View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Open Research Exeter

Running Head: PERFORMANCE ASSESSMENT IN SPORT

Please reference this paper as:

Rees, T., Hardy, L., & Ingledew, D. K. (2000). Performance assessment in sport: Formulation, justification and confirmatory factor analysis of a measurement instrument for tennis performance. *Journal of Applied Sport Psychology, 12,* 203-218. doi:10.1080/10413200008404223

Performance Assessment in Sport: Formulation, Justification, and Confirmatory Factor Analysis of a Measurement Instrument for Tennis Performance

Tim Rees, Lew Hardy

School of Sport, Health and Physical Education Sciences

University of Wales, Bangor, UK

David K. Ingledew

School of Psychology

University of Wales, Bangor, UK

Submitted: 25th September, 1999

FINAL REVISION

Author notes

Correspondence concerning this article should be addressed to Tim Rees, School of Sport, Health and Physical Education Sciences, University of Wales (Bangor), Bangor, LL57 2DG, UK. E-mail edp621@bangor.ac.uk. Telephone: +44 1248 383494. Fax: +44 1248 371053.

Performance Assessment in Sport: Formulation, Justification, and Confirmatory Factor Analysis of a Measurement Instrument for Tennis Performance

Submitted: 25th September, 1999

FINAL REVISION

Abstract

The present study reports the refinement and confirmatory factor analysis of a performance assessment instrument designed for tennis, first reported in Rees, Ingledew, and Hardy (1999). Background and justification for this study are reported, together with a detailed description of the sequential model-testing approach (Jöreskog, 1993) adopted. The factor structure of the instrument was tested using a sample of 155 full-time tennis players. Analyses revealed good fit for the proposed model to the new data sample, and provided confirmation for the seven performance factors: Execution of (Flexible) Plan; Loss of Composure; Feeling Flat; Determination; Worry; Flow; and Effective Tactics. Performance factors discriminated between winners and losers. Performers should look at the various factors comprising overall performance - in a sense, the processes by which they come to achieve their successes.

Performance Assessment in Sport: Formulation, Justification, and Confirmatory Factor Analysis of a Measurement Instrument for Tennis Performance

The need for more reliable and valid measurement of performance has been identified as an important future research issue for sport psychology (Gould & Krane, 1992; Hardy & Jones, 1990; Jones, 1995). In performance assessment, studies have often focused on outcome measures, such as winning versus losing. For example, in Gould, Petlichkoff, and Weinberg (1984) performance in wrestling bouts was measured solely in terms of winning and losing. Gould, Petlichkoff, Simons, and Vevera (1987) argued that such performance measurement is not standardized, because the standard of the opponent differs from bout to bout, making valid comparisons across bouts tenuous. In tennis, this is also true: one may play well one day, but lose to a higher-ranked opponent; conversely, one may play poorly, but win an easy match. As Weinberg (1990) noted, focusing solely on the outcome may mask the quality of the performance, and so does not necessarily reflect how well an individual has performed.

An alternative approach to performance measurement is to use process rather than outcome measures, as process measures may better reflect the task complexity of different sports. In creating a better understanding of how stressors might affect performance, Hockey and Hamilton (1983) suggested that stressors influence performance via various subcomponents or processes. Attention to such subcomponents or processes has paid dividends in research into the effects of anxiety on performance (Parfitt, Jones, & Hardy, 1990). More recently, Vealey (1992, 1994) has also called for more process-oriented measurement in sport psychology.

Tennis has provided some examples of alternative forms of performance assessment. Daw and Burton (1994) constructed tennis performance assessment instruments to reflect a player's self-reported general observation on how well he or she <u>tends</u> to play, and to assess perceptions of performance regarding mental skills only. The United Kingdom Lawn Tennis Association's unpublished Tactical-Technical Evaluation Sheet assesses aspects of tactics and technique. Mahoney, Gabriel, and Perkins (1987) assessed the psychological skills underlying exceptional athletic performance. All these examples provide more information regarding the range of factors that might underlie tennis performance, compared to outcome measures. In the present study, a refined version of a post-match measurement tool, first reported in Rees, Ingledew, and Hardy (1999), was used to examine the factors of tennis performance. Its structural validity was assessed using confirmatory factor analysis.

