Reproducibility and Efficacy of the Performance Profile Technique

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The purpose of this study was to examine the day-to-day reproducibility and efficacy of the performance-profile technique for effective discrimination of subtle self-perceived changes in performance. A total of 68 (38 male, 30 female) team players and individual athletes competing at varsity to national levels (age 21.4 ± 1.7 years, mean ± SD) gave informed consent to participate in the study. Athletes generated individualized performance profiles recording 10 to 15 qualities that he or she considered most important for sport performance. Participants undertook four practice and three daily experimental trial completions of this profile, which recorded their self-perception of current capability. Results of separate one-way analyses of variance with repeated measures revealed no significant differences in perceived profile ratings across the three experimental trials. This result suggests that intrasubject changes in performance-profile scores could be attributed to sources of random human variability, rather than to systematic learning. Group mean coefficient of variation scores indicated that the performance profile technique has limited measurement precision and efficacy when attempting the discrimination of subtle prognostic markers of deterioration in perceived performance using single-trial assessments. The mean score of 10 completions of the profile would be necessary to achieve arbitrary measurement precision of better than ± 5% (95% confidence levels).

Keywords: performance profiling, measurement precision, reproducibility

Introduction

Coaches, psychologists, physiologists, biomechanists, and clinicians are practitioners who frequently support successful sports performers. It has been the practitioner who has usually taken the lead in planning and organizing a program to ameliorate weaknesses that may have been identified in the athlete's capability. However, the athlete's relatively passive role in this process may lead to problems of adherence and effectiveness during the proposed training program (Butler & Hardy 1992). The performance-profile technique has been proposed as a means of overcoming such problems (Butler & Hardy 1992).

The performance profile (Butler 1989) reflects the selected principles of Personal Construct Theory (Kelly 1955), and takes the perspective of the individual to be fundamental. The profile allows the performer to construct a visual display of himself or herself in terms that are germane, allowing the performer to have an active role in the decision about where to focus attention in order to improve performance (Butler & Hardy 1992). The use of the performance profile has spread rapidly

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to several sports and is now widely used by a range of practitioners, including those offering sports medical support to the performer. It is often used as the first step in designing a training program that is oriented to the development of physical, technical, or psychological skills. The performance-profile technique may also offer important insights into self-perceived changes in performance capability that could act as subtle prognostic indicators of musculoskeletal injury, if it could be shown that this technique was capable of offering a suitable degree of measurement precision.

Only recently has the validity of the technique been objectively evaluated. Doyle and Parfitt (1996) found progressively stronger support for the predictive validity of the profile, as asymptomatic athletes competing in track-and-field events progressed during a season of competition. For example, during the first competition of the season, linear regression analyses indicated that the areas of perceived need identified by the profile were unable to predict the actual performance capability, the athlete's perception of performance scores, or the coach's perception of performance scores. In contrast, by the third competition of the season, the areas of perceived need identified by the profile were significantly predictive of actual performance capability and the perception of performance scores, both by the athlete and the coach, accounting for as much as 75% of the variance. These findings may indicate the effect of a continuous learning process in which the athlete is able to rate his or her current condition more precisely. In a more recent study, Doyle and Parfitt (1997) found moderate support for the construct validity of the performance-profile technique in a competitive elite population of athletes. Furthermore, the findings of this study suggested that practitioners should be aware of potential imprecision of prediction associated with the use of the technique, and that this should be an especially important consideration during periods of conditioning, in which only small changes in performance capability and perceived need might be expected.

An important purpose of the performance profile would be to provide practitioners with a precise estimate of performers' perceived current condition. Measurement precision in this context may be defined as the consistency of current condition ratings across repeated completions of the performance profile under the same experimental conditions (Vincent 1994). The effects of learning during this process may be a major influence on the assessment of measurement precision (Thomas & Nelson 1996; Vincent 1996; Sale 1991). The learning process would be expected to include both adjustment to the total assessment environment, including the physical location and social context in which the profile is completed, and accommodation to the specific demands of the profile technique such as the necessary instructions and categories of response.

