	.99	.94	.92	**.76**	.98	**.85**	.98	**.89**	.99	.92	.96	.92	.99	.93	.96	.91	.98	.98	.92	**.89**				

Note. Congruence coefficients < .90 are bolded for emphasis. C = component; MC = Morey (1991) clinical sample; MN = Morey (1991) nonclinical sample; K = Karlin et al. (2005) sample; T = Tasca et al. (2002) sample; G–E = Groves & Engel (2007) sample.

reported in Table 4. Congruence coefficients greater than .90 are typically interpreted as indicating a replicated dimension (Barrett et al., 1998), although more refined benchmarks have also been suggested (e.g., .98–1.00 = excellent, .92–.98 = good, .82–.92 = borderline; see MacCallum, Widaman, Zhang, & Hong, 1999). Columns represent the target component structure that the samples in the rows were maximally aligned to. The sample selected as the target structure has implications for the congruence coefficients. For example, when Morey's (1991) clinical sample is selected as the target matrix, and our sample is maximally aligned with it, congruence is .99, .94, .92, and .76, respectively; whereas when this is reversed and our sample is the target and his clinical sample is aligned with it, the congruence coefficients are .99, .95, .89, and .87, respectively.

The average congruence of Component 1 across samples was excellent (.98) and ranged from .96 to .99. The average congruence of Component 2 was good (.90) but varied from poor (.72) to excellent (.98) depending on which samples were compared. Component 3 had excellent average congruence (.94), but again varied from poor (.77) to excellent (.98). However, it is readily apparent that the lowest congruence coefficients were for the fourth dimension, which had an average of .83 and a range from .41 to .97. Thus, across samples, there was fair congruence for three of four dimensions.

With respect to the dimensions identified in these analyses, a general symptomatology and distress component appeared consistently across samples. A second dimension that emphasized antisocial tendencies, substance abuse, and aggression was dif-

ferentiated from a third dimension defined strongly by the Dominance and Mania scales and to a lesser degree by the Aggression and Antisocial Tendencies scales. It is not surprising that we observed discrepancies regarding what the final dimensions emphasized. A fourth dimension was defined by strong loadings from Paranoia, Warmth, and Nonsupport scales in five samples. However, each of these samples included inconsistent but moderately strong secondary loadings from a range of scales that made it challenging to concisely describe the dimension. Further, Morey's (1991) clinical sample produced a unique fourth dimension that emphasized only the ICN and INF scales.

Data for the congruence across three-component solutions is presented in Table 5 in which it is clear there is excellent congruence across all dimensions and samples. All coefficients were ≥ .90 with the exception of one, which was .89, and the averages across dimensions were excellent (C1 $M = .99$; C2 $M = .95$; C3 $M = .95$). Across samples, the actual solutions were nearly identical to those reported in Table 2. The most robust dimension was defined by general symptomatology and distress. A second was defined by antisocial practices, substance abuse, and carelessness and the third by mania and dominance, with less salient contributions from aggression and antisocial actions.

GENERAL DISCUSSION

Understanding the PAI's dimensional structure has been of great interest to researchers and clinicians alike. Despite many attempts to better understand how the instrument operates, the literature has suggested there may be different higher order

TABLE 5.—Personality Assessment Inventory three-dimensional congruence coefficients across samples.

	Target Matrix																	
Aligned	MC			MN			K			T			G–E			Study 1		
Sample	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
MC				.98	.95	.98	.99	.97	.96	1.0	.95	.95	.99	.97	.97	.99	.98	.96
MN	.99	.92	.97				.98	.92	.95	.97	.92	.91	.99	.99	.96	.98	.98	**.89**
K	.99	.98	.96	.98	.94	.95				.99	.95	.94	.99	.96	.96	.99	.96	.94
T	1.0	.95	.95	.97	.94	.92	.99	.95	.94				.99	.92	.97	.99	.94	.90
G–E	.99	.97	.96	.99	.97	.98	.99	.96	.94	.99	.96	.91				.99	.97	.94
Study 1	.99	.96	.98	.98	.93	.98	.99	.94	.96	.99	.92	.93	.99	.97	.94			