The issue of performance assessment was addressed by Rees et al. (1999) in studying the effects of social support upon tennis performance. Rees and associates piloted a post-match measure of perceived performance with tournament tennis players. Principal components analysis of this measure yielded eight factors, labeled: (1) Execution of (Flexible) Plan; (2) Loss of Composure; (3) Feeling Flat; (4) Positive Tension; (5) Worry; (6) Flow; (7) Effective Tactics; and (8) Double Faults. Execution of (Flexible) Plan represented having a plan of action which was sufficiently flexible to adapt to changing circumstances. Loss of Composure represented feelings of anger and frustration. Feeling Flat represented feeling sluggish, flat, and mentally tired. Positive Tension represented combined feelings of nervousness, determination and motivation. Worry represented feelings of hesitancy and worry regarding shots. Flow represented combined feelings of playing well and feeling good. Effective Tactics represented playing tactically well. Double Faults had just one item.

A sub-set of the players in the Rees et al. (1999) study had also completed the Interpersonal Support Evaluation List (Cohen, Mermelstein, Kamarck, & Hoberman, 1985), a multidimensional self-report measure of perceived functional social support, before their matches. Results demonstrated differential effects of the support dimensions on the performance factors. However, logistic regression analyses revealed no significant effects of the social support dimensions upon a winning versus losing outcome measure. Rees and associates, therefore, concluded that their exploratory research had identified effects of social support upon performance that were only apparent when attention was paid to the factors that might underlie performance.

Present Study

The purpose of the present study was to refine Rees et al.'s (1999) tennis performance assessment instrument, and to test its structural validity using confirmatory factor analysis and a new sample. Similarly to the Rees et al. study, it was also considered appropriate to examine whether players who won and players who lost differed on the confirmed factors.

Method

Scale Refinement

Initial scale refinement was based on the final principal components analysis reported by Rees et al. (1999). An item was selected for the present study if, in the Rees et al. study, it was a clear and unambiguous indicator of a factor. The following criteria were used: it had to have an absolute loading of at least .40 on one factor, and have absolute loadings at least .15 less on all other factors. In addition, as the factor Double Faults had only one item, it was removed, as such single-item factors are not generally considered good factors. This left Loss of Composure with five items, Execution of (Flexible) Plan and Flow with four items, Feeling Flat and Effective Tactics with three items, and Positive Tension and Worry with two items. Further new items were then theoretically derived and hypothesized to load on specific factors, so that each scale contained five items.

The revised instrument (see Appendix) was a 35-item checklist, reflecting the various criteria by which performance might be appraised. The instrument asked: "During this match, to what extent did you ...". Response options ranged on a 4-point scale from 0 to 3: from not at all;

through a little; and somewhat; to a lot. The instrument was given to participants immediately following their matches.

Participants

Participants were 155 full-time tennis players (147 males, 8 females; mean age 22.03, SD 7.94 years). The players (mostly British) ranged from players in the world top 200 to players with Lawn Tennis Association ratings not less than 3.1 (regional standard). They were recruited at various Lawn Tennis Association tournaments. They completed and returned the instrument on site.

The reason for choosing such high-level performers was that at this level a minor change in performance processes can be the difference between winning and losing. In this study, all players were considered "high-level" performers. Indeed, at the tournaments where the data were collected, players with rankings that were labeled as "regional" (i.e., 3.1) sometimes beat players with world rankings. Therefore, the difference in skill level was sometimes minimal. With lower standard performers, for whom skill level differs so much, the various processes tapped by this study's measurement instrument may make little difference to an overall result compared to skill level and may indeed not be of particular salience. Of the 155 sets of data, two were lost, due to listwise deletion for missing values.

Confirmatory Factor Analysis

The factorial validity of the performance instrument was tested by analyses of covariance structures, using LISREL 8 (Jöreskog & Sörbom, 1993). As the instrument was refined somewhat, it would be plausible and reasonable to re-use exploratory factor analysis (EFA) on this measure. However, following initial EFA in Rees et al. (1999), the process of refinement involved theoretically deriving new items in terms of content and the pattern of item-factor loadings. To test these hypotheses, the most effective method is to use confirmatory factor analysis (CFA) (Schutz & Gessaroli, 1993), as with EFA one cannot specify specific items to load on specific factors. Jöreskog and Sörbom (1993) argued that a hypothesis that has been largely derived through exploratory procedures should be confirmed using more rigorous procedures. They also argued that most studies are to an extent both exploratory and confirmatory, and CFA procedures can be used as a model generating tool, as opposed to being simply a strict confirmatory procedure (Jöreskog, 1993; Jöreskog & Sörbom, 1993).

