

MSP Research Note

CPQ Reliability and Validity

Introduction

This research note describes the reliability and validity of the CPQ. Evidence for the reliability and validity of is presented against some of the key the criteria in the EFPA Review Model for the Description and Evaluation of Psychological Tests. The EFPA Review Model (Bartram, 2002) was produced to support and encourage the process of harmonising the reviewing of tests. It provides a standard set of criteria to assess the quality of tests. These cover the common areas of test review such as norms, reliability and validity.

Internal consistency reliability

Table 1 shows the CPQ scale reliabilities. They range from 0.74 to 0.92 with all but one of the scale reliabilities at 0.80 or higher. The median reliability is 0.87 which is considered good in the EFPA Review Model.

The Standard Error of Measurement (SEm) provides an error band around a score. The SEm allows us to put confidence bands around the scores of individual test takers. If one standard error is added to a score and one standard error is subtracted from it, a range is created within which we can be 68% certain the true score falls. If two standard errors are added to the score and two standard errors are subtracted from it, a wider range is created within which we can be 95% certain that the true score falls.

The scale SEMs range from 2.28 to 3.18 with a median SEM of 2.88. This is equivalent to a sten score SEM of approximately 1. In other words, there is a 68% likelihood that the person's true score on one of the trait scales will lie one sten either side of the observed score.

Table 1. Internal consistency reliabilities for CPQ (n = 1,448)

Scale	Alpha	Mean	SD	Raw score SEM
Extraversion	0.88	36.54	8.38	2.90
Agreeableness	0.80	41.08	5.81	2.60
Openness to Change	0.74	33.65	6.24	3.18
Conscientiousness	0.85	37.44	7.39	2.86
Emotional Stability	0.88	33.50	8.38	2.90
Achievement Motivation	0.87	35.24	7.46	2.69
Power Motivation	0.86	30.43	8.01	3.00
Cognitive Ability	0.92	36.30	8.06	2.28

Scale intercorrelations

Table 2 gives the intercorrelations for the CPQ scales. The correlations range from -0.02 to 0.67 and reveal a moderate degree of overlap between the scales. The highest correlations are between Achievement and Power Motivation (0.67), and between Cognitive Ability and the two motivation scales (0.55, 0.64). The lowest correlations are between Agreeableness and Openness to Change, Agreeableness and Power Motivation, and between Conscientiousness and Openness to Change.

In order to determine how well a personality questionnaire differentiates between the different dimensions it is designed to measure, it is necessary to correct the correlations for unreliability. A correlation needs to be divided by the square root of the product of the two variables' reliability to determine what the correlation between the two variables would be if the variables' reliabilities were perfect. If two scales share less than 50% reliable variance, then we can be reasonably certain that they are independent.

Table 2. Intercorrelations of CPQ scales (n = 1,448)

Scale	Agreeableness	Openness to Change	Conscientiousness	Emotional Stability	Achievement Motivation	Power Motivation	Cognitive Ability
Extraversion	0.22**	0.42**	0.21**	0.39**	0.48**	0.56**	0.35**
Agreeableness		0.02	0.34**	0.34**	0.23**	-0.08**	0.16**
Openness to Change			-0.06*	0.19**	0.30**	0.35**	0.39**
Conscientiousness				0.40**	0.45**	0.19**	0.36**
Emotional Stability					0.35**	0.19**	0.31**
Achievement Motivation						0.67**	0.64**
Power Motivation							0.55**

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

Table 3 shows that the CPQ scales have a reasonable degree of independence. Two scale pairs exceed the benchmark of 50% common reliable variance. The strongest relationship is between Achievement Motivation and Power Motivation which share 60% common reliable variance. Cognitive Ability shares just over 50% common reliable variance with Achievement Motivation. With two exceptions, the CPQ differentiates reasonably effectively between the personality and motivational dimensions it is designed to measure.

Table 3. Percentage of common reliable variance for CPQ scales (n = 1,448)

Scale	Agreeableness	Openness to Change	Conscientiousness	Emotional Stability	Achievement Motivation	Power Motivation	Cognitive Ability
Extraversion	6.88	27.09	5.90	19.64	30.09	41.44	15.13
Agreeableness		0.07	17.00	16.42	7.60	0.93	3.48
Openness to Change			0.57	5.54	13.98	19.25	22.34
Conscientiousness				21.39	27.38	4.94	16.57
Emotional Stability					16.00	4.77	11.87
Achievement Motivation						60.00	51.17
Power Motivation							38.23

Standard error of difference

The standard error of difference (SEd) helps us determine the size of the gap that you need to see between a person's scores on any two scales before you can conclude that the difference is real. The SEd depends on the reliability of the scales – the higher the reliability the smaller the SEd is. If there are two full SEds between the scores on two scales, then there is a 95% likelihood that there is a real difference.