Note. Congruence coefficient < .90 is bolded for emphasis. MC = Morey (1991) clinical; MN = Morey (1991) nonclinical; K = Karlin et al. (2005); T = Tasca, Wood, Demidenko, and Bissada (2002); G–E = Groves and Engel (2007).

factor or component structures across samples. From a measurement perspective, this is problematic because it is necessary for a scale, factor, or multidimensional test to work similarly across samples if one is to have confidence drawing conclusions from the data it provides. For the PAI, a consistent, replicable component structure fosters a clear understanding of how its scales elevate and suppress in combination, which facilitates accurate clinical interpretation across settings, samples, and contexts.

In reviewing relevant literature, it became clear that there were many sample-based and methodological differences across investigations that might have contributed to discrepant PAI dimensional structures (e.g., see Table 1 or Morey, 2007). We conducted this research to better understand if four methodological decisions might contribute to nonreplicating dimensions. We were hopeful that a replicable PAI structure would emerge after applying uniform methods.

To our best knowledge, Study 1 was the first investigation to use multiple recommended component retention procedures (i.e., PA, MAP, inclusion of random variables) that increase the likelihood of retaining robust, replicable dimensions to the full set of 22 PAI scales. These procedures provided converging support for retaining three components in our sample, which is a smaller number of dimensions than previous studies had retained when examining the complete set of 22 scales. The first dimension evaluated general distress and symptomatology, the second emphasized energetic dominance and egocentricity, and the last measured externalizing problems that included variance specific to substance abuse, carelessness, and a disregard for societal standards.

We applied the same component retention procedures to five additional samples. In two of the samples, the results clearly indicate that fewer dimensions should be retained than were initially extracted (see Table 3). In two additional samples, at least one of the component retention criteria suggests there was a smaller number of legitimate components than initially identified. Thus, overextraction contributed to some of the variability previously seen across samples.

We next determined the congruence of three- and four-dimensional structures across the six samples using orthogonal vector matrix comparison procedures and found excellent congruence for three components but not four. Although some of the comparisons in Table 4 provided support for four highly congruent components (e.g., target matrix = Karlin et al., 2005, and comparison matrix = our sample), this level of congruence was not observed across all comparisons. Given this, and the finding that a fourth dimension in our sample was defined more strongly by random variables than by substantive scales, we believe it is most appropriate to describe the 22-scale PAI dimensional structure as having three invariant components. Across samples, these components evaluate (a) general symptomatology and distress; (b) antisocial practices, substance abuse, and carelessness; and (c) dominance, mania, inflated self-esteem, stimulus seeking, and aggressiveness. Although we outlined previously several limitations of CFAs, the robustness of the three-component solution suggests it could serve as the basis for a CFA model in future research, whereas a four-component model could not.

Several conclusions can be drawn from the robust three-dimensional PAI component structure. First, it is notable that the first component is fairly heterogeneous in nature and taps a range of psychological problems (e.g., depressive symptomatol-

ogy, atypical experiences, and borderline features). An elevation on this dimension clearly indicates an openness to report various forms of psychological distress. Because the NIM scale is a good marker of this component, the NIM-predicted profile available through the PAI Explorer (Morey, 1999, 2007) might be particularly helpful for interpreting clinical protocols that are elevated on this dimension, as the NIM-predicted profile allows one to see if particular content areas are uniquely elevated or suppressed despite a generally negative response set.

There is some conceptual overlap between the second and third PAI dimensions, with the Antisocial Features scale having a similar pattern loading on each dimension across samples. Despite this, these dimensions do evaluate different constructs, and they were not significantly correlated in any of the six samples investigated (e.g., see Table 2). One component evaluates a surgency dimension of mania and dominance (and to a lesser extent antisocial practices and aggression), whereas the other taps externalizing antisocial problems including substance use or abuse and carelessness. There are clear clinical advantages for evaluating psychopathology separately along each of these dimensions. For example, clinical treatment would vary significantly if just one of the dimensions were elevated rather than both.