The assessment of measurement precision is best achieved subsequent to this adjustment and accommodation phase, when repeated completions of the profile under the same conditions elicit no additional statistically significant changes in scores. Any subsequent changes in the rating scores on the performance profile can be attributed to random daily physiologic variation or error, rather than to the effects of systematic learning. Smaller variations in such rating scores would be indicative of greater precision or reproducibility for this technique (Thomas & Nelson, 1996; Sale, 1991; Verducci 1980). Large variability of response or measurement error is considered to be a threat to the proper interpretation of the performer's current state, by masking subtle but potentially important changes in performance. This threat would also probably hinder the implementation of strategies to effectively enhance performance. The coefficient of variation (CV) has been commonly used as a measure of acute variability associated with repeated assessments of the responses of the same individual (Gleeson & Mercer 1996, 1992). Despite the increasing popularity of the performance-profile technique, the reproducibility of the technique has not yet been evaluated objectively. Additionally, the fundamental question of how many completions of the profile by a performer are needed to establish a reliable and precise measure of the individual's current condition has not yet been addressed.

Assessment of perceived performance during rehabilitative-conditioning programs would be expected to offer an environment that is conducive to efficacy of measurement for the performance profile because of the relatively greater changes in performance capability that would probably occur. In contrast, it might also be expected that the precise discrimination of subtle self-perceived changes in performance capability, which may only barely exceed those associated with random physiologic variation in performance, would offer the greatest challenge to the efficacy of measurement. An example of this latter environment for measurement might involve the athlete seeking either performance improvement or avoidance of injury during the season of competition, and showing only commensurately small levels of self-perceived performance enhancement or degradation, respectively.

The primary purpose of this study was to assess the reproducibility and single-measurement reliability of the performance-profile technique in asymptomatic sports performers. A secondary aim of the study was to investigate the accommodation response to performance profiling.

Methods

Participants

Giving their informed consent to participate in the study, 68 (38 male, 30 female) competitive intercollegiate and recreational athletes who participated were also sports-science students. Participants ranged in age from 18–35 years with a mean age of 21.4 years (SD ± 1.7). The sample consisted of team players (n = 36) and individual athletes (n = 32). Team-game athletes consisted of 3 national (2 soccer, 1 hockey), 10 county-regional (3 hockey, 3 basketball, 2 soccer, 1 netball, and 1 rugby), and 23 varsity or club, level performers (7 hockey, 7 soccer, 4 rugby, 2 netball, 2 basketball, and 1 volleyball). Individual athletes consisted of 4 national (4 track and field), 10 regional-county (6 track and field, 2 badminton, 1 tennis, and 1 squash), 11 varsity or club (5 track and field, 4 badminton, and 2 squash), and 7 recreational level performers (4 rock climbers, 1 weight trainer, 1 aerobics athlete, and 1 squash player). This was the first application of the conventional performance-profile technique for this group of participants.

Procedure

Performance profiling was introduced to all participants during a group 'brainstorming' session. It was presented as a means to clarify each participant's perception of the demands of sporting performance. To illustrate the basic procedure, examples of completed profiles were shown to the participants. It was explained that there were no correct or incorrect answers but that the technique attempts to discover what the participant considers important. The participants were divided into sport-related groups of four to six individuals and asked to consider the question, "What, in your opinion, are the qualities or characteristics of an ideal sports performer in your particular sport or event?" After 5–10 minutes, the qualities generated by each subgroup were recorded and shared with the entire group. The contributions of respected individuals such as an accomplished performer, coach, physiologist, or sport psychologist were added to generate a broad range of qualities. The task for each participant was to select and record 10 to 15 qualities that he or she considered important for his or her sporting event and performance, and to label these using their own terminology. Bannister and Fransella (1986) acknowledged that, when constructing performance profiles, it is important to use the labels created by the performer to ensure that the profile accurately reflects what the performer perceives individually to be important to an accomplished performance. A variety of personalized descriptions for qualities that participants perceived to be important to an accomplished performance could be selected for inclusion within the individualized performance profile; these descriptions range from "confidence," "strength," "speed," and "mentally tough" in the example profile in this article, to "entry point," "right foot contact," "explode," and "bang."