The sequential model testing approach recommended by Jöreskog (1993) was adopted. Maximum likelihood estimation was employed.

The overall goodness of fit of the models was tested using the chi-square likelihood ratio statistic (χ^2), Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), Goodness of Fit Index (GFI), and Comparative Fit Index (CFI) (see Jaccard & Wan, 1996; Jöreskog & Sörbom, 1993). The criteria for evaluation of fit proposed by Jaccard and Wan (1996) were that the CFI and GFI should exceed 0.90, SRMR should be less than 0.05, and the RMSEA should be not greater than 0.05 with a related nonsignificant p value for close fit. RMSEA values of .05 or less generally indicate a close fit, values up to .08 indicate a reasonable error of approximation, and one would not want to use models with values greater than .10 (Browne and Cudeck, 1993).

Single-factor models. This first stage involved testing seven separate single-factor models corresponding to the seven performance scales. The purpose of this stage was to assess the convergent validity of the five items making up each scale. As well as examining the overall goodness of fit of the models, we examined the standardized residuals, the completely standardized factor loadings, and the modification indices for the covariances of the measurement errors. For example, a large positive standardized residual between two items would suggest that these items share more in common than the model allows; a large negative standardized residual between two items would suggest that these items share less in common than the model suggests. Similar diagnostic information is provided by the modification indices for the covariances between measurement errors.

Two-factor models. In the second stage of the analysis, each of the seven performance factors was paired with every other performance factor in two-factor models (a total of 21 pairings). Factors were allowed to correlate. The first purpose of this stage was to identify any ambiguous items. Therefore, as well as the overall goodness of fit of the models, the completely standardized factor loadings, the standardized residuals, and the modification indices for the covariances between measurement errors, we also examined the modification indices for the factor loadings. Large modification indices suggest that improvements in fit can be expected if items are allowed to cross-load on another factor. The second purpose was to investigate the discriminant validity of the factors. This was achieved by examining the 95% confidence interval (± 1.96 standard errors) around each correlation between factors. A confidence interval including 1.0 would suggest that the factors could be perfectly correlated and therefore lack discriminant validity (Anderson & Gerbing, 1988).

Based upon the diagnostic information from the single-factor and the two-factor stages, one item was deleted from each scale, and the single-factor and two-factor stages repeated with four items per scale. As a result of the process of item deletion, Positive Tension lost the item, “Feel nervous,” and was renamed Determination.

Full model. Finally, all seven performance factors, each represented by four items, were included in a full model. This model was assessed as in the second stage.

Multivariate analysis of variance was used to test whether players who won and players who lost differed on the confirmed factors.

Results

Single-Factor Models

Factor loadings and fit statistics for the final four-item single-factor models are shown in Table 1. New items are marked. Factor loadings were generally high, with the exception of two which were moderately low. These were "Adapt to changing circumstances" [loaded .32 on Execution of (Flexible) Plan] and "Become aggressive" (loaded .28 on Loss of Composure). Fits for the four-item models were excellent. The weakest was Flow. Whilst the RMSEA value for Flow was fairly high (< 0.10), the associated p-value (for RMSEA < 0.05) was nonsignificant. Apart from this, all other criteria for good fit were met for Flow. Fit statistics for the original five-item models are also shown.

Two-Factor Models

Fit statistics and correlations between factors for the final two-factor models are shown in Table 2. Fits were generally fairly good. The two weakest models involved the Feeling Flat factor (Feeling Flat with Determination, and Feeling Flat with Flow). For three of the correlations [Execution of (Flexible) Plan with Effective Tactics; Determination with Flow; Flow with Effective Tactics] the 95% confidence interval for the intercorrelation included figures close to 1.0, suggesting the possibility that those factors ought not to be separated. For one other correlation [Execution of (Flexible) Plan and Flow] the 95% confidence interval did indeed include 1.0. In all four of these cases, eight-item single-factor scales were tested, but provided poor fit. As a consequence of this and the fact that the items for these scales did appear to be measuring qualitatively different constructs, it was felt justifiable to maintain the distinction between these constructs.