All the SEds in Table 4 are around 4 so a difference of around 8 or more in CPQ raw scores constitutes a real difference. This is equivalent to a difference of 3 Stens.

Table 4. Standard error of difference of CPQ scales (n = 1,448)

Scale	Agreeableness	Openness to Change	Conscientiousness	Emotional Stability	Achievement Motivation	Power Motivation	Cognitive Ability
Extraversion	3.89	4.30	4.07	4.10	3.96	4.17	3.69
Agreeableness		4.50	3.68	3.87	4.17	4.37	3.91
Openness to Change			4.11	4.28	3.80	4.03	3.53
Conscientiousness				4.04	3.74	3.97	3.46
Emotional Stability					3.93	4.14	3.66
Achievement Motivation						4.24	3.77
Power Motivation							3.22

Factor analysis

We used factor analysis to explore the underlying structure of CPQ and achieved the best fit with the concept model by carrying out separate analyses of the personality and motivational dimensions. The best rotations of the Big Five were achieved when the positively-keyed and negatively-keyed items were analysed separately.

Principal factors extraction with varimax rotation was carried out on the 25 positively-keyed items and 25 negatively-keyed items separately. Five factors were extracted in each case that corresponded with models of the Big Five based on adjective markers, for example, those reported by Goldberg (1992) and Saucier (2002b).

Tables 5 - 8 show the outcomes of this procedure. In each case, the five extracted factors explained approximately 50% of the variance in the samples. The adjectives in the tables are ordered and grouped by size of loading and items loading under

0.32 (10% of variance) have been excluded. All the items from each scale loaded on the expected factor.

As indicated by SMCs, all factors for the 2 groups of items were internally consistent and well-defined by the variables. Internal consistency of the factors is shown as SMCs in the diagonal of the factor score covariance matrix in Table 6 and Table 8. The lowest of the SMCs for factors from variables was 0.70.

Table 5. Rotated matrix for CPQ factor analysis with positively keyed items (principal factors extraction, varimax rotation, n = 1,448)

Item	I	II	III	IV	V
Inventive	0.80				
Creative	0.80				
Imaginative	0.78				
Original	0.66				
Innovative	0.63				
Unruffled		0.80			
Calm		0.78			
Composed		0.74			
Even Tempered		0.67			
Relaxed		0.65			
Organized			0.85		
Systematic			0.75		
Thorough			0.64		
Neat			0.62		
Conscientious			0.60		
Warm				0.77	
Generous				0.72	
Sympathetic				0.72	
Agreeable				0.63	
Cooperative				0.60	
Extravert					0.79
Socially Confident		0.34			0.60
Talkative					0.60
Assertive					0.53
Spontaneous	0.34				0.43

Table 6. CPQ factor score covariance matrix with positively keyed items (n = 1,448)

Factor	I	II	III	IV	V
Openness to Change	0.864	0.023	0.015	0.021	0.059
Emotional Stability	0.023	0.860	0.042	0.020	0.019
Conscientiousness	0.015	0.042	0.855	0.022	-0.007
Agreeableness	0.021	0.020	0.022	0.834	0.031
Extraversion	0.059	0.019	-0.007	0.031	0.788

Table 7. Rotated matrix for CPQ factor analysis with negatively keyed items (principal factors extraction, varimax rotation, n = 1,448)

Item	I	II	III	IV	V
Introverted	0.84				
Reserved	0.83				
Shy	0.78				
Withdrawn	0.69				
Quiet	0.69				
Tense		0.74			
Worrying		0.72			
Anxious		0.70			
Emotional		0.68			
Over-sensitive		0.66			
Uncaring			0.61		
Selfish			0.58		
Demanding			0.53		
Superficial			0.49		
Distrustful			0.36		
Disorganized				0.66	
Untidy				0.65	
Inconsistent				0.46	
Unrealistic				0.46	
Aimless				0.44	
Traditional					0.73
Conventional					0.71
Rule-conscious					0.53
Conforming					0.43
Realistic					0.43

Table 8. CPQ factor score covariance matrix with negatively keyed items (n = 1,448)