Participants were also asked to consider, "How important are each of the qualities you have listed to the ideal sports participant?" A response scale ranging from 1 (not important at all) to 10 (of crucial importance) was used. The qualities and importance scores identified by each participant were then mapped onto an individualized visual performance profile by the researcher (Figure 1). The exact descriptions generated by each participant were displayed around the perimeter of the profile. Participants were required to retain the same qualities and labels within their performance profile throughout the period of this study. Importance scores were indicated with a rating of 10 shown at the perimeter of the profile, with ratings becoming progressively lower toward the center.

Participants practiced completing their profiles on four occasions before the collection of data. To complete the profile, each participant was asked to evaluate, "Where would you rate yourself at the present time on each of the qualities you have listed?" They recorded their responses by coloring an area of the profile corresponding to the response scale of 1 (could not be any worse) to 10 (could not be any better) (Figure 1). This practice period of profiling was used to account for the possibility of a learning effect intruding on the precision of profiling (Doyle & Parfitt 1996). Four practice completions of the profile were performed to verify that participants had accommodated to performance profiling before the subsequent completion and analysis of trial data by means of repeated-measures analysis of variance (ANOVA).

Participants were asked to complete their profile using the same protocol on three separate occasions during a period of 3 days. The first occasion was at 10:00 AM on the first day of data collection; the second was 1 hour later (11:00 AM) on the same day, and the third was at 10:00 AM, 2 days later. Data sheets were collected after each completion of the profile. The timing of the data collection reflects academic lecture sessions in which a researcher had access to the full cohort of participants in a controlled environment. All participants received the same informational lecture between the first and second completions of the profile. It was expected that the immediate collection of profiles from the participants following the first of the completions and the diversion of a lecture before the completion of the second profile would minimize the interference of potential recall of previous profile responses.

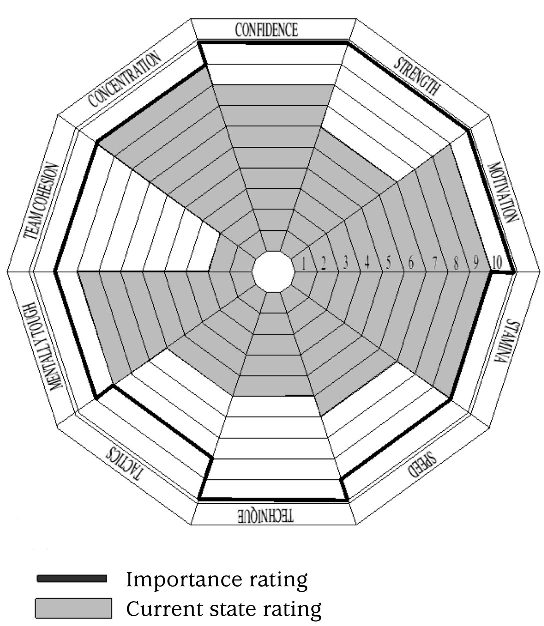

Fig. 1 Example of a completed performance profile. The exact labels generated by each participant were displayed around the perimeter of the profile. Importance scores were indicated, with a rating of 10 shown at the perimeter of the profile and ratings becoming progressively lower toward the center.

Data analysis

Three performers were unavailable on the second day of data collection and did not complete their profiles on this occasion. Therefore, statistical analyses were performed on a total of 65 performers. Consistent with previous research (Doyle & Parfitt 1999, 1997, 1996), each participant's performance profile was reduced to the 10 most important qualities for data analysis. The importance score given to each quality by the participant identified these qualities. In the event of tied importance ratings, qualities were chosen randomly from those with the same ratings for a given individual. For statistical analyses, the 10 qualities on each individual's performance profile were separately analyzed. Each individual performer completed his or her individualized performance profile on three occasions. The 10 profile qualities chosen by each individual performer remained constant across the three occasions, so that performers repeatedly rated the same qualities on each occasion. The relative importance of qualities labeled 1 to 10 was consistent across performers.

Accommodation response to performance profiling

Absolute scores for each of the 10 qualities on each participant's performance profile were compared across the three data collection occasions using repeated-measures ANOVA. This procedure was used to identify whether or not the practice period for the performance profile, incorporating four completions of the profile, was sufficient for participants to have adjusted to the technique. Under such circumstances, subsequent performances of participants would be influenced only by random physiologic variability, rather than by evidence of systematic residual effects between trials, such as learning. Parametric analyses were selected for application to data recorded at an integer level of scoring in preference to nonparametric equivalents, to allow more powerful exploratory hypothesis testing.