Full Seven-Factor Model

Fit statistics for the full seven-factor model are also shown in Table 2. The ratio of χ^2 to degrees of freedom was less than two, and the RMSEA was low enough and the CFI was high enough to feel reasonably confident about the fit of the model to the data. However, the GFI was fairly low (0.83) and SRMR marginally too high (0.07), leading to some caution in accepting the model. Completely standardized factor loadings and factor-factor correlations for the full seven-factor model are shown in Table 3.

Winners versus Losers

Multivariate analysis of variance was conducted to see whether those who won and those who lost differed on the new scales. Results (see Table 4) showed that winners and losers did differ on the scales, Hotelling's $T^2 = .45$, $F(7, 118) = 7.68$, $p < .001$. Follow-up discriminant function analysis revealed that all scales were salient in this regard (i.e., standardized structure coefficients greater than 0.30 in absolute value, which Pedhazur, 1982, regards as meaningful). However, Effective Tactics, Flow, and Loss of Composure were more salient than the others. On all scales, winners had more favorable scores than losers (i.e., scored higher for scales with positive connotations, scored lower for scales with negative connotations).

Discussion

The first aim of this research was to refine the original performance assessment instrument of Rees et al. (1999). This involved removal of low loading and ambiguous items, and the removal of one factor, Double Faults, which had only one item indicator. Twelve new items were then theoretically derived and hypothesized to load on specific factors, so that each scale contained five items. The revised instrument was a 35-item checklist, reflecting the various criteria by which performance might be assessed.

The second aim of this research was to test the structural validity of this refined instrument using confirmatory factor analytic procedures. The factor structure was essentially confirmed, using the sequential model testing approach. At the same time, each scale was reduced from five to the best four items. Although the test of the full model did reveal a reasonable fit to the data, the SRMR was marginally too high and the GFI was fairly low. The low GFI was probably a result of the relatively small sample size, as, whilst the GFI calculation does not explicitly use N in its calculation, it has been shown to be adversely affected by small sample sizes (Marsh, Balla, & McDonald, 1988). The relatively small sample size in this study is a natural function of a lack of tennis players of this caliber. If one were to use a lower standard, then one could more easily increase the numbers of participants. Despite this reservation, the present series of analyses demonstrate that much information about the factorial validity of an instrument can be gained using the sequential approach to model testing. Indeed, such attention to detail at the single- and two-factor stages may be more effective in helping to diagnose problems in structure than simply testing the full seven-factor structure, with its many degrees of freedom.

The discriminant validity of the measurement instrument was tested across winners and losers. As in Rees et al. (1999), the performance scales did distinguish winners from losers. In the present study, all seven performance scales were salient in this regard, although Effective Tactics, Flow, and Loss of Composure were the most salient, with winners having overall more favorable scores than losers. In light of these findings, it is interesting to speculate on the problem of disentangling cause and effect. Did players win or lose as a result of executing certain performance processes well or poorly? Or, were the answers on the measurement instruments more a reflection of the players' frame of mind (positive or negative) following a win or a loss? This is a problem for all retrospective measures, and further research is needed to confirm the current measure's predictive validity in this respect. One way to test such predictive validity might be to conduct process oriented goal setting, based upon individuals' scale scores, and examine the effect of this goal setting upon performance. Certainly, were this measure to be used in an applied setting, one might argue that one should not give the player the measurement instrument immediately following a match, but wait until the player has had time to come to terms with the win or loss. Vallerand's (1987) intuitive-reflective appraisal model would suggest that, given time, the player would be able to reflect on the win or loss in a less emotional way. This may, of course, lead to problems of recall, although there is evidence that athletes can accurately recall anxiety feelings two days following a competition (Harger & Raglin, 1994).