Factor	I	II	III	IV	V
Extraversion	0.884	0.052	0.039	0.044	0.000
Emotional Stability	0.052	0.815	0.050	0.028	0.067
Conscientiousness	0.039	0.050	0.745	-0.037	0.076
Openness to Change	0.044	0.028	-0.037	0.783	-0.010
Agreeableness	0.000	0.067	0.076	-0.010	0.700

Principal factors extraction with varimax rotation was carried out on the 30 positively-keyed items measuring the two motivation factors and cognitive ability. Three factors were extracted that corresponded reasonably well with the scales for Achievement Motivation, Power Motivation and Cognitive Ability. The three extracted factors explained approximately 50% of the variance. The adjectives in Table 9 are ordered and grouped by size of loading and items loading under 0.32 (10% of variance) have been excluded. The majority of items from each scale loaded on the expected factor.

Table 10 shows the outcomes of a factor analysis of the CPQ scales. Principal factors extraction with varimax rotation was carried out on 8 scales measuring the Big Five factors, the two motivation factors and cognitive ability. Two factors were extracted explaining approximately 48% of the variance. The scales in Table 10 are ordered and grouped by size of loading, and loadings under 0.45 (20% of variance) have been excluded.

To help interpret these higher-order factors, Table 11 shows the Great 8 competencies alongside the relevant CPQ scale. The first factor seems to be a broad measure of ambition and leadership; that is, people who have high scores on this factor describe themselves as interested in power and status, ambitious to succeed, able, outgoing and innovative. These traits would help acquire competencies in leadership, entrepreneurial activity, analytic/investigative work, interacting and presenting, and innovation.

The second factor could be interpreted as providing a measure of emotional competence, that is, people who score high on this scale are even-tempered, conscientious and show concern for others. These traits correspond with descriptions by Goleman (1998) and Collins (2001) of the emotionally intelligent/Level 5 manager. These traits would help acquire competencies in organisation, working with people and adapting and coping.

Table 9. Rotated matrix for CPQ factor analysis of motivation items (principal factors extraction, varimax rotation, n = 1,448)

Item	I	II	III
Can do	0.73		
Motivated	0.71		
Achieving	0.69		
Go getting	0.69		0.38
Raring to go	0.63		
Positive	0.59		
On the ball	0.58	0.45	
Inspirational	0.51		
Industrious	0.49		
Determined	0.45		0.39
Committed	0.41		
Workaholic	0.39		
Brainy		0.83	
Intelligent		0.79	
Clever		0.77	
Able	0.37	0.69	
Scholarly		0.68	
Brilliant		0.68	
Knowledgeable		0.60	
Sharp	0.39	0.60	
Talented		0.39	
Dominant			0.82
Leading			0.72
Controlling			0.72
Powerful			0.70
Authoritative			0.63
Influential	0.41		0.59
Striving			0.50
Challenging	0.38		0.49

Table 10. Rotated matrix for CPQ factor analysis of scales (principal factors extraction, varimax rotation, n = 1,448)

CPQ Scale	Factor I	Factor II	Great 8 Competency Factor
Extraversion	0.59		Interacting and presenting
Agreeableness		0.58	Supporting and cooperating
Openness to Change	0.50		Creating and conceptualising
Conscientiousness		0.65	Organising and executing
Emotional Stability		0.55	Adapting and coping
Achievement Motivation	0.71		Enterprising and performing
Power Motivation	0.88		Leading and deciding
Cognitive Ability	0.64		Analysing and reporting

Relationship to other measures

Table 11 describes the relationship between the CPQ Big Five and Cognitive Ability scales and adjectives identified in the literature as marker variables for the Big Five. There is a clear and consistent pattern of correlations between the CPQ Big Five scales and marker variables identified by Goldberg (1992). The relationship between these markers and the Big Five personality dimensions is statistically significant (all are significant at $p < 0.01$).

The CPQ has separate scales for ability and openness whereas in the studies by Goldberg and others, markers covering ability and markers covering creative style often appear together as markers for a broader scale often labelled Intellect. The author believes that there is good evidence in the literature (for example, Kirton’s (1994) work on creativity and problem solving together with the analysis of the trial questionnaire data for retaining separate scales for these constructs.

Table 11 also shows correlations between the additional motivation scales and adjective correlates cited by Costa & McCrae as evidence for the construct validity of the Assertiveness and Achievement Striving scales in the NEO-PI-R. There is obvious overlap between these scales and the CPQ Achievement and Power Motivation scales. It is also important to note that all the correlations in the table are positive because negatively-keyed items are reverse-scored - that is, rating the item talkative as ‘exactly like me’ is scored 5 just as rating the item shy ‘not at all like me’ is scored 5.