Intraindividual comparisons of profile ratings

The variability or random measurement error of the perceived profile ratings was assessed using CV for repeated completions of the profile by the same individual. This index has been used effectively in intrasubject designs (Mercer & Gleeson 2002) and, therefore, reflects an estimate of measurement variability and precision that is congruent with both the individualized nature of the performance-profile technique and its probable use to monitor perceived performance changes of individual athletes, both injured and uninjured. Furthermore, the CV index was chosen in preference to other potential indices of reliability and reproducibility, such as intraclass correlation coefficients and standard errors of the measurement, due to its potential independence from the influence of intragroup heterogeneity of performance (Mercer & Gleeson 2002). Thus, separate CV scores were calculated for each of the 10 qualities on each individual's performance profile. This index, corrected for small-sample bias (Sokal & Rohlf 1981), was calculated according to the expression (SD/mean) × (1 + [1/4n]) × 100, where mean and SD are the mean and standard deviation of the perceived ratings by the same individual on a profile quality across the three occasions (n = 3). To quantify both the mean variability response and intragroup heterogeneity across the three completions of the performance profile, group mean CV scores (± SD) were then calculated for each of the 10 qualities by summing the 65 individual CV scores and dividing by 65 for each separate quality.

Precision of measurement and serial profile completions

The group mean CV scores at 95% confidence levels (i.e. 1.96[CV]) were used as the basis from which to quantify the number of intrasubject completions of the profile that would be required to attain a criterion measurement precision of better than ± 5%. The latter was chosen to reflect the expected small changes in some of the qualities likely to be chosen by the performers, such as strength performance, during the season of competition (Gleeson & Mercer 1996), whereas the computation of 95% confidence intervals in preference to the 68% confidence intervals associated routinely with the CV facilitated a better appreciation of the probable extremes of variation of performance-profile scores that could be expected over repeated completions. The group mean score for each quality was used as an indication of the average response during estimates for the number of replicates needed to improve on this level of measurement error. In accordance with the Central Limit Theorem, estimated error of the mean score of multiple completions of the profile would be expected to vary inversely with the square root of the number of intrasubject completions, assuming a normal distribution of the scores (Winer 1981). Using this assumption, the number of intrasubject completions of the profile required to obtain a measurement precision of better than ± 5% about the group mean score for each of the 10 profile qualities were calculated.

Manual frequency count

A manual frequency count was also performed to assess deviation from the first profile rating on the second and the third profiles. This count was performed as an alternative method to evaluate the degree of fluctuation from the original profile ratings.

Results

Accommodation response to performance profiling

Results of the 10 separate repeated-measures one-way ANOVAs revealed no significant differences in perceived profile ratings across the three trials for any of the 10 qualities. The group means and standard deviations across the three occasions and the associated F values for each of the 10 profile qualities are shown in Table 1.

Intraindividual comparisons of profile ratings

Table 2 shows the group mean CV scores for the 10 profile qualities across the three profile occasions, at 68% and 95% confidence levels for a single profile completion. The CV scores for the 10 profile qualities ranged from ±4.7% to ±6.8%, and ±9.2% to ±13.3% for 68% and 95% confidence levels, respectively. The CV scores associated with 5 and 10 repeated intrasubject completions of the profile on each quality are also shown

Table 1. Statistical comparison of athletes' perceived ratings across three occasions on 10 profile qualities*

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Mean	7.55	7.65	7.56	7.32	7.79	7.48	7.28	7.42	7.51	7.67
SD	1.35	1.18	1.27	1.11	1.16	1.25	1.12	1.19	1.21	1.09
F	0.33	0.14	1.80	1.20	0.15	0.50	0.36	0.60	0.38	0.47
p	0.72	0.87	0.19	0.30	0.86	0.61	0.70	0.55	0.68	0.63

*Group means ($n = 65$), standard deviations, and F values from repeated-measures one-way ANOVAs, of perceived ratings across the three occasions for each of the 10 profile qualities (Q1–Q10).