This research and the original study by Rees et al. (1999) further point to the need for performers to look at the various factors comprising overall performance - in a sense, the processes by which they come to achieve their successes. It is potentially problematic when a performer concentrates solely on the outcome of an event at the expense of the process by which he or she arrives at the outcome (Hardy, Jones, & Gould, 1996). After the event, a focus on outcomes, such as winning versus losing, may mask the quality of the performance (Weinberg, 1990), so that it is difficult to pinpoint areas which need improving. On the other hand, focusing on process-oriented goals has been found to lead to better concentration, increased self-efficacy, and more control over negative experiences (Kingston & Hardy, 1997). Such influences as these are thought to lead to improvements in performance and ultimately to more successful outcomes. In actuality, to reach a high level in sport, performers probably need to have a strong desire to beat the opposition and so do set outcome goals (Hardy, 1997; Hardy et al., 1996). However, process goals may help to keep the performer focused on the task at hand and in the here and now (see, for example, Hardy et al., 1996).

In light of the numerous calls for improved performance measurement in the sport psychology literature and encouraging use of multi-component performance assessment (see

Introduction), future research should continue to adopt a more process-oriented and differentiated approach to performance assessment. Despite some reservations in terms of the fit of the full model, the performance measure highlighted in this study should be seen as a refinement of the measure in Rees et al. (1999). It addresses one of the concerns regarding outcome performance measurement, namely differentiation of performance factors/processes. Future research might examine the sensitivity of the measure; for example, to the use of different process oriented goals. Once validated, multidimensional performance assessment instruments such as the present one should aid in pinpointing areas of strength and weakness, and may better explain the effects of predictor variables, such as stress and social support.

References

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. Psychological Bulletin, 103, 411-423.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen & J. S. Long (Eds.), Testing structural equation models (pp. 136-162). Newbury Park, CA: Sage.

Cohen, S., Mermelstein, R., Kamarck, T., & Hoberman, H. (1985). Measuring the functional components of social support. In I. G. Sarason & B. R. Sarason (Eds.), Social support: Theory, research, and applications (pp. 73-94). Dordrecht: Martinus Nijhoff.

Daw, J., & Burton, D. (1994). Evaluation of a comprehensive psychological skills training program for collegiate tennis players. The Sport Psychologist, 8, 37-57.

Gould, D., & Krane, V. (1992). The arousal-athletic performance relationship: Current status and future directions. In T. S. Horn (Ed.), Advances in sport psychology (pp. 119-141). Champaign, IL: Human Kinetics.

Gould, D., Petlichkoff, L., Simons, J., & Vevera, M. (1987). Relationship between Competitive State Anxiety Inventory-2 subscale scores and pistol shooting performance. Journal of Sport Psychology, 9, 33-42.

Gould, D., Petlichkoff, L., & Weinberg, R. S. (1984). Antecedents of, temporal changes in, and relationships between CSAI-2 subcomponents. Journal of Sport Psychology, 6, 289-304.

Hardy, L. (1997). The Coleman Roberts Griffith address: Three myths about applied consultancy work. Journal of Applied Sport Psychology, 9, 277-294.

Hardy, L., & Jones, G. (1990). Future directions for research into stress in sport. In G. Jones & L. Hardy (Eds.), Stress and performance in sport (pp. 281-296). Chichester: Wiley.

Hardy, L., Jones, G., & Gould, D. (1996). Understanding psychological preparation for sport: Theory and practice of elite performers. Chichester: Wiley.

Harger, G. J., & Raglin, J. S. (1994). Correspondence between actual and recalled precompetition anxiety in collegiate track and field athletes. Journal of Sport and Exercise Psychology, 16, 206-211.

Hockey, G. R. J., & Hamilton, P. (1983). The cognitive patterning of stress states. In G. R. J. Hockey (Ed.), Stress and fatigue in human performance (pp. 331-362). Chichester: Wiley.

Jaccard, J., & Wan, C. K. (1996). LISREL approaches to interaction effects in multiple regression (Quantitative Applications in the Social Sciences No. 114). Thousand Oaks, CA: Sage.

Jones, G. (1995). More than just a game: Research developments and issues in competitive anxiety in sport. British Journal of Psychology, 86, 449-478.

Jöreskog, K. G. (1993). Testing structural equation models. In K. A. Bollen & J. S. Long (Eds.), Testing structural equation models (pp. 294-316). Newbury Park, CA: Sage.