When analyses were conducted in our sample with random variables to identify when overextraction had occurred, a fourth dimension appeared that emphasized four random variables and the INF and ICN scales. This finding implies the INF and ICN scales may evaluate a specific type of variance (i.e., "noise") that is uniquely different from scales specific to symptomatology. When we conducted analyses without random variables, this specific variance was no longer substantive enough to be included on a single dimension. Perhaps it is not surprising then that the three dimensions observed in Study 1 did not successfully capture the variance associated with the INF and ICN scales as indicated by their low communalities (see Table 2).[4]

Given that a three-dimensional component structure is invariant across different clinical and nonclinical samples, it is justifiable and appropriate to consider these three clinical markers during PAI interpretation. For example, a more refined top-down approach to interpretation would first consider these higher order dimensions; then the 22 full scales; and last, the subscales. This hierarchical interpretive framework would help organize interpretation of the PAI scales, and it would draw a clinician's attention first to scales that theoretically should elevate and suppress in unison.

To aid PAI clinical interpretation using these dimensions, we used Morey's (1991) normative sample to obtain regression weights that allow one to compute T scores for each component. These are provided in Table 6. To obtain patient-specific T scores for Component 1, multiply the T score for every scale by the first column of weights, sum the products across all scales, divide the total by 10, subtract the constant listed in the last row of Table 6, and round to the nearest whole number. Repeat these steps using the second and third columns of weights to generate T scores for Components 2 and 3. Although this is a bit tedious,

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[4]At the request of the Editor, we investigated PAI dimensional structure after excluding the INF and ICN scales. We extracted three components from the remaining 20 PAI scales, and each was highly correlated with a corresponding dimension reported in Table 2 (all rs = |.91|).

TABLE 6.—Weights to generate T scores for each component.

Scale	Component 1	Component 2	Component 3
Inconsistency	−.02	−.12	.17
Infrequency	−.07	−.06	.22
Negative Impression	.07	−.03	.08
Positive Impression	−.17	−.12	.13
Somatic Complaints	.09	−.09	.01
Anxiety	.15	−.09	−.03
Anxiety-Related Disorders	.16	−.03	−.09
Depression	.12	−.15	.02
Mania	.07	.34	−.02
Paranoia	.06	.03	.09
Schizophrenia	.09	−.04	.06
Borderline Features	.12	.08	.01
Antisocial Features	−.01	.21	.16
Alcohol Problems	−.05	.12	.19
Drug Problems	−.06	.02	.22
Aggression	.04	.22	.07
Suicidal Ideation	.06	−.05	.08
Stress	.12	.05	−.03
Nonsupport	.03	−.06	.12
Treatment Rejection	−.13	−.05	.08
Dominance	−.04	.36	−.01
Warmth	.01	.16	−.13
Constant to subtract	3.23	3.43	7.09

Note. To obtain a patient's T score for each component: (a) multiply the patient's T score by the weight listed, (b) sum the product across all scales, (c) divide the total by 10, (d) subtract the constant listed in the last row, and (e) round to the nearest whole number. For instance, a hypothetical patient with T scores of 70 on all 22 scales would have T scores of 63, 64, and 78 on Components 1 to 3, respectively.

an Excel program to generate these T scores can be obtained by contacting J. B. Hoelzle or downloaded from G. J. Meyer's Web page (http://psychology.utoledo.edu/default.asp?id=168).