Table 11. Correlations of CPQ scales and marker variables (n = 1,448)

CPQ Scale	Correlations with Markers identified by Goldberg (1992)			
Extraversion	Extraverted	Talkative	Assertive	Energetic
	0.74	0.61	0.58	0.57
	Introverted	Shy	Quiet	Reserved
	0.82	0.78	0.70	0.80
Agreeableness	Kind	Cooperative	Sympathetic	Warm
	0.58	0.63	0.65	0.68
	Cold	Unkind	Selfish	Distrustful
	0.45	0.50	0.62	0.52
Openness to Change	Creative	Imaginative	Innovative	Intelligent
	0.66	0.64	0.61	0.31
	Perceptive	Knowledgeable		
	0.21	0.24		
Conscientiousness	Organized	Systematic	Thorough	Neat
	0.81	0.72	0.65	0.70
	Disorganised	Careless	Inefficient	Hard-working
	0.72	0.56	0.56	0.47
Emotional Stability	Relaxed	Calm	Stable	Contented
	0.68	0.66	0.43	0.49
	Anxious	Moody	Nervous	Emotional
	0.49	0.58	0.64	0.72
Cognitive Ability	Intelligent	Perceptive	Imaginative	Innovative
	0.84	0.51	0.54	0.46
	Creative	Knowledgeable		
	0.50	0.73		
CPQ Scale	Correlations with ACL correlates of NEO-PI-R Assertive and Achievement Striving facet scales (Costa & McCrae, 1992)			
Achievement Motivation	Thorough	Ambitious	Industrious	Determined
	0.34	0.80	0.49	0.56
Power Motivation	Aggressive	Assertive	Self-confident	Shy
	0.46	0.73	0.58	0.29

All correlations are significant at the 0.01 level (2-tailed). All correlations are positive because negatively-keyed items are reverse-scored.

Criterion-related validity

Validity data for CPQ is based on a sample of 1,102 respondents. Of these, 59% reported that their manager had given them an excellent rating, 39% a satisfactory rating and 2% a poor rating. Self-assessment ratings were evenly balanced between

excellent and satisfactory (approximately 49% in each category) and 2% rated their performance as poor. Comparison of managerial and self-assessment ratings revealed some degree of disagreement as might be expected. For example, a significant number of respondents (14%) who rated their performance as excellent were rated by their manager as satisfactory or poor. Twenty seven percent who reported that their manager gave them an excellent rating rated their performance as satisfactory or poor.

Table 12 shows the correlations between the CPQ personality scales and managerial, self-assessed and combined ratings for 3 groups of respondents – respondents from the United States, the United Kingdom and the rest of the world. The combined ratings are based on the sum of the managerial assessments and self-assessments.

Although there are some variations in the pattern of correlations across the sub-samples, the Conscientiousness scale emerges consistently as the strongest predictor of job performance ($r=0.30$). This is followed by Emotional Stability ($r=0.20$), Extraversion ($r=0.20$), Agreeableness ($r=0.19$) and Openness to Change ($r=0.08$). All the correlations are statistically significant in the full sample. For the self-assessed ratings, the pattern is similar. There are some variations between the country sub-groups with the UK sample showing the smallest correlations with job performance. The overall pattern of correlations shown for the sample as a whole was, however, replicated for men and women and for different age groups.

The correlation levels seen in Table 12 are consistent with findings in the literature about the relationship between personality scale scores and job performance measures. Schmitt (1984) produced a validity coefficient of 0.15 for personality in general. More recent studies focusing on the Big Five have produced data for each of the Big Five separately. Barrick & Mount (1991) reported a correlation between conscientiousness and performance at the level of 0.22 and between extraversion and performance at the level of 0.17. Meta-analysis of the criterion-related validity of personality by Tett *et al* (1991) produced similar findings.

Regression analysis was used to help understand the contribution of the different CPQ scales on job appraisal ratings. A standard multiple regression was performed between managerially and self-assessed job performance as the dependent variables and the CPQ scales as the independent variables using the full sample. Table 13 displays the correlations between the variables, the unstandardised regression coefficients (B), the semi-partial correlations (sr^2) and R, R^2 and adjusted R^2 .