Jöreskog, K. G., & Sörbom, D. (1993). LISREL 8 user's reference guide. Chicago, IL: Scientific Software International.

Kingston, K. M., & Hardy, L. (1997). Effects of different types of goals on processes that support performance. The Sport Psychologist, 11, 277-293.

Mahoney, M. J., Gabriel, T. J., & Perkins, T. S. (1987). Psychological skills and exceptional athletic performance. The Sport Psychologist, 1, 181-199.

Marsh, H. W., Balla, J. R., & McDonald, R. P. (1988). Goodness of fit indexes in confirmatory factor analysis: The effect of sample size. Psychological Bulletin, 103, 391-410.

Parfitt, C. G., Jones, G., & Hardy, L. (1990). Multidimensional anxiety and performance. In G. Jones & L. Hardy (Eds.), Stress and performance in sport (pp. 43-80). Chichester: Wiley.

Pedhazur, E. J. (1982). Multiple regression in behavioral research. New York: Holt, Rinehart, & Winston.

Rees, T., Ingledew, D. K., & Hardy, L. (1999). Social support dimensions and components of performance in tennis. Journal of Sports Sciences, 17, 421-429.

Schutz, R. W., & Gessaroli, M. E. (1993). Use, misuse, and disuse of psychometrics in sport psychology research. In R. N. Singer, M. Murphey & L. K. Tennant (Eds.), Handbook of research on sport psychology (pp. 901-917). New York: Macmillan.

Vallerand, R. J. (1987). Antecedents of self-related affects in sport: Preliminary evidence on the intuitive-reflective appraisal model. Journal of Sport Psychology, 9, 161-182.

Vealey, R. (1992). Personality and sport: A comprehensive view. In T. S. Horn (Ed.), Advances in sport psychology (pp. 25-59). Champaign, IL: Human Kinetics.

Vealey, R. (1994). Knowledge development and implementation in sport psychology: A review of The Sport Psychologist, 1987-1992. The Sport Psychologist, 8, 331-348.

Weinberg, R. S. (1990). Anxiety and motor performance: Where to go from here? Anxiety Research, 2, 227-242.

Table 1

Fits and factor loadings for single-factor models

Factor/ Items	Loading	χ^2	d.f.	$p(\chi^2)$	RMSEA	p value (for RMSEA <0.05)	GFI	SRMR	CFI
Execution of (Flexible) Plan/		1.15	2	.56	0.00	.67	1.00	0.02	1.00
Keep to a routine	.65								
Plan each point	.63								
Adapt to changing circumstances	.32								
Use breaks in play to prepare for the next point or game (new)	.61								
Original model with "Solve problems as they occurred"		11.52	5	.04	0.11	.10	.96	0.06	.92
Loss of Composure/		1.82	2	.40	0.00	.53	.99	0.02	1.00
Get wound up	.80								
Get angry	.88								
Let errors bother you	.64								
Become aggressive	.28								
Original model with "Fret about mistakes"		21.18	5	.00	0.17	.00	.92	0.05	.92
Feeling Flat/		0.09	2	.96	0.00	.97	1.00	0.00	1.00
Feel sluggish	.89								
Feel mentally tired	.51								
Feel lively	-.74								
Feel slow (new)	.68								
Original model with "Feel sharp" (new)		18.94	5	.00	0.16	.01	.93	0.06	.94

(table continues)

Factor/ Items	Loading	χ^2	d.f.	p(χ^2)	RMSEA	p value (i.e. RMSEA <0.05)	GFI	SRMR	CFI
Determination/		1.69	2	.43	0.00	.55	.99	0.02	1.00
Work hard on each point	.76								
Feel determined (new)	.82								
Run down every ball (new)	.82								
Give up on some points (new)	-.49								
Original model with "Feel nervous"		2.83	5	.73	0.00	.82	.99	0.02	1.00
Worry/		0.02	2	.99	0.00	.99	1.00	0.00	1.00
Worry about your shots	.58								
Become hesitant	.67								
Feel tense (new)	.72								
Not always think positively (new)	.65								
Original model with "Play very cautiously" (new)		4.41	5	.49	0.00	.64	.98	0.03	1.00
Flow/		4.87	2	.09	0.10	.17	.98	0.03	.98
Keep a consistent standard	.66								
Feel good	.70								
Keep your mind on the present	.68								
Stay focused but relaxed (new)	.69								
Original model with "Enjoy yourself"		11.73	5	.04	0.11	.10	.96	0.05	.96