Interpretation of these broad markers will improve a clinician's understanding of their patient's PAI profile by identifying elevations and suppressions across the three greatest sources of scale-to-scale covariance. With respect to future research, interesting empirical questions include ways in which these broad markers improve the predictive validity of the PAI beyond the basic scales or whether these broad scales are more useful when tracking patients' progress during the course of treatment. Encouragingly, there is some reason to believe that broad dimensional scores may be more successful at predicting some clinical/diagnostic criteria than the individual scales. For example, Hopwood et al. (2008) reported a broad PAI externalizing dimension was useful to differentiate heroin users from alcohol, marijuana, and cocaine users.

Interpretation of these PAI dimensions can also facilitate combining data obtained from different clinical measures and can link the PAI to a broader literature on the structure of psychopathology. For instance, there are similarities between these PAI dimensions and those observed by Hoelzle and Meyer (2008) with the MMPI–2, using the Clinical, Content, and Restructured Clinical (RC; Tellegen et al., 2003) scales. A dimension reflecting general, internalizing distress was observed with the MMPI–2 that is conceptually similar to the first PAI dimension. Further, there were similarities between the PAI substance abuse and psychopathy dimension (Component 3) and a MMPI–2 dimension that emphasized externalizing antisocial behavior. Both of these internalizing and externalizing dimensions also are very similar to the higher order dimensions of psychopathology

reported by Krueger (1999) and Markon, Krueger, and Watson (2005) across the disorders in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; American Psychiatric Association, 1994) and a range of assessment instruments and methods.

It is obvious there is a robust three-dimensional structure to the PAI scales when the 22 full scales are analyzed. However, it is unclear whether additional components might emerge if identical protocol exclusion criteria were applied across samples. Three of the samples we investigated excluded protocols only if participants responded to less than 90% of the PAI items (Morey's, 1991, two samples and Groves and Engel, 2007). The other three samples also excluded protocols based on Validity scale elevations. Applying validity criteria could be viewed as artificially limiting the variance on certain scales, which could then restrict interscale correlations and ultimately limit the components derived. Although we could not adequately explore this issue across all samples, at our request, Morey applied the same validity criteria we used in Study 1 to his two samples and provided the resulting correlation matrices (personal communication, March 16, 2006), which we examined in four-dimensional orthogonal congruence analyses. Briefly, with Morey's revised clinical sample (*n* = 1,103) as the target matrix, there still was very poor congruence across samples. However, when the revised nonclinical sample (*n* = 857) was the target matrix, Groves and Engel (2007), Karlin et al. (2005), Tasca et al. (2002), and our sample showed excellent congruence on all four dimensions (the fourth component was defined by Paranoia and Nonsupport vs. Warmth). This raises the possibility that a fourth replicable dimension might be more discernable across many samples if invalid protocols are excluded from the analyses.

Additionally, it is unclear whether the underlying PAI structure might be different if PAI subscales were examined. Substituting the subscales for their parent scales would result in 43 variables for analysis rather than 22. Because the PAI subscales evaluate more specific components of psychopathology, using them in an analysis might produce a more differentiated or refined dimensional structure. In addition, because three or more variables are typically needed for a component/factor to be defined, it might be possible for a scale that includes three subscales to appear as its own single dimension (e.g., the Cognitive, Affective, and Physiological subscales may together define a single dimension of depressive symptoms), which would again produce a more differentiated structure. Research toward this goal would increase understanding of how the PAI operates at various levels relevant to clinical interpretation.

In conclusion, it is encouraging to find three invariant PAI components across six different samples. Clinicians can have confidence that the full 22-scale PAI assesses the same three core, higher order dimensions regardless of sample characteristics and setting. Clinical interpretation should improve when considering these components as opposed to those previously identified in the literature; as each identifies a set of scales that tend to elevate and suppress in tandem, and all three components together reveal the primary and largely independent influences on PAI data profiles. Methodologically, this study highlights the value of relying on several empirical component retention guides when deciding how many components to extract. Although these guides were not unambiguous, they indicated that overextraction affected some of the earlier research. In this

study, we also demonstrated the value of Barrett's (2005) orthogonal vector matrix comparison program for identifying a core, replicable dimensional structure when multiple samples are available for analysis.

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