Table 2. Statistical comparison of athletes' CV scores across three occasions and expected CV associated with 5 and 10 repeated intrasubject profile completions on 10 profile qualities*

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
CV (%)										
68%	± 4.9	± 5.0	± 5.5	± 4.8	± 4.7	± 4.9	± 6.8	± 4.7	± 4.9	± 5.2
95%	± 9.6	± 9.7	± 10.9	± 9.5	± 9.2	± 9.7	± 13.3	± 9.2	± 9.6	± 10.1
CV_5 (%)										
68%	± 2.2	± 2.2	± 2.5	± 2.2	± 2.1	± 2.2	± 3.0	± 2.1	± 2.2	± 2.3
95%	± 4.3	± 4.4	± 4.8	± 4.2	± 4.1	± 4.3	± 5.9	± 4.1	± 4.3	± 4.5
CV_{10} (%)										
68%	± 1.6	± 1.6	± 1.7	± 1.5	± 1.5	± 1.6	± 2.1	± 1.5	± 1.5	± 1.6
95%	± 3.0	± 3.1	± 3.4	± 3.0	± 2.9	± 3.1	± 4.2	± 2.9	± 3.0	± 3.2

*Group means ($n = 65$) for CV scores at 68% and 95% confidence levels across the three occasions and expected CV associated with 5 [CV_5] and 10 [CV_{10}] repeated intrasubject profile completions for each of the 10 profile qualities (Q1–Q10).

in Table 2. From this table, it can be seen that a group mean CV score of ±9.6% was calculated (95% confidence levels) for Quality 1. Using the assumptions of the Central Limit Theorem (Winer 1981), five intrasubject completions for Quality 1 would be required to obtain the criterion measurement error of better than ±5% at 95% confidence levels (i.e., $9.6/\sqrt{5} = \pm 4.29\%$).

Manual frequency count

The frequency count of the deviations from the first profile rating is displayed in Figure 2. Of the total sample of 68 participants, 3 did not complete their profiles on the third occasion. Thus, 65 participants had two occasions where their ratings could deviate from their first profile completion on each of the 10 qualities included on the profile (65 participants × 2 occasions × 10 qualities = 1,300 possible deviations). Three participants had one occasion where their ratings could deviate from their first profile completion on each of the 10 qualities included on the profile (3 participants × 1 occasion × 10 qualities = 30 possible deviations). Therefore, a total of 1,330 deviations from the initial rating of profile qualities were possible within this sample. The degree of these deviations is shown in Figure 2. The data seem to be normally distributed, with almost 54% of the total ratings ($n = 717$) not deviating from the first profile rating on the response scale of 1 (could not be worse) to 10 (could not be better). The figure shows that 19%

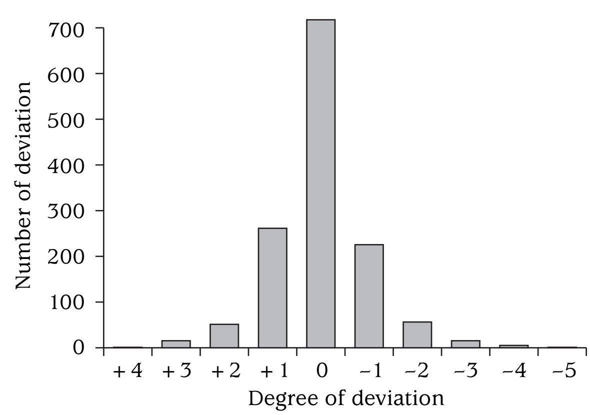

Fig. 2 Visual display of the distribution of the 1,330 possible deviations from the first profile rating. The degree of deviation is shown as the increase or decrease in ratings on the response scale of 1 (could not be any worse) to 10 (could not be any better).

and 17% of the ratings deviated by an increase of one point and a decrease of one point on the response scale, respectively.