(table continues)

Factor/ Items	Loading	χ^2	d.f.	p(χ^2)	RMSEA	p value (i.e. RMSEA <0.05)	GFI	SRMR	CFI
Effective Tactics/		1.71	2	.43	0.00	.55	.99	0.01	1.00
Use effective strategies	.88								
Employ good tactics	.92								
Keep up the pressure on your opponent	.77								
Play tactically well (new)	.91								
Original model with "Control the match" (new)		14.57	5	.01	0.13	.04	.95	0.03	.98

Note. N = 153. RMSEA = Root Mean Square Error of Approximation. GFI = Goodness of Fit Index. SRMR = Standardized Root Mean Square Residual. CFI = Comparative Fit Index.

Table 2

Fit measures for two-factor models and full seven-factor model

Scale	χ^2	d.f.	p(χ^2)	RMSEA	p value (for RMSEA <0.05)	GFI	SRMR	CFI	Correlations between factors (standard error)
Execution of (Flexible) Plan and Loss of Composure	27.94	19	.09	0.06	.38	.96	0.06	.97	-.39(.09)
Execution of (Flexible) Plan and Feeling Flat	23.22	19	.23	0.04	.61	.96	0.05	.99	-.52(.09)
Execution of (Flexible) Plan and Determination	19.42	19	.43	0.01	.79	.97	0.04	1.00	.77(.06)
Execution of (Flexible) Plan and Worry	20.02	19	.39	0.02	.76	.97	0.05	1.00	-.37(.10)
Execution of (Flexible) Plan and Flow	21.80	19	.29	0.03	.68	.97	0.04	.99	.89(.06)
Execution of (Flexible) Plan and Effective Tactics	32.59	19	.03	0.07	.21	.95	0.04	.98	.88(.05)
Loss of Composure and Feeling Flat	37.84	19	.01	0.08	.09	.95	0.07	.95	.37(.08)
Loss of Composure and Determination	26.65	19	.11	0.05	.44	.96	0.06	.98	-.39(.08)
Loss of Composure and Worry	24.04	19	.19	0.04	.57	.96	0.05	.99	.70(.06)
Loss of Composure and Flow	37.26	19	.01	0.08	.10	.94	0.07	.95	-.64(.07)
Loss of Composure and Effective Tactics	32.59	19	.03	0.07	.21	.95	0.07	.98	-.45(.07)
Feeling Flat and Determination	44.65	19	.00	0.09	.02	.93	0.06	.95	-.57(.07)
Feeling Flat and Worry	19.41	19	.43	0.01	.79	.97	0.05	1.00	.42(.09)
Feeling Flat and Flow	46.15	19	.00	0.10	.02	.93	0.06	.93	-.62(.07)
Feeling Flat and Effective Tactics	21.41	19	.31	0.03	.70	.97	0.04	1.00	-.32(.07)
Determination and Worry	29.95	19	.05	0.06	.30	.96	0.06	.97	-.31(.09)
Determination and Flow	28.74	19	.07	0.06	.35	.96	0.04	.98	.80(.05)
Determination and Effective Tactics	19.33	19	.44	0.01	.79	.97	0.03	1.00	.28(.05)
Worry and Flow	26.34	19	.12	0.05	.45	.96	0.05	.98	-.58(.08)
Worry and Effective Tactics	14.52	19	.75	0.00	.95	.98	0.03	1.00	-.48(.08)
Flow and Effective Tactics	41.82	19	.00	0.09	.04	.94	0.04	.97	.85(.04)
Full seven-factor model	486.70	329	.00	0.05	.55	.83	0.07	.92	