For the managerially-assessed ratings, R for regression was significantly different from zero, $F(8, 1094) = 21.96, p < 0.001$. Altogether, 13% of the variability in job performance ratings was accounted for by the CPQ scale scores. Conscientiousness contributed significantly to the combined job performance assessment and accounted for approximately 2.4% of the variability in job performance. The eight scales in combination contributed another 10.6% in shared variability.

Table 12. Correlations between CPQ scores and job appraisal ratings (n = 1,102)

Job Performance Rating		Extraversion	Emotional Stability	Conscientiousness	Agreeableness	Openness to Change	Achievement Motivation	Power Motivation	Cognitive Ability
United States (n = 664)	Manager	0.10*	0.20**	0.25**	0.18**	0.01	0.21**	0.14**	0.18**
	Self	0.19**	0.23**	0.27**	0.20**	0.05**	0.27**	0.16**	0.22**
	Combined	0.17**	0.24**	0.30**	0.22**	0.04	0.27**	0.17**	0.23**
United Kingdom (n = 154)	Manager	0.06	-0.03	0.11	0.01	0.16*	0.20*	0.07	0.18*
	Self	0.18*	0.15	0.33**	0.09	0.02	0.41**	0.23**	0.33**
	Combined	0.14	0.07	0.26**	0.06	0.10	0.36**	0.18*	0.30**
Rest of the World (n = 284)	Manager	0.33**	0.23**	0.35**	0.16**	0.18**	0.35**	0.25**	0.29**
	Self	0.28**	0.11	0.28**	0.17**	0.17**	0.32**	0.24**	0.21**
	Combined	0.35**	0.19**	0.36**	0.18**	0.20**	0.38**	0.28**	0.28**
Total (n = 1,102)	Manager	0.15**	0.17**	0.25**	0.16**	0.07*	0.23**	0.16**	0.20**
	Self	0.21**	0.18**	0.28**	0.18**	0.08*	0.29**	0.19**	0.23**
	Combined	0.20**	0.20**	0.30**	0.19**	0.08*	0.30**	0.19**	0.25**

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

We also carried out a regression between managerially and self-assessed job performance as the dependent variables and the CPQ higher-order factors as the independent variables using the full sample. Table 13 displays the results. Altogether, 13% of the variability in job performance ratings was accounted for by the two higher order factors. The higher-order factor made up of Conscientiousness, Agreeableness and Emotional Stability contributed significantly to the combined job performance assessment and accounted for 8.66% of the variability in job performance. The higher-order factor made up of Power Motivation, Achievement Motivation, Cognitive Ability, Extraversion and Openness to Change accounted for approximately 4.41% of the variability in job performance.

Table 13. Regression of CPQ scale scores on job performance ratings (n = 1,102)

Variables	Combined Assessment	Extraversion	Emotional Stability	Conscientiousness	Agreeableness	Openness to Change	Achievement Motivation	Power Motivation	Cognitive Ability	B	Beta	Significance	Unique
Extraversion	0.20									0.01	0.05	0.16	0.18%
Emotional Stability	0.20	0.38								0.00	0.02	0.50	0.04%
Conscientiousness	0.30	0.20	0.39							0.02	0.18	0.00	2.40%
Agreeableness	0.19	0.24	0.36	0.32						0.01	0.07	0.03	0.45%
Openness to Change	0.08	0.43	0.18	-0.07	0.02					0.00	0.00	0.97	0.00%
Achievement Motivation	0.30	0.46	0.32	0.44	0.23	0.30				0.01	0.11	0.02	0.51%
Power Motivation	0.19	0.54	0.16	0.17	-0.07	0.33	0.67			0.00	0.02	0.61	0.02%
Cognitive Ability	0.25	0.34	0.30	0.33	0.16	0.38	0.62	0.54		0.01	0.07	0.07	0.30%
Mean	5.05	36.82	33.86	37.96	41.07	33.62	35.57	30.62	36.58			R ² =	0.14
Standard Deviation	0.94	8.21	7.93	7.04	5.70	6.24	7.25	7.91	7.83			Adjusted R ² =	0.13
												R=	0.37

Table 14. Regression of CPQ higher-order factor scores on job performance ratings (n = 1,102)

Variables	Combined Assessment	Leadership	Emotions	B	Beta	Significance	Unique
Leadership Competency	0.22			0.22	0.20	0.000	4.41%
Emotional Competency	0.30	0.08		0.36	0.29	0.000	8.66%
Mean	0.00	0.02	0.05			R ² =	0.132
Standard Deviation	1.00	0.91	0.80			Adj R ² =	0.131
						R=	0.364

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