Discussion

This study represented the first attempt to assess the reproducibility and precision of the performance-profile technique. A secondary objective of the study was to investigate the accommodation response to performance profiling. The results of separate repeated-measures one-way ANOVAs for each of the 10 profile qualities showed that no significant learning trends were observed across the three data collection occasions. These results suggested that the completion of four practice profiles that preceded data-acquisition was sufficient for performers to have adjusted to the technique. Furthermore, they suggested that intrasubject changes in performance profile scores across the three data collections could be attributed to human variability rather than to systematic learning effects. Therefore, the assessment of the number of intrasubject trials to achieve stable baseline measures could be made on reproducibility criteria alone (Gleeson & Mercer 1996).

It is fundamentally important that sports practitioners working with individual performers have a precise measure of the performer's perceived current condition to implement effective performance-enhancing interventions. In this study, the CV scores ranged between ± 4.7% and ± 6.8% for 68% confidence levels and between ± 9.2% and ± 13.3% for 95% confidence levels across the 10 profile qualities. These results have important implications for the estimation of perceived current condition based on a single trial. For example, the observed CV score of ± 9.6% (95% confidence levels) suggested that the practitioner can be 95% confident that the performer's true rating would have been located between the values 6.82 and 8.28 (7.55 ± 0.73) if the performer had been scoring at approximately the group mean score on Quality 1 (7.55). These results for probable error associated with single-trial assessment in a given individual raise concern about the efficacy of single-trial performance profiling in asymptomatic athletic populations. On some performance qualities, an asymptomatic athlete's performance may not be expected to vary by more than 5% during the competitive season (Doyle & Parfitt 1996; Gleeson & Mercer 1996), making it difficult to discriminate between error in measurement and real change. The group mean CV scores were used to quantify the number of intrasubject completions of the profile that would be required to obtain an arbitrary criterion measurement error of ± 5% (95% confidence levels). Results presented in Table 2 show that the mean score of 10 completions of the profile would be required to achieve a measurement precision of better than ± 5% (95% confidence levels) for intrasubject comparisons across all of the 10 profile qualities. The logistic demands that would be necessary to achieve proper discrimination of subtle but important performance changes in the perceived condition of the accomplished athlete may suggest that the performance profile offers a compromised practical efficacy in this respect.

It is interesting to note that CV estimates relate to the average group response, which does not fully reflect the heterogeneity in perceived ratings of some performers within the group. It would be expected that profile ratings at the extremes of the response scale, such as those performers approaching the optimal level (a profile rating of 10), may be subject to greater measurement error and require a larger number of replicates to achieve the criterion measurement error.

In summary, these results indicate that the performance-profile technique as used in contemporary practice has a limited capacity to discriminate changes in a performer's current condition, based on single-trial assessments. The results for CV suggest that, for applications in which small changes in perceived current condition are evident, it would be imperative to use a mean score associated with at least 10 completions of the profile as the basis for estimating performers' current condition, to reduce measurement error and enhance precision. A consequence of this finding for the practitioner is a tension between the need for greater confidence in the mean score from the completion of several profiles by a performer, on the one hand, and the potential intrusions from confounding effects such as reduced psychological commitment and/or logistic constraints as a result of the repeated completions on the other (Gleeson & Mercer 1992). The potential sources of interference associated with the 10 repeated completions of the profile by the asymptomatic athlete, as required for the practitioner to be confident of either eliciting a true measure of the performer's current condition or detecting changes to that state, may present a substantial threat to the meaningful use of the technique. However, the technique would be expected to offer greater practical utility for guiding conditioning interventions in other populations, in which larger changes in current condition would be expected. For example, the latter may include athletes during rehabilitation, following injury in whom changes in performance and perceived capability would be expected to vary substantially.

The rationale for the use of the performance-profile technique to aid performer involvement in the decision-making process toward preparation for performance has compelling justification. Nevertheless, concerns about measurement error associated with the conventional profile technique suggest that it might offer only limited efficacy. Furthermore, measurement error associated with a single completion of the performance profile suggests that its efficacy may be similarly compromised in any potential use to identify subtle changes in self-perceived performance that might act as prognostic markers of injury.

Therefore, the extent to which the performance-profile technique is limited is probably specific to the population for which the profile is used. The results of this study suggest that the conventional technique may be most effective when used for populations in which considerable changes in current state and performance could be expected, such as performers involved in the rehabilitation process following a sports-related injury. In this scenario, the performance profile may prove to be a useful adjunct in the process of optimizing and individualizing conditioning interventions.

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