Note. N = 153

Table 3

Completely standardized solution for the full seven-factor model

	Factor						
	1	2	3	4	5	6	7
Items	Item-factor loadings						
1. Keep to a routine	.66						
9. Plan each point	.57						
15. Adapt to changing circumstances	.42						
29. Use breaks in play to prepare for the next point or game	.57						
2. Get wound up		.79					
8. Get angry		.87					
23. Let errors bother you		.68					
30. Become aggressive		.27					
3. Feel sluggish			.82				
10. Feel mentally tired			.51				
17. Feel lively			-.81				
31. Feel slow			.68				
4. Work hard on each point				.75			
18. Feel determined				.86			
25. Run down every ball				.79			
32. Give up on some points				-.47			
5. Worry about your shots					.63		
14. Become hesitant					.67		
20. Feel tense					.68		
34. Not always think positively					.64		

(table continues)

	Factor						
	1	2	3	4	5	6	7
Items	Item-factor loadings						
6. Keep a consistent standard						.58	
13. Feel good						.72	
27. Keep your mind on the present						.61	
33. Stay focused but relaxed						.78	
7. Use effective strategies							.89
12. Employ good tactics							.91
21. Keep up the pressure on your opponent							.78
28. Play tactically well							.91
Factor	Factor-factor correlations						
1. Execution of (Flexible) Plan	1.00						
2. Loss of Composure	-.39	1.00					
3. Feeling Flat	-.55	.38	1.00				
4. Determination	.78	-.40	-.57	1.00			
5. Worry	-.38	.69	.43	-.30	1.00		
6. Flow	.90	-.65	-.62	.79	-.59	1.00	
7. Effective Tactics	.88	-.45	-.49	.64	-.49	.85	1.00

Note. N = 153

Table 4

Multivariate analysis comparing winners and losers on performance scales

Scale	M (SD) Winners	M (SD) Losers	Standardized structure coefficient
Execution of (Flexible) Plan	7.13 (2.01)	5.92 (2.52)	.40
Loss of Composure	4.36 (2.70)	6.29 (2.87)	-.52
Feeling Flat	3.43 (2.81)	4.83 (3.24)	-.35
Determination	10.40 (2.26)	9.10 (2.62)	.40
Worry	4.09 (2.53)	5.53 (2.58)	-.42
Flow	8.15 (2.48)	6.12 (2.83)	.57
Effective Tactics	8.67 (2.63)	5.29 (2.87)	.92

Note. $N = 126$. Hotelling's $T^2 = .46$, $F(7, 118) = 7.68$, $p < .001$

Appendix

Original Performance Assessment Instrument

NAME		DATE
AGE	SEX	RATING

YOUR PERFORMANCE

Below are various ways in which you might judge how well you performed in a match. Please read each one and rate the extent to which it applies to the match you have just played.

0 = not at all
1 = a little
2 = somewhat
3 = a lot

During this match, to what extent did you ...

		not at all			a lot
1.	keep to a routine	0	1	2	3
2.	get wound up	0	1	2	3
3.	feel sluggish	0	1	2	3
4.	work hard on each point	0	1	2	3
5.	worry about your shots	0	1	2	3
6.	keep a consistent standard	0	1	2	3
7.	use effective strategies	0	1	2	3
8.	get angry	0	1	2	3
9.	plan each point	0	1	2	3
10.	feel mentally tired	0	1	2	3
11.	feel nervous	0	1	2	3
12.	employ good tactics	0	1	2	3

(Appendix continues)

13.	feel good	0	1	2	3
14.	become hesitant	0	1	2	3
15.	adapt to changing circumstances	0	1	2	3
16.	fret about mistakes	0	1	2	3
17.	feel lively	0	1	2	3
18.	feel determined	0	1	2	3
19.	enjoy yourself	0	1	2	3
20.	feel tense	0	1	2	3
21.	keep up the pressure on your opponent	0	1	2	3
22.	solve problems as they occurred	0	1	2	3
23.	let errors bother you	0	1	2	3
24.	feel sharp	0	1	2	3
25.	run down every ball	0	1	2	3
26.	play very cautiously	0	1	2	3
27.	keep your mind on the present	0	1	2	3
28.	play tactically well	0	1	2	3
29.	use breaks in play to prepare for the next point or game	0	1	2	3
30.	become aggressive	0	1	2	3
31.	feel slow	0	1	2	3
32.	give up on some points	0	1	2	3
33.	stay focused but relaxed	0	1	2	3
34.	not always think positively	0	1	2	3
35.	control the match	0	1	2	3